

WBGU

German Advisory Council on Global Change

Flagship Report

Healthy living on a healthy planet





German Advisory Council on Global Change

Healthy living on a healthy planet

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WBGU

German Advisory Council on Global Change

**Healthy living
on a healthy planet**

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Copy deadline: 17.03.2023

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This report should be cited as: WBGU – German Advisory Council on Global Change (2023): Healthy living on a healthy planet. Berlin: WBGU.

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Bibliographic information published by the Deutsche Nationalbibliothek
The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie;
detailed bibliographic data are available on the Internet at <http://dnb.d-nb.de>.

ISBN 978-3-946830-08-5
© WBGU Berlin 2023
Translation: Bob Culverhouse, Berlin

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The R&D project that generated this report was conducted on behalf of the German Federal Ministry of Education and Research and the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection under grant number 13N0708A5. Responsibility for the content of this publication rests with the author.

Designed by: WERNERWERKE GbR, Berlin
Cover photo: Ratnakorn Piyasirisorst

Produced by: WBGU
Typesetting: WERNERWERKE GbR, WBGU
Printed and bound by Bonifatius GmbH, Paderborn



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Acknowledgements

The WBGU would like to thank all external experts for their input and valuable assistance. Specifically, the following expert reports and statements were integrated into this report and are available on the WBGU website:

- › Dr Annika Baumann, Dr Antonia Köster, Prof Dr Hanna Krasnova, Dr André Ullrich (all at the Weizenbaum Institute for the Networked Society): Sustainable Digitalization: At the intersection of digital well-being, health, and environment, 2022.
- › Dr Sabine Baunach (international health consultant): Transformative Health Systems, 2023.
- › Beatrice Dippel (German Institute of Development and Sustainability – IDOS): boxes ‘Singapore’ and ‘Traditional Knowledge Systems’, 2022.
- › Dr Andreas Mandler (Rural Indicators Lab, Florence): Knowledge transfer in the context of advisory systems, 2022.
- › Dr Franziska Matthies-Wiesler (Helmholtz Munich): Background paper on environment and health, 2021; Analysis on research programmes, 2022.

As a technical introduction to the topic, the WBGU received valuable input at the expert hearing with Prof Sir Andy Haines (London School of Hygiene & Tropical Medicine) and Dr Martin Herrmann (German Alliance for Climate Change and Health – KLUG) held on 18 February 2021.

On 18 March 2021, the WBGU was given highly interesting insights into the thematic fields of the work of Dr Ramon Lorenzo Luis Rosa Guinto (St. Luke’s Medical Center College of Medicine, Manila) and Dr Nicole de Paula (Institute for Advanced Sustainability Studies – IASS).

During the expert hearing on 22 April 2021, the WBGU had the opportunity to exchange views with Prof Dr August Stich (Medical Mission Institute).

During a hearing on 18 June 2021, the WBGU was given important insights into the thematic fields of the experts Dr Kirsten Kappert-Gonther (Member of the Bundestag, Alliance 90/The Greens) and Prof Dr Katharina Stärk (Federal Food Safety and Veterinary Office, Bern).

The WBGU received further valuable information on 17 March 2022 at the lecture entitled ‘Financing Global Public Goods’ by Dr Christoph Benn (Joep Lange Institute, Geneva).

Another important hearing with the WBGU took place on 7 May 2022 with Prof Dr Thomas Mettenleiter (Friedrich-Loeffler-Institut – FLI).

Thanks are also due to the experts who made valuable contributions to the success of the WBGU webinar ‘Planetary Health: How do we want to shape our future?’: Dr Catharina Boehme (World Health Organization – WHO); Prof Dr Aletta Bonn (German Centre for Integrative Biodiversity Research – iDiv, Helmholtz-Centre for Environmental Research – UFZ); Dr Lilian Busse (German Environment Agency – UBA); Prof Dr Claudia Hornberg (Medical School OWL Bielefeld University, German Advisory Council on the Environment); Dr Anna-Babette Stier (Federal Ministry of Health) and the moderator Maike Voss (German Alliance for Climate Change and Health – KLUG).

On 16 February 2022, a virtual discussion of experts was held on the topic of ‘Planetary Health’ with representatives of the research community. Our thanks for important content input go to: Prof Dr Tanja Bogusz (Center for Sustainable Society Research, Faculty of Economics and Social Sciences at Universität Hamburg); Prof Dr Clara Brandi (German Institute of Development and Sustainability – IDOS and University of Bonn); Prof Dr Walter Bruchhausen (Institute for Hygiene and Public Health, University Hospital Bonn); Prof Dr Philipp Dann (Faculty of Law, Humboldt University Berlin); Prof Dr Michael Flitner (artec Sustainability Research Center at the University of Bremen); Prof Dr Wencke Gwozdz (Department of Consumer Research, Communication and Food Sociology, Justus Liebig University Giessen); Prof Dr Johanna Hanefeld (Centre for International Health Protection at the Robert Koch Institute, Berlin); Prof Dr Claudia Hornberg (Medical School OWL Bielefeld University, German Advisory Council on the Environment); Prof Dr Ilona Kickbusch (Global Health Centre at the Graduate Institute of International and Development Studies, Geneva); Prof Dr Stephan Pauleit (Chair for Strategic Landscape Planning and Management, Technical University of Munich).

An international (virtual) stakeholder workshop with the WBGU was held on 3 May 2022. We would like to thank the two invited experts for their expertise and many fascinating insights into their fields of work: Dr Tilly Alcayna (Red Cross Red Crescent Climate Centre); Dr Maria S. Guevara (Médecins Sans Frontières/Doctors Without Borders).

Furthermore, the WBGU wishes to thank all those who provided valuable support through discussions, comments, contributions, advice, research, and peer reviews of individual parts of this report: Prof Dr Dr Christian Apfelbacher (Otto von Guericke University Magdeburg); Max-Otto Baumann (German Institute of Development and Sustainability – IDOS); Katja Becken (German Environment Agency – UBA); Dr Kathrin Berensmann (German Institute of Development and Sustainability – IDOS); Dr Axel Berger (German Institute of Development and Sustainability – IDOS); Prof Dr Clara Brandi (German Institute of Development and Sustainability – IDOS); Dr Michael Brüntrup (German Institute of Development and Sustainability – IDOS); Prof Dr Jens Bucksch (Heidelberg University of Education); André Conrad (German Environment Agency – UBA); Dr Ines Dombrowsky (German Institute of Development and Sustainability – IDOS); Miriam Dross (German Environment Agency – UBA); Thomas Ebert (German Environment Agency – UBA); Lydie Fialova, PhD; Prof Dr Christian Flachsland (Centre for Sustainability, Hertie School); Kilian Frey (German Environment Agency – UBA); Helene Fröhlich (Potsdam Institute for Climate Impact Research – PIK); Sophie Gepp (Centre for Planetary Health Policy – CPHP); Prof Dr Dr Thomas Gerlinger (School of Public Health, Bielefeld University); Johann Friedrich Glawe (Chair of Public Law, esp. Administrative and Environmental Law, University of Greifswald); Dr Hannah Janetschek (German Council for Sustainable Development – RNE); Dr Niels Keijzer (German Institute of Development and Sustainability – IDOS); Prof Dr Ilona Kickbusch (Global Health Centre at the Graduate Institute of International and Development Studies, Geneva); Christian Kitazume (German Environment Agency – UBA); Anja Klauk (German Environment Agency – UBA); Sara Klinkebiel (BKK Dachverband); Adolf Kloke-Lesch (German Institute of Development and Sustainability – IDOS); Martin König (BKK Dachverband); Dr Marcel Langner (German Environment Agency – UBA); Prof Dr Dr Michael Leitzmann (Chair for Epidemiology and Preventive Medicine, Regensburg University Medical Center); Lilly Leppmeier (Ludwig-Maximilians-Universität München – LMU); Okka Lou Mathis (German Institute of Development and Sustainability – IDOS); Tobias Necke (Fraunhofer Institute for Materials Recycling and Resource Strategy IWKS); Hannah Otto; Dr Lisa Pörtner (Institute of Public Health

at Charité-Universitätsmedizin Berlin); adjunct Prof Dr Wilm Quentin (Department of Health Care Management, Institute of Technology and Management, Technische Universität Berlin); Prof Dr Eva Annette Rehfuss (Chair of Public Health and Health Services Research, Ludwig-Maximilians-Universität München – LMU); Prof Dr Gabi Reinmann (Hamburg Centre for University Teaching and Learning – HUL); Dr Elisabeth Schmid (German Advisory Council on the Environment); Prof Dr Sven Schneider (Medical Faculty Mannheim, Heidelberg University); Dr Julia Schröder (BKK Dachverband); Dr Christoph Schulte (German Environment Agency – UBA); Christian Schulz (German Alliance for Climate Change and Health – KLUG); Dr Anke Siebeneich (BKK Dachverband); Prof Dr Ute Stoltenberg (Faculty of Sustainability, Leuphana University Lüneburg); Dr Christoph Strupat (German Institute of Development and Sustainability – IDOS); Katharina Thiede (German Alliance for Climate Change and Health – KLUG); Lars Tietjen (German Environment Agency); Lena Vierke, PhD (German Environment Agency); Prof Dr Ulrich Volz (German Institute of Development and Sustainability – IDOS); Maike Voss (German Alliance for Climate Change and Health – KLUG); Katharina Wabnitz (Centre for Planetary Health Policy – CPHP); Ronja Wagner-Wenz (Fraunhofer Research Institution for Materials Recycling and Resource Strategies – IWKS); Alma Wisskirchen (German Institute of Development and Sustainability – IDOS).

Contents

Council Staff	V
Acknowledgments	VI
Contents	IX
Boxes	XVII
Tables	XIX
Figures	XX
Acronyms and Abbreviations	XXII
Summary	1
1 Introduction	11
2 Health – a systemic view	15
2.1 Evolutionary-biological and historical context	16
2.1.1 Industrial Revolution and the Enlightenment	17
2.1.2 Multiple modernities and new challenges	20
2.2 Human health: significant improvements, setbacks and new threats	24
2.2.1 Key problems of human health: which diseases cause the greatest burdens	25
2.2.2 Non-communicable diseases on the increase	25
2.2.2.1 Burden of disease, deaths and costs caused by non-communicable diseases	26
2.2.2.2 Risk factors for non-communicable diseases	29
2.2.3 Infectious diseases: old successes and new challenges	30
2.2.3.1 COVID-19 pandemic: harbinger of an age of pandemics?	30
2.2.3.2 Maternal and child health: existing inequalities and positive trends	32
2.2.3.3 HIV/AIDS, malaria and tuberculosis: socio-economic differences are jeopardizing successes	32
2.2.3.4 Neglected and poverty-associated tropical diseases: lack of attention despite high prevalence	33
2.2.3.5 Resistance to antimicrobial agents: a serious threat to health	33
2.2.4 Quality of life as a new indicator for healthy societies	33
2.2.5 Social, cultural, economic and ecological determinants of human health	34
2.2.6 Trends in determinants of human health	36
2.2.7 Syndemic times: numerous global health crises are converging	38
2.3 Global environmental changes and the health of humans and ecosystems: status quo and trends	38
2.3.1 Climate change, biodiversity loss and environmental pollution as drivers of health risks for ecosystems and humans	39
2.3.2 (Extreme) heat: it is getting too hot for people, animals and plants	43
2.3.3 Droughts	48
2.3.4 Storms: cyclones are becoming more intensive	49
2.3.5 Flooding due to extreme precipitation and sea-level rise	49
2.3.6 Environmental pollution: plastic is only one of the problems	50

2.4	Global governance for the protection of the environment and human health	51
2.4.1	Emergence of international negotiating spaces on environmental and health issues	51
2.4.2	Interfaces of multilateral environmental and health governance	53
2.4.3	Environmental and health governance in the global actor network	55
2.4.4	Implementation deficits	55
2.5	Health in times of multiple crises: five observations	56
3	The vision of “healthy living on a healthy planet”	59
3.1	Five cornerstones for the vision of ‘healthy living on a healthy planet’	60
3.2	Normative principles	61
3.2.1	The WBGU’s normative compass	61
3.2.2	Normative aspects in policy objectives	67
3.3	Existing integrative concepts for the health of humans and nature	68
3.3.1	Urban characteristics	69
3.3.2	Core elements of the most important concepts	69
3.3.2.1	One Health	69
3.3.2.2	Planetary Health	70
3.3.3	Significance for the WBGU’s vision	72
3.4	From vision to action	72
4	Shaping areas of life: what we eat, how we move, where we live	75
4.1	Ways to a healthy diet – for everyone	79
4.1.1	Current food systems: from scarcity to abundance, from diversity to imbalance	79
4.1.1.1	Malnutrition: trends and health impacts	79
4.1.1.2	Food production causes – and is affected by – global environmental changes	83
4.1.1.3	Food security, food sovereignty and food safety	87
4.1.2	Vision of healthy, resilient and future-proof food systems	87
4.1.3	Food security, food sovereignty and food safety	88
4.1.3.1	Make healthy, nutrient-rich and diverse foods more attractive and better appreciated	88
4.1.3.2	Adapt guidelines and recommendations for healthy and sustainable nutrition	89
4.1.3.3	Lifelong education on healthy and sustainable nutrition in theory and practice	89
4.1.3.4	Awareness initiatives as a contribution to health-promoting consumer behaviour	91
4.1.3.5	Contribution of state actors to healthy, equitable and resilient food environments	91
4.1.3.6	Promote ecological production methods and local markets	92
4.1.3.7	Make agricultural production environment-friendly and resilient	93
4.1.3.8	Make fisheries and aquaculture environment-friendly and resilient	95
4.1.3.9	Take market and power concentration into account	95
4.1.4	Research recommendations	96
4.1.4.1	Intensify research on the health and environmental effects of sustainable nutrition	96
4.1.4.2	Intensify transdisciplinary research on the effectiveness of measures aimed at changing dietary habits	96
4.1.4.3	Study food labelling and its effects on consumer decision-making	97
4.1.4.4	Research on the concentration of power and its impact on the availability of healthy food	97

4.1.4.5	Research reform options for tax and subsidy systems	97
4.1.4.6	Research the up-scaling of sustainable production practices in agriculture.....	97
4.1.4.7	Increase resilience research in agriculture and fisheries	97
4.2	Activity-friendly environment, environment-friendly activity	99
4.2.1	The 'double mobility crisis': our mobility behaviour damages our health and the environment	99
4.2.1.1	Lack of exercise and prolonged sitting are on the rise worldwide	99
4.2.1.2	Health effects and costs of physical inactivity and prolonged sitting.....	101
4.2.1.3	Negative effects of motor traffic on the environment, the climate and health	101
4.2.1.4	Motorized traffic endangers active mobility.....	103
4.2.2	Three observations on physical activity and mobility.....	103
4.2.2.1	Humans are made to move, but repress this fact in their everyday lives. ..	103
4.2.2.2	General external conditions play a key role when it comes to physical activity and mobility behaviour	106
4.2.2.3	General external conditions play a key role when it comes to physical activity and mobility behaviour.....	107
4.2.3	Reintegration of physical activity into all areas of everyday life: vision and strategy	109
4.2.4	Overarching approaches for an activity-friendly environment and environment-friendly activity.....	111
4.2.4.1	Cross-cutting strategy for environment-friendly physical-activity promotion in all sectors and across levels of governance	111
4.2.4.2	Activity-friendly conditions for the mobility transition	114
4.2.4.3	Children as a design focus and indicator for green, safe spaces for physical activity and infrastructures for everyone	119
4.2.5	Recommendations for action	119
4.2.5.1	Reintegrate physical activity into all areas of everyday life and link it to climate-change mitigation and environmental protection	119
4.2.5.2	From transport policy to mobility policy: systemic strategies for a real mobility transition.....	121
4.2.5.3	Use children's and adolescents' need for movement and autonomy as a creative guideline in all areas of life	123
4.2.6	Recommendations for action	124
4.2.6.1	Patterns and determinants of physical activity, sedentary behaviour and mobility.....	124
4.2.6.2	Political processes and integrated structures of physical-activity promotion; assessments of interventions.....	124
4.2.6.3	Systemic mobility research on health effects and new services, as well as research on linkages with politics and economics.....	125
4.2.6.4	Local mobility concepts and means of transport; vehicle and transport technology	125
4.3	Housing in health-promoting and sustainable residential areas	129
4.3.1	Factors with a detrimental impact on health in the residential environment.....	130
4.3.1.1	Air pollution: one of the most important environmental health risks.....	130
4.3.1.2	Effects of noise on health	131
4.3.1.3	Health risks due to climate change in urban agglomerations.....	132
4.3.1.4	Health impacts of housing insecurity.....	134
4.3.2	Buildings and settlement infrastructures that are harmful to the environment and health	135
4.3.2.1	Concrete in buildings and infrastructures with significant impacts on health and the environment	135

4.3.2.2	Health risks due to inadequate water supply and waste-water disposal . . .	136
4.3.2.3	Energy supply as an urgent prerequisite for health	137
4.3.2.4	Health risks from inadequate waste management and waste disposal	137
4.3.3	Healthy and sustainable housing: characteristics and prerequisites	138
4.3.3.1	Healthy housing	138
4.3.3.2	Urban form of cities	139
4.3.3.3	Settlement and housing structures for healthy living: the 15-minute city, cities on a human scale and age-friendly city	139
4.3.3.4	Green and blue spaces: multiple benefits for the environment and human health	140
4.3.3.5	Prerequisites of urban and spatial planning oriented towards health promotion and sustainability	142
4.3.4	Recommendations for action	143
4.3.4.1	Planning and governance	144
4.3.4.2	Infrastructure and construction	145
4.3.5	Research recommendations	148
4.3.5.1	Planning and governance	149
4.3.5.2	Infrastructure and construction	150
5	Managing planetary risks: climate change, biodiversity loss, pollution	153
5.1	A stable climate and high biodiversity for healthy ecosystems and healthy people	153
5.1.1	An integrated approach to climate-change mitigation and biodiversity conservation	153
5.1.1.1	Overarching recommendations for both climate-change mitigation and biodiversity conservation	158
5.1.1.2	Research recommendations	159
5.1.2	Focus topics	159
5.1.2.1	Focus on fossil energy sources: stop exploration and extraction	159
5.1.2.2	Focus on zoonotic pandemics: promote prevention	162
5.1.2.3	Focus on habitat loss and new limits to habitability	166
5.2	Pollution: dealing with substances that endanger people and the environment	174
5.2.1	Pollution as a high-urgency challenge with insufficient control	175
5.2.1.1	Overview of types and extent of pollution	175
5.2.1.2	Internationally agreed guiding principles	176
5.2.1.3	Piecemeal governance of pollution	177
5.2.2	PFAS: a group of hazardous substances where action came too late	177
5.2.2.1	Areas of application and routes into the environment and the human body	177
5.2.2.2	Effects on the health of humans and the environment	179
5.2.2.3	Status quo: PFAS regulation full of deficits	180
5.2.2.4	Reform dimension of the EU's REACH Regulation: from phasing out individual substances to group bans with exemptions	182
5.2.2.5	Interim conclusion: from negative lists to common guiding principles and group-related prohibitions	182
5.2.3	Pharmaceuticals and pharmaceutical residues: comprehensive management in cycles is not possible	182
5.2.3.1	Pollution from pharmaceutical residues: a growing problem worldwide . . .	184
5.2.3.2	Effects on health and the environment	184
5.2.3.3	Governance of pharmaceuticals: challenges and deficits	184
5.2.3.4	Interim conclusion: Documentation and regulation of the environmental impact of pharmaceuticals is in its infancy	185
5.2.4	Recommendations for action	186
5.2.4.1	Establish zero pollution and the circular economy as guiding principles internationally	186

5.2.4.2	Implement prevention and precaution as guiding principles for action . . .	187
5.2.4.3	Equip new chemicals governance with an international registration regime	187
5.2.4.4	Set up an intergovernmental science-policy platform on pollution	188
5.2.4.5	Expand pharmaceutical regulation to include consideration of environmental aspects	188
5.2.5	Research recommendations	189
6	Harnessing the transformative potential of health systems	191
6.1	Description of health systems	191
6.1.1	Definition and tasks of health systems	191
6.1.2	Demands on health systems	192
6.1.2.1	Goal of the WHO: universal health coverage	192
6.1.2.2	Strategy of the WHO: primary health care	193
6.2	Health systems in the context of global environmental changes	193
6.2.1	New challenges for health systems	193
6.2.2	Three barriers impeding health systems worldwide in addressing environmental challenges	194
6.2.2.1	Curative focus of health services	194
6.2.2.2	Lack of preparation for global environmental changes	195
6.2.2.3	Large ecological footprint of health systems	196
6.3	Vision for the further development of health systems	197
6.3.1	Acknowledging the importance of healthy ecosystems	197
6.3.2	Environmentally sensitive prevention and health promotion	197
6.3.3	Solidarity and inclusion	200
6.3.4	Transformations towards sustainability	200
6.3.5	Strengthening adaptation and resilience	201
6.3.6	From vision to implementation – from guiding principles to recommendations	202
6.4	Use health promotion and disease prevention as transformative levers	202
6.4.1	Multiple benefits of environmentally sensitive prevention and health promotion . . .	203
6.4.1.1	Promoting healthy and sustainable lifestyles	203
6.4.1.2	Initiation of measures for structural prevention	205
6.4.1.3	Reducing vulnerability and strengthening adaptation and resilience in the population	206
6.4.1.4	Reducing the demand for resource-intensive treatments	206
6.4.2	Strategies for generating multiple benefits	206
6.4.2.1	Adapt the primary health care approach in a targeted way	206
6.4.2.2	Enable health professionals to promote healthy and sustainable lifestyles	208
6.4.2.3	Adapt remuneration systems and expand cost-benefit analyses	210
6.4.2.4	Expand public health departments and equip them for structural prevention	211
6.5	Create sustainability and resilience – initiate transformations	211
6.5.1	Be prepared for environmental changes and health crises	211
6.5.1.1	Resilience of health systems to all anthropogenic environmental changes	211
6.5.1.2	Fields of action in health systems	212
6.5.1.3	Opportunities for low- and middle-income countries	213
6.5.2	Reduce overuse and improve sustainability	213
6.5.2.1	Avoid unnecessary medical measures	213
6.5.2.2	Reduce resource consumption and emissions	215
6.5.2.3	Use opportunities to initiate transformations	216

6.6	Recommendations for action and research	217
6.6.1	Recommendations for action	217
6.6.1.1	Acknowledge the importance of environmental changes and healthy ecosystems	217
6.6.1.2	Promote healthy and sustainable lifestyles and living conditions	217
6.6.1.3	Strengthen public health departments and use their potential	219
6.6.1.4	Implement targeted adaptation and resilience strategies	221
6.6.1.5	Improve sustainability in health systems	222
6.6.2	Research recommendations	223
6.6.2.1	Interactions between environmental changes, ecosystems, health and health systems	223
6.6.2.2	Prerequisites for transformations in health systems	223
6.6.2.3	Effectiveness and multiple benefits of environmentally sensitive prevention and health promotion	224
6.6.2.4	Measures, instruments and data for strengthening sustainability and environmental resilience	224
7	Global urgency governance	227
7.1	Principles of urgency governance for ‘healthy living on a healthy planet’	228
7.1.1	2030 Agenda and SDGs as an orientation framework and mandate for action	229
7.1.1.1	Implementation and further development of the 2030 Agenda as a unifying project of international politics	229
7.1.1.2	Health and environment as an integrative focus	233
7.1.2	Guiding principle and instrument for implementation: the human right to a healthy environment	234
7.1.2.1	Need for legally binding recognition	236
7.1.2.2	Content of the human right to a healthy environment	237
7.1.2.3	Enforcement requirements	238
7.1.2.4	Conclusions	239
7.1.3	Cooperative assumption of responsibility	240
7.1.3.1	Cooperative assumption of responsibility between countries	240
7.1.3.2	Cooperative assumption of responsibility across policy fields	241
7.1.3.3	Cooperative assumption of responsibility by non-state actors	243
7.1.4	Political, economic and intellectual leadership	243
7.1.5	Urgency governance as a mandate for Germany’s Federal Government	246
7.1.6	Recommendations for action	246
7.1.7	Research recommendations	248
7.2	WHO: international cooperation for ‘healthy living on a healthy planet’	249
7.2.1	Integrate the vision of ‘healthy living on a healthy planet’ in the WHO	250
7.2.2	Take advantage of the window of opportunity offered by the pandemic treaty	251
7.2.2.1	Elements of international cooperation on pandemics	252
7.2.2.2	Design of institutions	254
7.2.2.3	Outlook	256
7.2.3	Recommendations for action and research	256
7.3	From exclusive clubs to inclusive alliances: G7, G20 and multi-stakeholder alliances	257
7.3.1	Transformative potential of club governance: G7 and G20	257
7.3.2	Limits of club governance: G7 and G20	259
7.3.3	Advantages of ‘alliances’ over ‘clubs’: examples of health and climate alliances	259
7.3.4	Recommendations for action	261

7.4	European Union: moving towards an environmental and health union?	261
7.4.1	Health-policy competences and relevant EU policy areas	262
7.4.2	Non-communicable diseases as a field of action	262
7.4.3	Communicable diseases and cross-border health risks: the European Health Union	263
7.4.4	EU's external and international stimuli and initiatives	264
7.4.5	Recommendations for action	267
7.4.6	Research recommendations	268
7.5	International funding: overcome barriers	268
7.5.1	Debt swaps: reduce debt burdens, strengthen environmental and health protection	269
7.5.2	International Finance Facility for Immunisation as a model for climate finance	270
7.5.3	Mobilize private capital: identify instruments	271
7.5.4	Recommendations for action	271
7.5.5	Research recommendations	272
7.6	Corporate responsibility: from voluntary commitments to legal due-diligence obligations	272
7.6.1	Corporate social responsibility: voluntary commitment and reporting	273
7.6.2	Demand corporate responsibility in the supply chain through ambitious legal due-diligence obligations	275
7.6.3	Sustainable finance: levers for corporate sustainability	278
7.6.4	Recommendations for action	279
7.6.5	Recommendations for action	280
8	Education and Science	283
8.1	Education according to the guiding principle of 'healthy living on a healthy planet'	284
8.1.1	Education for sustainable development through lifelong learning: the status quo	285
8.1.2	Health professionals as multipliers: concepts and initiatives	289
8.1.3	Vision: from education on 'healthy living on a healthy planet' to comprehensive Planetary Health literacy	292
8.1.4	Recommendations for action and research: educational strategy in the sense of the guiding principle of 'healthy living on a healthy planet'	292
8.1.4.1	Recommendations for action for a nationwide education strategy in the sense of the guiding principle of 'healthy living on a healthy planet'	293
8.1.4.2	Recommendations for action focusing on health professionals as multipliers for the vision of 'healthy living on a healthy planet'	296
8.1.4.3	Research recommendations	296
8.2	Science and science funding	297
8.2.1	Financial structure: globally, European Union and Germany	298
8.2.2	Scientific practice: disciplines and types of science	301
8.2.3	Output: knowledge products and basis for action	303
8.2.4	Vision: partnership-based science that unleashes transformative potential to address environmental and health risks	306
8.2.5	Recommendations for action	306
8.2.6	Science in the spirit of the guiding principle of 'healthy living on a healthy planet'	309

Contents

Overview of the recommendations **310**

- Shaping areas of life: what we eat, how we move, where we live..... 310
- Managing planetary risks: climate change, biodiversity loss, pollution 321
- Harnessing the transformative potential of health systems 326
- Global urgency governance 329
- Education and science 334

References..... **339**

Glossary **401**

Boxes

Box 2.1-1	History of the German healthcare system as an example of the emergence of solidarity-based safeguards	20
Box 2.1-2	Interdisciplinary concepts of health: from public health to global health.	21
Box 2.1-3	Modernity in the nexus of science and technology	22
Box 2.1-4	Dimensions of modernity	23
Box 2.1-5	The guiding principle of sustainable development emerges	23
Box 2.2-1	Importance and calculation of the (global) burden of disease.	27
Box 2.3-1	Risks and planetary guard rails – how much is too much?	40
Box 2.3-2	Emerging and redistributed diseases: consequence of climate change, globalization and pollution	42
Box 2.3-3	Children as an example of a vulnerable population group	46
Box 3.1-1	Prevention and promotion as complementary perspectives: ward off dangers, create healthy living environments full of opportunities.	62
Box 3.2-1	The value of nature for health and the intrinsic value of nature	65
Box 3.2-2	Intertemporal safeguarding of freedom by preserving and shaping freedoms and spaces for Eigenart.	66
Box 3.2-3	Health promotion and well-being as guiding principles for health policy: from the Ottawa Charter for Health Promotion (1986) to the WHO Geneva Charter for Well-being (2021).	68
Box 3.3-1	Definitions and descriptions of One Health	70
Box 3.3-2	Definitions and descriptions of Planetary Health.	71
Box 3.3-3	Further integrative and transdisciplinary health concepts	71
Box 4.1-1	What does a healthy and ecologically sustainable diet look like?	80
Box 4.1-2	Nutrition and food environments in the first 1,000 days of life n	82
Box 4.1-3	The need to move away from diets heavy in animal food products	84
Box 4.1-4	Advertising for healthy and sustainable lifestyles	90
Box 4.1-5	Tobacco and alcohol in the context of the 'healthy living on a healthy planet' vision	93
Box 4.1-6	Microbiomes: microorganisms as allies.	94
Box 4.2-1	The WHO's global recommendations on physical activity, sedentary behaviour and sleep	100
Box 4.2-2	Interactions between short-distance, long-distance and freight traffic	102
Box 4.2-3	Need to take action in sport in times of climate change.	106
Box 4.2-4	Effects of digitalization on physical activity patterns	108
Box 4.2-5	Children and screen media: green time and physical activity as a counter-balance to screen time.	110
Box 4.3-1	Noise pollution guidelines	132
Box 4.3-2	Healthy housing – the WHO's definition	139
Box 4.3-3	The importance of green and blue spaces for urban biodiversity and ecosystem services.	142
Box 4.3-4	The reform of Brazilian urban planning in 2001 as an example of planning for the common good.	143

Box 4.3-5	The WBGU's salutogenetic perspective	144
Box 4.3-6	Participatory negotiation of future plans: how Singapore deals with the impacts of climate change on health and housing quality	145
Box 5.1-1	Health for species and ecosystems must also be considered	155
Box 5.1-2	New limits to habitability because of climate change: topical examples	172
Box 5.2-1	International chemicals governance	179
Box 5.2-2	European chemicals legislation	181
Box 5.2-3	Exemptions for essential uses	183
Box 5.2-4	Medicines with a direct greenhouse effect	186
Box 6.2-1	Diversity of health systems worldwide	195
Box 6.2-2	Waste from health facilities	198
Box 6.4-1	Community health nurses	208
Box 6.4-2	Health-promoting hospitals	208
Box 6.4-3	Examples of health-promotion and disease-prevention measures in Germany	209
Box 6.4-4	Climate-sensitive health counselling	210
Box 6.5-1	Approaches for an improved provision, interlinking and use of environmental and health data in Germany	214
Box 7.1-1	Health protection and environmental protection: state of the international debate ...	230
Box 7.1-2	Environment and health in SDG transformation fields	232
Box 7.1-3	Developing the codification of a human right to a healthy environment	235
Box 7.1-4	Added value of a human right to a healthy environment for human-rights catalogues	236
Box 7.1-5	Health in All Policies	242
Box 7.1-6	Cooperative assumption of responsibility by national government departments – from negative to positive coordination	244
Box 7.1-7	Tri- and Quadripartite as prime examples of cooperation between UN organizations	245
Box 7.2-1	The WHO strategy on health, environment and climate change	250
Box 7.2-2	The International Health Regulations and their reform	251
Box 7.3-1	Clubs and alliances: definitions and examples from international climate and health policy	258
Box 7.4-1	The role of the EU in its Member States' health policies	263
Box 7.4-2	Guiding principles of the new EU Global Health Strategy	266
Box 7.6-1	Case study: environmental and health impacts of the economic use of lithium	274
Box 7.6-2	European supply-chain laws and the EU Commission's draft due-diligence directive	276
Box 7.6-3	Draft for a binding instrument under international law on the protection of human rights by business enterprises (3rd draft)	277
Box 7.6-4	Case study on lithium – extended corporate responsibility for circular economic activity	278
Box 8.1-1	Vocational education and training as a lever for the guiding principle of 'healthy living on a healthy planet'	287
Box 8.1-2	Agricultural consultants as agents of Planetary Health competence	288
Box 8.1-3	Twelve cross-cutting principles for teaching Planetary Health	290
Box 8.1-4	The 'Planetary Health Education Framework' – a starting point for further educational concepts aimed at implementing the guiding principle of 'healthy living on a healthy planet'	291
Box 8.1-5	Local knowledge: traditional medicine in Indonesia	294
Box 8.2-1	Current examples of ministerial research funding for the environment-health nexus in Germany	301

Tables

Table 2.2-1	Burden of disease (expressed in DALYs) and deaths attributable to individual disease groups and conditions per year.....	29
Table 2.2-2	Change in the global burden of disease (in DALYs) from 1990 to 2019 in percent.	29
Table 2.2-3	Number of DALYs and deaths attributable to individual risk factors for non-communicable diseases per year	30
Table 5.1-1	Example of a classification of indicators for assessing ecosystem health. The described biological, physicochemical and socio-economic indicators are proposed as the three main categories for assessing ecosystem health.....	156
Table 5.1-2	Zoonotic pathogens causing recent epidemics.....	164
Table 5.2-1	Proposed categorization of uses of harmful substances as non-essential, substitutable and essential. The essentiality should not be considered permanent; rather, constant pressure is needed to search for alternatives in order to move these uses into the category “Substitutable”	183
Table 8.2-1	Expenditure on research and development (R&D) in selected countries	300
Table 8.2-2	Contributors to global health inequalities research (1966–2015)	305

Figures

Figure 1	Healthy living on a healthy planet: three complementary approaches.....	3
Figure 2.1-1	Simplified representation of principles of climate effects.....	18
Figure 2.1-2	Global development of life expectancy, child mortality rate and maternal mortality ratio	19
Figure 2.2-1	Burden of disease of individual disease groups worldwide.....	25
Figure 2.2-2	Global burden of disease caused by various diseases over time.....	26
Figure 2.2-3	Calculation of the burden of disease (DALYs).	27
Figure 2.2-4	Burden of disease by country.....	28
Figure 2.2-5	Number of deaths worldwide by risk factor and gender	31
Figure 2.2-6	Quality of life by domain and Human Development Index.....	33
Figure 2.2-7	Determinants of health	34
Figure 2.2-8	CSDH framework of social determinants of health.....	35
Figure 2.2-9	National income and life expectancy	37
Figure 2.3-1	Concept of risk assessment and examples of regional key risks	41
Figure 2.3-2	Risks of climate change for health under three adaptation scenarios.....	42
Figure 2.3-3	Ecosystem services and their importance for health	44
Figure 2.3-4	Habitat losses of climatically suitable areas in terrestrial biodiversity hotspots.....	47
Figure 2.3-5	Projection of population density and extreme heat	48
Figure 2.4-1	UN governance of global health and global environmental change	52
Figure 3.1-1	Healthy living on a healthy planet: three complementary approaches	62
Figure 3.2-1	Normative compass of the WBGU	64
Figure 3.4-1	The vision “Healthy living on a healthy planet”	73
Figure 4.1-1	Healthy and sustainable diet according to the Planetary Health Diet	80
Figure 4.1-2	Deaths from non-communicable diseases by health-related risk factors.....	81
Figure 4.1-3	Examples of communication strategies that promote health and sustainability	90
Figure 4.2-1	WHO recommendations on physical activity and sedentary behaviour	100
Figure 4.2-2	Victims of road accidents worldwide	103
Figure 4.2-3	Stylized physical activity patterns: current / target situation and fields of action. ...	104
Figure 4.2-4	Factors influencing physical activity.....	107
Figure 4.2-5	Importance of different determinants as regards individual transport choices	109
Figure 4.2-6	Benefits of physical activity for health and well-being.....	112
Figure 4.2-7	Three requirements for healthy, environment- and climate-friendly transport systems and their possible implementation.....	115
Figure 4.3-1	Health risks due to housing and residential location	130
Figure 4.3-2	Average annual concentration of particulate matter (PM 2.5) in cities	131
Figure 4.3-3	Cities with high noise pollution (selection).....	133
Figure 4.3-4	Effects of noise on health	134
Figure 4.3-5	Heat as a health risk in urban agglomerations	134
Figure 4.3-6	Change in the ratio of residential property prices to income	135
Figure 4.3-7	Percentage of the urban population living in informal settlements by world region	136

Figure 4.3-8	Annual global consumption of building materials.....	136
Figure 4.3-9	Proportion of municipal solid waste that is collected, by world region	138
Figure 4.3-10	Walkability of service infrastructures.....	140
Figure 4.3-11	Benefits of green and blue spaces in residential areas.....	141
Figure 5.1-1	Methodology for deriving indicators and management responses to achieve both human and ecosystem health in parallel	157
Figure 5.1-2	The 'Fossil Fuel Production Gap'	160
Figure 5.1-3	Origins and anthropogenic drivers of emerging zoonotic diseases and pandemics ..	163
Figure 5.1-4	Prospective loss of habitat as climate change advances	168
Figure 5.1-5	Loss and damage due to climate change 2008–2020 (exemplary selection)	169
Figure 5.1-6	Internally displaced persons as a result of natural disasters and conflict	171
Figure 5.1-7	Multifunctional connected 'scapes	173
Figure 5.2-1	Overview of national chemicals legislation worldwide	178
Figure 5.2-2	The life cycle of PFAS from the extraction of the raw material to disposal and their continuance in the environment.....	180
Figure 5.2-3	Pathways of human and veterinary pharmaceuticals into the aquatic environment.	185
Figure 6.2-1	Waste volumes from the health sector by country and Environmental Performance Index	199
Figure 6.3-1	Climate resilience in healthcare facilities	201
Figure 6.4-1	Possible synergies between protecting and strengthening biodiversity and activities in contact with nature	204
Figure 7.1-1	Human right to a healthy environment in national constitutions or legislation.....	235
Figure 7.1-2	Experience of threats and attacks among NGOs working for human rights in the EU	239
Figure 7.1-3	Environmental activists killed in 2020 by country.....	239
Figure 7.5-1	Structure of the International Finance Facility for Immunisation	271
Figure 7.6-1	Effects of entrepreneurial action on environmental and health protection and climate-change mitigation.....	273
Figure 8.1-1	The five domains of the Planetary Health Education Framework	291
Figure 8.1-2	Planetary Health literacy – a model	293
Figure 8.2-1	Spending on research and development by country.....	298
Figure 8.2-2	Spending on research and development by country income groups.....	299
Figure 8.2-3	Development of public expenditure on research and development in selected countries.....	299
Figure 8.2-4	Volume of publications on new or emerging viruses by country income groups	303
Figure 8.2-5	One Health and Planetary Health research trends, topics and global distribution.....	304

Acronyms and Abbreviations

ACT-A	Access to COVID-19 Tools Accelerator Global initiative to accelerate the development, production and equitable access to COVID-19 tests, treatments and vaccines
ADONA	Ammonium 4,8-dioxa-3 H-perfluoronanoate
AGU	American Geophysical Union
AIDS	Acquired Immune Deficiency Syndrome
AMR	Antimicrobial resistance
BfR	Bundesamt für Risikobewertung <i>German Federal Institute for Risk Assessment</i>
BLE	Bundesanstalt für Landwirtschaft und Ernährung <i>German Federal Agency of Agriculture and Food</i>
BMAS	Bundesministerium für Arbeit und Soziales <i>German Federal Ministry of Labour and Social Affairs</i>
BMBF	Bundesministerium für Bildung und Forschung <i>German Federal Ministry of Education and Research</i>
BMDV	Bundesministerium für Digitales und Verkehr <i>German Federal Ministry for Digital and Transport</i>
BMEL	Bundesministerium für Ernährung und Landwirtschaft <i>German Federal Ministry of Food and Agriculture</i>
BMFSFJ	Bundesministerium für Familie, Senioren, Frauen und Jugend <i>German Federal Ministry for Family Affairs, Senior Citizens, Women and Youth</i>
BMG	Bundesministerium für Gesundheit <i>German Federal Ministry of Health</i>
BMI	Body-Mass-Index
BMUV	Bundesministerium für Umwelt, Naturschutz, nukleare Sicherheit und Verbraucherschutz <i>German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection</i>
BMWSB	Bundesministerium für Wohnen, Stadtentwicklung und Bauwesen <i>German Federal Ministry for Housing, Urban Development and Building</i>
BMZ	Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung <i>German Federal Ministry for Economic Cooperation and Development</i>
BNatSchG	Bundesnaturschutzgesetz <i>German Federal Nature Conservation Act</i>
BOGA	Beyond Oil and Gas Alliance
BUND	Bund für Umwelt und Naturschutz Deutschland <i>German Federation for the Environment and Nature Conservation</i>
BZgA	Bundeszentrale für gesundheitliche Aufklärung <i>Federal Centre for Health Education</i>
CBD	Convention on Biological Diversity
CBDR-RC	Common but differentiated responsibilities and respective capabilities
CCS	Carbon Capture and Storage

CEPI	Coalition for Epidemic Preparedness Innovations
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CLP	Classification, Labelling and Packaging
CO	Carbon monoxide
CO ₂	Carbon dioxide
COP	Conference of the Parties
COPLANT	COhort on PLANT-based Diets <i>Study on plant-based diets in German-speaking countries</i>
COVAX	COVID-19 Vaccines Global Access
CSDH	Commission on Social Determinants on Health
DALYs	Disability-adjusted life years <i>A measure of burden of disease</i>
DFG	Deutsche Forschungsgemeinschaft <i>German Research Foundation</i>
DGE	Deutsche Gesellschaft für Ernährung <i>German Nutrition Society</i>
DIN	Deutsches Institut für Normung <i>German Institute for Standardization</i>
E-MOTION ^{kids}	Cross-cutting strategy for the promotion of physical activity, suggested by the WBGU
EFSA	European Food Safety Authority
EC	European Community
EIB	European Investment Bank
EMA	European Medicines Agency
EnDev	Energising Development
EOL	End of life
ESG	Environmental, social and governance
ESRS	European Sustainability Reporting Standards
EQS	Environmental Quality Standards
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
HCFC	Hydrochlorofluorocarbon
G7	Group of Seven (Germany, France, Italy, Japan, Canada, United Kingdom, United States of America)
G20	Group of Twenty (industrialized countries of the G7, emerging economies of the O-5, EU)
GAPPA	Global Action Plan on Physical Activity 2018–2030
GATT	General Agreement on Tariffs and Trade
Gavi	Global Alliance for Vaccines and Immunization
GCF	Green Climate Fund
GDP	Gross domestic product
GEF	Global Environmental Facility

Acronyms

GenX	substance that belongs to the so-called „forever chemicals“, which are practically not degraded; classified by the EU as a “substance of very high concern”
GG	Grundgesetz <i>German Basic Law</i>
GHG	Greenhouse gases
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit <i>German agency for development cooperation</i>
GPI	Global Public Investment
Gt	Gigaton
HDB	Housing and Development Board <i>Public authority in charge of public housing in Singapore</i>
HDI	Human Development Index
HERA	European Health Emergency Response Authority
HiAP	Health in All Policies
HIV	Human immunodeficiency virus
ICCPR	International Covenant on Civil and Political Rights
ICESCR	International Covenant on Economic, Social and Cultural Rights
IFAD	International Fund for Agricultural Development
IFFIm	International Finance Facility for Immunisation
IHR	International Health Regulations
ILO	International Labour Organization
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
ITF	Impact Taskforce
IMF	International Monetary Fund
KLUG	Deutsche Allianz Klimawandel und Gesundheit <i>German alliance for climate change and health (own translation)</i>
LDCs	Least Developed Countries
LDL	Low Density Lipoprotein
LGBTQI+	Lesbian, gay, bi, trans, queer and intersex, the “+” represents other sexual identities
LMICs	Low- and middle-income countries
LNG	Liquefied natural gas
MERS-CoV	Middle East respiratory syndrome-related coronavirus
N ₂ O	Dinitrogen oxide
NAKO	NAKO Gesundheitsstudie (formerly “Nationale Kohorte”) <i>Long-term health study on widespread diseases in Germany, with a very large number of participants</i>
NDCs	Nationally determined contributions
NFDI	Nationale Forschungsdateninfrastruktur <i>German National Research Data Infrastructure</i>
NGO	Non-governmental organization
NHS	National Health Service
NO _x	Nitrogen oxide
NTDs	Neglected tropical diseases
ODA	Official Development Assistance
OECD	Organisation for Economic Co-operation and Development
OIE	World Organisation for Animal Health (now: WOAH, founded as OIE)
PBT	Chemical substance that is persistent (P), bioaccumulative (B) and toxic (T)
PFAS	Per- and polyfluoroalkylated substances
PFHxS	Perfluorohexanesulfonic acid
PFNA	Perfluorononanoic acid
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid

PHA	Planetary Health Alliance
PHC	Primary Health Care
PM	Particulate matter
PMT	Chemical substance that is persistent (P), mobile (M) and toxic (T)
POP	Persistent organic pollutants
PPR	Pandemic prevention, preparedness and response
PRI	Principles for Responsible Investment
PTFE	Polytetrafluoroethylene
PHS	Public Health Services
R&D	Research and Development
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
rescEU	Programme for strengthening European civil protection and preparedness for disasters
RKI	Robert-Koch-Institute
SAICM	Strategic Approach to International Chemicals Management
SARS	Severe acute respiratory syndrome
SARS-CoV 1 and 2	Severe acute respiratory syndrome coronavirus 1 and 2 <i>Viruses from the coronavirus family that cause SARS and COVID-19</i>
SDGs	Sustainable Development Goals (UN)
SDSN	Sustainable Development Solutions Network
SGB	Sozialgesetzbuch <i>Social security code</i>
SO ₂	Sulphur dioxide
SVR	Sachverständigenrat zur Begutachtung der Entwicklung im Gesundheitswesen und in der Pflege <i>Advisory Council on the Assessment of Developments in the Health Care System</i>
TFEU	Treaty on the Functioning of the European Union
THE PEP	Transport, Health, Environment Pan-European-Programme
TWI	Tolerable weekly intake
UBA	Umweltbundesamt <i>German Environment Agency</i>
UCL	University College London
UDHR	Universal Declaration of Human Rights
UHC	Universal Health Coverage
UN	United Nations
UN Habitat	United Nations Human Settlements Programme;
UNCCD	United Nations Convention to Combat Desertification
UNCLOS	United Nations Convention on the Law of the Sea
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNEA	United Nations Environment Assembly
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNGA	General Assembly of the United Nations
UNICEF	United Nations Children's Fund
UPB	Umweltprobenbank des Bundes <i>German Environmental Specimen Bank</i>
Urban HEART	Urban Health Equity Assessment and Response Tool
V20	Vulnerable Twenty Group <i>Group of finance ministers from countries that are particularly vulnerable to climate change</i>
WBGU	Wissenschaftlicher Beirat der Bundesregierung Globale Umweltveränderungen <i>German Advisory Council on Global Change</i>

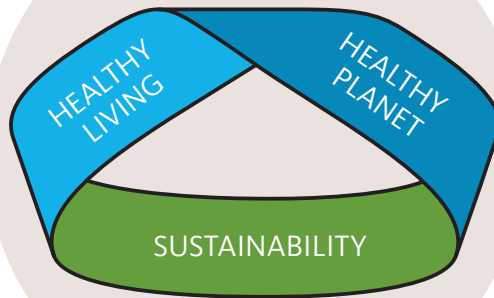
Acronyms

WHA	World Health Assembly
WHO	World Health Organization
WHOA	World Organisation for Animal Health
WTO	World Trade Organization
WWF	World Wide Fund for Nature

Prevention and resilience



People as part of nature



Inclusion instead of exclusivity



Planetary guard rails are respected



Cross-system cooperation

Summary

Our lifestyle is making us ill and is destroying the natural life-support systems. In the vision of 'healthy living on a healthy planet', human spheres of life – what we eat, how we move, where we live – are designed to be both healthy and environmentally compatible, and planetary risks – climate change, biodiversity loss, pollution – have been overcome. Health systems harness their transformative potential; education and science promote societal change. The vision can only be realized with international cooperation and requires what the WBGU terms global urgency governance.

Health is a precious asset and is of existential importance for every human being. It can never be taken for granted. However, our civilizational development does not automatically lead to ever better health; rather, we are well on the way to destroying the very preconditions of a healthy life for all people. This realization could generate enormous transformative power and give us the courage to change course.

The vision of healthy living on a healthy planet focuses on the inseparability of human health and nature, and thus on an extended understanding of health. The World Health Organization's comprehensive definition of human health as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" is dependent on a 'healthy' Earth – with functioning, resilient and productive ecosystems and a stable climate. In essence, the goal is to explore and implement development paths that do justice to people and nature. It is about healthy lifestyles that simultaneously protect nature – about what we eat, how we move and where we live. It is about framework conditions that make these lifestyles possible. It is about preserving natural life-sup-

port systems (halting climate change, biodiversity loss and global pollution), preparing our health systems for the challenges ahead and harnessing their transformative potential. It is about education and science that can make the vision of healthy living on a healthy planet a reality. And finally, it is about reaching an agreement on this guiding principle at the international level, because without international cooperation, this vision cannot be achieved.

Faced with global crises and short-term ad-hoc reactions, we currently risk losing sight of medium and long-term sustainability goals. More attention must therefore be paid to overcoming undesirable path dependencies – e.g. institutionally separate environmental and health-protection policies and fragmented political, administrative and legal systems – to ensure that long-term efforts to shape the future remain possible.

Prerequisites for a healthy life – five observations



As prosperity has increased in recent decades, human health has improved worldwide; yet not everyone has benefitted. Moreover, the prosperity gains themselves are increasingly having negative impacts on health: on the one hand from overeating, malnutrition and a lack of physical activity in everyday life, on the other as a result of their harmful side effects in the form of air pollution and environmental toxins. As a consequence, lifestyle diseases such as diabetes, cancer, cardiovascular and respiratory diseases as well as mental illnesses are on the increase; they are now the main causes of a loss of healthy life-years.

Last but not least, our resource-intensive way of life with its immense emissions of greenhouse gases, the destruction of natural habitats and increasing pollution on land and in the sea has led to a global environmental crisis that threatens the natural life-support systems and thus the health of all people. Heat waves, droughts, flood disasters and pandemics drastically show us how much humanity is dependent on functioning ecosystems and a stable climate. Furthermore, the global crisis could threaten the cohesion of our societies and overburden our health systems.

It is time to take a new look at civilizational progress. In what direction do we want to develop as human beings? What role do we as a species want to play on this planet in the future? How can we prevent the consequences of our actions from fundamentally endangering the foundations of a healthy life for us and for other species?

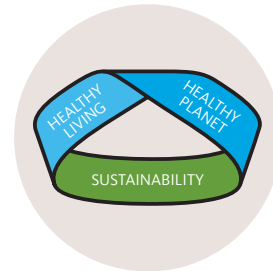
The WBGU's assessment can be summarized in the following five observations:

- We have not taken seriously enough the fact that human health is inseparable from the well-being of species and ecosystems.
- Halting climate change, biodiversity loss and globally increasing pollution is an indispensable prerequisite for making human health and the health of other living creatures and ecosystems possible.
- Combatting disease alone is not enough to maintain health in the medium and long term – preventive

healthcare, health promotion and the preservation of resilient ecosystems must be given a higher priority.

- Poverty and inequality make it impossible for many people to live a healthy life free from preventable diseases.
- Existing international cooperation structures cannot cope with the simultaneity and globality of the health and environmental crises.

Moving towards a healthy future



The WBGU counters these threatening future prospects with a vision of healthy living on a healthy planet, which can serve as an orientation for politics, business, science and civil society so that they can react systemically to the multiple crises described above. The vision can be outlined by five key points:

1. The inseparability of human civilization and nature finds its way back into public awareness.
2. Planetary guard rails are respected in order to protect the health of humans, species and ecosystems.
3. A reactive approach to diseases and environmental damage is complemented by more prevention and the comprehensive promotion of people's and nature's resilience and development potential (Figure 1).
4. Vulnerable groups receive solidarity worldwide, so that inclusion is guaranteed.
5. Cross-system cooperation promotes the vision of healthy living on a healthy planet.

The vision takes its orientation from the normative basis that the WBGU has developed in the form of a normative compass. The three dimensions of the compass are the preservation of natural life-support systems, the material, economic and political inclusion of all people, and the recognition of *Eigenart* (a German word meaning character, uniqueness) in the sense of valuing diversity and development possibilities. The linchpin is the inviolability of human dignity, which cannot be sufficiently respected without the three dimensions.

Integrative health concepts such as One Health and Planetary Health are very helpful for advancing the vision of healthy living on a healthy planet. These concepts have different priorities and disciplinary backgrounds,

Healthy living on a healthy planet: three complementary approaches

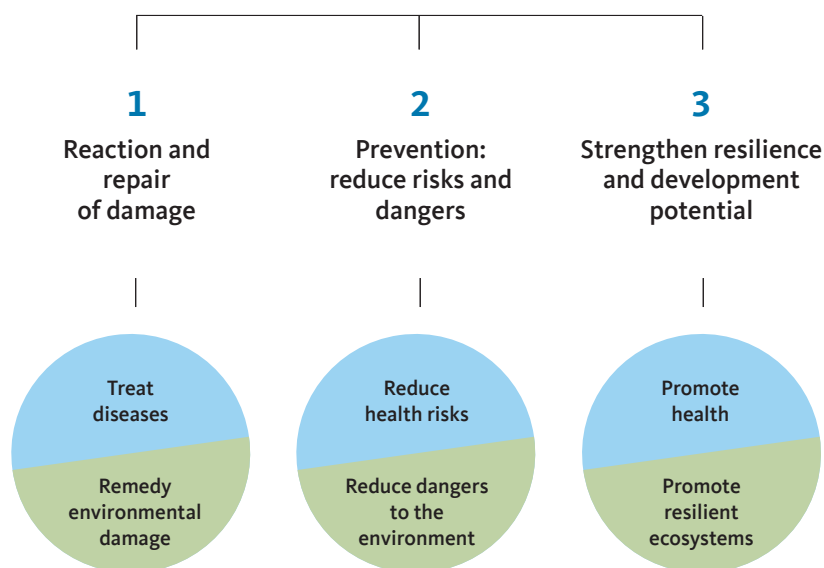


Figure 1
A reactive approach to diseases and environmental damage is complemented by more prevention and the comprehensive promotion of people's and nature's resilience and development potential.
Source: WBGU

and they should each be used depending on the context to make the most of their respective strengths.

The vision of healthy living on a healthy planet is transdisciplinary, values-based and application-oriented. At its core is the realization that human health and well-being today and in the future are only possible in interaction with a healthy natural environment, and that current developments are not sustainable. This implies that humans have a responsibility for all life, including the biosphere of the entire planet. Civilizational progress must therefore be critically reviewed: global, human-made processes such as digitalization, urbanization, defossilization and land-use changes should be brought into line with the vision of healthy living on a healthy planet. This simultaneously makes the vision a mandate for science: how might a living environment for the human species be specifically designed to facilitate the well-being and health of people and human societies as part of a thriving biosphere, and to preserve natural life-support systems in the long term? And finally, the vision contains the mandate for implementation – as a new ‘project for humanity’ that requires fundamental changes to current civilizational developments.

The vision of healthy living on a healthy planet fits in with the guiding principle of sustainability as already agreed in the context of the Rio Conventions, the Sustainable Development Goals, other international environmental treaties, and national environmental, sustainability and climate goals. However, its implementation leaves much to be desired. The attention being paid to

health – as a result of the COVID-19 pandemic, the increasingly evident impacts of climate change, biodiversity loss and environmental pollution, as well as growing warnings from the health disciplines, the Intergovernmental Panel on Climate Change (IPCC) and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) – therefore offers an opportunity to generate new momentum and support for solidarity-based transformations towards sustainability.

Firstly, transformations impact on people's personal lives and living conditions; changes can be envisaged here that are beneficial to individual health and simultaneously contribute to the conservation of natural life-support systems. For its global analysis, the WBGU has selected the examples of what we eat, how we move and where we live, as they concern elementary fields of human existence. Secondly, addressing planetary risks is more urgent than ever: climate change, ecosystem degradation and global pollution require accelerated, concerted and systemic action if we are to move away from our current path, which is destroying natural life-support systems. Parallel to this, a reconfiguration of health systems worldwide is necessary. They need to be equipped to deal with the simultaneously arising new and old health risks, while at the same time making their own contribution to sustaining natural life-support systems. Finally, the transformation requires focused education and science, as well as a form of global cross-system governance that meets the great global and critical challenges.

Global urgency governance



There is an urgent need for a form of global environmental and health governance that turns a healthy life on a healthy planet from a utopia into a realizable mission. Such a form of governance must be based on inclusive values that respect human dignity and a rules-based international order. The 2030 Agenda, the Paris Climate Agreement and the Kunming-Montreal Global Biodiversity Framework should serve as its orientation framework. There is also a need for globally coordinated, accelerating, long-term governance that responds to the urgent need for effective action. Global urgency governance, as recommended by the WBGU, is characterized by the following features:

1. interdepartmental, cross-scale and coherent policy-making based on systematic coordination processes between outward- and inward-facing policy fields and oriented towards the guiding principle of healthy living on a healthy planet;
2. forms of governance and process design that substantially accelerate transformation processes towards sustainability. Their features range from regulatory approaches, incentive structures and bureaucracy reduction to actor mobilization through involvement and inclusion;
3. a long-term, future-shaping perspective that is simultaneously radically effective in the short term. It is important to maintain room for manoeuvre in the medium to long term. At the same time, the dynamics arising from the interplay of interdependent global crises should be dealt with powerfully, with intelligent reflection and by democratic dispute.

There are no blueprints for such urgency governance. It should be developed locally, regionally and nationally according to the respective sustainability challenges, adjusted to the circumstances and designed to be adaptive – while always guided by the vision of healthy living on a healthy planet.

This involves:

- > strengthening and implementing the 2030 Agenda as a global orientation framework and a mandate for action;
- > integrating a human right to a healthy environment as a guiding principle and monitorable benchmark in national constitutions, especially in Germany's Basic Law and the EU Charter of Fundamental Rights, so that civil society can take the state to court to force it to take or stop certain actions;
- > establishing a cooperative assumption of responsibility oriented towards the guiding principle of 'Health in All Policies';
- > already making a start now to create arenas for discourse and actor structures to develop a post-2030 agenda for healthy living on a healthy planet.

In particular, Germany's Federal Government should assume political, economic and intellectual leadership in UN and EU forums, at the G7, G20 and multi-stakeholder alliances, and vis-à-vis businesses and civil society.

Within the UN, Germany should make use of the ongoing negotiations at the World Health Organization (WHO) on the Pandemic Treaty and the International Health Regulations to integrate a comprehensive understanding of pandemic prevention by means of nature conservation and climate protection and by strengthening health systems. It should also encourage interactions between different institutions: WHO, UN Food and Agriculture Organization (FAO), UN Environment Programme (UNEP) and World Organization for Animal Health (WOAH).

The EU should provide political leadership to boost links between environmental and health policies by taking concrete action to implement its high environmental and health standards, strengthening intra-European solidarity, EU-wide transparency and monitoring systems, and promoting partnerships.

The WBGU recommends that Germany should actively support global health policy at the G7 and G20 level and push for the establishment of a Planetary Health Task Force within the G7 negotiations. In addition, a contribution should be made to creating an Inter-Agency Global Health Standing Committee with the aim of coordinating global health organizations and alliances, their mandates and funding needs.

Companies must be given more incentives to assume responsibility for health and human rights beyond their immediate environment. An important contribution to this can be made by strengthening reporting and due-diligence obligations as well as sustainable finance, i.e. taking sustainability criteria into consideration when making investment decisions. These should be designed in such a way that people and the environment in all countries and societal groups benefit equally.

Harnessing the transformative potential of health systems



Many health systems around the world are not meeting the new challenges posed by global environmental change – because of their curative focus, which in some cases includes the overprovision of medical services, a lack of preparation for the new health risks, and a large ecological footprint. Yet health systems are key to protecting and improving health; it is therefore imperative to develop them further, especially in the face of the new challenges. A key role is played here by environmentally sensitive health promotion and preventive healthcare, where healthy ecosystems are recognized as a resource and a prerequisite for health, and environmental changes are taken into account as major determinants of disease. In this way, health systems can make a decisive contribution to the promotion of healthy and sustainable lifestyles and to the creation of health-promoting living conditions. Transformations towards sustainability, adaptation to environmental change and strengthening resilience can create the right conditions for appropriate healthcare while respecting planetary guard rails. Resilience in health systems should address not only the risks of climate change, but all anthropogenic environmental changes, especially pollution and biodiversity loss. A key aspect here is the security of supply, which must still be ensured in the event of unexpected and unlikely future events. Since social inequalities have a significant impact on health, health systems and their governance should be developed in a way that treats solidarity and inclusion as core elements and gives vulnerable groups special consideration.

The WBGU recommends significantly strengthening environmentally sensitive prevention and health promotion in health systems by enabling health professionals to promote healthy and sustainable lifestyles and to educate patients on environmental health risks and adaptation measures. This requires the provision of the corresponding training at all levels, the improvement of personnel resources and an adjustment of remuneration

systems. Public health services should be significantly expanded, networked and their tasks extended to enable them to initiate and coordinate cross-sectoral cooperation for structural prevention (health-promoting design of working and living conditions). Integrated environmental and health-information systems should be used to analyse exposure, vulnerability and adaptation and to implement personalized digital early-warning systems. Existing strategies for improving sustainability and resilience should be combined and implemented, taking all environmental changes into account. Cross-system and international cooperation can achieve decisive advantages in this context and also generate synergies for transformations both in other sectors and globally. There is a particular need for research on the influence of environmental changes and healthy ecosystems on human health, on preconditions for transformations in health systems, on the effectiveness and co-benefits of health promotion and preventive measures, and with regard to measures, instruments and data for strengthening sustainability and resilience.

Managing planetary risks: climate change, biodiversity loss, pollution



In addition to climate change and biodiversity loss, globally rising pollution is a major health risk for people and nature.

Promoting climate-change mitigation and biodiversity conservation

Climate change is developing into the biggest threat to human health and is inextricably linked to the progressive loss of biodiversity. Particularly promising for addressing these crises and the associated risks for nature and people is a nexus approach which integrates climate-change mitigation and biodiversity conservation, harnesses synergies and constructively addresses trade-offs. The WBGU recommends supporting efforts to reduce emissions by combining it with a halt to exploration for fossil fuels. Strengthening the terrestrial, freshwater and marine biosphere can complement climate-change mitigation and secure adaptation

Summary

to climate change, biodiversity conservation, human well-being and natural life-support systems. This will also help preserve nature's contributions to humankind and achieve a long-term stabilization of the climate.

Improved nature conservation also plays an essential role in preventing zoonotic pandemics: establishing protected-area systems, implementing an integrated landscape approach and regulating hunting and the wildlife trade – taking into account the rights of Indigenous peoples and possible side effects on other sustainability goals – are important starting points for reducing contacts between humans and wildlife. Research into such preventive strategies should be stepped up.

For regions where the limits of adaptation to environmental and climate change will be reached in the foreseeable future and the well-being of humans, animals and plants is under threat, orderly and regular forms of human migration should be developed. The migration of species should also be facilitated by creating networked protected areas and ecosystems.

However, the global goals for biodiversity, the climate and sustainability for 2030 and beyond are likely to be missed if the causes of climate change and biodiversity loss are not sufficiently overcome and if measures to comply with current agreements and goals do not increase in pace and scale as specifically required.

Pollution

The global increase in human-made pollution is a major health risk for people and nature. This can be reduced by means of a circular economy and controls on emissions.

Compounds with adverse health effects are released during production and consumption processes that are not managed in closed cycles. The problem of pollution could be reduced in the future as a side effect of climate-change mitigation measures in some areas. However, it could also shift to new substances and applications, e.g. in the course of the energy or mobility transition. For this reason, there must be a greater political focus on the issue of global pollution with hazardous substances right now – i.e. at a time when combatting climate change is a top priority on political agendas. Dealing with this issue could also generate co-benefits for biodiversity and climate-change mitigation.

To this end, a global framework convention to combat pollution by hazardous compounds should be negotiated, based on the concept of 'zero pollution'. The aim here is a relationship between humankind and the environment that is designed in such a way that no harm comes to either. A core element of such a framework agreement should be an international authorization regime for substances of very high concern.

The guiding principle of the circular economy, in turn, is crucial to achieving the zero-pollution goal. Many

chemicals are essential for economic processes and the functionality of technical products, and for some of them there is – as yet – no substitute. In future, therefore, especially persistent compounds whose release poses an increased risk to health must either be kept in technical cycles or not allowed to enter the environment during use.

Shaping areas of life: what we eat, how we move, where we live



How we eat, move, live, work and spend our leisure time – all these aspects of life affect our health and, at the same time, have consequences for the climate, ecosystems and the spread of harmful substances. If healthy, environmentally friendly behaviour is to become attractive or even possible in the first place, the corresponding external conditions must also be conducive. Using selected examples from key areas of life, the WBGU shows which conditions and behaviours could be desirable and achievable.

Ways to a healthy diet – for everyone

Whether the internationally agreed climate and biodiversity targets can be achieved will also depend on the transformation from environmentally damaging and unhealthy diets to a sustainable, plant-based, nutrient-rich and diverse diet. This transformation leads away from excessive consumption of animal products and ultra-processed foods and frees up land reserves previously tied up in animal feed production. The reassignment of land use should benefit human food production, climate-change mitigation and – by restoring ecosystems – biodiversity conservation. Such a transformation not only has ecological and economic benefits, it also significantly promotes human health, e.g. by improving nutrient supply and reducing disease risks, as well as by promoting diverse microbiomes in humans, cultivated soils and the food produced. Food production should be climate-smart and sustainable, be carried out in semi-natural landscapes, use only moderate amounts of synthetic and

organic fertilisers, and cultivate climate-smart crops and production methods. Regional marketing reduces the need for emissions-intensive transport and maintains the freshness and quality of the food. The influence of farm size, cultivation methods, processing and distribution on sustainable production should be further studied in corresponding research projects.

The political goal should be to make balanced and sustainable diets (based on the Planetary Health Diet) significantly more attractive and diverse and raise people's appreciation for health-promoting and sustainable foods. To this end, the WBGU recommends positive communication and education on nutrition within the context of educational measures and awareness campaigns, but also in advertising and the way political measures are communicated and implemented.

Activity-friendly environment – environment-friendly activity

Changing people's patterns of physical activity offers enormous potential for health and the environment. Currently, however, physical activity is sidelined in all areas of life – everywhere from employment, housework and education to mobility and leisure-time. Very many people fail to reach the WHO's recommendations for physical activity and spend many hours sitting. Physical inactivity and sedentary behaviour (i.e. sitting or lying when awake) are major risk factors for many non-communicable diseases, and the means used to avoid physical activity often harm the environment and people. Car traffic in particular consumes a lot of energy, resources and space, and causes air pollution, climate damage and noise. It restricts the freedom of movement, safety, social interactions and participation of people in their living environment and of all those who walk, cycle or rely on public transport, e.g. children and many older and poorer people.

Increasing environment-friendly physical activity and mobility requires an activity-friendly environment. The WBGU recommends pursuing three interlinked approaches:

First, physical activity should be re-integrated into all areas of life. To achieve this, above all the external conditions must be adjusted. Infrastructures, built-up and green public spaces, regulation, taxes, prices and public services should all be designed to make healthy and environmentally sound behaviour the easiest choice. This requires national cross-cutting strategies that stipulate and coordinate the contributions to be made by different policy areas to the promotion of environment- and climate-friendly physical activity.

Second, more active, clean and efficient mobility offers huge potential for synergies. Actors in the fields of health and sustainability should be given a greater

say in national mobility strategies. Active mobility should be promoted: by redistributing space and creating consistently safe footpath and cycle-path networks, compact settlements and dense, comprehensive local public-transport services. Furthermore, the negative societal and ecological effects of motorized private transport should be consistently incorporated into pricing, regulation and land allocation; its spatial access should be restricted accordingly.

Third, the needs of children and young people are a very good benchmark for designing cities and mobility systems because they can serve as a good proxy for many health and environmental aspects.

The three approaches should also be integrated into international development cooperation and financing, especially with regard to investment in the infrastructure.

Housing in health-promoting and sustainable settlements

The way residential areas are built also determines how healthily people can live there. Cities and residential areas cause climate change, biodiversity loss and pollution; at the same time they are impacted by them. This offers starting points for synergies which can be used to accelerate the transformation towards sustainability. This not only applies to the global need to improve both the residential environment and the building and housing stock. The need to build new urban settlements for around 2.5 billion people by the middle of the century offers a window of opportunity for advancing sustainable and healthy construction with climate-friendly building materials on a large scale in a short period of time – and for avoiding unsustainable path dependencies. This concerns, among other things, building materials, recycling, the design of cities and urban infrastructures, and health-promoting living conditions. It requires a planning policy which,

- first, gives priority to an urban form that enables healthy living, environmental protection and climate-change mitigation,
- second, speeds up construction projects worldwide in a way that keeps pace with rapid urban population growth and largely avoids unplanned urban growth, and
- third, finds a balance between building density, mobility and the creation of green and blue spaces ('triple inner development') that is adapted to the respective regional conditions.

With regard to planning and governance, the WBGU recommends overcoming institutional and disciplinary boundaries in planning processes (e.g. integrating public health services), reserving a relevant proportion of urban space for forms of use that are oriented towards the common good, ensuring safe and affordable

Summary

health-promoting housing in the long term, and establishing the position of an Urban Chief Health Officer. In order to promote environment- and health-friendly infrastructures and construction methods, further recommendations include the expansion of urban green and blue spaces and timber-based construction in the building sector, as well as the reusability and recyclability of building materials.

Education and science for healthy living on a healthy planet



Education and science occupy key positions in the vision of healthy living on a healthy planet. However, their transformative potential for the health of people and nature can only unfold globally if empirically based answers to research and education questions are developed worldwide in a context-specific manner, and networks for reflection and implementation are developed between politics, science, the private sector and civil society. This will require reducing the significant differences between national science systems, promoting transregional partnerships on the basis of reciprocity, and the systematic promotion of education for healthy living on a healthy planet worldwide.

Education

By bolstering a comprehensive health perspective, Education for Sustainable Development can also come to mean education for healthy living on a healthy planet. It should firstly enable and promote knowledge, attitudes and skills relating to environmental and human health throughout life, and secondly encourage sustainable action within the educational institutions themselves, thereby developing a role-model function for daily action. Participation and transdisciplinarity are important here. A core element of such an educational mandate is the conservation and restoration of healthy ecosystems and their typical biodiversity, also as a prerequisite for stabilizing the natural life-support systems for humankind. Another core element is designing the human-made

environment in a way that is oriented towards principles of promoting people's health. A third core element comprises the responsible and health-promoting use of natural resources and their regeneration to ensure their sustainable availability over generations, also taking into account social fairness in distribution.

Broadly based strategies from pre-school and school education to advanced-training programmes for lifelong learning serve to mutually strengthen the health of species, ecosystems and people and should be established as soon as possible. In addition, health professionals can be encouraged in their role as multipliers to promote the guiding principle of healthy living on a healthy planet.

This education strategy for healthy living on a healthy planet should feed into and give new impetus to the existing process of embedding Education for Sustainable Development in all areas of education. To this end, the WBGU recommends highlighting health as an integral and explicit field of action in the concept of Education for Sustainable Development and using education as a strategy for encouraging healthy and sustainable behaviour in healthy and sustainable conditions.

Science

The vision of healthy living on a healthy planet needs science to help shape society's future on a global scale – in an interaction between research, consulting and the promotion of young scientists at the interfaces between health science and the natural and social sciences. Research in partnerships between scientists from countries of different income groups and regime types is required, as well as continuous, iterative development processes of ideas and technologies, and the successive transformation of institutional guidelines and everyday cultural practices. To achieve this, it is necessary to strengthen underfunded science systems worldwide and to ensure the ability to speak and act on a common basis as a global society – by means of transregional cooperation between science, science policy and science funding.

The consequences of a fragmented and inequitable global science system could be observed during the COVID-19 pandemic. While vaccine development and production were possible in efficient national science systems, transregional distribution posed a huge challenge because of local demand. Accusations like 'global vaccination injustice' or 'vaccine apartheid' make multilateral cooperation difficult.

In Germany, the development of the Research Platform for One Health is promising. This should now be backed up by the various ministries providing the corresponding science funding in the spirit of the vision of healthy living on a healthy planet. The WBGU also advocates the establishment of an alliance to promote transformative research at the interfaces between

environment and health involving cooperation between universities and non-university institutions, based on the example of the German Marine Research Alliance.

Similarly, at the international level, transregional support programmes focusing on the environment-health nexus should be further expanded and a joint funding landscape institutionalized; this should also include private-sector actors. Initial transregional support networks exist in this field in the form of the Belmont Forum and Future Earth. These need to be further expanded and funded, especially in the area of transformative environment and health research.

Scientists are part of a global community that has the potential to conduct collaborative research on the environment-health complex across national and disciplinary boundaries. At the same time, it is important to build the transregional and transsectoral networks that are needed in order to implement and shape political, private-sector and civil-society decision-making processes.

German science policy has a responsibility for shaping the future – by means of interdisciplinary, globally oriented science practised in a transregional dialogue for healthy living on a healthy planet.

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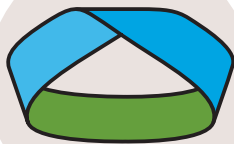
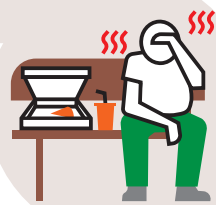
Epilogue: using the UN Summit of the Future as a forum and focusing on the post-2030 agenda

This report targets decision-makers in the field of international sustainability and health policy and is also a contribution to the discourse on the preparation process for the United Nations Summit of the Future, which will be held in New York in September 2024. On behalf of the UN General Assembly, Germany and Namibia are co-facilitators for this summit, which also focuses on improving multilateral capacities for dealing with global crises. Global health and a stronger role for the WHO are already being discussed as possible focal points of the summit. In the WBGU's view, the vision of healthy living on a healthy planet should play a visible role at this Summit of the Future.

However, the transformative power of the topic of health extends far beyond the Summit of the Future and could become a central building block for the further development of the sustainability agenda beyond 2030. After all, health as it is defined by the WHO – “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity” – requires a comprehensive transformation towards sustainability. This report aims to contribute to a political recognition of this broadened view of health.

1 Introduction

2 Health – a systemic view



3 The vision of 'healthy living on a healthy planet'

4

Shaping areas of life: what we eat, how we move, where we live



5

Managing planetary risks: climate change, biodiversity loss, pollution



6

Harnessing the transformative potential of health systems



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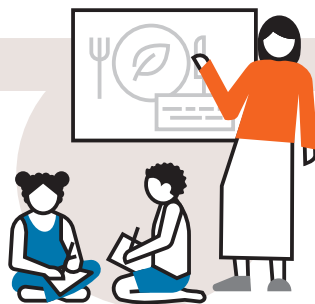
Global urgency governance



Overview of recommendations

8

Education and science



Introduction

The global health situation developed positively for many years. Infectious diseases were becoming more and more controllable, hygiene and medical advances were taking away the horror of many diseases, infant mortality was falling and life expectancy increasing. But this picture is becoming increasingly blurred. On the one hand, by no means everyone has been able to benefit from these advances – in many parts of the world poverty in particular still allows preventable diseases to run rampant. On the other hand, it is becoming increasingly clear that civilizational developments have brought with them new health risks that affect everyone worldwide.

The way many people around the world today eat and move, how they live and work, not only threatens the natural life-support systems, it is also increasingly damaging their own health. Climate change, ecosystem degradation and global pollution are putting more and more strain on human health – from heat waves, droughts or floods to crop failures. The COVID-19 pandemic, which had claimed 6.8 million lives by March 2023, is a manifestation of these new threats. It is therefore justified to speak of a health crisis, one which might also be called a syndemic: a syndemic is the co-occurrence of several diseases or disease risks that develop in specific ways under certain socio-economic and ecological conditions, interact with each other, potentially reinforce each other, and are partially due to common causes. The 2021/2022 Human Development Report of the United Nations Development Programme (UNDP) also provides impressive evidence of this development. For the first time since 1990, the Human Development Index has shown globally deteriorating living conditions in two consecutive years.

It is becoming clear that much more attention needs to be paid to the close link that exists between human health and the state of the natural environment if this health crisis is to be overcome. This is the starting point for the present WBGU report, which begins by discussing the developments and causes of the above-mentioned crises. It develops a vision called ‘healthy living on a healthy planet’ and makes recommendations for action and research that can promote the practical realization of this vision. In recent years, discussion on integrative

and transdisciplinary health concepts such as One Health, Planetary Health and EcoHealth has increased, and these concepts have made valuable contributions to overcoming this health crisis. The vision of ‘healthy living on a healthy planet’ brings many aspects of these concepts together. The overarching goal of this report is to boost the status of the topic of health in global discourse and to use its transformative power to promote sustainability. The vision of ‘healthy living on a healthy planet’ could become a key topic for the post-2030 sustainability agenda, since health concerns everyone in a fundamental way. Nature conservation, too, is an important concern for people worldwide, as shown by the Kunming-Montreal Global Biodiversity Framework adopted by the international community of states in 2022. This special duality – appreciating the health of both human beings and nature and recognizing their inseparability – encompasses formidable forces that can accelerate the necessary transformation towards sustainability.

Attention must also be paid to longer-term processes of disintegration – such as the crisis of multilateralism and the processes of societal polarization, fragmentation and autocratization that can be observed worldwide. This requires crisis-proof policy-making, also against the background of the Russian war of aggression on Ukraine and the multipolarity of the world order.

How can the negative health and environmental trends, which can be observed contemporaneously and globally, be stopped, especially at such a ‘Zeitenwende’ (turning point in history)? What pathways need to be followed to make a healthy and humane life on Earth possible, also in the long term? How should we deal with possible limits to habitability or the loss of habitats? In what ways can and should the topic of health create momentum for transformations towards sustainability? Strategic recommendations on such issues are developed in this report that offer promising multiple benefits in order to ensure a healthy human life on a healthy planet.

By taking a systemic view as well as looking from an individual perspective, the WBGU reveals ways in which environmental protection and health promotion can be effectively interlinked and integrated in times of

1 Introduction

multiple crises. International cooperation is essential in order to meet the challenges. The added value of this report compared to existing studies also lies in its interdisciplinary analyses of strategically important areas of human life – what we eat, how we move, where we live – and the way it identifies the transformative potential of health systems. One of the key objectives of this report is to contribute to the reorganization of global health and sustainability governance. Thus, the WBGU offers ideas for current international sustainability policy as reflected in the 17 Sustainable Development Goals, and beyond the 2030 Agenda.

Structure of the report

The report begins with a historical look at health and a status quo analysis of the health of human beings and nature (Chapter 2). On this basis, the vision of 'healthy living on a healthy planet' is outlined, and existing concepts are evaluated (Chapter 3). This is followed by a chapter describing the close linkages between certain exemplary areas of life – what we eat, how we move, where we live – on the one hand, and human health and the protection of ecosystems on the other; it also shows ways of integrating health promotion with environmental protection (Chapter 4). Chapter 5 looks at the triple planetary crisis – climate change, biodiversity loss and pollution – and its relevance to health. A separate chapter subsequently shows how health systems can meet these new challenges, promote healthy and sustainable lifestyles and initiate transformations towards sustainability in other sectors (Chapter 6). The following Chapter 7 focuses on the transnational and international shaping of environmental and health governance with the aim of setting a course for the future in a cross-sector and systemwide manner. The report concludes by examining the role of education and science in promoting the vision of 'healthy living on a healthy planet' (Chapter 8). At the end of the report, there is a quick reference guide to the key recommendations for action and research that are deduced and described in more detail in the previous chapters.



Health – a systemic view

2

Human health has improved all over the world in recent decades, yet not everyone has benefited. Increasingly, the advances in prosperity are themselves having a negative impact on health. At the same time, our resource-intensive lifestyle is leading to a global environmental crisis that threatens the natural life-support systems and thus the health of all people, species and ecosystems. Moreover, the global crisis could threaten the cohesion of our societies. It is time to take a new look at civilizational progress.

In recent decades, human health has improved worldwide as prosperity has increased. Many infectious diseases have been eradicated, maternal and infant mortality rates have fallen, and the percentage of people living in absolute poverty has been greatly reduced. On the other hand, lifestyle-related diseases are on the increase, and progress in the areas of prosperity and health is very unevenly distributed worldwide (WHO, 2022i). At the same time, biodiversity has declined drastically all over the world, significantly damaging the functions and services of many ecosystems, even to the point of impacting on the Earth system (IPBES, 2019). The immense emissions of greenhouse gases leading to anthropogenic climate change, the growing destruction of natural habitats and the rapidly increasing global pollution of the air, soils, lakes, rivers and oceans have led to a planetary crisis (UNEP, 2021a). In many societies, the relationship between humans and nature is characterized by considerable distancing and alienation, so that human activities are increasingly endangering the ecological life-support systems, as well as social and economic systems – and thus also the health of humans, other living organisms and the planet and its ecosystems as a whole. The progress regarding health in recent decades is at risk of being undermined by these developments.

In order to better understand this alienation of humankind from their natural life-support systems, it is first necessary to look at the fundamental laws of all life on this Earth, which also determine human life – and ultimately at the cultural-historical development of the

relationship between humans and nature (Section 2.1). This retrospective view shows that human health has historically benefited from the appropriation, development and exploitation of nature by humans. Industrialization and the development of energy and production systems improved living conditions, but parallel to that the negative effects on the climate, the natural environment and also human habitats constantly increased. The ever-advancing possibilities of modern medicine, e.g. the development of hygiene, vaccinations and antibiotics, fostered the illusion that humans could escape the natural context of life through technological progress and exercise more and more control over the perceived threat from nature. Human behaviour has a significant impact on planetary systems, affecting, for example, ocean currents, the climate system, glacier and ice cover, material cycles and large-scale ecosystem interactions. The abundance, distribution and health of species and ecosystems are changing, or rather continuously declining. The image of a healthy planet is giving way to that of a planet in crisis, where the long-term survival of human civilization as we know it today is no longer guaranteed. Nobel Prize winner and atmospheric chemist Paul Crutzen describes this as the beginning of a new age – the Anthropocene (Crutzen, 2002). Since the 1950s, many developments and trends, such as resource consumption and emissions, have been increasing at an ever-faster rate, leading to the term ‘Great Acceleration’ (Steffen et al., 2015a). The period since industrialization is often referred to as Modernity (Section 2.1).

Section 2.2 describes the developments that have taken place in the field of human health in recent decades, which diseases are currently the most prevalent, and which population groups are most affected by them. It also addresses challenges to combating diseases and protecting health, as well as the diversity of factors that influence human health. Social, political, economic and ecological determinants of health are taken into account.

Section 2.3 explains how planetary environmental change generates new health risks and exacerbates existing risks and health inequity: climate change, biodiversity loss and increasing global pollution are drastic changes caused by humans, mainly within the last 50 to 100 years, which have become an acute threat to the health of humans, other living beings and ecosystems.

Against this backdrop, the protection of health, the environment and the natural world gained political and societal importance all over the world in the course of the 20th century, although the policies and institutional landscapes that shaped them developed largely independently of each other at the national and international level (Section 2.4). Although the United Nations' 2030 Agenda addresses the cross-relationships between human health, well-being and ecological, economic and social sustainability, there is still a lack of any systematic political consideration of health risks and infrastructures against the backdrop of climate and biodiversity crises, pollution and the destruction of natural life-support systems. Many of the health and environmental problems described so far have common roots or are mutually reinforcing. Such linkages make it possible to use synergies when developing solutions. In order to break habits and make societies and natural spaces more equitable, sustainable and healthy, it is essential to fundamentally reflect on our ideas of prosperity, progress, health and nature.

Finally, the interdisciplinary analysis of global developments in health and the environment shows that humanity is experiencing syndemic times. Multiple health and environmental crises are no longer localized but global and simultaneous, requiring effective action with unprecedented urgency (Section 2.5).

2.1 Evolutionary-biological and historical context

With the spread of modern humans (*Homo sapiens*) across the entire ice-free land surface of the Earth over several tens of thousands of years, their impact on ecosystems and the latter's biodiversity has become ever greater through the use of fire, hunting weapons, stone tools and the development of modern technologies. Through the domestication of wild plants and animals, pastoral farming, the increasing prevalence of

agriculture, and finally the use of metals, nature became increasingly alterable and controllable in the course of the last approx. 10,000 years. Combined with the growth in population, humans progressively became – and are still becoming – ecosystem shapers everywhere. Anthropogenic environmental change was – and still is – the consequence, from altered fire regimes, deforestation, soil erosion, migration and extinction of species, through to humankind's influence on the climate. Even before industrialization, the planet had already been ecologically transformed to a large extent as a result of human activity (Stephens et al., 2019). However, in the last 10,000 years – up until the beginning of the Industrial Revolution in the 18th century – climatic conditions on our planet were relatively stable (Dansgaard et al., 1993; Petit et al., 1999; Rioual et al., 2001). The almost constant level of atmospheric CO₂ concentration in the Holocene, combined with a relatively stable climate and temperature regime, enabled further population growth and the emergence and further development of human civilizations. Since the beginning of the Industrial Revolution, anthropogenic influences on the planet have been accelerating enormously, and this is measurable not least in a rapid increase in atmospheric CO₂ concentration. Humans have ushered in a new era, the Anthropocene (Crutzen, 2002). In this 'age of humans', human activity has become the main driver of global environmental change and the degradation of natural systems on a global scale (Steffen et al., 2015a); this, in turn, has far-reaching consequences for the health of humans and the environment – both today and in the future (Crutzen, 2002; Zywert and Quilley, 2020). At the same time, the current changes reveal the fundamental laws that determine life on Earth and thus also the general preconditions for the existence of human civilization. For example, average and extreme temperatures now exceed those of the Holocene and are continuing to rise rapidly (on geological time scales; Gulev et al., 2021). Current observations of ubiquitous heat waves in the Northern Hemisphere indicate that the IPCC's projections are still too conservative, and that developments on land and in the ocean are already more threatening than was expected (Witze, 2022; Burger et al., 2022).

The current impacts of climate change on nature and humans mirror the degree to which today's species and ecosystems – and also human civilization – are specially adapted to today's climate and show how important the climate is for their well-being. This specialization, as well as the threats to life on Earth that result from exceeding climatic boundary conditions, are ultimately a result of evolutionary history. Climate and its variability have decisively shaped the paths of evolution throughout Earth's history and ultimately help determine the current geographical distribution patterns of biodiversity and its

ongoing changes (Theodoridis et al., 2020; Carvalho et al., 2021; Mathes et al., 2021a, b). They have also been a decisive cause of evolutionary crises (mass extinctions) and shaped the resulting higher development of life, for example the development of warm-bloodedness (i.e. the ability to keep the body temperature constant at a relatively high level) in mammals and birds (Clarke and Pörtner, 2010) or the shaping of habitats in different climate zones and thus also the evolution of human beings.

In all habitats, species have specific thermal performance ranges based on common principles (e.g. in the ocean: Fig. 2.1-1) which determine their biogeography and explain how climate warming is currently causing shifts in species distribution to higher latitudes (poleward) or altitudes (upward) or to deeper water (aquatic species; Pörtner et al., 2023). They also explain how health is damaged at tolerance limits and how deaths and thus local extinction events occur when tolerance limits are exceeded. Already today, species in coral reefs, savannahs, rainforests, high-latitude and high-altitude ecosystems, and in the Mediterranean are showing signs of exceeding tolerance limits, impacting on biodiversity and ecosystem services (IPCC, 2022d). The already visible habitat loss for humans, animals and biodiversity in the tropics and beyond triggered by climate change is also relevant here (IPCC, 2022d; Section 5.1.2.3). This observation reflects the fact that higher life is no longer possible beyond temperatures between 40 and 45°C. For humans, at high humidity levels temperatures above 28°C become increasingly unpleasant, and can be lethal at 35°C (IPCC, 2022d).

Furthermore, overlapping thermal performance ranges influence how species coexist and interact, reinforcing the cascading effects of climate change on their prevalence, the composition of species communities, ecological functions and ecosystem health (Pörtner et al., 2014; Chen et al., 2011; Warren et al., 2018; Molinos et al., 2016; Freeman et al., 2022). These principles are probably also involved in the formation of the latitudinal gradients in species diversity (Fig. 2.1-1b). Similarly, extremes of temperature or climate generally affect not only the functionality of ecosystems, but also the performance potential of human societies.

In turn, feedback mechanisms in the ecosystem functions influence the climate. This is caused by changes in photosynthetic capacity and CO₂ uptake and storage, modified reflection of radiation by the land surface, cloud formation and atmospheric dust pollution, changes in the biogeochemical cycling of nutrients and carbon and resultant concentrations of greenhouse gases in the atmosphere (Sobral et al., 2017; Zhao et al., 2017b; Chen et al., 2018; Huang et al., 2018; Crowther et al., 2019). All of these affect the natural life-support systems for biodiversity and humans, although there is insufficient

understanding of the drivers of these phenomena, the mechanisms and dynamics of the changes, the genetic principles and their functional consequences, and the effects of genetic adaptation processes.

What is clear, however, is that the basic physiological principles also apply to plants, birds, mammals and ultimately humans, and thus also to the functioning of natural and human-made ecosystems in agriculture and forestry, as well as to the functionality of human societies (Xu et al., 2020; Pörtner et al., 2021). In the end, the health, vulnerability and resilience of humans and nature vis-à-vis environmental change can only be understood against this evolutionary background. Human civilization, too, can ultimately only function effectively and ensure the health of its members in such a window of favourable environmental conditions (its niche). The dimensions of the human niche are also defined by the niches of the plants and animals used by humans, each of which is also limited by temperature and the availability of water, nutrients and food according to similar principles.

As regards human societies and their retroactive effect on the natural environment, cause-effect relationships and path dependencies emerge that have shaped environmental and human health since the Industrial Revolution. In this context, historical developments in Europe are described in terms of their global impact. According to the WBGU's assessment, it is particularly important for German and European policy-makers – and thus also for the WBGU's scientific policy advice – to be aware of these origins of European influence on the environment and global cooperative relations, in order to overcome current environmental and health crises and avoid future ones by means of internal and external policies.

2.1.1 Industrial Revolution and the Enlightenment

The Industrial Revolution in Europe (c. 1760–1840) can be seen as the material part of the 'double revolution' from the 17th century onwards, and the French Revolution and Enlightenment (c. 1650–1800) as its ideational part (Schäfers, 2016). Together, they form the foundation for what Crutzen has called the Anthropocene (2002), the era irrevocably shaped by humans on all continents.

Descartes' paradigmatic sentence "I think, therefore I am" (*cogito ergo sum*; Brunner, 2021), formulated as early as 1641, became a guiding principle of societal restructuring during the Industrial Revolution. It stood for a counter-programme to the monopoly on knowledge previously held by the churches and became the credo of enlightenment and secularity. Enlightened people no longer recognized and saw God as the subject of history, but themselves. God was superseded as the guiding

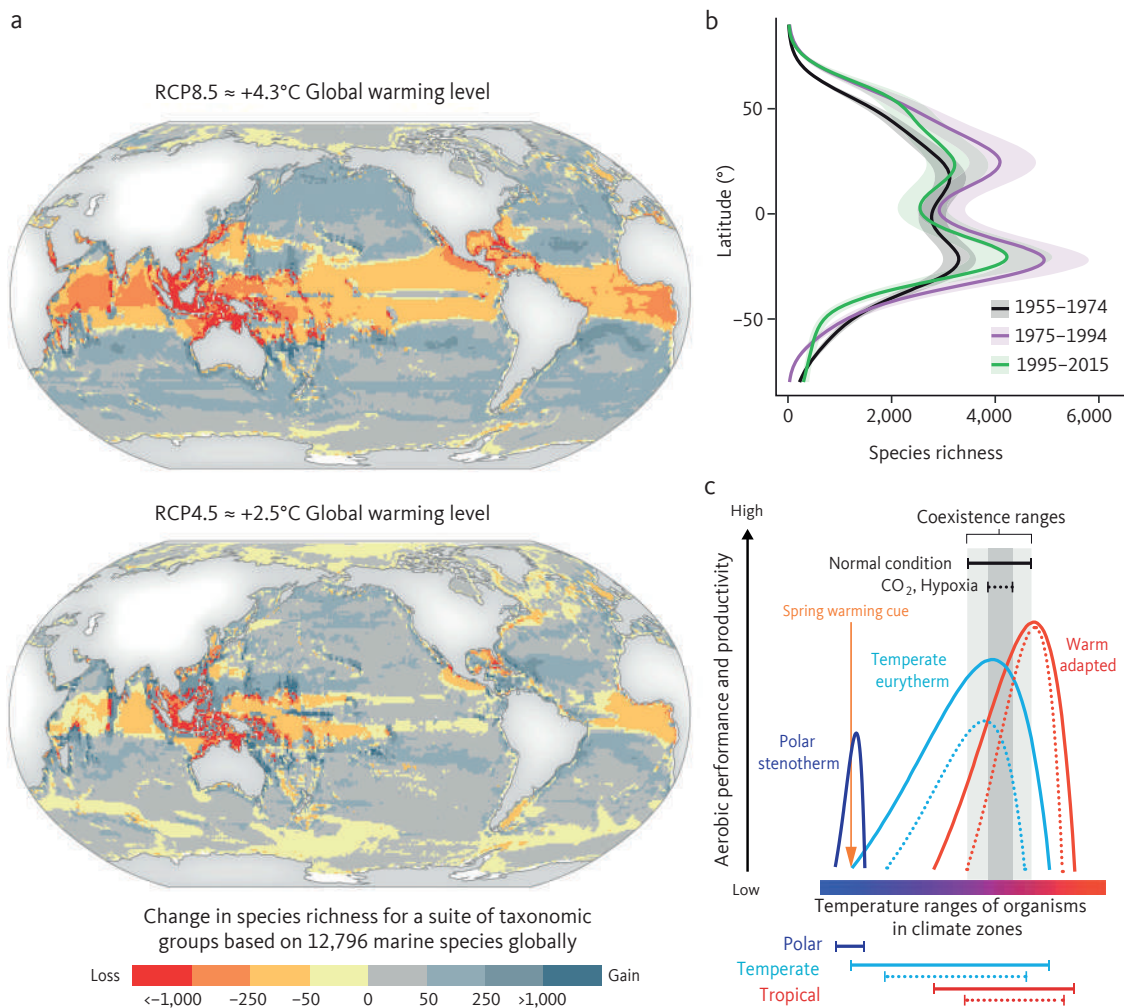


Figure 2.1-1

Simplified representation of principles of climate effects that determined life or survival in evolutionary history, are operative in the current climate crisis, and form the basis for the resilience of nature and humans to environmental change. The evolutionary events were mainly deduced using marine fossils; the explanation is therefore based on the marine example. (a) Projected latitudinal shifts in marine-species richness illustrate the responses of species to global warming (Molinos et al., 2016) and (b) the incipient impoverishment of species richness at low latitudes as reflected by present-day observations of reduced biodiversity at the equator compared to slightly higher northern and southern latitudes (Chaudhary et al., 2021). Here, heat limits for marine animals in warm ocean waters have already been exceeded (Storch et al., 2014). Similar phenomena can be observed in parallel in terrestrial systems (not shown, Section 2.3). (c) The performance curves of the species reflect the adaptation to the temperature regime of the former habitat. The thermal overlap range of the curves defines the temperature range of species' coexistence and interactions. Shifts in coexistence and ecosystem dynamics result from different geographical shifts of the species, possibly also from narrowed thermal windows caused by hypoxia and/or CO₂ enrichment (ocean acidification; Pörtner and Farrell, 2008; Pörtner et al., 2014; Akesson et al., 2021). Exceeding tolerance limits can trigger tipping points in ecosystems and dependent societies (e.g. loss of food sources). The physiological principles outlined here also apply in a derived form to birds, mammals and ultimately humans (IPCC, 2022d; Pörtner et al., 2023). Source: Pörtner et al., 2023

principle for action. Instead, from now on humans themselves decided what was good and evil by consulting their intellect. Church and state were separated in many areas of Europe. Human reason, intellect and rationality were

successively and increasingly placed above the body and nature. Mignolo, a representative of post-colonial thinking, takes up this theme and sees in Descartes' "I think, therefore I am" a "paradigm shift from 'theo-politics'

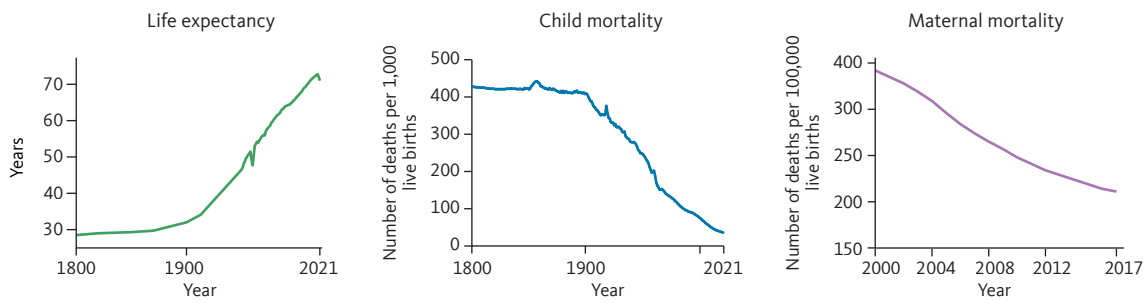


Figure 2.1-2

Global development of life expectancy, child mortality rate and maternal mortality ratio. Life expectancy at birth in years has increased considerably worldwide. Globally, the child mortality rate (or under-five mortality rate), i.e. the number of deaths before the age of five per 1,000 live births, has fallen significantly. Similarly, the maternal mortality ratio has fallen globally, i.e. the number of deaths related to the pregnancy during or up to 42 days after the end of pregnancy per 100,000 live births. Source: Roser et al., 2019; Gampinder, 2020; Roser and Ritchie, 2022

(Mignolo, 2012: 162) to ‘ego-politics’ [...] of knowledge” (Brunner, 2021). Sociologist Ramón Grosfoguel (2013) regards the enlightened-rational “I think, therefore I am” as the basis for the subsequent concepts of the centralization and separation of powers (Brunner, 2021) and the elevation of humankind above nature.

With the Industrial Revolution and the onset of the Enlightenment in 18th and 19th century Europe, further institutional foundations were laid and technological and social innovations introduced, promoting a world view that subordinated the body and nature to the mind – with very tangible effects on the health of people and ecosystems. The emergence of industrial conurbations with precarious living, working and social conditions led to growing threats to human health; the response was the successive introduction of formalized social-security systems (Box 2.1-1). The introduction of the steam engine accelerated mechanization processes. The formation of industries from textiles to steel involving a spatial concentration of a large number of jobs led to migratory movements away from the rural areas to the urban centres. Cities grew and individualization processes restructured the foundations of societal organization – families, living and working systems (Butschek, 2006; Condrau, 2005; Zehner, 2001; Reulecke, 1985; Krabbe, 1989). The end of feudal structures set in, and civic models took their place. Forms of democratic self-organization emerged and shaped the political restructuring of Europe. Towards the end of the 19th and the beginning of the 20th century, the second industrial revolution took place. The combustion engine, the electricity grid and the development of telecommunications hastened the already established processes of increased mobility, communication and the mass production of goods. Large amounts of energy became available through the combustion of fossil fuels (first coal, then increasingly oil and gas) and more easily distributable (partly as electricity).

This laid the foundations for greenhouse-gas-intensive energy structures and rising material prosperity. On the other hand, advances in medicine had a positive impact on the health of people in Europe, as exemplified by the emergence of the sciences hygiene and bacteriology. The growing awareness in the 19th century of the link between the spread of epidemics, like cholera, and polluted water (Gallardo-Albarrán, 2020) focused the attention of city planners on the central supply of cities with clean water and the disposal of waste-water. Life expectancy in England rose from 40 to 70 years between 1850 and 1950, the biggest increase occurring at the beginning of the 20th century (Haines and Frumkin, 2021). Globally, too, life expectancy has been rising continuously since the beginning of the 20th century (Fig. 2.1-2), although there are currently marked global disparities (e.g. 53 years in Chad and 86 years in Monaco; UN, 2022c), which can also be found in other health indicators such as maternal mortality (e.g. two deaths per 100,000 live births in Norway and 1,223 in South Sudan; WHO, 2023d). Health systems have been and are still being improved in Europe and around the world, but continue to face various structural challenges (Chapter 6) – plus new health risks as a result of global environmental changes (Section 2.3), which ultimately result from the Industrial Revolution (Section 2.1.2).

In addition to advances in obstetrics, the expansion of a central drinking water supply and sewage systems, hospital construction and urban rehabilitation promoted improvements in health in the 19th century. These advances can be described as milestones in the development of public health (Box 2.1-2). Public health refers to “the science and art of preventing disease, prolonging life and promoting health through organised efforts of society” (Committee of Inquiry into the Future Development of the Public Health Function, 1988). Further public-health milestones have been the development

Box 2.1-1

History of the German healthcare system as an example of the emergence of solidarity-based safeguards

Healthcare began as a purely individual matter with little connection to the environment. For centuries, social security, and also the management of disease, was subject to the decision-making power of landowners and lords of the manor. In the period of ancient, classical urban cultures, social services were provided in the form of relief for the poor. The Roman Empire, on the other hand, already offered constructs of health insurance and burial funds. Health insurance funds (*collegia tenuiorum*) financed benefits from entrance fees and regular contributions. The benefits offered included medical treatment, medicines and, where applicable, compensation for loss of earnings (in cash or in kind). The role of the Church in social security became established in late antiquity and the Middle Ages. Craft and trade guilds and fraternities improved social security and can be seen as the forerunners of private health insurance (Waltermann, 2020). Precursors of today's social security system, such as the Prussian General State Law of 1794 or the Prussian General Industrial Code of 1845, were unable to cover all social-security needs, but they were based on state obligations for the first time (Preusker, 2015).

The period of the German Empire can be described as the most defining period for the development of today's social system. The focus of social legislation was on the creation of subjective public rights for workers in order to cover the standard risks of advancing industrialization (Hähnlein, 2018). As technical dangers and social harm increased in the course of industrialization, the conviction grew that social security and welfare could be better achieved with instruments of public law than with private law constructs. A public-law programme of workers' insurance covering the risks of sickness, accident,

invalidity and old age was published with the adoption of the 'First Imperial Message on the Social Question' on 17 November 1881. The Healthcare Insurance Act was adopted on 15 June 1883 and came into force in 1884. It initially only covered industrial workers. However, the group of beneficiaries was gradually extended and included salaried employees from 1911 onwards. The aspects regulated by the Healthcare Insurance Act included compulsory insurance in statutory funds administered indirectly by the state. The insurance companies were local entities structured very similarly to those of today, e.g. with compulsory insurance, legal entitlement to benefits without means testing, income-based contributions, and self-administration by the insurance companies. The financing was based on a dual contribution system involving employers and employees. The principle of benefits in kind was already in place – but not yet predominant. Rather, the main principle was initially cash benefits to compensate for wages lost due to incapacity for work (Hähnlein, 2018; Quaas et al., 2018).

With the establishment of the statutory system of health cover in 1883, Germany became a pioneer in Europe. This is remarkable when seen against the background of the late onset of industrialization compared to other countries. Italy, Austria, Sweden, Denmark and Belgium followed Germany's example and had integrated statutory health insurance by 1894. Belgium, Denmark, France, Sweden and Switzerland set up voluntary, state-subsidized programmes to cover parts of the population. The other countries of Western Europe followed Bismarck's idea of compulsory insurance for specific population groups. Only Finland opted for a national insurance scheme. In most other countries of Western Europe, the range of persons insured steadily expanded between 1930 and 1946 and dependants were included. In 1941, Germany extended the scope of insurance to cover pensioners, a measure that was implemented generally in the countries of Western Europe by 1963 (Schölkopf and Gimmeisen, 2021).

of vaccinations (e.g. smallpox, polio) the beginnings of antibacterial therapy with the discovery of penicillin, and the fight against tuberculosis. Vaccination is one of the most effective and cost-efficient preventive measures against infectious diseases. As a result of a major vaccination campaign, no new cases of smallpox have been reported worldwide since 1979. The number of children paralysed by polio has fallen by 99.9% over the last three decades due to the availability of vaccination (Dattani et al., 2022). Other milestones include the establishment of a healthcare system that is accessible to everyone, as well as health-policy decisions – e.g. regarding road safety, rules on air-pollution control, and the restriction of tobacco consumption.

An important role was also played by socio-medical developments, which led to an improvement in the protection of employees, the establishment of solidarity-based care systems in the form of health insurance funds, and a social reform leading eventually to social insurance (Box 2.1-1).

These advances contributed not only to general prosperity and food security, but also to improved health for sections of humanity. However, in some ways the gains in prosperity that have accompanied progress have had a negative impact on natural ecosystems (Section 2.3) and, retroactively, on human health (Section 2.2).

2.1.2 Multiple modernities and new challenges

The period of the Industrial Revolution and the Age of Enlightenment laid the foundations for the Modern Age. Max Weber describes modernity as the "disenchantment of the world". It is characterized by (1) the dissolution of communitization and the emergence of processes of individualization, (2) the global dissemination of the capitalistically organized world economic system, increasing division of labour and the functional differentiation of societies, and (3) the emergence of efficient

Box 2.1-2**Interdisciplinary concepts of health: from public health to global health**

Since the beginning of industrialization, several interdisciplinary health concepts that go beyond monitoring health and illness at the individual level have emerged and constantly evolved.

Public health has its roots in ‘hygiene’ and the social reform movements in 19th century Europe; it is concerned with protecting, promoting and maintaining the health of populations. The scientific foundations of public health were laid by the physician and epidemiology pioneer John Snow (1813–1858), among others. In 1854 in London, he identified the contamination of drinking water by faeces as the cause of the spread of cholera. This realization led to the development of water and sewage systems in many European cities. The basic understanding of public health was expanded, among other things, by the work of the physician Rudolf Virchow (1821–1902), who described poor living conditions and social inequality as causes of diseases and called for political intervention to improve the health of the population. The fundamental objective of public health is to make living conditions possible in which people can live healthy lives. Prevention at the population level is considered a key policy measure and the establishment of social justice regarding health plays an essential role. Access to healthcare is understood as a prerequisite for equal opportunities in society. The public-health approach is interdisciplinary and, in addition to medicine, also includes perspectives and findings from various natural and, above all, social sciences, e.g. engineering and life sciences, ethics and law, information technology and educational sciences (Fried et al., 2010; Koplan et al., 2009; Leopoldina, 2015). In recent years, there have been increasing calls for public health to focus more on the growing burden of disease caused by lifestyle-related diseases, as well as underlying societal factors and environmental conditions (DeSalvo et al., 2016). Current examples of public-health measures in Germany include nationwide compulsory vaccination against measles in children (Measles Protection Law, Bundesrepublik Deutschland, 2020) and the regulation of compulsory mask-wearing during the COVID-19 pandemic (pursuant to section 28a subsection 1 no. 2 of the German Infection Protection Act).

There are also several health concepts that deal explicitly with international and global aspects of health. *Tropical medicine* has its roots in the early 20th century in a colonial context, and was initially concerned primarily with the health problems faced by the European colonial rulers in the colonies,

as well as with diseases of the local population, with the aim of maintaining their ability to work. It concentrated in particular on infectious diseases and climatic influences on health. Tropical medicine was also expanded later to include public healthcare issues and social determinants of health (Bradley, 1996; Müller et al., 2018). With the independence of the colonies, the concept seemed outdated. Tropical medicine is still a medical discipline that deals with diseases that occur predominantly in (sub-)tropical climates. The field of *International Health* also developed in the course of the 20th century, taking a broader interdisciplinary and cross-border approach. It has a clear focus on health in low- and middle-income countries and looks not only at infectious diseases, mother-child health and malnutrition but also at social determinants and the impact of migration on health. International Health is often placed in the context of classic development aid and binational cooperation, although its meaning has been significantly expanded and adapted over time (Bradley, 1996; Müller et al., 2018; Koplan et al., 2009).

By way of contrast, *Global Health* refers to health in all countries, with the aim of working together as equals on cross-border determinants of health and health problems that require global solutions. Health promotion and prevention are pursued at both the individual and population levels, incorporating a wide range of scientific, social, cultural, economic and political determinants and strategies. The goals of Global Health are social and economic equality, the implementation of health as a human right, and the reduction of health inequalities within and between different populations. The approach is interdisciplinary (Bozorgmehr, 2010; Fried et al., 2010; Koplan et al., 2009), and in recent years the influences on global health of global environmental changes, such as climate change, have also been increasingly addressed.

In recent decades, various *integrative and transdisciplinary health concepts* have also emerged that take up aspects of public, international and global health and expand the concept of health beyond human health to other living beings and higher-level systems. Key examples are *One Health*, *Planetary Health*, *EcoHealth* and *GeoHealth*. While previous concepts understand ecological determinants largely as external influencing factors, integrative concepts consider human health to be closely interwoven with the natural life-support systems and the health of other species and ecosystems. The new concepts are transdisciplinary and solution-oriented, but have different approaches and emphases, as they show varying degrees of influence from different scientific disciplines. Their common and individual features are explained in Section 3.3.

state apparatuses and administrations based on rational dispute, democracies and merit instead of family, ethnic and religious connections (Weber, 1934, 1981, 2002; Anter and Breuer, 2007).

European modernity and the economic, political and cultural progress that made it possible in Europe, the ‘New World’ (especially North America, Australia and New Zealand) and successively large parts of the rest of the world, are closely intertwined with the approximately 500 years of European colonialism. Decolonial theory points to the inseparability of the conceptual pair

of modernity and coloniality. Brunner (2021) speaks of ‘colonial modernity’, referring to European modernity being made possible by colonialism. The consolidation of social classifications along lines of ethnicity and gender enabled power-laden, unequal relations of domination within societies and between states and world regions. Although forms of discrimination and exclusion were also justified by gender, religion or societal classes before industrialization and the Enlightenment, these were racialized in the ‘success project’ of colonialism, which naturalized and universalized the power relations

and violent practices that went with it (Germaná, 2013, based on Brunner, 2021: 44). The category of ‘race’ thus ensured the ‘development of resources’ in the colonies and the accumulation of wealth in Europe (Kastner and Waibel, 2016; Quijano, 2007). To this day, the resulting power structures pose a challenge to the possibilities of international cooperation and global governance, both in dealing with the great global challenges in the field of the environment and climate and in the field of human health. For example, the IPCC points to colonialism as a driver of inequalities and vulnerabilities in local communities in Africa, Latin America and parts of Asia (IPCC, 2022c). This, in turn, results today in globally unevenly distributed adaptation opportunities for different income groups.

However, modernity and its respective forms, as well as the parallelism of modern, pre- and post-modern lifestyles, differ between world regions and societal groups with different cultural and religious influences. Therefore, contrary to classical theories of modernization (Rostow, 1959), modernity does not represent a linear history of development (Box 2.1-3). Eisenstadt (2000), for example, points out that modernity should be understood as a cultural programme, analogous, for example, to the emergence and spread of world religions. This cultural programme of modernity comprises the successive development and expansion of health and social-security

systems on the one hand, and the promotion of health risks worldwide caused by prosperity and environmental change on the other (Box 2.1-4).

The industrialization of production systems, the shaping of cities and the further development of transport and communication infrastructures are leading to a disruption of so-called traditional lifestyles as a result of tendencies towards individualization and secularization. Structurally-institutionally, this is reflected in the functional reorganization and differentiation of the economy, politics and society (Luhmann, 1987; Stichweh, 2000). Nevertheless, we know today that the cultural opening and the separation of body and mind that we could observe in 19th century Europe are not necessarily tied to a specific design of political and economic institutions. For example, the diversity of modernity ranges from western-style market economies with private ownership of the means of production (with a state that intervenes to a greater or lesser degree), to the Chinese so-called ‘socialist’ market economy, to the planned economies in the former Eastern bloc, and from pluralistic democracies to authoritarian, totalitarian and even fascist regimes. In the global survey of modernity, it can be said that, although it originated in the 18th and 19th centuries in the Europe of the Industrial Revolution and the Enlightenment, we can today observe traces of this and many other independent forms of non-European modernity all over the world. Today, for

Box 2.1-3

Modernity in the nexus of science and technology

The history of the Enlightenment and the Anthropocene is the history of modernity, of science and technological development. The promise of the modernization theories in the 1960s and 70s (Rostow, 1962; McClelland, 1961) was to develop agrarian societies into industrial societies through successive stages of development, embedded in a liberal global market economy and democratically organized; to leave behind the shards of world wars and struggles for independence, and to make peace and prosperity possible for all. This promise is equated by some authors with a world order characterized by power asymmetries, the “modern capitalist world system” (Scheidler, 2021 quoted from Wallerstein ‘The Modern World-System’, volumes 1–4), increasing material prosperity and, building on this, living independently of nature, even dominating it. In this context, Hannah Arendt emphasizes the catalytic role of science and technological development in the emergence of modernity, and at the same time its destabilization (Belcher and Schmidt, 2020; Arendt and Canovan, 2013). She speaks of “earth alienation” (Arendt, 1958) and postulates: “The consequence of earth alienation was that science – especially nuclear sciences and modern physics – had introduced the possibility that the permanence of the earth was no longer

guaranteed” (Belcher and Schmidt, 2020). Ulrich Beck adds and underlines that with every new item of knowledge created, with every innovation and new technology, our ignorance grows much more in relative terms (Beck, 1986). We can only guess at the possible future dynamics of these technological, social and institutional innovations in interaction with ecological and climate systems, but we cannot fully take them in and certainly not control them (Beck, 1987). It is these side-effects of the ‘first modernity’ – some of which can be ascertained and some only be guessed at – that characterize the ‘second modernity’ that Beck speaks of.

At the beginning of the first modernity, medicine was increasingly determined by the development of the modern empirical-experimental natural sciences, while holistic and philosophical approaches faded into the background. The healing arts of Greek and Roman antiquity, which were very much based on the natural philosophy of the pre-Socratics (e.g. theory of four elements) and reached its apogee in Hippocratic medicine (e.g. dietetics), are regarded as the origin of so-called modern scientific medicine. The physical-chemical advances in medical research, diagnostics and therapy, as well as therapeutically oriented medicine, “pushed the human being more and more into the role of the curative object” (Eckart, 2013). The complex and specific findings in medicine on the diagnosis and therapy of many diseases increasingly moved the human being as a whole and the interrelationships between human beings and nature into the background.

Box 2.1-4**Dimensions of modernity**

Three dimensions of modernity can be distinguished from an analytical point of view: a structural, an institutional and a cultural dimension. In the concrete design of modern societies, however, these are mutually dependent. These dimensions of modernity can be supplemented by a temporal dimension if we add Ernst Bloch's "simultaneity of the non-simultaneous" (Bloch, 1977; Bloch, 1985; Koselleck, 1979): the use of the

Enlightenment's achievements (e.g. modern weapons, organizational systems) to pursue goals that contradict the Enlightenment's intentions; this simultaneity is referred to by representatives of the Frankfurt School as the "dialectic of Enlightenment" (Horkheimer and Adorno, 1988). When applied to the context of human health, this means that modernity is on the one hand characterized by substantial progress in the field of healthcare, but at the same time itself generates new risks to human health (e.g. obesity, diabetes, lack of exercise, environmental degradation).

example, many modern societies are not democratically organized, which, according to Weber, was a defining characteristic of modern state organization (Weber, 1981, 2002). These different modernities stand side by side in dialogue – sometimes in dispute. At the same time, they stand alongside forms of pre-modernity (traditionally organized societies) and post-modernity (highly technological knowledge societies) – and all are interdependent on each other.

Another picture emerges if this diversity of co-existing, regionally different modernities is analysed from the health perspective. Regardless of their respective cultural and structural-institutional manifestations, what they

have in common is the creation of planetary-scale risks to the health of humans and many other species. Thus, climate change and resource degradation, species extinction and social inequalities are among the most prominent global change processes that have been reordering and threatening the foundations of global health for the last two centuries. Furthermore, the interplay of climatological and ecological challenges on the one hand, and poverty and social inequalities on the other also forms the basis for the debates on sustainable development that began in the mid-1980s (Box 2.1-5).

Beck and colleagues speak of the secondary consequences (e.g. climate change, global financial crises,

Box 2.1-5**The guiding principle of sustainable development emerges**

The origin of the concept of 'sustainable development' lies in the idea of a sustainable use of natural resources. Although ecologically sustainable production systems have traditionally existed in very different cultural contexts (Mazzocchi, 2020), the concept of sustainability is considered to have originated in European forestry. In 1713, in the face of an imminent timber shortage, Hans Carl von Carlowitz, an official from Saxony, decided it was necessary to use wood 'sustainably', i.e. that only as much wood should be felled as could grow back (Grober, 2013). He was mulling ideas that still shape the discourse on sustainable development today, in particular the trade-off between short-term profit maximization and the preservation of natural resources for use by future generations.

In the second half of the 20th century, the concept of sustainability gained international importance. The Brundtland Report, published in 1987 by the UN World Commission on Environment and Development under the title 'Our Common Future', represented a milestone in this respect by defining sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987). The report addressed both intergenerational justice and the need for fair opportunities

and burden sharing within a generation, ascribing a key role to poverty reduction in low-income countries.

At the 1992 UN Conference on Environment and Development in Rio de Janeiro, the concept of sustainable development was recognized by the global community of states as a guiding principle (UNCED, 1992b). The principle also included the concept of intergenerational equity. One result of the conference was the adoption of the Agenda 21, a programme of development and environmental policy with concrete recommendations for action. The Rio Declaration adopted there contained 27 fundamental principles of sustainable development, including the principle that people have a right to a healthy and productive life in harmony with nature.

Another key milestone was the adoption in 2015 of the 2030 Agenda for Sustainable Development (UN, 2015a). In it, the global community of states agreed on 17 Sustainable Development Goals (SDGs), which are intended to cover the three dimensions of sustainable development. By 2030, a range of targets is to be achieved on poverty reduction, hunger, health, education, gender equality, drinking water, energy, land use, decent work, and patterns of consumption and production, among others.

Recently, these milestones of sustainable policy were complemented by the decision by the UN General Assembly that humankind has a right to a clean, healthy and sustainable environment (UNGA, 2022). Sustainable development and the conservation of healthy ecosystems are seen as prerequisites for human well-being.

global terrorism) of the first modernity, which, in turn, have characterized the second modernity since around the mid-20th century (Beck et al., 1996). This so-called second modernity is characterized by growing insecurities, uncertainties and risks (Beck, 1986), as well as by successive acceleration processes (Rosa, 2005) in social interactions caused by technological developments, the dynamics of globally integrated economic systems, and ecological and climatic changes. Technological and economic developments of the first modernity can have unpredictable long-term consequences and show the limits of our knowledge. On the basis of this realization, today there are discussions on, for example, the value of basic research, the conservation of biological and cultural diversity – and even on freezing stem cells as a store of knowledge for challenges that are still undreamed of today.

Acceleration processes in the interplay of ecological, economic and societal changes, as well as the risks they cause are also discussed under the term ‘Great Acceleration’ (Steffen et al., 2015a). At the same time, trends towards deceleration can be observed. One example is the demographic development whose trend has reversed in almost all countries. Also, regionalization trends have been observed for years – depending on the economic sector – in the design of transregional supply chains (Baldwin, 2012; Baldwin and Lopez-Gonzalez, 2015).

Since the beginning of the 21st century, we have been witnessing the unfolding of the third modernity. This is characterized by an increasing and accelerated dynamization of the side-effects of the first modernity that are characteristic of the second modernity: climate change, species extinction, ocean acidification, global income inequality and the rise of autocratic regimes (Boese et al., 2022; Leininger and Nowack, 2022). These dynamics give rise to further risks – zoonoses, famines, violent conflicts, migratory movements, cyberattacks, the crisis of multilateralism – and undermine the existing governance systems at the national, regional and multilateral levels (Section 2.4) that were created to jointly deal with the challenges of the second modernity. It is no longer possible to consider only one of these global challenges in isolation. Instead, global challenges are interconnected to such a degree that cross-departmental and cross-governance action is fundamentally necessary. It is not possible to combat the climate crisis, the biodiversity crisis or the health crisis individually. They must be combated together, including their mutually reinforcing effects. It is about human, animal, plant and ecosystem health, all rolled into one. Global governance systems, however, are lagging behind the complexity of contemporary global challenges (Section 2.4).

The core of modernity as a cultural programme is the formation of new, and globally different, institutional

structures. In the 19th and early 20th centuries, these included the emergence of nation states (in Europe along the borders of former principalities; in large parts of Asia, Latin America and Africa as part of colonial negotiation processes and the attainment of national independence) and the successive development of international and multilateral governance systems. The second modernity thus not only brought about climate change, species extinction and health risks related to environmental changes; it was also accompanied by the formation of comprehensive international cooperation structures within the framework of the United Nations. Today, these make global cooperation possible by means of a differentiated landscape of institutions and instruments (Section 2.4). However, the prerequisite for membership and cooperation within this international community of states is recognition as an independent nation state – a condition that was not met by many former colonies only 60 years ago.

To sum up, today we are in a period of multiple crises, an era that can be seen as the third modernity: the side effects of the first modernity, including climate change and species extinction, which shaped the second modernity, are unleashing dynamics among themselves that are hardly controllable for humans. A COVID-19 pandemic grips the planet as a health crisis, is accompanied by an economic crisis in parts of the globe, exacerbates social injustices and acts as an accelerant for a geopolitical and multipolar reordering of the world. This simultaneity and the globality of multiple crises have grown historically and confront humanity with growing challenges. These are presented from the perspective of human health in the following section (Section 2.2).

2.2

Human health: significant improvements, setbacks and new threats

Human health has improved considerably all over the world in recent decades. This is evidenced, among other things, by a huge increase in life expectancy. At the same time, there has been a shift in key health challenges: locally restricted infectious diseases are becoming less important, while non-communicable diseases, which have been prevalent in high-income countries for some time, are posing new health challenges, especially for people in low- and middle-income countries. This “non-communicable disease pandemic” (WHO, 2022u) is a consequence of increased life expectancy combined with a westernized lifestyle, which also causes environmental changes and thus indirectly brings further health risks in its wake (Section 2.3). This also raises questions about the necessary conditions for a healthy life and the relationship between quality of life and health.

2.2.1

Key problems of human health: which diseases cause the greatest burdens?

Worldwide, cardiovascular diseases (e.g. heart attacks and strokes), cancers and neonatal diseases account for a significant proportion of the global *burden of disease* (Fig. 2.2-1; Vos et al., 2020). In addition, respiratory diseases, musculoskeletal disorders, mental illnesses, diabetes and kidney diseases engender a relevant burden of disease. Box 2.2-1 describes the concept of the (global) burden of disease and the underlying calculations.

While infectious diseases, maternal diseases, neonatal diseases and nutritional diseases (such as malnutrition) still accounted for most of the global burden of disease in 1990, in the meantime chronic, non-communicable diseases are most frequently found among the 25 diseases responsible for the greatest burden of disease globally; this has become known as the *epidemiological transition* (Fig. 2.2-2). Non-communicable diseases also account for the biggest share of deaths today, causing around 42 million deaths per year. This includes in particular premature deaths due to non-communicable diseases, i.e. deaths at a younger age. Communicable, maternal, neonatal and nutritional diseases cause around 10.2 million deaths per year. Injuries, e.g. as a result of traffic accidents, falls and suicides, lead to about 4.3 million deaths per year (Vos et al., 2020).

There are important regional differences in these global trends. While non-communicable diseases account for the main disease burden in middle- and high-income countries, low-income countries are affected by a *double burden of disease* due to the increase in non-communicable diseases, while infectious diseases persist (Fig. 2.2-4). Complications (mostly preventable or easily treatable) during pregnancy and birth for mothers and newborns also contribute to this – almost exclusively affecting low-income countries (Vos et al., 2020).

The burden of disease from the COVID-19 pandemic between 2020 and 2023 is not yet included in the latest study on the global burden of disease. However, initial surveys exist that at least estimate the burden of disease caused by COVID-19 for individual countries. While estimates for Scotland suggest that COVID-19 caused the second highest burden of disease after cardiovascular disease in 2020 (Wyper et al., 2022), COVID-19 was not among the top ten diseases in India (Singh et al., 2022).

2.2.2

Non-communicable diseases on the increase

Non-communicable diseases are a group of mostly chronic diseases such as cardiovascular diseases, cancers, chronic respiratory diseases, metabolic diseases like type 2 diabetes, musculoskeletal diseases (osteoarthritis,

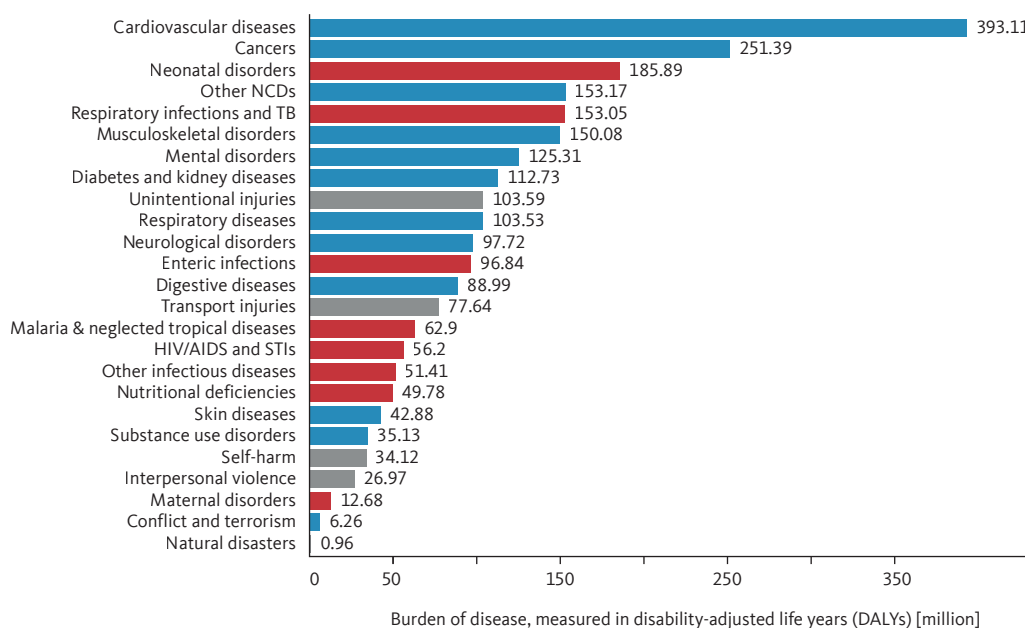


Figure 2.2-1

Burden of disease of different disease groups worldwide, measured in disability-adjusted life years (DALYs), i.e. the sum of years lived with disability and years of life lost due to premature mortality (Box 2.2-1). Non-communicable diseases are shown in blue; communicable, pregnancy-related and neonatal diseases as well as nutritional deficiencies in red; injuries in grey. Source: Ritchie and Roser, 2022a

2 Health – a systemic view

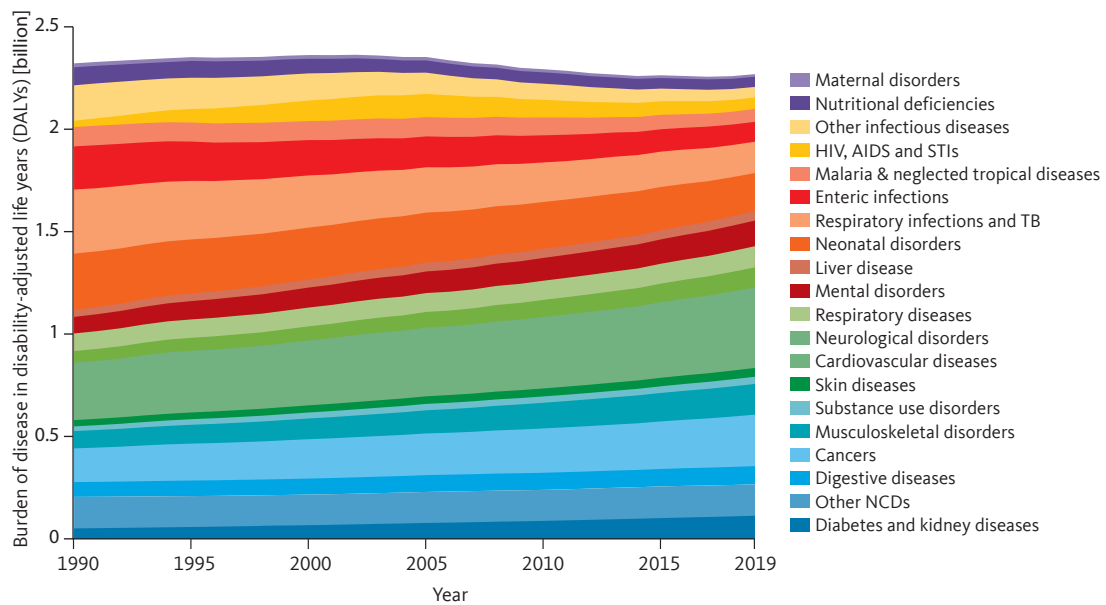


Figure 2.2-2

Global burden of disease caused by non-communicable diseases and communicable, pregnancy-related and neonatal diseases as well as nutritional deficiencies, 1990–2019. Injuries are not shown.

Source: Ritchie and Roser, 2022b.

back pain, etc.) and mental disorders. As a rule, non-communicable diseases have many different causes; individual behaviour in the context of living conditions and environmental stresses plays an important role.

2.2.2.1

Burden of disease, deaths and costs caused by non-communicable diseases

Today, non-communicable diseases are the largest contributor to the global burden of disease. Although they still only accounted for 43% of the total burden of disease in 1990, this percentage had risen to 64% by 2019 (Fig. 2.2-2; Vos et al., 2020). About 74% of all deaths worldwide are caused by non-communicable diseases (WHO, 2020a). Every year, 17 million people between the ages of 30 and 69 die of non-communicable diseases, with 85% of these so-called *premature deaths* occurring in low- and middle-income countries (WHO, 2020a). SDG 3.4 aims to reduce premature mortality from non-communicable diseases by a third from 2015 to 2030 (UN, 2015a). However, this goal has so far only been reached by a few countries (WHO, 2022d). In general, the prevention and treatment of non-communicable diseases play an essential role in sustainable development (WHO, 2022d). The high proportion of deaths attributable to non-communicable diseases reflects, on the one hand, the increase in risk factors such as overweight and an unhealthy diet. On the other hand, the ever-increasing ageing of the

population, as well as the decrease in deaths due to other causes such as infectious diseases, is also leading to a rise in the relative share. Table 2.2-1 provides an overview of the disease groups and conditions that contribute to a significant proportion of the burden of disease and cause a large number of deaths worldwide.

The burden of disease caused by non-communicable diseases rose between 1990 and 2019 not only relative to other causes of disease, but also taken by itself. However, a differentiated picture emerges when comparing the absolute figures with the figures relative to the population (Tab. 2.2-2). While the absolute figures for all the above-mentioned groups of non-communicable diseases are rising, relative to the population there is only an increase in diabetes, musculoskeletal diseases, cancers and mental illnesses. Cardiovascular diseases and chronic respiratory diseases, on the other hand, are actually decreasing (Global Burden of Disease Collaborative Network, 2021). This means that while a greater *number* of people are suffering from cardiovascular diseases and chronic respiratory diseases, this increase is due to the fact that the world population as a whole is growing. Looking at the *proportion* of people suffering from these diseases, it is noticeable that this has decreased – in contrast to the increased percentages of people suffering from diabetes, chronic kidney disease and musculoskeletal disorders.

Mental disorders, particularly depressive and anxiety disorders, also account for a significant proportion of

the global disease burden (GBD 2019 Mental Disorders Collaborators, 2022). Since 1990, this disease burden has increased by 55 %, largely affecting people between the ages of 16 and 65 (GBD 2019 Mental Disorders Collaborators, 2022). The burden of mental disorders is greater among women than among men (GBD 2019 Mental Disorders Collaborators, 2022). It is also greater in higher-income countries than in low- and middle-income countries (GBD 2019 Mental Disorders Collaborators, 2022), although the availability of epidemiological data on mental illness is more limited in low- and

middle-income countries, so that estimates are subject to greater uncertainty. The global availability of treatment options is nowhere near the level required, not least because of the stigma associated with mental disorders.

Apart from depression and anxiety disorders, substance-use disorders (addiction, intoxication, harmful use of alcohol, nicotine or other drugs) also cause a high burden of disease. Alcohol is responsible for the biggest burden of disease, especially in low- and middle-income countries (GBD 2016 Alcohol and Drug Use Collaborators, 2018). The suicide rate, on the other hand, has declined

Box 2.2-1

Importance and calculation of the (global) burden of disease

In order to answer the question of which diseases have the greatest impact worldwide, a common metric – similar to a common currency – is needed that makes the impact of different diseases on the lives of those affected comparable. One of the most commonly used measures of the burden of disease is disability-adjusted life years (DALYs). They refer to the sum of years of life affected by ill health or disability (years lived with disability, YLD; their calculation includes, among other things, a weighting factor that takes into account the severity of the disease or disability) and the years of life lost due to premature death (YLL) in a population (Porst et al., 2022; Fig. 2.2-3).

The Global Burden of Diseases, Injuries and Risk Factors Study (GBD) regularly calculates the burden of disease for

numerous illnesses. For 2019, the scientists calculated an absolute number of 2.5 billion DALYs worldwide, attributable to 396 diseases (Vos et al., 2020). This figure has remained almost constant since 1990 (Fig. 2.2-2). The absolute number of DALYs can be used to estimate the need for health services and how much of a strain this might cause on health systems.

In addition to the absolute number, DALYs can also be measured relative to the population (usually per 100,000 people) or be age-standardized. In this way, effects of population growth or demographic change can be taken into account, since there are usually more sick people in a larger and older population. Taking the ageing population into account, the DALY rate has fallen since 1990, which, in turn, reflects a general improvement in global health – although this is a result of very different and complex trends within individual disease groups and diseases (Vos et al., 2020).

DALYs

Disability-Adjusted Life Years are a measure of the burden of disease and refer to the sum of years affected by disability and years lost due to premature mortality

$$= \text{YLD} \quad + \quad \text{YLL}$$

Years Lived with Disability Years of Life Lost due to death



Figure 2.2-3

Calculation of the burden of disease in terms of disability-adjusted life years (DALYs). These correspond to the sum of the years of life affected by ill health or disability (years lived with disability; YLD; their calculation includes, among other things, a weighting factor that takes into account the severity of the disease or disability), and the years of life lost due to premature death (YLL) in a population.

Source: WBGU, based on Planemad (Wikipedia)

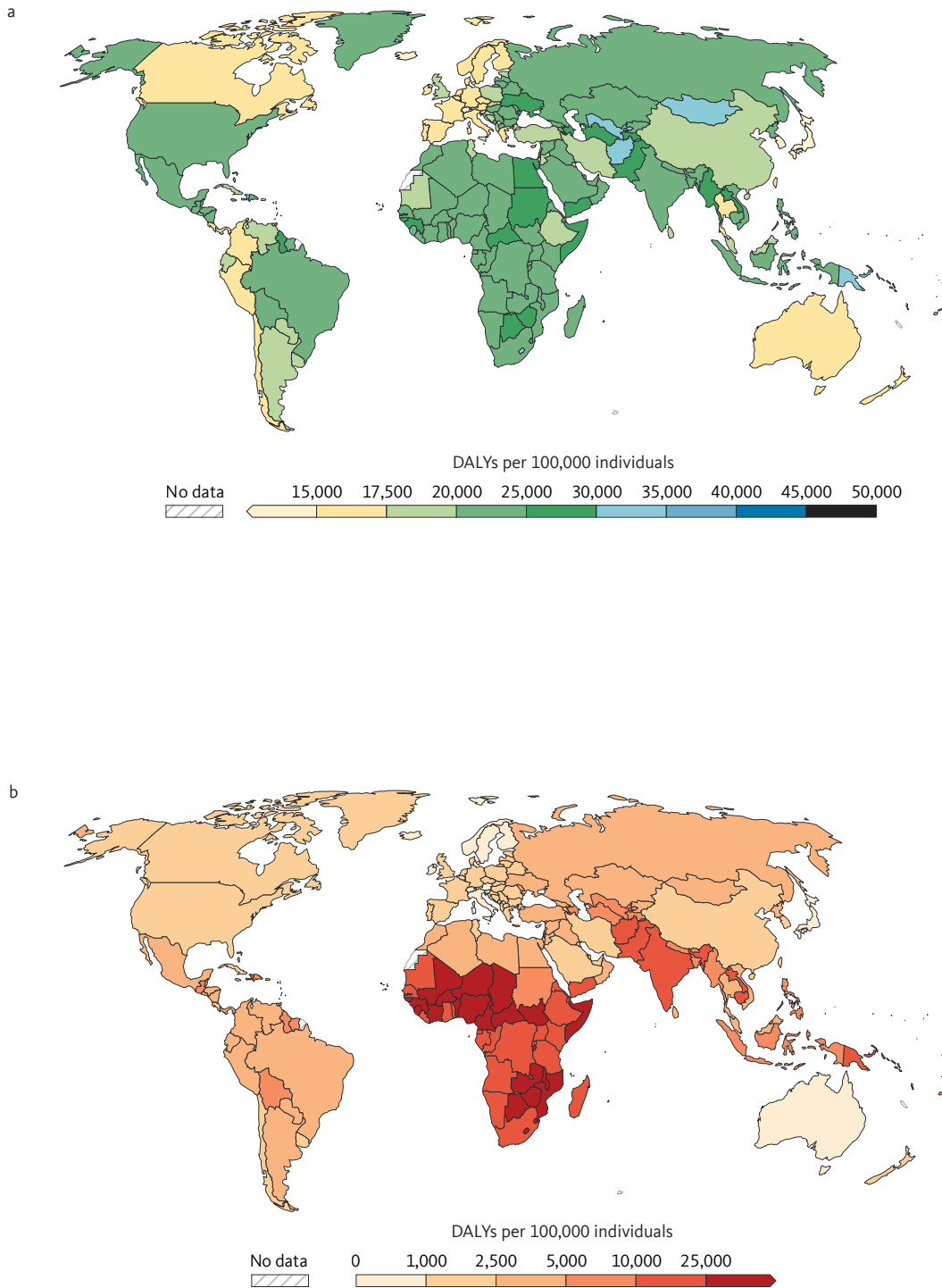


Figure 2.2-4
Burden of disease from (a) non-communicable diseases and (b) communicable, maternal, neonatal and nutritional diseases by country, 2019.
Source: Ritchie and Roser, 2022b

Table 2.2-1

Burden of disease (expressed in DALYs) and deaths attributable to individual disease groups and conditions per year.
Source: Vos et al., 2020

Disease	DALYs/year [million]	Deaths/year [million]
Cardiovascular diseases	393	18.6
including: Ischaemic heart disease	182	9.9
Strokes	143	6.6
Cancers	250	10.0
Musculoskeletal disorders	150	0.1
including: Lower back pain	63.7	
Neck pain	22.1	
Osteoarthritis	18.9	
Chronic respiratory diseases	104	4
including: Chronic obstructive pulmonary disease (COPD)	74.4	3.3
Asthma	21.6	0.5
Type 2 diabetes	66.3	1.5

continuously worldwide since 1990 (Global Burden of Disease Collaborative Network, 2021). Most suicides occur in connection with mental disorders. Suicides are more common in men than in women, and the suicide rate rises with age (Wolfersdorf and Hegerl, 2019).

Rising prevalence can also be observed for allergies, whereby the burden of disease is mainly borne by children. It is estimated that between 10 and 40% of the population is affected by allergies, depending on the country. Apart from genetic risk factors, environmental aspects play a major role in the development of allergies (WAO, 2013).

In addition to a high burden of disease and associated deaths, non-communicable diseases lead to a high economic burden: on the one hand as a result of the direct costs of illnesses and, on the other hand, through indirect costs, e.g. a reduced ability to work. Non-communicable

diseases are projected to cost the world US\$30,000 billion over the period 2011–2030, equivalent to about half of global GDP in 2010 (Bloom et al., 2011). On the other hand, investing in interventions to promote health and prevent non-communicable diseases would generate a high return on investment, which in turn could greatly benefit low- and middle-income countries (WHO, 2022d). For example, an additional investment of US\$18 billion per year across all low- and middle-income countries would lead to net economic benefits of US\$2,700 billion over the next seven years (Watkins et al., 2022).

2.2.2.2

Risk factors for non-communicable diseases

Individual lifestyle factors such as tobacco and alcohol consumption, physical inactivity, unhealthy diets and stress promote the development of many non-communicable

Table 2.2-2

Change in the global burden of disease (in DALYs) from 1990 to 2019 in percent.
Source: Global Burden of Disease Collaborative Network, 2021

Disease	Absolute change	Change per 100,000
Cardiovascular diseases	+ 40%	- 3%
Cancers	+ 53%	+ 6%
Musculoskeletal disorders	+ 77%	+ 23%
Mental illnesses	+ 55%	+ 7%
Chronic respiratory diseases	+ 21%	- 16%
Type 2 diabetes and chronic kidney disease	+122%	+ 53%

2 Health – a systemic view

diseases. These risk factors are closely linked to socio-economic status and ‘health-hostile’ living conditions, for example when water is more expensive than sweetened lemonades, unhealthy ultra-processed foods are more accessible than fruit and vegetables, or a lack of green spaces and road safety do not allow sufficient physical activity (WHO, 2022d). In addition, metabolic risk factors resulting from lifestyle factors – such as high blood pressure, overweight and obesity, high sugar and lipid levels in the blood – play a substantial role in the development of non-communicable diseases (Murray et al., 2020). Table 2.2-3 provides an overview of the burden of disease and the number of deaths attributable to individual risk factors.

Overall, a trend is emerging that, in addition to metabolic risk factors such as overweight, obesity and blood sugar, many environmental risk factors have also increased significantly in recent years (Murray et al., 2020). For example, a high body-mass index (BMI), ambient air pollution and high fasting blood plasma glucose levels were the three risk factors that contributed to more than one per cent of the global burden of disease in 2019, and whose exposure increased by more than one per cent per year (Murray et al., 2020). Figure 2.2-5 shows the risk factors that caused the most deaths in 2019 (Murray et al., 2020).

To sum up, non-communicable diseases and their risk factors are on the rise worldwide. They are playing an increasing role in the epidemiological transition

in many countries and regions and, together with infectious diseases, are contributing to a double burden. Factors and behaviours that favour the development of non-communicable diseases also often contribute to environmental problems.

2.2.3 Infectious diseases: old successes and new challenges

At the latest since the outbreak of the COVID-19 pandemic, it has been clear that, even in high-income countries, the spread of infectious diseases is by no means over.

Most infectious diseases originate in animals, although zoonoses in the narrower sense are defined only as those diseases that can be transmitted between animals and humans on a regular basis (and not just as a single event). About 70 % of newly emerging infectious diseases and almost all known pandemics are zoonoses, and there is a large reservoir of viruses in animals that could potentially infect humans (IPBES, 2020).

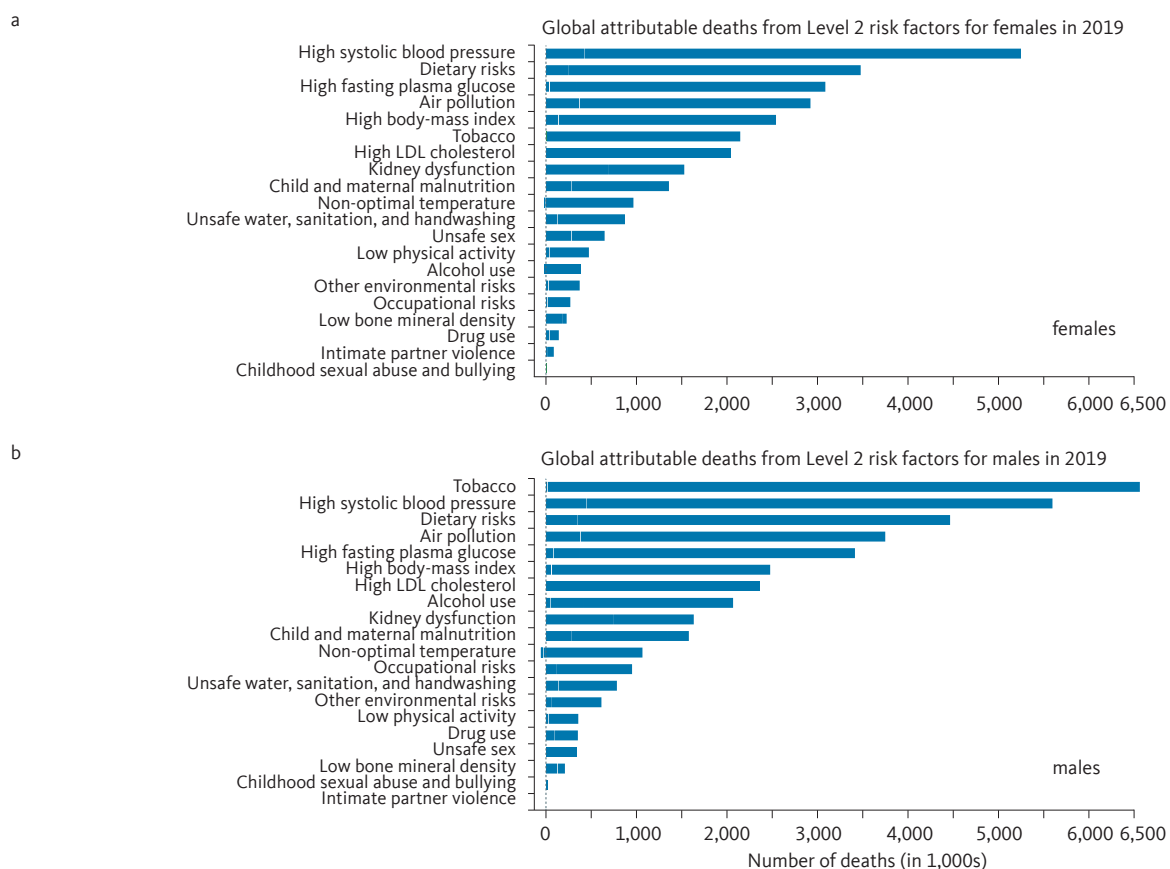
2.2.3.1 COVID-19 pandemic: harbinger of an age of pandemics?

Against the background of past pandemics (SARS, Ebola, influenza and others), the danger posed by emerging and re-emerging infectious diseases has been pointed

Table 2.2-3

Number of DALYs and deaths attributable to individual risk factors for non-communicable diseases per year.
Source: Murray et al., 2020

Risk factor	DALYs/year [million]	Deaths/year [million]
Lifestyle		
Tobacco consumption	230	8.7
Unhealthy diets	188	7.9
Alcohol use	93	2.4
Low physical activity	16	0.8
Metabolic		
High (systolic) blood pressure	235	10.8
High blood glucose	172	6.5
High body-mass index	160	5
High blood-lipid levels	98.6	4.4
Environmental and occupational		
Air pollution (ambient)	118	4.1
Air pollution (household)	91	2.3
Unsafe water, sanitation, and hand-washing	88	1.7
Non-optimal temperature	38	2
Occupational risks	66	1.2


Figure 2.2-5

Number of deaths worldwide in 2019, by risk factor and gender.

Source: Murray et al., 2020

out again and again. The WHO, for example, warned in 2014 that such diseases can lead to a large number of deaths and would have serious social and economic consequences (WHO South-East Asia, 2014). And this was by no means the only warning (e.g. Ross et al., 2015; Ross, 2017; Morse et al., 2012; Fineberg, 2014; Monaco and Gupta, 2018). The COVID-19 pandemic has dramatically demonstrated the justification of such warnings. Worldwide, there have been more than 760 million confirmed cases and more than 6.8 million deaths since the pandemic began (as of 16 March 2023). Most of these were recorded in high-income countries. However, model calculations suggest that the figures in low- and middle-income countries could be significantly higher than officially reported (Adam, 2022) and that the burden of disease from COVID-19 could be markedly higher in low- and middle-income countries than in high-income countries (Levin et al., 2022). The WHO attributes a total of nearly 15 million deaths to COVID-19 and other illnesses or injuries that could not be treated in time or adequately because the health systems were

overburdened during the pandemic (WHO, 2022r). Furthermore, there is a strong correlation between the presence of non-communicable diseases and COVID-19. For example, widespread diseases such as obesity, type 2 diabetes, cardiovascular diseases and the underlying risk factors, as well as pre-existing mental disorders, make severe cases of COVID-19 and COVID-19-related deaths more likely (Adab et al., 2022).

The consequences of the pandemic in many areas of society are enormous, and socially disadvantaged groups of society have been particularly hard hit. For example, in terms of both risk of disease and mortality rates, a higher risk was found among poor population groups, disadvantaged ethnic groups, people in lower-paid employment, people in regions affected by humanitarian crises and people affected by migration, as well as among the homeless (WHO, 2021b).

Economically, the COVID-19 pandemic triggered the deepest recession since World War II, hitting the poorest countries hardest (Yeyati and Filippini, 2021). In many states, the measures introduced to combat the

pandemic involved more far-reaching restrictions on freedom than constitutional lawyers could ever have imagined. In the field of public health in low- and middle-income countries, the COVID-19 pandemic has slowed down urgently-needed health-system reforms vis-à-vis non-communicable diseases and jeopardized many of the recent successes in the fight against infectious diseases. For example, after years of decline, the pandemic has led to a resurgence in deaths from tuberculosis (WHO, 2021n). Activities in the field of neglected tropical diseases (NTDs) were also affected by the pandemic (Aborode et al., 2022).

The response to the COVID-19 pandemic, on the other hand, has shown what is possible in the fight against infectious diseases when there is the necessary political will and cooperation between different sectors. Worldwide, approx. US\$16,000 billion was mobilized to tackle the pandemic in 2020 (Yeyati and Filippini, 2021). However, the Global Health Security Index concluded at the end of 2021 that still no country in the world is adequately prepared for another pandemic (Bell and Nuzzo, 2021).

2.2.3.2

Maternal and child health: existing inequalities and positive trends

Maternal and child health is categorized together with infectious diseases in the survey of the global burden of disease. Just like infectious diseases, maternal and child mortality is particularly high in low-income countries. Maternal and child health has improved in recent decades, as evidenced by, among other things, a 38% decline in maternal mortality between 2000 and 2017 (PMNCH, 2022). However, this is not in line with the annual decline that would be needed to reach the SDG target of a maximum of 70 maternal deaths per 100,000 live births (WHO and UNICEF, 2022b). In 2017, this figure was eleven per 100,000 live births in high-income countries and 462 per 100,000 live births in low-income countries (WHO, 2019f). In addition, the COVID-19 pandemic, conflicts and the climate crisis are currently endangering maternal and child health (WHO and UNICEF, 2022b). Furthermore, significant global differences persist. For example, 94% of maternal deaths occur in low- and middle-income countries, and 82% of deaths among children under the age of five occur in sub-Saharan Africa and South Asia (PMNCH, 2022). Most maternal deaths could be prevented if timely care was provided by qualified medical personnel (WHO, 2022h). The Global Strategy for Women's, Children's and Adolescents' Health formulates the vision of a world in which every woman and child has a right to physical and mental health and well-being, as well as social and economic opportunities and inclusion in shaping prosperous and

sustainable societies (EWEC, 2015). The implementation of these rights would also offer major economic benefits through higher educational achievements, more people in employment and more social contributions.

2.2.3.3

HIV/AIDS, malaria and tuberculosis: socio-economic differences are jeopardizing successes

Alongside malaria and tuberculosis, HIV/AIDS is one of the infectious diseases that receives a lot of attention worldwide. Deaths from HIV/AIDS have fallen by more than half since 2004. This is partially due to the fact that, in the meantime, an HIV infection has become a controllable chronic disease, thanks to the availability of new and improved drugs. However, in 2021, only 54% of infected children received such treatment (WHO, 2021o). A major barrier to more widespread treatment is the price of patent-protected medicines. Poverty is a major driver of HIV/AIDS, so that death rates in low-income countries are almost 50 times higher than in high-income countries (Global Burden of Disease Collaborative Network, 2021).

For malaria, there has also been a positive trend in recent years. The number of deaths from malaria fell by over 30% between 2010 and 2017, although there has been a slight increase since then (Global Burden of Disease Collaborative Network, 2021). Most malaria cases (95%) and malaria-related deaths (96%) in 2020 occurred in Africa, which is linked to socioeconomic factors as well as to the prevalence of the vector mosquito. About 80% of these deaths affected children under the age of five (WHO, 2021i). However, the fundamentally decreasing trend in malaria infections could reverse again in the future. With increasing warming, the spread of the vector mosquito to higher latitudes and altitudes may lead to the exposure of previously unaffected populations and countries.

About a quarter of the world's population is currently infected with the tuberculosis pathogen *Mycobacterium tuberculosis* (WHO, 2021k). The lifetime risk of infected people developing tuberculosis disease is 5–10%, although the risk is higher among people with HIV, malnutrition or diabetes (WHO, 2021k). Tuberculosis was the second most prevalent cause of death from infectious diseases after COVID-19 in 2020 (WHO, 2021k); 98% of tuberculosis cases occur in low- and middle-income countries (WHO, 2021k). Inadequate treatment can lead to multidrug-resistant forms of tuberculosis, which pose a significant threat to public health worldwide.

2.2.3.4 Neglected and poverty-associated tropical diseases: lack of attention despite high prevalence

Neglected and poverty-associated tropical diseases (NTDs) are infectious diseases that occur primarily in tropical and subtropical regions and are associated with poverty. These diseases include leprosy and dengue. Due to a lack of economic incentives, little research is carried out on them despite the large burden of disease, and they receive little political attention compared to other infectious diseases. According to the WHO, over one billion people are affected by NTDs (WHO, 2012a). Infections are linked to poor water quality, poor housing conditions and inadequate sanitation. Children are the most affected by these diseases (WHO, 2012a).

2.2.3.5 Resistance to antimicrobial agents: a serious threat to health

The WHO lists antimicrobial resistance (AMR) among the top ten threats to public health (WHO, 2021p). AMRs limit treatment options. The main reason for their emergence is the incorrect and excessive use of antibiotics in human and veterinary medicine and in industrial animal fattening (Section 5.2.3). In 2019, the deaths of almost five million people were associated with AMR: the highest death rate (27.3 deaths per 100,000 people) was in sub-Saharan West Africa (Murray et al., 2022). Section 5.2.3 goes into more detail on the topic of AMR.

2.2.4 Quality of life as a new indicator for healthy societies

Although the burden of disease is a useful concept for comparing the (global) importance of different diseases,

it is only of secondary importance for individual people. According to the WHO’s definition, human health is more than the absence of disease; rather it is “a state of complete physical, mental and social well-being” (Preamble of the WHO Constitution). Existing concepts of health promotion and prevention can be found in sources ranging from the Ottawa Charter to the WHO’s current Geneva Charter for Wellbeing (WHO, 1986, 2022a; Box 3.3-1). They all require a paradigm shift in the governance of societal, economic and political structures and processes that focuses not only on existing diseases, but rather on protecting and promoting the health of individuals and societies. Medicine is increasingly trying to assess health with this broad understanding using indicators such as quality of life (QoL) and health-related quality of life (HRQoL). The WHO defines quality of life as “an individual’s perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns” (WHO, 1998). Health-related quality of life looks at quality of life in relation to health and disease, and includes physical, psychological and social dimensions (CDC, 2022). The subjective perception of health plays an essential role here. However, up to now, research on health-related quality of life has come mainly from North America and Europe (Zheng et al., 2021). There has not yet been any standardization of different measurement methods or instruments.

Globally, quality of life is highest in countries where the Human Development Index (HDI) is very high (Fig. 2.2-6; Koohi et al., 2017).

However, in some cases available data have shown different developments of health-related quality of life in different countries and population groups in recent decades (Klar et al., 2021; Tang et al., 2020). In order to focus more on positive aspects of human health (including quality of life) in terms of prevention and health promotion at both the individual and societal

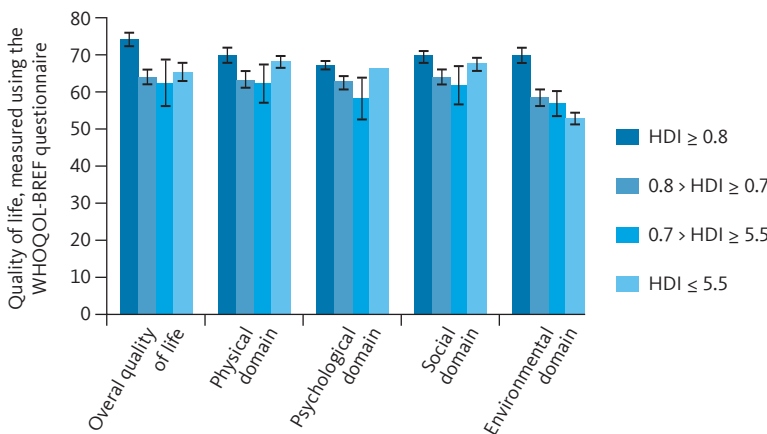


Figure 2.2-6 Quality of life is highest in countries with a very high Human Development Index (HDI). This also applies when considering individual domains of the quality of life. Source: Koohi et al., 2017

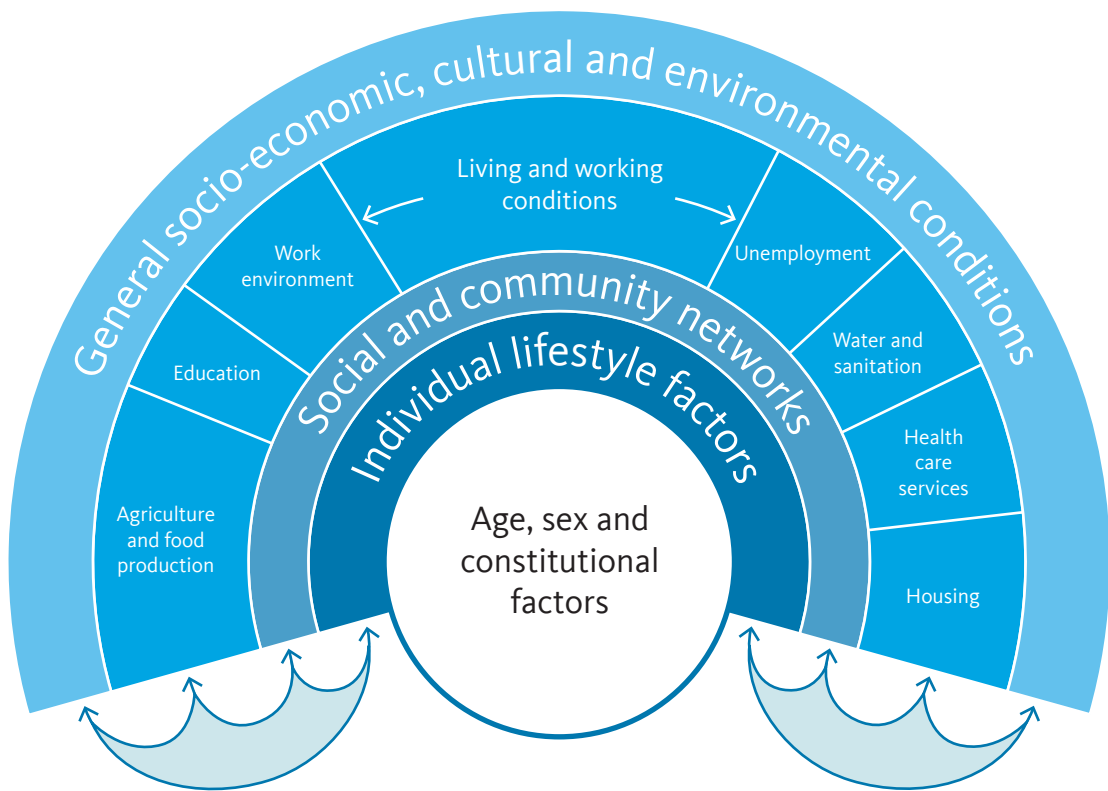


Figure 2.2-7

Determinants of health. The determinants of health can have a positive or negative influence on health and are divided into five areas: 1) genetic disposition, sex, age; 2) individual lifestyle factors; 3) social and community networks; 4) individual living and working conditions; 5) general conditions of the socio-economic, cultural and physical environment. While the factors at the core of the model are fixed determinants of health that cannot be influenced, the factors of the surrounding layers can potentially be modified via strategies of prevention and health promotion. The individual groups of determinants interact with each other in a complex way.

Source: Dahlgren and Whitehead, 1991

level, it is necessary not only to improve assessments of these particular aspects, but also to consider the other social, ecological and economic factors that can influence human health (Section 2.2.5).

2.2.5 Social, cultural, economic and ecological determinants of human health

Human health is decisively influenced by numerous other factors in addition to individual factors like age, sex or genes. These include the social, cultural and economic living conditions in which people find themselves, as well as natural environmental factors. In the model developed by Dahlgren and Whitehead (1991), the determinants of health are divided into five areas ranging from fixed

determinants such as age and sex to influenceable individual, socio-economic, cultural and environmental determinants (Figure 2.2-7).

In addition to the classification by Dahlgren and Whitehead (1991), there are other – in some cases very long – lists of health determinants that vary in detail and can be assigned to the most diverse categories. Social, economic, political, cultural, normative and ecological determinants are mentioned, although there is no consensus on these in the literature. There is agreement, however, that they all interact with each other in a multi-layered way. The following section addresses socio-economic or social, commercial and environmental determinants in particular.

For example, in countries of all income classes worldwide the health of people with a lower socio-economic status is worse than that of socio-economically better-off sections of the population (e.g. Mackenbach et

al., 2008). Building on this observation, the WHO defines social determinants of health as the living conditions and “circumstances in which people are born, grow, live, work and age”. Inequalities in living conditions affect health as a result of unequal access to education and healthcare, unequal working conditions and leisure opportunities, and unequal housing. Furthermore, these living conditions are shaped by existing national and international market imbalances and an unequal distribution of power, income, goods and services (CSDH, 2008).

The WHO Commission on the Social Determinants of Health (CSDH) thus inevitably regards the question of health inequity as an ethical question of social justice. Health equity – i.e. equal potential for health – is defined as “the absence of unfair and avoidable or remediable differences in health among population groups defined socially, economically, demographically or geographically” (WHO, 2021). State institutions are named as primarily responsible for making social and health equity a reality (WHO, 2010a2). Health systems have a key role to play here (Section 6.1.1).

In addition to socio-economic determinants, cultural conditions also influence human health and illness, e.g. through the way people think about health and illness and how their health behaviour is culturally shaped. In this context, societal conventions, values and norms also govern which determinants of health are attributed the greatest importance (Section 6.3.1).

Whereas the general socio-economic, cultural and environmental conditions can hardly be influenced by an individual alone, the degree of individual influence increases in the case of living and working conditions, through social relationships to personal lifestyle. On the other hand, all factors – with the exception of the innermost circle – can be decisively shaped by political, social or economic measures (Dahlgren and Whitehead, 1991; Figure 2.2-7).

Knowledge of these determinants is important because they provide the basis for improving people’s health (health promotion) or preventing the occurrence of diseases (prevention; Box 3.1-1; Section 6.3.2). If (political) measures aim at influencing people’s individual behaviour (e.g. information campaigns and health education), this is referred to as behavioural prevention. In addition, structural prevention aims to shape the living conditions and contexts in which people find themselves in a way that promotes health (e.g. environmental-protection measures, health-promoting subsidies relating to nutrition, occupational health and safety, social standards, strengthening social inclusion in communities; Dahlgren and Whitehead, 2007; BMG, 2019).

In addition to Dahlgren and Whitehead’s (2007) model of determinants of health (Figure 2.2-7), the WHO’s concept of social determinants developed by the CSDH in 2010 is also frequently used (WHO, 2010a; Figure 2.2-8). In this concept, the WHO integrates social, economic and political factors and explains the dynamic interactions

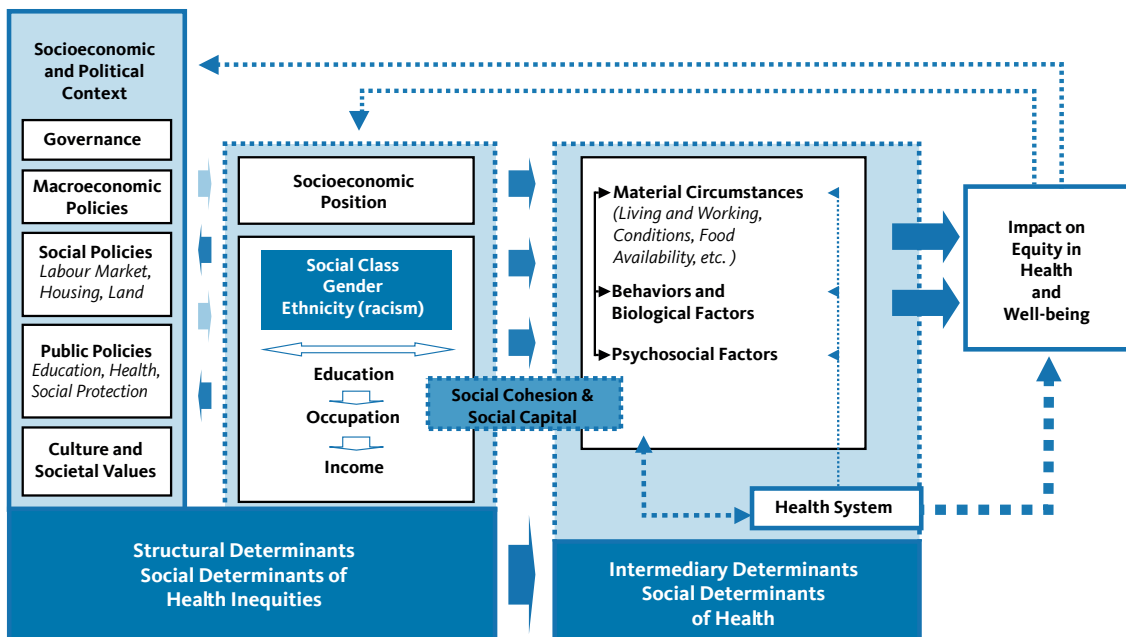


Figure 2.2-8

Social determinants of health. The framework distinguishes between structural and intermediary social determinants which interact in complex ways, thus influencing equity in health and well-being.

Source: WHO, 2010a

between the individual determinants and their influence on an individual's socio-economic position and health status in society. A person's socio-economic position is largely governed by the determinants of education, occupation, income, social class, ethnicity and gender; it is crucial for the expression of a group of specific health determinants (referred to here as 'intermediary determinants'). It includes the material living conditions such as housing conditions (including the neighbourhood and environment) and the ability to provide oneself with such goods as warm clothing or healthy food. It also includes working conditions as well as psychosocial circumstances (stressors at the psychosocial level or caused by aggravated living conditions, relationships or social networks). Behavioural and biological factors are also counted as intermediary determinants, and these can be more or less pronounced in different social strata. A person's socio-economic position also influences their access to health systems or health services, which in turn affects their health (Section 6.1.1). Resulting differences and injustices between individuals and different classes become clear at the societal level. The societal degree of health equity is thus greatly influenced by the above-mentioned determinants. At the same time, the WHO emphasizes that the socio-economic position described above does not arise independently of the societal context. It must be observed in interaction with the socio-economic and political context, i.e. all social and political mechanisms that influence the shaping of societal strata: governance in general, the design of the welfare state, social security, economic policy, education policy, the labour and housing market, but also culture and values can be named as examples. All the above-mentioned determinants of the socio-economic and political context, the socio-economic position and the intermediary determinants are referred to by the WHO as social determinants of health (WHO, 2010a).

The WHO CSDH concept has chosen 'social determinants' as the umbrella term for all the factors described. Economic factors such as jobs, incomes, financial resources or expenditure and debts, as well as per-capita income, income differences or the Gini coefficient are also defined elsewhere as economic determinants of health (Navarro et al., 2003; Chung and Muntaner, 2006; WHO, 2010c), although there is no fixed list for these either. However, positive or negative effects on health or health equity have been documented for numerous determinants – albeit based on qualitatively different (hitherto heterogeneous) data. These include market-regulation mechanisms relating to goods that are either harmful or beneficial to health, such as tobacco, alcohol, healthy or unhealthy food (regulations, taxes, subsidies), and a lack of financial resources due to economic crises or housing that is too expensive. Employment and good working conditions have a positive influence on health,

while the impact of income inequalities is negative. Unemployment insurance and welfare-state interventions that reduce precarious employment situations also have positive effects. The privatization of public healthcare facilities, on the other hand, can pose health risks. The data situation is still partially insufficient with regard to specific welfare-state interventions (Naik et al., 2019).

Increasingly, the literature also discusses commercial determinants of health, i.e. "private-sector activities impacting public health, either positively or negatively, and the enabling political economic systems and norms" (WHO, 2021h). The organization and nature of economic activities can affect the population's health in many ways. Examples include working conditions, the design of supply chains, product design, lobbying or influencing people's preferences and purchasing behaviour (for example through advertising), but also the sale of unhealthy products such as tobacco, alcohol or highly processed food. By these mechanisms, economic activities influence, for example, the incidence of non-communicable diseases such as overweight, diabetes, cardiovascular diseases and cancers (Kickbusch et al., 2016; WHO, 2021h).

At the same time, ecological criteria are also increasingly finding their way into models on the determinants of human health (Box 2.1-2; Section 3.2.2). Initially, the environmental determinants discussed included local or regional access to clean water and sanitation, hygienic living conditions, air pollution and extreme weather events (WHO, 2012b). Now, global, ecological determinants are also being named, e.g. by integrative and transdisciplinary health concepts such as One Health and Planetary Health (Section 3.3). Natural systems and their ecosystem services are seen here as fundamental determinants of human health and well-being. For example, climatic conditions, biodiversity and intact ecosystems, nitrogen and phosphorus cycles, a functioning ozone layer, but also general access to clean water, oxygen and food are listed (CPHA, 2015).

2.2.6 Trends in determinants of human health

Within the last 50 years, there has been a clear overall trend towards improved social determinants of health and increasing life expectancy. In addition to access to better-quality health services, the main contributory factors have been rising incomes, adequate nutrition, education and better housing conditions. However, the influence of politics on lifestyles and living conditions is also considered to have a great effect (James et al., 2017). In general, a correlation can be observed between rising national income and an increasing life expectancy in the population (Figure 2.2-9).

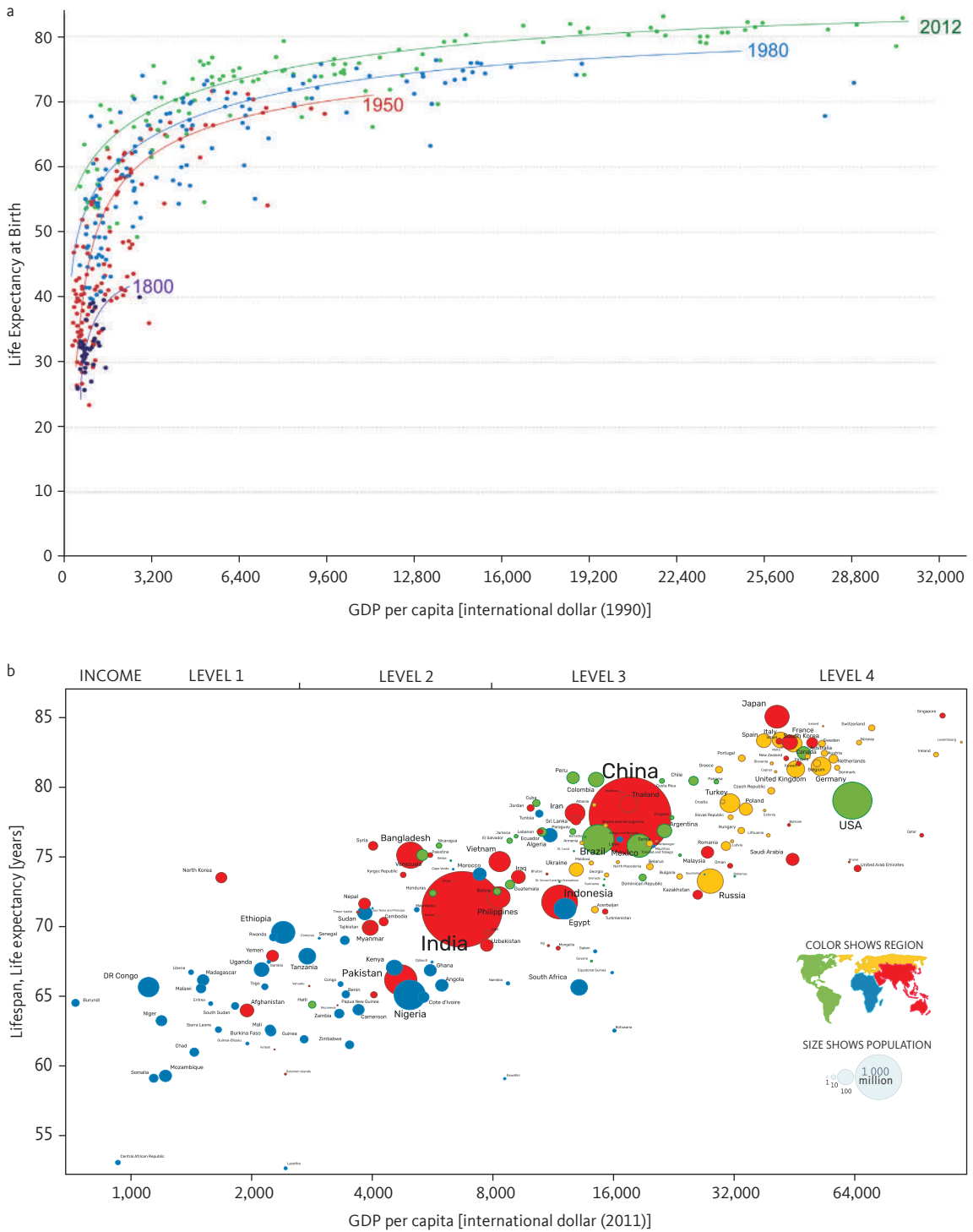


Figure 2.2-9
 Correlation between rising national income and increasing life expectancy in the population.
 Source: Roser et al., 2019

2 Health – a systemic view

However, it should not be forgotten that significant inequalities remain when it comes to life expectancy. While many billions of people have found their way out of poverty, about one billion people continue to live in extreme poverty and have been left behind by the rest of the world's population (World Bank, 2020). In addition, people in countries where a particularly large proportion of the population is below the poverty line also tend to be the furthest below this line (Hasell et al., 2022). Furthermore, the progressively worsening condition of ecological determinants such as climate change, biodiversity loss and pollution is also relevant, including the cumulative impacts of extreme events, especially on vulnerable groups (Section 2.3).

2.2.7

Syndemic times: numerous global health crises are converging

Humanity is already in the midst of numerous global health crises. Even before the COVID-19 pandemic, the simultaneous presence of globally widespread diseases and their risk factors was referred to as a global syndemic. The term syndemic is used to indicate that these different globally widespread health crises or disease risks not only occur simultaneously, but also interact with each other, potentially reinforcing one another. In some cases they are attributable to common causes (Singer, 2009). Swinburn et al. (2019) use the term syndemic to describe the simultaneous and globally cumulative presence of different non-communicable diseases, but also their risk factors (e.g. overweight, undernutrition and malnutrition in humans), as well as common causes of these different health crises (such as climate change, which can influence health both directly and indirectly). However, the term syndemic can also be applied to the aggregation of other widespread health risks such as social inequality, and diseases like mental or infectious diseases, as well as common drivers such as ecological changes (Singer, 2009; Singer et al., 2017).

The complex interaction of individual widespread diseases and disease risks within the syndemic is partly due to self-reinforcing common causes and leads to complex secondary diseases. The underlying causes of syndemics (syndemic drivers) and the resulting challenges posed by the different health crises make joint and integrated action necessary in order to effectively address the global syndemic.

The COVID-19 pandemic has exacerbated this pre-existing syndemic and its risk factors. Similarly, the global prevalence of lifestyle-related risk factors (e.g. unhealthy diets as well as physical inactivity) also became evident – because they influenced the course

of COVID-19 cases. For example, overweight and obese people experience much more severe cases of COVID-19 than people of normal weight (Zhang et al., 2021). In low- and middle-income countries, the COVID-19 pandemic, in combination with various other factors (e.g. unhealthy western lifestyles, economic and social factors), further exacerbated the existing double burden of disease. Thus, the COVID-19 pandemic is part of – or an indicator for – an undesirable global health development and provides a reason to introduce cause-oriented countermeasures that do more than alleviate symptoms.

Despite all its catastrophic consequences, COVID-19 should now be seen as an opportunity to strengthen global, strategic and preventive strategies with the aim of mitigating the global syndemic and thus also anticipated future epidemics or pandemics (e.g. caused by emerging infectious diseases, zoonoses but also other risk factors for non-communicable diseases) as well as their interactions with global environmental changes (Section 2.3).

2.3

Global environmental changes and the health of humans and ecosystems: status quo and trends

The World Health Organization sees climate change as the biggest threat to human health worldwide (WBGU, 2018c). It is an equally serious threat to the health of other living organisms that live together in ecosystems and determine the way the latter function. The World Economic Forum (2021) also believes that it is urgent to extrapolate actions from the realization that climate change, biodiversity loss and environmental pollution not only influence each other, but amplify each other's effects and endanger the health of all living beings. Climate change and biodiversity loss in particular are considered key factors threatening human health (IPCC, 2022c; IPBES, 2019). However, in terms of the planetary boundaries (Rockström et al., 2009b; Box 2.3-1), both already reached levels years ago that threaten the integrity of ecosystems and thus the fundamental prerequisites for sustainable life on Earth (Fanning et al., 2022). There is no doubt that Planet Earth is in a critical condition.

Climate change is advancing so rapidly that the natural adaptive capacity of many ecosystems cannot keep pace. Climate change, rising global pollution and the loss of biodiversity are limiting ecosystem functions and services in many cases. This has profound impacts on societal and economic systems and poses a substantial and multiple threat to human health. As a result, many of the UN Sustainable Development Goals are becoming increasingly difficult to achieve. The extent of the threat to human health posed by global environmental changes

and the urgency of successfully counteracting it are as yet not sufficiently reflected in political action. There are considerable deficits in environmental governance, especially in the national implementation of international regulations and targets (Secretariat of the Convention on Biological Diversity, 2020; Biermann et al., 2022b). Moreover, actors in environmental governance and the health sector are only gradually coming together, most recently accelerated by the COVID-19 pandemic.

The following section begins by explaining the orientation of environmental goals (guard rails) towards the assessment of risks, and then discusses the three environmental crises of climate change, biodiversity loss and environmental pollution as causes of health risks in general. Subsequently, some major health risks resulting from global environmental changes (heat, drought, storms and floods and environmental pollution) are explained in concrete terms as examples. The section also examines how these environmental drivers can interact.

2.3.1

Climate change, biodiversity loss and environmental pollution as drivers of health risks for ecosystems and humans

Climate change is taking on dramatic features. Its effects are also increasingly being felt directly by people in all regions of the world (IPCC, 2019c, 2022c). Caused by anthropogenic greenhouse-gas emissions, the mean temperature of the Earth's surface rose by 1.09°C in the period from 2011 to 2020 compared to the period from 1850 to 1900. The temperature increased more over land areas than over the oceans (1.59°C compared to 0.88°C; IPCC, 2021). Anthropogenic climate change is already having an impact on many regional weather and climate extremes worldwide. For example, the occurrence of extreme heat events, heavy precipitation and droughts has become more frequent and intense since the 1950s (IPCC, 2021). The physical and chemical properties of the oceans are also changing fundamentally (IPCC, 2022d); the intensity of storms is increasing, as is the extent of coastal flooding and habitat loss as the sea-levels rise (IPCC, 2019b; Magnan et al., 2022). A term used for the physicochemical changes in the ocean itself is the 'deadly trio' of ocean warming, hypoxia and acidification (Bijma et al., 2013). In many regions of the world's oceans, the frequency of marine heat waves has also roughly doubled since the 1980s due to the continuous warming of the oceans (IPCC, 2021). According to current projections, these changes will increase further in the course of the 21st century, and their extent will depend on future emissions (IPCC, 2021). For example, if global warming reaches 2°C, the projected number of days of combined

marine heat and acidification extremes will increase from 12 to 265 days per year compared to pre-industrial times (Burger et al., 2022). Extreme impacts on marine ecosystems and their services are to be expected, for example and especially in the Arctic (Orr et al., 2022).

At the same time and parallel to climate change, the loss of biodiversity is also advancing massively, and both processes will intensify more and more in the future. Globally, we are currently experiencing a mass extinction of species. The present extinction rate is 100 to 1,000 times higher than the natural background extinction rate of species (IPBES, 2019). Like climate change, mass species extinction is caused by humans, in particular by the destruction and fragmentation of habitats (IPBES, 2019). 77% of the Earth's land area (excluding Antarctica) and 87% of the ocean area have now been altered by the direct impact of human activities. To date, these changes have resulted in the loss of over 50% of plant biomass and around 83% of wild mammal biomass (Erb et al., 2018; IPBES, 2019: XXIX, 232). Humans and livestock today account for almost 96% of total mammalian biomass (IPBES, 2019). This means that all other mammals combined – from anteaters and elephants to bats and zebras – account for only 4% of biomass. Human over-exploitation of nature and the associated degradation of our own habitat are causing the loss of ecosystem services and biosphere resilience. As a result, our overexploitation of nature endangers not only the survival, performance and health of animal, plant and other species responsible for maintaining ecosystems and their services, but also the long-term well-being and health of humans, both directly (e.g. through the increased incidence of zoonoses; Box 2.3-2; Figure 2.3-2; Section 5.1) and indirectly (e.g. through a scarcity of biogenic resources and an increase in climate change; Figure 2.3-3).

Despite all existing knowledge, human interaction with the biosphere is predominantly geared towards short-term profits while accepting long-term damage. The biosphere is seen as a resource that can be exploited until it is exhausted (Maron et al., 2019). The destruction of ecosystems that drives biodiversity loss also exacerbates climate change – examples include deforestation, the destruction of marine ecosystems and the loss of peatlands. Furthermore, biodiversity plays an important role in the stability, adaptability and resilience of ecosystems vis-à-vis environmental changes like climate change. Climate change, too, causes damage to ecosystems, reducing the capacity of plants to absorb CO₂. This can change ecosystems from a carbon sink into a carbon source, and possibly even kill them. The degradation and destruction of these valuable ecosystems – exacerbated by climate change – means that less carbon can be stored; the contribution to climate-change mitigation is increasingly lost (WBGU, 2020).

Box 2.3-1**Risks and planetary guard rails – how much is too much?**

The WBGU has proposed and applied the concept of planetary guard rails for dealing with global environmental changes (WBGU, 1994, 2005, 2006, 2020). Guard rails are “quantitatively definable damage thresholds, whose transgression either today or in future would have such intolerable consequences that even large-scale benefits in other areas could not compensate these” (WBGU, 2011: 32). Beyond the guard rails the area begins where anthropogenic environmental changes represent a risk that is no longer acceptable to society and would overtax the ability of societies, species and ecosystems to adapt. Thus, planetary guard rails are not variables that can be extrapolated from scientific knowledge alone, but normative determinations that should be made by policy-makers on the basis of scientific knowledge within the framework of democratic processes.

The WBGU first proposed guard rails for anthropogenic climate change (WBGU, 1995, 1997), and later also for other global environmental changes such as biodiversity loss (WBGU, 2000), soil degradation (WBGU, 1994, 2005, 2020), ocean acidification (WBGU, 2006) and the threat posed by persistent pollutants (WBGU, 2014b). For some of these issues, such damage thresholds have now also been laid down in international agreements, e.g. a temperature limit for climate change in the Paris Agreement, or the goal of land degradation neutrality in SDG 15.3 and the UNCCD’s Strategic Framework 2018–2030. Land degradation neutrality “is a state whereby the amount and quality of land resources necessary to support ecosystem functions and services and enhance food security remain stable or increase within specified temporal and spatial scales and ecosystems” (UNCCD, 2015). However, up to now too little attention has been paid to how boundary conditions of life narrow when different environmental changes interact (Figure 2.1-1). This is also relevant when setting guard rails. The risk analyses in the sixth Assessment Report of the IPCC are related to setting guard rails. For example, according to the IPCC (2022d), the transition from moderate to high (no longer acceptable) risk occurs at about 1.5°C of warming in different sectors, systems and regions – an impressive confirmation of the ambitious side of the Paris climate goal as a guard rail for efforts to limit global warming (Figure 2.3-1). The IPCC’s risk analysis also takes into account cumulative risks and resulting shifts in the transition between risk zones. For example, the review of the five main global risk complexes (‘Reasons for Concern’) in the sixth Assessment Report revealed that the risk transitions currently have to be set at lower degrees of warming. This also confirms a maximum warming of 1.5°C as the most sensible guard rail for climate policy.

Planetary guard rails define boundary conditions as an orientation for political and societal action. They do not represent targets, but minimum requirements that must be met in order to achieve sustainable development. A forward-looking sustainability policy should prevent any imminent transgressing of the guard rails in time – or make it possible to return to the ‘prior’ zone if the guard rail has already been transgressed (WBGU, 2014b).

The planetary boundaries proposed by Rockström et al. (2009a, b) also point in a similar direction. Planetary boundaries aim to define a safe operating space derived primarily from the relatively stable conditions of the Holocene (Rockström et al., 2009 a, b; Steffen et al., 2015a). The planetary boundaries describe in various dimensions those environmental changes that will irreversibly damage the Earth and its conditions for

life (Steffen et al., 2015a). They represent “scientifically based levels of human perturbation of the earth system beyond which earth system functioning may be substantially altered” (Steffen et al., 2015b). Planetary boundaries do not describe thresholds or tipping points of the processes themselves, rather they lie ‘below’ the respective thresholds in order to compensate for possible uncertainties regarding the thresholds set (relative to the respective control variable) and to provide society with a timeframe for action (Steffen et al., 2015a). As a result of new scientific findings and discourses, the planetary boundaries are subject to constant, dynamic further development. For example, it has been proposed that the definition of a planetary boundary for biodiversity should be revised and adjusted (“retaining at least half of the area of each terrestrial ecoregion biologically intact to halt the extinction crisis and maintaining ecosystem integrity across all lands to preserve and regenerate biosphere, ecosystem functions and their contributions to human well-being”; DeClerck et al., 2021). Similarly, the boundary for marine biodiversity needs to be reviewed again and again. Exceeding the safe operating space was recently also postulated for the boundary for novel entities in the geological sense, e.g. chemicals that could have large-scale impacts and threaten the integrity of Earth-system processes (Persson et al., 2022). The introduction of new boundaries has also been proposed – e.g. only recently for green water (terrestrial precipitation, evaporation and soil moisture; Wang-Erlandsson et al., 2022).

The WBGU prefers to use the concept of guard rails in the sense of a societal agreement on which risks are to be avoided. As a basis, the risk assessment of the sixth IPCC Assessment Report makes risk levels systematically comparable across sectors and systems, taking system characteristics into account (e.g. their vulnerability and exposure to climate change).

The following reflections use the example of temperature to show how scientific findings can make the societal-political negotiation of guard rails possible: for all species, humans and their civilization, there is a corridor with conducive living conditions which is characterized, for example, by a suitable temperature range and factors that interact with it. On both sides of this optimum – i.e. at lower and at higher temperatures – conditions become increasingly unfavourable, also for humans (Pörtner, 2021; Xu et al., 2020; IPCC, 2022a). The IPCC’s report explicitly avoids speaking of boundary conditions in the sense of a more or less abrupt transition from good to bad, but talks about a progressive development of risk levels caused by adverse developments in ecosystems and human societies as global warming increases.

Although the specific impacts of climate change differ in each of the systems under consideration, a comparable determination of the risk level from low to very high can be made despite these differences (Figure 2.3-1). Unlike the previous report, the last Assessment Report of the IPCC Working Group 2 (IPCC, 2022d) stated that at 2°C warming the risk for many systems was already considered to be high, while, at 1.5°C warming, the risk level could still be classified as moderate (Figure 2.3-1c). Only few systems, e.g. warm-water coral reefs, are already very seriously damaged when the temperature rises by this amount. In many regions, these systems are already beyond their tipping point and in the high-risk phase at the current level of warming. At other tipping points in the Earth system, the risk development for humans and nature can also intensify (‘accelerate’) across a narrow warming range, e.g. as a result of a rapid sea-level rise due to the destabilization of Antarctic ice shelf edges. The projected impacts of climate change, together with the findings that the risk levels in the fifth IPCC Assessment Report were judged too conservative, make an impressive case for a guard rail of 1.5°C.

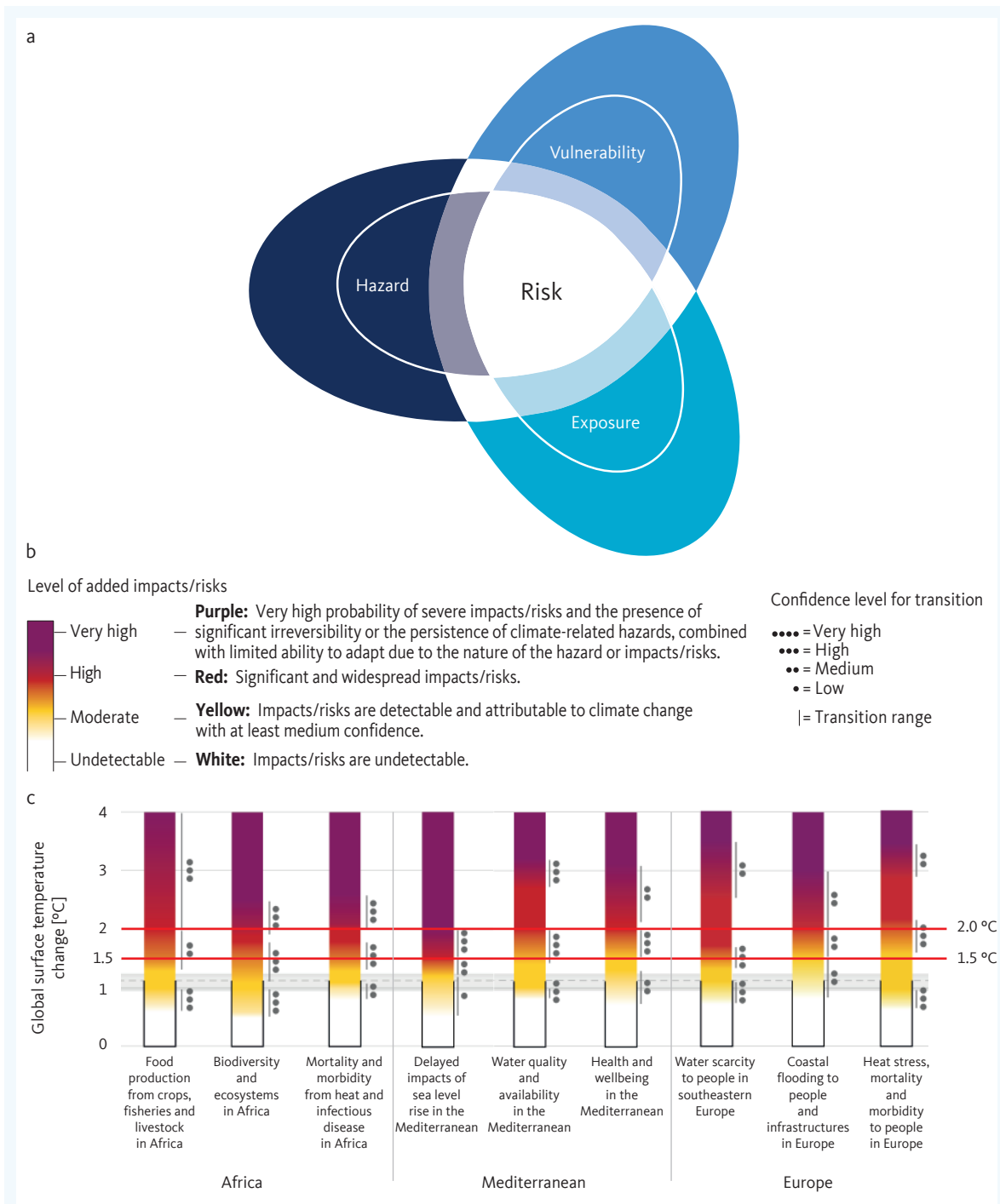


Figure 2.3-1

(a) The IPCC risk concept. The level of risk is deduced from the overlap of the environmental driver or hazard, vulnerability and exposure (of ecosystems and human societies), as illustrated in the propeller diagram. (b) The colour transitions in the ‘burning ember’ diagrams characterize the increase in the risk level depending on global warming and associated climate changes. The confidence level reflects the certainty of the semi-quantitative finding. Climate-change mitigation and various adaptation options reduce the risk, but there are limits to adaptation associated with an increase in climate damage. (c) Examples of key regional risks for Africa, Europe and the Mediterranean. Identified risks have at least a medium confidence level. The key risks were identified based on the magnitude of negative consequences and their likelihood and timing (how extensive, how big is the change, is it irreversible, will thresholds or tipping points be exceeded, or will cascading effects occur across system boundaries?). The ability to respond to the risk, e.g. through adaptation, was taken into account. Source: IPCC, 2019b: 46, excerpt; IPCC, 2019a: 23, excerpt; IPCC, 2022c: 17, merged excerpts

Box 2.3-2

Emerging and redistributed diseases: consequence of climate change, globalization and pollution

According to recent analyses, half of all human infectious diseases are being intensified by climate change due to shifts in the geographical distribution of pathogens and milder winters, flooding, the collapse of hygiene standards or a general reduction in the distance between people and disease vectors (Mora et al., 2022). Diseases affecting domestic animals, wildlife and plants are also affected by the changing climatic conditions, and this can also affect human food security. For example, the occurrence, intensity, species composition and toxicity of marine and freshwater algal species and bacteria (e.g. *Vibrio* spp.) change as a result of altered water parameters, and this can have an impact on the safety of aquatic food (IPCC, 2022c).

Shifts in wildlife habitats caused by climate change and alterations in human land use make zoonoses – diseases that are transmitted from animals to humans and vice versa – more likely (IPBES, 2020; Section 5.1.2.2). The tiger mosquito, for example, a carrier of several diseases – some of them serious – had been almost wiped out in Central Europe, but is now spreading back into Germany due to global warming (Pluskota et al., 2016; Nationale Expertenkommission “Stechmücken als Überträger von Krankheitserregern” am Friedrich-Loeffler-Institut, 2016).

In many cases, changing conditions of land use (e.g. deforestation, industrial agriculture or the establishment of artificial irrigation systems and reservoirs) lead to an increase in zoonotic infectious diseases in humans (Gottdenker et al., 2014). Habitat destruction and degradation force wildlife to move to habitats that are closer to humans, increasing the likelihood of contact and transmission. Zoonoses generally have the potential to cause pandemics, i.e. to spread across the entire planet (Alimi et al., 2021). This is not least a consequence of increasing international trade and travel in a globalized world (WEF, 2019). It is estimated that all viral pandemics since the beginning of the 20th century have been caused by animal-to-human transmission (Vora et al., 2022). However, a zoonotic risk also exists in cities, where urbanization is often rapid and chaotic, facilitating the spread of disease due to a high population density coupled with low living standards and a lack of hygienic infrastructure. One example of such diseases is leptospirosis – an illness often caused by contact with water or mud contaminated by rodent urine. Such conditions affect mainly socially disadvantaged population groups.

Another health consequence of climate change is considered to be an increase in asthma and allergy symptoms, since pollen can fly for longer and new heat-loving plants migrate into certain areas (Lake et al., 2017). Asthmatic and general respiratory diseases are favoured by fine-dust pollution. Successful human adaptation to all these challenges depends, among other things, on the success of emission reductions and meeting climate targets, but also on strengthening hygiene measures and healthcare (Figure 2.3-2).

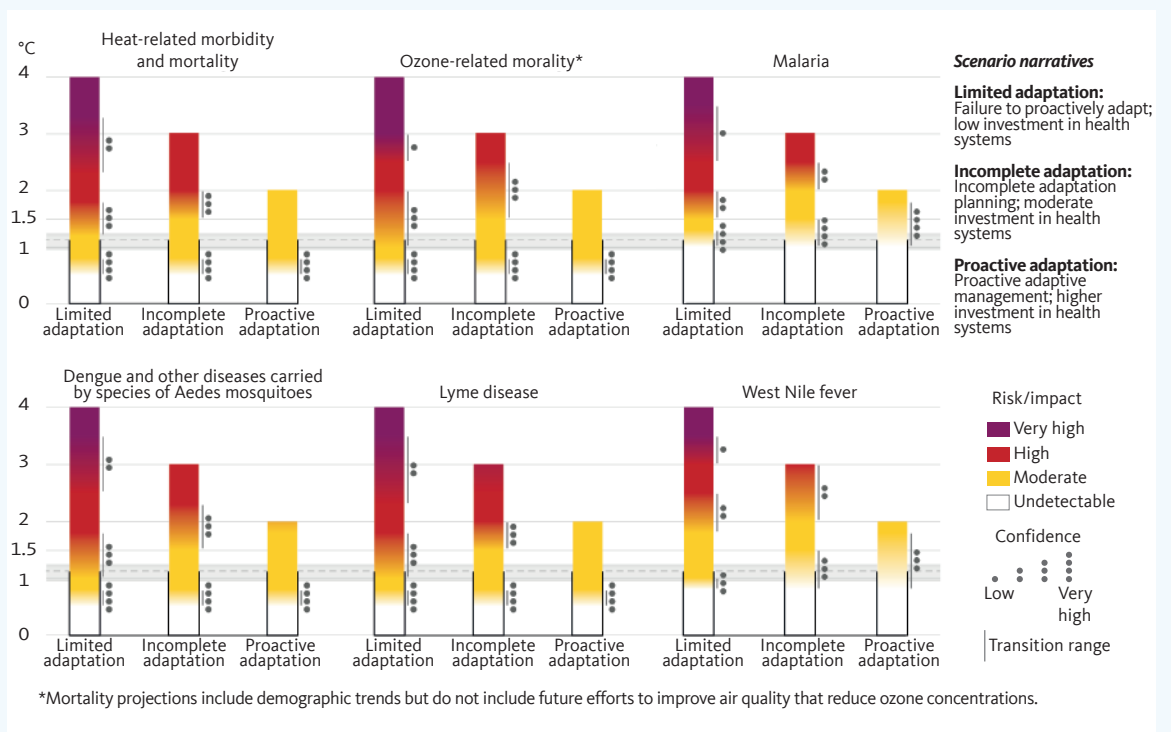


Figure 2.3-2

Climate-sensitive health outcomes under three adaptation scenarios. If warming remains between 0 and 2°C, proactive adaptation measures can limit the health impacts of climate change to a moderate risk level. The diagrams were truncated according to the scenario where the next integer temperature increase (in °C) is reached in 2100. For further explanations see Figure 2.3-1b.

Source: IPCC, 2022a: 2881

Furthermore, ecosystems are threatened by increasing environmental pollution, which also has effects on humans. Pollution of air, water and soil is now the most important environmental cause of human disease and premature death worldwide. Pollution-related diseases lead to about nine million premature deaths a year, which is 17% of all deaths worldwide (Fuller et al., 2022). The number of deaths attributable to ambient air pollution and toxic chemicals has increased by 66% since 2000 (Fuller et al., 2022), so that environmental pollution has led to significantly more deaths than AIDS, tuberculosis and malaria combined (Fuller et al., 2022). In some regions many sites are still contaminated as a result of previous human activities in the environment. Contamination with carcinogenic chlorine compounds (e.g. polychlorinated biphenols) or microplastics has even been detected in the most remote regions of the Earth, such as the deep sea or the Antarctic (Jamieson et al., 2017, 2019; Aves et al., 2022). This is exacerbated by the increasing presence of novel substances that are directly hazardous to health (Section 5.2). The consequences of these chemical cocktails – some of which have highly complex compositions – for nature and humans have only been rudimentarily researched up to now. Chemicals that are hazardous to health can also directly reduce biodiversity. Plastic waste, especially microplastics, and the rapidly growing amount of electronic waste pose a threat to the integrity of ecosystems. In 2019, approx. 53.6 million tonnes of electronic waste was generated globally, an increase of 21% in just five years (Forti et al., 2020). The disposal and incineration of plastic waste and electronic waste also result in feedback effects with climate change (Wiedinmyer et al., 2014; Royer et al., 2018; EPA, 2022).

Already, the three environmental crises – climate change, biodiversity loss and environmental pollution – which the UN Environment Programme (UNEP) now intends to concentrate on, are having negative effects on human health all over the world – although not with the same intensity everywhere. For example, nearly 92% of pollution-related deaths occur in low- and middle-income countries. In countries of all income levels, minorities, discriminated groups and vulnerable population groups are disproportionately affected by pollution (Landrigan et al., 2018). This affects children in particular (Box 2.3-3; UNICEF, 2021). It means that the people who contributed the least to the causes are increasingly bearing the consequences.

2.3.2

(Extreme) heat: it is getting too hot for people, animals and plants

Heat acts as a direct stressor on the organism and reduces performance and productivity; the growth of individuals and the population is restricted. Very few living beings can actively regulate their temperature. About 90% of all animals have a body temperature close to the ambient temperature, which they can influence through behaviour and positioning in temperature gradients or radiant heat. These species are particularly affected by climate change, as their temperature window also determines their geographical distribution. A changing climate will therefore also redefine the distribution limits of species, leading to new encounters and competitive situations and increasing the risk that species may become locally extinct. For organisms that can raise their temperature endothermically above the ambient temperature, such as humans and other mammals or birds, and regulate it by moisture evaporation (e.g. sweating or panting), it is the combination of heat and humidity – measured as wet-bulb temperature – that determines the effects of heat on health. The wet-bulb temperature indicates the lowest temperature that can be achieved by direct cooling via water evaporation. Since humans generate approx. 100W of power during metabolic processes which are dissipated as heat to the environment via the skin, skin temperatures above 35°C over several hours lead to increased core body temperatures. For this reason, wet-bulb temperatures of 35°C or more are lethal even for healthy people, as no heat can be released from the skin to the surrounding air (Sherwood and Huber, 2010). If wet-bulb temperatures of 35°C (corresponding to an air temperature of 40°C at a relative humidity of 70%) persist for several hours, this is lethal even in a shady, well-ventilated environment. This can be regarded as the upper temperature limit for human survival. But wet-bulb temperatures well below 35°C are also dangerous, as shown by past heat waves with thousands of deaths in South Asia (Im et al., 2017). Similar upper limits apply to other mammals, although these may vary depending on the core body temperature and mass (Sherwood and Huber, 2010). At a global average temperature rise of 2°C and the associated regular wet-bulb temperatures, without technical adaptation measures certain regions will become uninhabitable, at least seasonally (Mora et al., 2017; Im et al., 2017; Kang and Eltahir, 2018; IPCC, 2022c; Figure 2.3-4). Accordingly, even at 1.5°C, a significant proportion of the population will temporarily be living outside the thermal niche that is congenial to humans (Xu et al., 2020; IPCC, 2022c; Figure 2.3-5).

Heat waves are becoming much more frequent and intense due to climate change (IPCC, 2022c) and are a

2 Health – a systemic view

Ecosystem services		Global 50-year trend	Cross-regional trends	Selected indicators
REGULATING	1. Creation and conservation of habitats	↓	○	<ul style="list-style-type: none"> • Availability of suitable habitats • Integrity of biodiversity
	2. Pollination and seed dispersal, etc.	↓	○	<ul style="list-style-type: none"> • Pollinator diversity • Expansion of near-natural elements in agricultural landscapes
	3. Regulation of air quality	↓	↕	<ul style="list-style-type: none"> • Retention and prevention by ecosystems of air-pollutant emissions
	4. Climate regulation	↓	↕	<ul style="list-style-type: none"> • Avoidance of emissions and absorption of greenhouse gases by ecosystems
	5. Regulation of ocean acidification	→	↕	<ul style="list-style-type: none"> • Capacity of land and oceans to absorb carbon
	6. Regulation of quantity of fresh water	↓	↕	<ul style="list-style-type: none"> • Influence of ecosystems on water distribution (surface and groundwater)
	7. Regulation of the quality of freshwater resources and coastal waters	↘	○	<ul style="list-style-type: none"> • Availability of ecosystems as water filters and guarantors of water quality
	8. Composition, protection and decontamination of soils	↓	↕	<ul style="list-style-type: none"> • Organic carbon in the soil
	9. Regulation of risks and extreme events	↘	↕	<ul style="list-style-type: none"> • Capacity of ecosystems to act as a buffer against hazards
	10. Regulation of pests and diseases	↓	○	<ul style="list-style-type: none"> • Expansion of near-natural elements in agricultural landscapes • Diversity of suitable hosts
MATERIAL	11. Energy	↘	↕	<ul style="list-style-type: none"> • Expansion of agricultural land – potential area for bioenergy • Extension of forestry land
	12. Foodstuffs and feeds	↓	↕	<ul style="list-style-type: none"> • Expansion of agricultural land – potential area for foodstuffs and feeds • Abundance of marine fish stocks
	13. Materials and support	↘	↕	<ul style="list-style-type: none"> • Expansion of agricultural productiveland – potential area for material production • Extension of forestry land
	14. Medical, biochemical and genetic resources	↓	○	<ul style="list-style-type: none"> • Proportion of species known to have medicinal properties • Phylogenetic diversity
NON-MATERIAL	15. Education and inspiration	↓	○	<ul style="list-style-type: none"> • Number of people who feel close to nature • Diversity of life as a learning stimulus
	16. Physical and psychological experience	↓	○	<ul style="list-style-type: none"> • Expansion of near-natural and traditional landscapes and marine areas
	17. Emotional attachment to home	↓	○	<ul style="list-style-type: none"> • Continuity of feeling for the landscape
	18. Options for the future	↓	○	<ul style="list-style-type: none"> • Probability of species survival • Phylogenetic diversity



Figure 2.3-3
Ecosystem services and their importance for health.
Source: WBGU, based on IPBES, 2019

Examples of their importance for human health			
1.	Intact, i.e. functioning and resilient ecosystems are habitats in which all species, including humans, can live undisturbed. Intact ecosystems also have a prophylactic effect with regard to	conflicts between humans and wild animals. Being exposed to a high degree of biodiversity improves people's mental well-being. Furthermore, a high level of diversity, e.g. of	agricultural crops and pollinators like insects or birds, is important for global food production.
2.			
3.	Functioning ecosystems and their material cycles are essential for regulating and cleaning the air, water and climate. Plants, for example, absorb poisonous and other substances that are harmful to health, thus providing clean air for breathing. Forests and other vegetation-rich ecosystems store water in the soil and ensure the availability of drinking water by creating groundwater. The structure of multilayered and fertile soil is the basis of functioning terrestrial ecosystems and, e.g., the filtering of water or the agricultural cultivation of food. Coastal vegetation protects the land and human infrastructures which lie behind it from storms and flooding. Habitats that are	as undisturbed as possible by humans reduce the probability of new diseases emerging and spreading to humans. Furthermore, a biodiverse fauna effectively regulates the populations of pests and disease vectors.	
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.	Wind and hydroelectric power, as well as sustainable forestry and agriculture can contribute to the production of renewable energy and thus to the energy transition. Moving away from fossil fuels as an energy source is essential to counteract climate change. At the same time, sustainable	cultivation methods in agriculture, forestry and aquaculture can contribute to healthier food, global food security and climate stabilization.	
12.			
13.			
14.	The conservation of genetic diversity in animal and plant species, especially old and traditional varieties, is important	for the resilience of ecosystems. Furthermore, many plant species are the basis for the manufacture of medicines.	
15.	Environmental education that creates an awareness of the importance of biodiversity for human health is essential for a sustainable interaction with biological diversity. In various, especially Indigenous cultures, a	respectful attitude to nature is deeply ingrained in society. Such an attachment to nature, coupled with the knowledge that our home and places where we feel good are doing well, reduces stress and boosts our well-being. High biodiversity,	e.g. in green and blue urban spaces, contributes to our general human well-being.
16.			
17.			
18.	The conservation of biodiversity serves present and future generations. Much of global biological diversity, including plants and animals, has not yet even	been discovered. Who knows what methods or biogenic resources are still to be discovered and can be used, for example, to heal diseases? Only intact	ecosystems can maintain options for the future.

REGULATING

MATERIAL

NON-MATERIAL

Box 2.3-3**Children as an example of a vulnerable population group**

Children are particularly vulnerable to the impacts of climate change and biodiversity loss. According to calculations made by UNICEF, virtually all children on Earth are exposed to at least one of the risks analysed in the UNICEF Climate Risk Index: 820 million children are already suffering severely from heat waves; 570 million children in coastal regions and along rivers are exposed to flooding; 400 million children are at risk from hurricanes; 920 million children are already suffering from water scarcity. Infectious diseases transmitted by mosquitoes or other disease vectors are also on the increase due

to climate change, and already threaten 600 million children. 850 million children, i.e. about one third of all children worldwide, live in regions where several of the above-mentioned hazards resulting from environmental changes occur together (UNICEF, 2021).

Environmental pollution is also a particular danger for children. 815 million children are affected by lead poisoning. As many as one billion children are affected by ‘extremely high’ air pollution (UNICEF, 2021). Globally, in 2016 for example, pollution was responsible for 940,000 child deaths; two-thirds of the children affected were under the age of five. Unborn and newborn children are particularly vulnerable to environmental pollution. Even extremely low doses of pollutants lead to increases in illness, disability or death in early childhood (Landrigan et al., 2019).

threat to the health of humans, animals and plants. The temperature stress triggered by heat waves has profound physiological consequences for flora and fauna and increases the mortality of species – including higher human mortality – at the respective limits of distribution, and also causes a loss of ancestral habitats (Ruthrof et al., 2018; Stillman, 2019).

In addition to directly heat-related morbidity and mortality, high temperatures in humans can lead to an aggravation of pre-existing conditions such as respiratory, cardiovascular and renal diseases or diabetes (Watts et al., 2021), as well as effects on mental health such as increased aggressiveness or even suicide (Thompson et al., 2018). Heat-related mortality has risen by about 68% among older people (>65 years) in the last two decades (Romanello et al., 2022). Tens of thousands of people died, especially elderly people (UNEP, 2004), during the 2003 European heatwave alone, and the high temperatures in the summers of 2018 to 2020 also led to thousands of heat-related deaths (Winklmayr et al., 2022). In Europe’s hottest summer to date in 2022, excess mortality even exceeded 100,000 people (Rahmstorf, 2022). This can be observed particularly in conurbations – the ‘urban heat islands’ – where outdoor temperatures (especially at night) are higher than in rural or suburban areas (Kovats and Hajat, 2008) due to a high degree of soil sealing and lack of plant cover. The vulnerability of different population groups to excessive heat exposure varies for physiological but also socio-economic reasons. Particularly vulnerable population groups include people with chronic pre-existing conditions, but also older and very old people, infants and children, pregnant women and socio-economically disadvantaged people (WHO, 2022k; Watts et al., 2021).

Heat in combination with other factors, such as droughts, has also already led to mass deaths of wild organisms in terrestrial, freshwater and marine

ecosystems. Plants are particularly affected (Teskey et al., 2015; Marchin et al., 2022). Forests, for example, are vulnerable to warming and drought, and more and more trees are dying (Teskey et al., 2015; Hammond et al., 2022). Heat waves can also have serious and lasting effects in marine ecosystems (IPCC, 2021a). These range from coral bleaching followed by coral dieback (Hughes et al., 2018) to declining yields in fisheries and mariculture due to the decrease in biomass or shifts in the distribution limits of fish stocks (Cheung and Frölicher, 2020; IPCC, 2021a). This is especially problematic for poorer regions that are particularly dependent on these yields (Whitmee et al., 2015; IPCC, 2022c). Heat-related adverse effects in agriculture and forestry are also increasing. Milk production in cows is reduced, as is egg production in poultry (Amamou et al., 2019; Kumar et al., 2021; Thornton et al., 2022). In addition, heat waves without droughts or intensified by droughts jeopardize the water supply and quality as well as harvest yields. In the case of crops, this leads to a reduced build-up of biomass and ultimately to crop failures (IPCC, 2019c).

At the same time, the efficiency of the rural population decreases, further endangering harvest yields (IPCC, 2022c). As heat waves affect the health of humans, animals and plants, food chains are disrupted and, not least, food security and the provision of a diverse, healthy human diet are jeopardized (IPCC, 2019c, 2022c). This exacerbates the problems of hunger, undernutrition and malnutrition that continue to exist worldwide (Section 4.1). In 2020 for example, approx. 98 million additional people were affected by moderate to severe food insecurity compared to the 1981–2010 average (Romanello et al., 2022).

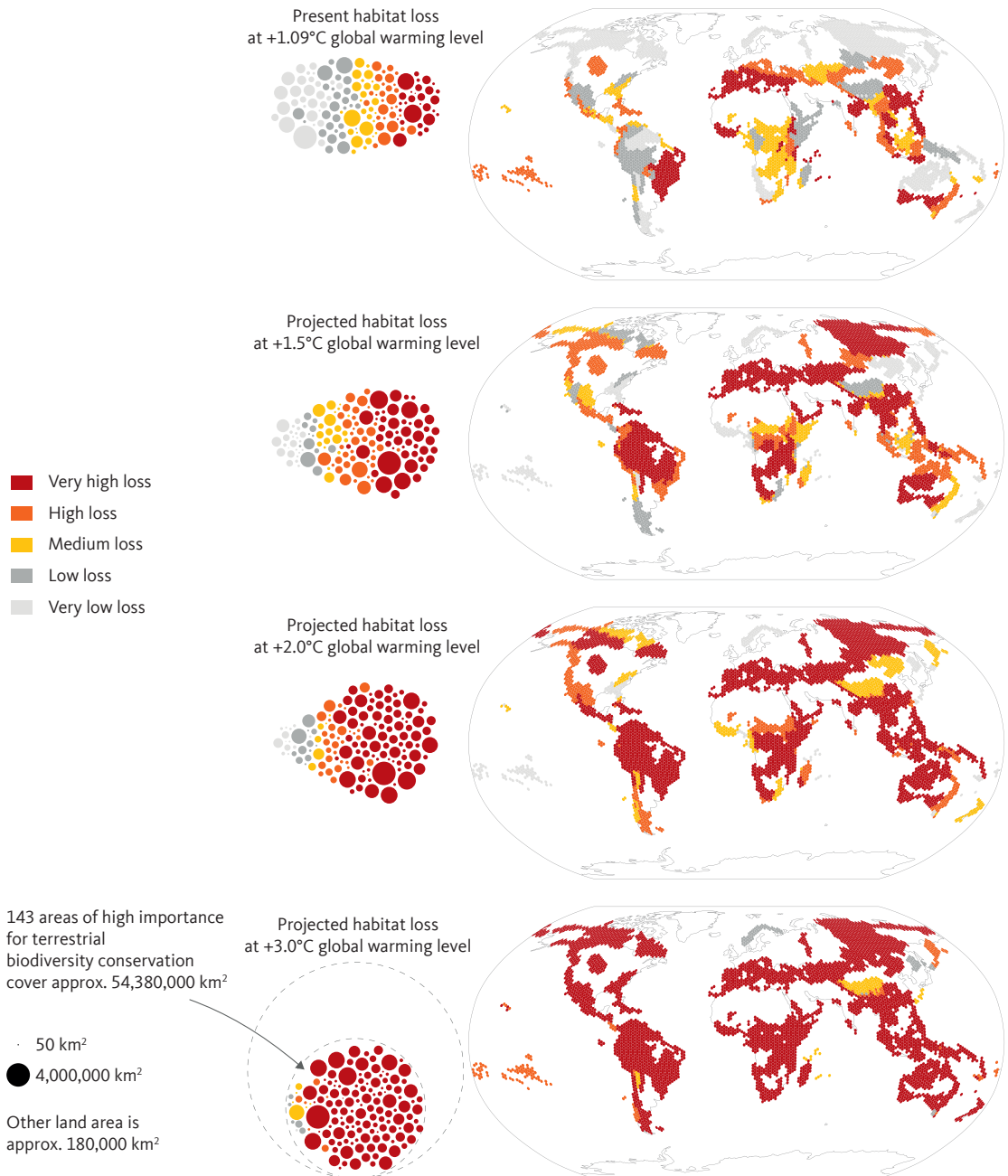


Figure 2.3-4

Present and projected habitat losses of climatically suitable areas in terrestrial biodiversity hotspots. Projected loss for present day (around 1°C warming) and at global warming levels of 1.5°C, 2°C and 3°C. Maps (on the right) show the regional distribution of losses in five categories of loss (very low loss 0–20%, low loss 20–40%, medium loss 40–60%, high loss 60–80%, very high loss 80–100%). The clusters of circles (in the middle) show losses in the five categories of loss in each of the 143 hotspot areas of high importance for terrestrial biodiversity conservation, with circles scaled by area size. Comparable habitat losses are also to be expected in the ocean.

Source: IPCC, 2022a: 2822

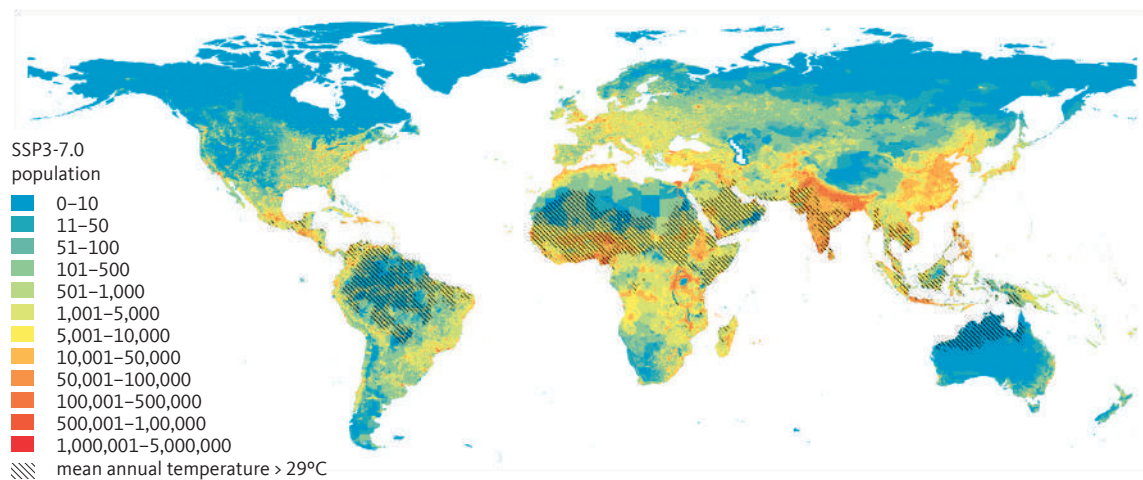


Figure 2.3-5

Overlap between future population distribution and extreme heat. CMIP6 model data (Coupled Model Intercomparison Project Phase 6; from nine global climate models available from the WorldClim database) were used to calculate the mean annual temperature (MAT) under SSP3-7.0 (Shared Socioeconomic Pathway) around 2070 (2060–2080) alongside Shared SSP3 demographic projections ~2070. The shaded areas depict regions where the MAT exceeds 29°C, while the coloured topography details the spread of population density.

Source: Kemp et al., 2022

2.3.3 Droughts

In addition to heat waves, droughts also have a wide range of impacts on human, animal and plant health. Droughts are caused not only by heat but also by precipitation deficits and a consequent lack of surface and groundwater. This usually results in problems with the available water quality and additional problems of drinking-water shortages, hygiene and food production that affect humans in particular. Droughts destroy arable and pasture land and accelerate soil degradation, especially in the world's arid regions (desertification), thus destroying the life-support systems of many people. When droughts continue for longer periods, the functionality of ecosystems collapses; biodiversity and services are also lost for humans.

The acute shortage of water due to a lack of precipitation leads not only to increased plant mortality due to desiccation but also to an increased risk of forest fires. Forest fires not only destroy ecosystems over large areas, they also release the carbon stored in vegetation in the form of CO₂, which contributes to climate change. Furthermore, droughts reduce plant growth rates and CO₂ uptake by ecosystems, which is considered important for mitigating climate change and stabilizing the climate (Zhao et al., 2022; Green et al., 2019). Since the moisture content of the atmosphere is lower than usual during periods with lower or without precipitation, more water may be released by plants and soils via evapotranspiration, further accelerating the depletion of water resources

and increasing the stress on ecosystems (Zhao et al., 2022). The long-term effects of droughts on watersheds should also not be underestimated. Even several years after the end of a drought, run-off can remain permanently lower than before the drought, with substantial consequences for aquatic ecosystems and planning for the human use of water resources (e.g. for irrigation or the drinking-water supply; Peterson et al., 2021).

Today, an estimated quarter of the world's population already lives in regions with acute or extreme water scarcity (Hofste et al., 2019). Arid areas make up 40% of the terrestrial land area and are home to about 30% of the world's population (Feng and Fu, 2013). Climate change will lead to an expansion of the world's arid zones (Feng and Fu, 2013). Projections see urban water demand increasing by up to 80% by 2050 and a lack of surface water availability to meet local water needs in about 27% of all cities worldwide (Flörke et al., 2018). In many places, the natural renewal of freshwater resources is already failing to keep pace with extraction rates. This already strained situation as regards global freshwater availability is being exacerbated by climate change. In addition to a decrease in water quantity, droughts also lead to a substantial decline in water quality (Whitehead et al., 2009), which affects drinking-water supplies.

Furthermore, an increase in direct adverse effects on public health from pathogenic germs and chemicals is to be expected (McClung et al., 2018; Fenwick, 2006; Schwarzenbach et al., 2006; UNESCO, 2020). Today, hygienically compromised water is already one of the biggest global health and environmental

problems – especially for the world’s poorest people. Current estimates suggest that about 1.3 million people die each year as a result of water pollution (Fuller et al., 2022). The water shortage that accompanies droughts affects not only drinking water supplies but also agricultural irrigation. An increase in acute food insecurity caused by droughts has already been observed in Africa and in Central and South America (IPCC, 2022d).

2.3.4 Storms: cyclones are becoming more intensive

As global warming progresses, the intensity and percentage of strong (category 4–5) hurricanes or tropical cyclones will increase (IPCC, 2021a). As cyclone intensity increases, so will flooding, further intensified by accelerated sea-level rise (Woodruff et al., 2013; Section 2.3.4). The mortality risk depends, among other things, on the intensity of the cyclones and the exposure of species and humans. Cyclones cause dramatic structural changes in ecosystems, especially coastal ecosystems (for example through deforestation, coastline reshaping or through land loss). In addition to direct impacts (injury and death) and habitat loss, these changes in the biotope also have an indirect effect on wildlife and ecosystems and their services (via food availability). In addition to droughts and floods, cyclones (and especially their consequences and risks to economic livelihoods) are among the main reasons why people migrate (IPCC, 2022c: 52; O’Neill et al., 2017). Already today, about 120 million people are affected by the negative impacts of cyclones every year (Mitchell et al., 2014). The projected increase in the global population and in the intensity of tropical cyclones over the next 20 years suggests that the risk of human health being affected by cyclones will increase significantly (Matthews et al., 2019; Peduzzi et al., 2012). Although cyclone-related mortality has been rather low over the last two decades (EM-DAT, 2022; Mitchell et al., 2014), cyclones pose other serious health risks to humans. This is because, in addition to direct storm-related deaths, cyclones cause numerous injuries, infectious diseases, psychosocial consequences, displacement and homelessness, damage to the health infrastructure, disruption of public health services, destruction of ecosystems and their services, social upheavals, loss of jobs and livelihoods, and economic crises. Developing countries are disproportionately affected by the negative impacts of cyclones (Shultz et al., 2005).

2.3.5 Flooding due to extreme precipitation and sea-level rise

Climate change is expected to lead not only to heat waves but also to more frequent and more severe heavy rainfall events and to a significant increase in the risk of flooding (pluvial and fluvial, i.e. caused by rain or rivers; IPCC, 2022c; O’Neill et al., 2017). The impacts of flooding on existing ecosystems can be positive (e.g. higher production due to increased nutrient input into aquatic habitats) or negative (e.g. through disease and wildlife death by drowning but also through habitat destruction). Like heat waves, floods also cause significant human morbidity and mortality worldwide. The health effects of floods on humans are diverse and depend on a number of factors (Du et al., 2010; Alewell et al., 2020). Floods have both short-term and long-term health consequences (Alderman et al., 2012). It is estimated that floods have claimed almost 54,000 lives worldwide in the last ten years (EM-DAT, 2022). Most flood-related deaths have occurred in poor countries and communities, mainly due to their greater vulnerability to disasters and poor disaster-management systems (Alderman et al., 2012). The main causes of morbidity among affected residents and relief workers immediately after floods are injuries and wound infections, inflammatory reactions of the skin, conjunctiva and respiratory tract, as well as a worsening of pre-existing chronic diseases (WHO Europe and UNECE, 2014). Floods are also associated with an increased risk of water- and vector-borne diseases such as cholera, diarrhoeal diseases, hepatitis A and E, leptospirosis, parasitic diseases, rotavirus, shigellosis (bacterial dysentery) and typhoid, especially if infrastructure is severely affected and water-supply systems are damaged, leading to a contamination of drinking water (WHO, 2014d; WHO Europe and UNECE, 2014). Furthermore, floods can lead to the release of toxic chemicals, which has a particular impact on populations living near flooded industrial or agricultural areas (Alderman et al., 2012).

Indirectly, floods can also contribute to compromising food security, drinking-water supply, social-system support or economic systems, thus also exacerbating existing poverty and resulting in further negative health consequences (Ramin and McMichael, 2009; Schwartz et al., 2006). This is particularly important in view of the ongoing sea-level rise. Even in scenarios of stringent reductions of greenhouse-gas emissions, the sea level will continue to rise in the 21st century due to the thermal expansion of the oceans and the ongoing melting of glaciers and ice sheets (IPCC, 2022c). From 1901 to 2018, the sea level rose by about 0.2 m. If future warming is less than 1.5°C (scenario SSP1-1.9), it will reach approx. 0.38 m by 2100 compared to the

1995–2014 reference period. If emissions remain unchecked (scenario SSP5-RCP8.5), the global sea level could rise by about 0.77 m by 2100 (IPCC, 2021a) and by several metres over the centuries, especially if the tipping points of the ice shelves are exceeded. This will mean new coastlines on many continents. Today, the rising sea level already means that flooding of flat areas of land is becoming more frequent. Countries such as Thailand, Bangladesh, Pakistan and the Netherlands lie below or only just above today's sea level and are thus particularly threatened. Small island states like the Maldives could even disappear completely. In addition, a growing number of people live in a low-lying, high-risk coastal zone (about 9% of the world's population, IPCC, 2019a); accordingly, coastal settlements and infrastructure will be increasingly affected. This will also mean the loss of coastal ecosystems (mangroves, seagrass, salt marshes, shallow coral reefs, rocky coasts and sandy beaches, IPCC, 2022c) and especially the destruction of breeding and rearing habitats, for example of seabirds, shorebirds and turtles (von Holle et al., 2019). Increased inputs of salt by seawater can destroy crops and, depending on the extent of the sea-level rise, also salinize groundwater. This can adversely affect ecosystems, water supplies and life-support systems far inland (IPCC, 2019a). Sea-level rise is already having an impact on ecosystems, human life-support systems, infrastructure, food security and climate-change mitigation on the coast; the associated risks, especially for coastal settlements and cities, will continue to increase (IPCC, 2022c).

2.3.6 Environmental pollution: plastic is only one of the problems

Environmental pollution by plastics and especially microplastics has far-reaching, partially irreversible effects on marine and terrestrial biodiversity worldwide, from the ecosystem level to the cellular level (MacLeod et al., 2021; Rochman and Hoellein, 2020). Larger pieces of plastic are broken down into microplastics by mechanical action, and many consumer products directly contain microplastics. In the soil, plastic impacts on material cycles and food cycles – both within animal food chains and, via these, to humans (Allouzi et al., 2021; Fundter et al., 2008). In this way, plastic contamination in the soil also affects the production of food for humans and therefore food security (Zhang et al., 2020). Plastic pollution is also a problem in water. Plastic is a major source of pollution in both freshwater ecosystems (Azevedo-Santos et al., 2021) and the world's oceans (Carney Almroth and Eggert, 2019) and has even reached the Arctic ecosystems (Bergmann et al., 2022). Marine wildlife such as

turtles and birds eat plastic and sometimes die in agony as a result (Roman et al., 2021). It has also been proven that fish are eating more plastic (Savoca et al., 2021). Although there is still a great need for research in this area, it is certain that microplastics end up on our plates, especially via industrial fishing (Barboza et al., 2018; Makhdoumi et al., 2022). In addition, microplastics can be absorbed by organisms through the air. For example, microplastics have been detected in human lungs (Jenner et al., 2022). Microplastics are also found in human blood (Leslie et al., 2022). Although the exact effects have not yet been conclusively clarified, a toxic effect of microplastics has at least been proven in human cell cultures (Danopoulos et al., 2021). Also apart from plastic, there are many threats to human health from environmental pollution.

The combustion of fossil fuels emits not only considerable amounts of greenhouse gases but also other substances that are harmful to health; this applies especially to the burning of coal (Landrigan et al., 2018). Fossil-fuel combustion in high- and middle-income countries and biomass combustion in low-income countries are responsible for 85% of particulate-matter pollution in the air and for almost all pollution with sulphur and nitrogen oxides (Landrigan et al., 2018). In addition, the concentration of air pollutants – and therefore also the associated health impacts – are directly influenced by the changing climate. Air temperature, humidity and atmospheric chemistry change the amount of pollutants in the air. Heat leads to higher ozone levels and concentrations of particulate matter in the air; this can result in irritations of the mucous membranes, impairments in lung function, cardiovascular diseases and reduced performance (Landrigan et al., 2018). Overall, air pollution (dust, soot, smoke, exhaust fumes, aerosols and vapours) kills more than six million people prematurely every year (Fuller et al., 2022).

In addition to air pollution, the contamination of soil and water with chemicals is a major and steadily increasing global problem. Chemical pollution of soils and water resources by industry, mining, power generation, mechanized agriculture and fossil-fuelled vehicles is on the rise (UNEP, 2019d). The effects of chemical pollution on human health are poorly defined and its contribution to the global burden of disease is almost certainly underestimated (Landrigan et al., 2018). Many chemicals and pesticides cause diseases, deaths and environmental degradation; examples include lead, asbestos, dichlorodiphenyltrichloroethane (DDT), polychlorinated biphenyls (PCBs), ozone-depleting chlorofluorocarbons and per- and polyfluorinated alkyl substances (PFAS; Section 5.2.2; Landrigan et al., 2018).

The increasing contamination of marine ecosystems and freshwater systems worldwide with thousands of

chemical compounds is one of the most urgent environmental problems for nature and humans (Schwarzenbach et al., 2006). In a global study of 258 rivers in 137 geographical regions, active pharmaceutical substances (e.g. antiepileptics, blood-sugar-lowering agents, antibiotics) were found in about a quarter of the cases in concentrations expected to harm aquatic organisms (Wilkinson et al., 2022). Global pollution with pharmaceuticals thus poses a global threat to the environment and therefore to human health. This endangers the achievement of the United Nations Sustainable Development Goals (Wilkinson et al., 2022; Section 5.2.3).

The increasing pollution of water bodies also threatens water-supply security (Vörösmarty et al., 2010). On the one hand, as mentioned in Section 2.3.3, increasing dry seasons and droughts lead to a worrying shortage of local freshwater resources, which can also increase contamination. On the other hand, the continuing increase in pollution and degradation of water resources, e.g. through the discharge of untreated sewage from households, industry and agriculture, will lead to a considerable deterioration in water availability in many regions in the coming decades (van Vliet et al., 2017). In some future scenarios, it is feared that up to five billion people will be exposed to increased water pollution (Chaplin-Kramer et al., 2019).

Furthermore, pesticide contamination is a significant global problem. Pesticides are ubiquitous environmental pollutants that have negative impacts on water quality, biodiversity and human health. In two thirds of the world's agricultural regions, groundwater, surface water, the soil or the air are impaired by the use of more than one pesticide, and one third of the corresponding regions are at high risk as a result. Of the high-risk areas, about 34% are in regions with high biodiversity, 5% in water-scarce areas and 19% in low- and middle-income countries. Watersheds in South Africa, China, India, Australia and Argentina are particularly subject to the worrying impacts of pesticides. Here, pesticide exposure also represents a high risk for biodiversity (Tang et al., 2021).

2.4

Global governance for the protection of the environment and human health

The governance of global health and the governance of global environmental change have developed as separate negotiating spaces (Section 2.4.1). The WHO pursues the global protection and promotion of human health, while the protection of the world's natural life-support systems is the task of the United Nations Environment Programme (UNEP; Figure 2.4-1). The recent past has

seen an increasing amount of mutual exchange and initial signs of cooperation between these institutions (Section 2.4.2). The connection and linkage between health and environmental protection is promoted by the 2030 Agenda, institutions for economic cooperation and development cooperation, as well as sectoral organizations such as the FAO (Section 2.4.3). However, there are considerable implementation deficits and a lack of political will for implementation (Section 2.4.4).

2.4.1

Emergence of international negotiating spaces on environmental and health issues

Wherever people live, they create systems to protect their health. These show different degrees of formalization. For a long time, they were organized locally but have since become increasingly regulated by the state. Germany, for example, introduced social insurance at the national level in 1883 with the 'Law on the Health Insurance of Workers', thus laying the foundation for today's health insurance system (Box 2.1-1). In some developing countries and emerging economies, informal healthcare still accounts for a considerable proportion of healthcare (Sudhinaraset et al., 2013; Kumah, 2022; Box 6.2-1).

The protection of the environment, however, was, for a long time, a less prominent object of community organizational structures. While many indigenous communities have always applied principles on the sustainable use of natural resources, their influence remains marginal. In Europe, the containment of environmental degradation first became relevant with 'the great fear of the great timber shortage' in the 1790s, although this did not lead to a broad alliance for nature conservation and environmental protection (Radkau, 2011: 40). Sweden was the first European country to pass a Nature Conservation Act in 1909 (Radkau, 2011: 57); however, it took several more decades before environmental protection became a state responsibility worldwide.

When the United Nations replaced the League of Nations after the Second World War, the WHO was founded in 1948 as one of the first UN specialized agencies; it was designated by its (currently 194) member states as the leading and coordinating organization on health worldwide. The WHO's objective is the "attainment by all peoples of the highest possible level of health" (Art. 1 WHO Constitution). To this end, it aims to network with relevant actors from other fields of international cooperation on health issues, to assist governments, upon request, in all health matters, and to facilitate international cooperation through administrative and technical services (e.g. for statistics; Art. 2 WHO Constitution). The WHO's broad understanding of health,

2 Health – a systemic view

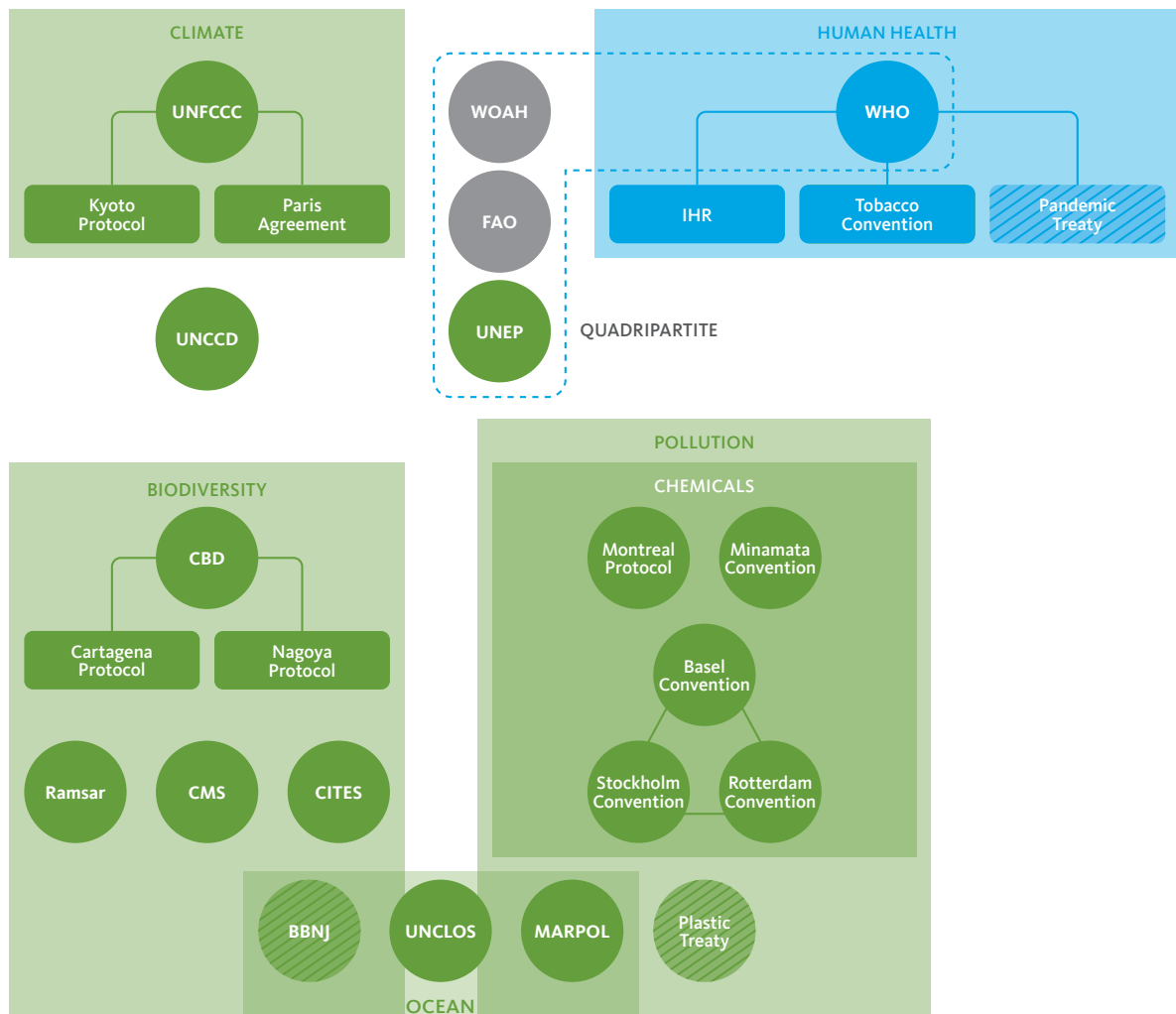


Figure 2.4-1

UN Governance of Global Health and Global Environmental Change. The governance of global health protection (blue) and the fight against global environmental changes (green) have developed as separate, largely unconnected negotiating spaces with their respective international health and environmental agreements. Further agreements are being negotiated in both areas (hatching). The WHO, WOAAH, FAO and UNEP recently joined forces for the first time to develop integrated solutions for interface issues in the so-called Quadripartite (dotted outline).

Source: WBGU

which encompasses not only the absence of disease but also the promotion of complete physical, mental and social well-being (Section 2.2.4), means that in its work, particularly in institutional cooperation with other organizations, the WHO addresses a wide range of factors that influence health (Determinants of health, Section 2.2.5; Mbengue, 2010: Rn. 11).

Compared to the health sector, the international community did not address globally significant negative environmental changes until much later. Early examples of international cooperation in the environmental field primarily addressed navigation regulations on border rivers or commercially relevant species such as seals (Mitchell, 2022). Only in 1972, the Conference

on the Human Environment in Stockholm established environmental protection in its entirety as an issue of global relevance, thus marking the hour of birth of global environmental governance. This conference initiated the United Nations Environment Programme (UNEP), which was adopted by the UN General Assembly the same year. The UNEP's mandate includes analysing and recording the state of the worldwide environment and related global and regional trends; providing policy advice and public-relations work on environmental issues including agenda setting; issuing early warnings of future environmental changes; promoting international cooperation and action in line with the state-of-the-art in science; advancing the development and coherence

of international environmental law; and strengthening its implementation (UNCHE, 1972; UNCED, 1992a; UNEP, 1997). Since 2014, the UN Environment Assembly (UNEA) has been UNEP's central decision-making body, with all currently 193 member states meeting every two years. The UNEA took over the function of the UNEP Governing Council, which, until then, had been meeting with only 58 rotating members.

Since the 1970s, the international community has adopted numerous binding, issue-specific environmental agreements, resulting in a comprehensive body of international environmental treaty law – in addition to principles of customary international environmental law such as the precautionary principle and the polluter-pays principle (Figure 2.4-1). For example, there are individual conventions on issues such as climate change, biodiversity, desertification and the trade in endangered animal and plant species. Environmental agreements are frequently designed as framework conventions (Bodansky et al., 2017; Sands et al., 2018: 106, e.g. Framework Convention on Climate Change, Convention on Biological Diversity, Convention on the Law of the Sea). Although this provides a basis for cooperation among a large group of states, framework conventions rely on detailed regulatory measures, e.g. in the form of protocols and detailed enforcement mechanisms (Epiney, 2017: Rn. 54–56). These are lacking in some areas. For example, although the Convention on Biological Diversity regulates biosafety in the Cartagena Protocol, and access and benefit sharing in the Nagoya Protocol, it lacks binding agreements on the conservation and sustainable use of biological diversity (WBGU, 2020). Nevertheless, the respective Conferences of the Parties to the environmental conventions have developed into powerful negotiating spaces outside the UNEP. In the wake of the hard- and soft-law decisions taken there, a differentiated, national environmental law has developed in most countries to date. Negotiations continue on developing new agreements, e.g. to curb plastic pollution or to protect marine biodiversity outside national territories.

In the health sector, by contrast, there are far fewer differentiated, binding provisions under international law. The WHA, i.e. the assembly of member states of the WHO, has wide-ranging authority to enact international law on all matters within the WHO's sphere of responsibility, according to Articles 19 and 21 of its constitution. However, this has only been used twice up to now. Art. 19 (the legal basis for the adoption of conventions and international agreements within the competence of the WHO) has only been invoked once – to pass the Framework Convention on Tobacco Control in 2003 – and this is regarded as a milestone in international law-making in the field of health (Nikogosian and Kickbusch, 2016). It was the first time the WHO

had adopted a framework convention for the health sector – something that is common in the environmental field – making a lifestyle factor that is harmful to health the subject of international regulation. The International Health Regulations (IHR) are the second component of the WHO's special international law on health. They were enacted in 2005 on the basis of Art. 21 of the WHO Constitution to replace the predecessor regulations (International Sanitary Regulations; WHA, 2005). To the present day, they still form the legal framework for dealing with infectious diseases that spread across borders, i.e. also for pandemic control (Gassner, 2021). Furthermore, an international legal instrument for pandemic prevention, preparedness and response (the 'Pandemic Treaty') is currently being negotiated within the WHO (WHA, 2021). The content and success of the Pandemic Treaty will demonstrate how seriously the global community of states can learn from crises (Section 6.3).

The environment and health are also key components of the 2030 Agenda, with which, in 2015, the global community set itself a common framework for sustainable development up to 2030. The 2030 Agenda interlocks the environmental, social and economic dimensions of sustainable development and lays down 17 Sustainable Development Goals (SDGs), which are fleshed out by 169 targets (UNGA, 2015), including among others:

- SDG 3 (Good health and well-being);
- SDG 13 (Climate action);
- SDG 14 (Life below water);
- SDG 15 (Life on land).

2.4.2

Interfaces of multilateral environmental and health governance

International cooperation for the protection of human health and for the protection of the environment have largely developed separately from each other (Section 2.4.1). Cross-references between the core institutions in the two fields – i.e. the WHO on the one hand and the UNEP and the various international environmental conventions on the other – have developed only gradually, although this development has clearly accelerated in the last decade.

First, it should be noted that the declarations and agreements of international environmental law (Figure 2.4-1) are anthropocentric, at least they have been up to now: alongside the environmental media (air, water, soil) and environmental goods (biodiversity/flora and fauna), human health is always the protected good. Accordingly, the declarations and agreements aim to avoid or minimize negative environmental impacts on humans and their health. The non-binding Stockholm Declaration

already made a clear link between the importance of human well-being and the state of the environment, for example making a direct connection between marine pollution and human health (UNCHE, 1972). The Rio Declaration of 1992 established as its first principle that people have a right to live healthy and productive lives in harmony with nature (UNCED, 1992a). This cross-reference to health is also evident in numerous environmental agreements. For example, in its definition of adverse effects of climate change, the Framework Convention on Climate Change clearly refers not only to ecosystems, but also to human health and well-being: “Adverse effects of climate change’ means changes in the physical environment or biota resulting from climate change which have significant deleterious effects on the composition, resilience or productivity of natural and managed ecosystems or on the operation of socio-economic systems or on human health and welfare” (UNFCCC, 1992: Article 1(1)). Similar statements can also be found, for example, in the preamble of the Paris Climate Agreement, the preamble of the Convention on Biological Diversity (CBD) and Art. 1 no. 1 (4) of the Convention on the Law of the Sea (UNCLOS). Some environmental agreements even focus primarily on human health, e.g. the Vienna Convention for the Protection of the Ozone Layer (1985) or the Basel Convention on the Control of Shipments of Hazardous Wastes and their Disposal (1989). Overall, definitions of boundaries (e.g. threshold values for pollutants) up to which the environment may be damaged, are generally based on how hazardous they are to human health (Mbengue and Waltman, 2018: 215).

In addition to their basic orientation, it should be emphasized that the Conferences of the Parties to various environmental conventions sometimes also deal with references to human health at the programmatic level. Resolutions on wetlands and health were adopted in 2008 and 2010 under the Ramsar Convention, for example (Resolution X.23; Resolution XI.12; Korn et al., 2019: 320). The prominence of the health issue varies from one convention to another. The CBD has prominently featured health as a separate agenda item in its negotiations since 2014, while the Conferences of the Parties to the Framework Convention on Climate Change has up to now only discussed human health in the context of negotiations on topics such as adaptation and agriculture (Willets et al., 2022).

The WHO, for its part, also deals with environmental issues. It initially examined sectoral environmental issues that are directly related to health, e.g. chemicals, water, sanitation and healthy cities (WHO, 1993), but since the early 1990s, it has been systemically and comprehensively analysing the cross-relationships between health and the environment. To provide input for the

1992 Rio Earth Summit, the WHO even set up an independent commission in 1992 to prepare the report ‘Our Planet, Our Health’ (WHO, 1992b). Subsequently, the WHO developed a global environmental and health strategy to guide the organization’s work in implementing Agenda 21. Over the past two decades, the WHO has continuously deepened its involvement in environmental issues. In addition to synthesis reports, the WHA has adopted a number of resolutions on topics such as climate change, ozone-layer protection and air pollution (e.g. WHA, 1998, 2008, 2015a), as well as environmental guidelines, e.g. on air pollution, which also provide recommendations on threshold values. For 2022–2026, the WHO’s Secretary-General has further announced his intention to prioritize climate change as an issue for WHO.

Recognizing the overlaps between their respective mandates, cross-references have also developed between the multilateral institutions in the health and environment sectors over the decades. Such forms of institutional cooperation aim to jointly promote health protection and environmental protection, among other things by exchanging information, exploiting synergies and handling trade-offs in a strategic way. Since 1994, for example, the WHO and the UNEP have been cooperating in the Inter-Organization Programme for the Sound Management of Chemicals, to which other institutions also belong, including the Food and Agriculture Organization of the United Nations (FAO) and the International Labour Organization (ILO). Another example is the partnership between the WHO, the FAO and the World Organization for Animal Health (WOAH), which was formalized in 2010; this is the ‘Tripartite’, which focuses on the mitigation of health risks at the interface between humans, animals and ecosystems. Furthermore, there are many examples of specific cooperation, including the publication of joint reports such as the Compendium of 500 recommended measures on the overall topic of environment and health, which the WHO published together with the UNEP and other UN institutions.

The declaratory recognition of the human right to a clean, healthy and sustainable environment by the UN Human Rights Council (UNHRC, 2021a) and the UN General Assembly (UNGA, 2022) recently strengthened the interdependence of environmental conditions and human health in human-rights terms – at least on paper.

Ultimately, it should be noted that – certainly in part as a result of the COVID-19 pandemic – increased efforts have recently been observed at the interface between global environmental and health governance. Towards the end of 2021, 50 countries joined a WHO partnership on decarbonization and the climate-resilient transformation of their health systems, and the Tripartite (WHO, FAO and WOAH) has been expanded to a quadripartite

following the official inclusion of UNEP (Section 6.3). The CBD is about to adopt an action plan on biodiversity and health. The IPBES is preparing a report on the nexus between biodiversity, water, food and health. Numerous partnerships between states, international organizations and also non-state actors have started up under the One Health concept, which is based on the understanding that human, animal and environmental health are closely linked (Box 2.1-2).

2.4.3 Environmental and health governance in the global actor network

Health and environmental governance is shaped not only by the WHO, the UNEP and the various conventions, but also by the interaction of various state and non-state actors at different levels:

- › *Nation states and sub-national governments*, which lay down the decisive regulatory framework for environmental and health issues;
- › *Regional organizations and intergovernmental alliance formats*, such as the European Union, African Union, G7 and G20, which adopt their own measures and shape global discourses;
- › *Civil-society organizations* such as the Red Cross movement, which emerged as early as the second half of the 19th century, or Greenpeace and WWF, which are crucial in generating attention for environmental problems;
- › *Scientific institutions* which identify problems, stimulate reflection and produce evidence-based solutions;
- › *Philanthropic actors* like the Bill and Melinda Gates Foundation, which was the WHO's second largest fund-provider after Germany in 2020–2021 (WHO, 2021j: 20), and Bloomberg Philanthropies, which provides financial support to transnational city alliances;
- › *Private-sector actors* such as pharmaceutical companies, whose decisions have a fundamental impact on the global medical supply situation, and energy companies, which sometimes block the shift away from fossil fuels;
- › *Public-private partnerships*, such as the Global Fund to Fight AIDS, Tuberculosis, and Malaria (Global Fund), and the Caribbean Catastrophe Risk Insurance Facility, which provides insurance against climate risks.

Furthermore, institutions and actors from other sectors also have an impact on environmental and health governance. Important examples include:

- › International Labour Organization (ILO);
- › World Bank, International Monetary Fund (IMF), New Development Bank (NDB);
- › Food and Agriculture Organization of the UN (FAO);

- › World Trade Organization (WTO) with its agreements on Trade-Related Aspects of Intellectual Property Rights (TRIPS), on Sanitary and Phytosanitary Measures (SPS), and on Technical Barriers to Trade (TBT);
- › United Nations Development Programme (UNDP);
- › United Nations Human Settlements Programme (UN-Habitat);
- › companies such as Unilever and Coca-Cola, which occupy a central position in the food industry, and similar market leaders from other relevant sectors such as the mobility sector, the construction industry or the financial sector.

2.4.4 Implementation deficits

A differentiated system of goals for environmental and health governance has developed in the course of the 20th and early 21st centuries (Section 2.4.1). However, many of the targets set have been missed, for example the Millennium Development Goals, the Aichi Biodiversity Targets and some SDG targets that should have been achieved by 2020 (CBD, 2020; UN, 2015b, 2020a). There have been successes in some areas, particularly in reducing emissions of ozone-depleting substances and lead poisoning (Chipperfield et al., 2017; Ritchie and Roser, 2022c). However, improvements have been slow and remain very heterogeneous when seen from a global perspective (UN, 2022b). At the current rate of progress, there is a risk that the sustainability goals will not be met by their 2030 deadline. The situation has actually worsened in many areas, for instance in poverty reduction or the fight against tuberculosis and inequality – and this is only partly due to the COVID-19 pandemic (UN, 2022b). Some of these negative trends have consequences that cannot be reversed, either in terms of preventable deaths, lifelong disability due to childhood malnutrition, or climate and environmental tipping points. The members of the Framework Convention on Climate Change set themselves the goal of stabilizing the greenhouse-gas concentrations in the atmosphere “at a level that would prevent dangerous anthropogenic interference with the climate system” (UNFCCC, 1992: Art. 2) and stated that “such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner”. However, as things stand, these demands can no longer be fully implemented (IPCC, 2022c).

There is neither a lack of political objectives nor a lack of knowledge about appropriate measures for combating environmental changes. Unfortunately, there is a lack

of obligations under international law for the signatory states. For example, although the Paris Climate Agreement stipulates that climate warming should be limited to well below 2°C, and preferably to 1.5°C, it does not include a corresponding commitment to phase out the extraction and combustion of fossil fuels (Section 5.1).

Furthermore, there are considerable deficits regarding the implementation of international agreements (World Bank, 2017: 259; CBD, 2020; IPCC, 2022b; UNEP, 2021b) relating to two aspects. First, contracting states do not, or do not sufficiently transpose obligations under international treaties into national law. For example, the Basel, Rotterdam and Stockholm conventions on chemicals and waste are international agreements for controlling chemical pollution, yet not every contracting party has a national chemicals law (UNEP, 2019: 251 ff.). Second, there are enforcement deficits in the implementation of national environmental laws.

In addition to implementation deficits, especially in the environmental sector, it must be noted that the health and environmental sectors largely exist side by side in organizational and regulatory terms, even though effective dovetailing between environmental and health concerns (Sections 2.2, 2.3) would be necessary. The identification of multi-benefit strategies – measures that are beneficial not only to e.g. biodiversity but also to human health – can serve to mobilize new and additional actors. Pricing in the corresponding co-benefits in cost-benefit considerations could overcome blockades and promote the implementation of measures. Finally, coordination across the health and environmental sectors also serves to avoid or consciously deal with trade-offs.

2.5

Health in times of multiple crises: five observations

After analysing the status quo in the previous sections, the WBGU has derived the following five observations. The following chapters build on these to develop the vision and resulting needs for action.

Observation 1:

We have not taken seriously enough the fact that human health is inseparable from the well-being of species and ecosystems.

Humans have made themselves seemingly independent of their natural environment through their individual actions, their social systems and their economic activities. In fact, however, humans are part of the ecological systems and depend on an intact biosphere for their long-term survival. Despite this realization, there is an increasing danger that natural life-support systems on Earth will be

irretrievably degraded – and the health of people, many species and ecosystems will be permanently damaged as a result. What is needed is a new relationship between humans and nature in which humans not only recognize other living beings and the planet's ecosystems as essential for human health, but also protect and respect them as valuable for their own sake.

Observation 2:

The three environmental crises determine and reinforce the global syndemic

The analysis of human-made global environmental changes reveals that the three environmental crises – climate change, biodiversity loss and the increasing worldwide pollution – have reached a scale that is leading to an acute threat to the health of humans and nature. People, animals and plants are suffering and dying from heat; droughts, floods and biodiversity loss are threatening food supplies; pollution is leading to the long-term degradation of natural and human habitats as well as damage to health. These three environmental crises are major contributors to the global health crisis and significantly affect the natural life-support systems of human societies. They are anthropogenic and have an impact on people through syndemic developments. Stopping and reversing these trends is therefore an indispensable prerequisite for maintaining and improving human health worldwide and also for improving the health of species and ecosystems.

Observation 3:

Combating disease alone is not enough to maintain health in the medium and long term

Human health has improved worldwide in recent decades, although by no means everyone has been able to benefit equally from this progress. However, improving human health has so far focused predominantly on combating diseases and known health threats. Too little attention has been paid to insidious threats to human health from global environmental changes – such as climate change, the loss of biodiversity and natural habitats and the associated spread of zoonoses, global pollution as well as the increase in non-communicable diseases and their risk factors (e.g. overweight). The focus is regularly on the acute, short-term treatment and control of diseases. Medium- and long-term measures of prevention and health promotion to forestall disease and to maintain and promote resilient ecosystems, some of which would require fundamental changes in behaviour and conditions, are hardly taken or not taken at all.

Observation 4:

Poverty and inequality make it impossible for many people to live a healthy life free from preventable diseases.

In addition to the increasing health hazards due to the effects of global and local environmental changes, as well as lifestyle-related non-communicable diseases, as a result of poverty a large section of humanity still suffers from preventable diseases and is unable to benefit from basic healthcare and medical progress. Vulnerable groups worldwide (e.g. people with low incomes, children, older people and people with physical or mental disabilities) are more seriously affected by health risks and environmental changes and have less access to health services. At the same time, existing social grievances and inequalities are exacerbated both by health crises (e.g. the COVID-19 pandemic) and by the consequences of global environmental changes such as extreme weather events or threats to food production. Inequality and poverty are significant amplifiers of global health and environmental risks. Combating them is therefore an essential prerequisite for stopping the negative health trends.

Observation 5:

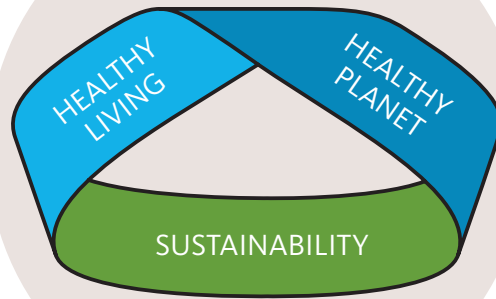
Existing international cooperation structures cannot cope with the simultaneity and globality of the health and environmental crises.

Existing international structures and institutions address the protection of human health and the fight against climate change, biodiversity loss and global pollution; however, while international environmental law has always addressed the protection of human health, international health policy has so far focused too much on disease control and not enough on the environmental causes of disease. At all policy levels, health and environmental governance lacks sufficient cooperation, interfaces and overarching strategies. There is also a lack of cross-system measures to coordinate, interlink and enforce the protection of human health and the environment. The weakness of multilateral cooperation in particular has become evident not least in the inadequate responses of the global community to the COVID-19 pandemic and its social and economic consequences. The strengthening of autocratic systems and the threat to democracies from autocratic-nationalist movements further hamper the international community's ability to act.

Prevention and
resilience



People as part
of nature



Inclusion instead of
exclusivity



Planetary guard rails
are respected



Cross-system
cooperation

The vision of ‘healthy living on a healthy planet’

3

The WBGU counters threatening future prospects with the vision of ‘healthy living on a healthy planet’: the inseparability of humans and nature returns to our consciousness, planetary guard rails are respected, prevention and resilience are promoted, vulnerable groups experience solidarity, cross-system cooperation enables the implementation of the vision. The vision fits into the internationally agreed but rarely implemented guiding principle of sustainability. The topic of health is an opportunity to strengthen transformations towards sustainability.

Multiple crises, especially the triple environmental crises of climate change, biodiversity loss and global pollution, are having an increasingly negative impact on the health of humans and other species (Section 2.3). At the same time, and partly for similar reasons, lifestyle-related non-communicable diseases are on the rise worldwide. These current, very dynamic changes in disease burdens are taking place against the backdrop of an extremely disparate point of departure: part of humanity still suffers from preventable diseases as a result of poverty and is thus especially vulnerable and less adaptable to the worsening crises. We refer to this coincidence of different, systemically interconnected health threats as a syndemic (Section 2.2.7).

The WBGU counters these threatening future prospects with the vision of ‘healthy living on a healthy planet’, which can serve as an orientation for politics, business, science and civil society so that they can react systemically to these crises. ‘Healthy planet’ should be understood here as a metaphor: it is about good global living conditions for people and ecosystems (IPCC, 2022d). On the one hand, this requires putting an immediate and decisive end to the destruction of our life-support systems: to respect planetary guard rails, restore resilient ecosystems, halt climate change and thus prevent the exacerbation of acute and long-term health hazards. On the other, the aim is to reduce not only the pandemic threat from communicable diseases, but also the pandemic scale of lifestyle-related non-communicable diseases.

In doing so, it is important to take along with us people who are left behind who, as a result of poverty, have not benefited from health advances: to enable everyone to lead healthy lives without preventable diseases. This requires a transformative approach.

How can this be achieved?

The following Section 3.1 first presents five cornerstones for the ‘healthy living on a healthy planet’ vision, building on the observations made in Section 2.5. In the subsequent Section 3.2, the WBGU reveals its normative principles: What are our recommendations based on? What values and overarching objectives do we use as a basis for assessing current developments and identifying needs for action? Reference points for this are the ‘normative compass’ developed by the WBGU (WBGU, 2016a, 2019a) and internationally agreed goals.

Building on these normative principles, in Section 3.3 we discuss existing integrative health concepts that address, in a narrower or broader sense, the syndemic of interacting health threats described above and corresponding possible solutions. In the face of this dynamically evolving field, where many approaches are neither sharply defined nor the relevant discussions concluded, we show how the elements of existing concepts can be brought together with further components to form a comprehensive and transformative vision for the health of humanity and the planet.

3 The vision of 'healthy living on a healthy planet'

Section 3.4 summarizes the vision and clarifies the challenges of putting it into practice; these are then addressed in the following Chapters 4, 5, 6 and 7. The aim is not to look at and deal with the problems in isolation from each other, but to specifically identify systemic connections between health-related and environmental problems and to develop synergetic solutions.

3.1

Five key points for the vision of 'healthy living on a healthy planet'

The following five key points draw on the observations made in the analysis of the status quo in Section 2.5 and contrast them with positive visions of the future.

Humans are part of nature – natural life-support systems are recognized as the basis of human health

The inseparability of human civilization from nature is finding its way back into public awareness: Human life has adapted to an Earth with a largely unpolluted biosphere with healthy ecosystems and rich biodiversity. The physicochemical living conditions – e.g. the temperature range; the availability, composition and purity of air and water; the protective ozone layer – are fundamentally different from the conditions that would prevail on an Earth with a further degraded environment. Ecosystem services, especially those based on high biodiversity (including microorganisms, plants and animals) and intact ecosystems, provide the basis for clean water, clean air, productive soils and a pleasant microclimate. Every human being, like every animal, lives in symbiosis with billions of microorganisms that are essential for our health, for example in the intestine or on the surface of the body. These form an ecosystem whose disturbance can cause damage to the health of its host. These insights form a universal reference point for human action.



Planetary guard rails are respected in order to protect the health of humans, species and ecosystems

Humanity adopts stewardship for all life, the biosphere and the entire planet by averting the immediate threat to the health of all life and the fundamental endangering of the natural life-support systems due to global environmental change. This is translated into principles, strategies, quantified and qualitative targets and political action across the system. Anthropogenic climate change is stopped. The loss of biodiversity is halted and, where possible, regionally reversed. Global pollution is at least significantly reduced or stopped, and where pollution is unavoidable, adverse health effects are prevented. Our actions and our way of doing business take into account the quality of the natural and human-made environment as well as human health.



Strengthen prevention and the comprehensive promotion of resilience and development potential

The short-term fight against diseases and environmental damage is complemented by long-term strategies of prevention and promotion (Box 3.1-1): health risks for nature and humans are anticipated and avoided or at least minimized. Health resources and resilient ecosystems are promoted to increase the resilience of humans and nature and to create development potential for health, well-being, diversity and *Eigenart* (character, uniqueness). Insidious, gradual threats to human health from global environmental changes as well as from the increase in non-communicable diseases and their risk factors are countered by systemic approaches that also address lifestyles that are harmful to health and the environment by designing healthy living environments (Box 3.1-1; SRU, 2023).



Inclusion instead of exclusivity: vulnerable groups receive global solidarity

Everyone has access to health services and benefits from medical progress and improved environmental conditions. Worldwide disparities in material, economic and political inclusion are reduced. Vulnerable groups that are particularly affected by old and new health and environmental risks – e.g. by global environmental changes such as climate change, biodiversity loss and pollution – are specifically protected. Healthy living environments and public spaces are made available for them, e.g. safe, exercise-friendly, green spaces, pathway networks and residential areas. No one has to suffer from preventable diseases as a result of poverty any longer. In addition to the political will to implement it, this requires, among other things, countries and population groups with higher assets and incomes to live up to their special responsibility and make higher contributions.



Cross-system cooperation promotes the vision of 'healthy living on a healthy planet'

The vision of 'healthy living on a healthy planet' forms the basis of lifestyles and ways of doing business and becomes the driver of resurgent national and global cooperation and transformative implementation measures. An understanding of health that also aims at planetary environmental protection and is based on the World Health Organization's definition (WHO; Section 2.2.4) but goes beyond it, and which is ideally also reflected in a new, expanded WHO concept of health, shapes a new type of global health and environmental governance. This new guiding principle is also expressed in an individual right to a healthy environment, which is enshrined in the constitutions of nation states (Section 7.1.2). The level of environmental quality to be striven for is oriented towards the needs of vulnerable groups in particular and the requirements of biodiversity promotion.



3.2 Normative foundations

The vision of 'healthy living on a healthy planet' takes its orientation from the WBGU's normative basis, the 'normative compass' (WBGU, 2016a, 2019a, 2020). Based on human dignity, the guiding principles for action are (1) sustaining the natural life-support systems (inter alia through compliance with the planetary guard rails; WBGU, 2014b), (2) the material, economic, political and social inclusion of all people, and (3) the recognition of *Eigenart* (character, uniqueness) in the sense of valuing diversity and protecting individual development opportunities (Section 3.2.1). Using this compass as a basis, it can be stated – with regard to the situation of humans on Earth described in Chapter 2 – that a transformative change is urgently needed, and that this includes the development of nature in healthy ecosystems. At the same time, there are already several politically agreed agendas and targets at the international level (Sections 2.4, 3.2.2), each of which is individually based on normative assumptions and which, taken together, underline the need for transformative action. In addition to the compass itself, they serve as a further normative framework for the WBGU's recommendations.

3.2.1 The WBGU's normative compass

The normative compass serves as an action-guiding, normative basis for the WBGU's advisory services for policy-makers, and as an orientation framework for the transformations towards sustainability. It refers to an "understanding of prosperity that goes beyond material/economic factors" (WBGU, 2016a: 132). The compass has been further developed in the WBGU's publications in view of the specific topics in each respective report (WBGU, 2019a: 35 ff.; WBGU, 2020: 38 f.); it is interpreted in the following in the context of the vision of 'healthy living on a healthy planet'. Human dignity is the starting point. The three other dimensions of the normative compass – (1) sustaining the natural life-support systems, (2) inclusion and (3) *Eigenart* (Fig. 3.2-1) – are the prerequisites for guaranteeing human dignity and the transformations towards sustainability. Section 3.2.2 briefly discusses the UN's multilateral objectives that are relevant to this report: they provide an important standard-setting framework that reflects the multilaterally agreed values on the relationship between humans and nature and the value of nature.

Box 3.1-1

Prevention and promotion as complementary perspectives: ward off dangers, create healthy living environments full of opportunities

In both the health and environmental sectors, the focus is still too often on reacting to diseases and damage that have already occurred, and curing or remedying them. However, in order to realize the vision of 'healthy living on a healthy planet', two further complementary perspectives need to be strengthened (Fig. 3.1-1): on the one hand, the dangers and risks to the health of humans and other living organisms – e.g. from specific, including climate-related disease risks or environmental toxins – must be averted or reduced by means of preventive action; on the other hand, resilience capacity and development potential must be strengthened for well-being, diversity and *Eigenart* by actively promoting health through building up health resources as well as by establishing resilient ecosystems by means of conservation and sustainable use. Health resources include not only individual factors such as nutritional status, health skills, psychological factors and material resources but also external factors such as social relationships and environmental conditions in different living environments such as the place of residence, school or workplace (Kaba-Schönstein,

2018; Rönnau-Böse et al., 2022). Strategies are therefore required that not only address individual skills and behaviour, but also shape the conditions, including the built-up and natural environments and thus healthy living environments.

Fig. 3.1-1 gives an overview of the three approaches. This threefold structure should definitely not be interpreted to mean that only one of the options for action should be used at any one time. Rather, they are complementary perspectives that support developing and implementing strategies as well as communicating them. The prevention of hazards is primarily based on known mechanisms of action and often focuses on individual health and particular environmental aspects. By contrast, the promotion of resilience and development potential, e.g. by designing healthy living environments ('settings'), places greater emphasis on systemic linkages and also gains hitherto unknown potential through less specific approaches. Individual measures can serve both goals: for example, green spaces in cities can help prevent heat stress and flooding, promote mental health and physical exercise, and provide habitats for animals and plants.

These concepts are not new to all sectors. However, the idea of placing greater emphasis on prevention and supportive approaches is rarely adequately implemented. In the health sector, the concept of health promotion exists in addition to the treatment and prevention of existing diseases (WHO, 1986;

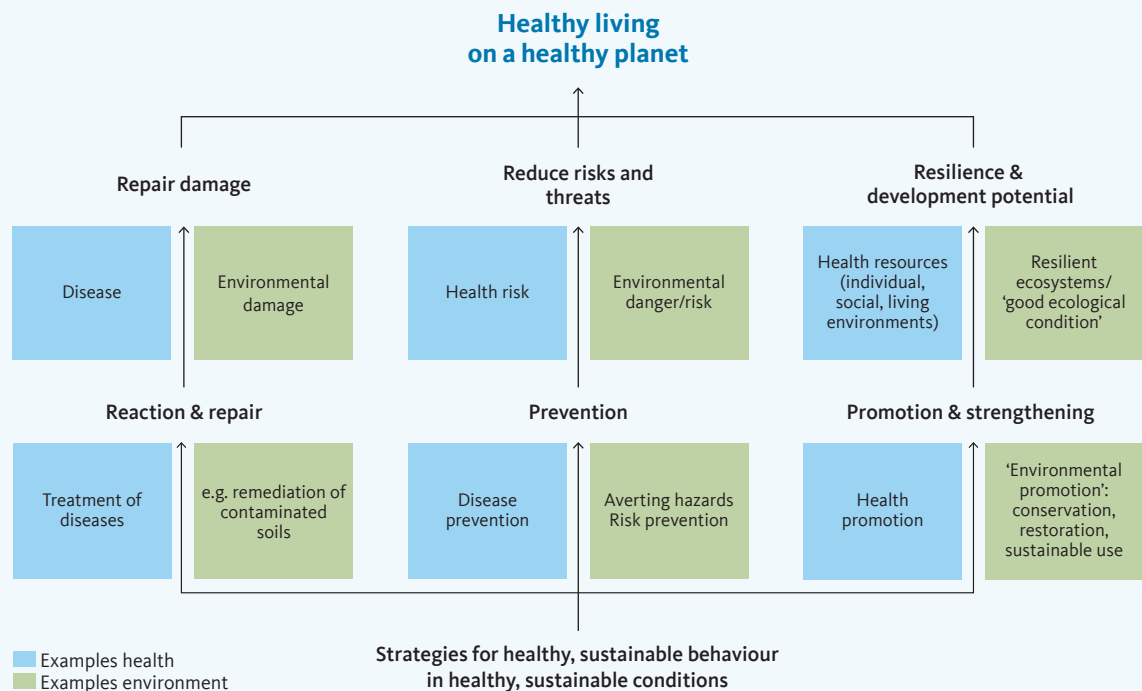


Figure 3.1-1

Healthy living on a healthy planet: three complementary approaches. The view of diseases, damage and reactive repair (left) should be complemented much more than hitherto by foreseeing and preventing risks (centre), and promoting development potential and resilience to external disturbances (right). This corresponds to a greater emphasis on systemic approaches that address individual behaviour by shaping external conditions in healthy human and natural environments.

Source: WBGU, further developed on the basis of Waller, 2006: 161.



Box 3.2-3; Section 6.3.2). While disease prevention includes e.g. vaccinations and screening, health promotion comprises e.g. individual health literacy and the provision of healthy options in all areas of life (e.g. in nutrition, transport, housing; Chapters 4, 6; Box 3.2-3). The latter requires corresponding external conditions, and issues such as cross-sectoral cooperation, funding, and unsustainable but established social practices can be major challenges. In environmental and climate policy, the focus has so far been on averting and preventing hazards – i.e. averting and preventing likely damage where occurrence is imminent – and risk prevention – i.e. early action even where there is scientific uncertainty about the time, type and extent of any damage (Proelß, 2022; Köck et al., 2023). In other areas, such as the EU Water Framework Directive or the EU Habitats Directive, the (re-)establishment of a good ecological status is also required, i.e. the promotion of environmental quality. Overall, however, implementation of the danger-averting, risk-preventing and quality-oriented approaches is inadequate.

However, comprehensive concepts of nature conservation and environmental promotion for the preservation, restoration and sustainable use of ecosystems point to a change in direction towards positive design, enablement and improvement.

Actors of the transformative change towards sustainability are individuals and groups from civil society, but mostly policy-makers and administrators at every level from the local to the international; they lay down the framework conditions. Just as the vision of ‘healthy living on a healthy planet’ unites health and environment goals, the corresponding hazard- and opportunity-oriented approaches must also be brought together and communicated jointly at the strategic level. Examples include the creation or transformation of food systems and ‘eating cultures’, transport infrastructures and physical activity patterns, public spaces and residential areas that not only reduce risks to health and the environment, but are also designed to be liveable and diverse – beyond primary functions such as food intake, mobility and weather protection (Chapter 4).

Human dignity

Human dignity is the “starting point and target of the normative compass” (WBGU, 2019a: 35 ff.). Dignity includes being able to live a life in conditions that allow good health and guarantee access to health services. This conviction is expressed, inter alia, in Article 25 of the Universal Declaration of Human Rights of the UN General Assembly of 10 December 1948: “Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing and medical care and necessary social services [...]” (UN, 1948). The States Parties to the International Covenant on Economic, Social and Cultural Rights of 16 December 1966 also “recognize the right of all persons to the enjoyment of the highest attainable standard of physical and mental health” (Art. 12 (1)) and the right to healthy working conditions (Art. 7). Germany has ratified this pact (BMZ, 2023a).

These provisions do not, of course, amount to a state guarantee of health; rather, the basic idea is that “the state – as the primary bearer of human-rights obligations – shall not impair people’s health, shall protect it from interference and shall take measures to ensure that people encounter healthy living and working conditions” (Krennerich, 2020). What lies behind this is the realization that healthy living and working conditions are a crucial prerequisite for making a life in dignity possible (Section 2.2.5).

Human dignity and ensuring decent living conditions are thus closely linked to the right to health. The right to health is already deeply and broadly enshrined in state constitutions worldwide – for example in the form of a fundamental right to life and physical integrity (Art. 2 (2) sentence 1 of Germany’s Basic Law). However, its implementation is by no means assured worldwide.

This is why, for example, the 2030 Agenda names the following sub-target in SDG 3: “Ensure healthy lives and promote well-being for all at all ages”. Germany’s Federal Ministry of Economic Cooperation and Development (2022) specifies: “All people should have access to basic health services without facing financial hardship.” Despite many advances in global healthcare in recent decades, one third of the world’s population is expected to still lack access to essential healthcare in 2030 (BMZ, 2022). This implementation gap must be closed (Section 3.4).

Sustaining natural life-support systems

The importance and urgency of preserving natural life-support systems becomes particularly clear in the Anthropocene in view of the massive impacts of global environmental changes on human health and well-being that can already be felt today (Section 2.3). Human life on this planet is inextricably interwoven with nature in multiple ways, so that its preservation is fundamental to the future of humanity (Box 3.2-1). This requires compliance with planetary guard rails, i.e. “quantitatively definable damage thresholds whose transgression, either today or in future, would have such intolerable consequences that even large-scale benefits in other areas could not compensate these” (WBGU, 2011: 32; Box 2.3-1). They include guard rails for climate change (WBGU, 1995, 1997), soil degradation (WBGU, 2005), ocean acidification (WBGU, 2006), biodiversity loss (WBGU, 2000) and persistent pollutants (WBGU, 2014b). These guard rails require regular review and, when necessary, updating. Such an update is discussed for climate change, for example, on the basis of the new insights from the sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC; Section 2.3).

3 The vision of ‘healthy living on a healthy planet’

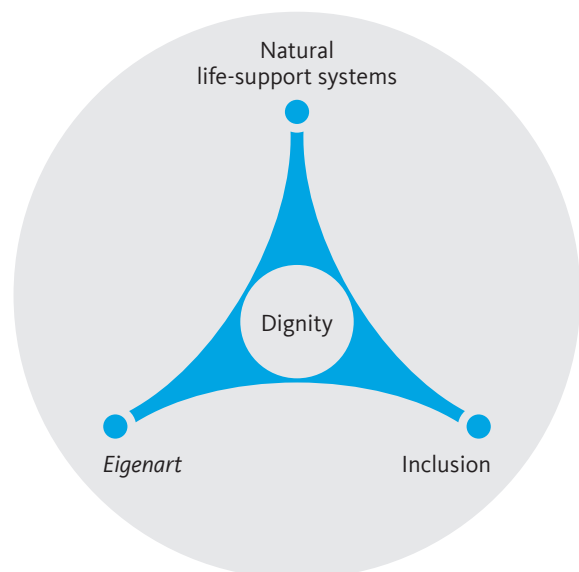


Figure 3.2-1

The normative compass based on human dignity, from which the need for a transformation towards sustainability is derived. The transformation can be achieved by interaction and balance between the following three dimensions:

- › *Sustaining the natural life-support systems*: respect planetary guard rails, avoid or solve local environmental problems, strengthen the health of ecosystems and species,
- › *Inclusion*: ensure universal minimum standards for substantive, economic, political and social inclusion,
- › *Eigenart*: recognize the value of diversity as a resource for successful transformation and as a condition for well-being and quality of life.

The WBGU’s explicit normative starting point is human dignity, which cannot be realized without the three compass dimensions. The WBGU explicitly names the inviolability of, respect for and protection of dignity as guidance in the sense of the transformation towards sustainability.

Source: graphics and text (partly verbatim) from WBGU, 2019a: 42; graphics: Wernerwerke, Berlin

However, preserving natural life-support systems is not only about the planetary dimension, it is always also about avoiding local environmental problems, for example by preventing harmful emissions (Section 5.2). Both dimensions of environmental protection, global and local, are crucial to the close interlinkage of humans and nature, and are decisive prerequisites for human and planetary health.

Inclusion

The goals of the transformation towards sustainability include “the achievement of societal inclusion for all people” (WBGU, 2016a: 138). Based on Sen and Nussbaum (WBGU, 2016a: 138 and citations there), the WBGU distinguishes between substantive, economic, and political and social inclusion. Such inclusion is a prerequisite for a healthy life for all people and for sustainable, (climate-) resilient development (IPCC, 2022d).

- › The aim of *substantive inclusion* is to enable people to meet their basic needs. This means providing qualitatively and quantitatively adequate access to, for example, food, drinking water, housing, land and both terrestrial and marine ecosystem services, as well as to a healthy, pollution-free environment, which is a prerequisite for a healthy life. Furthermore, substantive inclusion ensures access to basic services (such as energy, mobility, education, digital infrastructure). As already stated above, these include, in particular, the right to health and access to basic health services (SDG 3). The term ‘health equity’ belongs in this context. It refers to the absence of unfair, avoidable or remediable differences in health status between socially, economically, demographically or geographically defined population groups (WHO, 2021q; Section 2.2.5).
- › *Economic inclusion* aims to ensure people’s integration into economic processes, as well as formal and informal markets, and to enable them to help shape these markets; this is also an essential factor for the economic determinants of health and part of the transformation towards sustainability (Section 2.2.5).
- › *Political and social inclusion* encompasses people’s involvement in and co-creation of their living environment, democratic participation in societal and political decision-making processes, and in shaping state and legal systems. Taking into account the needs of species and ecosystems, this also involves inclusion in decisions that affect the environment. Enabling political and social inclusion can be seen as part of people’s self-efficacy and can thus contribute to health and well-being.

Substantive, economic and political inclusion find their basis in human rights, underpinned by the concept of human dignity. Access to health services remains indispensable as a policy priority in many parts of the world, especially in low- and middle-income countries. Health promotion and the prevention of damage to health should be added as a focus everywhere (Chapter 6). In many parts of the world, for example, the consumption of too much food, poor nutrition and a lack of physical activity as a result of Western lifestyles have led to a drastic increase in ‘lifestyle diseases’ (non-communicable diseases; Section 2.2.2).

Accordingly, inclusion involves ensuring healthy living conditions for all people in order to make a good and healthy life possible. A crucial prerequisite for inclusion remains the existence of personally experienced political inclusion. In this respect, inclusion is closely linked to solidarity and is an essential background for “solidarity-based quality of life” (WBGU, 2016: 133 f).

Box 3.2-1**The value of nature for health and the intrinsic value of nature**

In many people's view, the value of nature is derived from the value of the different services and contributions („commodities“) that ecosystems and their biodiversity provide for humans. The World Biodiversity Council (IPBES) calls these services and values „Nature's Contributions to People“ and distinguishes 18 categories of such contributions: some material (e.g. providing food), some regulatory (e.g. maintaining soil quality) and others non-material (e.g. providing recreation; Díaz et al., 2018; IPBES, 2019; Fig. 2.3-3). These contributions are based on ecosystem processes that are also essential for all other organisms. Many of these services have a direct or indirect impact on human health. These include, for example, the supply of food, natural medicines and other resources, clean water and air, the value of nature for recreation, and nature's contribution to our sense of identity. The latter is an example of the many relational values that reflect human's ideational connection with nature (Schröter et al., 2020) and are included in nature's non-material contributions to people.

Particularly important is the discussion about nature's intrinsic value. This is about giving nature a value independent of its usefulness for and use by humans. For example, nature's regulatory contributions to people also include the provision of habitats for all organisms that live in the wild. In addition to political and legal decisions in which animals and plants are granted legal personality (on current developments see Wolf, 2022: 451 ff.), an intrinsic value of nature is expressed in the idea that each individual animal and plant species and each ecosystem should be granted a right to exist without this being questioned from the human perspective. While some regard this value of nature as intrinsic (Stone, 1972; with regard to animals see Nussbaum, 2010; Cavalieri and Singer, 1994), as

is also mentioned in the preamble of the CBD, others take the position that there cannot be such an intrinsic value, since values are fundamentally ascribed by humans (Derrida and Roudinesco, 2006: 113). Even so, the latter view certainly allows for recognizing the intrinsic value of nature as a non-material value, i.e. recognizing the value that nature has for those who want to recognize it (Ott, 2021).

The IPBES's conceptual framework attempts to do justice to these ethical viewpoints by explicitly emphasizing that nature can be seen in different world views as ‚biodiversity and ecosystems‘, ‚Mother Earth‘ or as ‚systems of life‘, and the IPBES's conceptual framework is applicable accordingly from different perspectives and on different scales (Díaz et al., 2015). The many values that different actors, especially indigenous peoples and local communities, ascribe to nature, including the intrinsic value of nature, must be considered, taken into account and taken seriously in policies in the context of planetary health (IPBES, 2022; Gutmann, 2019).

German nature conservation law (BNatSchG) aims to protect nature for its own sake. Section 1 (1) states: „By virtue of their intrinsic value and importance as a basic necessity of human life, and also as a responsibility to future generations, nature and landscape in both settled and non-settled areas are to be protected, [...] in keeping with the following paragraphs [...]“. In some countries, this intrinsic value is recognized via intrinsic rights of nature, e.g. by the Constitution of Ecuador (Republic of Ecuador, 2008: Art. 71; Gutmann, 2019).

This concept, along with the conservation, restoration and sustainable use of natural resources that are based on it, is a fundamental prerequisite for living healthily on a healthy planet. This involves the sense of responsibility needed for coexisting with nature, giving it the space it needs to flourish, and advocating the preservation of natural life-support systems. It also takes on board the idea that we humans, as a biological species, are part of nature and should live „in harmony with nature“ (CBD, 2010) for true sustainability.

Eigenart

In the normative compass, *Eigenart* is, on the one hand, meant descriptively, outlining the typicality of societal structures (both built and institutional), socio-cultural characteristics and practices, as well as specific ecological environmental structures (e.g. cultural landscapes as an elementary component of identity and homeland); in other words „emotionally and physically experienced singularities [...] with which people feel connected“ (WBGU, 2020: 38 f). On the other hand, *Eigenart* has a target and orientation dimension and is thus also meant normatively, because *Eigenart*, with its emphasis on socio-cultural diversity and autonomy, is an important condition for well-being and quality of life (WBGU, 2019a: 40). *Eigenart* also serves as a „resource for the transformation towards sustainability and as a basis for resilience to future changes and shocks“ (WBGU, 2020: 39). Its close linkage with cultural diversity (including indigenous and local perspectives) as well as with biological diversity (linked inter alia to the

diversity of socio-ecological systems) gives rise to its importance for the resilience of societal and ecological systems. The resilience, diversity and sustainability of socio-ecological systems are closely related (Folke et al., 2002; Oliver et al., 2015; Grêt-Regamey et al., 2019). Similar to the way in which biodiversity promotes ecosystem resilience, actor diversity can increase the resilience of socio-ecological systems (Grêt-Regamey et al., 2019; e.g. marine protected areas: Jones et al., 2013). Deviations from societal norms and cultural patterns ensure diversity and allow for socio-cultural change. Appreciation and respect for the *Eigenart* of cultures and of people with their beliefs and lifestyles are prerequisites for the development of individual skills and self-efficacy (capabilities: Nussbaum, 1998), for social cohesion as well as for identity (WBGU, 2019a: 40) – and thus ultimately also for well-being. The WBGU has therefore described *Eigenart* as a „guiding concept for the protection of individual freedom of development“ (WBGU, 2019a: 40).

Box 3.2-2

Intertemporal safeguarding of freedom by preserving and shaping freedoms and spaces for *Eigenart*

Climate lawsuits, i.e. lawsuits filed with the aim of legally boosting climate-change mitigation, are a worldwide phenomenon and the subject of a transnational jurisprudential dialogue (Alogna et al., 2021). Germany’s Federal Constitutional Court made it clear in its landmark climate-change-mitigation decision of 24 March 2021, which also attracted international attention: „Under certain conditions, the Basic Law imposes an obligation to safeguard fundamental freedom over time and to spread the opportunities associated with freedom proportionately across generations. In their subjective dimension, fundamental rights – as intertemporal guarantees of freedom – afford protection ensuring that the greenhouse-gas-reduction burdens imposed by Art. 20a of the Basic Law are not unilaterally offloaded onto the future. Furthermore, in its objective dimension, the protection mandate laid down in Art. 20a of the Basic Law encompasses the necessity to treat the natural life-support systems with such care and to leave them in such a condition that future generations that wish to carry on preserving these foundations are not forced to engage in radical abstinence“ (Headnote 4). In order to achieve climate neutrality, the fundamental rights of freedom (inter alia Article 2 (1) of the Basic Law) oblige the German state to distribute opportunities for freedom proportionately over time (Bundesverfassungsgericht, 2021). This duty to ensure intertemporal freedom means that current state measures should not restrict future citizens’ exercise of freedom in such a way that this freedom, and also freedom of choice, is denied to them.

An intensive jurisprudential discussion has been triggered by the issue of what the content of the state’s intertemporal duty to safeguard freedom is, how conflicting rights of freedom – e.g. corporate freedom and health protection – are to be reconciled, and how future losses of freedom are to be fairly distributed among generations. In addition, a political negotiation process that strengthens the dimension of realizing *Eigenart* as a resource and necessity in transformation processes could also lead to more clarity. The results could be part of

a new social contract, as already proposed by the WBGU in 2011. Here, the WBGU recommended pursuing the model of a proactive state offering extended participation possibilities (WBGU, 2011b).

In order to also make choices possible in the future, it is important to strengthen the maintenance and creation of *Eigenart* and diversity as a goal of political strategies and measures, e.g. by offering several alternatives for combating harmful modes of behaviour. For example, instead of using cars with combustion engines, it should be possible to choose between walking or cycling or attractive local public transport. This also reduces the intensity of intervention if individual behavioural options are (or have to be) abolished or banned in the future to mitigate climate change (Bundesverfassungsgericht, 2021). In order to strengthen spaces for the development of *Eigenart*, countries should not only think of rights to freedom in a *defence mode* (how can citizens ward off possible state intervention – perhaps to protect the environment), but also in a *protection and guarantee mode* (what can and must the state do to protect the citizens’ *Eigenart* and freedom in a sustainable way, and to maintain them in such a way that the life-support systems of species and ecosystems are guaranteed). The more non-state threats to freedom are added in the future, the more the state’s task shifts from restraint from intervening in spaces for exercising freedom (defence mode) to actively shaping and maintaining those spaces (protection and guarantee mode). In this context, states can exert an influence on spaces for exercising individual freedom particularly in *three ways*:

1. States enshrine a fundamental right to a healthy environment (Section 6.2.1).
2. States create legal foundations for exercising freedom (e.g. by providing a private legal system and securing property). This effective power of the state is relevant for the realization of *Eigenart* and pioneering activities – i.e. when the legal system does not provide legal protection for social innovations.
3. States guarantee the actual foundations for the exercise of freedom (e.g. a subsistence level, social security, infrastructures and public spaces, climate-change mitigation); states can simultaneously maintain and create actual spaces for exercising freedom by making public spaces and infrastructures sustainable and attractive.

The importance of *Eigenart* for health and well-being becomes even clearer in this report: *Eigenart* is an important basis for shaping the areas of human life analysed in Chapter 4 (what we eat, how we move and where we live) with their close links to ecological and cultural diversity, for personally perceived well-being, as well as for the search for viable multi-benefit strategies in those areas of life. ‘What we eat’ (Section 4.1; WBGU, 2020) as an area of life is deeply interwoven with the climatic and ecological conditions and the cultural context of a region. The same applies to ‘How we move’ (Section 4.2) and ‘Where we live’ (Section 4.3; WBGU, 2016a).

Health promotion involves much more than just tackling ‘too little’. It is also about dealing with ‘too much’. Thus, the question as to the right balance must be raised.

For example, too much convenience (and thus too little physical activity) or too much food (leading to obesity or type 2 diabetes mellitus) are also unhealthy and promote lifestyle diseases that are linked to an unhealthy way of life (Section 2.2.2). People’s individual freedom makes it impossible to react to these problems only with state prohibitions and regulations on healthy lifestyles; that would be compatible neither with the principle of dignity in a free democratic basic order nor with the concept of *Eigenart*. Rather, in this context health promotion can take the form of a framework that focuses on enabling health-promoting living environments, and creating corresponding incentives and multiple-benefit strategies (Box 3.1-1; Chapter 4, Section 5.2). Wherever possible, incentives should encourage people to

organize their everyday lives in a way that also promotes health. This can improve people's well-being and the resilience of society. Against this background, enabling and securing inclusion and *Eigenart* can be interpreted as conditions for a health-promoting lifestyle, on the basis that the planetary guard rails – and thus also the needs of species and ecosystems – are taken into account and respected.

However, *Eigenart* is not just a *limit* to state action – partly as an expression of human rights (e.g. Art. 2 (1) of the Basic Law: “Every person shall have the right to free development of their personality [...]”). In situations where the biggest restrictions on personality development are threatened by environmental changes and non-state actors, it is above all the *task* of state action. Preserving and shaping spheres of freedom for *Eigenart* in the future should be understood as an important part of the intertemporal task of safeguarding freedom (Box 3.2-2).

3.2.2 Normative aspects in policy objectives

While the WBGU's normative compass (Section 3.1.1) is an action-guiding vision derived directly from human dignity, states and communities of states negotiate and agree on concrete political goals and targets which often involve clear time scales and measurable indicators, and sometimes obligations under international law. In this sense, there is not only widespread international agreement that a transformation towards sustainability is necessary, but corresponding, detailed goals on sustainability and health have already been adopted both internationally and, in many cases, nationally. These represent many facets of the WBGU's normative compass. Here are some examples:

1. The *Framework Convention on Climate Change (UNFCCC)* aims to prevent dangerous anthropogenic interference with the climate system. This was put into concrete terms in the Paris Agreement by setting temperature targets (to hold the temperature increase to well below 2°C and to make efforts to limit it to 1.5°C) and the goal of climate neutrality by the second half of this century derived from them.
2. The *Convention on Biological Diversity (CBD)* is intended to pursue the conservation of biological diversity, the sustainable use of its components and equitable sharing of the benefits arising from the use of genetic resources.
3. The *Basel, Rotterdam and Stockholm Conventions* address various aspects of global pollution (Box 5.2-1).

With a view to the ecological crises (Section 2.3), these agreements, each of which also has detailed health

references, have agreed on specific target catalogues for their topics.

Specific health goals are also comprehensively laid down at the multilateral level (Section 2.4). For example, the WHO's objective is the “attainment by all peoples of the highest possible level of health” (WHO, 1948). The Ottawa Charter for Health Promotion and the Geneva Charter for Well-being underpin this goal (WHO, 1986, 2022a; Box 3.2-3). In various forums, the WHO has furthermore promoted the guiding principle of ‘One Health’ to emphasize the close interlinkage between the health of humans, animals and plants, and the state of ecosystems (WHO, 2022p; Section 3.3). In the CBD's Kunming-Montreal Global Biodiversity Framework, One Health has been included as a fundamental idea for implementation (CBD, 2022).

The United Nations' current, overarching system of goals is the 2030 Agenda for Sustainable Development with its 17 global Sustainable Development Goals (SDGs), which came into force in 2016 and mostly have 2030 as their target year (UN, 2015a). SDGs 1–11 and SDG 16 address different dimensions of inclusion, SDGs 12–15 the preservation of natural life-support systems.

The agreement on these goals is a milestone of multilateralism, but they must now be put into practice (Section 6.2.2). In many areas, it is becoming apparent that the existing measures will not be sufficient to achieve the goals. In many cases, the already too slow implementation of the SDGs has been further slowed down by the COVID-19 pandemic, the global impact of Russia's invasion of Ukraine and other conflicts, and the growing impact of climate change, putting the 2030 Agenda at serious risk (UN, 2022b). In the climate sector, the states' nationally determined contributions (NDCs), taken together, are already insufficient to reach the global temperature targets, while the current national policies and measures are not even enough to achieve these insufficient NDCs (UNEP, 2022c). The IPCC and IPBES assessment reports also speak a clear language: we are currently not on a path that will keep us from breaching planetary guard rails or lead us back into the tolerable range (Section 2.3).

The message from both the normative compass and the normative framework provided by the multilateral target system is clear: we need to place the implementation of the agreed set of goals higher on the agenda and finally devote to the global problems the attention, willpower and resolve that the situation demands and that we owe to present and future generations.

Box 3.2-3

Health promotion and well-being as guiding principles for health policy: from the Ottawa Charter for Health Promotion (1986) to the WHO Geneva Charter for Well-being (2021)

In 1986, the first International Conference on Health Promotion was held in Ottawa, Canada, with more than 200 participants from 38 countries. Its key result, as summarized in the Ottawa Charter (WHO, 1986), is to re-orient away from the *pathogenetic* perspective pursued up to now, which focuses on the genesis of disease and its prevention, i.e. combating disease triggers and health risks, towards a *salutogenetic* view of medicine, which concentrates on factors and dynamic interactions that lead to the development and preservation of health (as put forward by Aaron Antonovsky, 1923–1994). In the Ottawa Charter, health is understood as an essential part of everyday life: “Health is created and lived by people within the settings of their everyday life; where they learn, work, play and love.” The Charter defines the term ‘health promotion’, which quickly became the guiding principle of health policy worldwide, as “the process of enabling people to increase control over, and to improve, their health”. Fundamental prerequisites such as peace, shelter, education, food, income, a stable ecosystem, sustainable resources, social justice and equity are mentioned as essential prerequisites for health. Core elements in the development of health-promotion strategies are: caring for each other, holism and ecological thinking (WHO, 1986).

The Ottawa Charter identifies the following three basic strategies for action to achieve ‘Better Health for All’:

1. Advocate: Health promotion requires active advocacy to positively influence political, economic, social, cultural, biological and behavioural factors and make them conducive to health;
2. Enable: “People cannot achieve their fullest health potential unless they are able to take control of those things which determine their health.” Equity in health is thus an essential prerequisite for (the promotion of) health.
3. Mediate: In order to implement health promotion, a coordinated interaction of many actors at different levels and in different sectors is necessary. Those responsible in governments, in the health, social and economic sectors, in non-governmental and self-organized associations and initiatives, as well as in local institutions, industry and the media, must be involved, as must people in all areas of life as individuals, families and communities.

The Ottawa Charter also identifies five fields of action: 1) build healthy public policy; 2) create supportive environments; 3) strengthen community action; 4) develop personal skills; 5) reorient health services.

In 2021, health promotion was further developed as a guiding principle for health policy in the Geneva Charter for Well-being by more than 5,000 participants from politics, academia, civil society and business from 149 countries at the 10th Global Conference on Health Promotion. The Charter underlines the urgent need for sustainable ‘well-being societies’, which should make equitable health possible for present and future generations without breaching ecological limits (WHO, 2022a). Well-being societies “apply bold policies and transformative approaches that are underpinned by:

- > a positive vision of health that integrates physical, mental, spiritual and social well-being;
- > the principles of human rights, social and environmental justice, solidarity, gender and intergenerational equity, and peace;
- > a commitment to sustainable low-carbon development grounded in reciprocity and respect among humans and making peace with nature;
- > new indicators of success, beyond gross domestic product, that take account of human and planetary well-being and lead to new priorities for public spending;
- > the focus of health promotion on empowerment, inclusivity, equity and meaningful participation.”

In the context of “complex and interrelated crises” and taking into account the “ecological, political, commercial, digital and social determinants of health”, the Geneva Charter points to the urgency of action, and calls for a whole-of-society approach and coordinated action in the following five areas to open up “a flourishing future” for humanity:

1. value, respect and nurture Planet Earth and its ecosystems;
2. design an equitable economy that serves human development within planetary and local ecological boundaries;
3. develop healthy public policies for the common good;
4. achieve universal health coverage;
5. address the impacts of digital transformation.

It should be noted that these are the final documents of conferences and thus non-binding declarations of intent, not instruments of international law.

3.3 Existing integrative concepts for the health of humans and nature

The core components of the WBGU’s vision (Sections 3.1, 3.2 and 3.4) are partly inspired by the integrative and transdisciplinary health concepts that have been increasingly discussed in recent years and have been rapidly

gaining in importance. These include One Health, Planetary Health, GeoHealth and EcoHealth. The German Advisory Council on the Environment (SRU) has also made conceptual considerations in this regard (SRU, 2023). The WBGU recognizes the significance of these concepts for the broad implementation of its vision, and welcomes the developments in recent years as they reflect a growing awareness of the linkages between health and global environmental change. Moreover, the concepts show a

growing interest in the topic among actors from the health sector and their willingness to take on responsibility for transformations towards sustainability.

3.3.1 General characteristics

The integrative and transdisciplinary health concepts discussed below (One Health, Planetary Health, GeoHealth and EcoHealth) have emerged from the realization that human influence on the environment has become a threat to the health of humans, other living beings and the planet's ecosystems. The concepts are closely related and clearly overlap, but are characterized by specific approaches and emphases, as they each reveal varying degrees of influence from different academic disciplines. They all draw on aspects of the long-standing interdisciplinary health concepts explained in Box 2.1-2 (public health, tropical medicine, international health and global health). However, the integrative and transdisciplinary concepts of health go a lot further than this in their perspective; they integrate different determinants and concepts of health and extend the health concept beyond human health to other living beings and/or overarching natural systems, depending on the concept. Whereas, in the past, ecological determinants were mostly understood only as external factors influencing human health, integrative and transdisciplinary health concepts realize that human health is closely interwoven with intact natural life-support systems and the health of other living beings and ecosystems.

Transdisciplinarity is mentioned as an important approach in the key One Health and Planetary Health publications (Section 3.3.2), for example, but is rarely defined in concrete terms. As a rule, the term refers to cooperation between a variety of natural-science, social-science and humanities disciplines, crossing disciplinary boundaries – often including cooperation with societal actors outside of science, and even the consideration of different forms of knowledge, such as indigenous knowledge. For example, Planetary Health is defined not only as a theoretical concept but sometimes also as a societal movement (Box 3.3-2). Theoretical concepts, perspectives and approaches from different disciplines are integrated via the transdisciplinary health concepts to link theoretical science with an action-oriented, target-oriented approach to current problems (Almada et al., 2017; Charron, 2012; Whitmee et al., 2015; Wilcox et al., 2004).

In this context, the concept of health is also used in the sense of the maintenance and stability of essential functions of complex natural systems in general (IPCC, 2022a). In this way the image of 'healthy living on a healthy planet' is becoming more attractive in discourses

on nature conservation and sustainability, as it characterizes the value of intact physical, chemical and biological processes (e.g. radiative balance, material cycles, food chains, ecosystems) – analogous to a physiology of the Earth that can only be kept functioning if planetary guard rails (Section 2.3) are observed.

3.3.2 Core elements of the most important concepts

In general, it can be noted that the definitions and interpretations within each of the integrative and transdisciplinary concepts vary to a similar extent as those between them. Because of this great variability, the dynamic evolution of the concepts and the many actors involved, their description cannot be exhaustive. In particular, characteristics are therefore identified here that can be helpful in implementing the vision of 'healthy living on a healthy planet' and can therefore, in the WBGU's view, make particularly valuable contributions to future discussions and the development of solution approaches. The assignment of a characteristic to one of the concepts means that this aspect is particularly prominent there – which does not mean that it cannot also play a role for other concepts. In the following, One Health and Planetary Health are described in detail, as they show the most overlaps with the WBGU's vision. The related EcoHealth and GeoHealth concepts are described more briefly in Box 3.3-3.

3.3.2.1 One Health

The starting point for the current concept of One Health (Box 3.3-1) was the 'One World, One Health' conference, which was held in New York in 2004 against the background of outbreaks of various zoonotic infectious diseases associated with anthropogenic environmental changes (Cook et al., 2004). Participants included representatives of the WHO and the UN's Food and Agriculture Organization (FAO). The conference resulted in the Manhattan Principles, which, among other things, emphasize the importance of the health of farmed and wild animals for human health, and at the same time suggest possible synergies between species conservation and the protection of human health (Cook et al., 2004). Subsequently, both narrower and broader understandings of the One Health concept have developed. Narrower definitions look at the interactions between animal and human health from a biomedical perspective. The focus here is on monitoring (zoonotic) infectious diseases and antibiotic resistance, and the general management of health threats to humans and animals (Gibbs, 2014; Zinsstag, 2012). More broadly formulated and

Box 3.3-1

Definitions and descriptions of One Health

“One Health approach: an approach to address a health threat at the human-animal-environment interface based on collaboration, communication, and coordination across all relevant sectors and disciplines, with the ultimate goal of achieving optimal health outcomes for both people and animals; a One Health approach is applicable at the subnational, national, regional, and global level.” (FAO, 2019)

“One Health is a collaborative, multisectoral, and trans-disciplinary approach – working at local, regional, national, and global levels – to achieve optimal health and well-being outcomes

recognizing the interconnections between people, animals, plants and their shared environment.” (One Health Commission, no date)

“One Health is an integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals and ecosystems. It recognizes the health of humans, domestic and wild animals, plants, and the wider environment (including ecosystems) are closely linked and inter-dependent. The approach mobilizes multiple sectors, disciplines and communities at varying levels of society to work together to foster well-being and tackle threats to health and ecosystems, while addressing the collective need for clean water, energy and air, safe and nutritious food, taking action on climate change, and contributing to sustainable development.” (OHHLEP, 2022)

practice-oriented is the FAO’s definition of One Health as an approach to tackling specific health threats at the human-animal-environment interface (Box 3.3-1). A similar definition is given by the One Health Commission (Box 3.3-1), which addresses the health of humans, animals, plants, the environment and ecosystems, and seeks transdisciplinary collaboration beyond the disciplines of human and veterinary medicine (Gruetzmacher et al., 2021; Lerner and Berg, 2017). Both definitions refer to several spatial levels (local, regional, national, global). The prominent importance of animal health and the explicit inclusion of veterinary medicine can be found in both the narrower and broader definitions and represent a special feature of the One Health concept. The Berlin Principles on One Health, developed in 2019 at the conference ‘One Planet, One Health, One Future’, were adopted as an update of the Manhattan Principles (Gruetzmacher et al., 2021). In these, the classic topics of the One Health concept are embedded to a greater extent in the context of anthropogenic environmental change. In addition, infectious diseases are considered here in general, and non-communicable diseases are also mentioned as topics. A special focus is placed on practical measures to prevent and combat disease, with particular emphasis on the importance of conserving biodiversity.

Several international institutions make use of the One Health concept: the WHO, the FAO, the World Organization for Animal Health (WOAH) and the UN Environment Programme (UNEP) have even established a One Health High Level Expert Panel (OHHLEP), which has developed an even broader definition (Box 3.3-1). The first draft of the WHO Pandemic Treaty, prompted by the COVID-19 pandemic, enshrines One Health as a guiding principle, with “multisectoral actions that recognize the importance of animal health, human health and environmental health working together to achieve better public health outcomes” (WHO, 2022n). From the

WBGU’s perspective, the One Health concept is significant for its vision of ‘healthy living on a healthy planet’ because it emphasizes the conservation of biodiversity, focuses on practical measures to prevent and combat diseases, and explicitly takes animal health and veterinary medicine into account. These features suggest that the elements of the One Health concept can be particularly useful in relation to zoonotic infectious diseases, in the context of future pandemics, and in managing and reducing biodiversity loss.

3.3.2.2

Planetary Health

The starting point for the Planetary Health concept (Box 3.3-2) is the article ‘From public to planetary health: a manifesto’ by Horton et al. (2014). The manifesto contains a vision “for a planet that nourishes and sustains the diversity of life with which we coexist and on which we depend”. It explicitly mentions the goal of minimizing disparities in health according to wealth, education, gender and place. Furthermore, the report of the Rockefeller Foundation–Lancet Commission on Planetary Health was also instrumental in shaping the Planetary Health concept. It emphasizes the linkages between human health and social, political and economic systems as well as the planet’s natural systems (Whitmee et al., 2015). It becomes clear from the explicit reference to the concept of planetary boundaries (Section 2.3) and the definition of Planetary Health used in the report (Box 3.3-2) that the preservation of natural life-support systems is given paramount importance. In addition, the ecological and societal determinants of health are included from a systemic perspective, and equity issues are explicitly taken into account. Also in 2015, the Planetary Health Alliance (PHA) was founded, a “consortium of more than 350 universities, non-governmental organizations, research institutes, and government entities from 60+

Box 3.3-2**Definitions and descriptions of Planetary Health**

“Our definition of planetary health is the achievement of the highest attainable standard of health, well-being, and equity worldwide through judicious attention to the human systems—political, economic, and social—that shape the future of humanity and the Earth’s natural systems that define the safe environmental limits within which humanity can flourish. Put simply, planetary health is the health of human civilization and the state of the natural systems on which it depends.” (Whitmee et al., 2015)

“Planetary health is a solutions-oriented, transdisciplinary field and social movement focused on analysing and addressing the impacts of human disruptions to Earth’s natural systems on human health and all life on Earth.” (Planetary Health Alliance, 2023)

“We need a fundamental shift in how we live on Earth, what we are calling the Great Transition. Achieving the Great Transition will require rapid and deep structural changes across most dimensions of human activity. This includes how we produce and consume food, energy, and manufactured goods; how we construct and live in our cities; and how we consider and measure growth, progress and development, and govern ourselves. It will also require rethinking our values and relationship within Nature and to each other from human exceptionalism, domination, and scarcity to interdependence, equity, and regeneration. The Great Transition offers the possibility of greater richness of experience, greater well-being, and an enhanced opportunity for all beings to thrive. It will take practitioners, scholars, and policy makers across every dimension of human activity working together. It will require listening to, integrating, and amplifying voices in every community from Indigenous Peoples, faith traditions, artists, entrepreneurs, to scientists. Every person, in every place, from every calling, has a role to play in safeguarding the health of the planet and people for future generations.” (Planetary Health Alliance and USP – Universidade de São Paulo, 2021)

Box 3.3-3**Further integrative and transdisciplinary health concepts****EcoHealth**

The EcoHealth concept developed from the ecology discipline at the end of the 20th century and builds on numerous precursor concepts such as Ecosystem Health (Buse et al., 2018). It was largely shaped by Canada’s International Development Research Centre, which launched a science programme on EcoHealth in 1997 (Charron, 2012, Mi et al., 2016). The EcoHealth concept looks at human, animal and ecosystem health, including aspects of sustainability and socio-economic stability. There is a major focus on biodiversity and ecosystem resilience (Waltner-Toews, 2004; Wilcox et al., 2004). It studies the relationship between health, ecosystems and sustainable development, based on equity and the participation of different groups and sectors, often at the regional level and involving local people (Charron, 2012, Waltner-Toews, 2004). With regard to the vision of ‘healthy living on a healthy planet’, the WBGU considers the explicit reference to sustainable development, the emphasis on equitable participation at the regional and local level, and the focus on the resilience of ecosystems to be particularly significant in the EcoHealth concept.

GeoHealth

The GeoHealth concept emerged at about the same time as the Planetary Health concept from an initiative of scientists from the fields of ecology, earth and space sciences. The aim is to scientifically study key drivers of ecological change from the local to the global level in order to mitigate their impact on human health (Almada et al., 2017; McNutt, 2017). In 2016, the American Geophysical Union (AGU) founded the GeoHealth initiative and the journal of the same name to support the rapidly growing GeoHealth community (Almada et al., 2017; Rehr et al., 2020). The aim is to promote transdisciplinary cooperation with the aim of advancing “understanding of the complex interactions between our geospheric environment (including earth, water, soils and air) and the health, well-being and continuous progress of human populations in concert with all ecosystems” (AGU, 2023). According to GeoHealth, an amalgamation of different disciplines, such as engineering, natural sciences and computer science, should benefit both health and the environment (McNutt, 2017). With regard to the vision of healthy living on a healthy planet, the WBGU considers the focus on studying drivers of ecological change, the reference to different areas of the geosphere, and the idea of progress in harmony with all ecosystems to be particularly relevant in the GeoHealth concept.

countries around the world committed to understanding and addressing the impacts of global environmental change on human health and wellbeing” (Planetary Health Alliance, 2023). The PHA’s current definition of Planetary Health includes the idea that all life on Earth should be protected (Box 3.3-2). Furthermore, Planetary Health is explicitly described as a transdisciplinary and

solution-oriented concept as well as a social movement. The São Paulo Declaration on Planetary Health also emphasizes the need for transformations in many areas of society, involving a high diversity of different perspectives and actors. It also calls for a fundamental redefinition of the human-nature relationship (Box 3.3-2).

3 The vision of 'healthy living on a healthy planet'

Planetary Health is mentioned in prestigious and high-profile international publications, and seemed to attract the attention of influential actors shortly after its establishment (Lerner and Berg, 2017). The scientific journal *The Lancet Planetary Health* has been in existence since 2017, and the concept is referred to in the IPCC's sixth Assessment Report (*The Lancet Planetary Health*, 2017; IPCC, 2022c). From the WBGU's point of view, the following is particularly significant in the Planetary Health concept with regard to the vision of 'healthy living on a healthy planet': the prominent importance of preserving natural life-support systems; the systemic perspective on ecological and societal determinants of health; the emphasis on the need for transformation; the call for a redefinition of the human-nature relationship; and the strong references to inclusion (minimizing inequities) and *Eigenart* (inclusion of different perspectives and actors). The explicit references to the concept of planetary boundaries also suggest that Planetary Health as a concept can be helpful in addressing the systemic planetary environmental crises of climate change, pollution and biodiversity loss.

3.3.3 Significance for the WBGU's vision

In the WBGU's view, the various theoretical concepts – all of which aim to improve the health of humans, other living beings and ecosystems with different focus areas and disciplinary backgrounds – are very helpful in promoting and implementing the WBGU's vision of 'healthy living on a healthy planet'. In this sense, the WBGU concentrates not on emphasizing the differences between the various concepts or on hierarchizing them, but on highlighting their strengths and combining them in the spirit of a transdisciplinary approach. In this context, a fusion of the concepts into a single guiding principle is neither imperative nor necessarily expedient, as this could inhibit helpful specific features and developments. Furthermore, the literature points out that when implementing a merged principle, the large number of disciplines (and actors) involved could lead to structural problems and conflicts (Lerner and Berg, 2017), which could undermine its effectiveness. Moreover, the complicated interactions between the health of humans, other living beings and ecosystems represent a complex subject area; its scientific analysis and the development of approaches to finding solutions can benefit from the different perspectives of several integrative concepts. At the same time, competition between communities supporting different related concepts could also be a hindrance. Since the process of defining and implementing the various concepts is by no means complete but in constant development, it would

be highly desirable from the point of view of the WBGU and its vision if these further developments were to take place in a process of close exchange between these communities, and with a view to a common vision and a great transformative impact.

3.4 From the vision to action

The WBGU's vision of 'healthy living on a healthy planet' comprises the cornerstones elaborated in Section 3.1, is founded on the normative basis described in Section 3.2 and combines many aspects of the integrative and transdisciplinary health concepts described in Section 3.3. The WBGU supplements these by placing them in a comprehensive ecological and environment-related context and adding a strong transformative aspiration. The vision includes compliance with planetary guard rails, especially with regard to climate, pollution and biodiversity; it takes into account the interactions between human health and animals, plants, fungi, bacteria and other microorganisms; it comprehensively incorporates issues of physical and mental health; it assumes a sustainable and fair health system for all, and a societal self-conception characterized by prevention and the active promotion of healthy living environments, fostering healthy and environmentally friendly lifestyles. It convincingly demonstrates that human health can only be realized by improving many other dimensions of sustainability. Achievement of the vision is therefore inconceivable without a comprehensive transformation towards sustainability – and in this sense it can also become the driving force of such a transformation (Figure 3.4-1).

The vision of 'healthy living on a healthy planet' is transdisciplinary, values-based and application-oriented. At its core is the realization that human health and well-being are only possible today and in the future in interaction with a healthy natural environment, and that current developments are not sustainable in the long term. This means that humans have a responsibility (stewardship) for all life, including the biosphere of the entire planet. The development of civilization must therefore be critically reviewed: global human-induced developments such as digitalization, urbanization, defossilization and changes in land use should be brought into line with the vision of 'healthy living on a healthy planet'.

At the same time, the vision is a mandate for science: how might a living environment for the human species be practically designed in such a way that the well-being and health of humans and human societies are made possible as part of a thriving biosphere, and that the natural life-support systems can be preserved

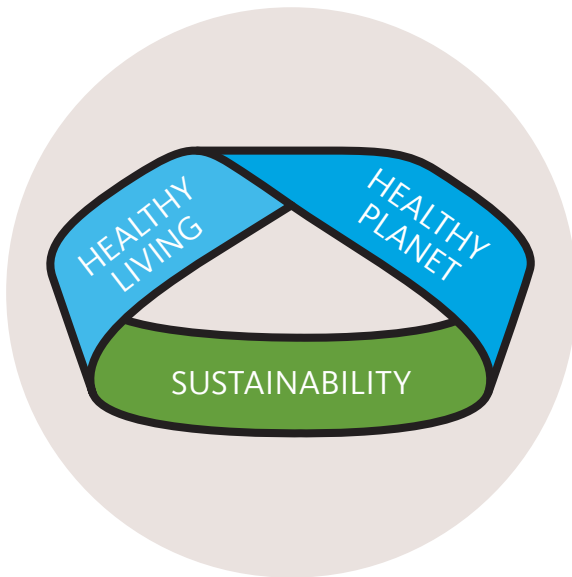


Figure 3.4-1

The realization of the ‘healthy living on a healthy planet’ vision is inconceivable without a comprehensive transformation towards sustainability. At the same time, the topic of health can also be a great motivation to drive forward the transformation towards sustainability.

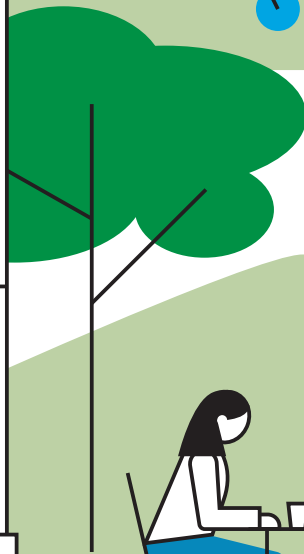
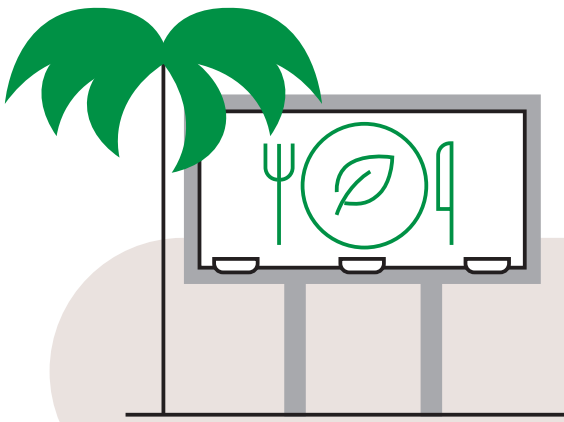
Source: WBGU; graphics: Wernerwerke

in the long term? What kind of built-up infrastructures are suitable? How must we imagine the future of work, and how must we handle our time, so that healthy lifestyles and a healthy interaction with the biosphere are possible? What role can digitalization play? How can a positive relationship between humans and nature be strengthened? Which human needs are perhaps being neglected and compensated by resource-intensive alternatives? What do alternatives to current development paradigms look like?

And finally, the vision contains the mandate for implementation – as a new ‘project for humanity’ that requires fundamental changes to current civilizational developments. The vision of ‘healthy living on a healthy planet’ fits in with the guiding principle of sustainability as already roughly agreed in the context of the Rio Conventions, the SDGs, other international environmental treaties, and national sustainability, climate and environmental goals – although their implementation leaves much to be desired (Sections 2.4, 3.2.2). What is new, however, is the force and speed with which negative effects on health – which had previously been perceived more as forecasts and scenarios of science – are now manifesting themselves in reality. The attention currently being paid to health as a result of the COVID-19 pandemic – combined with the increasingly evident impacts of climate

change, biodiversity loss and environmental pollution, as well as growing warnings from the health disciplines, the IPCC and the IPBES – together with the existential importance of every human being’s health, thus offers a unique opportunity to generate fresh momentum and support for solidarity-based transformations towards sustainability. The fragility of humanity already being experienced in the face of new health threats makes it very real: prevention and active, comprehensive promotion of resilience – especially by designing healthy living environments – are necessary to avoid even greater risks and damage in the future, and to make development and evolution possible. If the transformation towards sustainability does not take place, the goal of ‘healthy living on a healthy planet’ will recede into the distance.

The WBGU has described such a transformation towards sustainability as a ‘societal search process’ (WBGU, 2011) that requires the assumption of responsibility, participation and support from actors at all levels. For the WBGU, the transformation towards sustainability consists of a large number of polycentric societal processes that play out on a pathway towards the vision. In the context of health, it affects the personal spheres of people’s lives (Chapter 4), requires the management of planetary risks (Chapter 5) and the further development of health systems (Chapter 6). It can only be achieved with appropriate governance (Chapter 7), education and science (Chapter 8).



Shaping areas of life: what we eat, how we move, where we live

4

How we eat, move around, live, work and spend our leisure time – all these aspects of life affect our health and, at the same time, have consequences for the climate, ecosystems and the spread of harmful substances. If healthy, environment-friendly behaviour is to become attractive or even possible in the first place, external conditions must also be conducive. Using selected examples from key areas of life, the WBGU shows which conditions and behaviours might be desirable and achievable.

The vision of ‘healthy living on a healthy planet’ is based on the WBGU’s normative compass; it implies transformations towards sustainability that affect a wide range of levels and actors. Very often, this involves political or production systems, e.g. energy generation, agriculture or industrial production. If any of these change, it affects the reality of people’s lives. Increasingly, there is also discussion on which combinations of measures can be used to stimulate changes in behaviour and actually make them possible (Creutzig et al., 2022; de Coninck et al., 2018: 362 ff.). Limiting climate change to 1.5°C, for example, cannot be achieved with technological innovations alone; it also requires people to change their lifestyles and behaviour and to create the necessary conditions, e.g. reduce their demand for energy or consume fewer greenhouse-gas-intensive products and foods (Rogelj et al., 2018, Creutzig et al., 2022). Lifestyles and societal practices in a wide range of cultural and socio-economic contexts can also act as indirect drivers of biodiversity loss by influencing how much land is used for food cultivation, energy crops or plantations (Díaz et al., 2015: 9). Lifestyles and individual behaviour, e.g. with regard to nutrition, physical exercise and sleep, or living conditions that cause stress are simultaneously important factors in the rapid increase in non-communicable diseases worldwide (Section 2.2).

In this chapter, the WBGU takes a look at people and their everyday lives, their practices and habits, and the realities of their life situations – also in different cultural and socio-economic contexts. It is about individual decisions and, at the same time, the living conditions and

environment in which they are made – assuming that decisions are possible at all.

The behaviour of one individual may seem marginal in the context of global environmental changes, but, in aggregate, a significant difference can be achieved – especially if the behaviour of the world’s affluent populations is taken into account. For example, the Intergovernmental Panel on Climate Change (IPCC) emphasizes that wealthy individuals not only make a disproportionately high contribution to emissions, but also have great potential for reducing them while still maintaining a decent standard of living and well-being (Creutzig et al., 2022: 505). Lifestyles can even make a decisive difference for people’s own health.

How and what we eat, where and how we live, whether and how we move, the kind and amount of work we do, what we do with our free time – all this not only affects our own well-being, it has consequences for the climate, for global ecosystems, for the spread of harmful substances. How, then, can changes in people’s everyday life situations be made possible and motivated that are good for their own health in the sense of the WBGU’s vision, while promoting the transformation towards sustainability? To find out, the WBGU looks in this chapter at selected examples of the key areas of life: what we eat, how we move and where we live. What changes in circumstances and behaviour are desirable and achievable in these areas? What overall conditions can make changes in habits and practices possible, and what obstacles need to be overcome? What do visions look like that take

into account social and economic differences as well as cultural diversity, i.e. people's *Eigenart*?

It is certainly not a matter of shifting the responsibility for a global transformation – or the part of the transformation that can be achieved by changing lifestyles – onto the shoulders of individuals. On the contrary, policy-makers have a special responsibility here to develop the corresponding framework, to set incentives, remove obstacles and enable people to make healthy and sustainable choices – entirely in the spirit of a social contract for transformation as outlined by the WBGU in 2011 (WBGU, 2011). However, up to now – e.g. in the German Federal Government's Global Health Strategy (BMG, 2020) – the focus has often been on motivating changes in individual behaviour by, for example, providing better information. Fundamental changes in external conditions that can facilitate healthy and environmentally conscious behaviour – such as the design of infrastructures, public spaces and services, or financial incentive structures – are not yet being sufficiently addressed. And in very many cases, the task is to give people in the areas of life concerned a minimum level of inclusion in the first place (Section 3.2; 'leave no one behind', 2030 Agenda).

The perspective of people's everyday lives also allows us to pursue a question that is often not at the centre of political considerations: how can individuals integrate the demands and requirements that are placed on them from many different directions and reconcile them with their own well-being and the health of the planet? Earning a living, raising children and caring for relatives, getting physical exercise, moving around actively in everyday life, being climate-conscious, making provisions for old age, eating healthily, shopping regionally and seasonally, cooking for oneself, getting involved in politics, keeping up with digitalization, maintaining social contacts, protecting oneself from extreme weather events, avoiding stress ... It is a question of a systemic linkage between demands and requirements at the individual level. At first glance, this seems to be a private problem – but some collectively perceived challenges are emerging. It is important here to discuss solutions that allow both for individual development opportunities and for diversity in the sense of *Eigenart* (Section 3.3), and to use these as a resource for transformations. It is about finding and exploiting synergies in order to link individual well-being with overarching sustainability goals, so that the topic of health can become a driver for transformations towards sustainability. Because the question of how those transformations can be shaped and made possible should not be answered without taking a look at people's everyday lives.



4.1

Ways to a healthy diet – for everyone

The transformation of environmentally damaging and unhealthy diets to a sustainably plant-based, nutrient-rich and diverse diet is essential in order to achieve the internationally agreed climate and biodiversity targets. Human health also benefits considerably from such a change in dietary habits. The WBGU recommends creating healthy, resilient and future-proof food systems for everyone and enabling consumers to make responsible choices.

The ‘EAT-Lancet Commission on Food, Planet, Health’ calls nutrition “one of the greatest health and environmental challenges of the 21st century” (Willett et al., 2019). In many cases, the way people eat damages their health, while the collective impact of our food systems is threatening our natural life-support systems. The diversity of food we eat and produce is decreasing in many cases. Excessive consumption of unhealthy food is a growing problem in all parts of the world, yet at the same time many people are suffering from hunger. Moreover, because of partly inefficient production and transport chains, as well as wasteful consumption habits, a large proportion of the food produced is being lost or disposed of. At the same time, food production is being threatened by increasing global environmental changes. Current agricultural production methods themselves also contribute greatly to this, for example through the excessive and sometimes unnecessary use of chemicals, which further threatens global food security (Section 4.1.1). Limiting global warming to 1.5°C cannot be achieved without transforming food systems (Clark et al., 2020).

After describing the status quo (Section 4.1.1), this chapter outlines a vision of how food systems can be designed in such a way that they comply with planetary guard rails while promoting human health (Section 4.1.2). In nine fields of action, obstacles and barriers that stand in the way of transformations of food systems are described, as well as opportunities for promoting them. Recommendations for action are made that can pave the way to healthy nutrition for everyone (Section 4.1.3). In addition, the WBGU makes research recommendations for various aspects of the production and consumption side (Section 4.1.4).

4.1.1

Current food systems: from scarcity to abundance, from diversity to imbalance

Although the basic principles and benefits of a healthy and sustainable diet are well known (Box 4.1-1), at present such a diet is insufficiently implemented on a global average (Micha et al., 2021). Diets high in salt, sugar and certain fats, too much meat and too few plant-based ingredients, large proportions of ultra-processed foods, and overweight and obesity due to an excessively high calorie intake contribute significantly to premature mortality and cause high costs for health systems (Meier et al., 2015; Murray et al., 2020; Section 4.1.1.1). At the same time, many people around the world do not have sufficient access to healthy food. Different forms of malnutrition thus exist in parallel; the corresponding trends and health consequences are described in Section 4.1.1.1. Section 4.1.1.2 explains how today’s agricultural and food systems contribute decisively to climate change, environmental pollution and biodiversity loss, and how they are, in turn, themselves endangered by them. Finally, Section 4.1.1.3 explains the objectives of food security, food sovereignty and food safety, and highlights the urgent need for transformations towards healthy and sustainable dietary and production patterns.

4.1.1.1

Malnutrition: trends and health impacts

Malnutrition can lead firstly to overweight (BMI ≥ 25 kg per m^2) and obesity (BMI ≥ 30 kg per m^2) and subsequent diseases; secondly to underweight (BMI < 18 kg per m^2) and the resulting health risks; and thirdly to a lack of micronutrients such as vitamins (hidden hunger). Overweight, underweight and micronutrient deficiencies can occur simultaneously in one population group; this is called the *triple burden of malnutrition* (Meenakshi, 2016). Fourthly, in addition to these three health risks, unhealthy proportions of different food groups in individual diets (e.g. too little fruit, too much red meat), and the intake of unhealthy amounts of certain food components (e.g. too much salt) are significant risk factors, especially for non-communicable diseases (Fig. 4.1-2; Micha et al., 2021; WHO, 2023g). While unhealthy diets, overweight and obesity play a significant role in countries of all income levels, the combined burden together with undernutrition due to insufficient calorie intake and micronutrient deficiencies predominantly affects low- and middle-income countries (Swinburn, 2019).

Box 4.1-1

What does a healthy and ecologically sustainable diet look like?

“A healthy diet is health-promoting and disease-preventing. It provides adequacy, without excess, of nutrients and health-promoting substances from nutritious foods and avoids the consumption of health-harming substances” (Neufeld et al., 2021).

Although the basic tenets of a healthy diet are universal (Willett et al., 2019; <https://www.who.int/news-room/fact-sheets/detail/healthy-diet>), dietary and nutritional needs vary according to age, gender, health or disease status, levels of physical activity, and specific life stages, such as during pregnancy and breastfeeding. In general, healthy diets should contribute to maintaining and improving individual health (in the sense of the WHO’s definition of health; Section 2.2.4). Following the German Nutrition Society (DGE), a healthy diet takes into account the following ten rules: (1) enjoy food variety; (2) vegetables and fruit – have ‘5 a day’; (3) choose whole grains; (4) complement the selection with animal food products; (5) use health-promoting fats; (6) cut down on sugar and salt; (7) prefer to drink water; (8) prepare food carefully; (9) eat and enjoy mindfully; and (10) watch your weight and keep moving (DGE, 2017). These recommendations are currently being revised and will in future also include the environmental and social dimensions.

Although healthy dietary habits are often also ecologically sustainable, this is not always the case (Dwivedi et al., 2017). For example, although certain kinds of fruit and vegetables,

legumes and nuts are considered healthy because of their nutrients, they cannot be grown in an ecologically sustainable way in arid regions because their water consumption is in some cases high. Conversely, foodstuffs that are produced in an ecologically sustainable way are not necessarily healthy. Especially for food innovations such as ultra-processed meat substitutes or alternative protein sources in general, long-term studies on health effects have been lacking to date.

The Planetary Health Diet – recommendations for healthy and ecologically sustainable nutrition

The recommendations of the EAT-Lancet Commission on Food, Planet, Health highlight the urgent need for a transformation of the global food system (Willett et al., 2019). With its recommendation of a universal reference diet, the Planetary Health Diet (Fig. 4.1-1) provides a framework that can be flexibly applied worldwide. Its implementation protects the health of people and the planet alike and will make healthy and ecologically sustainable nutrition possible for around ten billion people by the middle of the century. Consistent implementation of the Planetary Health Diet could prevent 11 million premature deaths per year worldwide (Willett et al., 2019). The two focal points of the Planetary Health Diet are, on the one hand, *healthy dietary habits* and, on the other, *sustainable food production* while avoiding losses.

Global implementation of these recommendations in regionally specific ways requires a fundamental change in predominantly Western dietary behaviour, which is now being adopted in many other countries. More fruit, vegetables, legumes and nuts should be eaten, as well as much less added sugars and red meat. National dietary recommendations should be adapted accordingly.

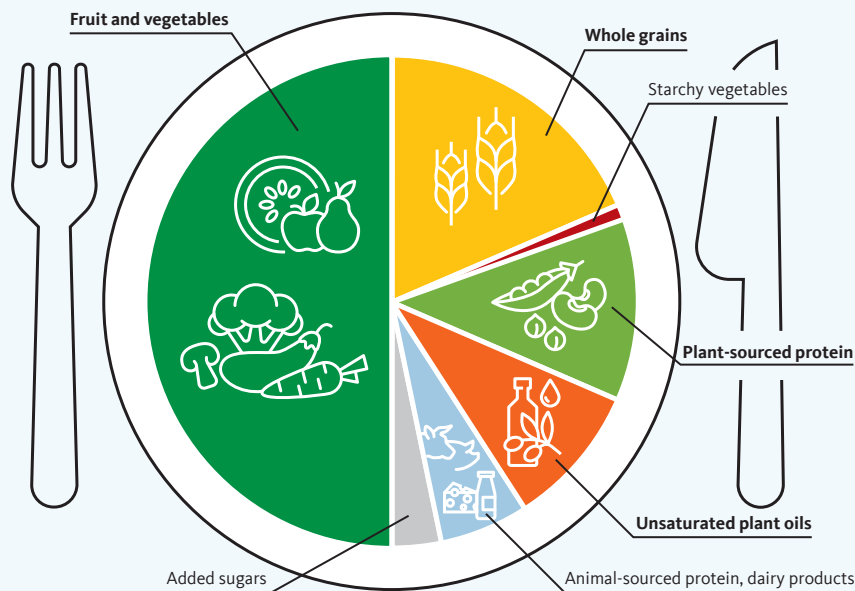


Figure 4.1-1
Composition of a healthy and sustainable diet according to the guidelines of the Planetary Health Diet.
Source: based on EAT-Lancet Commission, 2019

Half a plate: vegetables and fruit should make up about half of the food volume

The other half – measured in calorie percentages – should consist mainly of wholegrain products, plant proteins and unsaturated plant oils (optional: small percentage of animal food products)

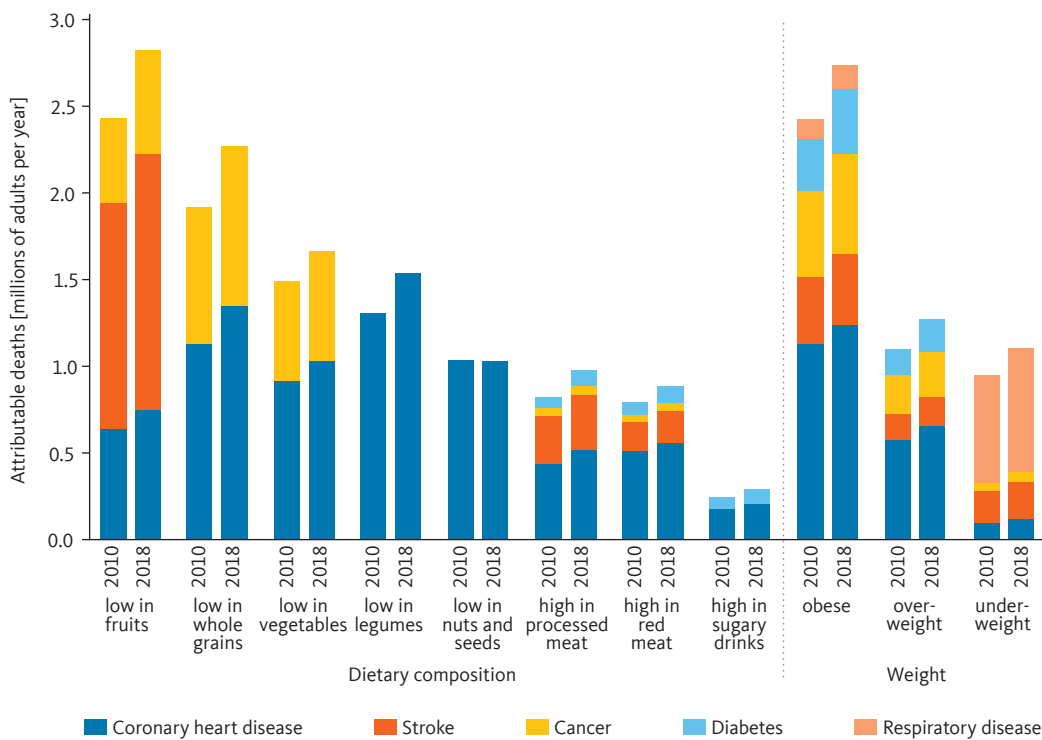


Figure 4.1-2 Deaths from non-communicable diseases in the years 2010 and 2018 which can be attributed to unhealthy proportions of different food groups in the diet (left) and too high or too low body weight (right). In addition to these risk factors, the consumption of unhealthy amounts of individual food components also poses a significant health risk, especially the excessive intake of sodium, sugar and certain fats (WHO, 2023g). Source: Micha et al., 2021

Overweight and obesity due to excessive calorie intake

Worldwide, about 2.2 billion adults and about 39 million children are overweight or obese (Micha et al., 2021). The proportion of overweight or obese children and adolescents (5–19 years) more than quadrupled from 1975 to 2016 (from 4% to 18%; Brand et al., 2021) and continued to rise during the COVID-19 pandemic. The pandemic levels of overweight and obesity are projected to increase further (Bodirsky et al., 2020a). Obesity, high blood pressure, elevated blood sugar levels and pathologically altered blood lipids can promote each other and often occur together, a condition known as metabolic syndrome (Saklayen, 2018). They are all associated i.a. with overeating and represent major risk factors for cardiovascular disease, one of the leading causes of death worldwide (Dagenais et al., 2020; Yusuf et al., 2020). Overweight and obesity are also associated

with bronchial asthma, certain cancers, musculoskeletal diseases and mental ill-health (Blüher, 2019; GBD 2019 Cancer Risk Factors Collaborators, 2022). The health of overweight children and adolescents is endangered not only acutely but also in the long term: they have an increased risk of being overweight and suffering from the above-mentioned subsequent diseases also in adulthood (Simmonds et al., 2016; Weihrach-Blüher et al., 2019). Nutrition in early childhood plays an essential role not only in preventing overweight and obesity but also in learning healthy and sustainable dietary habits (Box 4.1-2).

Undernutrition due to insufficient calorie intake

The number of people suffering from chronic hunger fell until 2010, then initially stagnated, but rose again by about 150 million people in the wake of the COVID-19 pandemic, so that in 2021 more than 820 million people

Box 4.1-2

Nutrition and food environments in the first 1,000 days of life

What happens in the first 1,000 days of a person's life – before and after birth – has lifelong effects on their health and well-being. Environmental and nutritional factors in particular, but also other lifestyle factors such as physical exercise during pregnancy and during the first two years of life, shape the development of health and disease throughout a person's whole life. For example, a diverse, balanced and plant-based diet for pregnant or breastfeeding persons and toddlers helps prevent the development of obesity, allergies and non-communicable diseases over the course of a lifetime (e.g. Abou-Dakn et al., 2022; Roduit et al., 2014; Stampfli et al., 2022).

The (biological) basic need for food and drink, which starts in every human being just a few moments after birth, can be satisfied naturally in the vast majority of cases. Breast milk provides babies with the optimum mix of nutrients. The supply, composition, but also the quality and quantity of available breast milk is highly diverse. According to WHO recommendations, for example, infants should be breastfed exclusively and on demand for the first six months of life, and given safe and adequate complementary foods from the age of six months, while they can continue to be breastfed up to an age of two years and beyond (WHO, 2003b). Even though breastfeeding is considered the healthiest and most ecologically sustainable nutrition pattern for mother and child in infancy, breastfeeding practices vary widely around the world and regionally. Worldwide, only about half of all infants are exclusively breastfed in the first six months according to WHO recommendations, the highest proportion being in South Asia at 61% and the lowest in the Middle East and North Africa at 32% and North America at 26% (UNICEF, 2022).

As toddlers, children acquire their eating behaviour mainly through imitation, in their relationship and social interaction with their parents and caregivers. Regular meals taken together,

with sufficient time, calmly and in a pleasant atmosphere, therefore play a major role (Abou-Dakn et al., 2022). Parents can help children to learn a positive way to eat by providing a balanced and diverse range of food, and by paying attention to the child's hunger and satiety signals (Abou-Dakn et al., 2022). Both within the family and in other social settings such as day-care centres, children can thus become accustomed to a health-promoting, nutritious and resource-saving diet from an early age. In these settings, it is therefore particularly important to align diets with the Planetary Health Diet (Box 4.1-1).

However, existing frameworks and food environments (environments in which decisions about nutrition are made) currently often tend to be counterproductive when it comes to supporting people to develop healthy and sustainable dietary habits from an early age. In many countries there is a lack of framing conditions enabling for example working people to continue breastfeeding (UNICEF, 2020). In supermarkets, sweets are placed within reach of young children, and children are the main target group of advertisements for unhealthy products such as sweets or sweetened drinks. In day-care centres and schools, depending on the region, standard fare is often a diet heavy in animal products rather than a whole-food diet (in high-income countries) or a diet rich in carbohydrates and low in animal proteins and vegetables (in low- and middle-income countries).

Approaches such as the current German federal government coalition's plan to further restrict advertising of foods with high sugar, fat or salt content to children should therefore be implemented promptly and expanded to include aspects of promoting ecological sustainability with regard to food (Section 4.1.3.4). In an open letter to the German federal government in November 2022, a broad alliance of child-protection and nutrition organizations called for "Advertising barriers for unhealthy products – comprehensive protection for children!" ("Werbeschränken für Ungesundes – Kinder umfassend schützen!"). Only if children as a target group are moved more into the focus of political decisions and framework conditions can a food transition really succeed in the long term.

were affected, the majority of them in sub-Saharan Africa and South Asia (de Lusignan et al., 2018; FAO, 2022a). Delays and disruptions in supply chains, trade blockades, the considerable global economic downturn in 2020 and slumps in many economies have led to lower incomes and higher and more volatile food prices, particularly affecting populations and countries which were already experiencing disadvantaged food situations (Osendarp et al., 2021; WBGU, 2020; HLPE, 2021). Also the Russian war of aggression on Ukraine led to a significant increase in food prices on the world market (HLPE, 2022; Abay et al., 2022). These current developments reveal weaknesses in global food systems (WBGU, 2020; HLPE, 2021; HLPE, 2022) which are not resilient either to current problems or to future developments (Pörtner et al., 2022b). Projections indicate that 8% of the world's population will still be suffering from hunger in 2030 (FAO, 2022a). Children's health is at risk both

acutely and in the long term because undernutrition has negative effects on their growth, development and the formation of cognitive abilities (Kirolos et al., 2022). In addition, undernourished children are more vulnerable to diarrhoeal diseases, which can further exacerbate their undernutrition and lead to premature death (Tickell et al., 2020). Currently, 22% of children under five worldwide are stunted (too small for their age) and just under 7% of children are wasted (too thin for their size; FAO, 2022a).

Micronutrient deficiencies due to insufficient intake

The insufficient intake of micronutrients such as iron, zinc, iodine, vitamin A, and B vitamins results in corresponding deficiencies and subsequent diseases (Muthayya et al., 2013). Worldwide, about 370 million preschool children and at least 1.2 billion women of reproductive age are affected by micronutrient deficiencies (Stevens et al., 2022). This can lead to impaired physical and cognitive

development, as well as, for example, anaemia (due to iron deficiency), blindness (due to vitamin A deficiency), increased occurrence of infectious diseases and, as a result, lower labour productivity (Bailey et al., 2015). Micronutrient deficiencies often occur in combination with undernutrition due to insufficient calorie intake, but they can also affect overweight people as a result of excessive and imbalanced consumption of foods that are high in calories and low in micronutrients (Jun et al., 2020). It occurs mainly in low- and middle-income countries and is responsible for about 7% of the global burden of disease each year (Ezzati et al., 2006). However, micronutrient deficiencies also occur in socio-economically disadvantaged populations in high-income countries, and here too, children in particular can suffer lifelong consequences (Biesalski, 2021).

Risks caused by unhealthy proportions of different food groups in diets

According to the Global Nutrition Report 2021 (Micha et al., 2021), only 35% of diet-related premature deaths from non-communicable diseases (coronary heart disease, respiratory disease, stroke, cancer, diabetes) are due to risks related with too high or too low body weight; 65% of these premature deaths are due to unhealthy proportions of different food groups in individual diets. In particular, insufficient consumption of fruits, whole-grain products, vegetables, legumes, nuts and seeds, and excessive consumption of processed meat, red meat and sugared beverages play a major role (Fig. 4.1-2; Micha et al., 2021). Moreover, the production of meat and other animal food products contributes disproportionately to the environmental changes caused by food production (Section 4.1.1.2). Global trends, as well as health and environmental consequences of excessive meat consumption, are discussed in Box 4.1-3. This is an example of how the unhealthy distribution of food groups in diets not only poses direct health risks, but is often also ecologically unsustainable. Currently, the recommendations for a healthy and sustainable diet in the sense of the Planetary Health Diet (Box 4.1-1) are not being met with regard to almost all food groups and continents (Micha et al., 2021). An exception is the average consumption of dairy products in Africa and Asia, which is below the recommended maximum amount (Micha et al., 2021). In addition, the recommended maximum amount of fish in the average diet is complied with on most continents, except in Europe (Micha et al., 2021).

Significant health risk factors can also be identified at the level of individual food components: globally, for example, the average intake of sodium is a long way above the WHO's recommendations (WHO, 2023g). Diets with excessive amounts of salt were responsible for approx. 1.89 million deaths in 2019 (GBD 2019 Risk

Factors Collaborators, 2020b; 2020a). Excessive consumption of certain fats (especially those containing trans-fatty acids) is also an important dietary risk factor for health (GBD 2019 Risk Factors Collaborators, 2020c; 2020a). Such unhealthy nutrient profiles, which promote non-communicable diseases in particular, as well as the occurrence of many of these diseases, are associated, among other things, with high proportions of ultra-processed foods in the diet (Monteiro et al., 2019).

4.1.1.2 Food production causes – and is affected by – global environmental changes

Despite significant global progress in reducing undernutrition, with the world population increasing at the same time, the majority of people today are affected by one or more forms of malnutrition (Section 4.1.1.1). Furthermore, at the last count most of the global nutrition targets set by the WHO for 2025 (WHO, 2014c) were far from being met (as of 2019; Micha et al., 2021); these include, for example, reducing the proportion of women of reproductive age with anaemia by 50% and reducing the proportion of children with a too-low birth weight by 30%, both compared to 2012 (WHO, 2014c). The COVID-19 pandemic and disturbed exports due to the Russian war of aggression on Ukraine have further aggravated the global food situation in recent years. The intensification of agriculture in many countries has also been accompanied by a concentration on a small number of varieties, an expansion of animal husbandry and liquid-manure fertilization, a significant increase in net emissions of greenhouse gases (Ivanovich et al., 2023), far-reaching changes in land-use systems, large-scale inputs of synthetic fertilizers into ecosystems, a significant increase in freshwater use, and an increasing use and release of pesticides and medicines (Willett et al., 2019; IPCC, 2019c). Large regional differences and various unsustainable development paths can be observed in this context: globally, depending on agro-ecological, economic and cultural conditions, there are different (regionally typical) characteristics and undesirable developments of agriculture and fisheries; the environmental impacts of different forms of subsistence agriculture must also be considered in a differentiated manner (WBGU, 2020; WBGU, 2013): For example, 'soil mining' on resource-poor subsistence farms (cultivation of crops without adequate replacement of the nutrients they remove; under-fertilization) leads to soil and land degradation (WBGU, 2020), whereas multifunctional farming systems such as agroforestry can offer various ecological benefits (Rosenstock et al., 2019). Overall, environmental pressures from global food systems continue to increase and, despite some improvements, no region in the world is currently on track to comply with the corresponding environmental boundaries (Micha et al., 2021). The following describes

Box 4.1-3**The need to move away from diets heavy in animal food products**

Meat consumption has doubled worldwide in the last 20 years (González et al., 2020). In 2018, a total of 320 million tonnes of meat were consumed worldwide, with per-capita consumption in high- and middle-income countries at 68.6 kg per year, much higher than in low-income countries, where it was 26.6 kg per year (Heinrich-Böll-Stiftung et al., 2021). In many countries, average meat consumption already exceeds the health recommendation many times over (González et al., 2020) and, as prosperity rises, an increase in demand for animal food products can be observed worldwide (Haines and Frumkin, 2021: 323). A high consumption of meat (especially red and processed meat) leads, among other things, to an increased risk of colon and breast cancer, high blood pressure, cardiovascular disease and type 2 diabetes mellitus (González et al., 2020). In addition, livestock farming and the production of animal food products contribute greatly to the many environmental changes caused by agriculture (Horrihan et al., 2002; Poore and Nemecek, 2018; Section 4.1.1.2). Although there is an increasingly critical attitude towards meat consumption, especially among young people in high-income countries, a further increase in global demand for animal food products is forecast for the coming decades (Bodirsky et al., 2020b).

The conversion of plant calories into animal calories is highly inefficient (for beef about 33:1, for poultry 4:1 to 5:1; Shepon et al., 2016). Compared to plant foods, the provision of calories from animal food products therefore requires a significantly larger land area. By contrast, with a diet that is lower in animal food products the food demand projected for 2050 could already be met today (WBGU, 2020). Changes towards

plant-based diets could reduce land-use competition and create space both for safeguarding human nutrition and for the restoration and flourishing of biodiversity. At the same time, the negative impacts of animal food production on nature and humans would be reduced (Section 4.1.1.2; WBGU, 2020). A site-appropriate reduction in stocking density especially on natural grasslands, by means of reduced and rotational grazing, can boost the soil's CO₂ sequestration (Bai and Cotrufo, 2022) and provide higher-quality meat products. In wealthy countries with currently high meat consumption (>55 kg per person per year), such as Germany, a reduction in consumption by about 75% is recommended, accompanied by a reduction of milk consumption by more than 50% and an expansion and diversification of plant-based food cultivation (Springmann et al., 2020; Springmann et al., 2018; Fesenfeld et al., 2022). These measures are seen as having the potential to reduce greenhouse-gas emissions from the food sector by 75% and total adult mortality by about 20% (Fesenfeld et al., 2022). Estimates suggest that externalized costs of about US\$19,800 billion are not priced into global food production (compared to a current market value of food of US\$9,000 billion); of these, about US\$7,000 billion are environmental costs, about US\$11,000 billion are health costs and about US\$1,000 billion economic costs (Hendriks et al., 2021). In the light of these findings, the WBGU repeats its recommendations from the report 'Rethinking Land in the Anthropocene: from separation to integration' (WBGU, 2020): (1) consistently promote sustainable nutrition with guidelines that are in line with the Planetary Health Diet (PHD) (Box 4.1-1); (2) support the trend towards a diet low in animal food products and gear dietary biographies towards sustainability; (3) support consumers in practising sustainable dietary habits; (4) promote 'healthy trade' both nationally and internationally (WBGU, 2020).

the contributions of global food systems to various environmental changes and their feedback effects on food production. In addition, the environmental changes described entail further health risks, which are discussed elsewhere (Section 2.3, Chapter 5).

Large contribution to global greenhouse-gas emissions

Current food systems and the changes in land use that accompany them are responsible for 21–37% of global greenhouse-gas emissions (IPCC, 2019c). Food production in intensive agriculture consumes high levels of energy (production of artificial fertilizers and pesticides, cultivation methods using energy-intensive agricultural machinery); more energy consumption and emissions come from global transport chains (FAO, 2020a). These activities are still based predominantly on the consumption and combustion of fossil fuels (Flammini et al., 2022). Rice cultivation and factory farming also release large quantities of the greenhouse gases methane and nitrous oxide, which are highly potent compared to CO₂ (FAO, 2020a). Methane's contribution to global warming

and its importance for climate-change mitigation must be considered in a differentiated manner, because it is comparatively short-lived in the atmosphere, so that the relationship between emissions development and temperature increase has a different dynamic than in the case of longer-lived greenhouse gases like CO₂ (Allen et al., 2022). Besides enteric fermentation (the digestion process of ruminants) in the farm animals themselves, greenhouse-gas emissions from livestock farming are mainly caused by the production and processing of feed (Rojas-Downing et al., 2017). In the reference year 2005, the global livestock sector emitted a total of about 7.1 Gt CO₂eq – about 14.5% of global greenhouse-gas emissions and more than the entire global transport sector (Gerber, 2013). Global climate change, which is accelerated by agricultural emissions, is in turn increasingly endangering food production itself (Bezner Kerr et al., 2022: 717). For example, changing temperature and precipitation patterns reduce crop yields (Zhao et al., 2017; Hasegawa et al., 2022), which can lead to an increase in undernutrition, especially in low- and middle-income countries (Pörtner et al., 2022a: 60; Bezner Kerr

et al., 2022). Whether and to what extent technical progress can offset climate-change-induced declines in agricultural yields, even in the long term, is the subject of scientific debate (Aggarwal et al., 2019; Gomez-Zavaglia et al., 2020), but in any case the issue poses a major challenge in practice and requires extensive system adjustments. Furthermore, rising CO₂ concentrations may reduce the quality of food crops by leading to a lower micronutrient content, which could also exacerbate micronutrient deficiencies (Myers et al., 2014).

Unsustainable land use leads to the loss of natural ecosystems and fertile soils

Industrial agriculture causes a loss of natural landscapes and healthy soils, both through conversion to agricultural land and through unsustainable land-management practices (Foley et al., 2005; WBGU, 2020; IPCC, 2019c). Currently, almost 40% of the global land area is used for agriculture and forestry (Jering et al., 2013). About 80% of the total agricultural area is used for the production of animal food products (as pasture land or for growing fodder), but these contribute only 18% of the global supply of food calories and 37% of the supply of proteins (Poore and Nemecek, 2018). This large land requirement can lead to land competition with the cultivation of plant food for humans, whereby it should be borne in mind that pasture land is only suitable for cultivating plant food to a limited extent (WBGU, 2020). More than 90% of tropical deforestation is directly or indirectly related to the expansion of agricultural land, to which the expansion of oil-palm cultivation areas makes a major contribution (Pendrill et al., 2022; Vijay et al., 2016). The loss of natural habitats and the fragmentation of ecosystems have a big impact on regional and global climate systems, freshwater cycles, bio-geochemical processes and biodiversity (Foley et al., 2005). For example, the ongoing deforestation of the Amazon and other tropical rainforests is having profound climatic consequences, as they are increasingly being lost as sinks in the global carbon cycle, and biophysical cooling effects diminish (Boulton et al., 2022, Lawrence et al., 2022).

In addition, unsustainable land-management practices are leading to a continuing loss of fertile arable and pasture land (IPBES, 2018; WBGU, 2020). Soil degradation and desertification increase the risk of flooding and reduce soil quality, which reduces the nutrient content of the soil, the diversity of soil fauna and the soil microbiome, and the productivity of cultivation areas (WBGU, 2020; UNCCD, 2022). The function of soils as carbon sinks is also increasingly being lost, indirectly accelerating global warming (Lal, 2004). Every year, about 2.9 million ha of agricultural land is lost to soil erosion alone (Lambin and Meyfroidt, 2011).

Substantial use of artificial fertilizers and irrigation

Every year, about 110 million tonnes of nitrogen and about 40 million tonnes of phosphate are spread on agricultural land globally for fertilization purposes (FAO, 2017). However, about 60% of this nitrogen and about half of the phosphate is not taken up by the food crops, but released into terrestrial ecosystems (West et al., 2014). This leads to locally increased nitrate pollution of soils, further reducing their quality, as well as enormous nutrient runoff into freshwaters and oceans, where large-scale eutrophication can lead to the spread of dead zones and the destabilization of aquatic ecosystems (Willett et al., 2019; Diaz and Rosenberg, 2008). The enormous amounts of phosphate and nitrate released overload the bio-geochemical cycles of both substances; at the same time, phosphate is a limited resource whose sustainable use is essential for future food production (Rockström et al., 2009; Yuan et al., 2018). To compensate for the declining productivity of degraded soils, the use of artificial fertilizers is often further increased (Rickson et al., 2015). Although their application – in combination with agro-ecological measures – is useful, especially in areas where natural nutrient regeneration is insufficient and undernutrition is widespread, e.g. in sub-Saharan Africa, the corresponding boundaries are already exceeded here as well (WBGU, 2020; Micha et al., 2021).

Furthermore, modern agricultural production methods often rely on artificial irrigation. Over 70% of global freshwater consumption is attributable to agriculture (FAO, 2022b). In many regions, the overuse of available water resources is already causing massive water shortages (Mekonnen and Hoekstra, 2016). Moreover, the availability of green water (precipitation, evaporation and soil moisture), which is essential for food crops, is already significantly limited globally, and the need for artificial irrigation will be further intensified in many arid regions by climate change (Liu et al., 2022; Wang-Erlandsson et al., 2022; Section 2.3). Water shortages lead to reduced crop yields and promote diarrhoeal diseases due to the use of contaminated water sources, both of which can have a negative impact on the nutritional status of people (Watts et al., 2015; Yongsu, 2010).

Use of pesticides and antibiotics to increase yields

Pesticides are used worldwide to control pests and plant diseases in order to improve crop yields; more and more new substances and increasing quantities overall are being used due to the increasing development of resistance (Carvalho, 2006). Residues in food and the environment can promote i.a. various cancers, neurological diseases and developmental disorders (Mostafalou and Abdollahi, 2017). In addition, other living organisms and ecosystems are damaged, which contributes to the loss of biodiversity (UNEP, 2019; Dudley and Alexander, 2017).

4 Shaping areas of life: what we eat, how we move, where we live

The intensification of livestock farming is accompanied by a growing use of veterinary pharmaceuticals, especially antibiotics. These are not only used for the targeted treatment of diseases, but are also added to the feed to promote the growth of the animals, improve their feed conversion and prevent disease outbreaks (Manyi-Loh et al., 2018). Residues are found in animal food products and also released into the environment in large quantities (Manyi-Loh et al., 2018; Larsson and Flach, 2022). They can have a direct, toxic effect on humans and other organisms and promote the further development of microbial antibiotic resistance, which can also endanger the health of the farm animals themselves (Section 5.2.3; Vishnuraj et al., 2016; Larsson and Flach, 2022).

Food production causes biodiversity loss and is affected by it

Intensification of food production results in the loss of adaptable species of food crops, which reduces the potential of agriculture to adapt to climate change and other environmental changes (FAO, 2019). Food production also threatens terrestrial and aquatic biodiversity through its own contribution to global warming, the expansion of cultivated land, unsustainable land-management practices and use of aquatic food resources, as well as the spreading of various agrochemicals and pharmaceuticals (IPBES, 2019). This affects i.a. pollinating insects, whose numbers and diversity are reduced (Godfray et al., 2015). This is again particularly relevant for agriculture as 75 % of the food crop species used worldwide and 35 % of global food production depend on natural pollination (IPBES, 2019, Klein et al., 2007). This particularly concerns plants that contribute to the supply of vitamin A, folic acid and iron, which is why the existing deficiencies with regard to these important micronutrients and their health consequences are further exacerbated (Section 4.1.1; Ellis et al., 2015; Smith et al., 2015). 3–5 % of annual yields of fruits, vegetables and nuts are already lost to insufficient pollination, which particularly affects low-income countries (Smith et al., 2022).

Threats to and overexploitation of aquatic food resources

Aquatic food resources play an important role in human nutrition. Globally, they provide 17 % of the animal protein consumed – even more than half in some low- and middle-income countries (FAO, 2022c). Global consumption of fish and other seafood has increased significantly in recent years, and global fisheries and aquaculture production are at a record high. However, almost 60 % of the world's fish stocks are already maximally sustainably fished and another 35 % are overfished (FAO, 2022c). Illegal, undocumented and unregulated fishing (IUU fishing) accounts for about 20 % of the global catch

and in some areas even up to half of the regional catch (Widjaja et al., 2020). Furthermore, an estimated 40 % of the biomass taken by marine fisheries worldwide consists of unwanted bycatch (Davies et al., 2009).

The rapidly expanding aquaculture sector now produces almost 60 % of all aquatic food, but the ongoing intensification of production processes has several negative impacts on coastal habitats, freshwaters and the global climate that continue to increase (FAO, 2022c; Klinger and Naylor, 2012; Alff and Hornidge, 2019; Manlosa et al., 2021b; Manlosa et al., 2021a). At the same time, yields from fisheries and aquaculture themselves are threatened by ocean acidification, rising water temperatures, freshwater scarcity, large-scale eutrophication, chemical pollution and biodiversity loss, to which already overexploited aquatic ecosystems are especially vulnerable (WBGU, 2013; Willett et al., 2019; Whitmee et al., 2015; IPCC, 2019a, 2022). This affects both salt-water and freshwater fisheries and aquacultures. The small-scale, coastal and industrial fisheries each contribute to the environmental changes to varying degrees and each is also experiencing specific vulnerabilities (Hornidge and Keijzer, 2021). The existing problems are exacerbated by increasing competition between small-scale and coastal fisheries in low-income countries on the one hand, and industrial fishing fleets from high- and middle-income countries on the other (e.g. in the wake of fisheries partnerships between EU states and West Africa; Belhabib et al., 2015; Hornidge and Keijzer, 2021). The endangerment of aquatic ecosystems has considerable impacts on the provision of ecosystem services to humans, particularly with regard to food security, and also lead to the loss of cultural identity and traditional diets (Laffoley et al., 2020; Gattuso et al., 2015; Pörtner et al., 2022a; IPBES, 2019).

Food loss and waste

A significant proportion of the food currently produced is lost or disposed of – between 11 and 60 % depending on food type and world region (FAO, 2011) – and on global average about 25–30 % (IPCC, 2019c), which corresponds to about 1.3 billion tonnes of food per year (FAO, 2011). The production of the lost and wasted food generates additional emissions without adding any value to human nutrition (IPCC, 2019c). The causes of food loss and waste vary around the world. In high- and middle-income countries, it is mainly due to wasteful consumption habits and inadequate purchase planning by consumers, the disposal of edible food with expired best-before dates, quality requirements based on the external shape and appearance of food, a lack of coordination within supply chains, and inflexible sales agreements between farmers and intermediaries (FAO, 2011). In low-income countries, technical, managerial and financial limitations in

harvesting techniques, cooling and storage facilities, supply infrastructures, and packaging and marketing systems are the main contributors to food loss (FAO, 2011).

4.1.1.3

Food security, food sovereignty and food safety

The three objectives of food security, food sovereignty and food safety are currently far from being achieved globally. *Food security* describes a situation in which “all people at all times have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life” (FAO, 1996). Above all, equal (economic) access to (physically) available food is crucial for food security (Sen, 1981). In many countries, however, access to food is not sufficiently guaranteed for socio-economically disadvantaged people (D’Odorico et al., 2019).

The term *food sovereignty* was coined by La Via Campesina, a transnational alliance of i.a. smallholders, agricultural workers, fishers and pastoralists from more than 80 countries, representing about 200 million people (La Via Campesina, 2021; Sampson et al., 2021). Food sovereignty was defined in the Declaration of Nyéléni in 2007 as “the right of peoples to healthy and culturally appropriate food produced through ecologically sound and sustainable methods, and their right to define their own food and agriculture systems” (La Via Campesina, 2007). The approach thus aims on the one hand at the possibility of healthy and sustainable nutrition for all people while, on the other hand, emphasizing the importance of people’s self-determination over their diet and agriculture. Current food systems jeopardize these goals. One factor here is the great influence of multinational agricultural and food corporations on agricultural production methods and the diets of many people (Section 4.1.3.9). A second factor is the dependence of many countries on international food imports (Suppan, 2008) with simultaneously limited choices relating to the food imported. Food sovereignty can contribute to food security and adequate nutrition, especially as a consequence of greater autonomy over production processes through the introduction of agroecological practices (Sampson et al., 2021).

Finally, the aim of *food safety* is to ensure that no adverse health effects are caused by the consumption of contaminated food. This objective is currently threatened by, among other things, the massive use of pesticides and antibiotics, the residues of which can lead to health risks (Section 4.1.1.2). In the aquatic realm, increasing toxic algal blooms as a result of climate change should be mentioned (Pörtner et al., 2022a: 64).

It is clear that the developments of recent decades are not future-proof, for health, ecological and social reasons (Myers and Frumkin, 2020). Profound transformations

of food systems are urgently needed to promote healthy and ecologically sustainable nutrition, and to ensure food security, food sovereignty and food safety. Therefore, integrated solutions must be developed for their comprehensive and global implementation. Modern food chemistry can also make a contribution to this, for example, by extending the shelf life of food or improving its transportability. Visions and strategies for transformations of food systems should incorporate health, equity, sustainability and resilience, and think of them together (Section 4.1.2). In this way, current negative trends and developments can be weakened and reversed, and food systems can be restructured to meet the complex and interrelated challenges.

4.1.2

Vision of healthy, resilient and future-proof food systems

The vision of healthy, resilient and future-proof food systems worldwide describes a world in which existing opposition has been overcome and healthy and sustainable diets are possible for all people. At the behavioural level, the vision includes that people and societies are able to make sustainable and health-promoting choices about their diets, also through appropriate knowledge, skills and transparency along the value chain. Conditions should be such that food environments (environments where personal choices about nutrition are made) enable healthy and sustainable nutrition for all as the easiest option. All relevant actors set themselves the maxim of making a sustainable and health-promoting diet possible. Sustainable diets avoid greenhouse-gas emissions and other environmental damage, conserve water resources, avoid food waste, and protect and appreciate ecosystems and biodiversity (Lang, 2017).

At the consumer level, healthy, resilient and future-proof food systems are characterized by food that is healthy, nutritious, safe, available, affordable and culturally appropriate for all people (Lang, 2017; Willett et al., 2019). Sustainable diets can also feed a growing world population in a healthy way (Willett et al., 2019). The Planetary Health Diet is considered a possible reference diet here (Box 4.1-1). Furthermore, food security, food sovereignty and food safety are key components of this vision.

At the production level, the focus is not only on the short-term production of large quantities of cheap food but also on long-term soil fertility and the conservation of ecosystems and biodiversity, on which our food supply depends. The main aim is to shape a new understanding of food production: agriculture is not only a producer of food. Within the framework of the integrated landscape

approach (WBGU, 2020), farmers can see themselves as an important part of landscape management and of the conservation and enhancement of biodiversity. Alongside farmers, fishers should also become ‘resource managers’ who place sustainability at the centre of their activities – and are respected and suitably remunerated for it (Lang, 2017). Furthermore, this applies to all economic actors involved in the production and processing of food.

The vision also goes hand in hand with stronger food-system resilience. This has been defined as the “capacity to provide food security over time and despite disturbances” and aims to ensure “sufficient, appropriate and accessible food to all” (Tendall et al., 2015). Resilient food systems enable all actors to anticipate climate risks and threats, prevent and mitigate the impacts of adverse events, and adapt and change long-term development trajectories so that “the economic social and environmental bases to generate food security and nutrition for current and future generations are not compromised anywhere in the world” (Hertel et al., 2021: 3; FAO, 2020c). In order to make this vision of healthy, resilient and future-proof food systems a reality for everyone as soon as possible, existing obstacles to implementation, such as subsidies for non-sustainable production methods, must urgently be overcome (Section 4.1.3).

4.1.3 Fields of action and recommendations for pathways to healthy nutrition

A far-reaching transformation of food systems is necessary in order to achieve global food security, food sovereignty and food safety, and at the same time address climate-change mitigation, biodiversity conservation and other goals of the 2030 Agenda (e.g. Willett et al., 2019; HLPE, 2020; WBGU, 2020; Fanzo et al., 2022). Various starting points for strengthening the resilience of food systems have already been identified in the past; two aspects are considered in more detail below: (1) strengthening the role and position of consumers as key actors in the system (Burchi et al., 2011; WBGU, 2020), and (2) building resilience in food production by protecting and sustainably enhancing ecosystem services. For the latter, sustainable production practices in agriculture and fisheries, as well as local markets, must be promoted, and market and power concentrations made transparent.

Although many starting points are known and are already the subject of scientific discourse and publications, implementation of the identified proposed solutions is often still lacking. Due to the complexity of (global) food systems and the challenges they face, as well as their regional and local differences and different contexts, there is no single ‘golden pathway’ for a future-proof

transformation, and change will only be possible with the involvement of all actors along the value chains (Willett et al., 2019; Leeuwis et al., 2021; Zurek et al., 2022). The respective linkages within the systems and thus the specific synergies and trade-offs between possible mitigation or adaptation strategies must always be evaluated in the specific context and on the basis of scientific data (Zurek et al., 2022). This represents a challenge for science, politics and society. Overall, by fundamentally restructuring the way we produce and eat, we can achieve and combine the goals of improved and healthier diets for the population that are accessible to everyone, while simultaneously reducing the impact on the environment. On the basis of nine fields of action, the following section describes existing hindering and supporting factors on the road to healthy nutrition for everyone, and gives corresponding recommendations for action.

4.1.3.1 Make healthy, nutrient-rich and diverse foods more attractive and better appreciated

Resource-intensive and predominantly unhealthy dietary habits are widespread globally. The consumption of meat or foods containing high amounts of fats, sugar or salt are still considered desirable objectives in many regions and population groups with growing incomes, although their negative health consequences have been sufficiently documented (Section 4.1.1; Box 4.1-3). Instead, the principles of healthy and sustainable dietary recommendations, like the Planetary Health Diet, should be elevated to a global guiding principle in order to develop regionally and locally adapted diets based on them. It must also be recognized here that traditional diets in some countries already comply with these principles. Such a global guiding principle includes an appreciative approach to food (from selection to preparation and consumption, also in order to avoid food waste) as well as mindful dietary behaviour, which manifests itself, for example, through social interaction when eating together, or through allowing enough time for food preparation and consumption. At present, however, insights into the attractiveness and diversity of a nutrient-rich, predominantly plant-based diet are being obscured by a widespread debate focusing on restriction and the abandonment of options. This is partly accompanied by an ongoing wasteful, non-appreciative way of dealing with food. Positive communication and education on healthy, sustainable nutrition that takes into account the above-mentioned aspects is an important overarching strategy for action.

The WBGU recommends:

- *Make healthy nutrition more attractive and better appreciated:* The benefits and diversity of sustainable nutrition (based on the principles of the Planetary

Health Diet) and the related, necessary appreciation of health-promoting and sustainable food should be communicated more clearly. To this end, the WBGU recommends positive communication and education on nutrition within the framework of educational measures (Section 4.1.3.3) and awareness campaigns (Section 4.1.3.4), but also in advertising (Box 4.1-4) and the way in which political measures are communicated and implemented.

- › *Promote dietary change:* Taking into account specific local, regional and national characteristics, the shift towards a predominantly plant-based diet should be promoted – following the guidelines of the Planetary Health Diet – in a way that makes healthy, diverse food in sufficient quantities available to everyone.

4.1.3.2 Adapt guidelines and recommendations for healthy and sustainable nutrition

The recommendations of the German Nutrition Society (DGE) should be adapted in line with the reference diet of the Planetary Health Diet. This would include a reduction in the recommendations for the consumption of dairy products and red meat by about two thirds in each case, as well as a positive recommendation for the consumption of pulses and nuts (Springmann et al., 2020). The ‘Healthy Start Network’, for example, recommends a balanced, needs-based and plant-oriented diet in childhood, which includes, among other things, a greater variety of foods and eating together, preferably in a calm and friendly atmosphere (Abou-Dakn et al., 2022). At present, the DGE’s dietary recommendations are being revised to take into account nutritional, health and environmental aspects (Renner et al., 2021). An adaptation of national and also international guidelines and recommendations with regard to healthy and sustainable nutrition should be accompanied by appropriate nutrition communication and education (Sections 4.1.3.3, 4.1.3.4) as well as by political measures (Section 4.1.3.5). The health-promoting and sustainable aspects of breastfeeding (Box 4.1-2) can also be emphasized more strongly in the course of such an adaptation, communication and implementation of recommendations.

The WBGU recommends:

- › *Adapt nutrition guidelines:* National (e.g. from the German Nutrition Society) and international nutrition and breastfeeding guidelines for all age and population groups should be adapted in line with the Planetary Health Diet guidelines for a healthy and sustainable diet (Box 4.1-1), taking specific local, regional and national characteristics into account.

4.1.3.3 Lifelong education on healthy and sustainable nutrition in theory and practice

The topic of health-promoting and sustainable nutrition hardly plays a role in the existing educational landscape from early childhood to higher education and vocational training to adult education (Section 8.1). Yet day-care centres, kindergartens and schools are important places of education for laying the foundation for health-promoting and sustainable nutrition in theory and practice (e.g. by preparing meals together in an environment conducive to healthy eating). Such measures are already implemented in some countries, e.g. in Germany within the framework of health promotion and disease prevention in living environments (Box 6.4-3). In this way, corresponding nutritional habits can be taught from an early age and a long-term societal impact can be achieved via the generations to come. In higher education, vocational and adult education, health-promoting and sustainable food environments (environments where personal food choices are made) and the teaching of relevant content are important as they can positively influence the dietary habits of adults of all ages. A decisive role in promoting healthy and sustainable dietary habits can also be played by health professionals, who should impart the relevant knowledge and skills in a targeted manner when advising patients (Section 6.4.1.1).

The objectives should be both theoretical knowledge transfer and practical training in choosing and preparing food that make healthy and sustainable decisions possible. An appreciative approach to food, i.e. its mindful selection, preparation and consumption and avoidance of waste, should also be part of theoretical and practical education. In the sense of a whole-institution approach, changing both food supply and processing (in the large kitchens of public institutions, kindergartens, schools, universities, clinics and companies) and food environments plays an essential role. Examples of corresponding recommendations are the revised DGE quality standard for catering in schools (DGE, 2022) and existing guidelines for establishing healthy and sustainable catering in hospitals (Hünninghaus and Dobos, 2022; Section 6.5.2.2).

The WBGU recommends:

- › *Communicate theoretical knowledge and promote practical action on healthy and sustainable nutrition:* Extensive educational measures should, on the one hand, communicate knowledge about healthy and sustainable nutrition. On the other hand, they should enable the development of action-oriented planetary health literacy that makes sustainable choices in food selection and preparation possible and is accompanied by corresponding transformative action in practice.

Box 4.1-4

Advertising for healthy and sustainable lifestyles

How would it be if attractive and successful-looking people were depicted on advertising posters with briefcases riding stylish e-bikes through appealing landscapes or traffic-calmed city districts – instead of driving through big-city scenarios in big, fast cars? Or if happy-looking children got big, shiny eyes when they bite into a juicy apple of regional origin in an advertisement – instead of into a chocolate bar? Health promotion and sustainability are often hardly considered with regard to many products from the areas of nutrition and mobility. However, in order to attractively advertise a health-promoting and sustainable lifestyle, we need appealing images and content that invite people to choose ‘different’ products.

What communication content and formats can convey the positive narrative and vision and invite transformative action

and health-promoting and environmentally sustainable behaviour? For example, healthy and sustainable behaviours and products can be encouraged by awareness campaigns and positive images in advertising (Fig. 4.1-3 a, b). Although private companies can generally decide for themselves how they advertise which products (as long as they stay within legal requirements), public-service media could increasingly provide corresponding content, and use the legal framework for putting different prices on different advertising content. In addition, advertising for products that are harmful both to health and to the environment should be more strictly regulated. The ban on tobacco advertising can serve as examples here, or the obligation to advertise walking or cycling in car advertisements, which has been in force in France since March 2022 (Fig. 4.1-3 c). Furthermore, consumers can be given information via further developed sustainability and health labels (Brown et al., 2020; Asioli et al., 2020).



Figure 4.1-3

Examples of communication strategies that promote health and sustainability: (a) awareness campaigns on health-promoting and environment-friendly behaviour, here on the benefits of active mobility; (b) positive food advertising, e.g. child with regional fruit and vegetables; (c) mandatory warnings in advertisements for products that potentially endanger health and sustainability, e.g. cars.

Source: WBGU; photos used: (b) Tatevosian Yana/Shutterstock.com; (c) Macrovector/Shutterstock.com

In addition to comprehensive education for all age groups, a focus on the education, training and further training of multipliers such as cooks, nutritionists, midwives, paediatricians, adolescent specialists, kindergarten and nursery-school teachers and educators, etc. is recommended (Sections 8.1, 6.4.2.2).

- › *Make communal and away-from-home catering healthy and sustainable:* Food supply and processing, as well as the food environments in communal or away-from-home catering in general – in the large kitchens of public institutions, kindergartens, schools, universities, clinics and companies – should be adjusted in the sense of a whole-institution approach to a health- and biodiversity-promoting and climate-friendly diet.

4.1.3.4

Awareness initiatives as a contribution to health-promoting consumer behaviour

In addition to measures in educational institutions (Section 4.1.3.3), awareness campaigns can give a short-term boost to health-promoting and sustainable nutrition. The topic of nutrition is usually addressed in public only in the context of small-scale initiatives to prevent obesity or eating disorders, or in relation to the general role of nutrition in human health. A comprehensive and extensive awareness campaign on the consequences of dietary behaviour could, on the one hand, make the population aware of the attractiveness and necessity of a new global diet standard as mentioned in Section 4.1.3.1 and, on the other hand, inform them about the harmful effects of current dietary patterns on health and the environment. Awareness campaigns on a more reasonable approach to best-before and use-by dates – such as the nationwide ‘Too good for the bin’ strategy of the German Federal Ministry of Food and Agriculture (BLE, 2023a) – can furthermore contribute to reducing food waste.

Food labelling by the industry that informs consumers about nutritional value, health consequences and environmental impacts can help them make healthy and sustainable purchasing decisions (Shangguan et al., 2019; Asioli et al., 2020; Brown et al., 2020). However, there is still room for improvement in existing labelling, e.g. in view of the many different labels and the complexity of sustainability assessment (WBGU, 2020: 184 Gwozdz et al., 2020; Brown et al., 2020). Furthermore, food labelling is sometimes misunderstood, so that, for example, best-before and use-by dates lead to unnecessary food waste (Toma et al., 2017). Furthermore, advertising for unhealthy food has a negative impact on the consumption behaviour of children in particular (Boyland et al., 2016). Yet advertising could encourage people to adopt a varied, health-promoting and future-proof diet (Box 4.1-4).

The WBGU recommends:

- › *Use and concretize existing structures and projects for fostering the food transition:* The German Federal Government should concretize its plans to support a food transition. For example, a campaign aimed at more sustainable nutrition and physical exercise in the first 1,000 days of a person’s life, accompanied by the implementation of corresponding measures, could tie in with existing structures such as the ‘Healthy Start Network’ (BLE, 2023a) or ‘IN FORM’ (BMEL and BMG, 2008).
- › *Use awareness campaigns for fostering the food transition:* National and international target-group-oriented awareness campaigns should draw the population’s attention to the attractiveness and necessity of a new diet standard for healthy and sustainable nutrition, inform them about the harmful effects of current dietary patterns on health and the environment, and emphasize a mindful and appreciative approach to food, thereby also counteracting food waste.
- › *Label food uniformly with regard to their health and environmental effects:* Consumer-friendly, integrated and (for companies) compulsory labelling of food showing its nutritional value and impact on health and the environment should help people when buying food. This also means reducing the current large number of different labels in order to improve clarity and make their presentation more standardized.
- › *Reduce advertising for unhealthy and unsustainable food products:* Advertisements for unhealthy and unsustainable food should be curbed in public-service media. In Germany, for example, a uniform federal regulation could not only further restrict advertising for foods with a high sugar, fat or salt content that targets children, but also communicate aspects of ecological sustainability in foods.

4.1.3.5

Contribution of state actors to healthy, equitable and resilient food environments

In order to encourage consumers to adopt sustainable and healthy dietary habits, fundamental changes in food environments (food shops, canteens, cafeterias, markets) are necessary. State actors play a crucial role in shaping corresponding food systems and environments. However, here the freedom of the individual encounters the protective task and responsibility of the state to contribute to human health on a healthy planet by way of fostering healthy and resilient nutrition. The Club of Rome regards “state-mandated sustainable and healthy diets [as] a rather unlikely scenario” (Club of Rome, 2022: 162), but at the same time appeals to governments to be courageous, and to advocate for a sustainable, health-promoting and equitable food system by regulation and providing support.

4 Shaping areas of life: what we eat, how we move, where we live

Only by taking on this state responsibility and acting accordingly can access to healthy and sustainable food for all people be assured. By regulating food advertising, food labelling and consumer information (Box 4.1-4), governments can make a significant contribution to healthy and equitable food environments and to strengthening the role of consumers. When the environmental and health costs of food are reflected in its prices, this has a steering effect on dietary and purchasing behaviour (Andreyeva et al., 2010; Bock et al., 2022; White et al., 2020). Taxes or other levies can contribute to this. They can, for example, be levied in the context of agricultural production (where the environmental costs arise), and partly passed on to consumers (Section 4.1.3.6; Fesenfeld et al., 2022). However, the levies can also be directly consumption-related, e.g. if environmental levies on production are not sufficient (Funke et al., 2022) or to address health costs. For example, a tax on sugary drinks in the UK has led to a reduction in their sugar content (Sasse and Metcalfe, 2022). That such a tax's steering effect can notably reduce sugar consumption is confirmed by examples from other countries such as Chile and South Africa (WHO, 2022c; WHO Europe, 2022). In the multilateral context, the WHO Framework Convention on Tobacco Control can serve as an (expandable) example of how states can address the consumption of unhealthy and unsustainable stimulants by means of global cooperation (Box 4.1-5).

The WBGU recommends:

- ▶ *Reflect environmental and health costs in food prices:* Taxes and other levies should be used to price-in and make visible the societal follow-up costs of food – e.g. from environmental pollution and GHG emissions in production – as well as the health consequences of their consumption. This makes sustainable products proportionately cheaper and more attractive. One example of such a steering tax is the sugar tax, which makes the costs of high sugar consumption visible. Food should only be subsidized if its consumption is associated with positive effects on health and sustainability.

4.1.3.6 Promote ecological production methods and local markets

Preserving traditional and local food habits is seen as a way of promoting better diets. Shifting to the 'sustainable intensification' of production methods is a core recommendation for transforming the food system; this was reaffirmed in the Kunming-Montreal Global Biodiversity Framework (CBD, 2022), adopted in December 2022, under Target 10. In low-income countries in particular, this includes expanding market access for small-scale producers and thus direct marketing channels to end consumers.

The role of traditional and local dietary habits in promoting healthy consumption patterns is also repeatedly referred to (Reyes et al., 2021; Gaupholm et al., 2022). Existing expansion plans of many companies in the food industry to concentrate on low- and middle-income countries, due to the growth potential and low market saturation in the ultra-processed food sector (Milsom et al., 2021), should therefore be viewed with caution (Moodie et al., 2013).

Ecological production methods would benefit from a more consistent pricing of external effects and a redirection or abolition of current subsidies. In agricultural production, many externalities are still not or not sufficiently regulated, priced or otherwise addressed (WBGU, 2020; Fesenfeld et al., 2022). One sector that is particularly affected here is fisheries – for example in the form of misdirected subsidies (Skerritt and Sumaila, 2021). The costs caused by current production methods to the environment – and to people through unhealthy diets – are currently borne predominantly by the general public and not by the actors who profit from these production methods (Myers, 2017). Subsidizing non-sustainable production methods, for example in fisheries (Sumaila et al., 2021) or the EU's common agricultural policy (WBGU, 2020), represent a failure of governance. Other subsidies accelerate the loss of tropical forests (Ding et al., 2021). A trend reversal towards diverse and sustainable production methods can be promoted by abolishing or redirecting current subsidies.

The WBGU recommends:

- ▶ *Certify farms:* Compulsory certification of sustainability at the farm level should be successively introduced (WBGU, 2020: 286 ff.). Food-processing and trading firms should be able to use obligatory reporting and certifications of farms to reveal the societal costs of food and to support informed consumer decisions.
- ▶ *Strengthen supply-chain laws and transparency rules:* Supply-chain legislation and transparency rules across all stages of food production, taking key regional issues into account, offer an important starting point for improved transparency (Reyes et al., 2021; EEAC, 2022).
- ▶ *Price and regulate externalities and adjust subsidies in agriculture:* The food system in its current form causes high costs that have to be borne by society. A consistent system that prices-in externalities in agriculture through steering taxes and makes them visible to consumers (Section 4.1.3.5), regulates them where necessary and links subsidies primarily to public goods (WBGU, 2020) can contribute to the sustainable use of land and to healthy, sustainable nutrition.
- ▶ *Make fisheries sustainable:* This involves in particular the implementation of the WTO's decision on the targeted reduction of subsidies for industrial fisheries

Box 4.1-5**Tobacco and alcohol in the context of the ‘healthy living on a healthy planet’ vision**

Like unhealthy nutrition and a lack of physical exercise, tobacco and alcohol consumption are among the influenceable, lifestyle-related risk factors that can have serious health and social consequences. Moreover, the production of tobacco and alcohol products have numerous negative environmental effects (WHO, 2017f; WHO, 2020k). In total, around 8.7 million deaths per year worldwide can be attributed to tobacco consumption (Murray et al., 2020). About 2.4 million deaths per year are caused by alcohol consumption (Murray et al., 2020). Serious health consequences for the individual lead to a high burden of disease for society, a lot of pressure on the health system and thus, in some cases, to severe social and economic consequences (WHO, 2018k).

Analogous to the food crisis, in the meantime it is mainly the countries that are least able to cope with the environmental and

health consequences of tobacco production and consumption that are affected the most. Transnational tobacco companies from industrialized countries profit from global tobacco consumption. In 2003, the WHO Framework Convention on Tobacco Control became legally binding as an international treaty for 179 parties (WHO, 2003a). In it, the contracting parties undertake to take measures to reduce the supply of and demand for tobacco. The Framework Convention on Tobacco Control is increasingly seen as an accelerator for sustainable development (Small and Linou, 2017). The creation and implementation of similar framework agreements could also make the risk factors of alcohol consumption, unhealthy nutrition and lack of physical exercise transparent, and generate multiple benefits for the environment and health. For example, standards could be introduced governing the advertising of alcoholic beverages, unhealthy food and cars (Box 4.1-4). In addition, enforcing a transparency obligation could make it easier to control the influence of the respective industries and other actors as well as any conflicts of interest between actors (Section 4.2.5.2).

(WTO, 2022). In 2018 alone, subsidies for fisheries amounting to US\$35.4 billion were made available worldwide (Skerritt and Sumaila, 2021) – with far-reaching consequences for the use of marine resources. Low-income countries, on the other hand, should be given more support in building their own Blue Economies. According to the OECD, the percentage of Official Development Assistance (ODA) that was used for the sustainability-oriented further development of the Blue Economy amounted to only 1.6% of total ODA in the period 2013–2018, and was considerably smaller than the subsidies for industrial fisheries (OECD, 2020). Based on Hornidge and Keijzer (2021), the WBGU also recommends the targeted development of local fish-processing industries and transregional marketing to strengthen local value chains.

4.1.3.7**Make agricultural production environment-friendly and resilient**

Diversification of farming systems is a useful instrument for a transformation towards resilient and ‘sustainably intensive’ (i.e. multifunctional and sustainability-oriented) farming systems (WBGU, 2020). In addition to the greening of industrial agriculture, this includes a sustainable increase in productivity and adaptation to climate change, especially in subsistence agriculture (WBGU, 2020). Many of these integrated agricultural approaches, such as agroecology, increasingly include social aspects in addition to ecological production practices, and can therefore help to achieve the goal of food security while increasing resilience to environmental changes (Wezel et al., 2020). Agroecological approaches serve not only

sustainable food production but also carbon storage in soils, grasslands, agroforests and mixed forests. They increase the climate resilience of food crops and thus secure the basic food resources and income of the population. Sustainable agriculture also prevents soil degradation and enables the restoration of degraded soils, e.g. by strengthening and using the soil microbiome (Box 4.1-6). Site-appropriate diversification of agricultural production methods, for example by increasing the number of crop types (spatial mixing and crop rotations) and by cultivating forgotten or underutilized crop types, can reduce risks in production, help adapt to climate change, strengthen ecosystem services and maintain genetic diversity (IPCC, 2019c; WBGU, 2020: 142). In particular, the cultivation of legumes (pulses, e.g. peas, lentils, etc.) promotes the biological fixation of nitrogen and could reduce the use of synthetic fertilizers (Drinkwater et al., 1998; Pörtner et al., 2022b). Finally, reducing meat consumption frees up land for cultivating plant-based food and increasing the production of alternative proteins, as well as for the expansion and renaturation of natural ecosystems and forests. Production adaptations in animal husbandry include, e.g. integration with cropping, mixed herds, increased mobility in grazing, soil, nutrient and water management, and farm diversification.

However, the transformation to regenerative agriculture faces a number of obstacles. For farmers, switching to sustainable production practices represents a transitional risk, and current government subsidies often support more intensive forms of agriculture (FOLU, 2019; WBGU, 2020; Section 4.1.3.6). Furthermore, new approaches have hitherto been applied mainly in smallholder communities; whether and how these can be transferred to

Box 4.1-6

Microbiomes: microorganisms as allies

Microorganisms have been shaping all life on our planet for billions of years: the health of animals, plants, humans and ecosystems as a whole is directly dependent on them (Blaser et al., 2016). Microorganisms drive the Earth's carbon cycle (Blaser et al., 2016). They are co-responsible for a wide range of ecosystem services, up to and including the establishment of complex food webs and natural purification in water from rivers or lakes (Blaser et al., 2016). The microorganisms in the soil help plants to absorb nutrients, protect them from insects and pathogens, are responsible for nitrogen fixation (Blaser et al., 2016) and thus represent an agriculturally important, natural bioresource (Suman et al., 2022). However, industrial agriculture has negative impacts on soil quality, e.g. on nutrient content, the diversity of soil fauna and soil microbiome, soil fertility and resilience to stress (WBGU, 2020; Section 4.1.1.2). A healthy soil microbiome could, for example, reduce the need for pesticide and fertilizer use. Resistance to abiotic and biotic stresses facilitated by the microbiome and its influence on nutrient availability under current and especially under future climate conditions could be crucial for future food production (Blaser et al., 2016). The health of the plant microbiome also plays a role in the resilience of agricultural production (Gupta et al., 2021a)

Furthermore, almost all internal and external surfaces of animal and human bodies are colonized by billions of microorganisms (Bosch, 2019). They influence our health, development,

behaviour and also feelings (e.g. in the sense of the 'gut-brain axis'; Bosch, 2019; Blaser et al., 2016). The microbiome of the human gut, for example, is an individual, dynamic ecosystem consisting of more than 1,000 different bacterial strains whereby the microorganisms can account for a biomass of up to 1.5 kg (Bosch, 2019). The gut microbiome influences human health in many ways. It produces vitamins and essential amino acids, supports natural digestion and has protective functions against pathogens (Stecher and Hardt, 2008; Singh et al., 2017). In addition, the co-evolution of humans and their microbes has, for example, decisively influenced the development of our acquired (adaptive) immune system (Lee and Mazmanian, 2010). The human microbiome can change depending on diet (Kau et al., 2011; Wastyk et al., 2021), infections and the intake of pharmaceuticals (e.g. antibiotics). Systemic stress and inflammation are also associated with acute and sometimes irreversible changes in the microbiome. Depletion of diversity in the human intestinal microbiome can be attributed, among other things, to an imbalanced diet and the excessive use of antibiotics, and is discussed as a cause of health problems. Loss of contact with the environmental microbiome and a biodiverse environment can also contribute to this (Stanhope et al., 2022; Haahtela, 2022).

The interconnectedness of humans, animals, plants, fungi and the environment is reflected in this mediating role of microbiomes and emphasizes the need to 'rethink' the relationship between humans and nature (Section 2.1) across systems (Bosch, 2019). In general, it can be concluded that the well-being of all multicellular organisms depends on their specific communities with diverse microorganisms. Many environmental influences on the microbiome are still unexplored.

large-scale farms depends, according to Dong (2020), on the actors in the agricultural value chain, governments, scientific knowledge and public support. The development of new practices, their financing and the necessary global exchange of knowledge are also insufficient (FOLU, 2019; WBGU, 2020). It is particularly important to support all actors in this transition process with advice, education and training (Lampkin et al., 2020).

The WBGU recommends:

- *Strengthen sustainable spatial and landscape planning and land use to conserve biodiversity and ecosystem services*, e.g. as part of an integrated landscape approach (WBGU, 2020). The need for integrated landscape planning has risen further against the background of the new Kunming-Montreal Global Biodiversity Framework. This applies especially to African countries with large populations that have a large demand for food to ensure food security, and simultaneously play an important role in biodiversity conservation, e.g. Ethiopia, Nigeria and Somalia. Sustainable spatial and landscape planning can mean i.a. maintaining and expanding near-natural mosaic landscapes or land-sharing approaches, coupling crop and livestock production, and using more diversified, multifunctional

agricultural production systems. This involves, in particular, maintaining or restoring healthy and degraded soils by means of appropriate management and other measures, for example through greater crop diversity and crop rotation or the use of alternative fertilizers.

- *Promote the (further) development and implementation of scientific and technical innovations and digitalization in agriculture*: Existing technical innovations for sustainability (especially on the field of digitalization) that are adapted to the respective agricultural systems should be further developed and implemented (WBGU, 2020). Governments, companies and investors should therefore increase their expenditure on research, development and innovation (FOLU, 2019).
- *Promote knowledge transfer, education and (further) training on sustainable production practices*: The aim is to promote active participation and understanding, knowledge transfer and mutual learning (e.g. about the sustainable production methods of local communities), as well as the joint generation of knowledge by all actors involved (FOLU, 2019; WBGU, 2020), for example by creating networks and providing training courses.
- *Reduce food losses and inefficiencies in agricultural production*: Reducing food losses that happen directly after production and along processing and supply

chains (Section 4.1.1.2) would reduce greenhouse-gas emissions and the need to increase productivity in agriculture, and would also contribute to food security in particular.

4.1.3.8

Make fisheries and aquaculture environment-friendly and resilient

The overexploitation and endangerment of aquatic ecosystems has considerable impacts on the provision of ecosystem services also for humans, as well as on food security and the preservation of natural life-support systems (Section 4.1.1.2; Gattuso et al., 2015; Bezner Kerr et al., 2022; IPBES, 2019). A reduction in fishing pressure and the adaptation and development of sustainable fishing methods that adequately consider fish stocks and ecosystems is necessary to promote the regeneration of stocks and to reduce the destructive impacts on ecosystems (Bezner Kerr et al., 2022: 767). In the aquaculture sector, technological innovations, especially in feeding (e.g. feeding with alternative protein sources), digitalization and the site-specific promotion of efficient and environmentally friendly practices, can reduce environmental impacts and increase resilience to climate change (WBGU, 2013; FAO, 2022c).

Effective instruments for sustainable fisheries are available, but they need to be adapted to local and regional conditions and systems (e.g. industrial fisheries or small-scale fisheries) and intelligently combined and applied (WBGU, 2013; Rätz and Lloret, 2016; Pauly and Froese, 2017; Ekau, 2017). In fisheries and aquaculture, too, there is a need to reduce harmful subsidies that promote overfishing and overcapacity instead of sustainable production practices (Section 4.1.3.6; Hornidge and Keijzer, 2021). In addition to ecological resilience and the maintenance of ecosystem services, changes in fisheries management can help make the actors more flexible, and thus secure livelihoods (Free et al., 2020; FAO, 2022c). This applies in particular to the shifts in the distribution areas of fish stocks with rising ocean temperatures and the associated global redistribution of maximum catch potential (Bindoff et al., 2019). Local, national, regional and international fisheries should prepare for this, e.g. by adopting dynamic, cooperative management approaches (Bindoff et al., 2019; Bezner Kerr et al., 2022; Ojea et al., 2020). The allocation and distribution of fishing rights must be made more equitable in general, depending on stock-recovery plans, in order to ensure the food security of small-scale fishers and their communities, and to harmonize them with the economic and environmental objectives of commercial fishers (FOLU, 2019). Reducing losses and waste along the value chain in the fisheries and aquaculture sector not only contributes to food security, but also reduces the pressure on fish stocks (FAO, 2020b).

The WBGU recommends:

- › *Promote sustainable fishing methods*: This includes promoting and adapting ecosystem-friendly fishing methods, introducing and enforcing bans on – and more effective monitoring of – e.g. destructive fishing methods and the management of bycatch.
- › *Reduce the environmental impact of aquaculture and adapt systems to climate change*: Promoting and implementing environment-friendly practices and technical innovations can both reduce environmental impacts and increase the resilience of aquaculture systems to climate change.
- › *Promote flexible and sustainable fisheries management*: Management strategies and conservation measures in times of climate change should be planned and implemented in a flexible manner; given the scientific uncertainties about the impacts of climate change, the capacities of regional fisheries management, for example, should be institutionally strengthened and developed (Hornidge and Keijzer, 2021).
- › *Strengthen small-scale and coastal fisheries, especially in low- and middle-income countries*: This can be done, for example, by banning all fishing activities outside the Exclusive Economic Zone (EEZ or 200-nautical-mile zone; Sumaila et al., 2015; Hornidge and Keijzer, 2021) or by distributing fishing rights more equitably (FOLU, 2019).
- › *Promote technology and knowledge transfer*: This includes intensifying the generation of data that is generally accessible to all actors, e.g. through science and monitoring, technology transfer, build-up of digital infrastructure (Winther et al., 2020), promoting knowledge transfer and exchange, and the joint production of knowledge by all the actors involved.
- › *Minimize food losses and wastage in fisheries and aquaculture*: This can be achieved, for example, by means of technological improvements along the value chain (e.g. with regard to fishing methods and the cold chain), more efficient infrastructure for logistics and processing, and the reduction of bycatch and the excessive use of wild catch as feed in aquaculture (FAO, 2020b).

4.1.3.9

Take market and power concentration into account

Multinational agricultural and food companies have substantial market shares and market power along the value chain (Sexton and Xia, 2018), and exert considerable influence over the diets of many people (Walls et al., 2020; FAO et al., 2022). In the absence of adequate regulation, profit interests can lead to negative environmental impacts through the way production is carried out; they can also have social and health consequences due to a focus on ultra-processed products

(Section 4.1.1.1), and generally represent an incentive to influence regulations (White et al., 2020; Swinburn et al., 2019; Walls et al., 2020).

Concentration processes exist not only when it comes to agricultural land but also along the broader food value chain (Clapp, 2022; Sexton and Xia, 2018), e.g. in the production of ultra-processed foods (Yates et al., 2021; White et al., 2020), in drinking-water production, or in seed or pesticide production (Folke et al., 2019; OECD, 2019). The high level of market concentration is reflected in a small number of companies and products (Clapp, 2021). This can stand in the way of a sustainable transformation of agriculture, the food sector and its products, e.g. when influence is exerted on regulatory processes or bargaining power is abused (Garton et al., 2021; WBGU, 2020; FAO et al., 2022: 119 ff.). Furthermore, influence also extends to relevant scientific research (Fabbri et al., 2018; Sacks et al., 2020) and the innovation focus in the food sector (Clapp, 2021). Resistance to stricter regulation of producers, especially of highly processed foods, is, according to Swinburn (2019) and Yates et al. (2021), one of the main obstacles to a stronger spread of healthy diets. Yet an evaluation of reports by various multilateral organizations (FAO, IPES-Food, UNEP) between 2016 and 2020 shows that market concentration and power imbalances are currently only rarely addressed by recommendations for action on transformation (Slater et al., 2022). Antitrust agencies, which are supposed to monitor market power and its potentially abusive use, are in some cases insufficiently resourced, especially in low-income countries, or else corruption weakens their supervisory role (Waked, 2010; Grajzl and Baniak, 2018).

The WBGU recommends:

- *Make the role of agricultural and food corporations more transparent:* The role of food and agricultural corporations in food systems should be made more transparent, as should their influence (Walls et al., 2020), e.g. on multilateral agenda-setting regarding food systems. Meetings like the UN Food System Summit should discuss the considerable influence of corporations (also on the conferences themselves; Canfield et al., 2021) and look for structural solutions for a better balance (Clapp, 2021). The WHO's (2017d) first drafts on this are still perceived as insufficient (Rodwin, 2022). More international cooperation in the form of a 'Framework Convention on Food Systems' as proposed by Swinburn (2019) can bring together the various groups of actors in this context.

4.1.4

Research recommendations

Coordinated research in the fields of production and consumption can and should go beyond what is already known and point the way forward to transform food systems for the benefit of humanity, species and ecosystems, and thus make a significant contribution to making them future-proof

4.1.4.1

Intensify research on the health and environmental effects of sustainable nutrition

The WBGU recommends improving research into the linkage between a transition to a healthy, sustainable diet (in the sense of the Planetary Health Diet) and improved human health (e.g. reduction of overweight/obesity in childhood and adulthood, type 2 diabetes mellitus, cardiovascular disease, cancer, quality of life). This research should look at countries with different income levels and also be conducted by various countries. Ongoing large cohort studies, such as the German National Cohort (GNC) or the COPLANT study, can also be used for this purpose. In addition, the effects of food and especially food innovations (e.g. plant-based milk and meat substitutes) on health and the environment should be researched at the same time (Musicus et al., 2022). A distinction must be made between different plant-based diets, since not all have the same positive effect on health and the environment (Musicus et al., 2022).

Furthermore, the WBGU recommends linking up with existing studies – e.g. the 'study on the nutrition education (including breastfeeding) of paediatricians, adolescent specialists and cooperating health professions' by the BMEL (BLE, 2022) – and, in future studies, addressing training and skills in the fields of nutrition and physical exercise (from a health perspective) and integrating aspects of ecological sustainability.

4.1.4.2

Intensify transdisciplinary research on the effectiveness of measures aimed at changing dietary habits

The WBGU recommends conducting transdisciplinary research on the effectiveness of measures for health-promoting and sustainable nutrition in canteens with respect to health and quality of life, also taking aspects of health economics into account. Studies should cover both canteens for children and adolescents in educational institutions, including early childhood care, as well as catering provisions for adults. Particular attention should be paid to the factors that promote or hinder the adaptation of current consumption patterns to the targets in the different settings. When measures are successfully

implemented and effective, the accompanying communication should also be evaluated.

Systematic reviews show that people's dietary habits changed during the COVID-19-related lockdown compared to the preceding period (Mignogna et al., 2022). The reasons for such short-term changes in dietary habits should be understood in order to prevent negative effects during future crises, and to harness positive effects for transformations towards sustainability.

Moreover, the WBGU recommends transdisciplinary research on institutional innovations across national, regional and international governance levels that make a food transition possible in different regions of the world.

4.1.4.3 Study food labelling and its effects on consumer decision-making

Recent research findings from the UK and Ireland show that (processed) foods which, according to nutritional labelling (such as NutriScore), have a relatively favourable nutritional value, are usually more environment-friendly in their production (Clark et al., 2022). Such calculations have not yet been carried out in Germany, nor in most other countries. Apart from the combination of nutritional value and environmental impact, the complex interplay with affordability and accessibility of healthy and environment-friendly foodstuffs should also be explored, especially with regard to the purchasing decisions, health and well-being of population groups.

4.1.4.4 Research on the concentration of power and its impact on the availability of healthy food

More research should be conducted on concentrations of power in food production and their impact on the availability of healthy food. The WBGU recommends research into effective measures to promote resilient structures in food production and upstream sectors such as agrochemicals or seed production (White et al., 2020), in different regions of the world. Research should examine the potential synergy effects or economic advantages of market concentration on the one hand, and, on the other, its negative effects, such as a possibly lower prevalence of healthy diets.

4.1.4.5 Research reform options for tax and subsidy systems

Current production methods generate negative externalities for humans and the environment which are not reflected in product prices. In some cases, the negative effects are further exacerbated by subsidies (Fesenfeld et al., 2022). The WBGU therefore recommends more research into options for internalizing negative societal

and environmental costs both at the European and at the multilateral level. To this end, the respective ecological, economic and social implications of different measures to internalize external costs should be compared (e.g. taxation, regulation; White et al., 2020). Similarly, possibilities for reforming current subsidy systems must be studied so that subsidies for unsustainable production can be identified and eliminated as quickly as possible (WBGU, 2020). The WBGU further recommends always orienting agricultural subsidies towards ecological standards, and developing suitable assessment and transformation mechanisms for this purpose.

4.1.4.6 Research the up-scaling of sustainable production practices in agriculture

Up to now, new approaches have mainly been applied in smallholder structures or communities. In view of the ambitious climate and biodiversity goals, it is necessary to determine the suitability of different business structures for demand-oriented and sustainable production methods in agriculture and forestry, as well as in aquaculture and fisheries, and to promote any necessary restructuring.

4.1.4.7 Increase resilience research in agriculture and fisheries

Increasing ecological, social and economic resilience in food production involves a sustainable increase in productivity and a simultaneous adaptation to climate change, as well as securing the food basis and incomes of the population in the key sectors of agriculture and fisheries. Both sectors are complex socio-ecological systems. Whether and how resilience can be operationalized and aligned at all levels therefore remains a fundamental research question. The WBGU recommends increasing resilience research, supported by local knowledge (traditional practices, traditional ecological knowledge). Knowledge gaps in agriculture and fisheries – especially on the practical implementation of measures and on any barriers that might stand in the way of these measures – should be assessed and clarified proactively and as early as possible. Ways should be developed of improving the ecological health of soils, landscapes and water bodies, and the climate resilience of a production that meets demands while minimizing climate-damaging emissions at the same time. In this way, it should be possible to avoid unsustainable water use, eutrophication, land degradation and biodiversity loss, as well as the collapse of ecosystem services (WBGU, 2020; IPCC, 2019c; IPCC, 2022d; IPBES, 2019).



4.2

Activity-friendly environment, environment-friendly activity

Physical activity in green environments is one of the best strategies for health, climate and the environment. Three quarters of adolescents worldwide and one third of adults in high-income countries do not get enough exercise. Active mobility integrates physical exercise into everyday life and reduces the burden on the environment. The WBGU recommends integrating more physical activity into all areas of life by adapting infrastructures, regulations and public services. Active mobility should be encouraged and car travel made less attractive. Children's needs are a good benchmark for shaping our environments.

The everyday lives of many people in all parts of the world, in all age groups and social strata is characterized by a lack of exercise and too much sedentary behaviour, and this has considerable, direct health consequences. Apart from physical inactivity – i.e. not meeting the WHO's recommendations, which include comprehensive, moderate and intensive exercise (Box 4.2-1) – prolonged and uninterrupted sedentary behaviour is regarded as a risk factor for human health in its own right. Sedentary behaviour is any waking behaviour with low energy expenditure in a sitting or lying position (Tremblay et al., 2017). Physical activity is being displaced by technical aids. Such devices, especially in transport, also contribute greatly to local environmental damage and climate change and, together with accidents, further increase health risks (Section 4.2.1). All population groups are affected, including children and adolescents, some of whom grow up in environments that are far removed from nature and are hostile to physical activity. Apart from individual and social factors, people's mobility behaviour at school, at work, when travelling, in the household and during leisure times depends above all on external conditions (e.g. attractive footpaths, compact cities and safe cycle paths have a positive effect; Section 4.2.2). An activity-friendly environment is therefore key to reintegrating healthy and environment-friendly physical activity into all areas of life. Overall conditions and incentives must be changed, especially as regards active mobility, as this offers particularly great potential for health, the environment and the climate. Focusing on the needs of children and adolescents in this context is an effective lever for several societal goals (Section 4.2.3).

There are already many local, national and global goals and approaches for promoting physical activity on the one hand, and for the mobility transition and reduction of transport emissions on the other. However,

they mostly exist independently of each other, promoting primarily either recreational sports or electric vehicles instead of active mobility; overall, therefore, they achieve little progress (Section 4.2.4). The WBGU therefore recommends the following: (1) better integrate target systems, strategies and governance structures (and the corresponding research communities) to achieve more physical activity, environmental protection and climate-change mitigation; (2) promote active mobility in a strategy-based way by improving external conditions, combined with attractive shared mobility options and, when it comes to car traffic, consistent access restrictions, pricing and regulation; and (3) use children and adolescents and their need for physical activity and autonomy as a benchmark for designing schools, mobility systems and cities (Sections 4.2.5 and 4.2.6).

4.2.1

The 'double mobility crisis': our mobility behaviour damages our health and the environment

It is widely known how important getting plenty of physical exercise, minimizing sitting, and having contact with nature are for individual people's health and well-being; also well-known are the benefits of physical activity and active mobility in attractive public spaces for social interaction, the environment and people's relationship with nature. Nevertheless, we find ourselves in the middle of a 'double mobility crisis': First, we don't move enough – because of changes in the world of work, in our leisure-time behaviour and in the excessive use of motorized vehicles and devices. Lack of physical activity and sedentary behaviour have massive health consequences which have now reached pandemic proportions. Second, the way in which we move damages the environment (air pollution, climate change, resource consumption, land sealing) and the health of others through traffic accidents.

4.2.1.1

Lack of exercise and prolonged sitting are on the rise worldwide

Although there are clear differences in physical activity and sedentary behaviour between different countries and regions (as well as in different areas of life, Section 4.2.2), global trends can be identified.

Most toddlers are able to give free rein to their natural urge to move; they spend relatively little time at a stretch engaged in sedentary activities (Bauman et al., 2018). However, as early as at the age of three to six years, about half of children fail to meet the WHO's recommendations for physical activity (Box 4.2-1) and they spend about

Box 4.2-1

The WHO's global recommendations on physical activity, sedentary behaviour and sleep

The WHO's current guidelines on physical activity and sedentary behaviour make evidence-based public-health recommendations for children from the age of five, adolescents, adults and older adults, as well as for pregnant women, chronically ill adults, and children and adults with disabilities (WHO, 2020b). Separate recommendations, including on sleep, apply to children up to the age of five (WHO, 2019e). Both policies apply regardless of gender. For example, adults should be physically active for at least 150–300 minutes per week at moderate intensity, e.g. brisk walking or cycling. Alternatively, at least 75–150 minutes per week of high-intensity physical activity such as jogging is recommended. In addition, adults should do muscle-strengthening activities of moderate to high

intensity on at least two days a week, e.g. strength training (WHO, 2020b). Sedentary behaviour should be limited, and its negative effects counteracted by additional, at least moderate physical activity (beyond the above recommendations).

To improve implementation of these recommendations, the WHO has published the Global Action Plan on Physical Activity 2018–2030 (GAPPA; WHO, 2018d). This complements the Action Plan on Non-communicable Diseases (WHO, 2013a) and extends its target of reducing physical inactivity by 10% by 2025, adding a reduction of 15% by 2030. The WHO's action plan proposes four strategic goals (active societies, environments, people and systems) with a total of 20 policy measures, and identifies basic principles and key implementation actors in order to achieve health-promoting active lifestyles while taking the SDGs into account. However, the new Global Status Report on Physical Activity shows that progress on the implementation of these measures is very slow and uneven (WHO, 2022t).

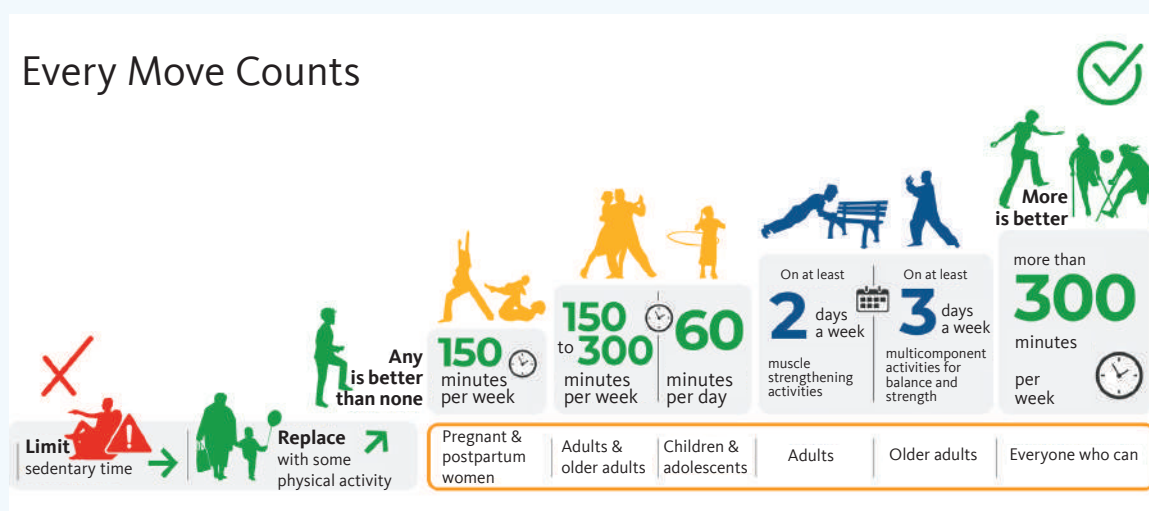


Figure 4.2-1

Summary of the WHO's recommendations on physical activity and sedentary behaviour. Sedentary behaviour (red) should be limited; instead, adults, for example, should exercise for at least 150–300 minutes per week with moderate endurance activities (green) or engage in at least 75–150 minutes of intense physical activity, as well as strengthening their muscles on at least two days per week (blue). Every additional movement counts, both at a low level and at an already higher level (yellow).

Source: WHO, 2021m

four hours a day sitting (Finger et al., 2018; Bauman et al., 2018). A marked decrease in physical activity and a simultaneous increase in sedentary behaviour can be observed in many countries in children from the age of six to seven (Steen-Johannessen et al., 2020). Of the seven- to ten-year-olds, only about 30% are sufficiently physically active, and girls are much less active than boys (Cooper et al., 2015). The lack of physical activity is highest among adolescents. Worldwide, more than three quarters of adolescents (84.7% of girls and 77.6% of boys) do not meet the WHO's recommendations (Guthold et al., 2020). Furthermore, they spend

around nine hours a day with sedentary activities (Bauman et al., 2018). About a quarter of adults worldwide do not meet the WHO's recommendations, with significantly more women (31.7%) than men (23.4%) suffering from physical inactivity. The proportion of physically inactive adults in high-income countries is steadily increasing and, at 36.8%, is more than twice as high as in low-income countries (Guthold et al., 2018). However, physical inactivity is an increasing problem worldwide – also in low- and middle-income countries due to economic change, urbanization and the associated lifestyle changes (Ding, 2018). In these countries, people in cities move

less than in rural areas (unlike in high-income countries; Sallis et al., 2016a). The extent of physical inactivity varies greatly among the over-60s. For example, about 5 to 30% of older people in Europe do not meet the physical-activity recommendations (Gomes et al., 2017). As they age, adults spend less and less time engaging in intense physical activity and instead spend more time with activities involving little physical effort (Jaeschke et al., 2020). Across all age groups, people with a physical or mental impairment meet the WHO's recommendations significantly less often than healthy people of the same age (Martin Ginis et al., 2021).

Adults, including older adults over 65, spend around eight hours per day engaged in sedentary activities (Bauman et al., 2018). 60 to 75 minutes of moderate physical activity per day are necessary to compensate for the increased mortality caused by sedentary behaviour (Ekelund et al., 2016). However, a third of adults worldwide do not even manage the 150 to 300 minutes of moderate physical activity per week recommended by the WHO (Box 4.2-1).

4.2.1.2

Health effects and costs of physical inactivity and prolonged sitting

In 2019, approx. 0.8 million deaths worldwide were attributable to physical inactivity (Murray et al., 2020; Section 2.2). Physical inactivity promotes the development of widespread non-communicable diseases such as diabetes, cancer (e.g. colon, breast and endometrial cancer), cardiovascular diseases and high blood pressure (Lee et al., 2012; WHO, 2020b). The WHO expects around 500 million preventable cases of non-communicable diseases in the period 2020–2030 if physical inactivity does not decrease (WHO, 2022t). Long, uninterrupted sitting increases the risk of developing cancer as well as fatal cardiovascular diseases (Ekelund et al., 2019; Hermelink et al., 2022). Lack of exercise is also a risk factor for many other diseases; for example, severe courses are more frequent for COVID-19 infections (Sallis et al., 2021). The burden of disease caused by physical inactivity and sedentary behaviour is distributed differently around the world. The prevalence is twice as high in high-income as in low-income countries, with most deaths occurring in middle-income countries (Katzmarzyk et al., 2022).

The negative health consequences of physical inactivity and sedentary behaviour through the development of non-communicable diseases are also reflected in high monetary costs. The global cost to health systems is US\$27 billion per year (WHO, 2022t); for the UK, for example, the cost of excessive sedentary behaviour alone is estimated at £0.8 billion per year (Heron et al., 2019). Health-system costs, for example, are largely borne (75%) by the public sector in Europe, 40% by

the private sector in North America (such as voluntary health insurance), and almost half by households in South East Asia (Ding et al., 2016). In addition, there are follow-up costs due to lost productivity.

Compared to physical inactivity, the available data and current research on the health consequences, underlying biological mechanisms and associated costs of sedentary behaviour still need to be improved.

4.2.1.3

Negative effects of car traffic on the environment, the climate and health

In addition to direct health consequences and costs, current mobility patterns also have serious consequences for the environment and climate, which, in turn, have further repercussions for human health. Physical activity is being replaced by technical devices in all areas of life (Section 4.2.2), with corresponding energy and resource consumption as well as pollutant emissions. The most important example is mobility. On average, just over an hour is spent each day moving around – this is irrespective of the mode of transport and remains relatively stable over time, countries and cities (Ahmed and Stopher, 2014; Stopher et al., 2017; Metz, 2008, 2021). People who can afford it continue to use their own cars predominantly (as in Europe, North America) or increasingly (as in non-OECD countries, especially China; SLoCaT, 2018; Fountas et al., 2020). Between 2000 and 2015, passenger traffic increased by 75% worldwide, mainly in non-OECD countries; traffic in cities accounts for about half of this figure (SLoCaT, 2018). The ratio of private motorized transport to non-motorized transport is 2:1 in cities in industrialized countries, and 3:4 in cities in developing countries (Sustainable Mobility for All, 2017: 50). But even there, the share of private motorized transport is increasing, mainly due to the sharp rise in vehicle ownership – which increased by 45% between 2005 and 2015 worldwide, and by around 80% in Africa and South America (Jaramillo et al., 2022). While drive systems are becoming more efficient, cars are getting bigger, heavier and more powerful: in 2019, around 40% of vehicles sold worldwide were SUVs (Jaramillo et al., 2022), and the average vehicle weight in the EU, for example, rose by 40% from 1975 to 2015 (ITF, 2017).

Private motorized transport damages human health and the environment through air pollution, noise, environmental degradation for resource extraction and infrastructure, and its contribution to climate change (as well as accidents, Section 4.2.1.4). Air pollution is one of the most important risk factors for many non-communicable diseases – in Europe it causes 400,000 premature deaths every year (EEA, 2019b). Almost everyone in cities is exposed to air pollutants in excess of the WHO's recommendations (EEA, 2022b). Globally, outdoor air

Box 4.2-2

Interactions between short-distance, long-distance and freight traffic

Long car journeys and freight transport are responsible for a large proportion of greenhouse-gas emissions, other exhaust gases and traffic noise. However, mobility over medium and long distances also influences behaviour over short distances, e.g. if cars are purchased for daily commuting, but are then used frequently elsewhere – and vice versa if buying a car is unattractive in cities, so that trains are then used on longer distances, for example. There are also interactions between private shopping trips, growing online shopping and freight transport. These interlinkages underline the importance of systemic policy approaches.

Vehicle acquisitions and long-distance passenger transport

In Europe, cars are used for most long, overland journeys (Joint Research Centre et al., 2015). Long-distance passenger transport (distances over 100 km) accounts for only about 3% of trips (Shepherd et al., 2019) but about half of the CO₂ emissions from passenger transport (van Goeverden et al., 2016). Cars purchased primarily for longer journeys displace other, active means of transport, also for short journeys (Reichert and Holz-Rau, 2015; Van Acker and Witlox, 2010), and thus promote physical inactivity. They are also often larger, more polluting and more dangerous for other road users than cars purchased primarily for urban use (Niklas et al., 2019). Shifting long-distance traffic to trains and buses (by developing infrastructure, making attractive offers, pricing roads and externalities, etc.; Section 4.2.4.2; SRU, 2017), combined with convenient public transport and car-sharing options using small vehicles for the first and last mile, thus has multiple benefits for the climate, the environment and health. As longer journeys are often work-related (in Germany 27% of journeys and 38% of distances travelled; Follmer and Gruschwitz, 2019) and vehicles are often first registered as company cars or for

company fleets (in Germany 64%; Statista, 2022), abolishing company-car subsidies, offering employers incentives and expanding the digital infrastructure for teleworking can also have a major benefit. Furthermore, air traffic must be included and drastically reduced, especially in high-income countries, in order to achieve the Paris climate goals (Åkerman et al., 2021).

Shopping trips and freight transport

Global freight transport is expected to continue to grow rapidly – faster than passenger transport – because of global supply chains and international trade, and it plays a significant role in the transport sector's environmental impact and greenhouse-gas emissions (Jaramillo et al., 2022). The transport of goods causes 40% of CO₂ emissions in road transport (Axsen et al., 2020). Some passenger-transport strategies are also relevant for freight transport (e.g. shifting traffic to rail; alternative fuels or powertrains), but the link with economic activity requires separate policy approaches in some cases (Axsen et al., 2020). However, there is a direct link with everyday behaviour and health in the case of home-delivered online purchases. They replace some shopping trips made on foot or by bicycle but also car journeys, which can reduce emissions (Jaller and Pahwa, 2020). Online shopping has ambivalent environmental impacts (Rai, 2021), which depend on the choice of transport, the shipping distance, the number of returns, packaging waste, and other factors. In efforts to optimize the growing 'last mile' delivery traffic in cities, small, electric vehicles or e-cargo bikes (LNC, 2019; DPD Deutschland, 2022) require adjustments to logistics chains and depot structures, but offer considerable potential for reducing energy consumption, climate and environmental impacts and, in some cases, costs (Browne et al., 2011; Melo and Baptista, 2017; Oliveira et al., 2017; Patella et al., 2020; LNC, 2019). They can also reduce the risk of accidents for pedestrians and cyclists, especially for children, in residential areas, which is many times higher for collisions with large vehicles than with smaller ones (Edwards and Leonard, 2022), thus making active mobility more attractive. Further research on this is advisable.

pollution, e.g. particulate matter with particles smaller than 2.5 µm and, to a much lesser extent, ozone, led to over four million premature deaths in 2019, 55% more than in 2000 (Fuller et al., 2022; Section 2.2). In high-income countries, up to one third of such deaths can be attributed to road-traffic emissions (Lelieveld et al., 2015). These health consequences are unequally distributed: less affluent people often live in places with high levels of air pollution (Hajat et al., 2015; Barnes et al., 2019; Jbaily et al., 2022; UBA, 2020a). The same applies to noise pollution from motor traffic, to which, for example in Europe, most people in urban areas are exposed (EEA, 2020b; Section 4.3.1.2). Furthermore, air pollution damages the local environment, e.g. animal health (EEA, 2020b). In addition, there is the destruction of natural areas for road traffic and resources: roads and car parks can account for 35–50% of land in car-dependent cities, and worldwide they already cover about 1.5–2% of the

land area (Rodrigue, 2020). This is also due to the fact that most private cars are stationary most of the time – e.g. in Germany 97% of the day on average (Nobis and Kuhnimhof, 2018). The road network could still grow by almost 25% by 2050, especially in biodiversity hotspots such as the Amazon, the Congo Basin or New Guinea (Meijer et al., 2018), with corresponding risks to human health. Road transport consumes half of global oil production (IEA, 2020), and vehicle manufacturing 12% of steel (2019; Statista, 2021). Finally, all motorized road transport contributed to climate change in 2019 with 16% of global CO₂ emissions coming directly from fossil-fuel combustion, in addition to indirect emissions from fuel production and transport, vehicle production and disposal (for medium-sized passenger cars in the order of one third of greenhouse-gas emissions from fuels over the vehicle's lifetime) as well as infrastructure (Jaramillo et al., 2022). Although some of these

emissions also occur on long journeys outside cities or are caused by freight transport, they should nevertheless be taken into account by policy measures primarily aimed at short-distance mobility, since mobility behaviour on short and long journeys influence each other (Box 4.2-2).

4.2.1.4

Motorized traffic endangers active mobility

In 2016, 1.35 million people were killed in road-traffic accidents worldwide; between 20 and 50 million people are injured each year. The risk of dying in road-traffic accidents is three times higher in low-income countries than in high-income countries (WHO, 2018b; UN, 2021c; Fig. 4.2-2). Traffic accidents are the main cause of death for people between the ages of five and 29 (UN, 2021c). Pedestrians and cyclists are particularly vulnerable and account for about a quarter of all fatalities, especially where the infrastructure is inadequate (WHO, 2018b). Large vehicles are especially dangerous. Data from the USA shows, among other things, that a child is eight times more likely to die if hit by an SUV than by a smaller car (Edwards and Leonard, 2022). Also overproportionately endangered are users of two- or three-wheeled motor vehicles, which are particularly common in low- and middle-income countries (WHO, 2018b; Fig. 4.2-2).

Apart from traffic accidents, pedestrians and cyclists are often more seriously affected by air pollution (Cepeda et al., 2017). Looking at the population as a whole, however, the health benefits of linking mobility with physical activity far outweigh the disadvantages. Walking and cycling, also in combination with public transport, are significantly healthier than travelling by car (Cepeda et al., 2017; Mueller et al., 2015; Howse et al., 2021; Cissé et al., 2022). Nevertheless, in people's individual choice of mode of transport, air quality (Zhao

et al., 2018) and the subjective perception of safety and the potentially serious injuries and fatal consequences of accidents, especially involving cyclists in collisions with cars (Javaid et al., 2020; Félix et al., 2019), play a significant role. Safe infrastructure, adequate traffic regulations and traffic monitoring, as well as the improvement of air quality (Howse et al., 2021) are therefore of key importance for a mobility transition and the prevention of accidents, injuries and fatalities.

4.2.2

Three observations on physical activity and mobility

4.2.2.1

Humans are made for movement, but are pushing it out of their everyday lives

The human body is optimally equipped for movement, and throughout human history this has always been integrated in many ways into all areas of everyday life. However, with technical progress, especially the changes in workplaces and means of transport in the course of industrialization and automation processes, physical movement is increasingly being pushed out of all areas of life, while sedentary behaviour is on the rise (Ng and Popkin, 2012). Physical activity as an optional leisure activity or as an end in itself (e.g. sport or walking) has increased slightly in some countries, but even there it has not been able to compensate for the much greater decrease in absolute terms in physical activity in other areas (e.g. in the USA, the UK, Brazil, China and India; Ng and Popkin, 2012).

Sporting activity is also declining slightly across the EU (European Commission, 2018).

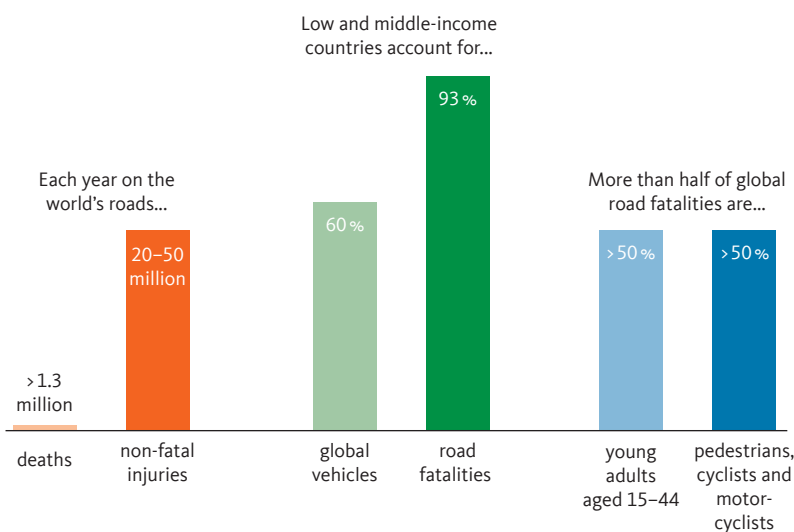


Figure 4.2-2

Victims of road accidents worldwide, left: number of annual road deaths and injuries; centre: low- and middle-income countries account for a much higher proportion of global accident fatalities than of the global vehicle fleet; right: young adults account for more than 50% of accident fatalities worldwide; people on foot, bicycles or motorbikes also account for more than 50%. Source: UN, 2021c

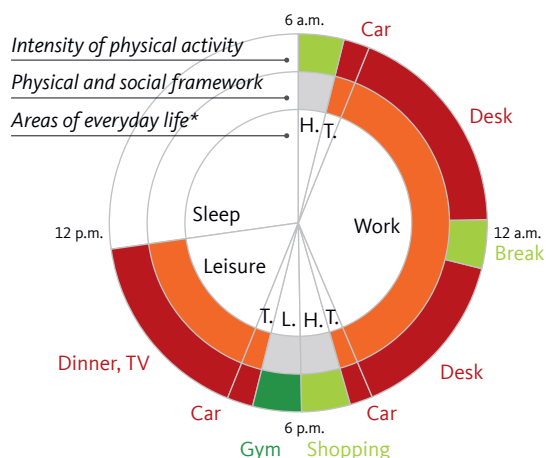
4 Shaping areas of life: what we eat, how we move, where we live

Regional and social differences in physical activity patterns

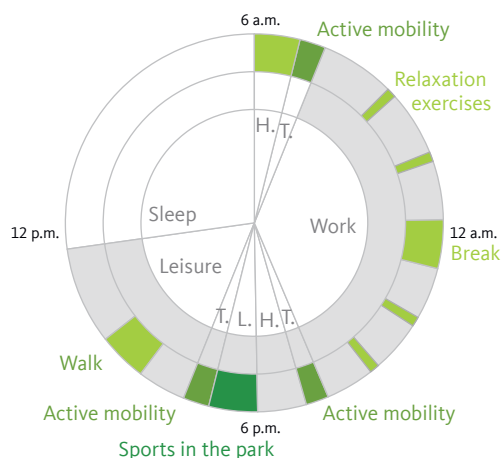
The daily spectrum of physical activity – ranging from activities of different intensities to sedentary behaviour

and sleep – varies greatly among people and also for each individual, both from day to day and over the course of a lifetime. Even so, there are basic patterns. For example, a large proportion of adults in high-income countries

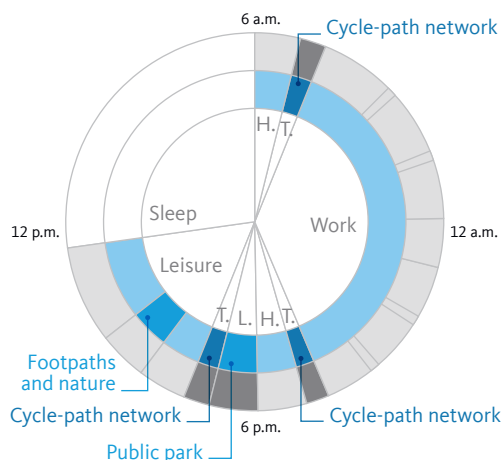
(a) Physical activity pattern of an office employee with little activity



(b) Physical activity integrated in everyday life



(c) External conditions for active mobility



(d) Physical activity pattern of an active primary-school child

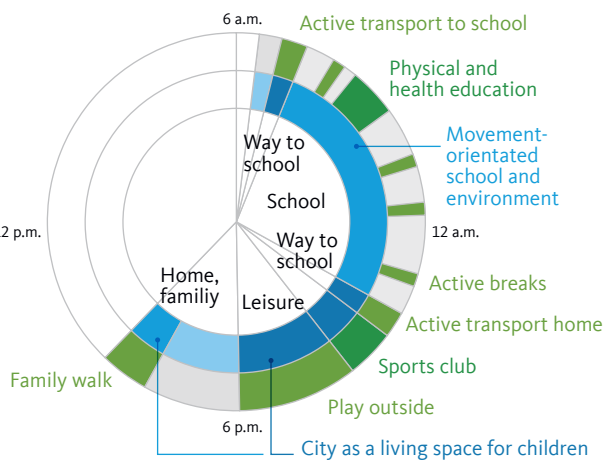


Figure 4.2-3

Examples of stylized physical activity patterns of an office employee over 24 hours in the current state with little physical activity (a; Section 4.2.3; H.: household, T.: transport, L.: leisure time) and in the target state with sufficient physical activity distributed over the day, integrated into daily routines (b; Section 4.2.4.1). Highlighted below are two further key topics that will be elaborated in Section 4.2.4: (c) the important role of external conditions for active mobility and (d) an example of the physical activity pattern of a primary-school child. In different parts of the daily routine (in the centre respectively), individual factors, social and cultural determinants – as well as external conditions such as the built and natural environment, prices and regulation (middle circle) – lead to more or less intensive exercise or sitting (outer circle). Unfavourable influencing factors and long, continuous sedentary periods are coloured orange and red respectively. Favourable influencing factors and times of physical activity are coloured blue or green (the darker, the more favourable, i.e. intense). In the three focal topics (b-d), only the respective focal parts are coloured.

Source: WBGU

spend about eight to twelve hours a day engaged in sedentary behaviour in addition to an average sleeping time of about eight hours. The remaining four to eight hours are spent in physical activity, predominantly of light intensity and, only to a small extent, of moderate to high intensity (Bauman et al., 2018; Fig. 4.2-3).

The intensity of physical activity in different areas of everyday life varies regionally as well as between population groups (for children, see Section 4.2.2.3):

The (*paid*) work of many people in high-income countries, and increasingly in low- and middle-income countries, is characterized by a high proportion of sedentary behaviour at the workplace (Bauman et al., 2018; Finger et al., 2017a) in a wide range of occupations from office workers to long-distance truck drivers. In sub-Saharan Africa, some women's activities in particular, such as selling merchandise at local markets, are associated with long periods of sitting (Yiga et al., 2020). For people with a lower level of education and lower socio-economic status, gainful employment is, however, also often characterized by physically demanding, active jobs (e.g. factory workers, craftsmen/women, smallholders). In low-income countries, most moderate physical activity takes place in paid work and in the household (Strain et al., 2020). However, physical activity in the context of gainful employment can also have negative health consequences depending on the activity and working conditions (Cillekens et al., 2020). In sedentary jobs, regular changes, e.g. to standing positions, and sufficient activity breaks are important (baua, 2011). Even if the potential for more intense physical activity is mostly limited here, it can at least reduce the negative consequences of sedentary behaviour and have positive effects on the well-being of the individual. Employers, trade unions and employers' liability insurance associations, as well as legislators where appropriate, have a special responsibility to create healthy workplaces and working conditions. Companies can and should also exert influence on their suppliers (Section 7.6.2).

In most private *households*, technical devices have reduced the overall amount of work and thus also physical activity. This has relieved the burden on women in particular, and in some cases on children, and e.g. made gainful employment or education possible. The potential for more physical activity must therefore be seen in the context of these areas of life; it varies regionally and individually. The environmental relevance here is rather low, but activities such as gardening can improve mental health through contact with nature (Bratman et al., 2019) and can enhance the relationship between humans and nature.

In high-income countries, a large proportion of physical activity now takes place during *leisure time* (28% of moderate or high intensity physical activity; Strain

et al., 2020). Here, people whose work is not predominantly physical but who are physically active to the recommended extent often achieve this primarily with sport (European Commission, 2018a; Repenning et al., 2020). People with higher educational and socio-economic status are more often active in sports in their leisure time (O'Donoghue et al., 2018), while sedentary activities such as screen media consumption take up a larger proportion of leisure time among people with lower educational and socio-economic status (Bauman et al., 2018). In Germany, for example, only 34% of people (aged 16 and over) do enough sport to meet the WHO recommendations on endurance activities. Overall, these recommendations are carried out by 46% of adults; 29% achieve the muscle strengthening recommendations and only 22% meet both (Repenning et al., 2020; Finger et al., 2017b). Across the EU, too, sport or regular moderate physical activity is only practised by about half the people, mainly by younger people with higher educational status and no financial difficulties; lack of time is most frequently cited as the main obstacle (European Commission, 2018a). Women are less physically active than men in most countries, especially during leisure time, e.g. because of a lack of safe environments or due to cultural norms (Guthold et al., 2018; Section 4.2.2.2). In sub-Saharan Africa, financial constraints and long working hours are common barriers to physical activity for women (Yiga et al., 2020). Older people are also much less active (Sallis et al., 2016a), whereby, in addition to personal factors, the attractiveness and accessibility of the surroundings play an important role (Chastin et al., 2015). An exception is China, where an overall increase in leisure-time physical activity is associated with increased activity among the rapidly growing elderly population (Guthold et al., 2018). Thus, although sport contributes substantially to regular physical activity levels for those willing and able to practise it, sport and recreational activities, especially in nature, can and should play an even greater role. To achieve this, sport would have to be designed in an environment-friendly and climate-adapted way (Box 4.2-3), and safe, attractive places, green spaces and facilities for sport and leisure activities within walking distance would have to be created for all population groups (Sallis et al., 2016a, b; Bonaccorsi et al., 2020). However, this alone is unlikely to compensate for the lack of physical activity in the population as a whole in all areas.

Thus, *mobility* is of key importance both for healthy physical activity and for the environment (Section 4.2.1). Mobility is not the area where the most activity has been lost in absolute terms (Ng and Popkin, 2012) – but active mobility on foot or by bicycle offers an opportunity to integrate much more physical exercise into everyday life with relatively little individual effort. Physical inactivity

Box 4.2-3

Need to take action in sport in times of climate change

Compared to the numerous positive effects of sport on human health, the risks to which athletes have always been exposed – e.g. through injuries – play a subordinate role from a population perspective. However, sports organizations should focus more on the health impacts of climate change on athletes, e.g. via thermal stress, extreme weather, UV exposure and air pollutants (Schneider and Mücke, 2021; Schneider et al., 2022). Possible adaptation measures relate to sports facilities, times

of day and seasons of events, coach education and personal measures, e.g. through cooling (Schneider et al., 2022). Germany's Ministry of the Environment has funded a first cross-sport project that gives sports clubs assistance regarding climate adaptation (BMUV, 2023).

However, sport, especially at large events, in turn also interferes with natural habitats and can generate considerable traffic and energy consumption. This should be addressed e.g. by building multifunctional, low-energy sports facilities and by avoiding travel-related CO₂ emissions (Abu-Omar et al., 2020). Apart from isolated concepts (e.g. DOSB, 2023), this responsibility has not yet been at all sufficiently taken on by clubs, or by national and, above all, international associations.

at work, at school or at home can be offset in this way with large synergies between achieving goals in the fields of health, environmental and climate (Hamilton et al., 2021; Jaramillo et al., 2022; Flint et al., 2016; Stevenson et al., 2016; Guthold et al., 2018; WHO, 2018d). Therefore, in addition to reducing emissions and increasing efficiency, a significant increase in active mobility should become a further goal of the necessary mobility transition. However, it can only be achieved with systemic approaches and bundles of measures to change mobility behaviour as a whole (Section 4.2.4.2; Jaramillo et al., 2022; Giles-Corti et al., 2016, 2022a, b).

4.2.2.2

External conditions play a key role for physical activity and mobility behaviour

In addition to individual factors such as age, gender, educational and socio-economic status, a significant influence on physical activity, sedentary and mobility behaviour is also exerted by social, cultural and environmental factors such as the built and natural environment, supply and cost structures (Fig. 4.2-3, 4.2-4; Sallis et al., 2006; Bonaccorsi et al., 2020; Jaramillo et al., 2022).

At the social and cultural level, e.g. marital status and the number of children, social norms are also relevant – for example, adults with several children show less sedentary behaviour overall, but sit longer during transports (O'Donoghue et al., 2016). Cultural values and gender stereotypes can be important barriers to physical activity, e.g. the perception among women in some countries of sub-Saharan Africa that physical activity is not feminine and prevents prestigious weight gain – as well as a restriction to domestic activities (Yiga et al., 2020). Fear of violence also inhibits outdoor physical activity, and walking is often perceived as a sign of poverty (Yiga et al., 2020).

When it comes to mobility, apart from individual factors (level of information, personal values and norms, perceived freedom about transport decisions), a switch

to exercise- and environment-friendly mobility is also influenced by the mobility behaviour of other people (descriptive social norms), especially if this is accompanied by a perception of corresponding normative attitudes on the part of others (injunctive norms). The overall effect of individual and social factors is, however, limited compared to the influence of the infrastructure (Fig. 4.2-5; Javaid et al., 2020).

General external conditions such as price structures or the built and natural environment have a significant influence on activity and sedentary behaviour. Important factors include the availability and design of public spaces (including nature and sports facilities), the accessibility of the most important everyday destinations using different modes of transport and their attractiveness (time required, costs, safety vis-a-vis traffic accidents and crime, comfort and convenience, etc.) as well as local weather conditions (Turrisi et al., 2021; Bonaccorsi et al., 2020).

The availability of attractive, green recreational and leisure areas in public spaces as well as easily accessible sports facilities can lead to more physical activity and less sitting time (Bonaccorsi et al., 2020; Sallis et al., 2016b). This is especially important for girls, women, older people, disadvantaged groups and people with disabilities or chronic illnesses, who in many countries lack safe, affordable and appropriate programmes and venues for physical activity (WHO, 2018d).

Infrastructure factors such as safe walking and cycling paths, but also the density of destinations and intersections, have considerable influence on the means of transport chosen (Javaid et al., 2020; Ewing and Cervero, 2010, 2017; Stevens, 2017; Aston et al., 2021; Fig. 4.2-5) and physical activity (Sallis et al., 2016b). Inadequate, missing or unsafe infrastructure for pedestrians and cyclists, as well as a lack of public transport services often limit freedom of choice and attractiveness. Motorized private transport, on the other hand, is usually promoted both financially and in terms of

urban development, for example through subsidies on vehicle acquisition, fuels and taxes, parking spaces and the environmental and climate costs that are not priced in. This influences daily decisions which then become habits, medium-term purchases such as driving licences, cars, public-transport season tickets or bicycles, as well as long-term decisions on where to live, work and spend leisure time, and dissuades many people from choosing active means of transport (UNECE, 2021; for women in sub-Saharan Africa: Yiga et al., 2020). New shared-mobility offers, teleworking and online shopping increase the range of choice, but up to now have not had a major effect on mobility behaviour (Javaid et al., 2020; Creutzig et al., 2021).

Environmental conditions, above all heat – which is increasing as a result of climate change and is extremely exacerbated locally by dense building and land sealing – and air pollution, but also natural disasters, also have a negative impact on physical activity, with older people and people with chronic diseases or obesity being particularly affected (Bernard et al., 2021).

Overall, short distances to everyday destinations and safe and pleasant public spaces and infrastructures can promote physical activity in all societal groups if they are adapted to local conditions (Bonaccorsi et al., 2020).

4.2.2.3

The current lack of physical activity among children and adolescents reflects neither their natural urge to move nor their needs

Children and adolescents spend time in different social contexts (settings, living environments), e.g. in educational institutions such as day-care centres or schools but also in geographical settings such as city districts or neighbourhoods. These living environments – together with the family context of children and adolescents – in turn have a significant influence on their physical-activity and mobility behaviour, both during school and during leisure time.

Young children follow their natural urge to move

Physical activity is than an important means for children (and adults) to understand and be aware of themselves and their own bodies in the environment, and to communicate with others and with the environment. In addition to the development of e.g. linguistic and cognitive skills, the first years of every person's life are characterized by milestones in motor development. These include movement patterns such as crawling or walking that enable the child to move independently. Children aged three to six years spend much more time engaging in physical activity than older children and adolescents. Prolonged and uninterrupted sedentary behaviour is mainly limited to transport (in prams, cars or bicycle seats) and when

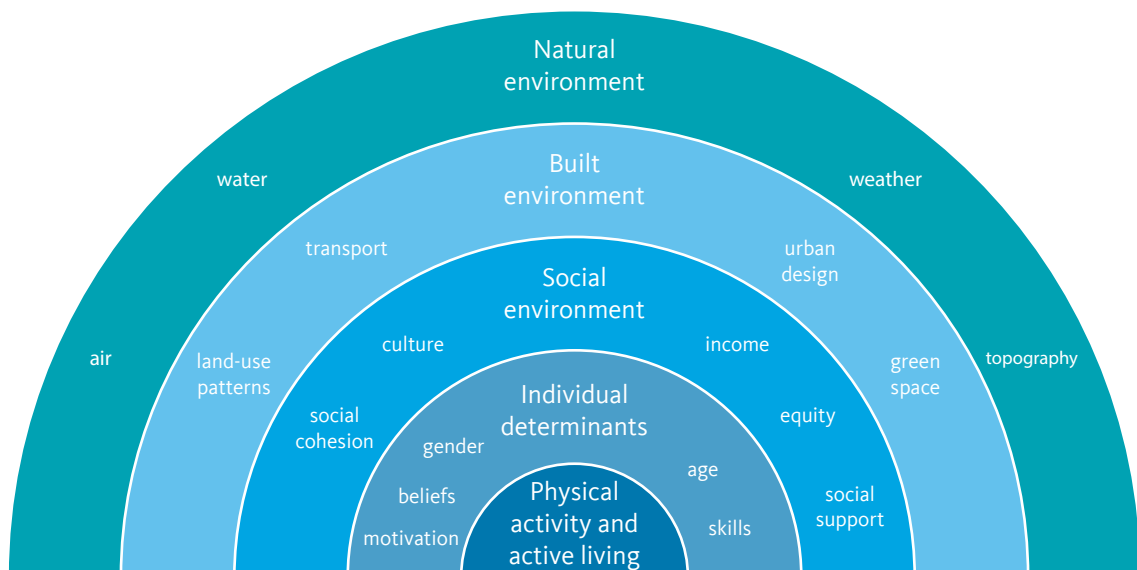


Figure 4.2-4

Factors influencing physical activity. Some further external economic factors such as prices are not shown here.

Source: Edwards and Tsouros, 2006

Box 4.2-4

Effects of digitalization on physical activity patterns

New virtual possibilities are changing physical-activity patterns and social interactions; in some cases they are replacing mobility, for example in the world of work. How can they be used in the long term for the benefit of health and the environment, and how big is the effect?

Digitalization is changing all areas of life (WBGU, 2019a), including the respective physical activity patterns. In work and education, sedentary (computer) work and work from home or telecommuting are on the increase, while automation in industry and, to some extent, also in craft trades is advancing. Household work is becoming more convenient through e-commerce and delivery services for groceries and food, through the digitalization of organizational tasks and household helpers such as vacuuming and mowing robots. New media offers and online games are influencing leisure-time behaviour. There are contrary effects on transport behaviour: teleworking and online mail ordering are making some relatively short, previously actively travelled routes superfluous, but also longer, sedentary and environmentally damaging car journeys can be dispensed with in some cases (Jaramillo et al., 2022: 1063), although this can also promote urban sprawl. Multimodal mobility as well as sharing and on-demand services become more attractive, which can promote public transport and the use of smaller vehicles such as bicycles, e-scooters or e-bikes and replace cars, but car sharing, ride-sharing and especially ride-hailing can come

at the expense of walking, cycling and public transport (SRU, 2020). The overall effect of the rapidly evolving systems is still unclear (Jaramillo et al., 2022: 1061). Another important trend is the increasing (technical) availability of highly automated and, in the foreseeable future, autonomous vehicles. These can have big effects on transport behaviour – from the choice of the means of transport to where to live and work – and thus on physical activity and accidents. They also influence transport's consumption of energy and resources – traffic can become more energy-efficient because it flows better; on the other hand it may increase in volume. Only through appropriate regulation can positive effects be bolstered and negative ones avoided (Milakis et al., 2017; Dean et al., 2019; Rojas-Rueda et al., 2020; SRU, 2020).

The transformation of physical-activity patterns as a result of new digital technologies and digitized services received a boost during the COVID-19 pandemic, especially in the fields of communication, virtualization and shopping behaviour, while physical-activity levels decreased and sedentary behaviour increased in all age groups (Stockwell et al., 2021; Runacres et al., 2021; Rivera et al., 2021). Even if some services are now being used less intensively again for the time being, the basic level of acceptance has increased and new habits have emerged. In addition, the pressure to improve digitalization, for example in public healthcare and basic infrastructure in low-income countries, has increased further. This makes it all the more important to give digitalization and especially new digitally based mobility options a direction through policy measures, so that digitalization serves the environment and health instead of harming them (WBGU, 2019a).

consuming screen media, and does not correspond to children's natural urge to move. Overall, children under school age usually have much more scope for movement than those of school age and older. Nevertheless, early-childhood education and care – in the family, in daycare centres or kindergartens – play an essential role in their physical-activity behaviour. They can provide an environment that is conducive to physical activity and thus foster health-promoting behaviour.

Schoolchildren spend too much time sitting

Sedentary behaviour increases significantly worldwide when children start school. On the one hand, this is due to everyday life at school, where children and adolescents spend a lot of time every day – and more than half of it sitting down (Kuzik et al., 2022; Egan et al., 2019). This means that around 40% of all sedentary behaviour in children and adolescents takes place at school on school days (Grao-Cruces et al., 2020). On the other hand, pupils spend a considerable percentage of their free time with homework and school-related screen-media consumption and thus again with sedentary behaviour: for 15-year-olds, the duration of homework varies between 30 minutes and two hours per day (Hynynen et al., 2016).

For children and adolescents, school is a key living environment in which their health and well-being can be positively influenced, e.g. by imparting health-relevant knowledge and skills (Section 7.1), but also by making the school itself health-promoting. The physical activity behaviour of children out of school, and that of their families and social environment, can also be influenced in this way. Recommendations for children and adolescents on school-related sedentary behaviour were published for the first time in 2022 in order to reduce the high level of sedentary behaviour in the school context. A healthy school day includes i.a. frequent breaks from long periods of sitting, and provides for more physical activity during homework time (Saunders et al., 2022).

Schoolchildren do not get enough exercise outside school either

Similarly, less and less physical activity and more sedentary behaviour is taking place in other living environments of children and adolescents – on the way to school and other routes, in leisure time and at home in the family environment. The roaming range is becoming smaller and smaller due to the lack of activity-friendly and safe environments (SRU, 2020; Pooley et al., 2005). Physical activity is often concentrated in organized recreational sports. Younger

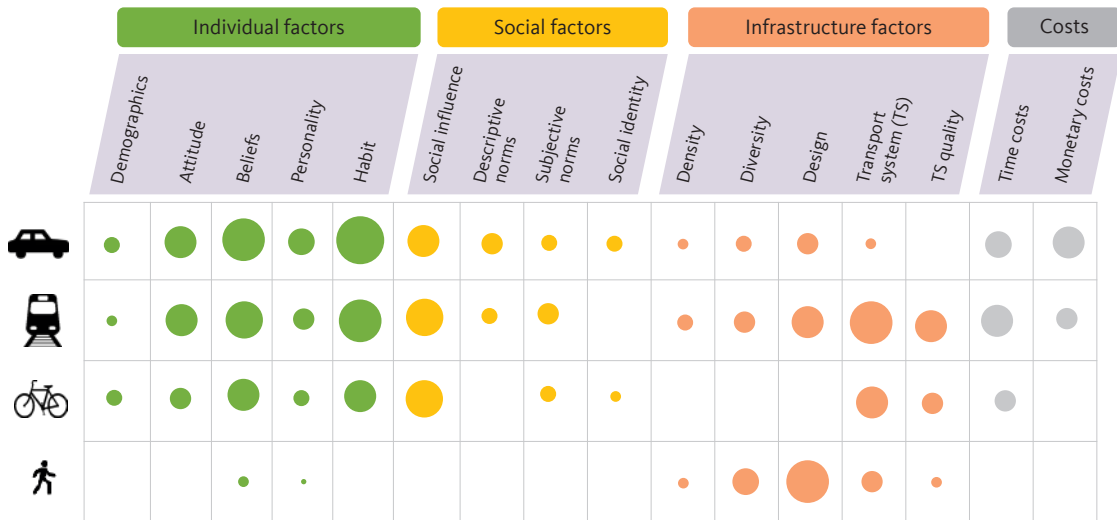


Figure 4.2-5

Importance of different determinants as regards individual transport choices, by means of transport (private car, public transport, bicycle or walking) and groups of determinants. The size of the circle represents the strength of the influence of the respective determinant on the decision to choose the respective means of transport (in five levels: very weak – weak – medium – strong – very strong). Empty fields indicate a lack of sufficient empirical evidence. Source: Javaid et al., 2020.

children in particular are often taken by car to school, to see friends or to leisure activities. Furthermore, sedentary activities during leisure time are also on the increase as a result of screen media consumption, e.g. video games and social media use (Box 4.2-5). This unfavourable trend towards more sedentary behaviour and less physical activity in this age group can be observed worldwide (Felez-Nobrega et al., 2020; Guthold et al., 2020).

To sum up, different spheres of life – school, family, residential environment – offer important starting points for multiple-benefit strategies that can create an activity-friendly environment for children and adolescents, and thus promote environment-friendly physical-activity behaviour from an early age.

4.2.3 Reintegration of physical activity into all areas of everyday life: vision and strategy

The prerequisite for a fundamental change towards more physical activity in everyday life (Fig. 4.2-6) is that external conditions and opportunities make health- and environment-friendly behaviour attractive for everyone, or even make it possible in the first place. In analogy to the Planetary Health Diet (Willett et al., 2019), ‘planetary health activity patterns and environments’ are conceivable as a vision. This vision has the following core characteristics:

- *Activity-conscious society:* The many different functions of physical activity are explicitly taken into account in all areas of everyday life and society – in addition to physical work or mobility. It is seen as a basic physiological need, a prerequisite for individual well-being, social interactions, experiencing nature and many pleasure-giving activities. This contributes to individual and societal well-being, health promotion and disease prevention from childhood onwards.
- *Healthy exercise integrated into everyday life:* Every person has attractive opportunities and incentives to integrate sufficient exercise into their everyday life, to reduce prolonged sitting and to get adequate and regular sleep (according to the WHO’s recommendations: Box 4.2-1; Fig. 4.2-3b). Individually, sufficient physical activity is distributed across different areas of everyday life (gainful employment or school, household, transport, leisure time) depending on preferences, occupational and life situation, and local or regional conditions – but in each area there are corresponding opportunities for everyone, some of which are coordinated and interact with each other. Examples include regular opportunities for breaks and physical activity, as well as bicycle-parking facilities and changing rooms at the workplace; opportunities for exercise during school breaks; accessible shopping facilities within walking distance and green spaces with many different opportunities for physical activity; attractive, high-quality public spaces, and

Box 4.2-5**Children and screen media: green time and physical activity as a counter-balance to screen time**

Although children and adolescents can benefit from using screen media, these media pose a number of risks and can lead to more sedentary behaviour. On a positive note, school lessons can be made more interactive and interesting by using computers, tablets or laptops. E-learning enables children and adolescents to acquire knowledge independently and in a self-determined way. In social networks they can establish and maintain contacts with people from different cultures and societal classes. But children and adolescents are spending more and more time with screen media (smartphones, tablets, laptops, computers, TVs, etc.) and are getting less and less exercise. This trend became especially evident during the pandemic with the increased use of digital learning instead of face-to-face teaching, and the necessary abandonment of many personal contacts and leisure activities. Long screen times pose risks for children and adolescents in particular because of their incomplete physical, cognitive, social and emotional development (Domingues-Montanari, 2017), especially if this is linked to too little physical activity (Oswald et al., 2020; Page et al., 2010). The following section focuses on these risks.

On average, children and adolescents spent 4.1 hours a day using digital media during the pandemic, almost 1.5 hours more than before the pandemic (Madigan et al., 2022). Long screen time is associated with a number of negative effects on the development of children and adolescents (Madigan et al., 2019; Radesky and Christakis, 2016). For example, studies show a connection with a generally reduced sense of well-being and with depression (Liu et al., 2016; Trott et al., 2022), with physical problems such as sleep disorders (Calamaro et al., 2012; Martin et al., 2021) or weight problems (Fang et al., 2019; Wijga et al., 2010). Socio-emotional problems (Page et al., 2010) and cognitive impairments such as attention deficit hyperactivity disorder (ADHD; Nikkelen et al., 2014) and reduced language competence (Madigan et al., 2020) are also associated with excessive media consumption. The use of digital media can induce addictive behaviour in children as young as ten (Schulz van Endert, 2021). Studies see this as being connected with psychological and behavioural disorders (Cho and Lee, 2017; Sahu et al., 2019). Children from families

with a low socio-economic status seem to be particularly at risk from the trend towards more screen time. They spend more time with screen media and use apps with more manipulative designs (Radesky et al., 2022).

When children and adolescents spend a lot of time on social media, this not only poses health risks due to long screen times as such but also because of the content consumed. Anti-social behaviour in social networks poses a serious risk, especially for mental health. One example is cyberbullying. Victims of cyberbullying show an increased tendency to depression and substance abuse, even suicidal thoughts (Kowalski et al., 2014). Recent research suggests that not only victims but also witnesses of cyberbullying suffer (Doumas and Midgett, 2021; Wright et al., 2018). There is also the question of how best to protect children and adolescents from pornographic content and the risk of becoming victims of sex offenders online.

By contrast, studies show that time spent outdoors and in nature – also referred to as ‘green time’ (Oswald et al., 2020) – can have a positive effect on the physical and mental health of children and adolescents (Oswald et al., 2020; Jackson et al., 2021; McCurdy et al., 2010; Tillmann et al., 2018; Tremblay et al., 2015; Dadvand et al., 2019), partly because children and adolescents are more active when they are outdoors (Gray et al., 2015; Raustorp et al., 2012; Skala et al., 2012; Vanderloo et al., 2013; Tremblay et al., 2015). Green time can even counteract the health risks of too much screen time, according to new findings (Oswald et al., 2020). However, most children and adolescents do not get enough exercise (Section 4.2.1.1). Especially during the pandemic, physical activity among children and adolescents decreased by about 20% on average (Neville et al., 2022). Children and adolescents also spent less time outdoors and in nature (Larson et al., 2019).

One recommendation in particular follows from these observations in order to achieve a healthy use of digital media by children and adolescents: parents should limit screen time and encourage screen-free time and physical activity (Madigan et al., 2022; WHO, 2020a), preferably outdoors and in nature. Policy-makers can also support a trend reversal towards less screen time and more physical activity, e.g. in the way everyday school life is designed.

Parents, guardians and political decision-makers should also ensure that children and adolescents use age-appropriate apps and platforms, and that their media skills are honed from kindergarten age onwards.

Source: Based on Krasnova et al., 2023

safe places and facilities where girls and women can practise sport.

- *Environment-friendly physical activity, especially in mobility:* Physical activity can replace many technical devices, primarily in transport. The environment and the climate (and thus everyone) benefit from the reduced consumption of resources, energy and land, and from lower emissions of pollutants, greenhouse gases and noise. Active mobility has great potential for integrating a lot more physical activity into everyday life with relatively little effort: walking and cycling, supplemented by public transport especially on long distances, replace many car journeys, form an

important ‘foundation’ of light, moderate or intense physical activity for many people, and provide contact with the natural environment.

- *Activity-friendly physical and social environment:* Health- and environment-friendly physical-activity patterns, mobility habits and, in the long term, social norms are shaped by external overall conditions such as the natural and built environment (spatial distribution and quality of living, working, leisure and natural areas, as well as public spaces and infrastructures), regulations, economic incentives (including tax and levy systems, pricing of external costs and subsidy reforms, support programmes), and a targeted use of

technologies (digitalization, electrification) – even under challenging environmental conditions (e.g. heat stress, air pollution, pandemics). They create safe, inclusive and near-natural spaces where all population and age groups enjoy moving around. They make personal and social costs transparent or price them into individual decisions, and make physically active mobility the easiest, cheapest, fastest and safest option. The design of exercising and mobility facilities takes into account economic, social and psychological aspects (e.g. the role of social norms and the effects of status and habit in transport) as well as the respective cultural environment.

4.2.4 Overarching approaches for an activity-friendly environment and environment-friendly activity

To implement the above vision (Section 4.2.3), the WBGU recommends three interlinked approaches. Sufficient physical activity is achieved across different areas of everyday life and in their interactions. Therefore, *firstly*, cross-cutting strategies are needed that embed and coordinate contributions to the environment- and climate-friendly promotion of physical activity into several crucial policy areas in a binding way. *Secondly*, this should trigger the creation of real choices and improved overall conditions in all areas of everyday life, making personal and social costs transparent, and healthy, environment-friendly options attractive to everyone. This is illustrated by the transport sector, which is equally important for the environment and health. *Thirdly*, the design of public spaces and infrastructures should place the needs of children and adolescents at the centre of attention, as this leads to activity-friendly living spaces *for all* and ideally combines contributions to environmental, climate and health goals. Concrete recommendations for action and research on the three approaches follow in Sections 4.2.5 and 4.2.6.

4.2.4.1 Cross-cutting strategy for environment-friendly physical-activity promotion in all sectors and across levels of governance

In the health sector, there are already many political goals, strategies and measures on physical activity at different levels; the same applies in the environment and climate sector with regard to active transport, climate-sensitive urban redevelopment, etc. However, in order to increase their effectiveness, they should be more closely interlinked and address individual, socio-cultural and environmental factors (Section 4.2.2) equally.

In the promotion of physical activity, there is a lack of cross-sectoral cooperation particularly for structural prevention

To combat physical inactivity, the WHO's Global Action Plan on Physical Activity (GAPPA for short; WHO, 2018d; Box 4.2-1) is an international programme that already links physical-activity promotion well with environmental, climate and sustainability agendas. It contains a quantified target, namely the reduction of physical inactivity by 15% by 2030 compared to 2010, as well as all important implementation aspects – including the promotion of active mobility through appropriate infrastructure. With a local focus and special emphasis on active mobility, which offers considerable accompanying benefits for environmental and climate goals, the plan should be implemented comprehensively and at all levels in each country.

To this end, a large number of programmes specifically aimed at promoting physical activity or combating non-communicable diseases can be linked, especially at the regional and national level, e.g. the EU strategy on health issues related to nutrition, overweight and obesity (European Commission, 2007), on which the Council of the EU adopted conclusions in 2014 and 2020 with a focus on sport (Council of the European Union, 2014, 2020). In 2015, 80% of countries had physical-activity-promotion plans (Sallis et al., 2016a), strategies explicitly targeting sedentary behaviour are less common (Klepac Pogrmilovic et al., 2020). Examples include the IN FORM initiative in Germany (BMEL and BMG, 2008), the national physical activity action plans of Ireland and Kenya (Healthy Ireland, 2022 and Ministry of Health, 2018, respectively), or the more specific 'Sport 2030' and 'Girls make your move' programmes in Australia (Australian Government, 2018a, b). However, in many cases these have yet to be implemented (only 56% were in the process of implementation, Sallis et al., 2016a) or significantly developed in the face of almost unchanged or deteriorating indicators on physical activity (Section 4.2.1 and 4.2.2). This is also true in high-income countries (including Germany, Niestroj et al., 2019), which actually experienced the biggest increase in physical inactivity between 2001 and 2016 in a global comparison (Guthold et al., 2018; Section 4.2.1), although they generally already have comparatively well-developed strategies (Klepac Pogrmilovic et al., 2020).

At sub-national levels, physical inactivity is generally addressed as part of broader strategies. For example, in the Shanghai Declaration on Healthy Cities (WHO, 2017b), over a hundred cities committed to, among other things, "[promoting] sustainable urban mobility, walking and physical activity through attractive and green neighbourhoods, active transport infrastructure, strong road safety laws and accessible play and leisure facilities".

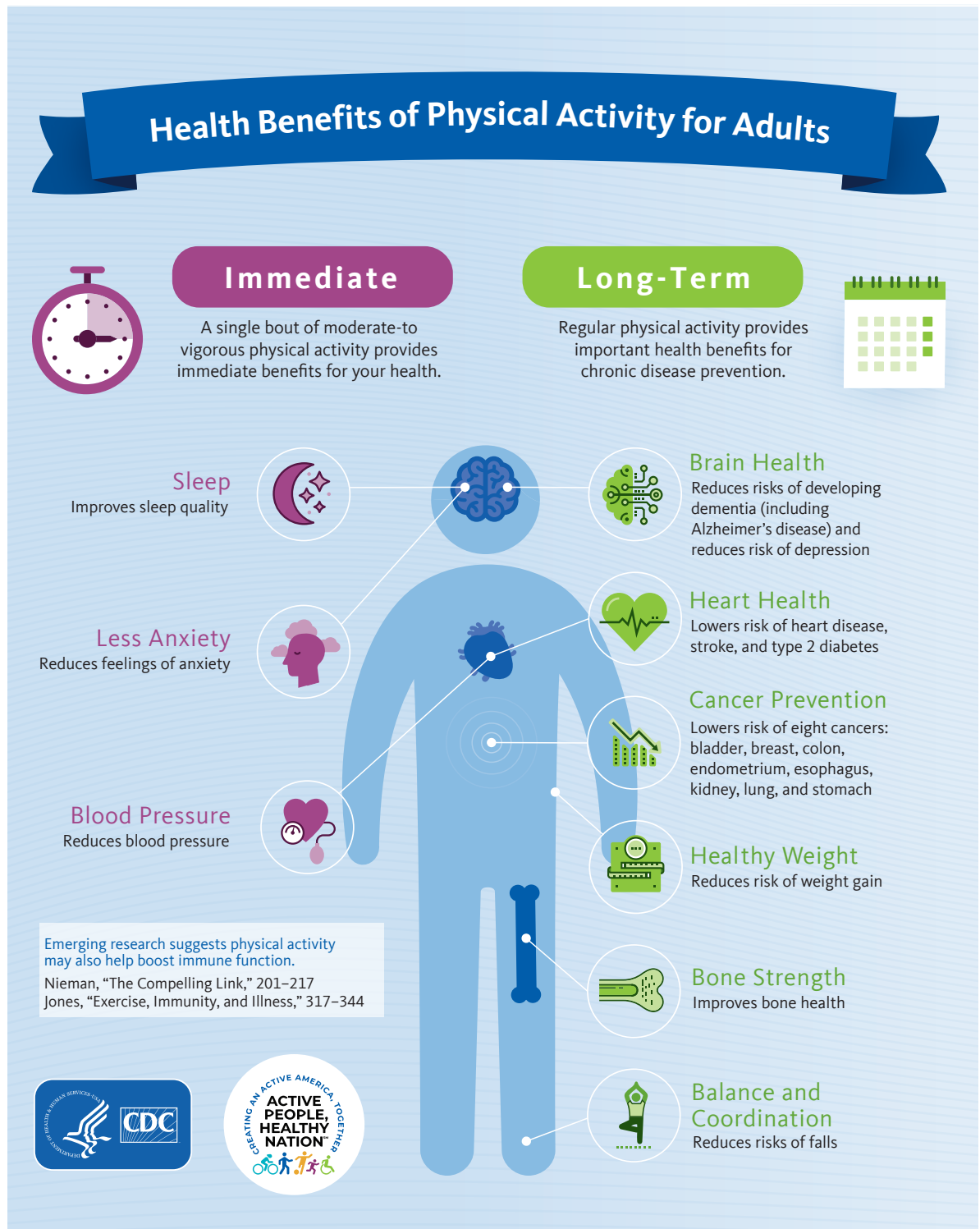


Figure 4.2-6
Benefits of physical activity for health and well-being.
Source: CDC, 2020

This is also relevant, for example, for the European Commission's '(2021k) Mission for 100 Climate Neutral and Smart Cities by 2030' and the 'Urban Transitions Mission'

of the Global Covenant of Mayors for Climate & Energy (2022), which is similar in content but global in scope.

The following obstacles and constraints are common at the national level:

- › *monitoring of physical activity and sedentary behaviour and their determinants in different everyday settings* that could inform agenda-setting and policy design, especially in low- and middle-income countries (Sallis et al., 2016a; Reis et al., 2016; Pratt et al., 2015; Gelius et al., 2021).
 - › *No quantified targets:* For example, of 76 countries studied by Klepac Pogrmilovic et al (2020), 92 % had policy documents on physical activity and 62 % on sedentary behaviour, but only 52 % and 11 %, respectively, had formulated corresponding quantified national targets, and the policies were not being sufficiently implemented in most countries.
 - › *Lack of cross-sectoral/cross-departmental implementation and structural prevention:* Current strategies to promote physical activity, such as the GAPP, aim to appeal to all areas of life, and to address not only individual behaviour but also fundamental changes in external and overall conditions, which require relatively large-scale efforts in the relevant sectors or departments. In many countries, several government departments are committed to promoting physical activity in joint or separate strategies and policy documents. However, substantive implementation, e.g. in the form of laws or comprehensive, well-funded programmes, is only taking place in a few departments – e.g. in EU countries mainly in health, sport and education; there is a backlog in the transport, urban planning and environmental sectors (Bull et al., 2015; Breda et al., 2018; Gelius et al., 2021; Klepac Pogrmilovic et al., 2020). However, it is precisely in spatial and urban planning and transport policy that essential levers for (re)designing living environments lie (Section 4.2.4.2); these cannot be replaced e.g. by information campaigns from the health sector or sports promotion (Section 4.2.2). Implementation partnerships that go beyond the health sector and jointly identify and address the most important areas and (especially structural-prevention) levers – and provide the corresponding funds – are therefore an essential success factor for the promotion of physical activity (Reis et al., 2016; Sallis et al., 2016a; Pratt et al., 2015; Niestroj et al., 2019). For example, only the German federal ministries BMG and BMEL (for healthy nutrition) are involved in the German IN FORM strategy. To ensure that all areas of life are addressed, the BMDV (transport), BMI (sport), BMAS (workplaces, programmes tailored to specific social groups), BMBF, BMFSFJ (schools, families, senior citizens) as well as BMUV and BMWWSB (green and blue spaces, urban development) should also be involved in promoting physical activity, which has been neglected in the programme up to now (Niestroj et al., 2019).
 - › *Lack of coordination:* Structures for coordinating strategies and measures for knowledge building and exchanging experience are often too weak and are consolidated too late or not at all. In addition, a lack of resources and funding often hinders implementation at the national level (Reis et al., 2016; Pratt et al., 2015; Niestroj et al., 2019).
 - › *Missing or inadequate evaluation of strategies and measures, no feedback on results* (Reis et al., 2016; Gelius et al., 2021; Niestroj et al., 2019): Since measures are often not implemented in isolation but in packages and are influenced by complex local and national circumstances (Gelius et al., 2020), quantitative impact comparisons are difficult and any transfer to other contexts always involves an adjustment phase. However, in order to choose good starting points and to learn quickly, it is essential to have regular evaluations planned from the outset (e.g. of data collection, communication and participation strategies), systematic feedback of findings and their availability to others in the selection, further development and scaling of measures and strategies.
 - › *Little capacity:* In the promotion of physical activity and public health, there is a lack of qualified personnel, technologies, structures and funding for monitoring, research and implementation, especially in low- and middle-income countries (Reis et al., 2016; Sallis et al., 2016a). There is too little planning or implementation capacity in offices and municipalities for designing activity-friendly urban spaces and infrastructures (Jáuregui et al., 2021).
- The problems involved in implementing the promotion of physical activity at the municipal level are often analogous to those encountered by national programmes (Lowe et al., 2022): declarations of intent in strategy papers are not backed up by measurable targets; funds and skills for implementation are either not provided or do not exist (especially in low- and middle-income countries); the promotion of health and physical activity are insufficiently taken into account in urban planning and transport policy (e.g. decisions are made without making a prior health- and environmental-impact assessment; no mandatory requirements on the density and quality of environments and infrastructures that encourage physical activity); policies are sometimes even undermined (e.g. by building more roads and parking spaces). Moreover, there are often problems with the division of competences between the different levels of government, sometimes leading to inconsistent goals and measures and unclear political responsibilities (Jáuregui et al., 2021).
- On the other hand, the promotion of physical activity and its possible synergies with environmental protection and climate-change mitigation are still neglected in the

relevant sectors and policy fields such as transport and mobility policy and urban planning (Section 4.2.4.2).

Combining forces by means of common goals and a cross-cutting strategy

The insufficient coordination of strategies on the promotion of physical activity, transport policy and urban planning means that strengths (such as the focus on individuals and their motivation or on overall conditions) cannot be augmented and forces cannot be bundled. Multiple-benefit strategies should focus on increasing physical activity in all areas of daily life, especially in transport. In addition to the existing behavioural and technological measures in health and transport strategies, this requires a joint effort to fundamentally change conditions, i.e. infrastructures, public spaces and facilities for physical activity, price structures and regulations (Section 4.2.4.2; on living environments and public spaces, see Section 4.3). National strategies to promote physical activity should take on a cross-cutting function here by defining overarching, quantified goals and approaches, making contributions from different policy areas (Section 7.1.3.2) mandatory and tracking them (in a similar way to the German Climate Protection Act, which establishes a joint strategy with clear allocations of responsibility and follow-up mechanisms), and embedding sub-national activities.

For this reason, and with a view to the problems of promoting physical activity identified above, the WBGU proposes (in Section 4.2.5) eight priorities for cross-cutting strategies aimed at the integrated, environmentally aware promotion of physical activity, and groups them under the acronym E-MOTION^{kids}. Similarly, Wen and Wu (2012) have made a proposal for promoting physical activity that is similar to the 'MPOWER' initiative (WHO, 2008) for tobacco.

In parallel, a comprehensive research programme on the interaction of physical activity, environmental protection and climate-change mitigation should be initiated (as already exists for nutrition with the EAT-Lancet Commission on Food, Planet, Health; Section 4.2.6).

4.2.4.2 Activity-friendly conditions for the mobility transition

Reintegrating physical activity into all areas of everyday life has great benefits for health, and – especially in the case of transport – also for the environment, climate and quality of life. However, the functions of and demands on transport systems are diverse, and individual mobility behaviour is dependent in a complex way on individual and social factors and, in particular, on external circumstances (Section 4.2.2.2). To make fundamental improvements in the mobility sector, the WBGU therefore

recommends a systemic approach that aims equally at health promotion through active mobility, at emissions reductions, and at greater efficiency in energy, resource and land use, and focuses in particular on solutions that contribute to all three goals. In the following, we will first outline such a target vision and then go into important implementation aspects and options for the actual measures.

Think about mobility systems from the point of view of active mobility

Redesigned or new mobility systems should be active, efficient and emission-free or low-emission for reasons of health, climate and the environment. One possible solution combines walking and cycling with shared, improved means of transport (Fig. 4.2-7):

1. *As far as practicable, it should be possible to get around actively, i.e. on foot or by bicycle – for longer distances, hilly terrain and heavy loads, perhaps with e-bikes and cargo bikes.* This is healthy for the individual, locally emission-free and minimizes space, material and energy requirements (central overlapping area in Fig. 4.2-7). In order for this to be attractive, safe and suitable for everyday use for as many people and routes as possible, settlements and cities should be compact ('15-minute city'; Section 4.3.3.3); footpath and cycle-path networks should be comprehensive, attractive and safe without gaps (Zukowska et al., 2022; Mölenberg et al., 2019; Panter et al., 2019; Stappers et al., 2018), also for unaccompanied children, older people and women. They should also be subjectively perceived as safe; e.g. minimum distance between cycle paths and car traffic is often particularly important to women (Aldred et al., 2017). Other vehicles must not endanger cyclists and should therefore be as small and light as possible, their speed should be limited, and they should be low-emission (Section 4.2.1.4).
2. *Efficient use of scarce space, energy and materials in urban planning, infrastructure and vehicles* (lower circle in Fig. 4.2-7) to further reduce the impact of transport on climate and environment. Motorized means of transport are needed for distances that are too far for active travel, for transporting heavier loads and for people with mobility impairments. To maximize efficiency, such means of transport should be shared as much as possible so that fewer vehicles are needed, they are as near capacity as possible on each trip, and are adapted in size to the respective transport purpose. This requires networked, comprehensive public mobility services: above all, public (local) passenger transport, which is essential for people with low incomes and without cars, and should be affordable (WBGU, 2016; WHO, 2010:111). Where

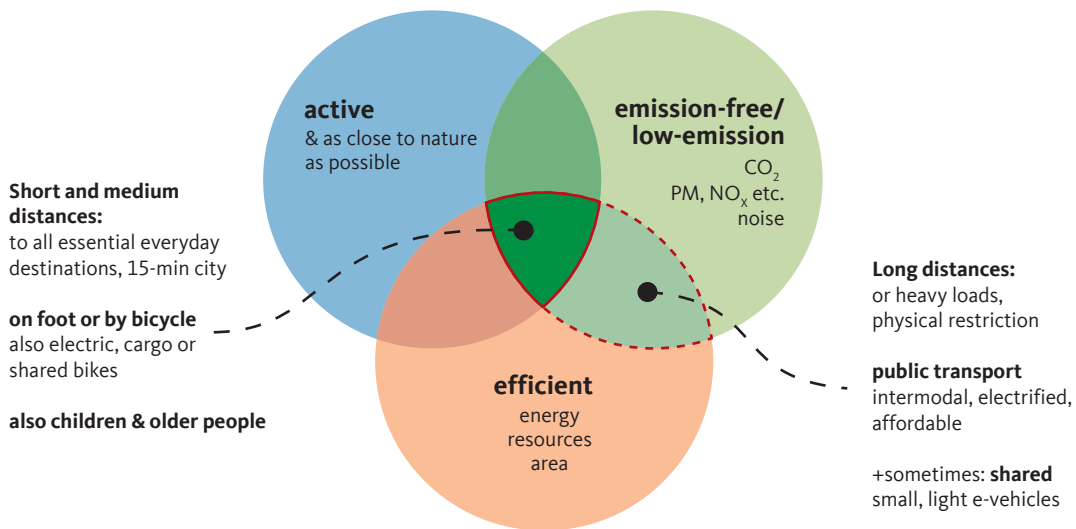


Figure 4.2-7

Three requirements for healthy, environment- and climate-friendly transport systems (in this case only passenger transport) and their possible implementation on short and long routes. Outside the overlap areas are approaches that contribute to only one of the objectives – e.g. private electric cars (low emissions, but passive and not efficient with their usual design, size, motorization and use) or public buses powered by combustion engines (greenhouse-gas emissions, no physical activity except for the access route).

Source: WBGU

the population density is lower, this can be supplemented on shorter routes by ride-pooling services using smaller call-buses (Tikoudis et al., 2021), as well as various vehicle-sharing services (bicycles, cargo bikes, small cars and commercial vehicles). However, additional measures may be necessary to ensure that the services actually replace private cars and their journeys and do not, for example, replace bicycle journeys.

3. *Lower emissions*: Finally, all remaining motorized vehicles should be emission-free or low-emission (top right circle in Fig. 4.2-7), i.e. electrified as a rule ('energy transition in transport': Agora Verkehrswende, 2017) to reduce greenhouse-gas emissions, local air pollution and noise, and to increase energy efficiency.

Complement improvements in vehicles with a fundamental mobility transition

Current attempts at reform in transport and mobility policy focus on emission reductions; efficiency in terms of energy, materials and land, as well as the health impact of physical activity (and their synergies with emission reduction and efficiency) have been neglected up to now. The urgently needed reduction of greenhouse-gas emissions in transport (Section 4.2.1) has hitherto been pursued primarily by making technical changes to vehicles

and engines (e.g. by using alternative *propulsion* systems), or with corresponding regulations and financial incentives; e.g. electric cars are an important strategy for avoiding emissions (Jaramillo et al., 2022; Creutzig et al., 2016, 2022; Pojani and Stead, 2015). However, although the market share of electric vehicles is growing, especially in China, the EU and the USA (Paoli and Gül, 2022), greenhouse-gas emissions from road transport continue to rise because there are more cars and traffic, engine performance is higher and vehicles are heavier (Jaramillo et al., 2022). Local air pollution, especially from particulate matter, the number of pedestrians, cyclists and motorcyclists killed in traffic, and the pollution and economic damage caused by traffic jams remain high (European Commission, 2021i; Section 4.2.1).

Therefore, on the one hand, efforts to improve vehicles must be intensified and, for example in Germany, rebound effects in vehicles, mileages and the fossil vehicle fleet must be reduced (ERK, 2022). On the other hand, fundamental changes in mobility behaviour should make a significant contribution to rapid emission reductions in the future (Jaramillo et al., 2022). For example, greenhouse-gas emissions from land transport could be cut by about a quarter or, in the most optimistic case, by half by avoiding and shifting motorized road transport (Creutzig et al., 2021) – and conversely, more active

4 Shaping areas of life: what we eat, how we move, where we live

mobility and shared vehicle use could furthermore benefit health and reduce land and material consumption. This shift in focus is increasingly being reflected in urban and mobility models (UN, 2021c; WBGU, 2016a), e.g. by the WHO (2010), the European programme THE PEP (UNECE, 2022) and the German Federal Environment Agency (UBA, 2017b), as well as in transport strategies of the European Commission (2020h, 2021f), but has yet to be implemented at a national or municipal level.

Combine mobility-promoting and car-displacing measures in mobility strategies

Bringing about fundamental changes in mobility behaviour is complex and requires, above all, changes in external conditions (e.g. infrastructures) as part of long-term strategies that combine different measures.

Mobility behaviour and habits – daily destinations, choice of means of transport and routes as well as longer-term decisions such as vehicle purchases and place of residence – are shaped by external circumstances, personal and social aspects. The main influencing factors are spatial structures and distances, infrastructure and other built and natural environments, available vehicles or mobility services, prices, travel times and comfort, as well as individual knowledge, skills, habits, beliefs or peer-group effects, status needs and cultural norms (Javaid et al., 2020; Zukowska et al., 2022; Section 4.2.2.2). Many of these factors have developed together, are mutually dependent and are deeply embedded economically, politically and culturally (Mattioli et al., 2020; Urry, 2004). For example, vehicle fleets, infrastructure networks and spatial patterns function as a system, are expensive and time-consuming to construct and very long-lasting (Shalizi and Lecocq, 2009). Their conversion or adjusted construction, e.g. in cities that are still growing (WBGU, 2016) – and the possibly necessary early decommissioning of parts of the fossil-fuel-based vehicle fleet (Tong et al., 2019; ERK, 2022) – require robust coordination and reliable long-term investment signals.

Accordingly, *combinations of measures* are useful for changing mobility patterns (Jaramillo et al., 2022; Axsen et al., 2020); they should be embedded in *long-term mobility strategies* for all modes of transport at the national and sub-national level. This involves changes in urban planning and infrastructure measures, and requires various regulations, pricing instruments and information campaigns. In particular, active and shared mobility should be promoted across the board as an attractive alternative to the car; cars and car traffic should be made less attractive (pull and push instruments, respectively; Hrelja and Rye, 2022; SRU, 2020).

Such mobility strategies should integrate national mobility and climate policy with municipal planning and should be launched as soon as possible because of the sometimes long lead-in time and in order to avoid further lock-ins. In Europe, the ‘New European Framework for Urban Mobility’ (European Commission, 2021k) aims to place a greater responsibility on Member States and cities, among others. It calls for and supports the preparation of Sustainable Urban Mobility Plans (SUMP) for urban nodes of the trans-European transport network, focusing not only on the development of local public transport but also on active mobility (explicitly also for health reasons), micromobility and networked mobility services. However, the level of obligation or incentive should be stepped up, e.g. through funding conditions. Cities outside the defined nodes should be included.

To address political and societal barriers to implementation, firstly, the health benefits and *potential* for individual quality of life should be used and emphasized more strongly in national and municipal mobility strategies, and linkages with strategies to promote physical activity should be strengthened. Secondly, smart *sequencing* of measures in long-term mobility strategies is crucial for their success (Creutzig et al., 2022). For example, regulations, pricing and restrictions on car use should be tightened in parallel with the creation and improvement of alternatives. Thirdly, the strategy development should be transparent and involve a *broad participation* of actors, including those outside the car, fuel and road-construction industries.

Low-income countries need rapid support in strategy development and implementation to avoid lock-ins

The European Commission (2021k) would like to strengthen international cooperation in the field of urban mobility, e.g. with the Global Covenant of Mayors for Climate & Energy (2022), which is necessary in view of urban growth, especially in Africa and Asia (Section 4.3; Jaramillo et al., 2022). Overall, low- and middle-income countries should be comprehensively supported in the development of active, shared mobility – where appropriate, including locally produced electric bicycles or buses (Section 4.2.5.2).

Promote active mobility directly and indirectly: urban planning, infrastructure and public transport

The most important measures to promote more active mobility behaviour (Gelius et al., 2020; Zukowska et al., 2022; Jaramillo et al., 2022: 1058; Creutzig et al., 2022: 527; Creutzig et al., 2021; Pojani and Stead, 2015; Pucher and Buehler, 2008) include the development of compact, mixed cities in which, for example, as many everyday destinations as possible can be easily reached on foot or

by bicycle, the creation of safe, attractive public spaces and infrastructure, e.g. cycle tracks separated from car traffic, good footpaths and green spaces instead of heat islands (high level of ‘walkability’: Saelens et al., 2003 Cerin et al., 2006; Bonaccorsi et al., 2020), and, indirectly, the provision of comfortable, convenient and fast public transport which also requires some physical activity, making private cars unnecessary even for longer journeys (Morency et al., 2011).

Interventions in the work environment can also contribute to the *direct promotion of active mobility* (Petrunoff et al., 2016), e.g. secure bicycle-parking facilities and showers at the workplace to make cycling more attractive (Hamre and Buehler, 2014; Heinen and Buehler, 2019). Bicycle-sharing systems have increased bicycle use in cities in Brazil, Korea and China, for example, although they have not led to a reduction in car traffic (Pojani and Stead, 2015). Another option is the promotion of e-bikes (Pojani and Stead, 2015).

The use of *public transport* is influenced, among other things, by the accessibility of important destinations, the distance to the nearest bus stop, etc., prices and travel times (Taylor and Fink, 2013; Shen et al., 2016; Ewing and Cervero, 2017; Javaid et al., 2020). Moreover, integrated, multimodal planning and ticketing systems are important for many users (European Commission, 2020g). Apart from rail-based systems, buses on separate lanes are also efficient but cheaper and thus particularly relevant for cities in low- and middle-income countries, and especially for poorer people there (Pojani and Stead, 2015; Venter et al., 2018; Ingvarsson and Nielsen, 2018). In the local context, ride-pooling (on-call buses) and vehicle-sharing services can be integrated into local public transport; these can be quite convenient and efficient in the meantime with the help of digital communication tools and algorithms (Shaheen and Cohen, 2019). In the sense of the above guiding principle (Fig. 4.2-7), such systems are particularly useful for the ‘last mile’ in areas with a lower population density (Tikoudis et al., 2021) and for goods transport. Car sharing can indirectly increase the use of active and shared transport (Amatuni et al., 2020), e.g. if the availability of car sharing for occasional trips discourages a person from buying their own car (Nijland and van Meerkerk, 2017). However, it should be ensured that such services are used mainly instead of private cars and not instead of local public transport or active mobility (Becker et al., 2018). Where the population density is low, subsidies tied to availability and quality criteria can be necessary for local public transport and integrated local sharing systems, and may also make sense as part of the general provision of public services.

Improving active and public mobility options should be accompanied by intensive political communication and information campaigns on health and environmental impacts (Mulley and Ho, 2017), while positive personal attitudes should be promoted and societal norms, feasibility and the effectiveness of the measures should be emphasized (UBA, 2022b).

No longer put the use of cars at an advantage

Promoting active mobility is particularly effective in combination with measures that make car-use less attractive and prevent the costs from being passed on to other road users and the general public, making the active option the more pleasant and cheaper option for most journeys. Because of the various negative effects of car traffic on third parties, combinations of several measures are useful here, too:

- ▶ Pricing road use, parking and local emissions, especially in cities (Pojani and Stead, 2015; Creutzig et al., 2020), as well as pricing fuel, electricity consumption and greenhouse-gas emissions, in line with the actual societal costs – which has been avoided up to now for political reasons (Axsen et al., 2020) – or at least in line with the efficiency benefits.
- ▶ Reducing emissions and improving efficiency by means of regulations such as pollutant- or greenhouse-gas caps for vehicles, fleets or fuels (e.g. EU, California, Canada); mandatory sales quotas for ‘zero emission vehicles’ (some US states, China) up to a complete ban on registrations of new combustion engines (e.g. in the EU from 2035 onwards: Council of the European Union, 2022; in British Columbia by 2040: Axsen et al., 2020) and fuel efficiency standards (e.g. in the USA, China and Japan: Lipman, 2017). Regulations to date contain exceptions and loopholes in some cases; e.g. in the EU there are exemptions for heavier cars in the fleet-emissions targets, which should be gradually abolished (Axsen et al., 2020; SRU, 2017), and up to now there is no effective regulation of energy efficiency (including for electric cars), which should be added. Since company cars make up a large proportion of new cars – e.g. approx. 60% in Europe (Transport & Environment, 2023) – electrification and efficiency targets for company fleets may also be effective.
- ▶ Reducing tax benefits and subsidies on car purchase and use, including inefficient subsidies on the purchase of electric cars, and e.g. vehicle-related taxes staggered according to CO₂ emissions, efficiency and weight. Income-related per-capita payments and better public transport services (Creutzig et al., 2020) are suitable for the targeted social cushioning of higher prices.

4 Shaping areas of life: what we eat, how we move, where we live

- Redistribution of traffic and parking areas, changes in traffic rules and management, e.g. speed limits and traffic-light phases that are more pedestrian- and bicycle-friendly (Pucher and Buehler, 2008).
- Restrictions on routes accessible to vehicles, especially for through traffic, e.g. in residential areas (such as ‘superblocks’ in Barcelona and Vitoria-Gasteiz, Spain; car-free neighbourhoods or ‘Kiezblocks’ in Berlin) or between city districts. For example, since 1977, Groningen’s city centre has been divided into four sectors, each accessible to cars only from a ring road, while pedestrians and cyclists can take the direct, faster routes. Thanks to these and other measures such as cycle lanes, bicycle-parking facilities and traffic lights, cycling accounts for almost 60% of local trips there (Pucher and Buehler, 2007), and car traffic has been halved. Similar concepts were introduced in The Hague and Ghent in 2009 and 2017 respectively (Tsubohara, 2018; Engels, 2020).
- Protection of cyclists and pedestrians by traffic management, traffic installations, speed and weight limits and mandatory safety systems for cars and trucks, e.g. when turning or exceeding the speed limit.

Overall, these regulatory and pricing instruments make the use of private and shared cars less attractive than active transport, buses and trains. Nevertheless, where private cars continue to be used, the regulation and pricing of parking, as well as vehicle-related taxes have a greater impact on private vehicles than on ride- and car-sharing services, so that the latter can become better established as more attractive options and as business models. Furthermore, in areas with a high population and public-transport density, sharing services could be restricted to prevent shifts away from active mobility and local public transport (Tikoudis et al., 2021).

Address political-economic and societal barriers

Up to now, measures that could reduce preference for the car and thus significantly shift the relative attractiveness of transport options have been largely ignored – even where alternatives to the car are available. This is due to various political-economic and societal barriers that should be taken into account in the choice and sequence of measures, and then successively dismantled:

- Noticeable financial burdens on motorists via taxes and charges are considered *politically risky and difficult to communicate* (Axsen et al., 2020; Creutzig et al., 2020), e.g. because they are regarded primarily as a source of state revenue and their steering effect is not seen, or because of their expected distributional effects (Maestre-Andrés et al., 2019). Alternatively, regulations, e.g. traffic and access rules, and infrastructure measures with a steering effect rather than to satisfy demand, can initially be implemented.

- The automobile, oil and road-construction industries, whose business models are based on the sale and use of as many and as large vehicles as possible, have considerable economic weight and *political power* in many countries. They are still partly seen as key industries of a growth-oriented economic policy and are particularly promoted (Mattioli et al., 2020). These linkages and the distribution of profits and societal costs should be made transparent; the influence of lobbying should be limited, and active and shared transport should be given greater weight in state structures, budgets and processes according to their contribution to societal goals. This also applies, for example, to administrative institutions in spatial and transport planning, which in some cases need to be restructured or rebuilt in order to be able to establish new practices (Hrelja and Rye, 2022).
- The motor car is deeply interwoven with societal structures and narratives which are hardly questioned and which people are hardly aware of. In *car-oriented societies*, the private car is ascribed other functions apart from transport (Mattioli et al., 2020; Urry, 2004). It is part of individual and collective identities and is used as a cultural symbol – e.g. in films, literature and music – of freedom and independence, success, status and class, power and masculinity. In some cases it is perceived as a private space and as protection against the outside world; it has been made an integral component and flexible tool for managing an everyday life that is in turn attuned to car use and, indeed, demands it (coercive flexibility: Urry, 2004). Alternatives to the car-oriented society – and e.g. guiding principles for cities (such as Paris; Section 4.3) – should therefore not only aim at active and healthy, efficient and clean modes of transport, but also be embedded in a broader societal narrative. This should also address other areas of everyday life, social and political aspects such as meeting places, inclusion, public goods, power, participation, consumption, status, social role models and norms, wealth measurement, etc. (Sections 3.2, 4.2.2; WBGU, 2016a).

Summing up, therefore, comprehensive long-term strategies should be developed with infrastructure and complementary measures that set out overall conditions for active and shared mobility, and make driving less attractive – as an entry point and catalyst for new habits and broad societal trends.

4.2.4.3

Children as a design focus and indicator for green, safe spaces for physical activity and infrastructures for everyone

Given their appalling lack of physical activity in many countries, children and adolescents are one of the most important target groups in promoting physical activity (Sections 4.2.1, 4.2.2.3), also as a long-term, sustainable investment in health and the environment. The residential environment, school and family offer essential starting points for structural and behavioural prevention.

In the *residential environment*, the physical-activity and mobility behaviour as well as the independent action radius of children and adolescents are good indicators of attractive, safe, environment-friendly and, in some cases, near-natural public spaces and transport infrastructures that benefit *everyone*, e.g. also people with mobility restrictions as a result of disability, age or prams. Designing cities and infrastructures for children and adolescents spaciouly and not only in fenced-off areas such as playgrounds and school-yards, and adapting them to children's natural urge to move, is therefore a lever that is effective for several societal goals. It is also a useful guiding principle that can further enrich many concepts for sustainable urban redevelopment and transport that already exist worldwide (Gill, 2021). Thus, the incompatibility of child safety with heavy motorized traffic is a further argument in favour of a much greater focus on a 'real' mobility transition in the transport field of climate-change mitigation, i.e. a massive shift to active or public transport as well as to smaller, lighter and slower vehicles (Section 4.2.4.2). Demonstrating the benefits for children of public welfare policies can increase support for such policies (Toossi, 2022). Giving children access to suitable spaces for physical activity and play in nature and the built environment, strengthening their self-determination, and also their experience of space, time, physical and natural limits through free and nature-based play, can in turn promote skills that have a positive impact on health, social interaction and the relationship between humans and nature.

In the *school setting* and in early-childhood educational institutions such as day-care centres and kindergartens, a key role is played by a comprehensively physical-activity-oriented design of the kindergarten and school environments, which, in turn, can have an influence on the family environment. Many families develop new transport habits when their children enter kindergarten and start school, or even with the birth of a child (Lanzendorf, 2010; Muggenburg et al., 2015; Plyushteva and Schwanen, 2018). This is an opportunity to shape or change mobility biographies not only for the children. It requires a transport and infrastructure policy, urban planning and small-scale design that

enables parents and children to travel independently to school safely, actively and appropriately, provides accompanying information and 'peer activities' for parents starting with their first contacts with the kindergarten or school. Furthermore, subsidy programmes for public transport or e.g. (cargo) bicycles for low-income households can be useful. This should be combined in the school or educational setting with holistic 'Planetary Health Education', which includes teaching formats where lessons are interspersed with activities involving movement, where physical activities are encouraged during breaks, and where there are sports lessons and other low-threshold sports activities in schools already in early-childhood education (Section 8.1).

4.2.5

Recommendations for action

The following recommendations for action refer predominantly to the national and sub-national level. However, some countries need support with implementation, e.g. in designing cities, mobility systems and health promotion, which can be provided by international development-cooperation institutions, financial institutions such as the World Bank and regional development banks. The WBGU therefore recommends across the board that these institutions adopt the guiding principle of (1) creating conditions for environment-friendly physical activity in all areas of everyday life, especially (2) for a genuine mobility transition, and, in doing so, (3) making the needs of children the benchmark for measures.

4.2.5.1

Reintegrate physical activity into all areas of everyday life and link it to climate-change mitigation and environmental protection

Promoting physical activity, protecting the environment and climate-change mitigation support each other and should be communicated and approached as a joint project with directly experienced, positive impressions of a healthy, mobile life in a healthy environment. This requires external conditions – regulation, taxes and prices, infrastructures, spatial planning, public services – in which healthy, environment-friendly behaviour is the most attractive kind of behaviour, and sustainable business models can prevail everywhere, e.g. in transport. Thus, different areas of political policy, as well as international, national and municipal levels need to work closely together to develop overarching strategies and implement locally adapted solutions.

Integrate a 24-hour approach and environmental perspective into recommendations on physical activity

National and international recommendations on physical activity and sedentary behaviour, e.g. by the WHO (Section 4.2.4.1), should be supplemented with information on areas of life and environmental impacts, and explicitly refer to the multiple benefits of active mobility for the environment and health. The focus should be on the following questions: How much physical activity can be achieved (order of magnitude)? In what way? What effects would the changes in the respective areas of life have on *individual health and the SDGs*? Which indicators should be used for monitoring, selecting and implementing measures? Based on this, the WHO and other international organizations (e.g. UN Habitat, the World Bank) could support countries in defining, quantifying and implementing detailed national targets and strategies, and provide a sound basis for recommendations to multipliers such as health professionals (Reis et al., 2016).

Strengthen cross-cutting strategies to promote physical activity – E-MOTION^{kids}

Large-scale, systemic approaches to increasing environment-friendly physical activity require nation-state coordination, overall frameworks and public goods, supported by communities, civil society, businesses and individuals. The WBGU therefore recommends defining overarching quantified goals and approaches in national cross-cutting strategies to promote environment- and climate-friendly physical activity, making contributions and responsibilities in different policy areas binding, and tracking them (in a similar way to the joint assumption of responsibility, concrete contributions and follow-up mechanisms in the German Climate-Change-Mitigation Act) and ensuring consistency with sub-national activities (Jäuregui et al., 2021). Initial priorities can be set ‘opportunistically’ according to short-term national and local needs, and experimental spaces can be created (SRU, 2020) to quickly create directly experienced, positive impressions of a healthy, mobile life in a healthy environment and generate acceptance (e.g. through national policy and funding packages for play streets, public spaces, parks, cycle paths and sports fields to be realized at the municipal level), which are then expanded thematically. The following core elements should be included in the strategies:

➤ **Environment – create an activity-friendly environment to achieve environment- and health-friendly physical activity:** Designing the physical, regulatory and social environment (as well as pricing structures) for structural prevention should become a focus in all areas of life. Everyone should have attractive options for healthy and environment-friendly behaviour. Structures that

promote everyday physical activity are supplemented by attractive, safe and, as far as possible, near-to-nature sports facilities, especially for girls and women, older people and people with disabilities.

- **Monitoring and evaluation:** (1) Collection, public provision and analysis of data on physical inactivity and sedentary behaviour – as already partly carried out by the Global Observatory for Physical Activity (Varela et al., 2017) – and the underlying factors, preferably broken down by areas of life, and (2) data collection and provision on strategies and measures to promote physical activity and evaluation of their effectiveness. Based on this, best practices should be shared and actively scaled, e.g. through permanent coordinating bodies.
- **Competences:** Capacity building in the population and among professionals through (1) health and environmental education in theory and practice from school onwards, improved information, campaigns, etc., (2) training of public-health professionals, and (3) training of professionals in all medical sectors (Section 6.2, Chapter 8).
- **Targets:** The targets of 10% and 15% reductions in physical inactivity by 2025 and 2030 respectively compared to 2010 (WHO, 2013a; 2018d) adopted by the WHO should be embedded in national strategies. It should be laid down in law which contributions are expected in different areas of life, which government department is responsible for each, how this is to be followed up and, if necessary, readjusted. For children, separate quantified targets should be defined for physical activity and its prerequisites, e.g. on proximity to public spaces and facilities for physical activity, ‘child-safe’ transport opportunities, or distances that can be covered on foot or by bicycle.
- **Incentives and financing:** Incentives should be created to encourage physical activity; externalities should be priced and subsidies that are harmful to health and the environment should be abolished in all areas of life. In addition, environmentally aware programmes on physical activity and sedentary behaviour should be funded.
- **Organizational structures/coordination and implementation structures:** Establish, strengthen and locally implement structures and processes for the environmentally aware promotion of physical activity that coordinate everyday areas, sectors and cross-departmental programmes. Permanent national coordinating bodies can (1) network actors; (2) develop and coordinate national and municipal strategies in a participatory manner, taking into account recommendations and guidelines on physical-activity promotion and urban mobility internationally, e.g. from the WHO’s Global Action Plan on Physical Activity

(Box 4.2-1), in Europe from the proposals of THE PEP (UNECE, 2022) and recommendations by the EU; (3) coordinate their implementation through intersectoral partnerships and independent evaluation; (4) ensure the continuation of successful projects through timely funding; and (5) collect and disseminate knowledge and experience. For locally adapted, effective measures, cities and municipalities need sufficient decision-making powers and resources, e.g. for the design of public spaces, the reallocation of road space, parking-space management and speed limits.

- › **Networks, cross-sector partnerships and policies:** Effective promotion of physical activity, especially fundamentally changing external conditions, requires cross-sectoral and cross-actor cooperation, e.g. between health, transport, spatial-planning, sports, education and family policies and corresponding authorities from the national to the municipal level, as well as scientific and civil-society actors. Legally binding quantified sectoral contributions (e.g. of transport and urban planning) as well as coordination obligations can ensure sufficient weight and resources for environment-friendly promotion of physical activity. The national implementation of the WHO Global Action Plan on Physical Activity should be coordinated with environmental and climate strategies, for example on green and natural spaces, climate-impact adaptation and the reduction of transport emissions. Locally, for example in spatial and transport planning, strong emphasis should be placed on opportunities for more physical activity – especially for children and adolescents – in addition to climate and environmental impacts. Research fields related to physical exercise – e.g. physical activity, sedentary behaviour, sleep, the environment/climate and mobility – should be brought together with a common agenda on health and the environment (Section 4.2.6, Chapter 7).
- › **kids – children as an important focus:** The focus on children should be taken into account when considering the above-mentioned aspects for strategies (Section 4.2.5.3).

4.2.5.2

From transport policy to mobility policy: systemic strategies for a real mobility transition

Specifically in the mobility sector, combinations of measures are needed that affect all modes of transport and have a systemic effect, e.g. on the infrastructure, spatial and urban planning, public services, the regulation and pricing of vehicle size and efficiency, emissions, noise and space consumption. Mobility should become not only low-emission and efficient in terms of energy, resources and land, but above all involve much more

physical activity. It should enable all those who walk, cycle or use public transport to participate fully in society. Consistently set framework conditions for private cars make the complementary use of shared transport much more attractive, i.e. above all local public transport as the ‘backbone’ of mobility networks without a car of one’s own, supplemented locally by sharing systems where necessary.

Develop long-term strategies for more active mobility

National and urban mobility strategies should be further developed and focus on physical activity for all population groups in addition to emission reductions (greenhouse gases, local air pollution, noise) and efficiency (energy, resources, land; Fig. 4.2-7). They should be embedded in a broader, inclusive narrative that offers individuals, society and the economy an alternative to the car-centric society, and addresses not only health and quality of life but also other areas of everyday life beyond transport, as well as social and political aspects. The strategies should include quantified targets for more active mobility, including specific targets for children and the prerequisites for achieving these targets, e.g. traffic-calmed or traffic-free living environments and routes to school. Climate targets, the reduction of traffic fatalities, the limitation of material and land consumption and the sector’s energy consumption – in line with the expansion of renewable energies and the defossilization of all sectors – should finally be tackled more decisively. This requires a combination of measures that promote physical activity, restrict car traffic, and accompany this with communication. Societal and political-economic barriers (Mattioli et al., 2020), as well as the development of new habits and social norms in various population groups (e.g. families, commuters), should be taken into account when coordinating and sequencing measures (Creutzig et al., 2022). For cities in the EU, funding from the New European Framework for Urban Mobility (European Commission, 2021k) should be linked to the preparation of Sustainable Urban Mobility Plans (SUMPs; European Court of Auditors, 2020). To avoid further private and public misinvestment, new road-construction plans and many instruments of transport and relevant fiscal policy should be immediately reviewed, strategically realigned and, if necessary, stopped.

Make the influence of interest groups transparent, engage more with sustainability actors

In order to be able to develop and implement mobility strategies in a balanced manner in the interest of society as a whole (Fig. 4.2-7), there must be a discussion for current and possible future mobility systems and business models on who benefits, who bears the internal and

4 Shaping areas of life: what we eat, how we move, where we live

external costs and the health and environmental risks, and how broadly-based inclusion opportunities can be secured. Political influence by all interest groups should be made fully transparent to the public. Cases must thus be disclosed and prevented in which certain actors, for example from the car, fuel and road-construction industries (including their workers' representatives), are given special access to politicians and authorities, are disproportionately involved in committees, or even have job overlaps and receive donations (Mattioli et al., 2020; Traufetter, 2019). Examples of measures include introducing lobby and secondary-income registers, without exceptions, for all political levels and senior positions in ministries, local authorities and the judiciary (Council of Europe, 2022; Lobbycontrol et al., 2021). A balanced political participation of public and private mobility providers, civil-society and public environmental and health actors and e.g. urban planners as well as academia should be ensured.

Promote active mobility: infrastructure, compact settlement areas and traffic regulation

A key factor in promoting active mobility is a safe, attractive infrastructure with cycle paths and footpaths, bicycle-parking and traffic facilities. Such an infrastructure should offer extensive networks that are *seamlessly* safe, especially for unaccompanied children, women, older people and people with physical and mental impairments. The overall role of attractive public spaces, especially for pedestrian traffic, and the influence of changing environmental conditions, should also be taken into account, e.g. urban green spaces, shade and drinking water, seating and play facilities (Section 4.3). Spatial planning should be oriented towards compact, mixed-use settlement areas in order to shorten distances (Section 4.3). Traffic rules and traffic management, e.g. through speed limits and traffic-light circuits, should be geared towards the safe, efficient mobility of active road users.

Expand (local-)public-transport services nationwide, integrate pooling and sharing services above all in non-urban areas

Public passenger transport on short and long routes should be further improved. It should be fast and safe, have a wide range, offer a frequent service, be equipped with barrier-free access and have attractive, simple fare structures. Above all outside urban areas, complementary ride-pooling or vehicle-sharing services should be conveniently integrated, e.g. digitally, and primarily use smaller vehicles. (Local) public transport and flexible complementary services in non-urban areas should be treated as public services, as only a comprehensive network of highly available services can offer many people an alternative to private cars and make their purchase less

attractive. This can be done via tenders or operator models, with subsidies especially for areas with a low population density. A close coordination of mobility strategies and spatial planning is necessary to combine efficient mobility systems with the avoidance of urban sprawl and the preservation of natural spaces. The development, construction and efficient operation of integrated mobility systems also have considerable economic potential.

Increasingly redesignate public space, price its use and reduce access for cars

Parallel to the expansion of alternatives to the car, public parking spaces should be greatly reduced and increasingly priced according to the opportunity-cost of space. Prices should be time-based, also to encourage shared-vehicle use. All road use by cars should be priced, where possible based on time, distance covered and location, in order to address climate, environmental and health effects as well as traffic flow and urban sprawl. In residential areas, car traffic should be reduced to a child-safe level, limited to walking speed, and through-traffic should be blocked out with physical barriers. In the medium term, car traffic in urban areas should be limited to a few ring roads and cul-de-sacs, as in Groningen. Freed-up spaces should be used not only for footpaths and cycle paths but also, for example, for parks, exercise-friendly green public spaces and public housing policies (Section 4.3).

Increasingly regulate and price car use according to efficiency potential and societal costs; create incentives for small vehicles

Fuel prices should reflect environmental and climate externalities from extraction to combustion. Subsidies should be reduced and taxes on vehicle purchase and ownership should be staggered according to weight, energy consumption, pollutant class and greenhouse-gas emissions. Digital technologies, e.g. for traffic management, sharing systems and vehicle automation, can lead to efficiency gains but also to more traffic. They should therefore be linked to proportionally more stringent targets and regulations – e.g. on emissions reduction, energy and land consumption or the total number of vehicles – in order to use them for sustainability goals and prevent rebound (WBGU, 2019b). Together with parking and road pricing, these measures contribute to cost equity vis-à-vis (local) public transport, make shared mobility, corresponding business models and smaller vehicles more attractive, and are an important part of a guiding framework for more highly automated vehicles in the future. Lightweight micro-vehicles, which are more efficient and less dangerous to other road users, should be promoted by less stringent regulations for registration and use, and by subsidies and public procurement.

Offset the effects of public investment and regulation on private housing costs and land prices for the socially vulnerable, skim off land rents

Upgrading urban neighbourhoods and infrastructures with public funds, traffic regulation and more compact settlements can lead to increases in property and land values ('land rents') and distribution effects via changes in housing prices. These should be planned for from the outset. Land rents should be skimmed off, e.g. via taxes (WBGU, 2020, Section 4.2.6; Schwerhoff et al., 2020; Stiglitz, 2015a, b; Edenhofer et al., 2015) and can be used e.g. for public housing policy (Section 4.3) or direct payments to low-income households.

Develop user-group-specific promotion and communication measures

To improve political feasibility and ensure societal consolidation, social and psychological effects, societal trends and demographic changes should be taken more into account, e.g. young people not buying cars, more older road users or urban growth (WBGU, 2016a). Some of these measures should be bundled for specific user groups, e.g. for students and trainees, commuters or families (Section 4.2.4.3) and communicated as a package. This can be supported by information campaigns or major public events such as car-free days. In the case of typical watersheds in an individual's life – such as changing jobs, starting a family, moving house or retiring, when many changes take place at the same time – suggestions and incentives on new mobility behaviour by municipalities, educational institutions, employers or national support programmes can also be effective.

Make it obligatory for car advertising to include references to negative environmental and health effects as well as to active mobility

Since cars are harmful to health and to the environment, advertising concerning them should be more strictly regulated. The ban on tobacco advertising or the obligation to advertise walking or cycling on car advertisements, which has been in force in France since March 2022, can serve as examples of this (Box 4.1-4).

Support LMICs in the development and implementation of mobility strategies

Low- and middle-income countries (LMICs) and their cities will strongly affect future global emission pathways (Jaramillo et al., 2022). They should therefore be given support with their integrated mobility and urban planning and its implementation at the national and municipal level. In addition to the infrastructure and overall conditions for cycling and walking, this also applies to improvements to locally established, shared mobility options as well as to micro-mobility, perhaps

with e-bikes and micro-vehicles from the countries' own production. In city networks such as ICLEI – Local Governments for Sustainability (iclei.org), the Global Covenant of Mayors for Climate & Energy (2022) and C40.org, as well as in civil-society networks such as the Habitat International Coalition (hic-net.org), active mobility programmes should be boosted for everyone, especially for children, women and people with low incomes.

4.2.5.3

Use children's and adolescents' need for movement and autonomy as a design perspective in all areas of life

The needs of children and adolescents should be used as a substitute indicator and design focus ('proxy') for naturally green, activity-promoting and safe public (exercising) spaces and infrastructures for everyone. This is an important element of a new, integrated narrative on physical activity and the environment, as well as a powerful strategic focus that brings together many aspects of physical-activity promotion, environmental protection, climate-change mitigation, participation and social inclusion.

Child-friendly spatial and transport planning for activity- and environment-friendly living environments, participation and social inclusion

The independent, safe action radius of children and adolescents should be increased, and they should be given access to suitable play and exercise spaces in nature and the built environment. In children's and adolescents' daily routine, times with predominantly sedentary behaviour (e.g. screen time) should be limited and compensatory times with physical activity, especially outdoors (green time), should be encouraged (Box 4.2-5). To achieve this, cities and infrastructures must be designed appropriately for children and adolescents not only in fenced-in areas and near schools but over a wide area and adapted to their natural urge to move. This should become even more of a focus in many existing concepts for sustainable urban redevelopment and transport worldwide. Design examples can be found in Gill (2021). National coordination centres for the environmentally aware promotion of physical activity (Section 4.2.5.1) could accompany and promote all such activities. In Germany, the local authority associations can also play a role.

Local, national and UNESCO programmes for the living environments of day-care, school and training

Effective health and environmental education and the shaping of physical-activity and mobility biographies requires an integrated, whole-institution approach (Section 8.1). Together with theoretical and practical educational content, educational institutions and their environment as a whole should be realigned – buildings

4 Shaping areas of life: what we eat, how we move, where we live

and outdoor facilities, administration, equipment, access, catering, excursions, etc.– to ensure consistency and direct experience in everyday life on site. For example, school buildings, schoolyards and classrooms should be made activity-friendly, e.g. with standing desks, ‘loosening-up units’ in lessons, facilities for physical activity during breaks and (recreational) sports opportunities in school gyms. School playgrounds can be made accessible to the public outside school hours. Independent and active travel to and from school requires knowledge transfer and agreements with parents, whose mobility habits might be influenced more comprehensively as a result (Section 4.2.5.2). Furthermore, in addition to road-safety training for children, it is necessary above all to document their concerns in schools and to take these into account in urban and traffic planning. Designing the living environments of kindergartens and schools in this way requires overarching support programmes at the local and national level (Section 8.1.4.1), e.g. for the development of curricula, school construction, educator and teacher training. These could be accompanied and promoted by UNESCO, for example.

Boost global programmes for child-friendly cities

Global programmes for child-friendly urban planning and the implementation of such plans, e.g. in the context of sustainable mobility strategies (Section 4.2.5.2), should be quickly supported and expanded. Examples include the Child Friendly Cities Initiative (UNICEF, 2022), the Urban95-Initiative (Bernard van Leer Foundation, 2021) and the Streets for Kids Programme (GDCl, 2022).

4.2.6

Research recommendations

4.2.6.1

Patterns and determinants of physical activity, sedentary behaviour and mobility

Patterns of physical activity in low-income countries, among older people, and shifts caused by climate change

Current patterns, trends and determinants of physical activity have been relatively well studied in high-income countries, and progress has also been made in middle-income countries, but there is still a considerable need for research in low-income countries (Sallis et al., 2016a). Furthermore, there is a lack of high-quality studies on certain population groups, e.g. older people, in most countries (Sun et al., 2013). Finally, research should be conducted into the possible effects of environmental changes, e.g. as a result of climate change, on physical-activity patterns in the course of a day (Zisis

et al., 2021; Fig. 4.2-3) and on mobility behaviour, as well as the corresponding health and environmental consequences and anticipatory policy measures.

Basic research on sedentary behaviour worldwide

Data and research on sedentary behaviour as a risk factor in its own right, its causes and consequences are still very limited internationally (WHO, 2020b) and should be improved. Standardized or comparable measurement methods, e.g. using portable devices, as well as context-specific documentation are important here.

Determinants of mobility behaviour in low- and middle-income countries

Above all in low- and middle-income countries, there is still a lack of comprehensive data and studies on the determinants of short- and long-term mobility behaviour, e.g. choice of transport, purchases or place of residence, also outside of urban areas. Such data and studies should include individual and socio-cultural factors such as knowledge and expectations about health effects, as well as external general conditions such as infrastructures, nature, regulations or price structures. The effectiveness of measures aimed at reducing sedentary transport behaviour should be evaluated more intensively.

4.2.6.2

Political processes and integrated structures of physical-activity promotion; assessments of interventions

Comparative research on governance and structures in the environmentally aware promotion of physical activity

Research on effective policy-making for physical activity, i.e. not only on individual interventions and above all outside the Anglo-Saxon region, is still relatively underdeveloped (Rütten et al., 2016). To ensure the effectiveness of cross-cutting strategies for physical-activity promotion, comparative research is needed on the governance and structures of physical-activity promotion and its integration with environmental concerns, e.g. on institutional ways to better integrate health concerns into urban and spatial planning. Different countries – especially those with low or medium incomes (Reis et al., 2016) – as well as intermediate federal levels and municipalities should be compared and their cross-level cooperation included in the analysis (Bull et al., 2015; Breda et al., 2018; Gelius et al., 2021; Messing et al., 2022). Where, by whom, how and how effectively are physical-activity, climate and environmental issues integrated into the national and municipal policies and administrations of different countries? What are the obstacles, what can be improved?

Evaluations of specific interventions to promote physical activity, especially in the school context

More methodologically thorough evaluations into individual interventions to promote physical activity are needed. Particular attention should be paid to the transferability of methods and results to other contexts (Reis et al., 2016). There has been an increase in this field of research, e.g. in lower and middle income countries, but further research capacity should be developed here (Sallis et al., 2016a). In particular, more research is needed on the effectiveness of interventions aimed at reducing sedentary behaviour and increasing physical activity among children and adolescents at school. This should include an evaluation in the field of health economics.

Survey methods on physical activity and mobility behaviour

Methods, international standards and databases documenting physical activity and mobility behaviour should be further developed (Breda et al., 2018), above all in order to be able to also use data from mobile terminal devices better, more efficiently and safely (Huang et al. 2019) and, for example, to record everyday activity and non-motorized traffic better and comparably.

4.2.6.3

Systemic mobility research on health effects and new services, as well as research on links with political economics

Pay more attention to health aspects in systemic mobility research

Health aspects of active mobility are still given too little consideration in systemic, transdisciplinary mobility research, such as that pursued by the Federal Ministry of Education and Research under the research agenda ‘Sustainable Urban Mobility’ (BMBF, 2018). In line with the target vision of an active, efficient and low-emission mobility system (Fig. 4.2-7), the “assessment and modelling of measures, technologies and transformation pathways” should also give greater consideration to health effects for individuals and third parties, e.g. physical activity, emission reduction and exposure, accidents and corresponding strategies that use synergies. There should also be more research on the interactions between active mobility and physical activity or sedentary behaviour as a whole. For example, how does sedentary behaviour change in duration and frequency when people use a bicycle or local public transport instead of car to move around?

Effects of new mobility services on interacting short- and long-distance mobility

Research should be stepped up on the effects of new means of transport (e.g. e-bikes, e-cargo bikes, autonomous

vehicles), mobility options (e.g. digitally supported scooter-, bike-, car-sharing systems, on-call buses, offering lifts) and digital mobility platforms (for planning and booking, sometimes integrated into (local) public-transport systems) on short-term mobility decisions, connecting means of transport, vehicle purchases, long-term mobility behaviour and biographies. Environmental and health impacts should also be assessed and policy measures extrapolated or evaluated. Interactions between mobility behaviour over short and long distances and corresponding ‘long-distance effects’ of new options and policy measures in urban and rural areas, e.g. through changes in vehicle ownership, should also be better researched.

Effects of bicycle-parking facilities and car-park design on mobility behaviour and health

The impact on health and quality of life of urban parking areas or of urban planning options such as clustered parking within walking distance of residential areas is still under-researched (Kirschner and Lanzendorf, 2020). There are also gaps in research on the effects of secure bicycle-parking facilities at the workplace or public-transport stations, above all at the place of residence and distributed throughout the city (Heinen and Buehler, 2019).

New narratives for a more active, sustainable mobility system and transformation research in the field of political economics

Social-science research on new narratives and visions of sustainable, more active mobility and possible implementation pathways should be stepped up, e.g. complementing technology-focused climate-change-mitigation scenarios. Above all, there is a need for political-economic analyses of transformation strategies for car-centric transport systems and societies, little-questioned high mobility, urban sprawl and commuting, as well as car-related practices and cultural images (Mattioli et al., 2020; Urry, 2004).

4.2.6.4

Local mobility concepts and means of transport, vehicle and transport technology

Mobility concepts and strategies; local means of transport in low- and middle-income countries

Low- and middle-income countries should be supported in researching and developing alternative mobility concepts and strategies. These should include alternative means of transport that are adapted to local needs, clean, robust, easy to repair, and developed and produced using local resources.

4 Shaping areas of life: what we eat, how we move, where we live

Health aspects of traffic-guidance systems and in-vehicle safety systems

Technical innovation potential is offered by traffic-guidance systems which, in addition to efficiency and environmental aspects, take into account effects on health and the promotion of active mobility, as well as in-vehicle safety systems with intervention options. Automatic speed-limitation systems (Pyta et al., 2020) and turn-assist systems should be made mandatory for all cars and trucks.



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4.3

Housing in health-promoting and sustainable settlements

The way in which cities are built greatly influences people's opportunities for physical activity and recreation in their residential environment. More green and blue spaces not only reduce land sealing, they also lessen the heat-island effect and improve the residential quality of life. The need to build new settlements for around 2.5 billion people by the middle of the century offers a window of opportunity to advance sustainable and healthy construction with climate-friendly building materials on a large scale in a short period of time – and to avoid unsustainable path dependencies. This opportunity must not be missed.

The way in which settlements are built also determines how healthily people can live there. Furthermore, cities and settlements cause – but also suffer from – climate change, pollution and biodiversity loss. Buildings are responsible for about 31 % of global CO₂ emissions (Cabeza et al., 2022: 955). These arise during the production of the building materials, the construction and, above all, running of the buildings (e.g. heating and electricity consumption). At the same time, many negative health impacts of climate change are particularly pronounced in cities, e.g. as a result of the heat-island effect. Urban and housing development must therefore be designed to be health-oriented, climate-resilient and as low-emission and environment-friendly as possible.

Another major challenge in the coming decades will be the need to create housing for about 2.5 billion additional urban dwellers worldwide (UN DESA, 2018). By 2050, the global population is expected to rise to around 9.4–10.2 billion people, with around two-thirds of the global population expected to live in cities. Their percentage ranges regionally between 58.9% for Africa and 89% for North America (UN DESA, 2018; Statista, 2022b). The United Nations estimates that more than 90 % of future urban population growth will take place in low- and middle-income countries (Tonne et al., 2021), especially in Asia and Africa. The need for massive and rapid new housing construction is a window of opportunity for sustainable, healthy building, but it also entails the risk of decades of path dependency if the wrong decisions are made (WBGU, 2016b; Creutzig et al., 2016; Tonne et al., 2021). Urbanization processes taking place under great pressure could lead to uniform drawing-board cities in which insufficient attention is paid to the environment, health and local conditions; they often also lead to a lower quality of buildings and infrastructures, for example because large quantities of emission-intensive building

materials are used (WBGU, 2016b, 2020). It is therefore essential to avoid unsustainable lock-in effects in urban planning, as well as in buildings and the construction sector in general. At the same time, existing urban spaces, too, must be redesigned in an environmentally sound and health-promoting way.

Finally, ensuring adequate standards of hygiene in dense settlement areas is a further issue (spread of infectious diseases) that should be taken into account in future settlement and housing construction, and must be reconciled with the aim of densification. Informal settlements, which are at particular risk of emerging in low- and middle-income countries, often have neither sufficiently hygienic conditions nor an adequate supply of green spaces, and they are frequently not built in a climate-sensitive manner. For these reasons, their emergence should be prevented in a socially acceptable way. At the same time, adequate provision of green spaces must be ensured in densification processes ('double inner development'). Furthermore, standards of ecologically sustainable construction need to be met in planning, building construction, the use phase and deconstruction.

The phenomenon of shrinking cities also exists in some regions of the world as a result of regional economic crises (e.g. in the rust belt in the USA, for example in Detroit), political upheavals (e.g. end of the Cold War in the former Soviet states of Eastern Europe) and demographic changes (e.g. ageing populations in Japan, parts of Europe, increasingly also in China). This is usually countered by new settlement campaigns, economic revitalization concepts, the development of (industrial) brownfield sites for recreational purposes (e.g. riverside promenades in former port facilities) or deconstruction. In particular, the development of unused areas, reclamation and conversion create new opportunities for an environmentally and health-oriented design of urban spaces, reducing the pressure of use on the natural environment.

Housing affordability and safe housing conditions are key to the health of the urban population. In many places, however, the percentage of their income that people have to spend on housing is rising. Those who can no longer afford to live in the city centres due to the development of property prices often have to move to the outskirts or to poorer locations. This can be accompanied by negative consequences for their mental and physical health. Socio-economically disadvantaged and discriminated population groups tend to be more exposed to health risks such as air pollution, noise and heat due to deprived housing locations, and often suffer from multiple burdens (Hajat et al., 2015; Barnes et al., 2019; Jbaily et al., 2022; UBA, 2020a). At the same time, they are often particularly vulnerable to these burdens, which is why disadvantaged population groups and the

4 Shaping areas of life: what we eat, how we move, where we live

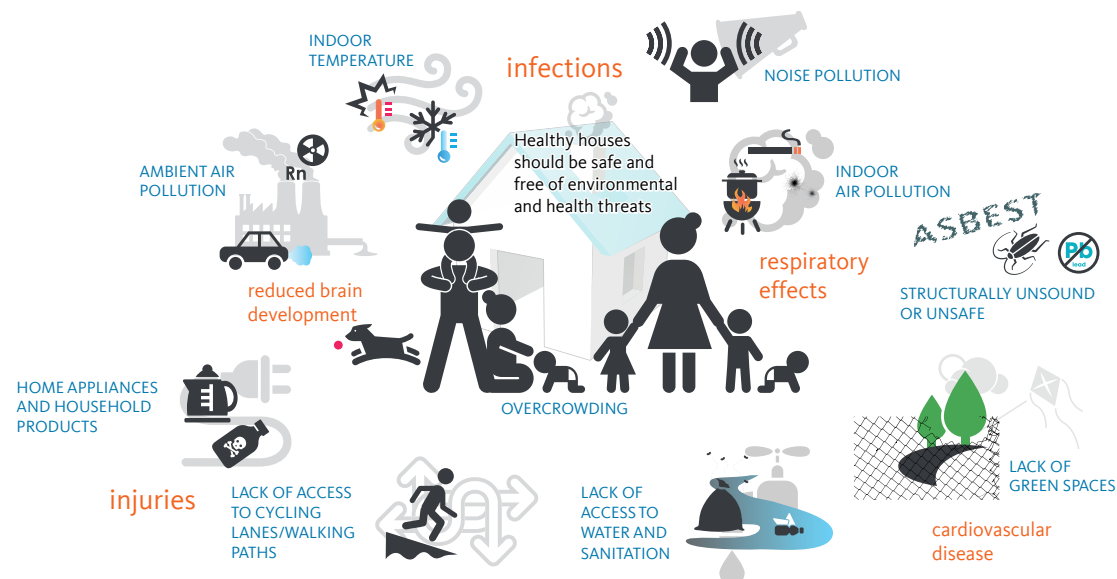


Figure 4.3-1

Housing and the residential location can entail various health risks. The health quality of indoor spaces depends, for example, on the room temperature, the fuels used for cooking, the sanitary facilities and the number of people sharing a space (overcrowding). The quality of the residential area is affected, among other factors, by noise pollution, air pollution, a lack of green spaces and a lack of opportunities to move around on foot or by bicycle.

Source: WHO, 2019b

reduction of socio-economic disparities should be given sufficient consideration in urban planning.

In view of these developments, it is important, on the one hand, to exploit the potential environmental and health benefits of settlements and cities (e.g. easier access to public transport and health services) and, on the other hand, to minimize their adverse effects. Creating health-promoting and sustainable housing conditions involves a wide range of fields of action and intervention options; these are examined in more detail below.

Section 4.3.1 takes stock of the factors that negatively affect health, the impacts of which are directly felt by many people in their everyday lives. Section 4.3.2 deals with infrastructures which, in their current form, contribute to the health burden in the residential environment: classic concrete construction, water and waste-water, energy supply and waste management. Finally, the WBGU's vision for healthy and sustainable housing (Section 4.3.3) shows how these challenges can be met.

4.3.1

Factors with a detrimental impact on health in the residential environment

This section describes the factors detrimental to health for which there is currently the most evidence: air pollution, noise, climate change and housing insecurity. A further emerging issue, on which there are few studies up to now, is light pollution. The globally increasing

emissions of artificial light (with an annual increase of 2.2% between 2012 and 2016) are suspected of being harmful to health and the environment (TAB, 2020). Because of the lack of data, the topic is not addressed here but in the research recommendations.

Healthy living (Box 4.3-2; Section 4.3.3) is not guaranteed for everyone, and various interdependent factors in the residential environment can negatively affect it (Fig. 4.3-1; WHO, 2021e). Many health risks are associated with environmental and climate changes, and with an unsustainable design of the urban and residential environment. People living in poorer neighbourhoods, especially in informal settlements or slums, are the worst affected by unhealthy housing conditions. Globally, about 24% of the urban population lived in slums in 2020; in sub-Saharan Africa the figure was 50% and in Central and South Asia 48% (Statista, 2022b). However, inadequate housing also has a negative impact on health in wealthier parts of the world. According to the WHO's estimates, inadequate housing is responsible for more than 100,000 deaths per year in Europe (WHO, 2016b: 173).

4.3.1.1

Air pollution: one of the most important environmental health risks

Every year, over seven million premature deaths are attributable to air pollution (UN-Habitat, 2022), of which over three million are due to indoor air pollution (WHO, 2022; surveyed in 2020) and over four million to

outdoor air pollution (WHO, 2022e; surveyed in 2019). In addition, the number of healthy life-years is considerably reduced (WHO, 2023c, 2023i). This makes air pollution the biggest environmental health risk worldwide (Tonne et al., 2021; WBGU, 2016a: 79; Section 2.2). Air pollution can arise from a variety of sources, both outdoors and indoors. Densely populated and large cities are particularly affected by polluted outdoor air (WBGU, 2016a). The main sources of emissions are the combustion of fossil fuels by power plants, vehicles, industrial plants and building heating systems. Polluted outdoor air is a particular problem in urban agglomerations in low- and middle-income countries that are experiencing rapid industrialization and the rapid growth of motorized traffic. However, it remains the biggest environmental health risk even in high-income countries (EEA, 2022a). The great majority of Europe's urban population is exposed to air pollution above the recommended limits. In low- and middle-income countries, important sources of pollution are cooking and heating with solid fuels and kerosene. About 2.5 billion people have no access to 'clean' cooking facilities (IEA, 2021a).

Air pollution includes pollution from particles and various gases (e.g. CO, SO₂, NO_x, O₃). Particulate matter represents the greatest health risk here. Urban concentrations of particulate matter are particularly high in Central and South Asia, Africa and parts of South America (Fig. 4.3-2). The toxicity and thus the danger of the particles varies depending on the emission source and composition. For example, there is evidence that diesel emissions are particularly hazardous to health (Longhin, 2016; Thomson, 2015). Air pollution promotes the onset and worsening of diseases, including those of the cardiovascular system (the leading cause of death

worldwide), the respiratory system and the nervous system (Landrigan et al., 2018; SRU, 2023: 52 f.). Children, as well as older and pre-diseased people, are particularly threatened by these health risks (Kurt et al., 2016). In addition, socio-economically disadvantaged people often live in neighbourhoods with particularly high levels of air pollution (increased exposure) and, due to various mechanisms, are especially vulnerable to the health risks described (Bolte and Kohlhuber, 2009; SRU, 2023: 40 ff.). The WHO significantly tightened its air quality guidelines in 2021 (WHO, 2021f). Compliance with the new limits would significantly reduce premature mortality and morbidity (UN-Habitat, 2022). Nevertheless, the limits are often exceeded worldwide.

4.3.1.2 Health effects of noise

The main causes of noise are transport and industry; noise is the second most common cause of negative environmental health impacts in Europe after air pollution (European Commission et al., 2016; WHO, 2018i, 2011; Hänninen et al., 2014). The UNEP calls noise an "emerging issue of environmental concern" (UNEP, 2022b).

In 2017, according to noise mapping, 19% of the population in Germany was affected by all-day noise and 13% by night-time noise, especially in conurbations (UBA, 2020d). In Europe, about 113 million people are exposed to potentially harmful noise from road traffic, and over 20 million people suffer from noise from train or air traffic and industry (with noise levels above 55 dB averaged over all days and nights in a year; EEA, 2019c; Box 4.3-1). About 78 million people are exposed to noise levels above 50 dB at night (EEA, 2019c, 2021). Yet European cities are generally relatively

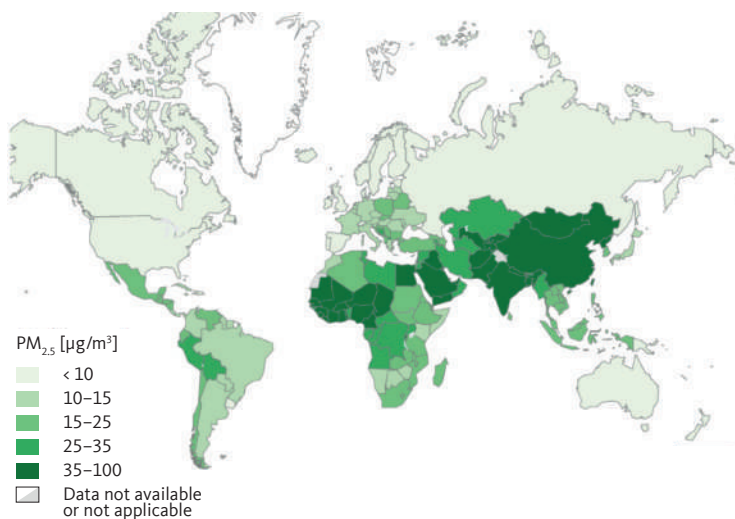


Figure 4.3-2

Average annual concentration of particulate matter (PM 2.5) in cities in 2019 (by way of comparison: the WHO guideline value is an annual average of 5 µg/m³; WHO, 2021f).
Source: WHO, 2022g

quiet compared to many African and Asian cities. UNEP surveyed 61 cities worldwide for noise pollution (UNEP, 2022b; Fig. 4.3-3).

The health impacts of noise pollution are considerable: across Europe, they are responsible for an estimated 43,000 hospital admissions and 10,000 premature deaths per year (EEA, 2014; European Commission et al., 2016). Among other problems, noise promotes cardio-vascular diseases (WHO, 2011; EEA, 2014; European Commission et al., 2016). Furthermore, noise can have negative impacts on children's learning behaviour and cognitive development, for example by impairing memory, and it can cause hearing problems such as tinnitus and sleep disorders (WHO, 2011; Hygge, 2011; European Commission et al., 2016). The Disability-Adjusted Life Years (DALYs; Box 2.2-1) lost due to noise have been estimated by the WHO for the EU and other Western countries as follows: for coronary heart disease about 61,000 DALYs, for cognitive disorders such as long-term memory and reading comprehension in children as a result of aircraft noise 45,000 DALYs, 22,000 DALYs for tinnitus and 903,000 DALYs for sleep disorders (WHO, 2011). An overview of the health damage caused by noise is shown in the pyramid of noise effects in Fig. 4.3-4.

4.3.1.3

Health risks due to climate change in urban agglomerations

Climate change is already having considerable health impacts in many cities and densely populated areas (Dodman et al., 2022; UN-Habitat, 2022). In its Sixth Assessment Report, the IPCC evaluated the most important health risks to which vulnerable population groups in cities and settlements in particular are – and will be – exposed as a result of climate change. Rising temperatures and heat waves will promote or exacerbate various non-communicable diseases in humans, such as cardiovascular and respiratory diseases, and cause increased mortality. High temperatures can also negatively affect infrastructures such as roads, railways or power lines and cause them to malfunction or break down. In densely populated regions, water supplies also often come under pressure, caused by a combination of

decreasing precipitation, overexploitation of groundwater supplies and decaying water infrastructures with high leakage losses. Low-income populations in low- and middle-income countries in particular already face major challenges in accessing sufficient quantities of clean water. In addition, there are health risks from flooding, which can be caused by heavy precipitation and exacerbated by high levels of surface sealing. During water shortages and floods, contaminated water is increasingly used for drinking, cooking and hygiene, thus promoting infectious diseases such as typhoid and cholera. After heavy rainfall, vector-borne infectious diseases such as malaria can also spread more frequently. In coastal zones, sea-level rise, sometimes in combination with storm events, threatens land loss and the salinization of groundwater (WBGU, 2008). Again, people from low-income groups and other vulnerable groups such as women or children will be most affected because they are more likely to live in vulnerable zones and have limited opportunities to adapt.

The health risks from rising temperatures and heat described here are among the main health risks of climate change for humans and are particularly pronounced in cities (Fig. 4.3-5). The urban heat-island effect increases temperatures within cities compared to their surroundings.

Depending on the development of concentrations of various greenhouse gases in the atmosphere (the IPCC scenarios use so-called Representative Concentration Pathways (RCPs), see glossary), between half (RCP2.6) and three quarters (RCP8.5) of the human population could be exposed to life-threatening climate conditions by 2100 (Dodman et al., 2022: 923). Mid-latitude cities will potentially be exposed to twice as much heat stress by 2050 compared to their rural surroundings according to all scenarios used today (Dodman et al., 2022: 22). A particularly high level of heat stress is expected in cities in the subtropics with year-round warm temperatures and often higher humidity. Especially cities in North Africa and the Middle East will be exposed to extreme heat waves (Pörtner et al., 2022).

Box 4.3-1

Noise pollution guidelines

The 7th European Environmental Action Programme defines a 'high noise level' as one above 55 dB during the day and 50 dB at night (EU, 2013). Different frequencies are weighted differently corresponding to human hearing ('A-weighting';

EEA, 2023b); in the case of the figure for the whole day (day-evening-night noise index, L_{den}), volumes are weighted differently at different times of the day (WHO, 1999, 2018; EEA, 2023a). According to the WHO's guidelines (2018i), however, exposure should be well below these figures, depending on the source or type of noise. For comparison: 20 dB for leaves rustling, 80 dB for heavy traffic in cities, 130 dB for pneumatic hammer (beyond the pain threshold; UNEP, 2022b).

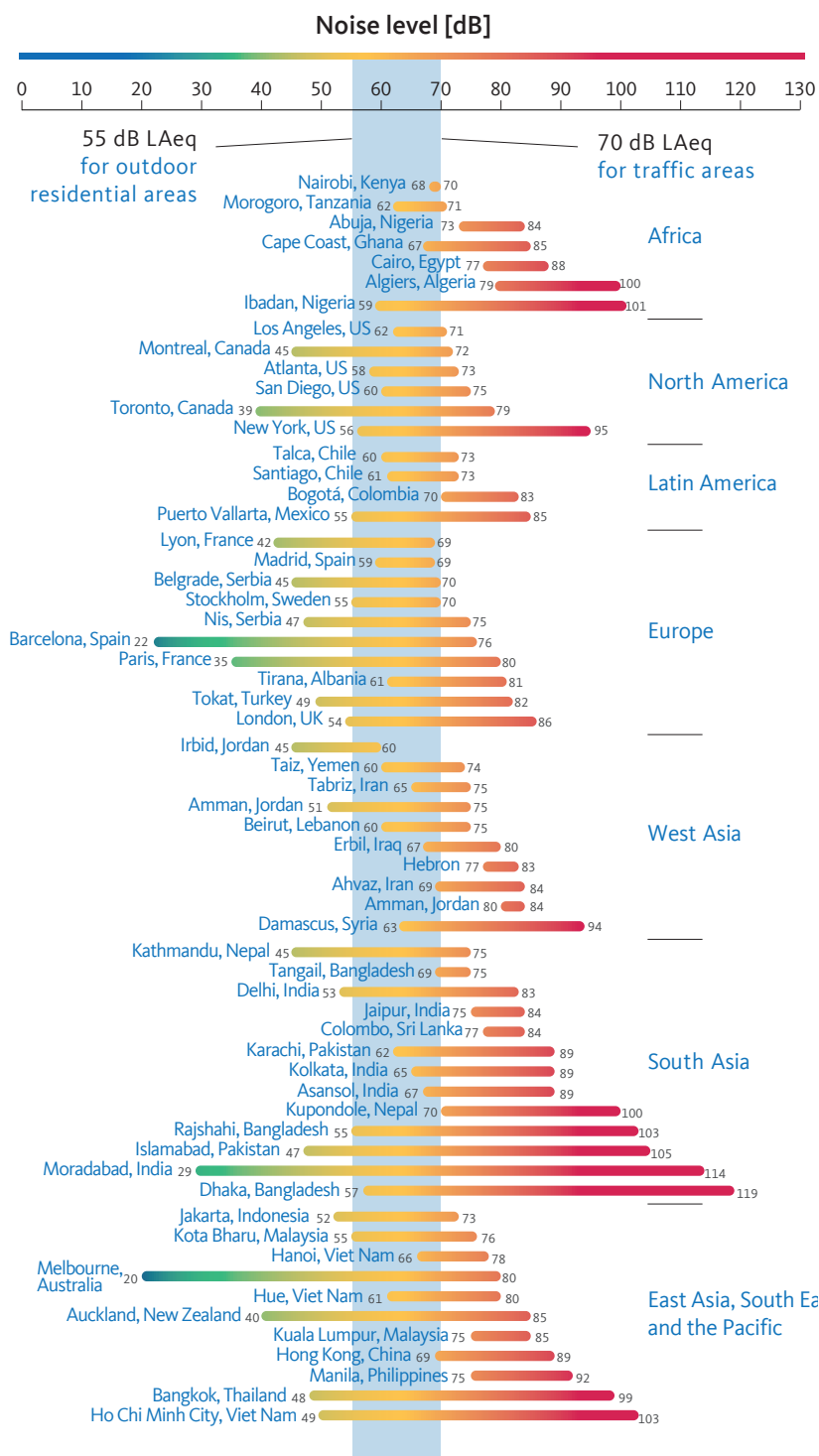


Figure: 4.3-3

Cities with high noise pollution (selection). The diagram shows the figures above and below the recommended upper limits for noise (Box 4.3-1) according to the WHO guidelines of 1999 (WHO, 1999) for selected cities: 55 dB is mentioned here as the limit for noise outdoors in residential areas, 70 dB for commercial areas and areas with heavy traffic. By way of comparison, 70 dB corresponds approximately to the noise level of a vacuum cleaner. Noise levels can vary greatly within a city, with socio-economically disadvantaged people tending to be more exposed.

Source: UNEP, 2022b

4 Shaping areas of life: what we eat, how we move, where we live

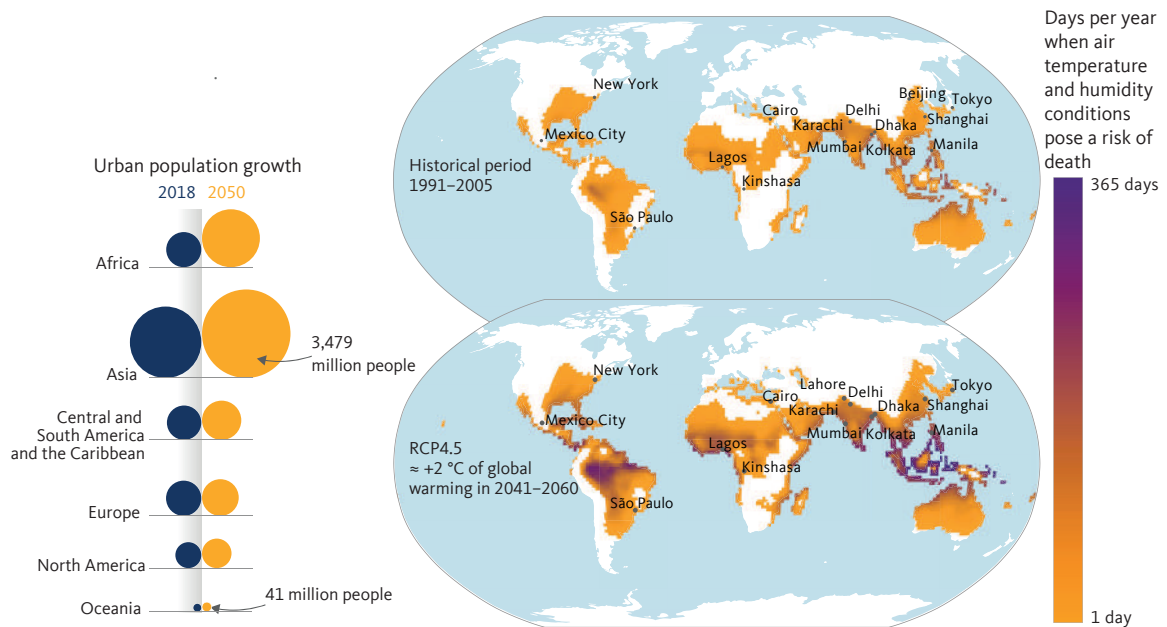


Figure 4.3-5

Heat as a health risk in urban agglomerations. Heat is a growing global health risk due to increasing urbanization and rising temperature extremes. In cities, the urban-heat island effect leads to a further rise in temperatures. Individual population groups there are particularly vulnerable; they include low-income groups in informal settlements, children, older people, disabled people, people working outdoors and ethnic minorities. The data do not take heat waves into account; these are projected to increase and can cause thousands of deaths even at higher latitudes.

Source: Pörtner et al., 2022a: 80

4.3.1.4

Health impacts of housing insecurity

The nexus of healthy housing and well-being also includes psychosocial aspects such as autonomy, security and status as well as being part of a neighbourhood (Rolfe et al., 2020). Tenure security and the affordability of housing play an important role here. High or sharply rising house prices and rents can turn housing costs into a major financial burden (Deb et al., 2022; Elfayoumi et al., 2021). Since housing is one of the most basic human needs, fear of losing one's home or of being displaced by gentrification also means psychological stress, with negative consequences for people's health.

In the New Urban Agenda of 2016 (Habitat III), UN-Habitat identifies housing affordability as a key element of the (non-binding) 'Right to Adequate Housing'; UN, 2017). This 'vision' cannot be achieved if housing costs jeopardize or compromise access to food, healthcare, education and/or transport. A survey by UN-Habitat concludes that in around 80% of cities worldwide there are no affordable housing options for half of the population to rent or buy (Sharif, 2020).

In the countries belonging to the Organization for Economic Co-operation and Development (OECD), rents account on average for more than a third of people's income, with housing prices rising three times faster than

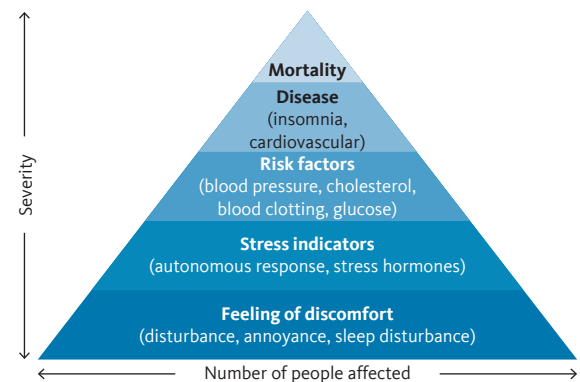


Figure 4.3-4

Effects of noise on health. The width refers to the number of people affected. The severity of the effects increases upwards.

Source: EEA, 2014

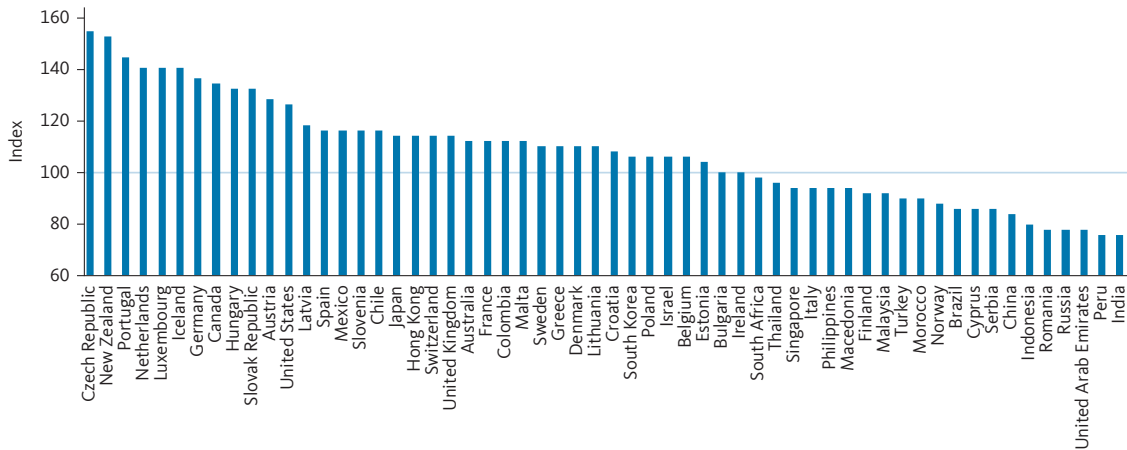


Figure 4.3-6

Change in the ratio of residential property prices to income compared to 2015 (2015 index = 100). Residential property prices rose faster than incomes in many countries (figures for the fourth quarter of 2021).

Source: IMF, 2022

incomes over the last 20 years (Sharif, 2020; Fig. 4.3-6). Insecure tenure, especially in informal settlements, also contributes in various ways to exclusion and exacerbates environmental stress-related risks of illness. In particular, forced evictions can lead to the disruption of a person's livelihood and social networks, escalating stress and mental illness, and the loss of material assets, thus exacerbating poverty and exclusion. More than a billion people currently live in slums (2018 figures); on a global average, this corresponds to 23.9% of the urban population (UNSD, 2022; Fig. 4.3-7).

Socio-economically disadvantaged people and those affected by discrimination not only often suffer from precarious housing situations and the accompanying health consequences, they also tend to be more exposed to health-threatening stressors such as noise, air pollution and heat (UN-Habitat, 2022; Bolte and Kohlhuber, 2009). This multiple health burden in disadvantaged urban neighbourhoods can be mapped socio-spatially (Senatsverwaltung für Umwelt, 2022; SRU, 2023: 39 ff.). Furthermore, access to health resources – e.g. green and blue spaces (Section 4.3.3.4) – and health services tends to be worse. The linkages between social and health inequities in relation to environmental determinants of health are described by models such as the Stress-Exposure Disease Framework (Gee, 2004) and the Social Determinants of Health and Environmental Health Promotion Model (Schulz, 2004).

4.3.2

Buildings and settlement infrastructures that are harmful to the environment and health

4.3.2.1

Concrete in buildings and infrastructures with significant impacts on health and the environment

Concrete is the most widely used building material: residential buildings, industrial buildings, infrastructure for transport, energy supply, water treatment, water supply and waste-water disposal have predominantly been – and still are – constructed with concrete (Fig. 4.3-8; Huang et al., 2020). The demand for concrete as a building material is expected to rise substantially (Habert et al., 2020). The use of concrete in conventional reinforced-concrete construction is associated with very high energy consumption as well as considerable CO₂ emissions from cement production: in 2019, the production, transport, use and demolition of cement and concrete accounted for an estimated 6–10% of global CO₂ emissions (9–10% according to Cao et al., 2021, or about 6% based on IPCC data from Cabeza et al. (2022: 955) if the 18% share of material use in total GHG emissions is also assumed for pure CO₂ emissions). In addition to high greenhouse-gas emissions, the production of concrete leads to a shortage of local, non-renewable resources, high levels of water consumption, and dust, particle and

4 Shaping areas of life: what we eat, how we move, where we live

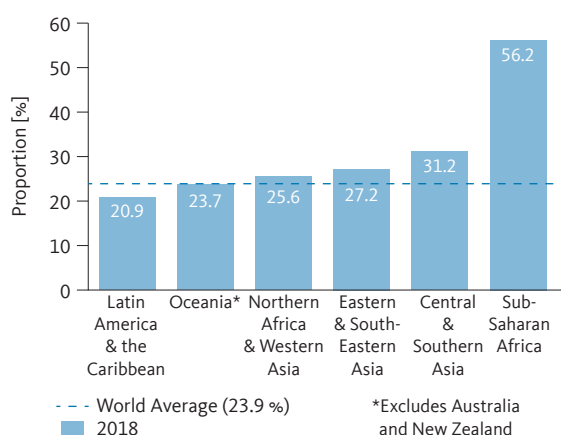


Figure 4.3-7

Percentage of the urban population living in informal settlements by world region

Source: UNSD, 2022; © United Nations. Reprinted with permission of the United Nations.

mercury emissions (Habert et al., 2020). Breathing in such small particles promotes respiratory infections, lung cancer and other lung diseases, heart attacks and other illnesses. In addition, resource extraction (sand, gravel) for concrete production damages ecosystems and reduces biodiversity (Habert et al., 2020). Sand and gravel are the most frequently used resources after water, and the quantities extracted have tripled over the last 20 years

(40–50 billion tonnes per year; UNEP, 2022a). Large areas of land are needed for the extraction of gravel and sand, and in many cases forests are cleared for this purpose. The continuing growth in demand poses a major challenge in the context of sustainability and compliance with the planetary guard rails (UNEP, 2022b).

4.3.2.2

Health risks due to inadequate water supply and waste-water disposal

A reliable supply of clean drinking water and adequate treatment and disposal of waste-water are fundamental prerequisites for the development of prospering settlements. In the 2030 Agenda, ensuring the availability and sustainable management of water and sanitation is formulated as one of the 17 Sustainable Development Goals. This goal is coming under increasing pressure: by 2050, total global water demand is expected to increase by about 20–30% (Burek et al., 2016), while an estimated quarter of the world's population already lives in regions with acute and extreme water scarcity today (Hofste et al., 2019).

Despite progress over the past 20 years, 2.2 billion people still do not have access to a safe supply of drinking water. In low-income countries, less than 60% of the urban population has access to tap water (Dodman et al., 2022). Even in high-income countries, the situation is not entirely positive: so-called 'plumbing poverty', i.e. lack of access to safe drinking water caused by structural social

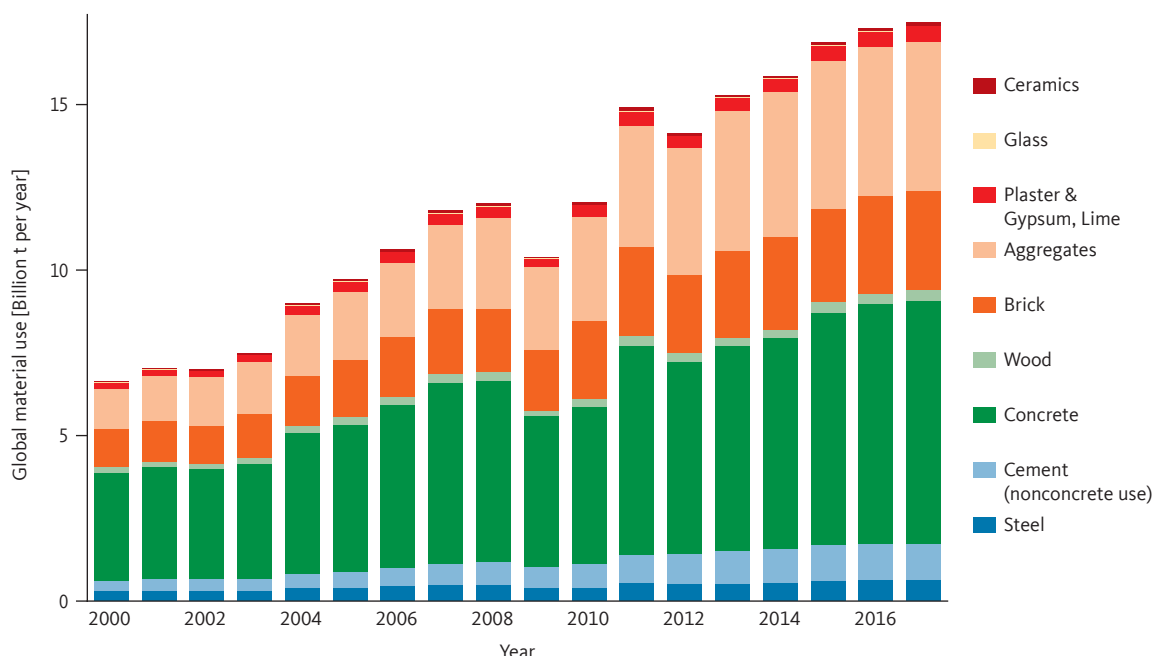


Figure 4.3-8

Annual global consumption of building materials in the period 2000–2017 by material and region.

Source: Huang et al., 2020

inequity, also exists, for example in the USA (Meehan et al., 2020). Besides the insufficient water supply, inadequate waste-water disposal also represents a problem: globally, two billion people lack access to basic sanitation and 673 million people practise open defecation (UN, 2020a). In addition, an estimated 80% of all industrial and municipal waste-water worldwide is discharged into the environment without prior treatment (WWAP, 2017). The increasing pollution of freshwater resources means a simultaneous decrease in the availability of water of sufficient quality for use as drinking water (Boretti and Rosa, 2019). Lack of adequate sanitation facilities and the use of contaminated water promote a variety of infectious diseases. These risks are exacerbated by water scarcity as a result of climate change (Boretti and Rosa, 2019).

4.3.2.3

Energy supply as an urgent prerequisite for health

Worldwide, 2.5 billion people have no access to clean cooking facilities; they traditionally use mainly biomass and charcoal as well as (fossil) coal or kerosene in inefficient cooking stoves (IEA, 2021a) which pollute indoor air and seriously affect people's health (Section 4.3.1.1). Moreover, this consumes 90% of the timber harvested in Africa and 66% in Asia; much of this logging is unsustainable, especially in East Africa and South Asia, and leads to forest degradation, deforestation and CO₂ emissions (Bailis et al., 2015; Masera et al., 2015; WBGU, 2020: 224). About 733 million people have no electricity supply (UN, 2022b), especially in sub-Saharan Africa and some countries in North Africa, the Middle East and Asia (e.g. Libya, Myanmar, Yemen, Pakistan; World Bank, 2023a). A reliable electricity supply to households can have a direct influence on health, because food can be cleanly and safely prepared and refrigerated. Indirectly, health is influenced e.g. by lighting and means of communication, which help people to co-determine educational and employment opportunities. In hospitals, electricity is needed for operating equipment and for cooling, e.g. medicines (WHO, 2023e).

There is a clear gap between urban and rural areas in low-income countries when it comes to access to clean cooking facilities (in 2020, 28% and 8% of the population, respectively) and electricity (70% and 30% of the population, respectively; World Bank, 2023a). In sub-Saharan Africa, after progress had been made between 2015 and 2019, the number of people without access to electricity has recently been growing again, since many cannot afford electricity as a result of the COVID-19 pandemic and rising prices (IEA, 2021b, 2022a). Even health facilities in some countries do not have a reliable power supply, e.g. in Bangladesh, Zimbabwe, Kenya, Senegal, Tanzania, and around half of the hospitals in Ethiopia (WHO, 2023b).

From a health perspective, the sustainable eradication of energy poverty (SDG 7) requires enhanced efforts to replace traditional bioenergy use with more efficient, cleaner alternatives. Local cooking habits and other functions – e.g. for heating, lighting or food conservation and for building materials – must be taken into account (Masera et al., 2015). On the other hand, in addition to reducing negative impacts on the climate, environment and health, local healthcare and health promotion should play an important role in the further improvement of the electricity supply: in the development and expansion of decentralized electricity generation from renewable sources, investments in a reliable electricity supply for health facilities should have a high priority. Such investments can also make an important contribution to stabilizing local electricity systems. In sub-Saharan Africa, photovoltaic power generation in particular is now more attractive than, for example, diesel generators and, in many places in the context of 'island grids', also compared to expanding the transmission network (IEA, 2022b; BMWi, 2020). As climate change presents a growing challenge for the supply of both energy and healthcare (IEA, 2021a; WHO, 2015c; 2020h), strategies for resilient energy and health systems (Chapter 6) should be developed in an integrated manner.

4.3.2.4

Health risks from inadequate waste management and waste disposal

As urbanization increases, the total amount of municipal waste worldwide will grow from two billion tonnes in 2016 to four billion tonnes in 2050 (UN, 2019c) and could even triple by 2100 (WBGU, 2016a).

At present, two billion people have no access to waste disposal through waste collections, and three billion people have no way to dispose of their waste in a controlled manner (UN, 2019c). Although a total of 81% of solid waste is collected (2010–2018; Fig. 4.3-9), proper disposal often does not take place, especially in low- and middle-income countries (UN, 2019c). This has far-reaching consequences for human health and the environment.

Waste from high-income countries is sometimes illegally exported to poorer countries, where it can cause local environmental damage and have adverse health effects (WHO, 2015b). In addition, CO₂ and methane emissions from landfills account for a not insignificant percentage of global greenhouse-gas emissions: in 2010, the figure was 3% (WBGU, 2016a; IPCC, 2014b). Although the percentage of greenhouse-gas emissions that comes from waste is decreasing in Europe, in 2017 solid waste in Europe still accounted for 100 million tonnes of CO₂ eq (Eurostat, 2020), which is roughly equivalent to Belgium's annual emissions.

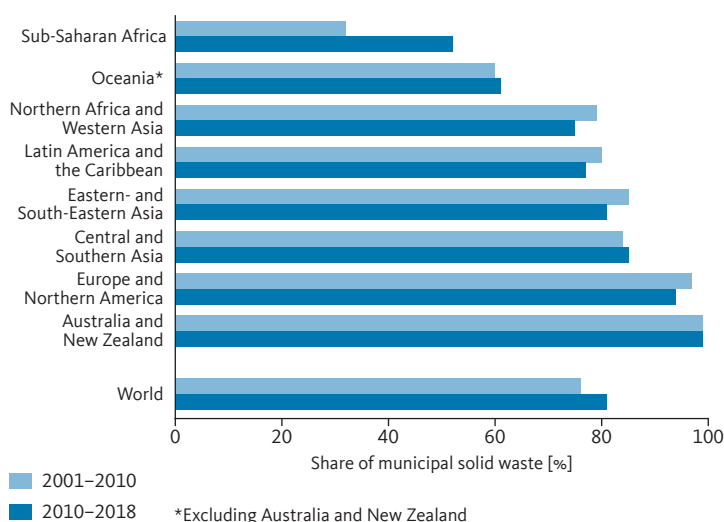


Figure 4.3-9
Proportion of municipal solid waste that is collected (by world region). The proportion of regularly collected solid waste increased from 76 % (2001–2010) to 81 % (2010–2018).
Source: UN, 2019c; © United Nations. Reprinted with the permission of the United Nations

Inadequate protective measures lead to the pollution of air, water and soil, especially when the waste is stored in open waste dumps (WBGU, 2016a; UN, 2019c). Pollution is caused in particular by waste-incineration plants, uncontrolled gas emissions and seepage water from the plants (UN-Habitat, 2021b). In addition, there is decentralized incineration at the roadside or in landfills, especially in low- and middle-income countries (WBGU, 2016a: 241). The gases produced in the process are highly hazardous to health (WBGU, 2016a: 212 ff.). Especially people who live near landfills and waste-incineration plants, who often belong to socially disadvantaged groups (WHO, 2015b), as well as ‘waste pickers’, who separate waste at landfills, sell it or use it themselves, are affected by harmful emissions and exposed to increased risks of infection (D-Waste, 2014); children are a particularly vulnerable group.

Various health risks have been detected that particularly affect people living in the immediate or close vicinity of landfills (WHO, 2015b; Njoku et al., 2019). These include respiratory diseases, noise pollution and its consequences, and congenital malformations. Furthermore, neurological damage has been shown in children living in the direct vicinity of waste facilities. Especially in the case of older waste-incineration plants, an increased incidence of cancer has been reported among nearby residents. Near modern plants, increased congenital abnormalities of the urinary tract and premature births and miscarriages have been detected to date. The development of cancers and lung diseases has been shown to be more likely near landfills that are specifically used for the disposal of hazardous substances (WHO, 2015b).

4.3.3 Healthy and sustainable housing: characteristics and prerequisites

Access to adequate housing is essential for human health and well-being, as poor housing quality promotes infectious and chronic diseases, injuries, malnutrition and mental illness (WHO, 2018e). Inadequate housing affects the health of billions of people worldwide. How is healthy living defined? What constitutes adequate housing? What urban form and infrastructures must cities have in order to be health-promoting and sustainable? These questions and the resulting challenges for urban and spatial planning are the subject of this section.

4.3.3.1 Healthy housing

Key elements that characterize healthy housing conditions are the quality of the living space (such as protection from the weather, indoor air quality, indoor climate and living space), the availability of services and infrastructure (e.g. water supply and sanitation), the quality of the environment, exposure to health risks such as air pollution, noise or weather extremes, accessibility (e.g. by hard-surfaced roads or public transport), security of tenure, and the affordability of the living space (WHO, 2018e; Box 4.3-2). Improving housing conditions in terms of health promotion as well as environmental and climate-change mitigation – which can be achieved by urban-renewal programmes or slum upgrading – would yield multiple additional benefits, especially for socio-economically disadvantaged households. Investments to improve the energy structure of residential buildings can, for example, improve the climatic conditions within the living space by means of optimized insulation, and thus have positive health effects while,

Box 4.3-2**Healthy housing – the WHO’s definition**

“Healthy housing is shelter that supports a state of complete physical, mental and social well-being. Healthy housing provides a feeling of home, including a sense of belonging, security and privacy. Healthy housing also refers to the physical structure of the dwelling, and the extent to which it enables physical health, including by being structurally sound, by providing shelter from the elements and from excess moisture, and by facilitating comfortable temperatures, adequate

sanitation and illumination, sufficient space, safe fuel or connection to electricity, and protection from pollutants, injury hazards, mould and pests. Whether housing is healthy also depends on factors outside its walls. It depends on the local community which enables social interactions that support health and well-being. Finally, healthy housing relies on the immediate housing environment, and the extent to which this provides access to services, green space, and active and public transport options, as well as protection from waste, pollution and the effects of disaster, whether natural or man-made” (WHO, 2018e: 2).

at the same time, saving energy costs and reducing GHG emissions. When people live in cramped conditions, spatial extensions can improve both the indoor climate and the social climate, allow more privacy and thus improve the conditions for concentrated learning, for example.

4.3.3.2**Urban form**

According to UN-Habitat, public health should be treated as a key component of the urban development framework and have a high level of priority in planning processes (UN-Habitat, 2022). Urban form is the key lever for this, because it decisively determines the extent to which healthy living is possible in the long term (WHO, 2016b; de Sa et al., 2022). This also includes the design of green and blue spaces (Section 4.3.3.4).

Urban form also exerts a strong influence on the feasibility of climate-change-mitigation and adaptation measures, the way in which resources are used, and access to adequate housing conditions and public spaces (WBGU, 2016b: 167 f.). As buildings, road networks and infrastructures have a long lifespan, unsustainable decisions on urban form can lead to decades of unsustainable path dependencies. It is therefore all the more important that the health, environmental and socio-political effects of the expansion or new construction of cities and urban districts are taken into account in planning at an early stage. However, there is no one-size-fits-all solution that is independent of time. Sustainable and healthy settlement and urban development always depend on local geographical and cultural conditions as well as on socio-demographic trends, such as changes in population structure and lifestyles. Therefore, keeping open a certain flexibility of settlement design in combination with the involvement of the residential population in planning decisions is a further condition for the success of healthy and sustainable settlement construction and development. UN-Habitat has developed five principles for designing sustainable urban neighbourhoods: adequate space for streets and an efficient street network,

high density, mixed land use, social mix and limited land-use specialization (UN-Habitat, 2014). These principles are intended to help realize the key characteristics of a sustainable and healthy city: vibrant street life, walkability and affordability (UN-Habitat, 2014).

4.3.3.3**Settlement and housing structures for healthy living: the 15-minute city, cities on a human scale and age-friendly city**

There are various approaches to designing sustainable and healthy settlement structures; three of those more frequently discussed are introduced here as examples. The ‘15-minute city’ aims to ensure that much of what city dwellers need in their daily lives can be reached within 15 minutes on foot, by bicycle or by public transport (Weng et al., 2019; Moreno et al., 2021; UN-Habitat, 2022; Fig. 4.3-10). Longer journeys to work should be manageable by public transport wherever possible. The main things needed to achieve the 15-minute city are better footpath and cycle-path networks, as well as more and better public transport connections (Section 4.2). The aims are to promote an urban quality of life and to reduce the burden of disease caused by non-communicable diseases, many of which are partly a result of obesity (Section 4.1) and a lack of physical activity (Section 4.2; UN-Habitat, 2022; Moreno et al., 2021; Weng et al., 2019). The concept of the 15-minute city has received a lot of attention in recent years; similar guiding principles such as the ‘city of short distances’ were propagated in Germany and the USA as early as the 1980s.

‘Cities on a human scale’ is an urban-planning concept developed in 2010 that aims to make a city or neighbourhood better adapted to human needs (Gehl, 2010). According to Gehl’s idea of a lively, safe, sustainable and healthy city (‘cities for people’), a city is worth living in if it respects the human scale. A lively city can be recognized, for example, by how many children and elderly people are out on the streets and squares. This means that people in a liveable city can move around on

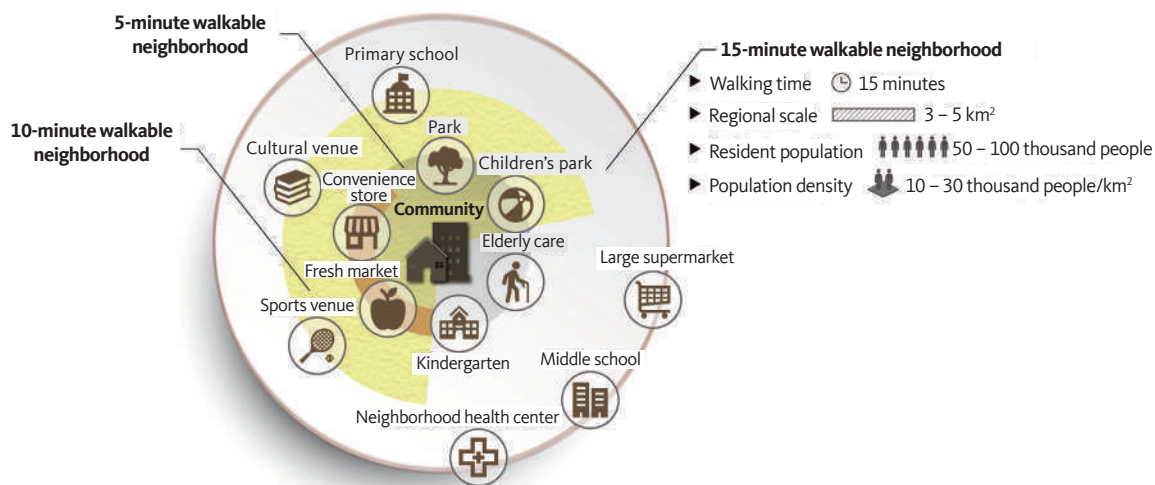


Figure 4.3-10

Walkability of service infrastructures within 5–15 minutes in an urban neighbourhood (examples).

Source: Weng et al., 2019

foot or by bicycle, and can meet each other in conveniently-sized squares and streets. More and wider streets increase inner-city car traffic; narrower and fewer streets and fewer parking facilities create space for cyclists, pedestrians, cafés and public open spaces (Gehl, 2010).

A similar perspective is taken by approaches to age-friendly (children, seniors or both groups) or disability-friendly urban design; here, too, the focus is on well-being, urban quality of life and health. The book ‘Urban Playground: How Child-Friendly Planning and Design Can Save Cities’ (Gill, 2021), for example, shows how cities would have to be built from a child’s point of view (Section 4.2) to do justice to their needs and health. Conclusions can then be drawn for people of other age groups or with mobility impairments. Other studies ask general questions about designing an age-friendly city or urban planning for all age groups (Warner and Zhang, 2019).

Regardless of the respective approaches pursued, the aim in each case is to improve quality of life, health and well-being in urban and settlement development. Studies (WHO, 2016b) show that pedestrian-friendly streets and neighbourhoods, a high residential density, diversity and mixed use of urban space, a dense network of footpaths and adequate lighting and visibility (e.g. to eliminate areas of fear) can significantly increase regular physical activity, which would bring further health benefits (Section 4.2). Within buildings, signs on lifts and stairs can increase the use of stairs and promote physical activity. Making stairwells more attractive by improving their accessibility, their interior design (e.g. with music, art or natural lighting) has also been shown to lead to increased staircase use (WHO, 2016b: 91 f.).

4.3.3.4

Green and blue spaces: multiple benefits for the environment and human health

Cities are usually a mosaic of built infrastructure and green and blue spaces. The latter have a variety of positive effects on the urban climate, human health and urban biodiversity, and are an important resilience factor for the urban water balance. Green spaces include parks of all types and sizes, verges and central strips along roads, green tram tracks, gardens, urban forests and greened roofs and façades. Blue spaces include rivers, lakes, ponds and streams, human-made water features such as fountains, as well as waterways and port facilities.

Green and blue spaces contribute substantially to improving the urban microclimate. Due to the urban heat-island effect, the temperature in urban areas can be 3 to 4°C higher than in the surrounding areas (Fig. 4.3-5). And greening the urban space can do more than lower the surface temperature (Edmondson et al., 2016); shady trees also reduce direct solar radiation in urban homes. Lower temperatures reduce the use of air conditioning and thus help reduce energy consumption and emissions. Moreover, vegetation improves the air quality in its immediate surroundings by filtering out particulate matter and other air pollution (Kumar et al., 2019). In addition, green and blue spaces as places in which it is pleasant to spend time have several other positive health effects (Fig. 4.3-11). Green spaces offer people living and working in their vicinity opportunities for exercise and sport (Lee and Maheswaran, 2011); they also serve as spaces for relaxation and promote healthy lifestyles. Parks, gardens and public flowerbeds (urban gardening)

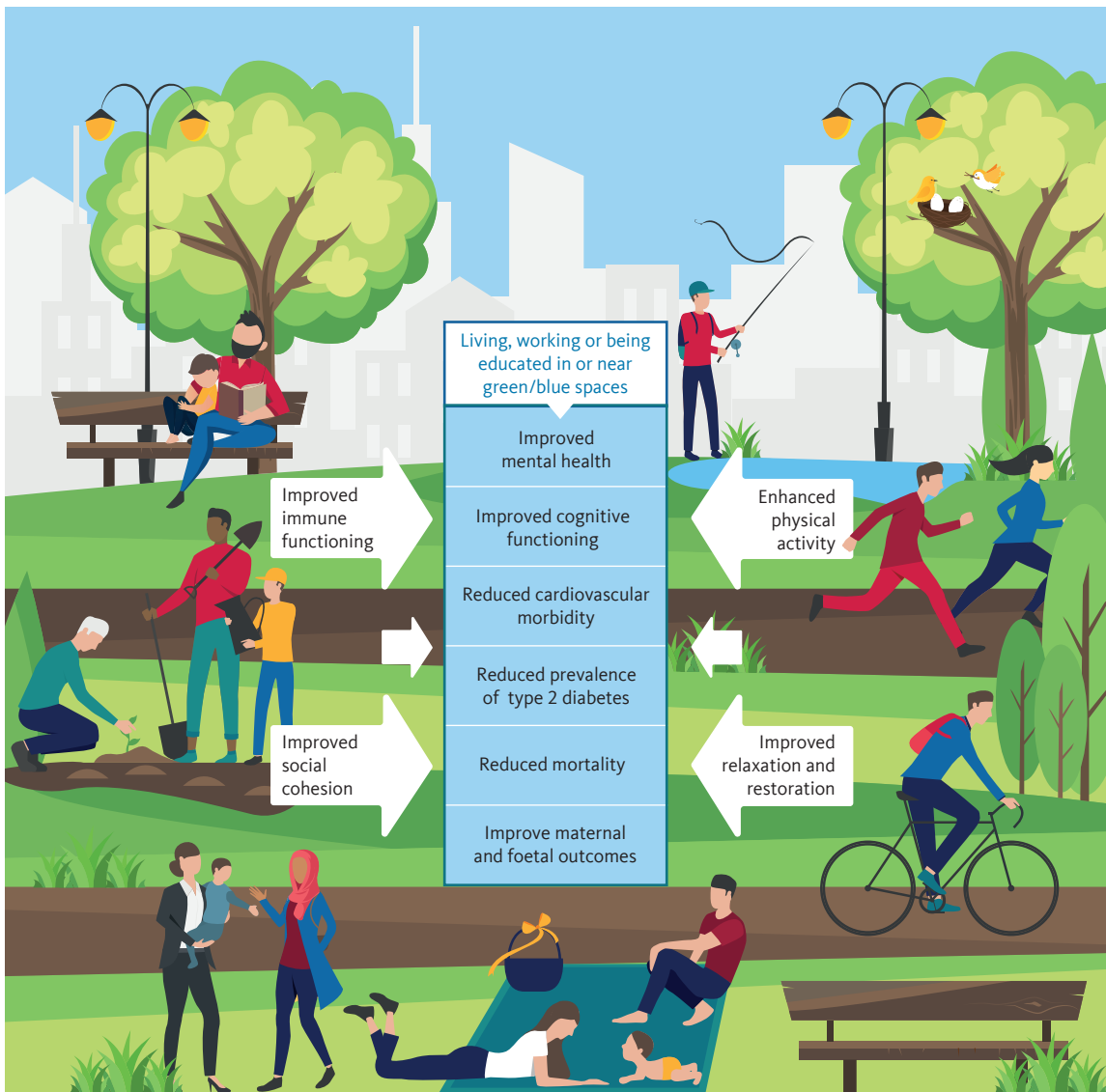


Figure 4.3-11

Benefits of green and blue spaces in residential areas for health and human well-being.

Source: EEA, 2019b: 44

also make societal inclusion and social interaction possible. All this has a positive effect on people's mental and physical health (Chen and Yuan, 2020; Methorst et al., 2021), which is particularly relevant for children, adolescents and older people (Engemann et al., 2019; Dzhambov et al., 2018). Furthermore, various studies have shown direct, positive effects of spending time in green spaces on psychological and physiological health parameters (Kabisch et al., 2021). The greening of urban space and the use and restoration of rivers (e.g. urban river pools) and lakes for swimming invite people to relax where they live, so that leisure traffic to the surrounding area can be reduced. With appropriate management, riverbank habitats can be particularly biodiverse

(Box 4.3-3) and, in addition to their importance for tourism, the economy and health, have invaluable scientific, cultural and educational value (Albert et al., 2021).

Closely linked to the creation of green spaces to improve the urban microclimate and human well-being is the upgrading of cities to 'sponge cities' or water-sensitive cities (Nguyen et al., 2019). The core idea of this concept is that the precipitation that accumulates in cities is not channelled off superficially, but absorbed and stored decentrally. In addition to the above-mentioned green spaces in which precipitation can seep away, the crucial elements here are the water-permeable surfacing of streets, squares and pavements, natural flooding areas in the vicinity of rivers and streams, areas for the

Box 4.3-3

The importance of green and blue spaces for urban biodiversity and ecosystem services

Originally, green and blue spaces in residential areas were (technically) called ‘green infrastructure’ (Ying et al., 2021). Today, the term ‘urban nature’ is widespread and has also found its way into urban planning. For example, there is a wide range of projects in urban and rural residential areas that specifically promote individual animal and plant species and their habitats, and provide information on biodiversity in residential areas. Furthermore, there are various approaches to better integrating green and blue spaces into the built infrastructure. They offer opportunities to implement the integrated landscape approach (WBGU, 2020) in the smallest possible space and ensure that ecosystem services (Section 2.3) can be provided.

Green spaces (such as parks) can provide protection, enabling wildlife to make residential areas their entire habitat (Magle et

al., 2021). It is therefore important to promote societal acceptance for sharing residential areas with wildlife, and neither regard them as a danger nor endanger them. This includes keeping an appropriate distance from wild animals, for example to prevent the possible transmission of diseases. This is because wild animals come closer to humans in residential areas, and this can favour the transmission of zoonoses (Felappi et al., 2020; Gibb et al., 2020a; Section 5.1.1.3).

One concept that has been proposed to promote the coexistence of wildlife and people in residential areas is that of ‘animal-aided design’ (Hauck and Weisser, 2015), or ‘wildlife-inclusive urban design’ (Apfelbeck et al., 2019), in which animals in residential areas and their needs are taken into account in urban planning. However, green and blue spaces in residential areas cannot counteract the overall loss of biodiversity caused by large-scale land-use changes, nor can they stop species extinction (Popkin, 2022). Nevertheless, urban nature has many positive effects on the environment and health, and can be promoted and implemented in both urban and rural areas.

decentralized infiltration of rainwater (such as infiltration ditches, hollows and ponds), as well as (underground) retention areas. This increases resilience in the event of extreme precipitation and can prevent urban flash floods and flooding, which pose a direct threat to human health. Infiltration enables local groundwater to recharge from precipitation and thus ensures the urban availability of water for drinking water supplies and irrigation.

In Europe, green and blue spaces are mostly already part of urban planning. Nevertheless, only 3 % of European cities on average are made up of publicly accessible green spaces (capital cities 7 %; EEA, 2022a). Especially in fast-growing urban areas in low- and middle-income countries, there is even more potential for creating, enlarging and upgrading green and blue spaces. Singapore is a global pioneer in effectively planning green and blue spaces, harnessing their benefits and promoting them (Abdullah et al., 2022; Kumar et al., 2019). In order to make the best possible use of the diverse potential of green and blue spaces and to avoid unintended negative ecological and health consequences, adequate and targeted planning and careful management of green and blue spaces – taking into account the latest scientific findings – are of key importance.

4.3.3.5

Prerequisites of urban and spatial planning oriented towards health promotion and sustainability

The systematic integration of health aspects into urban-planning processes is a fundamental prerequisite for ensuring the well-being of the urban population (WHO, 2020a; Giles-Corti et al., 2016; Böhme et al., 2021).

If these processes are to do justice to the promotion of health, well-being and environmental protection, the extensive new settlement construction and/or urban renewal measures required in the course of global urbanization dynamics require a planning policy which

- gives priority to an urban form that enables healthy living, environmental protection and climate-change mitigation,
- speeds up construction projects in a way that keeps pace with rapid urban population growth and largely avoids unplanned urban growth,
- contributes to the creation of healthy and liveable cities and neighbourhoods through participatory planning processes (Böhme et al., 2021; Tonne et al., 2021; an example from Singapore is described in Box 4.3-6),
- promotes settlement and housing structures that can be adapted as flexibly as possible to the changing housing needs of the urban population, for example through modular construction,
- finds a balance between building density, mobility and the creation of green and blue spaces (‘triple inner urban development’ UBA, 2022a) that is adapted to the respective regional conditions,
- prioritizes pedestrians, cyclists and local public transport in terms of mobility and transport (Section 4.2),
- consistently creates the planning conditions for compliance with regulatory limits for air pollution and noise pollution,
- provides for measures to adapt to climate change (SRU, 2023),
- promotes settlement and landscape planning in the sense of an integrated landscape approach (WBGU, 2020),

- › ensures sufficient access to affordable housing, healthy living conditions and protection from displacement, for example through the timely creation of milieu-protection areas, the promotion or creation of municipal housing cooperatives, and the regulation of real-estate speculation, for example through the diversification of urban ownership models (WBGU, 2016b: 182; e.g. social-compatibility assessment for land acquisition),
- › works to reduce inner-city socio-economic disparities and improve housing and living conditions in growing informal settlements, especially in slums in low- and middle-income countries, and
- › promotes the use of common-good-oriented urban planning tools (Box 4.3-4).

4.3.4

Recommendations for action

Alongside land use and energy systems (including transport), urbanization is the third area of transformation towards sustainability identified by the WBGU (WBGU, 2011b, 2016b, 2020). Further areas of transformation include the oceans and digitalization. Healthy living is closely linked to these areas of transformation: urban energy use and transport policies significantly determine the extent to which people are exposed to air or noise pollution, for example. The way in which cities are built greatly

influences people's opportunities for physical activity and recreation in their residential environment. More green and blue spaces in cities not only reduce land sealing, they also lessen the health-damaging heat-island effect and enhance residential quality of life. The need to build new residential areas for around 2.5 billion people by the middle of the century (UN DESA, 2018) offers a window of opportunity for advancing sustainable and healthy construction with climate-friendly building materials on a large scale in a short period of time, while avoiding unsustainable path dependencies (WBGU, 2016b; Creutzig et al., 2016; Tonne et al., 2021). The US\$90 billion expected to be invested in housing and urban development by 2030 (NCE, 2018) is an opportunity to integrate health issues, together with climate-change adaptation and mitigation, directly into urban infrastructure and planning, social policies (including the education and health infrastructure) and urban environmental management. If this opportunity is missed, such urban growth will not only perpetuate unsustainable, unhealthy housing patterns, it is also likely to cause a further significant acceleration of global warming.

Building on these recommendations, which are based on a salutogenetic approach (Box 4.3-5), more in-depth suggestions for health-promoting and environmentally compatible settlement development will be made here. In particular, this involves Germany's international cooperation within the framework of international institutions such as the WHO, the World Bank, UNEP,

Box 4.3-4

The reform of Brazilian urban planning in 2001 as an example of planning for the common good

An example of the application of common-good-oriented urban-planning instruments can be found in Brazil, where the 'Estatuto de Cidade' (City Statute) reformed the specifications for urban planning in 2001. Since then, the 'right to the city' i.a. has been enshrined in the national constitution and has been an important reference point and guiding principle for urban-planning measures (WBGU, 2016b). In order to ensure a city's social functions, urban property is to be used for the common good, for the safety and well-being of the urban community, and to protect the environment. In addition to the social function of real-estate and land ownership, the guiding principles are the fair distribution of the costs and benefits of urbanization and a democratic city constitution.

In Brazil, master plans, zoning and taxation of the non-use of land are used as common-good-oriented urban-planning instruments (WBGU, 2016b). All cities with more than 20,000 inhabitants are obliged to draw up master plans with the participation of the population. In order to create and/or maintain adequate, affordable housing, local governments

have the right to designate uninhabited or unused areas and informally settled districts as 'Zones of Social Interest'. Cities can force owners of unused or underused land to parcel it out and use it for social housing. The city can also levy a compulsory tax based on the value of the land, which increases the longer the conditions set by the city are not complied with.

Although the success of this framework in terms of practical planning steps has not yet been comprehensively studied, an evaluation 20 years after the adoption of the Brazilian Urban Statute concludes that this legislation has noticeably strengthened the status of the 'right to the city' worldwide, especially in low- and middle-income countries (Rossbach et al., 2021). Many countries have adopted similar legislation and developed tools similar to the Zones of Social Interest. The global association of cities, municipalities and other local and regional authorities (United Cities and Local Governments, UCLG) are also committed to the right to the city and promote its recognition at the international level (UCLG, 2019). A major impact of the Urban Statute in Brazil has been the growing recognition of the rights of residents of informal settlements and the introduction of comprehensive programmes to improve living conditions in the favelas (Rossbach et al., 2021). The supplementary Metropolitan Statute came into force in 2015 and also covers metropolitan regions.

Box 4.3–5

The WBGU's salutogenetic perspective

In its report 'Humanity on the Move: the transformative power of cities' (2016), the WBGU already commented on urban development and health, noting that up to now health-related interventions in many cities have been predominantly sectoral and pathogenetic, i.e. disease-focused. Instead, the WBGU recommended tackling health promotion in cities from

a salutogenetic perspective, i.e. focusing on the genesis of health. To this end, the WBGU identified five starting points (WBGU, 2016b: 435):

- › strengthening integrative, holistic and participatory planning approaches,
- › promoting urban poverty groups,
- › promoting knowledge and action on health,
- › promoting food security and healthy eating, and
- › creating and protecting areas for recreation, activity and social interaction.

UNDP and UN-Habitat. To this extent, the following recommendations are primarily intended as suggestions for international guidelines, strategies or programmes. However, it should not be forgotten that implementing such recommendations at home also strengthens Germany's credibility on the international stage.

In order to provide actors in different fields and at different action levels with clear access to the recommendations for action developed here, they have been divided into two areas: 'Planning and Governance' and 'Infrastructure and Construction' (this also applies to the research recommendations in Section 4.3.5).

4.3.4.1

Planning and governance

Develop visions of a desirable future for one's own residential environment

In addition to municipalities, city governments and regional administrations, the participation of civil-society actors is also needed to jointly initiate a process of reflexive and experimental learning with the aim of developing visions of a desirable future for a city's residential environment. How do we want to live in the future and what must be initiated today for healthy living? There are no universal solutions for this; rather, geographical, social and cultural factors play a major role (WBGU, 2016b). This makes it all the more important that political decision-makers are willing to engage in a reflective and experimental process of 'learning by doing' in real-world laboratories. In this way, the feasibility of various innovative approaches to sustainable settlement development and ways of overcoming conflicting goals can be tested (UNEP, 2019c: 429; Box 4.3-6).

Overcome institutional and disciplinary boundaries in planning processes

The targets for urban and spatial planning oriented towards health promotion and sustainability should be formulated as ambitiously as possible. If the implementation of these goals for liveable cities is to succeed, it will be necessary to overcome the institutional and disciplinary

boundaries that still exist in planning processes. For example, planning beyond urban boundaries, e.g. the preservation or creation of green belts, requires cooperation with spatial-planning authorities in the surrounding areas. Urban-planning processes require not only inter-agency cooperation but also the active participation of urban society and the involvement of informal structures (e.g. the informal sector is usually the dominant part of the urban economy in low- and middle-income countries). Initiatives, ideas and innovations 'from below' should be given an opportunity to develop, and space for experimentation in planning processes provided in the sense of 'real-world laboratories' (Welling et al., 2022), so that urban planners can act as facilitators for transformative change (WHO, 2020a: 32).

Establish locally adapted indicators and targets for environment- and health-oriented urban planning

There is a need for regionally and locally adapted indicators that make it possible to measure progress with the implementation of environment- and health-oriented urban planning (WHO, 2010, 2020a; UN-Habitat, 2021a). This underlines the need to improve the data basis for cities down to the neighbourhood level, and to use better indicators for monitoring and benchmarking. Nevertheless, monitoring and benchmarking, even within countries, are often difficult to implement. Spatial data is not always readily available. Where it is, different cities often use slightly different data and collection methods, making comparisons difficult. Uniform data standards, comprehensive data collection and comparable methods for monitoring and benchmarking should therefore be developed, based on regionally and locally adapted indicators and targets.

Reserve an appreciable proportion of the urban space for common-good-oriented uses

A key condition for the success of transformative planning processes, i.e. processes that clearly deviate from previous planning patterns and open up new paths to sustainability, is an appropriate design of urban land use. This makes it necessary to diversify urban-ownership

Box 4.3-6**Participatory negotiation of future plans: how Singapore deals with the impacts of climate change on health and housing quality**

Like most Southeast Asian countries, Singapore, with its approx. 5.5 million inhabitants, is particularly affected by the impacts of climate change because of its geographical location. The rise in sea level represents one of the greatest future threats to the low-lying city-state. In addition to storms, increasingly frequent heavy rainfall events and flooding, Singapore is also struggling in particular with the consequences of the urban heat-island effect. This is a well-researched phenomenon caused by the heating of densely built-up and extensively sealed surfaces in combination with, for example, a lack of air circulation and higher absorption of solar radiation (Heaviside et al., 2017). The annual mean temperature in Singapore has already risen by more than one degree in the last forty years, partly due to urban densification (Roth et al., 2022). The result is, among other things, an increase in the hospitalization rate due to heat stroke and circulatory collapse. The changed climatic conditions also favour the spread of infectious diseases and enable, for example, the Egyptian tiger mosquito, which transmits dengue fever viruses, to breed much faster. The probability of transmission here increased by 12% between 1951–1960 and 2012–2021 (Romanello et al., 2022).

Heat-related health risks are a particular focus of public discourse in Singapore. The government does not rely solely on the medical standards of the well-equipped public health system, but also invests in a number of action plans, information campaigns and scientific projects. Based on the 2030 Agenda, a national agenda has been developed: the Singapore Green Plan 2030, with which five government ministries are looking to shape Singapore's future together. Citizens can share their ideas and participate in the further development of this 'living plan' at any time. To this end, events are organized for regular exchanges between various representatives of politics and society. Social networks and apps are used to disseminate campaigns through the media, while at the same time volunteers carry out home visits or carry banners with slogans through the streets. Despite justified criticism of the 'nanny state syndrome', or the way freedom of expression is handled in Singapore, this strategy seems to be working on the issue of climate-change-related health risks, and to be strengthening social cohesion. One example is a popular music and dance

video published on Youtube to combat dengue fever, explaining ways to fight mosquitoes ('Do the Mozzie Wipeout', Kin Mun Lee), which incorporates government advice. Invoking successful collective efforts in the face of insecurity is deeply rooted in the young nation's post-colonial history and search for identity, and is also sought in the sense of the Green Transition: "Just like how we confronted many national challenges in the past, we can turn our constraints into strategic opportunities and be pioneers, [...] we can be a living laboratory. [...] Having come from mudflats to a metropolis, we will turn our metropolis into a global city of sustainability" (Singapore Government Agency, 2021). The idea is that only collectively can the city be at the forefront of evidence-based climate policy in combination with economic development, despite adverse circumstances.

As a city-state, Singapore repeatedly emphasizes its laboratory character, inviting people to try out and develop new ideas before they can subsequently be taken up in other parts of East and Southeast Asia (Hornidge et al., 2020; Hornidge and Antweiler, 2012). The scientific monitoring of experimental projects plays a key role here. For example, after two relatively small test phases, 130 government-subsidized housing complexes have been painted with a solar-radiation-reflecting paint in a large-scale pilot project under the ten-year 'HDB Green Towns Programme' (Singapore Government Agency, 2021). In combination with additional greenery, it is hoped that the ambient temperature can be reduced by up to 2°C. Again, residents are actively involved in project design and implementation, collecting data and providing feedback. Furthermore, attempts are being made to use solar and ambient heat to power air-conditioning systems. This can save up to 32% of energy use per year and cut CO₂ emissions by up to 97 tonnes (CLC, 2019; Philipp and Chow, 2020). After all, the constantly rising temperature caused by the intensive use of air conditioning is part of the problem: its energy consumption accounts for 60% of Singapore's carbon footprint (The Straits Times, 2022). Such data is obtained using scenarios and modelling in the interdisciplinary Cooling Singapore project. A procedure is used here that is also envisaged in the German Federal Government's Strategy for the Future of Research and Innovation (BMBF, 2022b: 20): a digitally created 'twin' of the city is used to simulate and research which measures are suitable for sustainable solutions and how effective plans that have already been implemented are. Green connecting corridors, roof gardens, façade planting and rainwater recycling, like in Singapore, are also sensible approaches for cities outside the tropics. Source: Dippel, 2023a

models, secure land for municipalities and/or the public sector, take local conditions into consideration when deciding on land uses, link informal and formal aspects of land use, and take precautions against corruption in the allocation and use of land (WBGU, 2016b: 181). An appreciable proportion of the urban space should be reserved for common-good-oriented uses (WBGU, 2016b: 180). This should apply both to public and (partially) to private areas, including construction projects carried out by private investors. In particular, it includes the designation and protection of publicly accessible spaces, such as paths and thoroughfares, parks, squares, playgrounds,

cultural centres and other meeting places. Against the backdrop of a worldwide dominance of private investors in urban development (e.g. in city centres), regaining public planning power is key (WBGU, 2016b).

Be more consistent in sanctioning inner-city noise pollution caused by motorized traffic

Motorized road traffic is the number-one source of noise in cities. Noise makes people ill and is an "emerging issue of environmental concern" (UNEP, 2022a). In addition to air pollution, noise pollution, especially in densely populated areas, should be consistently regulated to keep it

4 Shaping areas of life: what we eat, how we move, where we live

below the statutory limit. Speed limits and even driving bans should be imposed in cities for individual vehicle types and motorbikes that exceed a certain noise limit (UNEP, 2022b). As a rule, noise pollution can be reduced by avoiding motorized transport wherever possible: e.g. by walking or cycling (which also has multiple benefits for health; Section 4.2), sharing transport instead of using it individually (thus cutting CO₂ emissions), using quieter vehicles, adapting road surfaces, building noise barriers and soundproofed buildings. The targeted use of vegetation, e.g. in the form of tree belts, can also reduce noise pollution and provide multiple benefits for the living environment and biodiversity in settlements: a 15 m-wide belt of trees can reduce noise pollution by about 6 dBA at a distance of 50 m (The HOSANNA project, 2013; European Commission et al., 2016).

Take into account the multiple burdens of disadvantaged neighbourhoods and population groups

Disadvantaged neighbourhoods and population groups are often simultaneously affected by housing insecurity, multiple environmental stressors and poor health resources. These multiple burdens should be evaluated according to population group and given special consideration in all urban planning processes. Existing evaluation tools such as the Berlin Environmental Justice Atlas can serve as an orientation; here, noise, air pollution, bioclimatic burdens, provision of green and open spaces and social disadvantages are depicted in integrated, multiple maps. Environmental and health justice should be established as guiding principles of sustainable urban design.

Ensure safe, affordable and health-promoting housing for all population groups

When urban neighbourhoods are upgraded by redevelopment or conversion, resulting in higher property and rental prices, the traditional residential population of an urban neighbourhood is often displaced (gentrification). All measures to improve housing conditions and design neighbourhoods in a health-promoting way should therefore ensure that these population groups are adequately protected from displacement, and that the social mix is maintained. Instruments for milieu protection (e.g. prohibition of luxury refurbishments) can be used to avoid segregation processes. To ensure that existing social and health inequities are not further exacerbated, rising rents should be counteracted and cooperative home ownership promoted.

Establish a new position of Urban Chief Health Officer

The need to create a coherently health-oriented settlement and urban-development structure requires an assertive institution at the administrative level. Analogous to the functions of a Chief Digital Officer or Chief Sustainability Officer, cities should therefore establish a position of Chief Health Officer to ensure that the health dimension is taken into account in all urban- and neighbourhood-development issues. Existing structures of public health services can be used here (e.g. medical staff in health authorities).

4.3.4.2 Infrastructure and construction

Expand, connect and enhance urban green and blue spaces

Green and blue spaces have a substantially positive impact on human health and well-being; they regulate environmental stressors such as heat, air pollution and noise, and provide important other ecosystem services. Existing green and blue spaces should therefore be extended, qualitatively upgraded and interconnected wherever possible, for example by unsealing surfaces and rewilding degraded and polluted green and blue spaces. When planning green and blue spaces, existing tools for evaluating availability, quality and accessibility should be used to identify places where special action is needed. Disadvantaged neighbourhoods and population groups should be given special consideration in evaluation and planning, as they have less access to green and blue spaces. The impact of green and blue spaces is crucially dependent on how they are designed. They should therefore be designed in ways that maximize their potential for reducing environmental stressors (as spaces for recreation and physical activity) and for providing other ecosystem services.

Promote biodiversity protection in urban green and blue spaces – nationally and internationally

When designed accordingly, green and blue spaces can act as protective spaces for conserving biodiversity. To this end, the German federal government's 'Urban Nature' master plan (BMU, 2019) should be consistently implemented, given a financial boost and further developed in terms of content. The same applies to the 'Urban Nature' funding priority of the Federal Programme on Biological Diversity. This should also be internationalized within the framework of the international climate-change-mitigation initiative. 'Animal-aided design' and 'wildlife-inclusive urban design' should be promoted in the context of urban planning, and acknowledged as part of urban planning services.

Upgrade public urban areas outside of green or blue spaces to recreational and exercise spaces – and green them

Generally accessible areas can be upgraded to health resources by making them more pleasant for people to spend time in, even if they contain no green and blue spaces. Especially in densely built-up areas, spending time in public squares or streets is often associated with negative physical- and mental-health effects as a result of both noise and pollution, as well as sensory overload and social stress. Redesigning public spaces in a way that promotes health would, among other things, help to ensure that people are not exposed to avoidable health hazards during their everyday activities within their residential environment and beyond. Conceivable measures in this context include creating more generous areas for pedestrian traffic and relaxation in public squares, for greening areas, street spaces and building façades, and providing seating and a basic sanitary infrastructure (drinking fountains, public toilets). Greening should take into account the specific characteristics of the selected plant species in order to maximize the ecosystem services achieved and ensure that the vegetation is as resilient as possible to environmental stressors and changes. In addition, there are many unused or fallow areas in public spaces that could be upgraded with a health-promoting revamp without having to take space away from other uses. Special attention should therefore be paid to these unused areas.

Promote timber as a sustainable alternative in building construction; construct public buildings using timber-based methods

Modern engineered timber construction meets the demands we place on buildings today – load-bearing capacity, height, construction time, fire resistance (Crawford and Cadorel, 2017) and earthquake-proof design (Pei et al., 2019). Furthermore, the production and processing of standard construction timber emits fewer greenhouse gases than conventional reinforced concrete (Churkina et al., 2020). In particular, the CO₂ absorbed by trees during growth is stored long-term in timber, so it can represent a much more effective carbon sink than conventional reinforced concrete (Churkina et al., 2020). According to a model calculation, up to 106 Gt of CO₂ could be saved worldwide by 2100 by providing the housing needed in the future in the form of timber construction (Mishra et al., 2022). However, the land needed for sourcing timber, e.g. from plantations, can have a detrimental effect on natural, biodiversity-rich forests; the globally sustainable potential therefore needs to be precisely estimated here (WBGU, 2009). In order to actively promote timber construction as a sustainable building method, environmental costs should be priced into conventional construction, and building

regulations (i.e. norms and standards) adapted accordingly (WBGU, 2020: 238). The public sector can take on a pioneering role by constructing public buildings out of timber – using wood from sustainable forestry. For further recommendations on timber construction, see the WBGU report ‘Rethinking Land in the Anthropocene: from separation to integration’ (WBGU, 2020).

Reduce greenhouse-gas emissions from concrete construction

The current dominance of concrete in the construction of new housing and the infrastructure needed for it will probably continue in the coming decades, even if the use of wood and other sustainable building materials increases (Habert et al., 2020). It is therefore necessary to significantly reduce greenhouse-gas emissions by improving energy and resource efficiency in each phase of conventional cement and concrete production and use. This should be done at the material level by using supplementary cementitious materials or modern, recycled types of concrete. In addition, there is a need to improve building practices internationally, especially in low- and middle-income countries where the biggest increase in demand for concrete is expected in the future. For example, the use of ready-mixed concrete from concrete plants can reduce the amount of cement in concrete; stricter control of hardening time and water use, as well as better training for construction workers, can also improve resource efficiency on construction sites (Habert et al., 2020).

Promote the reusability and recyclability of building materials

Increasing the reusability of building materials requires, among other things, designing buildings in a way that allows modular disassembly – e.g. by using simpler components (Kleinhenz et al., 2016) – and, at the same time, minimizes losses and chemical pollution during deconstruction (Bertino et al., 2021; Hopkinson et al., 2018; Eberhardt et al., 2019; Ghisellini et al., 2022). Sustainability can be further increased by choosing circular materials and material combinations that are easily separable and reusable (Eberhardt et al., 2019). Changing the concrete structure towards lighter components (e.g. gradient concrete) and timber hybrid ceilings would also improve the CO₂ balance of the buildings (Schmeer and Sobek, 2018; Sobek et al., 2019; Huber et al., 2019). In order to implement a circular economy in the building-materials sector, more work should be undertaken on databases for materials and components that cover building materials, the degree of their reusability and recyclability, including suitable, standardized methods for life-cycle analysis. This requires information on old and new buildings to be made available to municipalities, construction

4 Shaping areas of life: what we eat, how we move, where we live

companies and private individuals (RessStadtQuartier, 2021; Cai and Waldmann, 2019). An assessment of the reusability of building materials is also required for the deconstruction of old buildings (e.g. project DIN SPEC 91484, DIN, 2022). The secondary products should be processed locally and to a high quality in order to reduce energy-intensive logistic processes and downcycling – in which materials experience a loss of quality as a result of processing (Helbig et al., 2022). Qualitative certification is required for secondary building materials and components (Braun et al., 2022; UBA, 2022a). In addition to this certification, proof of the ability to recycle and re-use a primary and secondary building material as a prerequisite for building-material approval can help promote sustainable construction (UBA, 2022a).

Promote sustainable and more efficient water management by recycling water

More efficient water use can reduce the risk of water scarcity and increase both economic and environmental resilience. Water re-use is a promising option here, as drinking-water quality is not required for many applications. Various approaches to water re-use should therefore be promoted, both small-scale (e.g. grey-water recycling for toilet flushing and washing machines) and larger-scale (e.g. irrigation of green spaces with treated waste-water). More efficient water use and lower water demand also lead to less demand for energy and thus to reduced greenhouse-gas emissions (UNESCO, 2020b).

Develop and apply precautionary strategies for protecting water resources at the municipal and regional level

Against the backdrop of advancing climate change, precautionary water-resource strategies should be developed at the municipal and regional level, especially in cities that will be increasingly affected by droughts in the future. These strategies should preferably be developed in the area of the respective watershed. A core element of such strategies is a comprehensive risk assessment based on current hydrological data and models that consider different climate scenarios. In addition, technical adjustments are necessary: any type of waste-water (industrial, municipal, agricultural) should urgently be treated either technically or in a natural way to the extent that there are no emissions of pollutants and nutrients into surface waters (e.g. lakes and rivers) that are relevant to health or the environment, in order to conserve them as water sources. Water re-use should be explored to diversify water sources. Measures for the decentralized infiltration of rainwater not only make local groundwater recharge possible, but also contribute to protection against floods and urban flash floods. Involving the population, especially in clarifying socially sensitive issues such as

water distribution, is essential for the acceptance of a precautionary water-resources strategy.

Improve energy supply and health in an integrated way

Energy strategies should be linked to strategies for resilient health systems (Section 6.5.1) and supplemented with a component geared towards health systems. This requires, above all, strengthening development-cooperation programmes for improved access to ‘clean’ energy and electricity. Existing platforms such as EnDev or GET.pro are suitable for this (GIZ, 2021, 2023). In low-income countries, a focus should be on the distribution of clean and efficient cooking facilities. These should be locally adapted and low-maintenance, made widely available through robust supply chains and, where necessary, affordable by means of subsidies (Pattanayak et al., 2019; Bensch and Peters, 2019; Jeuland et al., 2020; Bensch et al., 2021). Another focus should be on a reliable power supply to health facilities. Local electricity grids can be developed or consolidated around these facilities on a case-by-case basis. The use of local supply chains and capacity for assembly and maintenance also contributes to greater resilience, acceptance and integration in the broader development agenda. Opportunities for the economic inclusion of the local population in decentralized power generation plants are important in this context. Even in industrialized countries, an assessment of the existing energy infrastructure is often still necessary to determine vulnerabilities and priorities for adjustment, and to develop recovery plans in the event of disruptions (IEA, 2022a, c). A comparison should be made with the challenges and strategies for resilient and climate-change-adapted health systems (Section 6.5.1).

4.3.5

Research recommendations

Promoting and ensuring healthy and sustainable housing conditions involves new challenges for urban and settlement development in view of global urbanization dynamics and advancing climate change. Research can and should provide important answers on how sustainable, climate-sensitive and health-promoting construction and housing can succeed, be interlinked and accelerated globally, so that unplanned settlements spread as little as possible. Research can also identify potential synergies in addressing the various challenges.

As early as 2016, the WBGU saw a need for research on ‘urban health’, for example on the conditions of a paradigm shift from a post-cautionary to a precautionary, health-promoting perspective. In addition, the WBGU has ascertained that health disparities within cities are

only slowly coming into the focus of research and policy. In particular, there is a lack of disaggregated data describing urban health, i.e. data on morbidity, mortality and risk factors that should be linked with demographic, socio-economic and spatial variables (WBGU, 2016b: 459). These data are fundamental for health-promoting and environmentally sound spatial and settlement planning. Furthermore, there is little evidence on how climate change affects urban health, especially in low- and middle-income countries, and how resilience can be promoted. There is also little data on access to health services by different population groups. Finally, the WBGU (2016a) recommended research on the question of how non-communicable diseases can be reduced in cities, and how behavioural changes in the population can be triggered in a target-group-specific manner.

The following research recommendations build on these WBGU recommendations based on a salutogenetic perspective (Box 4.3-5) and focus on the interface between environment, climate and health.

4.3.5.1

Planning and governance

Research on integrating health into overarching urban agendas

The WHO has identified approaches to integrating health into overarching urban agendas as a priority research topic for the next ten years (WHO, 2022f). Research is needed to enable health professionals to better integrate health into economic, social and other development plans and policy-making processes. Secondly, the relationship between political, environmental, economic and social factors in the urban environment and health outcomes should be explored. Thirdly, research is also needed on the impact of spatial inequities within cities on vulnerable groups and their access to health services and health equity (WHO, 2022d).

Investigate methods for implementing the 15-minute city in the context of urban regeneration

The 15-minute city is gaining more and more acceptance and appeal in urban design. Further research should therefore show how this approach can be implemented on a broad scale, especially in the context of urban-regeneration measures, and which planning and incentive models are conducive to it (Moreno et al., 2021). Special attention should be paid to the enforceability of planning measures vis-à-vis a housing sector that is dominated by the private sector. To operationalize the 15-minute city, further studies are needed to understand the respective significance and interlinkages of density, proximity, diversity and digitization. Interdisciplinary teams can best explore urban systems and health, and

develop refined policies and research approaches for identifying appropriate interventions and incentives for private investors towards the creation of a 15-minute city.

Improve knowledge about the health risks of vulnerable groups

There is a need for research on the health risks of vulnerable groups (WHO, 2022f). This includes, firstly, research into urban inequities, their role in exacerbating health risks at the neighbourhood level, and how eliminating these risks can improve health equity. Factors such as social-group membership, gender, disability, age and ethnicity should be taken into account. Secondly, there is a need to collect, assess and, where appropriate, develop local and global indicators to monitor and evaluate urban health interventions aimed at specific population groups (e.g. age-friendly cities) and to increase equity (e.g. with regard to migrants and ethnicity, by gender or socio-economic status).

Intensify research on climate change and urban health

The interrelations between climate change and urban health (WHO, 2022f) are under-researched to date, as are intervention options. These include, above all, health-promotion measures in different geographical contexts such as island states, coastal areas, arid zones or the tropics. Research is also needed on the impacts of climate change on population groups at risk, and on ways to reduce their vulnerability and improve their health. Finally, interactions between climate change and other health threats are another field where a lot more research is needed.

Examine interactions between different stressors of urban life and identify potential ways to reduce stress

Simultaneous social density and social isolation are discussed as social stressors and important psychological stress factors in cities (Adli, 2020). Furthermore, it has been determined that spending time in busy street spaces has negative impacts on physiological health parameters (Kabisch et al., 2021). A lot more research is needed on interactions between different stressors, the conditions under which they increase the morbidity and mortality of mental and physical illnesses, and on vulnerable population groups (Adli, 2020). This is particularly relevant against the background of increasing densification. Moreover, research should be conducted into how cities can be designed to be as stress-free and health-promoting as possible. Knowledge about the diseases associated with urban stress can provide an important basis for this.

4 Shaping areas of life: what we eat, how we move, where we live

Explore experience with innovative urban legislation

The ‘right to the city’ was enshrined in Brazil’s national constitution in a reform of Brazilian urban planning that has received much attention, especially in low- and middle-income countries (Section 4.3.3.5). There should be research to determine to what extent this could address the concerns of marginalized and poorer population groups in urban development, especially women, people with disabilities, homeless people and people with a migration background. The experience of other countries with similar laws and tools based on this, e.g. with Zones of Social Interest, should also be examined. South-South research cooperation could be initiated for this purpose.

Strengthen the link between research results and their implementation

An important recommendation of the WHO (2022f) in its ten-year strategy for research priorities on urban health is to strengthen the link between research findings on urban health and their application or appropriate measures. In particular, methods to improve knowledge transfer from research to application should be identified. This would comprise sharing knowledge, creating and disseminating databases, applying systems thinking and predictive methods, using comparative urban-health research, and monitoring the impact of policies and measures. It includes research on mapping existing urban-health interventions and their effectiveness and facilitating factors (framework conditions and intervention design). Examples include the effectiveness of land-use-planning measures, public spaces, green and open spaces, nutritional environments, road safety, active mobility, child- and age-friendly environments, upgrading informal settlements, water and sanitation, housing, and air, soil and water pollution. Finally, research is also needed on existing health-assessment tools (e.g. Health Impact Assessment, Urban HEART). This particularly concerns their application in different urban environments.

4.3.5.2

Infrastructure and construction

Investigate the health impacts of urban green and blue spaces

The positive health impacts of urban green and blue spaces have been increasingly studied in recent years, but much research is still needed. Due to the great diversity of cities, requirements differ greatly. Research should be conducted on how green and blue spaces should be designed to meet specific requirements for ecosystem services, health benefits and social and cultural needs. In addition, green and blue spaces should be as resilient as possible in the face of increasing environmental changes. Here, transdisciplinary and practice-oriented studies are

particularly needed on how these spaces can be designed in a health-promoting and resilient way.

Improve the data basis on green and blue spaces and set up urban observatories

The data basis on green and blue spaces should be improved. Moreover, there is a need to merge existing data with data that will be collected in the future, and to standardize the methods of data management. This includes capacity building for remote sensing using satellites or drones. In addition, a global network of ‘urban observatories’ should be established to carry out small-scale monitoring of air and other forms of pollution. Only in this way can green and blue spaces be planned and established in a targeted manner.

Study the health impacts of urban nature

The unequivocal benefits of urban nature, such as strengthening mental and physical health or improving the microclimate, can be offset by potentially negative effects such as pandemic risks or conflicts between humans and wildlife. Research on avoiding such conflicts and risks, and on the role of urban-planning concepts like ‘animal-aided design’, should be better funded and expanded.

Promote the development of sustainable and circular building materials

Modern materials research and new materials with suitable physical and chemical properties can make a major contribution to improving resource efficiency and environmental protection in construction, and to health protection. Noise, light, humidity or drying properties, temperatures, indoor climate and filtration effects can all be influenced by building materials with different properties; moreover, research is also being conducted on ‘self-healing’ building materials, for example (Kanelopoulos and Norambuena-Contreras, 2021; Wang et al., 2022). Suitable material properties and ‘design for recycling’ (e.g. refurbishment, re-use, renovation of old buildings using aerosols) can play an important role for durable building methods, re-use and recycling worldwide, alongside renewable raw materials and recycled concrete. The research and development of suitable materials and concepts for durable construction methods should be promoted.

Initiate comparative studies on climate-friendly construction methods and natural building materials

In addition to building with wood, other ways of reducing the use of climate-damaging building materials include the use of modern and recycled materials, straw-bales, clay (bricks or rammed clay) and stone. Unlike timber

construction, however, they are less often perceived as viable alternatives. Comparative studies on the GHG emissions of different construction methods or on the locally adapted use of different natural building materials (resource availability, overall economic conditions for production and transport, the necessary technical properties of the building material, durability, re-use, scalability) can provide clarity here. Materials ageing should also be taken into account in life-cycle analyses. This applies not only to alternatives to environmentally harmful types of concrete, but also to alternative materials for building insulation, such as modern, sustainable insulation materials or cork, hemp and jute, among others. In addition to GHG emissions, pollutant emissions should always be considered, especially for substances that can be emitted indoors and thus contribute to air pollution. There is a particular need for research in low- and middle-income countries. In this context, research institutes on construction and building materials should be even more strongly networked internationally.

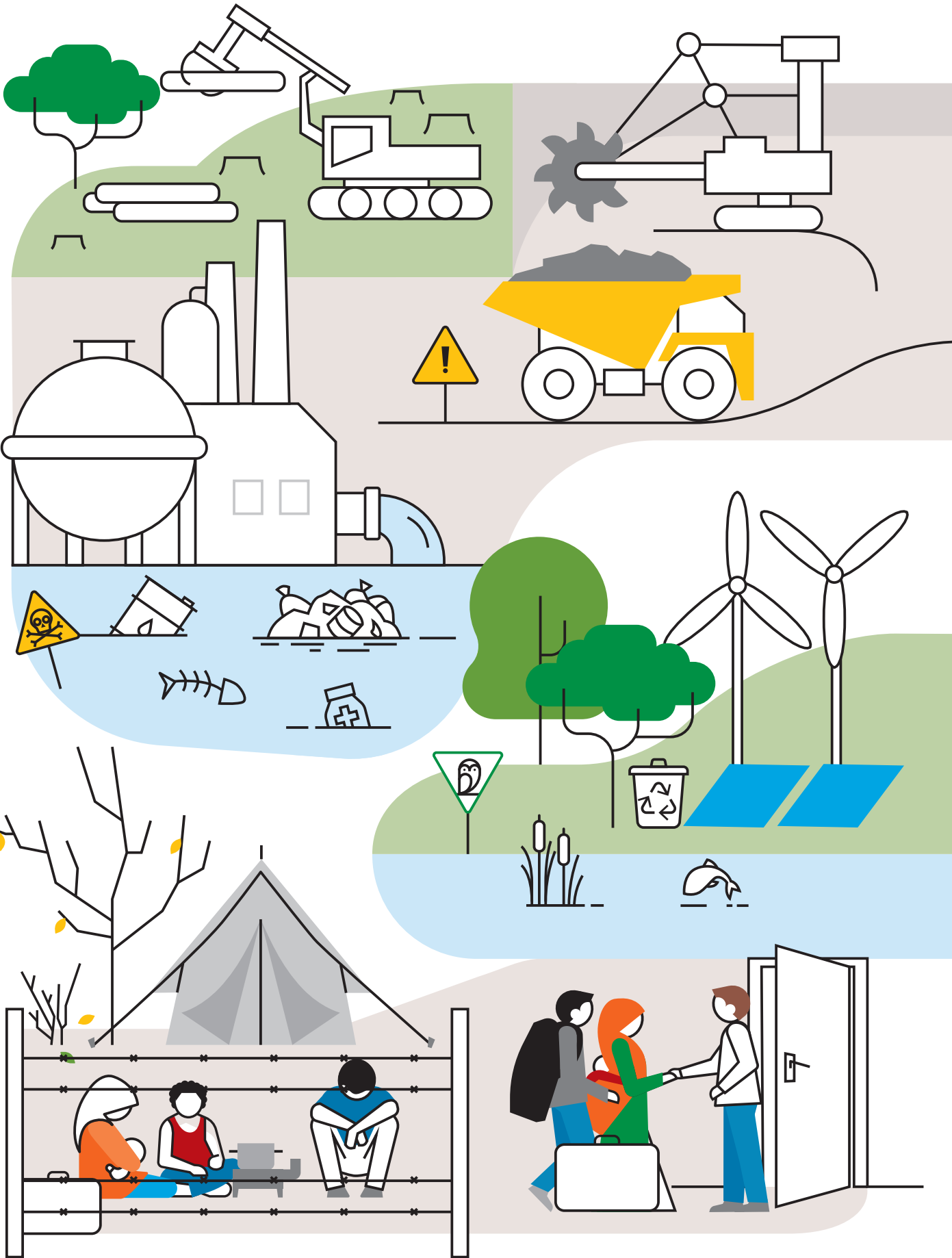
of these impacts have come mainly from laboratory tests. The extent to which outside ecosystems could be altered by light pollution is unclear and requires extensive research. Areas of uncertainty include the effect of different light sources, the impact on hormonal changes, shifts in species communities, and invasive species, the impact of pollinator loss on plant communities, and the importance of light pollution in combination with factors such as urbanization and climate change (TAB, 2020).

Examine the conflict of objectives between the use of natural building materials and the protection of biodiversity

According to a model calculation (Mishra et al., 2022), a transition to the intensive use of wood as a building material could lead to an increase in forest plantations, mainly at the expense of unprotected natural forests and other natural vegetation. Further studies are needed on possible conflicts between the aims of biodiversity conservation and an increased use of timber and other natural building materials (e.g. clay, straw), specifically on the globally sustainable potential in each case, on how much land is available and how much needed, and on future uncertainties due to climate change.

Investigate the potential impacts of light pollution

There are already indications of the possible impacts of light pollution on health and the environment (TAB, 2020) but not yet sufficient data to prove a causal linkage to health risks. In addition to the acute effects of light at night (such as sleep deprivation), it is suspected that artificial light indoors can also affect the synchronization of the body's own rhythms with the natural alternation of day and night. The result can be circadian sleep-wake rhythm disorders. There is a need for research here, especially on light pollution in outdoor areas and on the extent of the rhythm shift at which health hazards can arise. Light pollution is also suspected of changing the behaviour and composition of species in flora and fauna. This could affect both nocturnal and, indirectly, diurnal species and entire ecosystems; cascading, as yet incalculable impacts on ecosystems and biodiversity could result. Up to now, indications



Managing planetary risks: climate change, biodiversity loss, pollution

Health requires a halt to climate change, biodiversity loss and global pollution. This implies, among other things, stopping the exploration of fossil fuels and increasing efforts of nature conservation to prevent zoonotic pandemics. In addition, regulated forms of human migration should be developed and the migration of species facilitated by networked protected areas. Pollution should be politically addressed more strongly and a global framework convention on hazardous substances should be negotiated following the guiding principle of ‘zero pollution’.

The urgency of preserving natural life-support systems becomes particularly clear in view of the massive impacts of global environmental changes on human health and well-being that can already be felt today (Section 2.3). However, preserving natural life-support systems is not only about the planetary dimension, it is always also about avoiding local environmental problems, for example by preventing harmful emissions. Both dimensions of environmental protection, global and local, are crucial for the interconnectedness of humans and nature and are decisive prerequisites for human and planetary health. In this chapter, the WBGU focuses on climate change and biodiversity loss (Section 5.1) and the rising global pollution with hazardous substances (Section 5.2)

interact. Section 5.1.2 sets out priority issues which, in the WBGU’s view, deserve more political attention: ending the exploration and extraction of fossil resources (Section 5.1.2.1), preventing zoonotic pandemics (Section 5.1.2.2) and dealing with increasing habitat loss for humans and nature (Section 5.1.2.3).

5.1

A stable climate and high biodiversity for healthy ecosystems and healthy people

Climate change and the loss of biodiversity are detrimental to the health of species, ecosystems and humans. The impacts affect the sustainable functioning of ecosystems, human societies and planet Earth (Section 2.3). Healthy living on a healthy planet will therefore only be possible in the long term if both climate change and biodiversity loss are halted. Section 5.1.1 summarizes the most important recommendations for climate protection and biodiversity conservation and explains how the two

5.1.1

An integrated approach to climate-change mitigation and biodiversity conservation

A stable climate is inconceivable without healthy ecosystems and their ability to regulate the climate over long time scales. Stopping global deforestation and excessive livestock husbandry – and restoring overcultivated, degraded soils and destroyed ecosystems – are essential contributions to the long-term stabilization of the global climate. The prerequisite for such stabilization, however, is halting anthropogenic climate change by largely ending CO₂ emissions from fossil-fuel combustion, which still generates about 80 % of the world’s primary energy (Clarke et al., 2022: 698). From 2020 onwards, a maximum of 500 (400) Gt CO₂ may be released into the atmosphere if warming is to be stopped with a probability of 50 % (67 %) at 1.5°C, and a maximum of 1,150 Gt CO₂ if it is to be stopped with a probability of 67 % at 2°C (IPCC 2021a: 29, 2022b). With current annual emissions at more than 37 Gt CO₂ from fossil fuels and 4 Gt CO₂

from land-use changes (Friedlingstein et al., 2022), these budgets could be used up in just over a decade or in just under three decades. Taking climate variability into account, global warming is likely to intermittently reach an average value of 1.5°C as early as the second half of this decade (IPCC, 2021b).

Russia's invasion of Ukraine has triggered a global energy crisis; among other consequences, the number of people without access to modern energy is rising again for the first time in ten years (IEA, 2022a: 29), with corresponding health risks from the resurgence in the use of unhealthy fuels for cooking (e.g. traditional bioenergy such as wood or charcoal). The global energy transition needed to protect the climate and health must therefore always be understood as twofold: on the one hand, it is a matter of safe access to modern, non-harmful energy for all people; on the other, it is about a complete phase-out of the use of fossil fuels for energy production. Hope comes from the enormous fall in the cost of technologies that are relevant for the energy transition. Between 2010 and 2019, for example, the unit cost of solar energy fell by 85%, that of wind energy by 55% and that of lithium-ion batteries by 85% (IPCC, 2022b: 12).

Reducing other greenhouse-gas emissions, such as those from agriculture and forestry, is an essential prerequisite for maintaining the 1.5°C guard rail – but this alone cannot stop climate change as long as considerable amounts of CO₂ from fossil fuels continue to enter the atmosphere. The same applies to the removal of CO₂ from the atmosphere. It will probably be necessary for limiting climate change to 1.5°C, but it can be no replacement for the resolute reduction of anthropogenic CO₂ emissions (WBGU, 2021). Similarly, the contribution of ecosystems to climate-change mitigation through carbon storage can only make a difference if warming is limited to 1.5°C – because the health of ecosystems is threatened not only by ongoing environmental degradation but increasingly also by climate change (Section 2.3; IPCC, 2022d).

Ecosystem degradation and biodiversity loss have fundamental implications for human health. Important regulating ecosystem services are lost, including ensuring stable climate conditions, clean air, clean water and productive soils, as well as the supply of biological resources such as food, bioenergy, building materials and medicines. In addition, this reduces the resilience of ecosystems, i.e. their ability to re-establish an ecological balance after disturbances. It is not only humans who suffer, but also all other living creatures such as animals and plants. For example, about a million species are currently threatened with extinction (IPBES, 2019), some of whose function in ecosystems has not yet even been understood.

The main drivers of ecosystem degradation and biodiversity loss are changes in the use of land, freshwater and oceans, mainly by agriculture and forestry and for infrastructure – e.g. mining, urban development, transport and energy – and the overexploitation of natural resources – e.g. logging, hunting and fishing (WBGU, 2021: 85; IPBES, 2019). The negative impact of climate change on biodiversity is also becoming increasingly visible (IPCC, 2022d). The dimension of the threat is made clear by the loss of habitats as a result of climate change. For example, endemic marine fauna in the polar regions is threatened with extinction (Penn and Deutsch, 2022). In this respect, it is essential to safeguard the remaining intact ecosystems from further destruction, to protect them in the long term and to strengthen their resilience to climate change (Box 5.1-1).

Far-reaching decisions on this topic were taken in 2022 within the framework of the Convention on Biological Diversity (CBD). The Kunming-Montreal Global Biodiversity Framework envisages expanding protected areas for biodiversity conservation to at least 30% of terrestrial ecosystems and inland waters as well as marine and coastal areas worldwide by 2030 (30x30 target; CBD, 2022). The focus is to be on areas that are particularly important for biodiversity and ecosystem services, and on ensuring that these are effectively managed (CBD, 2022). Also outside of protected areas, utilized ecosystems need effective management and sustainable farming methods (i.e. sustainable agriculture, forestry and fisheries) to maintain their functionality and ecosystem services (CBD, 2022). In addition, already damaged or destroyed ecosystems in and outside protected areas are to be restored (CBD, 2022) with the emphasis on the restoration of near-natural ecosystems adapted to local conditions (WBGU, 2021; Geschke and Fischer, 2021). Indigenous peoples and local communities are to be appropriately involved in the management of areas that are important for biodiversity (CBD, 2022) – for reasons of human dignity, to resolve conflicts of interest, to use traditional knowledge and practices, and to avoid conflicts between humans and wildlife. The sustainable use of natural resources by indigenous peoples and local communities must not be suppressed in this context (CBD, 2022).

When formulating strategies and measures for climate-change mitigation and biodiversity conservation, synergies can arise, but so can conflicts of objectives. This can be the case, for example, in the energy or food sector. Implementing the integrated landscape approach, combining different forms of use in a mosaic-like manner in one area, offers options and instruments for realizing synergies and constructively addressing trade-offs (WBGU, 2021: 42; Pörtner et al., 2021).

Parallel to this, adaptation to climate change is essential for humans and nature. Exploiting corresponding options for action makes it possible to shift some, especially societal (soft) adaptation limits and to mitigate future risks (IPCC, 2022d). For some communities and ecosystems (warm-water corals, high mountains), however, hard adaptation limits

have already been exceeded; the affected ecosystems are in retreat, people are losing their livelihoods and are confronted with the need to abandon ancestral areas. Clearly formulated adaptation limits and risk thresholds (Box 2.3-1) provide guidance for ambitious action in climate-change mitigation and biodiversity conservation.

Box 5.1-1

Health for species and ecosystems must also be considered

To ensure effective climate-change mitigation and biodiversity conservation, it is necessary to develop criteria for the health of species and ecosystems and, on this basis, to formulate and implement targets for protecting biodiversity and developing healthy and therefore resilient ecosystems. A transfer of the concept of health to species and ecosystems is also proposed by integrative health concepts such as One Health, Planetary Health and EcoHealth, and is taken up by the WBGU in its vision (Section 3.3). However, there are still no clear concepts available for achieving the corresponding health goals. In a similar way to human health systems, the relevant actors should be provided with the necessary criteria (e.g. involving nature conservation) with which to maintain or restore a healthy environment and, overall, healthy ecosystems for species, communities and biodiversity.

What is a 'healthy ecosystem'?

A natural ecosystem is a community of species and their individuals with characteristic biodiversity and characteristic interdependencies or interactions of species, for example in the food web or through competition. In this context, the health of individuals of these species can be defined physiologically and biochemically in a similar way to the physical and mental health of a human being. Veterinary approaches are relevant for animals, and the phytomedical science of plant disorders is relevant for plants. However, both concentrate mainly on species of farm animals or crops that are kept or grown in human-designed environments such as stables, cages or gardens. The current discussion is primarily about animal welfare and housing animals in a way that is as species-appropriate as possible. In nature, the natural environment of a species is of great importance for maintaining its health. Here, the physical health and well-being of individuals at the population level initially add up to the health of the population in a region. For animals and plants, the relevant area is the area that a population needs for the community and interactions with populations of other species, or for retreating into resting areas. According to recent findings, communities also include diverse types of microorganisms which are grouped together in microbiomes of the animal or plant body and the environment (e.g. of soils; Box 4.1-6). Interaction between the organisms ensures food or nutrient acquisition and processing, immunity, manifestations of life such as behaviour and reproduction, and finally genetic diversity and thus the preservation of populations and species. Communities are also specially adapted to characteristics of their abiotic environment, e.g. the climate zone.

Structures of human society are sometimes compared to an ecosystem. However, the analogy with human society works better in relation to the specific development of societies of

a species (e.g. ants, bees) with their (settlement) structures in a natural environment. These societies, too, interact with other species. The terms health and disease are thus applicable to individuals of a species and, beyond that, also to the structure, behaviour, nutritional status, stress level, environment or infestation of a population with pathogens (see e.g. Tregenza et al., 2022 on behaviour; see e.g. Newediuk and Bath, 2023 on stress level). The generally applicable and comparable criteria for health still need to be worked out by conducting appropriate research, especially on the health of populations (and ecosystems, see below). To apply them, there is a particular need for research on characterizing, measuring and restoring the natural environment and its importance for communities of wild species, because many landscapes have been greatly transformed by humans; this should be accompanied by measuring the health criteria in individuals and populations (Kophamel et al., 2022).

Finally, the findings for individuals and populations flow via the community level into the concept of ecosystem health (e.g. Costanza and Mageau, 1999; Rapport et al., 1998), which describes an ecosystem's qualitative condition. Based on this, health can be defined as "the status and potential of an ecosystem to maintain its organizational structure, its vigor of function and resilience under stress, and to continuously provide quality ecosystem services for present and future generations in perpetuity" (Lu et al., 2015: 3). A reference for different quality levels of health can be provided by the idealized ecosystem in its largely pristine state, unaffected by humans (or invasive species). However, since this state often no longer exists, it can be approached via various concepts such as 'rewilding' or 'potential natural vegetation' and other reference models, also by assessing previous human influences and uses (IPBES, 2019; WBGU, 2021: Fig. 3.1-4). Given the human interest in ecosystem use, in this case the definition of ecosystem health may involve some degree of value judgement and is often not a purely objective, scientific concept, but also a normative concept involving specific societal goals (Costanza, 2012; Lu et al., 2015).

Ecosystem health has become an active area of research and dialogue over the years and has developed into a 'guiding framework' (Costanza, 2012) and a useful tool, for example in the characterization and assessment of mangrove ecosystems (Faridah-Hanum et al., 2019), agroecosystems (Ashok et al., 2020) and other marine ecosystems (Yang et al., 2021). This applies, for example, to characterizing the state of marine and coastal ecosystems with the aim of informing the public and decision-makers (Harwell et al., 2019). Although several indicators exist for assessing the health or health status of ecosystems (e.g. Table 5.1-1), so far neither the health of populations (see above) nor ecosystem health can be measured by one or more generally applicable indicators. Perhaps more comprehensive indicator systems – such as the Essential Biodiversity Variables (Schmeller et al., 2018) or a further development of them – can make a contribution here in the future. Selected indicators

Table 5.1-1

Example of a classification of indicators for assessing ecosystem health. The described biological, physicochemical and socio-economic indicators are proposed as the three main categories for assessing ecosystem health.

Source: Lu et al., 2015: 5

Classifications	Major indicators
Biological indicators	
Ecosystem level	vigor, organization, resilience
Community level	biomass, productivity, biodiversity, organization structure, trophic structure, relationships within and between species
Population and individual level	individual organization, biochemical reactions, age structure, size structure, natality and mortality, individual growth rate, yield, geographic range
Physicochemical indicators	
Air	air composition, degree of air pollution
Water	water resources, precipitation, level of eutrophication, degree of water pollution, degree of sediment pollution
Soil	physical characteristics, chemical characteristics, soil structure, soil enzyme activity, degree of soil pollution
Socioeconomic indicators	
Human Health	mortality rate, incidence of major disease, potential risks to human health arising from environmental factors
Ecosystem services	use of natural resources, conservation of water and soil, recreation and aesthetics, sustainability of services provision
Influence of human activities	industrial emissions, land use, legislation, public participation

necessarily only reflect facets of the respective ecosystem on a spatio-temporal scale (Kelly and Harwell, 1990). As a result, in most cases there is as yet no adequate, more profound, causal understanding of impairments of ecosystem health.

Pathways to healthy ecosystems

Accordingly, ecosystem-specific criteria are required to restore and maintain health. Structural organization, vitality and resilience reflect the structure, function and resistance of the ecosystem (Costanza and Mageau, 1999; Costanza, 2012). The so-called biophysical dimensions (physical environment, species composition, population density) and – in habitats shared by humans and nature – socioeconomic dimensions (nature’s contributions to people) characterize the health of ecosystems, which vary in their closeness to nature. They may also include the contribution of an ecosystem to human health (Rapport et al., 1998; Lu et al., 2015; IPBES, 2019). Here, the greatest challenge is the “[e]ffective integration of ecological understanding with socioeconomic, biophysical, biogeochemical, and public-policy dimensions” (Lu et al., 2015: 1) as a prerequisite for implementation. The socioeconomic and political dimensions here encompass human interests. According to Buse et al. (2018), this concept of ecosystem health can be seen as a precursor of the EcoHealth concept. However, EcoHealth, One Health or Planetary Health (Box 3.3-3) still focus too much on environmental risk factors for human health and (from a human perspective) the desired integration of human health into its ecological environment. However, up to now they have also failed to integrate the different dimensions (Morand et

al., 2020), for example in successfully protecting the health of ecosystems.

Implementation of the ‘healthy living on a healthy planet’ vision will therefore require the systematic promotion of ecosystem health (taking into account the health of both individuals and species populations) by fighting ‘diseases’, by prevention, spatial planning, restoration and resilience building (Box 3.1-1), in a similar way to human health systems and their health services (Section 6.1.1). To enable degraded ecosystems to recover, the measures should, as far as possible, lead back to something close to their original state, or to a state of high biodiversity that has historically functioned sustainably. In order to ensure resilient ecosystem health, species and ecosystems first require a certain minimum amount of space that enables them to maintain biodiversity with a high level of genetic variety, self-sustaining population sizes (Hoban et al., 2022) and the lowest possible extinction rate. The first step is a global target of promoting biodiversity on 30% of land and ocean areas by 2030 by means of conservation or other effective area-based measures (CBD, 2022). Another aim is to preserve essential functions such as safeguarding the stored carbon necessary for climate protection, and to continue this storage without interruption or enhance it through restoration. Whether the objectives are achieved also depends on (re-)establishing suitable living conditions for the community of species that provides these services (‘provision’ of space, microclimate, species composition, nutrients and nutrition). The spatial requirement should be specified depending on the ecosystem and can also exceed the figure of 30% of protected



area for the conservation and regeneration of biodiversity. For the Amazon rainforest, a requirement of as much as 80% protected area is postulated in order to maintain the ability to self-regulate its climatic conditions (Pörtner et al., 2023). The specific criteria and objectives for diverse ecosystems, from the protected to the sustainably used, should be the subject of further research. Finally, the healthy mosaic landscape described in Figure 5.1-7 can include a productive neighbourhood of largely protected and native ecosystems, spaces used sustainably and jointly by nature and humans (shared spaces), and intensively used spaces such as settlements (Pörtner et al., 2023). In urban areas, planning for the design of green and blue spaces would also follow corresponding criteria.

For a concerted national and international approach, a coordinated, multilateral strategy should be sought, and its implementation promoted through reporting (e.g. in national reporting on Target 1 of the Kunming-Montreal Global Biodiversity Framework) and the exchange of information. The task of developing health competence for ecosystems should also involve

the above-mentioned veterinary and phytomedical disciplines as well as conservation physiology and conservation ecology. To achieve health competence for ecosystems, a cross-cutting action programme could initially involve nature-conservation authorities and planning and landscape-management offices, supported by privately organized associations and NGOs. This would make it possible to pool relevant knowledge and coordinate implementation. Figure 5.1-1 shows that human and ecosystem health can be achieved in parallel and can mutually reinforce each other. In this context, knowledge of the physiology and pathophysiology of humans, farm animals and crops offers starting points for identifying health criteria for species, populations and possibly ecosystems (by looking at them in an integrative way). Mutual learning between health systems for species and ecosystems on the one hand and health systems for humans on the other (Chapter 6) makes an optimal implementation for both conceivable.

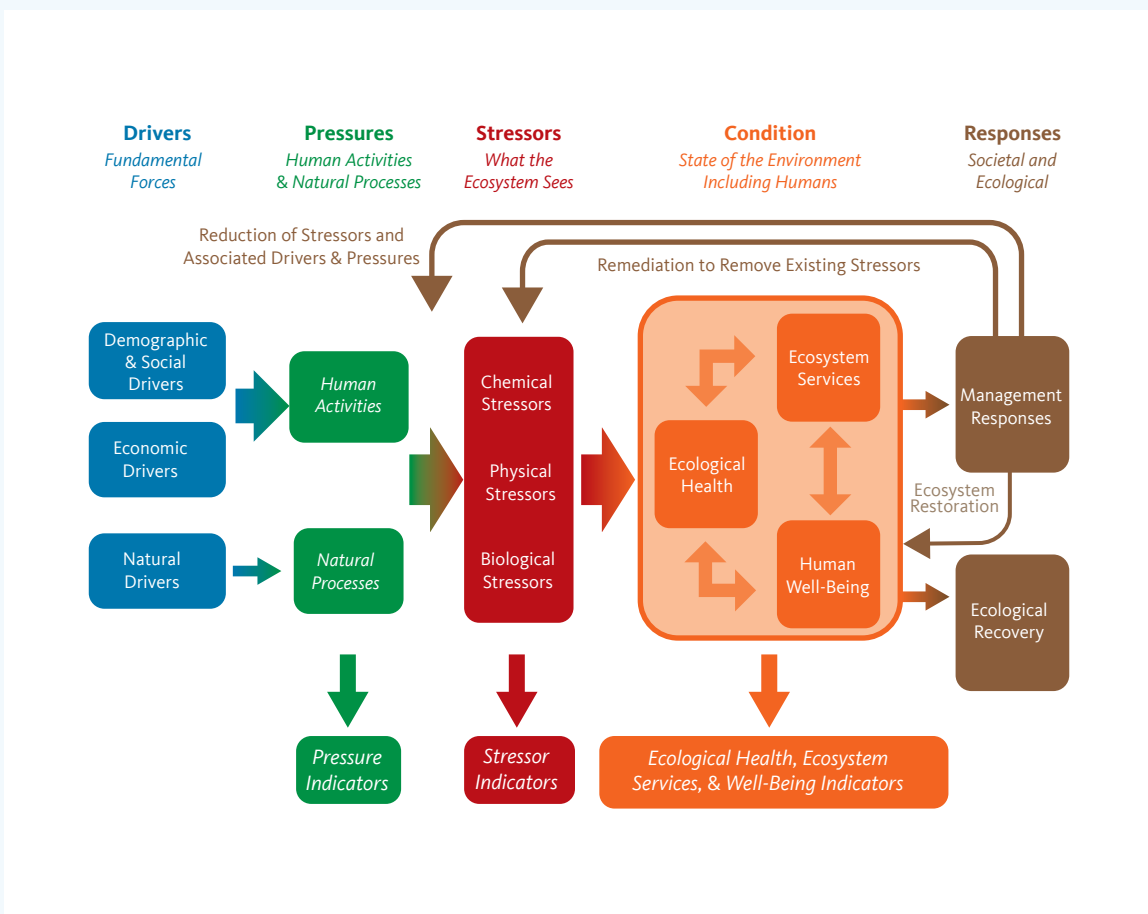


Figure 5.1-1

General methodology for deriving indicators and management responses to achieve both human and ecosystem health in parallel. The conceptual framework consists of the following elements: drivers – pressures – stressors – condition – responses. By means of a comprehensive set of filters, information on the coupled human-ecosystem is systematically subdivided and filtered to derive a specific set of indicators and measures. A report on the health of the ecosystem can be drawn up on this basis.

Source: Harwell et al., 2019; adapted

5.1.1.1

Overarching recommendations for both climate-change mitigation and biodiversity conservation

- ▶ *Abolish harmful subsidies; correct balance sheets:* Harmful subsidies that drive climate change or biodiversity loss should be redirected or abolished. This applies, for example, to subsidies for fossil fuels, which should be abolished immediately while compensating for social hardship, and to subsidies for cultivating fodder or energy crops that lead to deforestation and biodiversity loss. Public and private sector reporting, taxes, levies and tariffs should take the hitherto externalized environmental and health costs into account.
- ▶ *Reconcile infrastructure investments with climate-change mitigation and biodiversity conservation; avoid path dependencies:* An important success factor for the global energy transition is avoiding undesirable path dependencies and lock-in effects. Infrastructure investments, for example, can influence trends in emissions for decades. Phasing out the use of fossil fuels and expanding renewable energies must therefore go hand in hand to avoid supply bottlenecks that could lead to a return to fossil fuels. Lock-in effects caused by new investments in the exploration and extraction of fossil energy sources must be avoided (Section 5.1.2.1). In addition, biodiversity protection should be taken into account in each case. Land conversion for new infrastructure (housing, roads, industry) should be geared towards the 30 × 30 target and integrated mosaic landscape planning to protect natural areas and biodiversity.
- ▶ *Advance the global energy transition:* The shortage of fossil fuels resulting from the Russian war of aggression on Ukraine should be actively used to accelerate a successful transformation of energy systems; emissions should be reduced to a path compatible with a 1.5°C global warming limit. A concerted mix of market-based and regulatory measures can coordinate the transformation of interdependent sectors, help avoid energy shortages, mobilize market forces and contribute to achieving climate, biodiversity and related health targets – e.g. by avoiding air pollution and climate extremes.
- ▶ *Conserve ecosystems:* The protection of ecosystems has multiple benefits for human health by safeguarding ecosystem services. The habitats of humans and wildlife can be kept more separate, thus reducing the risk of new pandemics (Section 5.1.2.2). Conserving ecosystems avoids the release of CO₂ and maintains their ability to absorb more carbon, which counteracts climate change. To this end, protected-area systems should urgently be expanded to cover 30% of land and ocean areas – in line with the Kunming-Montreal Global Biodiversity Framework (CBD, 2022; WBGU, 2021). This can also help to reduce land-use changes and deforestation (Dobson et al., 2020; Bernstein et al., 2022). In addition to implementing the protected-area target, the goal of restoring degraded ecosystems is also particularly important, both for the restoration of biodiversity (WBGU, 2021: 49 ff.) and for adapting to climate change (e.g. migration corridors; Section 5.1.2.3).
- ▶ *Ensure the sustainable management of ecosystems that are in use:* Ecosystems should be managed in a way that takes into account both biodiversity conservation and climate-change mitigation, e.g. by means of diversified, multifunctional agricultural systems (WBGU, 2021) or climate-friendly and biodiversity-promoting forestry (Smith et al., 2022b). This also includes the production of healthy, appropriately certified food for humans and animals, for example through the use of sustainable, biodiversity-promoting methods and practices in agriculture and fisheries (Section 4.1) and improved, more flexible management. The reduction of animal-based diets can open up new scope here and make multiple benefits possible (Section 4.1). Public funds should only be used if sustainability criteria are taken into account.
- ▶ *Adaptation and dealing with loss and damage:* High-income countries must finally live up to their responsibility for climate change and biodiversity loss by promoting adaptation and compensation measures, especially in low-income countries – also to avoid negative health impacts there.
- ▶ *Sustainably safeguard the health of species and ecosystems:* Designing a healthy environment (according to physicochemical and biological criteria) is a prerequisite for sustainably ensuring the health of species and ecosystems, also as a prerequisite for human health. The definition of acute fields of action should include the establishment of unpolluted (e.g. from dirt and noise) conditions in settlements and ecosystems, the latter initially applying nature-conservation law. Spatial planning should designate areas where species can develop healthy populations, where ecosystems can function resiliently, and people can find recreation, sometimes in places directly adjacent to those areas or in areas shared by species and people. In the restoration of degraded ecosystems, measures should be oriented towards the original sustainable condition and, if possible, approach it. In more intensively managed areas, sustainable human use can include food production and forestry, but should remain linked to the goal of sustainable biodiversity, also in soils. Protection and design rules, as well as criteria for health, should be further developed and coordinated with relevant research activities. Actors in health systems

for ecosystems and species, as well as human health systems, should be engaged in a constant exchange so that decisions and actions are conducive to both human health and nature's health.

5.1.1.2

Research recommendations

- › *Research the foundations for ecosystem health:* Aside from recognizing the spatial needs of species and ecosystems and strengthening natural plant and animal communities, there are few generalizable and quantifiable criteria for restoring and maintaining ecosystem health and resilience. This means there is a corresponding need for research. Such criteria require knowledge of the causes and therapeutic options when ecosystems have suffered disruptions of functionality, species diversity and species populations, as well as knowledge of their spatial requirements. Research is needed on how ecosystem health can be measured and implemented, also involving nature-conservation authorities and further developing their fields of action. Recovery measures include (1) diagnostic competence (e.g. the stress levels and disease burdens of populations), (2) ecosystem cleaning (removal of environmentally harmful substances and influences), (3) strengthening regenerative capacity and resilience, (4) restoring and stabilizing native conditions and species populations and the balance between the species, (5) preventing disease by creating healthy environmental conditions for species, biodiversity and interspecies interactions, and (6) balancing health protection and the exploitation by humans according to sustainability principles. In each case, this should be based on a deeper physiological understanding of the ecosystem functions in a stable state. Following the analogy of the medical health system, authorities that can contribute significantly to ecosystem health should be transformed accordingly; in particular, new findings in the fields of animal, plant and microbial physiology, pathophysiology and ecology should be taken into account promptly in therapeutic measures by connecting with the research landscape.

5.1.2

Focus topics

In the following, the WBGU highlights a number of priority issues that deserve more political attention: ending the exploration and extraction of fossil resources (Section 5.1.2.1), preventing zoonotic pandemics (Section 5.1.2.2), and dealing with a growing habitat loss for humans and nature (Section 5.1.2.3). The selected topics also reflect the overarching, existential pressure to act.

5.1.2.1

Focus on fossil energy sources: stop exploration and extraction

Stopping climate change is a *conditio sine qua non* for the protection of natural life-support systems and the vision of 'healthy living on a healthy planet'. To this end, the CO₂ emissions from fossil sources must be stopped and their material use limited to cases where no sustainable alternatives can be developed.

International negotiations and national strategies of climate-change mitigation have, to date, focused on reducing the use of fossil fuels. While this focus is right and important, more attention should also be paid to the exploration and extraction of fossil resources and the corresponding planning: there is a growing discrepancy between the climate-change-mitigation goals of the Paris Agreement and the investments that are nevertheless continuing in the development of fossil-energy resources. Furthermore, the exploration, extraction and burning of fossil fuels also have significant direct negative impacts on ecosystems and human health. The need to come to an understanding about the future of fossil fuels as a whole is coming into focus too slowly. In the Glasgow Climate Pact (UNFCCC, 2021), the Parties to the Paris Agreement are explicitly called upon for the first time to reduce (as quickly as possible) the use of coal for energy (using the term 'unabated coal', which refers to the use of coal without CCS), although it does not call for the use of coal to be stopped altogether. There have not been any such agreements on reducing the use of oil and gas – and none were reached in 2022 at the 27th Conference of the Parties to the UNFCCC (COP27) in Egypt either.

The Production Gap Report (SEI, 2021) makes it urgently clear that the planning of production capacity for fossil fuels has not yet been adjusted to the necessary reductions in use and emissions: by 2030, the countries plan to produce about twice as much fossil fuel as would be compatible with limiting climate change to 1.5°C, and 45% more than would be compatible with 2°C (Fig. 5.1-2). The required emission cuts are more than 7% per year from 2020 to 2030 (UNEP, 2019b: 26), although the shares of coal, gas and oil in the reduction can vary. The Production Gap Report (SEI, 2021) understands that, based on the assumptions made, reductions in coal, oil and gas production of 11%, 4% and 3% per year respectively will be necessary in this period. Yet this is not happening; instead, production plans for 2030 include 240% more coal, 57% more oil and 71% more gas than is compatible with the goal of limiting warming to 1.5°C. Taken together, the planned production volumes of fossil fuels even exceed the quantities that would be compatible with the announced (and still insufficient) Nationally Determined Contributions to climate-change mitigation.

Apart from the fact that the planned production of fossil fuels is not compatible with the CO₂ emissions that will still be permissible in the future, it also involves other problems. Fossil fuels not only release CO₂ when they are used; even their extraction involves considerable methane emissions that are harmful to the climate (Saunio et al., 2020; Plant et al., 2022). For biodiversity, the extraction of fossil fuels has both indirect effects via climate change and the direct negative consequences of habitat destruction and pollution (Harfoot et al., 2018). Relevant deposits of fossil fuels are located in areas that have hardly been touched by humans up to now, in areas with ecosystems of particular global importance for biodiversity and climate (e.g. DR Congo), or in areas with especially fragile ecosystems such as the Arctic. The IPBES identifies mining (including fossil-fuel extraction) as a driver of ecosystem degradation (Balvanera et al., 2019). Furthermore, the extraction of fossil fuels is associated with numerous other direct environmental and health impacts (e.g. oil: O'Rourke, 2003; unconventional oil and gas: Li et al., 2022). Reducing pollution from

petrochemical substances and industrial products derived from them improves human health (Howard et al., 2022). There is a need for further research on the local health hazards of fossil-fuel extraction (Howard et al., 2022).

Fossil reserves (i.e. deposits that are technically and economically immediately exploitable) have continued to grow as a result of ongoing exploration, often supported by large government subsidies (Clarke et al., 2022: 646). It is already becoming apparent that many of these investments will be lost if climate-change mitigation is taken seriously. About 30% of oil reserves, 50% of gas reserves and 80% of coal reserves must remain unused if climate change is to be limited to 2°C – and these figures are much higher if the ceiling is 1.5°C (Clarke et al., 2022: 698). Welsby et al. (2021) estimate that by 2050 almost 60% of oil and gas reserves and 90% of coal reserves will have to remain unexploited in order to limit climate change to 1.5°C. The quantity of fossil resources as a whole is far larger (albeit considerably more uncertain) than that of fossil reserves, and their use could potentially release quantities of CO₂ two orders of magnitude above the CO₂ budgets that are still permissible (WBGU, 2011b: 113).

In its 2021 Net Zero by 2050 Roadmap, the International Energy Agency (IEA) shows that a global energy supply consistent with net zero emissions by 2050 will not require investment in new oil and gas fields or coal mines beyond the projects already agreed on up to 2021 (IEA, 2021c). However, the realignment of fossil-fuel markets in the wake of Russia's war of aggression against Ukraine has triggered a rapidly growing number of projects to develop new natural-gas or LNG capacity that threaten to seriously undermine compliance with the 1.5°C limit (CAT, 2022). To date, it is unclear whether and to what extent these new projects really will be matched by the kind of reductions in Russian production currently expected by the IEA (IEA, 2022a).

In principle, the lack of explicit agreements on the production of fossil fuels would be less problematic if states would credibly and bindingly agree on reducing global demand for fossil fuels in line with climate targets. However, the Paris Agreement and the other climate-policy agreements reached so far do not deliver on this. Although the Paris Agreement sets global goals, it leaves the individual states considerable freedom on the size and design of their contributions. Uncertainty over the successful implementation of the climate targets thus remains high. First, the exploration and extraction projects reflect the expectation of resource-rich countries and the companies involved in exploration and extraction that climate policy will ultimately fail. Second, they are an expression of a certain race among suppliers to use the remaining sales markets for themselves.

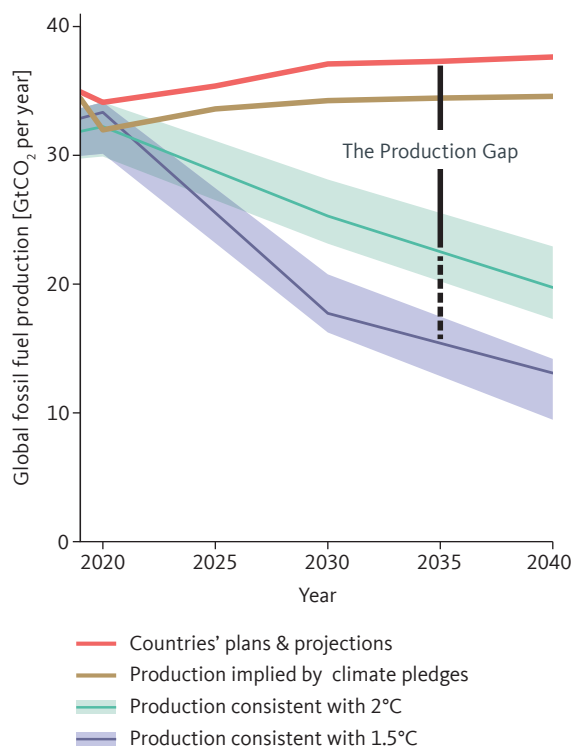


Figure 5.1-2

The 'Fossil Fuel Production Gap' is large – it represents the difference between the projected global fossil-fuel production based on government plans (red line) and what would be consistent with limiting global warming to 1.5°C or 2°C (blue and green lines), represented as the CO₂ emissions that would result from burning the fossil fuels produced.

Source: SEI, 2021

Continued investment in deposits of fossil resources creates and entrenches interests and structures that make climate targets economically and politically more difficult to implement, for example because of political resistance from the investing companies or from people who fear for their jobs in the extraction of fossil fuels (Trout et al., 2022). If climate-policy targets are ambitiously implemented in the future, these investments will have to be written off. Moreover, serious structural problems can arise especially for resource-rich countries whose national budgets are highly dependent on revenues from the sale and export of fossil fuels if the diversification of their economic structures away from fossil fuels is postponed for too long. A consistently high or even growing supply of fossil fuels also has a dampening effect on their prices and thus makes climate-friendly alternatives less competitive. As a consequence, these alternatives have to be given more support, for example by politically enforcing higher CO₂ prices.

In the WBGU's view, it is high time to finally take these discrepancies seriously and to address them, as otherwise the chances of maintaining the internationally agreed limit on warming and ensuring the implementation of the 'healthy living on a healthy planet' vision will be further diminished (IPCC, 2022c). Nation states are key actors in bringing the production of fossil fuels into line with climate targets: more than half of global fossil-fuel production is directly in the hands of states, and they have a great deal of control over the rest via policies and concessions (SEI, 2021). They are therefore called upon to enforce internationally a termination of the exploration and extraction of fossil fuels.

Negotiations and measures to directly limit the exploration and extraction of fossil fuels are not a fundamentally simpler or more promising path in climate policy and should not be seen as a substitute for international efforts to reduce CO₂ emissions on the demand side. However, they can additionally safeguard emissions-related agreements and processes and increase their effectiveness by counteracting 'leakage' – shifting emissions to countries that are less ambitious as regards climate policy (Asheim et al., 2019).

The question of distribution – i.e. the quantity of reserves a country will leave in the ground (Newell and Simms, 2020: 1047) – could become an explicit topic in multilateral negotiations – and this represents both an opportunity and a challenge. It raises questions as to how resource-rich countries can transform and diversify their economies and economic models – which are often highly dependent on the production and sale of fossil fuels – or reorganize them in time. It also raises questions as to which countries should receive international support in doing so and in what form. At the same time, supply-side measures may, to some extent, even be

in the self-interest of resource-rich countries. This is because effective demand-side climate policies ultimately devalue the reserves of fossil fuels solely at the expense of the suppliers or producers. Supply-side measures, on the other hand, at least work towards higher prices which resource-rich countries can achieve for the remaining quantities of fossil fuels (Asheim et al., 2019).

Several initiatives have already been set up to make progress on this issue. The Fossil Fuel Non-Proliferation Treaty Initiative is a network of numerous civil-society organizations from around the world calling for an agreement to phase out the use of fossil fuels. The agreement it is calling for would involve ending exploration and phasing out existing fossil-fuel production, accompanied by a just transition. This demand is supported by many cities, governments and individual signatories, including the WHO and the European Parliament (Fossil Fuel Non-Proliferation Treaty Initiative, 2022).

The 'Beyond Oil and Gas Alliance' (BOGA), founded by Denmark and Costa Rica, has set itself the goal of advancing and internationally discussing the phase-out of oil and gas production. Further members are France, Greenland, Sweden, Quebec, Ireland and Wales; other states are associate members or 'friends' (BOGA, no date).

Individual countries such as France, Greenland, Denmark, Belize, Spain and Ireland already have legislation to stop exploration: Belize, for example, with the aim of protecting its coral reefs (Frost, 2022).

On the occasion of the publication of the IPCC's sixth Assessment Report, UN Secretary-General António Guterres also called on countries to refrain from new exploration and production of fossil fuels and to redirect subsidies for fossil fuels to renewable energies ("This report must sound a death knell for coal and fossil fuels, before they destroy our planet. [...] Countries should also end all new fossil-fuel exploration and production, and shift fossil fuel subsidies into renewable energy" (UN, 2021b).

Recommendations for action

- *Avoid undesirable path dependencies (lock-in effects) caused by fossil infrastructures:* Countries should limit the development of fossil infrastructures along the entire value chain from the exploration and extraction of fossil fuels to processing and use in order to avoid path dependencies that counteract the climate goals.
- *End funding and other government support for exploration and extraction:* Countries should phase out their support for fossil-fuel production. They should end the subsidization not only of fossil fuels themselves but also of their extraction, and instead prioritize financing climate-resilient development pathways with renewable energies. The call to phase out inefficient fossil-fuel subsidies can also be found, for example, in the Glasgow Climate Pact (UNFCCC, 2021).

- ▶ *Create transparency on exploration and extraction projects:* Countries should regularly disclose their plans, or the concessions they have granted, for the extraction and exploration of fossil resources, including the corresponding subsidies, and report on them under the UNFCCC, for example in their NDCs or long-term strategies (SEI, 2021). It would also be conceivable for the IPCC to report on extraction pathways or to include measures to control extraction in the Global Stocktake.
- ▶ *Launch multilateral negotiations on phasing out the extraction of fossil fuels:* The WBGU recommends that ending the exploration and extraction of fossil fuels be made an issue at the international level. Multilateral negotiations should be sought to agree on an immediate halt to the exploration of new oil and gas fields and on timetables to end fossil-fuel extraction. The aim should be to bring the extraction of fossil fuels into line with exit paths from the use of fossil resources for energy and, if possible, also for material uses – paths that are in line with the still-permissible CO₂ budgets (WBGU, 2021). The starting position of different resource-rich countries and their willingness to engage in such negotiations vary, especially in terms of their economic dependence on fossil fuels and their level of development. Exploration moratoria, caps and phase-out pathways are negotiation options in the UNFCCC process (Asheim et al., 2019: 327). Similarly, explicit phase-out paths and moratoria can be agreed between the members of climate-action alliances or clubs – if they include countries with fossil deposits.
- ▶ *Support poorer countries in their transition away from fossil fuels:* High-income countries should support low-income countries in building modern energy-supply systems and thus becoming independent of the extraction and use of fossil fuels. To achieve a just transition away from fossil fuels, wealthier resource-rich countries might forego the further extraction of their fossil deposits in favour of poorer resource-rich countries, thus giving poorer countries more time to make the transition. In addition, targeted financial and technological support should be provided to help poorer countries build modern and climate-friendly energy-supply systems. Economically weaker countries with few resources should also be supported in order to prevent from the outset the emergence of energy-supply structures based on fossil technologies. Promising approaches in this regard include ‘Just Energy Transition Partnerships’ (BMZ, 2022b), e.g. the current partnership with South Africa for a phase-out of coal. This approach should be expanded, including corresponding funding models (SEI and CEEW, 2022: 112)

Research recommendations

- ▶ *Equity in the phase-out of exploration and extraction:* Further research should be conducted on how to handle the phase-out of exploration and extraction in an equitable manner, also using different principles of equity, and on which instruments can support such a phase-out at the national and international level.
- ▶ *Design of agreements on phasing out exploration and extraction:* There should also be more detailed research on how agreements on phasing out exploration and extraction can be designed in such a way that they reliably safeguard phase-out decisions in the longer term – even if fossil-fuel prices rise in the meantime. There should also be discussion in particular on what role might be played by financial incentive systems involving compensation or more targeted support payments for resource-rich countries as well as the design of such systems, e.g. with regard to one-off payments vs. longer-term payment flows.
- ▶ *Economic-policy instruments:* Furthermore, possible economic-policy instruments should be developed and examined which might enable resource-rich countries to initiate and accelerate the necessary diversification of their economic structures. Deep structural breaks should be avoided and spaces created for new economic developments. However, there are considerable limits to how far the latter can be (meaningfully) planned. In this context, the countries’ financial room for manoeuvre must also be taken into consideration, since they may temporarily come under pressure as a result of their withdrawal from the extraction and sale of their own fossil deposits.

5.1.2.2

Focus on zoonotic pandemics: promote prevention

Anthropogenic changes in ecosystems and the climate system are also reflected in the emergence and increasing spread of infectious diseases. Emerging infectious diseases and pandemics are currently becoming more common, cause a great deal of damage and entail considerable costs (over US\$ 1,000 billion per year, not including the costs of COVID-19; IPBES, 2020: 3; Dobson et al., 2020). The COVID-19 pandemic alone may have cost tens of trillions up to now. As in the case of climate-change mitigation and biodiversity conservation, the costs of possible damage (loss of human life and economic costs) are considerably higher than the costs of precaution or prevention (Bernstein et al., 2022).

The pandemic risk is increasing rapidly (IPBES, 2020: 2). The occurrence of new pandemics is made more likely by human activities and anthropogenic changes in the environment (Wu, 2021; Gibb et al., 2020a; Fig. 5.1-3). The majority of all emerging infectious diseases (70%) and almost all pandemics are zoonoses (IPBES, 2020: 2; Judson

and Rabinowitz, 2021; Table 5.1-2), i.e. they are caused by the transmission of pathogens from wild animals to livestock and humans. The spillover can occur directly from wild animals to humans (e.g. Ebola) or indirectly from wild animals via livestock to humans (e.g. influenza; Fig. 5.1-3). So in all likelihood, the next, as yet unknown, pandemic will also be a zoonosis. Zoonotic transmission becomes more likely the closer the contacts between humans, livestock and wild animals (especially mammals – bats, rodents, primates – and birds). Humans are increasingly entering intact ecosystems and wilderness areas, hunting wildlife, clearing primary forests and savannahs, keeping livestock there (e.g. pigs, cattle, poultry) and extracting raw materials, which not only leads to ecosystem degradation but also creates new contact areas and pathways for pathogens to spill over to humans and their livestock (IPBES, 2020).

The World Biodiversity Council IPBES has compiled the scientific evidence on the relationship between biodiversity and pandemics in a workshop report; this report has been an essential source for this chapter (IPBES, 2020). The following causes of emerging pandemics are discussed:

The most important causes are *land-use changes* (which are responsible for more than 30% of the new infectious diseases that have emerged since 1960; IPBES, 2020: 11), usually for the expansion of agriculture

including livestock farming, resulting in the destruction of natural ecosystems and deforestation, as well as the *fragmentation* of the remaining areas of wilderness (Dobson et al., 2020). In addition, there has been a considerable expansion of *wildlife hunting and trading* (fivefold increase in the last 14 years; a quarter of mammal species are affected), which involves a high risk of zoonotic spillover (Hilderink and de Winter, 2021). *Biodiversity loss* also appears to increase the risk of spreading zoonotic pathogens, since animal populations that pose a greater zoonotic risk are more common in human-dominated landscapes than in semi-natural ecosystems (Keesing and Ostfeld, 2021). *Climate change* is causing geographical range shifts in host populations, as well as in populations of infectious-disease pathogens (Box 2.3-2), which may also increase the number of contacts between wild species and human populations and thus to more zoonotic spillovers (IPBES, 2020: 18 ff.; Baker et al., 2022; Gupta et al., 2021b). According to Carlson et al. (2022), climate change could become the dominant anthropogenic factor in interspecies viral spillover. Both the biodiversity and climate crises not only have an additive effect, but each can also reinforce the other's impact. *Population growth and urbanization* can also increase interaction between wildlife and humans (Baker et al., 2022; Perrin et al., 2022; Gibb et al., 2020b).

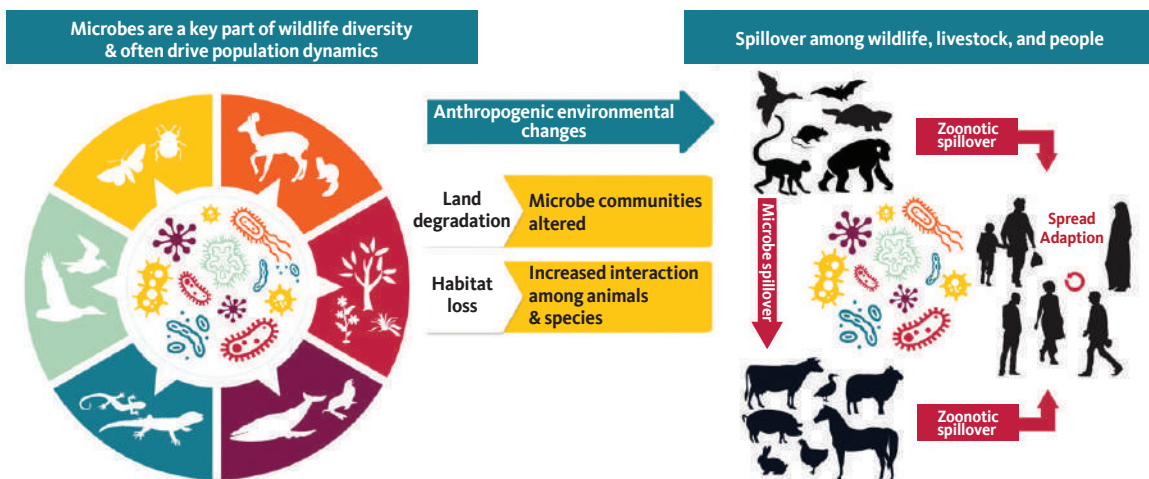


Figure 5.1-3

Origins and anthropogenic drivers of emerging zoonotic diseases and pandemics. Microbes have evolved within species of wildlife over evolutionary time (left). These microbes become emerging infectious diseases (EIDs) when anthropogenic environmental changes alter the population structure of their reservoir hosts and bring wildlife, livestock and people into contact (centre). These interactions can lead to interspecies transmission of microbes, spillover to livestock and people and the emergence of novel diseases (right). Some EIDs can develop into pandemics when zoonotic pathogens transmit easily among people and spread in cities and travel and trade networks.

Source: IPBES, 2020: 12; caption abridged.

Table 5.1-2

Zoonotic pathogens causing recent epidemics

Source: based on Judson and Rabinowitz, 2021; extended with information from Laurenson-Schafer et al., 2023;

Lum et al., 2022; Falendysz et al., 2023; Titanji et al., 2023; Pan et al., 2023

Zoonotic pathogen	Reservoir host/Vector	Disease (key syndromes)	Major recent epidemics
MPXV	Rodents, other mammals	Mpox (rash, fever, skin and mucosal lesions)	Global (2022–present)
SARS-CoV	Likely bats	SARS (systemic inflammatory reaction, focus on lungs)	Global (2002–2003)
MERS-CoV	Dromedary camels	MERS (systemic inflammatory reaction, focus on lungs)	Saudi Arabia, South Korea (2012–2019)
SARS-CoV-2	Unknown	COVID-19 (systemic inflammatory reaction, focus on lungs)	Global (2020–present)
Ebola virus	Likely bats	Ebola virus disease (haemorrhagic fever)	West Africa (2013–2016), DRC (2018–2020)
Lassa virus	Multimammate rat	Lassa fever (haemorrhagic fever)	Nigeria (2018)
Rift valley fever virus	<i>Aedes</i> and <i>Culex</i> mosquitoes	Rift valley fever (haemorrhagic fever)	East Africa (2006–2007)
Zika virus	<i>Aedes</i> mosquitoes	Zika virus disease (arthralgia/myalgia, rash)	Brazil, Americas (2015–2016)
Chikungunya virus	<i>Aedes</i> mosquitoes	Chikungunya fever (arthralgia/myalgia, rash)	Indian Ocean islands, India (2004–2007)
Dengue virus	<i>Aedes</i> mosquitoes	Dengue fever (arthralgia/myalgia, rash, haemorrhage)	Americas (2010)
West Nile virus	Birds/ <i>Culex</i> mosquitoes	West Nile disease (meningitis/encephalitis, paralysis)	United States (2002)
Influenza A viruses	Waterfowl, poultry, pigs	Influenza (pneumonia)	Global (2009)
<i>Yersinia pestis</i>	Rats/fleas	Plague (sepsis, pneumonia)	Madagascar (2017)
<i>Brucella spp.</i>	Cattle, sheep, goats	Brucellosis (undulant fever, endocarditis)	China (2020)
<i>Coxiella burnetii</i>	Cattle, sheep, goats	Q fever (pneumonia, hepatitis)	Netherlands (2007)

The main indirect causes are changing global consumption patterns, as well as the considerable increase in demand for agricultural and wildlife products (e.g. farmed and wild meat, bushmeat). In addition to the direct causes mentioned above, this leads to an expansion and intensification of contacts between humans and wild animals, which harbour a very large number of as-yet-undiscovered viruses that can be transmitted to humans.

Prevention and multiple-benefit strategies

Preparatory and reactive strategies to zoonotic pandemics are indispensable but not sufficient. Many pandemic strategies do not begin until after the infectious disease has broken out. One example is the report of the Global Preparedness Monitoring Board of the World Bank and WHO entitled 'A World in Disorder' (GPMB, 2020), which gives valuable recommendations on vaccines,

pharmaceuticals and diagnostics, but does not even mention the preventive strategy of reducing zoonotic spillovers (Bernstein et al., 2022). Reactive strategies available to date (early detection and containment of pandemics, research and education, quarantine, masks, vaccines, therapies; e.g. Edwards et al., 2022) are indispensable but not sufficient. In addition, drug development often relies on biodiversity, natural compounds, indigenous knowledge and traditional medicine.

Preventive strategies must therefore also be developed (Box 3.1-1), especially biodiversity conservation. These begin before the zoonoses spill over to humans, the aim being to reduce contacts between humans and wild animals (Ellwanger et al., 2021). The starting points are the causes that lead to increased contacts between humans, wild animals and livestock and thus to the emergence of zoonoses (spillover): primarily land-use changes and biodiversity loss. The establishment of protected-area systems, the containment of wildlife hunting and trading – taking into account the rights of indigenous peoples and local communities and possible side effects on other sustainability goals – as well as the inclusion of the demand side and consumer behaviour and, last but not least, climate-change mitigation offer important starting points. These measures aim to separate humans and wildlife more in order to reduce contacts. The costs of prevention strategies are orders of magnitude lower than the costs of pandemics (Bernstein et al., 2022), so that they are cost-effective even if they only cause a small reduction in the frequency of viral zoonoses.

Synergies between several SDGs (Di Marco et al., 2020) as well as multiple benefits offered by the different measures should also be used to mitigate pandemic risks. Here are two examples:

- ▶ Ecosystem protection is also a public-health strategy (Ellwanger et al., 2021). Biodiversity-conserving preventive measures (e.g. protected-area systems) against zoonoses have important multiple benefits with global goals of conserving and restoring biodiversity and ecosystems, sustainable land use and, last but not least, climate-change mitigation (WBGU, 2021; IPBES, 2020; Dinerstein et al., 2020; Wu, 2021).
- ▶ Lower consumption of animal products involves multiple benefits. Reducing animal-based products in diets has positive effects on human health (Section 4.1). However, less factory farming also leads to improvements in animal welfare, reduces the risk of zoonotic spillovers and contributes to climate-change mitigation and biodiversity conservation. Because livestock are a driver not only of zoonoses (Ellwanger et al., 2021) but also of climate change, land-use changes (expansion and intensification of agriculture), biodiversity loss, food crises (also due to land requirements for animal feed production) and competition for

land use (WBGU, 2021). Wildlife hunting threatens more than 300 mammal species with extinction in developing countries (Ripple et al., 2016) and is a factor in the development of pandemics (Hilderink and de Winter, 2021).

Recommendations for action

- ▶ *Strengthen efforts to set up protected-area systems:* Implementation of the CBD's Kunming-Montreal Global Biodiversity Framework is key not only for biodiversity conservation, but also for combating zoonotic pandemics (CBD, 2022b). In particular the target of placing 30 % of terrestrial, limnic and marine areas under protection by 2030 – or taking other area-based nature-conservation measures and integrating them into protected-area systems – should be pursued now with great momentum, as protected areas can help to reduce land-use changes and deforestation (Dobson et al., 2020; Bernstein et al., 2022) and to keep human and wildlife habitats more separate. Strategies for the restoration of degraded ecosystems should be added (WBGU, 2021: 49 ff.). In view of the tension between the integrated landscape approach and the need to separate people and wild animals, sufficient space must be given to protected areas in accordance with the mosaic approach.
- ▶ *Regulate the trade in wildlife and wildlife products:* Wildlife hunting in low-income countries and trading in the products is a factor in the emergence of zoonoses and should therefore be more strictly regulated (IPBES, 2020; Vora et al., 2022; Dobson et al., 2020; Bernstein et al., 2022). However, blanket prohibitions should be avoided because of the complexity of the issues involved. Due to possible side effects on other SDGs (e.g. protein supply), and out of respect for indigenous peoples' ways of life, regulation should be based on a holistic view of ecological and socio-economic contexts (Booth et al., 2021).
- ▶ *Begin with consumption patterns and supply chains:* Strategies should be promoted that, for example, focus on reducing the consumption of animal-based products and thus help reduce factory farming and the associated use of land for animal feed production. Along supply chains (Section 7.6), more attention should be paid to avoiding or repairing destruction caused by infrastructure projects (e.g. road construction, mining), further destruction of primary forests and fragmentation of essential natural areas (especially in biodiversity hotspots), and to using sustainable timber management as an instrument for expanding natural and near-natural forest areas.
- ▶ *Establish measures for zoonosis prevention and management:* More use should be made of nature-conservation measures to prevent zoonotic spillovers.

The Financial Intermediary Fund for Pandemic Prevention, Preparedness and Response (FIF PPR; World Bank, 2022), which was set up by the World Bank in 2022, seems to focus primarily on promoting measures in the health sector, not on using conservation measures as preventive strategies for averting zoonotic spillovers as discussed in this chapter. It should therefore first be examined whether – in close cooperation with the CBD and the GEF – this focus can be extended, or whether additional financing instruments should be created within the CBD framework. Second, the capacities of regional networks and authorities for zoonosis prevention should be strengthened. The Washington Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) plays an essential role in monitoring and regulating the trade in wildlife. To improve implementation, the financial, organizational and personnel capacity of regional networks and national authorities should be expanded (Dobson et al., 2020). Third, implementation of the CBD's Kunming-Montreal Global Biodiversity Framework (2022) should always pay special attention to the role of biodiversity conservation in the prevention of zoonotic pandemics (Vora et al., 2022). The CBD should become the main forum for pandemic prevention in the context of biodiversity and nature conservation, and be given corresponding financial, capacity-building and regulatory backing. Preventive strategies should also be taken into account in the multilateral Pandemic Treaty that is yet to be negotiated (Section 7.2.2). Close cooperation with CBD and CITES would make sense here. Fourth, there is a need to create a pandemic early-warning system in which information on sporadic zoonotic events up to large-scale epidemics can be accessed quickly and transparently (Holmes, 2022). Global databases on virus genomes and serology should be developed and networked with the early-warning system (Bernstein et al., 2022). Fifth, the World Biodiversity Council should consider updating the workshop report on Biodiversity and Pandemics (IPBES, 2020) and potentially developing it into a special report together with the IPCC, also in order to encourage relevant research activities. Finally, the WHO identifies five phases in infectious diseases (pre-emergence, emergence, localized transmission, epidemic, and pandemic). Zoonotic spillover should be added as a further phase (Bernstein et al., 2022).

Research recommendations

Research into the above-mentioned preventive strategies should be stepped up across the board. In particular, knowledge gaps on the following points should be closed:

- *Step up research on the conservation and restoration of biodiversity and ecosystems as pandemic prevention:* It should be clarified in greater detail how anthropogenic factors (e.g. land-use changes, climate change, overexploitation) influence the emergence of zoonoses and whether ecosystem restoration can reduce the frequency of zoonotic host animals (Keesing and Ostfeld, 2021). How do climate-change-induced species shifts influence the emergence and spread of zoonoses? Is it possible to estimate the specific land requirements for biodiversity and ecosystem services required from the perspective of pandemic prevention? Can the integrated landscape approach (WBGU, 2021: 42) be helpful in providing a framework for the preventive strategies against zoonoses that are the focus here, e.g. in preventing zoonotic spillovers from livestock to humans?
- *Improve research into and monitoring of wildlife trafficking:* Research and monitoring should be strengthened to improve knowledge and data on the causes, connections and containment of wildlife trafficking.
- *Strengthen microbial research on the emergence risks of zoonoses:* Longitudinal studies on virus dynamics in reservoir and spillover host populations could contribute significantly to containing the zoonotic risk (Guth et al., 2022). Monitoring and detection of viruses and their transmission pathways between wildlife species should be linked to studies on climate-induced range shifts of species (Carlson et al., 2022).
- *Strengthen economic research on the cost-benefit ratio in the prevention of zoonoses:* Targeted economic research should be promoted on the cost-benefit ratio in the prevention of zoonoses by conserving and restoring biodiversity and ecosystems, and by sustainable land use.

In all these research efforts, particular attention should be paid to an appreciation of indigenous knowledge and the incorporation or consideration of this knowledge in other knowledge systems of research and education.

5.1.2.3

Focus on habitat loss and new limits to habitability

Humans and nature are equally affected by a growing impairment of the natural living conditions in their native living environment or habitat. Because of increasingly extreme climatic conditions and the progressive degradation of ecosystems, environmental conditions in some regions are shifting away from what has hitherto been a life-friendly niche (Sections 2.1, 2.3; Box 5.1-2). As a result, humans, animals and plants are losing their

Box 5.1-2**New limits to habitability because of climate change: topical examples**

The following examples of heat waves, forest and moorland fires and drinking-water shortages illustrate the consequences of climate change relating to shifting limits of habitability that are already being felt around the world today. Due to comparable physiological effects, similar health burdens are to be expected at least in the animal world.

Heatwaves in India and the UK in 2022: In March 2022, India experienced the hottest month since weather records began 122 years ago (Zachariah et al., 2022). A few weeks later, there was another prolonged heat wave with temperatures exceeding 42°C in numerous cities across the country (ESA, 2022). Temperatures of 43–46°C were recorded in many parts of India in April 2022, and the European Space Agency (ESA) recorded ground surface temperatures above 60°C (ESA, 2022) in several areas in India. Climate change has led to a thirty-fold increase in the probability of such an event occurring in South Asia (Zachariah et al., 2022).

The July 2022 heatwave in the UK, which saw temperatures exceed 40°C for the first time since weather records began, presented major challenges to the national health system. The number of emergency calls skyrocketed across the country. The full extent of the impacts of these heat waves on regional ecosystems, human and animal life-support systems, and on the health of humans and other species will require further investigation. However, heat and heat waves pose a major health risk and can be the reason for many illnesses and for spikes in death figures (Section 2.3; Phung, 2016; Song, 2017; Turner, 2012).

Forest and moorland fires in Siberia, 2020: Forest fires are not uncommon in Siberia in summer. However, high

temperatures caused particularly extensive forest and peat-bog fires in 2020, accompanied by a massive release of methane. The highest temperature ever recorded in the Arctic was 38°C on 20 June 2020 (WMO, 2021). The 2020 event was exceptional because it led to a significant increase in fire activity, also north of the Arctic Circle. The increase in the extent, severity and frequency of fires as climate warming continues will affect the vegetation and permafrost dynamics and increase the likelihood of irreversible thawing of the permafrost, leading to a gigantic methane release as well as a conversion from forest to savannah (Talucci et al., 2022). The heat and the massive air pollution caused by the emission of smoke over wide areas led to considerable health hazards for the population (Ciavarella et al., 2021).

Drought in Cape Town 2018 – The ‘Day Zero’ crisis: The South African province of Western Cape suffered from extreme rainfall shortages between 2015 and 2017 (Otto et al., 2018). In early 2018, the water crisis finally reached a level that raised fears that the mega-city of Cape Town would run out of water in March 2018; this became known as the ‘Day Zero’ crisis. In such an eventuality, the population would have received a daily ration of 25 litres of water per person from central distribution points (the average daily consumption per capita is about 200 litres; Parks et al., 2019). This would have made Cape Town the first city in the world to run out of water. The daily ration of only 25 litres per person per day would have been insufficient for people to live hygienically. Authorities warned that water-borne diseases such as cholera, hepatitis A and typhoid fever would become more common if water from contaminated collection containers was used for drinking (Parks et al., 2019). Heavy rainfall finally defused the situation in June 2018. As the likelihood of such a drought event has tripled due to climate change (Otto et al., 2018), the Cape Town Water Strategy has since been revised (City of Cape Town, 2022).

habitats and life-support systems, and in lower latitudes they are being irretrievably lost – especially for higher life forms – as climate change advances (Fig. 5.1-3). The settlement of a region is based on “environmental conditions [...] that support a healthy [...] life, productive livelihoods, and sustainable intergenerational development” for humans and other species (Horton et al., 2021: 1280).

Climate change and degradation of the natural environment

Not only are global temperatures racing from one record to another; extreme weather events such as heat waves, periods of drought, storms and heavy rainfall events are also increasing in intensity, duration and, in some cases, frequency (Box 5.1-2). In addition, there are more frequent fires, flooding events along rivers and coasts, and rising sea levels. These are all causes of increasing habitat loss and of new limits to habitability, which are affecting humans, animals and plants in approximately the same regions or latitudes, and depend on the extent of global warming (IPCC, 2022d). Heat waves with extreme

temperatures above the tolerance limits for life for humans and other species are particularly relevant drivers (Section 2.3; Fig. 5.1-4). Warming further exacerbates habitat loss (IPCC, 2022d). International climate policy discusses this connection as ‘loss and damage’ (Fig. 5.1-5).

The currently observed migration of a wide variety of species from their present habitats as a result of climatic changes indicates that climate change is progressing too rapidly for organisms to adapt to the changing conditions (Figs. 2.1-1, 2.3-5). At the same time, there are evolutionary limits to adaptation that cannot be overcome (Pörtner, 2021). This has already led to different distribution patterns of marine, terrestrial and freshwater species; it influences the functionality of ecosystems and also has a direct, negative impact on human health and well-being through the loss of ecosystem services (Pecl et al., 2017; Beyer and Manica, 2020).

In the foreseeable future, climate developments can be expected that will make human life and the life of animals and plants permanently impossible in some regions of the world. In addition, there will be a loss of land area due to sea-level rise. A prominent example is

Percentage of species exposed to potentially dangerous climate conditions

Percentage of biodiversity exposed

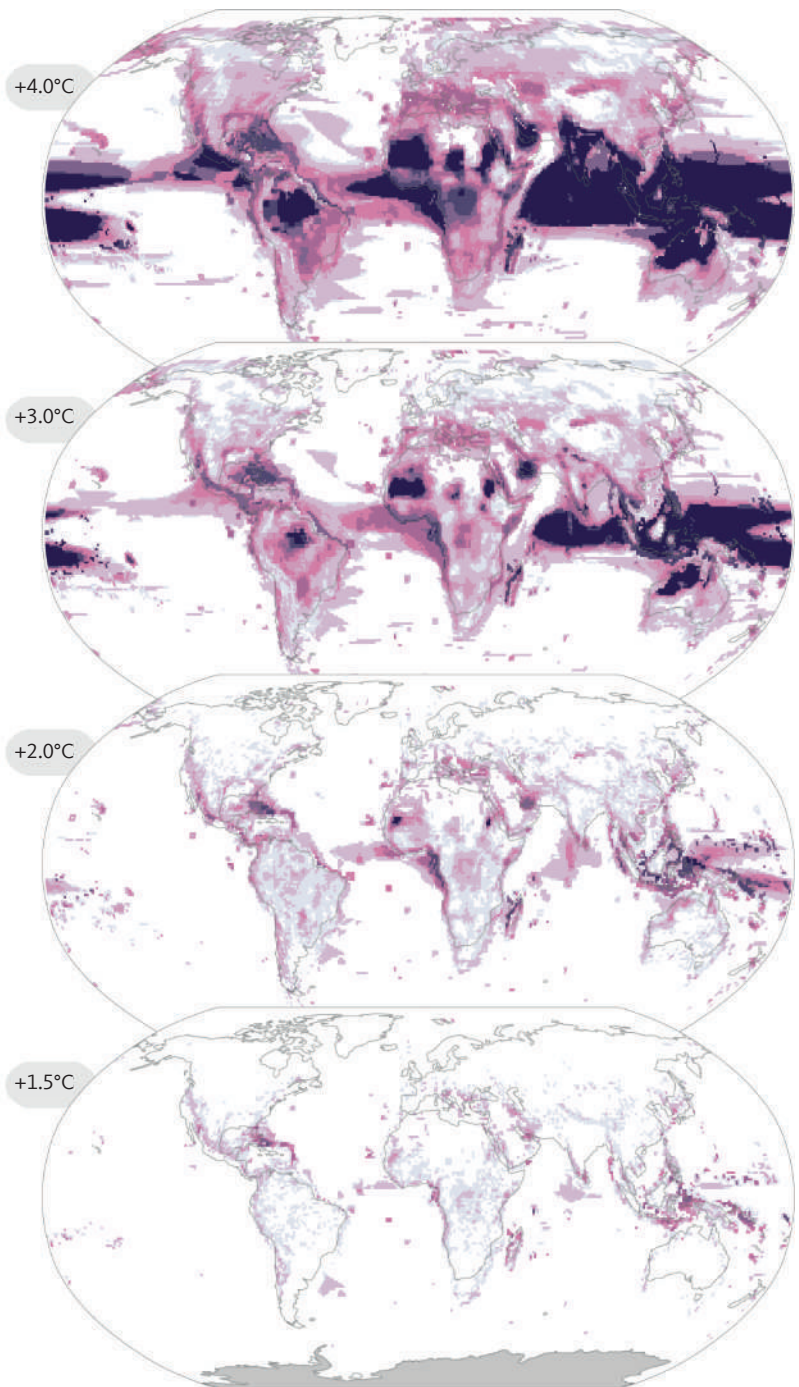
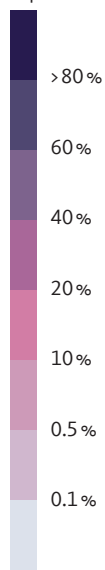


Figure 5.1-4

Prospective loss of habitat in terrestrial and marine ecosystems as climate change advances. Native habitat is being lost in all latitudes due to the climate-dependent emigration of species (Fig. 2.1-1, 2.3-5). In some cases, new ecosystems with unknown properties can emerge there as a result of immigration from warmer areas. However, habitat loss in low latitudes is irreversible and expansive as climatic conditions become more hostile to life (purple zones). This also applies to the human habitat in low latitudes due to the increasing combination of extreme temperatures with high humidity (Fig. 2.3-5).

Source: IPCC, 2022a: Fig. AI.15.

Non-economic loss and damage associated with climate hazards attributed to climate change with background map of global vulnerability

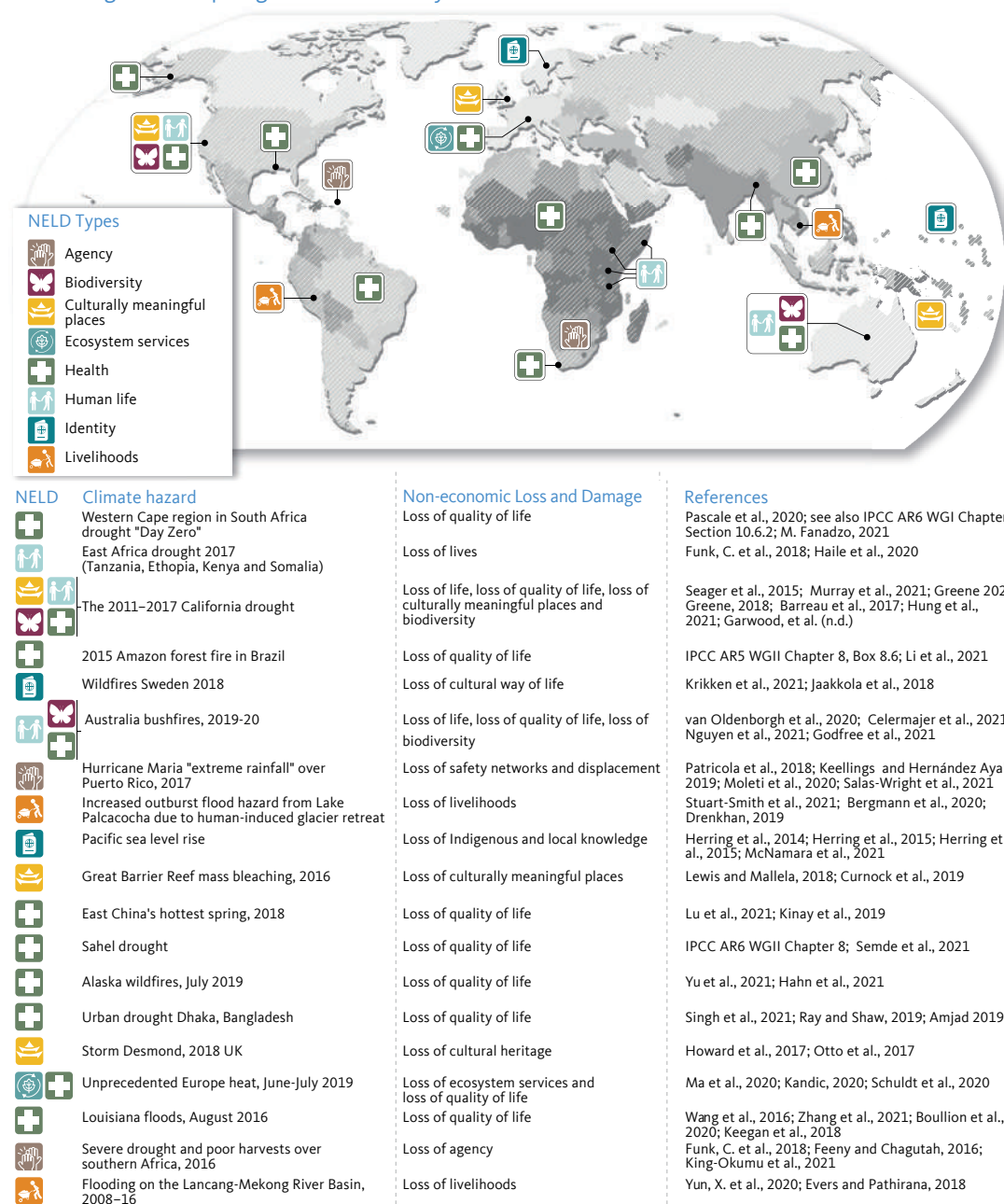


Figure 5.1-5

Loss and damage due to climate change 2008–2020 (exemplary selection). The list demonstrates the restriction of living conditions and thus the quality of the natural habitat on many continents, e.g. due to an increasing number of extreme events. Source: Birkmann et al., 2022: Fig. 08.10

the flooding of small island states and low-lying coastal zones (Section 2.3). Without migration, in 50 years a third of the world's population is expected to be living outside the thermal niche suitable for humans, and some regions will be at least seasonally uninhabitable (Section 2.3; Mora et al., 2017; Im et al., 2017; Kang and Eltahir, 2018; IPCC, 2022d; Xu et al., 2020). In addition to direct impacts on human, animal and plant health, this will also have negative consequences for agriculture and forestry. The threat to food security and economic life-support systems will contribute to a further narrowing of the human niche.

Similarly, the risk of flooding for humans and ecosystems in coastal zones and the corresponding habitat losses will also increase significantly in the course of the century due to rising sea levels (Pörtner et al., 2022a: 62; Section 2.3). By 2050, also driven by population growth and urbanization, more than a billion people in low-lying cities and settlements will be endangered by coastal climate risks, a significant proportion of them in Asia (Pörtner et al., 2022a: 62). Timely adaptation can at least temporarily reduce most of the damage for humans and ecosystems here. However, if climate change continues unchecked, withdrawal will be the only possible response in many coastal cities (WBGU, 2016: 80; IPCC, 2019a).

Climate change as a cause of migration and flight

In the future, climate change and consequent environmental changes will gain significant weight as factors in migration decisions, and global migration movements are likely to be increasingly shaped by climatic and environmental changes as well. In the meantime, the term 'climate-induced human (im-)mobility' has been coined to describe migration (voluntary decision), displacement (involuntary) and planned resettlement (voluntary), as well as voluntary and involuntary ('trapped') immobility caused by various social and economic factors. Immobility in the face of climate risks can be an expression of an insufficient ability to act and an associated higher or high level of vulnerability. At the same time, it can also be a deliberate decision to maintain life-support systems, economic activity and social and cultural ties to places (Cissé et al., 2022). In most cases, people only leave their homes temporarily and return as soon as it is possible (unless there is an irreversible loss of spaces with conducive living conditions).

About 80% of climate-induced migration and refugee movements worldwide take place within national borders (internal migration; WBGU, 2018; Pörtner et al., 2022a). International, i.e. cross-border, movements are mainly between countries with common borders (Pörtner et al., 2022a). In 2021, weather-related extreme events, above all storms and floods, caused 22.3 million people to become internally displaced (iDMC, 2022). Geophysical

events, such as volcanic eruptions or tsunamis, led to 1.4 million internally displaced persons. East Asia, Africa and South Asia have the highest number of internally displaced persons globally, and natural disasters in Southeast Asia and the Pacific are the dominant cause of internal displacement and internal migration (Fig. 5.1-6).

Health risks for migrants

The comprehensive 2018 report of the UCL-Lancet Commission on Migration and Health sets out in detail the many health risks threatening people who are currently migrating or have migrated in the past (Abubakar et al., 2018). These differ according to the type and distance of the migration (e.g. regional seasonal migration, fleeing over long distances), phases of migration (before departure, during transit, upon arrival, after a possible return) as well as with regard to specific groups of people (e.g. children, women, elderly people; Abubakar et al., 2018). The health of the people affected is determined by many political, cultural and structural factors: for example, social and economic exclusion due to racial and cultural discrimination, limited access to education and health systems, food insecurity, and lack of access to health-related technical infrastructure (e.g. supply of clean water, energy) can affect people's health situation in different migration situations (Abubakar et al., 2018). In this context, the health of migrants can be at risk their entire lives. For example, there is a higher risk of illness for mothers and babies before, during and after birth (Bollini, 2009). Children and adolescents are at risk of mental illness, malnutrition and developmental deficits (Abubakar et al., 2018). They are also increasingly exposed to traumatic experiences such as child marriage, sexualized violence and abuse (Mason-Jones and Nicholson, 2018; iDMC, 2022). The health consequences of such trauma, learning losses and reduced social interactions can have long-term negative effects on the socioeconomic situation of the children affected, and contribute to poverty later in life and across generations (Mason-Jones and Nicholson, 2018). Unaccompanied migrant minors and children left behind in the places of origin are particularly vulnerable to health risks (Fellmeth G, 2018; Abubakar et al., 2018). Migrants of all ages who suffer from chronic non-communicable diseases (e.g. cardiovascular diseases) also often do not have sufficient access to the necessary health services during and after transit (WHO/Europe, 2018). Migrants are increasingly affected by a double health burden of non-communicable and communicable diseases, i.e. infectious diseases such as tuberculosis or malaria (Abubakar et al., 2018). Finally, older people with a migration history often report deteriorating health and exhibit increased health-risk factors (Solé-Auró, 2008; Pudaric, 2000).

Moreover, the loss of one’s home and familiar living environment due to natural disasters, climate change or environmental degradation and the resulting migration represent drastic and traumatic life events that can have a long-term and profound impact on mental health (Shultz, 2019). The people affected experience a sudden and comprehensive loss of their material possessions, social networks and communities, as well as their cultural identities, roles and functions. People who are forced by environmental changes to migrate are also often exposed to further trauma and violence during their flight (Shultz, 2019). There is a higher risk of various mental illnesses such as post-traumatic stress disorder, anxiety disorders and depression, which particularly affect migrants (Close, 2016). In addition, people can be affected by psychological stress as a result of environmental destruction in their living environment even before their displacement; this is referred to as solastalgia or eco-grief (Albrecht et al., 2007; Cunsolo and Ellis, 2018). Overall, it can be assumed that the societal inclusion of migrants and their individual opportunities for development are impeded or reduced by the health risks mentioned.

Organized retreat from endangered areas: migration as a strategy

Adaptation to climate change and local disaster-risk-reduction measures will reach their limits in some regions in the future, leaving only emigration as a meaningful option for a life of well-being and health. Against this backdrop, the discourse on climate-change-induced and environment-induced migration has changed from a negative connotation (e.g. climate refugees, environmental refugees) to a proactive and ‘(more) positively connoted’ strategy that should be managed and promoted (Vinke et al., 2020). One of the main arguments here is that the people affected should have a choice to weigh up available options in advance in order to be able to make a conscious, situation- and context-specific decision (Vinke et al., 2020). However, deficits also become clear: those affected do not always have such freedom of choice and action; moreover, (planned) migration and also resettlement can worsen a person’s quality of life and lead to ‘maladaptation’, an unsuccessful adjustment to new living conditions. A planned retreat must include not only the participation and support of the people

Internal displacements in 2021

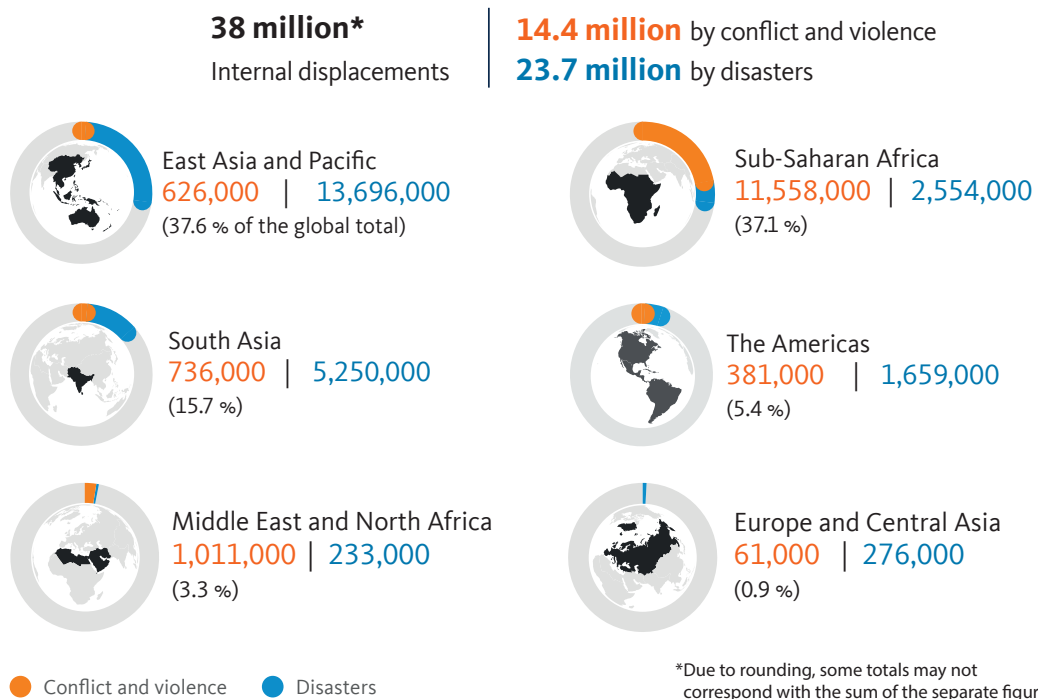


Figure 5.1-6

Internally displaced persons as a result of natural disasters (weather-related and geophysical) and conflict by world region in 2021. On methodology: many people are displaced more than once. For example, if a person flees four times in one year, that is counted as four internal displacements.

Source: IDMC, 2022

affected in planning a relocation to safe settlement areas (planned relocation), but also measures to facilitate safe, orderly and regular migration via normal routes, as well as comprehensive risk prevention to minimize the negative side effects of flight and displacement (UNHCR, 2022). This underlines the important role of planning and implementing a proactive migration policy and migration itself by the responsible actors which, above all, takes into account the needs of the most vulnerable people (Ajibade et al., 2020; Nagle Alverio et al., 2021; Horton et al., 2021). The comprehensive provision of health services before, during and after migration (Abubakar et al., 2018) is crucial in order to address the multiple health risks described above that migrants face. Health systems should be equally accessible to all migrants (universal health coverage), meet migration-specific requirements (Abubakar et al., 2018) and make societal, including economic, inclusion possible. Successful adaptation to the climatic and other natural living conditions of the new settlement area is also essential.

Conservation of biodiversity and ecosystem services: planned or controlled relocation of species

Human-health stresses due to climate change are a specific manifestation of the health stresses to which individual species and biodiversity are exposed in climate change and during migration. The primarily temperature- and precipitation-driven migration of organisms leads to shifts of and changes in ecosystems, new encounters between species and with pathogens, and new roles for species in ecosystems. This results in a destabilization of the functional structure of ecosystems, the stress-induced decrease of biomass and a weakening of ecosystem services.

In a similar way to managed migration for human societies, planned relocation or facilitated migration of species can moderate the impacts of climate change, for example by creating migration corridors in the course of ecosystem restoration (Fig. 5.1-7). This applies in particular for stationary (non-mobile or sessile) or slow-moving species (e.g. trees, corals, mussels) that would otherwise be threatened with extinction outside their adaptation limits. In this way, the functionality of ecosystems can be largely preserved and their resilience increased (Schwartz et al., 2012). This also applies to the managed relocation of species, populations or genotypes outside their historical geographical ranges (Richardson et al., 2009; Schwartz et al., 2012). The environmental conditions of the new locations should also be within the species-specific niche over the long term. Maintaining connectivity between current and future habitats (e.g. migration corridors for all life stages) is also becoming increasingly important to ensure sustainable protection of biodiversity over generations (Schloss et al., 2022). This requires, for example, the designation

of sufficiently large protected areas, the early incorporation of connectivity information into regional spatial planning, and the integration of over- or underpasses into transport infrastructure planning. The controlled return of species to former habitats can also be affected by climate change. Successful (re-)establishment is only possible within the species-specific niche, building on knowledge of adaptation limits or tipping points of the species involved as well as their communities, taking into account the respective location- and system-specific interactions. This includes food availability and type, the existence of predators and other, new interactions, both for the target species and for the 'recipient ecosystem' (Schwartz et al., 2012). Government agencies or non-governmental conservation organizations must develop detailed guidelines or strategies for resettlement, depending on the respective region and the competencies prevailing there. In the best case, this would be done with the involvement of the public, be accompanied by interdisciplinary expert advice and the systematic monitoring of the relocated species and the recipient ecosystem. This enables resource managers to make informed decisions, above all when existing management practices are no longer effective for future changes (Schwartz et al., 2012). In already degraded ecosystems, migration corridors (Fig. 5.1-7) can also facilitate the reintroduction of locally extinct species from neighbouring areas, provided climate change still allows this. Examples of successful migration include the reintroduction of the wolf to Germany and the recovery of the beaver and other species. On the other hand, in the case of climate-change-induced migration and resettlement, it is ultimately still unclear how the newly emerging ecosystems will develop their functionality and properties in habitats abandoned by native species.

Recommendations for action

► *Develop regulated forms of human migration, especially from regions that will be uninhabitable in the future:* Regulated forms of human migration should be developed for regions where the limits of adaptation to climatic and environmental change will be reached in the foreseeable future. This includes strengthening and expanding regional migration regimes in Africa, Asia, Latin America and in European neighbours that promote regulated cross-border movement, make migration conducive to development, guarantee freedom in migration decisions and protect migrants from violence and abuse. Already in 2018, the WBGU recommended creating a climate passport for the population of low-lying island states as a strong multilateral instrument to open up early, voluntary and dignified migration options (WBGU, 2018). In order to reduce the health risks of migrants, negative political, cultural

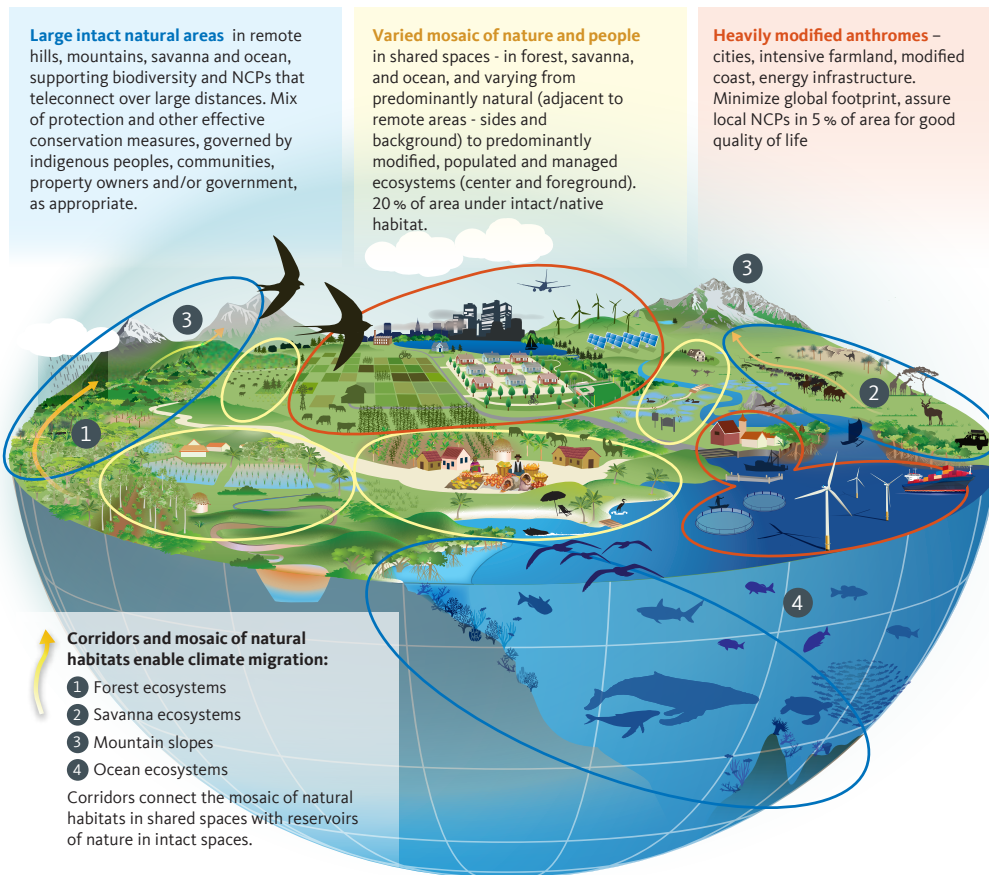


Figure 5.1-7

A multifunctional 'scape across land, freshwater and marine biomes, including large, intact wilderness spaces (blue circles), shared spaces (yellow circles) and anthromes (red circles). In shared spaces the mosaic of intact natural habitat provides critical contributions from nature to people. Corridors of natural habitat (yellow arrows) are illustrated facilitating climate migration of species up elevational gradients. This multifunctional 'scape concept can assist integrating global and large-scale targets within local geographies.

Source: Pörtner et al., 2021

and structural influences on health should be reduced and equal access to health-related infrastructures, educational and health systems should be ensured. These should provide adequate health services for all migrants and meet migration-specific requirements.

- **Loss and damage – pay people's 'moving costs':** Climate change is already causing damage and loss worldwide. The foreseeable necessary relocation of settlements and cities requires the acquisition of land, the construction of new buildings and infrastructure elsewhere, and the creation of income opportunities for the population affected. Against this background, Germany's Federal Government should commit to the Global Compact on Refugees. This means using the bilateral and multilateral instruments of humanitarian aid and development cooperation in the spirit of the

'humanitarian development peace nexus' increasingly to support sustainable prospects of integration and adaptation at the place of resettlement.

- **Facilitate the migration of species with interconnected protected areas and ecosystems:** The climate-change-induced migration of organisms reduces the functionality of ecosystems and weakens ecosystem services. Planned relocation or the facilitated migration of species/organisms, e.g. by creating migration corridors, can mitigate the impacts of climate change. Therefore, protected areas and their connectivity through migration corridors should be planned and implemented accordingly, taking into account the species-specific requirements of the respective environmental conditions. In line with the integrated-landscape approach (WBGU, 2021), the

WBGU recommends improving the interconnectivity of protected areas –both with each other and with the surrounding land area – in order to conserve and enhance biodiversity and ecosystem services, strengthen resilience to climate change and ensure goods and services for people in the long term (WBGU, 2021). Furthermore, an expansion of protected areas to 30% of the global area and the conservation of natural carbon storage by ecosystems should be integrated into the management plans.

Research recommendations

- *Rethink ecosystem management for the translocation of species and species communities:* In order to maintain and strengthen ecosystem services and biodiversity, it is necessary to develop new management approaches that take into account not only regional human activities but also the impacts of climate change on species and ecosystems. Regional scientific studies on the possibilities of the migration of species or species communities (e.g. via natural corridors) and especially on managed relocation are necessary to answer the scientific, ethical and legal questions and concerns that may arise in this context (Schwartz et al., 2012). These studies should be carried out in direct cooperation with the competent authorities and stakeholders. There should also be more research investment in the production of global datasets on the status of ecosystems, threatened species and protected areas, as well as on the “status of interconnections between protected-area systems, on their integration into the landscape, and on the coverage of critical ecosystem services and other effective area-based conservation measures” (WBGU, 2021: 299).
- *Improve understanding of the adaptation limits of species and species communities:* In order to assess whether species can colonize a region, it is necessary to understand the adaptation limits or tipping points of both the species involved and their communities, taking into account the respective site- and system-specific food chains and, if applicable, symbioses (e.g. in the case of warm-water corals). Particularly with regard to the selection of new sites for the translocation of species and species communities, this includes knowledge of the environmental conditions and their variability, or the occurrence of limiting environmental conditions (with values beyond tolerance or adaptation limits, both temporary and permanent).
- *Prepare for the limits of habitability:* It is foreseeable that the number of places will increase where measures for adapting to the impacts of climate change will reach their limits due to detrimental natural living conditions (e.g. heat, flooding). Therefore, climate migration should also be internationally recognized

in the future as one strategy among others (Mach and Siders, 2021; Aleksandrova et al., 2020). Interdisciplinary research on climate-induced migration should be promoted in order to develop a better understanding, as well as long-term and flexible protection options (WBGU, 2018). The key element is to ensure a safe and orderly movement of people within and between countries and to guarantee the freedom of those affected when making migration decisions. The WBGU has discussed the option of a climate passport in this context (WBGU, 2018). By preparing in good time for the approaching limit of habitability in a region, a gradual deterioration of life-support systems and the associated negative psychological, health and socio-cultural effects should be prevented as early as possible.

- *Improve understanding of migration processes:* More research should be conducted on the criteria according to which preparations should be made for a timely and orderly withdrawal of individuals or groups, under what conditions this should take place, and what framework conditions would need to be created. In addition, our understanding of the expected extent of migration, the decision to migrate and the health or psychological effects of migration should be improved. According to Horton et al (2021), the complexity of the issue requires a holistic approach involving modelling, data aggregation and ethnographic insights. An integrated, place-specific habitability assessment is needed, with increased exchange within and between the respective research fields. Models need to be validated by local research on the ground to improve the available data (e.g. on when, where and why people have migrated or are considering migrating, how they define habitability, etc.; Horton et al., 2021). Integrative, interdisciplinary research approaches and more nuanced definitions of habitability can promote a broader, more place-specific range of policy recommendations or measures, especially for receiving communities (Horton et al., 2021).

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5.2 Pollution: dealing with substances that endanger people and the environment

In addition to climate change and biodiversity loss, rising global pollution is a major risk for human and environmental health. The United Nations Environment Programme (UNEP) underlines the importance of global pollution (UNEP, 2021a) by using the term ‘triple crisis’. The resource-intensive, open-loop modes of production and consumption currently prevalent worldwide are causing this pollution. As a result of

uncontrolled emission, deposition and dissipation, i.e. continuance and fine distribution in the environment, chemical substances contribute to pollution and have adverse effects on human health and the environment (immission). Especially problematic substances are those defined as hazardous substances by the German Hazardous Substances Regulation (Gefahrstoffverordnung, GefStoffV) and the CLP Regulation of the European Union (§ 2 GefStoffV in conjunction with Art. 2 of the Regulation (EC) No 1272/2008), or as environmental chemicals according to the REACH Regulation (Art. 3 of the Regulation (EC) No 1907/2006; Section 5.2.1.3; Box 5.2-2). In addition, substances that are considered non-toxic (such as nitrogen or phosphate) can also lead to problematic immissions, depending on their quantity, properties and form. New synthetic substances, modified organisms and natural substances that have been brought into circulation by humans or human use are referred to as ‘novel entities’ in the concept of planetary boundaries (Rockström et al., 2009b; Steffen et al., 2015a; Persson et al., 2022; WBGU, 2014b).

Measures aimed at addressing other challenges (such as climate change) could further exacerbate the problem of pollution in the future. For this reason, there must be a greater political focus on the issue of global pollution with hazardous substances right now – i.e. at a time when combating climate change is a top priority on political agendas. On the one hand, technical innovations are necessary for the energy transition towards a defossilized society and can help secure human health and the natural life-support systems of a still growing world population. On the other hand, however, they are based on more and more new substances which, if released in an uncontrolled manner, can lead to as-yet unforeseeable damage to the environment and human health. Combating pollution also offers potential for multiple benefits relating to climate-change mitigation and biodiversity conservation.

Section 5.2.1 initially provides an overview of different types of pollution, their extent and existing forms of governance. Possible implications of the production and consumption of substances for humans and the environment are illustrated in the subsequent sections 5.2.2 and 5.2.3, using two classes of substances as examples:

1. *Per- and polyfluoroalkyl substances (PFAS)*: These industrial chemicals are used in numerous industrial processes and consumer products for their special technical properties. PFAS are also called ‘forever chemicals’ because of their high mobility in the environment and their lack of biodegradability. They are one example of a class of substances that is already ubiquitously distributed (SRU, 2023: 70) and raises the question of how to deal with this form of hazardous waste and with future applications. At the

same time, they are still needed for use in the energy and mobility transition, so that a comprehensive ban would not be expedient, but would have to be supplemented by exemptions for essential uses (Section 5.2.2).

2. *Pharmaceutical residues*: Medicines are an example of a class of substances that plays a major role in human health and, in most cases, cannot be fully managed in cycles because they are used on an individual basis (Section 5.2.3).

The pollution of the air, soil and water by the use of pesticides and fertilisers in agriculture as well as emissions from industrial plants and the extraction of resources are highly significant in terms of quantity. The consequences of this contamination for humans and the environment, as well as measures to reduce them, have been discussed by politicians and scientists for years. This section therefore focuses on substance groups that have been less prominently discussed to date and are also highly relevant for human health. As will be shown in the following, the national and international assumption of responsibility by governments in the field of pollutants is ineffectively organized and overburdened by the sheer number of different substances, as shown by the example of PFAS in particular. Furthermore, there is a lack of coordination between the requirements of health and environmental law on the regulation and application of substances, as illustrated by the example of pharmaceuticals.

5.2.1 Pollution as a high-urgency challenge with insufficient control

5.2.1.1 Overview of types and extent of pollution

Environmental pollution can affect environmental media – air, water and soil – as well as flora and fauna (including humans). Human-caused pollution of the environment includes various groups of substances that differ in their temporal and spatial impact. Fossil-fuel combustion by industry, households and transport emits not only greenhouse gases but also air pollutants (e.g. CO, NO_x, SO₂, particulate matter), which – unlike greenhouse gases – have a largely local negative impact on people’s health. For example, a direct relation has been proven between high exposure to particulate matter and lung and cardiovascular diseases (Landrigan et al., 2018). Industry, underground and open-cast mining and landfills contaminate soils and groundwater with heavy metals (especially lead, cadmium, chromium and mercury) worldwide. This pollution is usually locally

restricted; however, the number of people affected globally is high due to the large number of polluted sites (Landrigan et al., 2018).

Another key environmental problem is global nitrogen pollution, which contributes substantially to climate change (e.g. via emissions of N_2O from artificial fertilisers) and biodiversity loss and has direct negative health impacts. Nutrient inputs from urban sewage, industry and agriculture lead to eutrophication and oxygen deficiency in water bodies. The intensive use of pesticides worldwide also contributes significantly to the loss of biodiversity: the drastic decline in insect populations and the negative impact this has on important ecosystem services such as pollination have been documented by numerous studies (UNEP, 2021c).

In addition, water pollution by persistent, i.e. non-biodegradable, organic pollutants (POPs) is a major problem. The biggest risk is posed by substances that are both persistent and toxic and that accumulate in the food chain (PBT substances: persistent, bioaccumulative, toxic) or are very mobile (PMT substances: persistent, mobile, toxic) and can thus spread over long distances. Although the use of some substances, e.g. polychlorinated biphenyls (PCBs), has been banned, their persistence and mobility mean they are still widespread globally and can even be detected in remote regions such as the deep sea (Jamieson et al., 2017). Many such substances are still being used.

In addition, plastic pollution, and microplastic pollution in particular, have received a lot of attention recently (Section 2.3). Plastics production has increased from 2 million tonnes in 1950 to more than 400 million tonnes per year today; about 40% of this is made up of single-use plastic items and 98% of newly produced plastic is made from fossil raw materials (OECD, 2022c; Ritchie and Roser, 2022a; Landrigan et al., 2022). Combined with plastic's longevity and inadequate waste management, this immense growth in production results in increasing plastic pollution. It is estimated that more than 19 million tonnes of plastic end up in the environment every year. This figure is expected to double by 2060 (EEA, 2020a).

Environmental pollution is highly relevant to human health. The World Health Organization (WHO) estimates that in 2019 chemicals caused 2 million deaths and a disease burden of 53 million disability-adjusted life years (DALYs; WHO, 2021d). DALYs are the sum of years lived with disability and years of life lost due to premature mortality (Section 2.2.1; Box 2.2-1). This is a significant increase compared to 2012, when the WHO estimated 1.3 million deaths and 43 million DALYs (WHO, 2016a). Almost half of the deaths mentioned in 2019 were caused by exposure to lead; exposure to dusts and carcinogens in the workplace also played a significant

role (WHO 2021d). However, the WHO emphasizes that its assessment was based on data for only a small selection of chemicals, and that people are exposed to many more chemicals every day. The actual negative health effects of all chemicals and substance mixtures are therefore likely to be significantly higher. Chemical pollution is considered a silent threat, as the hazardousness of many chemicals has not been ascertained (Fuller et al., 2022) or is difficult to ascertain (nanotoxicity).

5.2.1.2 Internationally agreed guiding principles

Unlike in the area of climate governance, with its goal of climate neutrality and agreed temperature targets, no concise, multilateral guiding principles or objectives have yet been laid down for the field of chemical pollution. They would have the advantage of establishing a common, long-term vision that could be targeted by individual measures.

At the international level, there are only non-binding targets for chemicals regulation, e.g. SDG 12.4 which aims to “[...] achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks [...]” by 2020 (UN, 2015a). This target has still not yet been achieved (UNEA, 2022a). SDG 3.9 furthermore specifies the target to “[...] substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution [...]” by 2030 (UN, 2015a). Within the framework of the European Green Deal, the European Commission formulated a zero-pollution target by 2050, at least for the EU, with the new Chemicals Strategy for Sustainability (European Commission, 2020j) and the Action Plan ‘Towards Zero Pollution for Air, Water and Soil’ (European Commission, 2021j). Zero Pollution means: “air, water and soil pollution is reduced to levels no longer considered harmful to health and natural ecosystems and that respect the boundaries our planet can cope with, thus creating a toxic-free environment” (European Commission, 2021j). The implementation of zero pollution is to be ensured in particular by establishing non-toxic material cycles (European Commission, 2021j). The guiding principle of the circular economy is also laid down as a transformation area in Germany's Sustainable Development Strategy and is another important goal of the Green Deal proclaimed by the European Commission (European Commission, 2019a, 2020m). While guiding principles for action are becoming established at the European level with the goals of zero pollution and a circular economy, the internationally pursued guiding principle of “the environmentally sound management of chemicals and all wastes throughout their life cycle” (SDG 12.4) is lagging behind because it lacks concretization.

5.2.1.3

Piecemeal governance of pollution

Up to now, production processes, raw-material extraction and the use, decomposition, storage and disposal of substances have not been geared towards their recovery and recycling. As a result, they are often released uncontrolled into the environment. Furthermore, substances that have been identified as harmful to health and the environment are often replaced by alternatives without adequate assessment and evaluation of their effects on the health of humans and the environment. Thus, they might be substituted by even more dangerous substances. Recent studies indicate that new substances, such as chemicals and technical metals or materials, are already finely dispersed and non-recoverable in the environment because their production and release is proceeding much faster than the available capacities for their assessment and monitoring (Persson et al., 2022). Furthermore, there is a relocation problem: production and disposal processes are being relocated from countries with high standards and strict limits to countries with few or no standards or with poor enforcement of existing standards. In addition, marginalized population groups are often affected, so that toxic substances and their effects contribute to environmental injustice (Levinson and Taylor, 2008; Bullard, 1993; McIntyre-Brewer, 2019; Holifield, 2013). Moreover, PFAS and radioactive dusts, for example, spread through the air to even the most remote regions.

Pollution governance is challenging because all environmental media are affected, and very different substances and processes can cause pollution. Hazards to humans and the environment are possible at very different stages of the product life cycle, and release and individual exposure are often very difficult to control. The danger to humans often varies greatly between different products containing toxic substances. Additional risks arise when toxic substances mix after their release (Coria, 2018). The governance of pollution varies according to different environmental media and substance types. This section focuses on chemical pollution. On the whole, it can be said that, when it comes to chemical substances, negative lists are the most commonly used methods internationally and nationally. This means that substances that are harmful to the environment and health must first be identified, assessed and listed as harmful before they can be regulated. Furthermore, international law relies on transparency and consent in trade and transboundary movements of hazardous substances (Box 5.2-1).

The development of national and regional chemicals regulation, which is essential for the field of chemical pollution, has progressed very differently around the world (UNEP, 2019d: 251 ff.; Figure 5.2-1).

In the European Union, Regulation (EC) No 1907/2006 on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH Regulation) adopted a regulatory approach to chemicals that allows for marketing restrictions and bans as well as compulsory registration (Box 5.2-2). The REACH Regulation is part of an international legal dialogue on chemicals regulation. It is prominently discussed internationally; several countries and groups of countries – e.g. Japan, South Korea, Türkiye and the Eurasian Economic Union – follow a similar step-by-step approach based on registration, assessment, impact evaluation and, where necessary, regulation.

5.2.2

PFAS: a group of hazardous substances where action came too late

PFAS are per- and polyfluorinated organic compounds, which in the past were also referred to as per- and polyfluorinated chemicals (PFCs). Perfluorinated means that the hydrogen atoms are completely replaced by fluorine atoms; polyfluorinated means that they are partially replaced. Different PFAS can be distinguished by their functional groups, i.e. by further structures present in the molecule. They can also be classified into short- and long-chain PFAS according to the length of their carbon chains. The best-known representatives of long-chain PFAS are PFOS (perfluorooctanesulfonic acid) and PFOA (perfluorooctanoic acid). PFAS have been produced since the mid-20th century, and more than 4,700 different PFAS compounds now exist (UBA, 2020b). The EU banned PFOS in 2011 and PFOA in 2020 because of negative health effects. In the meantime, polyfluorinated compounds are mainly used. In the environment, they transform into stable short-chain perfluorinated substances, which is why polyfluorinated compounds are also regarded as precursors of perfluorinated substances. Authorities and the scientific community know little about how the newer PFAS are used, how they behave in the environment or how they affect humans and the environment (Cousins et al., 2022). Per- and polyfluorinated ether compounds are also used as substitutes for PFAS, e.g. ADONA and GenX.

5.2.2.1

Areas of application and routes into the environment and the human body

Certain PFAS are used to produce fluoropolymers such as polytetrafluoroethylene (PTFE). Fluoropolymers combine important chemical and physical properties: they are inert, i.e. resistant to reaction with other chemicals and oxygen (flame retardancy), electrically insulating, and

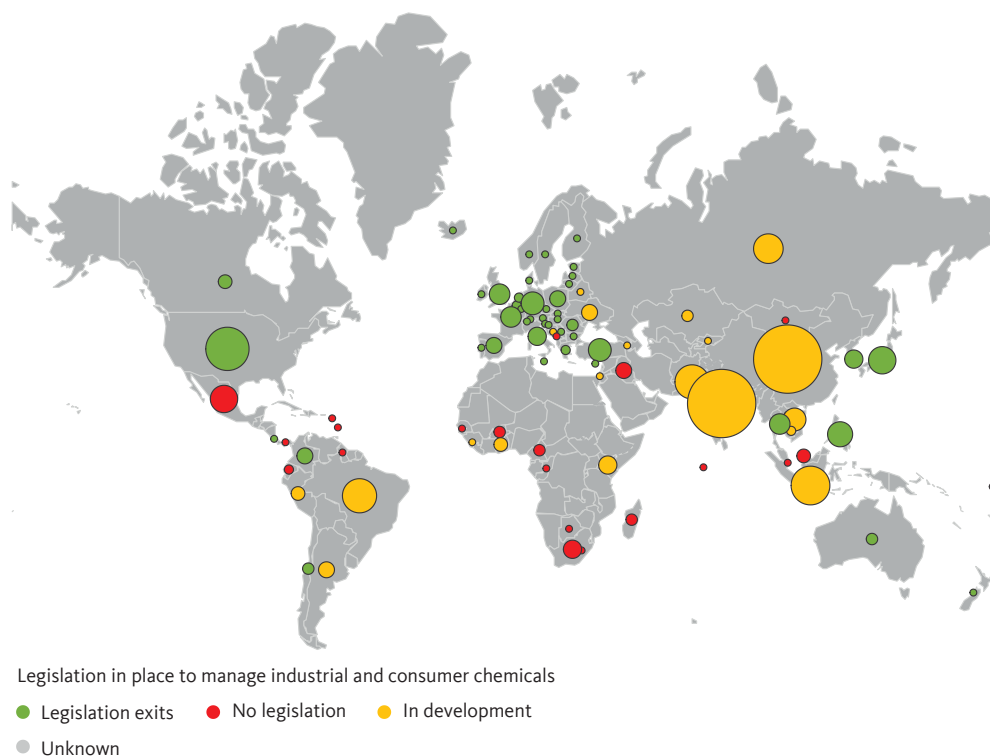


Figure 5.2-1

Overview of national chemicals legislation worldwide: by no means all countries worldwide have chemicals regulation. At the same time, numerous states are working on their own laws on chemicals.
Source: OECD, 2022b

water-, dirt- and grease-repellent in a single chemical structure. This broad range of properties is the reason why PFAS are used in a wide variety of products. In motor vehicles and aircraft, printing inks, waxes and lubricants, for example, they serve to reduce frictional resistance. They are used in non-stick pots and pans and to make carpets more resistant to stains (UBA, 2020b). PTFE is also found in protective clothing as a waterproof and breathable membrane. Thanks to their special material properties, a demand for fluorinated polymers in electronics and energy converters (batteries, fuel cells and electrolyzers) will remain, especially in view of the energy and material transition. The electrification of entire industrial and energy sectors will require large amounts of these special polymers in the future.

PFAS enter the environment via various routes (Fig. 5.2-2). A distinction is made between point source pollution and diffuse forms of pollution. Point source pollution is caused mainly by the repeated use of fire-extinguishing foams containing PFAS, by using

the substances for a long time in electroplating plants, or by applying or discharging polluted materials such as certain paper sludges or compost materials. PFAS enter sewage treatment plants via domestic sewage and industrial wastewater. Persistent PFAS can also be formed there from structurally related compounds. As a result, the substances can be found in sewage sludge and surface waters (UBA, 2020c). In production processes, PFAS can also enter the surrounding soils and water bodies via exhaust air. Furthermore, PFAS can be transported in the air by adhering to particles, thus reaching even remote areas over long distances and then entering soils and surface waters via precipitation (UBA, 2020b). Diffuse pollution by PFAS is even more difficult to control. It develops when PFAS are used in numerous consumer products such as waterproof clothing, coated household goods, paints, varnishes and waterproofing sprays, as well as medical devices and food packaging. Since PFAS are used and distributed worldwide, a global background exposure can be detected even in regions

Box 5.2-1**International chemicals governance****International treaty law**

The Basel Convention, the Rotterdam Convention and the Stockholm Convention (BRS Conventions) form the authoritative core of international chemicals governance. Since 2010, the three conventions have been undergoing a process of synergy characterized, among other things, by the fact that their secretariats have been merged, they have a joint Executive Director, and their Conferences of the Parties meet jointly.

The *Basel Convention* on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal was adopted in 1989. It obliges its member states to minimize the generation of hazardous and other wastes. Above all, it imposes export regulations: transboundary movements of waste require the consent of all the states involved; this is intended to protect in particular those states that do not have the necessary technical prerequisites for handling hazardous wastes.

The *Rotterdam Convention* on the Prior Informed Consent (PIC) Procedure for Certain Hazardous Chemicals and Pesticides in International Trade was adopted in 1998. The aim is to exchange information on toxicological and ecotoxicological properties and on the safety-related assessment of these substances. The PIC procedure applies for substances that are included in an annex to the Convention by the Conference of the Parties. Up to now, 104 substances have been listed in this annex.

The 2001 *Stockholm Convention* on Persistent Organic Pollutants (POPs) is applicable for bans and restrictions on the use of particularly hazardous substances. Unlike the two previously mentioned conventions, this convention addresses the production, use and unintentional release of POPs from industrial processes in addition to transboundary movements.

Like the Rotterdam Convention, the Stockholm Convention uses lists of substances subject to bans and restriction regimes. 30 substances are now listed in the annexes to the Convention: their inclusion requires a lengthy process, starting with a proposal, followed by an assessment and recommendation, and ending with a decision by the signatory states.

In addition, there are specific conventions on occupational health and safety when working with chemical substances, the protection of the atmosphere from ozone-depleting substances, the protection of the biosphere from mercury, as well as conventions banning the traffic in narcotic drugs, psychotropic substances and chemical weapons.

Multi-stakeholder initiative of the International Conference on Chemicals Management

In addition to the international environmental conventions, an International Conference on Chemicals Management (ICCM) has been held every five years since the World Summit on Sustainable Development in Johannesburg in 2002. These conferences aim to identify an international approach to sustainable, cross-sectoral chemicals management with the participation of all relevant actors. Until 2020, the 'Strategic Approach to International Chemicals Management' (SAICM) was the focus of the negotiations, but it can be criticized for its vague objectives and soft indicators (Simon, 2018). Negotiations on the successor instrument, like the ICCM5 planned for 2020, have been delayed by the COVID-19 pandemic. The ICCM5 will now take place in Germany in September 2023. It is a forum to negotiate a meaningful successor instrument to the SAICM, involving state actors, the chemical industry and civil society. For this reason, the SAICM follow-up mechanism can be seen primarily as an opportunity to promote joint action by all groups of actors according to the cooperation principle in environmental law.

such as the Alps, the Arctic and the Himalayas, which are a long way from industrial production sites (Cousins et al., 2022).

When soils and waters become contaminated with PFAS, the substances accumulate in plants and animals and can subsequently be ingested by humans through food. PFAS can also enter the human body through the air. They are already being found in blood and breast milk (UBA, 2020b). PFAS have even been detected in the blood plasma of children and adolescents (Duffek et al., 2020). The European Food Safety Authority (EFSA) and the German Federal Institute for Risk Assessment (BfR) currently regard fish, game meat, eggs and fruits as the main sources of PFAS intake through food (BfR, 2018, 2020).

5.2.2.2**Effects on the health of humans and the environment**

Released PFAS have negative effects on the health of humans and the environment (SRU, 2023: 70 ff.). A comparison of studies of human- and ecotoxicological effects conducted to date shows that human health as a protected good is more sensitive to all the PFAS investigated than the food chain of aquatic organisms that is to be protected. However, the ecotoxicological effects (i.e. harmful effects on the living environment) of only a few PFAS have been comprehensively investigated up to now. The human-toxicological effects (i.e. the harmful effects on humans) and particularly the damage to cells caused by individual substances – e.g. by PFOA, PFOS, perfluorononanoic acid (PFNA) and perfluorohexanesulfonic acid (PFHxS) – have already been extensively described. In 2020, the EFSA set a new guidance value on this basis. It defines the tolerable weekly intake (TWI) for the sum of these four PFAS as 4.4 ng per kg body weight per

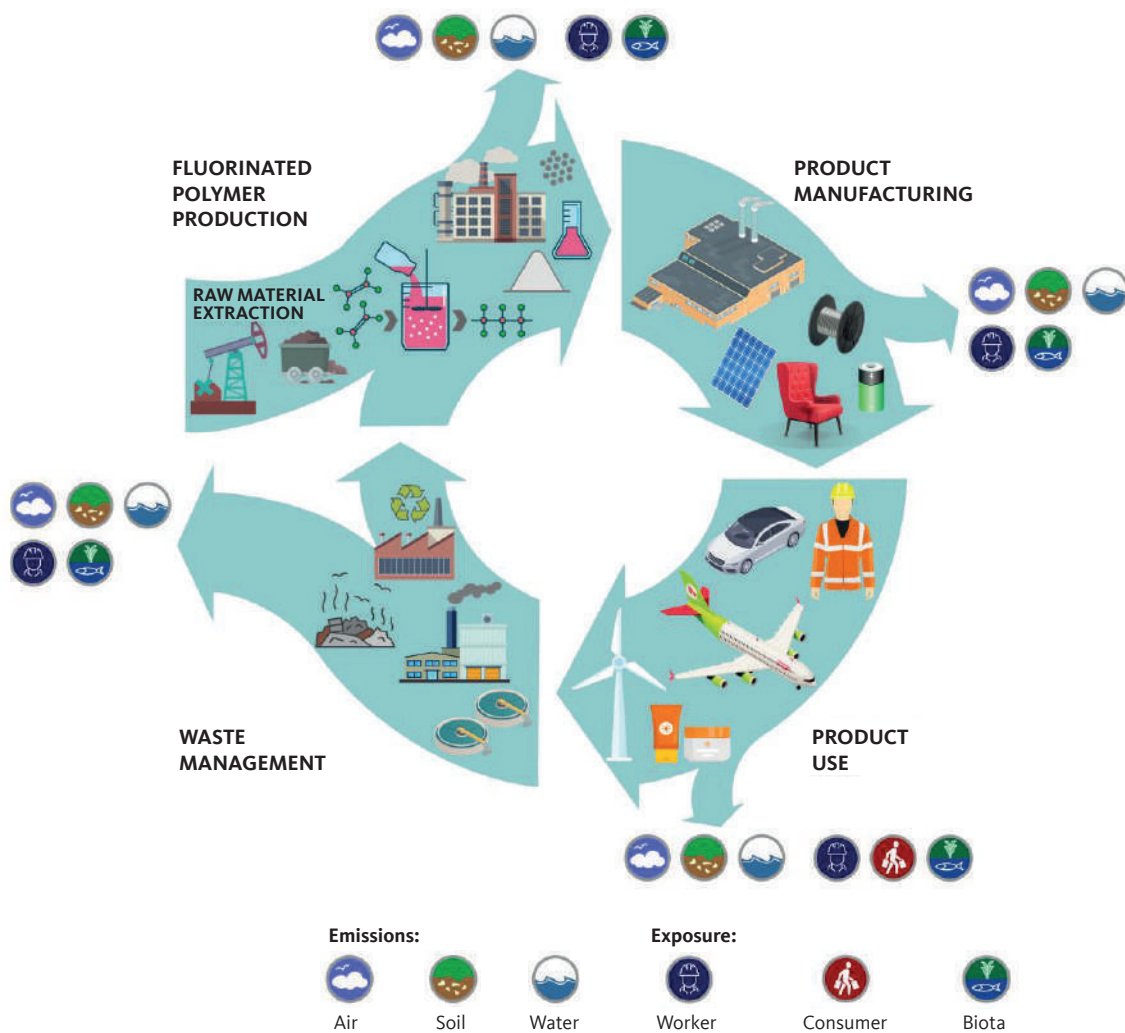


Figure 5.2-2

The life cycle of PFAS from the extraction of the raw material to disposal and their continuance in the environment. PFAS are emitted into the environmental media air, water and soil at various stages of their life cycle, resulting in exposure of humans and ecosystems.

Source: Wahlström et al., 2021

week (EFSA, 2020). The EFSA determined this value based on a reduced response of young children’s immune systems to vaccinations (reduced antibody titre). The BfR also considers it harmful to health to exceed this limit (BfR, 2021). The significant lowering of the EFSA guideline values is an important decision with unknown consequences for assessment values (such as drinking-water limit values, health orientation values and environmental quality standards), for the emission and immission limit values, as well as for risk-management measures deduced from these. Most of the other PFAS have so far been less extensively characterized toxicologically, which is why no adequate assessment values are available (BfR, 2021). In particular, ultra-short-chain PFAS and PFAS substitutes (ADONA, Gen-X) have not

yet been examined at all, even though they can already be detected in the environment. It becomes clear that, despite existing legal restrictions, especially relating to PBT and PMT substances that are non-biodegradable, highly persistent and mobile, and have toxic properties, a substantial global health hazard has emerged. This calls for a decisive course correction in the authorization procedure and the handling of hazardous substances.

5.2.2.3

Status quo: PFAS regulation full of deficits

Although the hazardous nature of certain PFAS compounds such as PFOA and PFOS has been known since 2002 at the latest (OECD, 2002), they are only gradually being banned under national and supranational

Box 5.2-2**European chemicals legislation**

The main elements of EU chemicals legislation are Regulation (EU) 2019/1021 on persistent organic pollutants (POP Regulation) implementing the Stockholm Convention, Regulation (EC) No 1272/2008 on the classification, labelling and packaging of substances and mixtures (CLP Regulation), and Regulation (EC) No 1907/2006 on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH Regulation) of 2006. The REACH Regulation provides the general legal framework for all chemicals in the EU, including PFAS.

Under the REACH Regulation, chemicals are subject to a registration obligation to ensure that substances imported into, manufactured or distributed in the EU in relevant quantities are known (Art. 5 of the REACH Regulation). It is a registration procedure reserving the right to retroactively intervene (Pache, 2018), differing from mandatory pre-consent procedures such as those regulated by the EU Industrial Emissions Directive for industrial plants. The registration of a chemical is followed by

an evaluation based on the substance dossier submitted during registration (Art. 40 ff. of the REACH Regulation). Substances that are hazardous to health can be made subject to authorization according to Art. 55 ff. of the REACH Regulation by inclusion in Annex XVI, or restricted pursuant to Art. 67 ff. of the REACH Regulation. In the case of new substances and substance groups, however, a corresponding restriction only takes place after market introduction. Authorization depends in particular on a socioeconomic assessment of the advantages of a substance's use over the health-related and ecological disadvantages. Furthermore, the REACH Regulation obliges users to apply risk management measures (Art. 14 of the REACH Regulation).

In addition to the REACH Regulation, there are regulations in the EU regarding certain substances that are particularly relevant to pollution, e.g. Regulation (EU) 2019/1009 on fertilising products, which will not be discussed in detail here. Chemicals governance is flanked by a medium-related approach. For example, concrete limits are defined for pollutant concentrations that are just tolerable in the respective medium.

chemicals regulation and under the Stockholm Convention, which is relevant in international treaty law (Box 5.2-1). PFOS was the first substance from the PFAS group to be classified as a POP under chemicals law and banned accordingly. The chemical industry has often reacted to PFAS restrictions by developing substitutes such as ADONA or GenX. Some manufacturers (e.g. 3M and Dupont) already withdrew from the production of PFOS and PFOA at an early stage (presumably because of concerns about product liability; Gelles and Steel, 2021). Such voluntary commitments by industry have succeeded in reducing, but not eliminating, the overall release of these compounds into the environment (Brennan et al., 2021).

Regulation (EC) 850/2004 on persistent organic pollutants implemented the international standards of the Stockholm Convention in the EU and banned the production, use and marketing of PFOS throughout Europe, with a few exceptions. Since 2020, this has also applied to PFOA. The EU has plans to ban other PFAS in addition to PFOS and PFOA under the REACH Regulation. Currently, perfluorobutanesulfonic acid (PFBS) and perfluorohexanesulfonic acid (PFHxS), their respective salts and some related substances are on the Candidate list of substances of very high concern that are eligible for authorization, which must be published according to Art. 59 of the REACH Regulation (ECHA, 2020, 2017). The question of whether these long-chain PFAS should be subject to compulsory authorization is thus being examined. However, PFHxS was also included in the annex of the Stockholm Convention in 2022, so it is

likely to be regulated under the POP Regulation soon.

The EU has now recognized PFAS as a serious environmental problem and has reacted to it in some areas (Köck, 2022). The amended EU Drinking Water Directive (Directive (EU) 2020/2184) lays down a drinking water limit value for PFAS for the first time. The limit value for the cumulated concentration of 20 defined PFAS (i.e. the sum of all 20 individual values, PFAS 20) is 100 ng per litre. The PFAS included have a chain length of four to thirteen carbon atoms. The figure was justified as a precautionary value, which, however, does not yet take into account the new toxicological findings of EFSA (Section 5.2.2.2). For this reason, the amendment of the German Drinking Water Regulation (Trinkwasserverordnung, TrinkwV) provided for a further limit value of 20 ng per litre for the four compounds covered by the EFSA guideline value (PFOA, PFOS, PFNA and PFHxS). In the German Surface Water Regulation (Oberflächengewässerverordnung, OGewV), PFOS is the only representative of PFAS that has been taken into account up to now. Environmental quality standards (EQSs) of 9.1 µg per kg for biota (fish) and 0.65 ng per litre for water have been set for this purpose. The EQSs aim to protect human health when consuming fish, based on a tolerable weekly intake (TWI) of PFOS of 1,050 ng per kg body weight as laid down by the EFSA in 2008. Today, a not insignificant proportion of the fish examined are already above this EQS. As a consequence, some German states such as Lower Saxony have issued a ban on eating fish from surface waters (Niedersächsisches Ministerium für Ernährung, 2020).

These welcome legal responses to the harmful effects of PFAS cannot, however, hide the shortcomings of chemicals governance. Key challenges for national, European and international regulation are the high number of new substances and the lack of scientific knowledge about their effects (UNEP, 2019d; Persson et al., 2022). The governance mechanisms aiming to counter these challenges are reactive, piecemeal and slow. International chemicals governance lacks an obligation to identify, assess and, if necessary, ban or restrict potentially risky (new) substances that are in use worldwide, as well as a comprehensive, globally applicable chemicals regulation framework (Persson et al., 2022). The various conventions under international law, above all the Stockholm Convention (Box 5.2-1), only identify a small number of particularly hazardous substances that are regulated, i.e. restricted or banned, via lists. Substances that are not listed may be used (Garnett and Van Calster, 2021). With regard to PFAS, it transpired that, step by step, first PFOS and PFOA and then also PFHxS were included in the lists. The merely selective bans or restrictions often no longer have any practical relevance when they come into force, because by then the substances in question have already entered the environment and, in some cases, have already been substituted by new substances with unknown risks (SRU, 2023: 76 f.).

Although the EU has a comprehensive legal framework for chemicals in the form of the REACH Regulation and the POP Regulation (Box 5.2-2), a systemic failure is evident here, and not only with regard to PFAS (EEB, 2022). The REACH Regulation does not prevent harmful substances from entering the market; rather, like the Stockholm Convention, it is reactive in nature. Substances are only evaluated and assessed after registration (and when they are already on the market). Thus, although it is possible to identify which substances are harmful to health and must be eliminated, *de facto* the European authorities only act with considerable delay. The assessment of chemicals under the REACH Regulation takes an average of 10 years (EEB, 2022). There is a registration obligation, but it is very time-consuming. Bans and restrictions come too late: hazardous substances have already entered the environment and new substances have been invented to replace the banned ones.

5.2.2.4

Reform dimension of the EU's REACH Regulation: from phasing out individual substances to group bans with exemptions

In the course of the EU Chemicals Strategy for Sustainability within the framework of the European Green Deal and the upcoming evaluation of the REACH Regulation at the EU level, its further development is also being discussed. The EU Commission intends to introduce

group-based substance bans in the reorganization of chemicals regulation – with the option of allowing exemptions based on the concept of ‘essential uses’ (European Commission, 2020j; Box 5.2-3). Following the model of the risk-management approach applied by the EU to carcinogens, the most harmful chemicals, including PMT substances such as PFAS, would be banned by default in consumer products; their continued use would be allowed only for essential uses (European Commission, 2020j: 11 ff.). PFAS applications are a precedent for classification according to essential uses (European Commission, 2022d; Cousins et al., 2019; Garnett and Van Calster, 2021; Box 5.2-3); it is essential to develop corresponding criteria and restrictions for these uses (European Commission, 2020d; Monfort, 2021). An initial proposal for a group-based ban on PFAS was published by the European Chemicals Agency in February 2023. The European Commission is expected to decide on this proposal in 2025 (ECHA, 2023).

5.2.2.5

Interim conclusion: from negative lists to common guiding principles and group-related prohibitions

The transition from individual substance assessments to group-based bans proposed by the EU is to be welcomed. The WBGU advocates a ban on the entire PFAS substance group (following Cousins et al., 2020), whereby justified exemptions should be permitted for specific essential uses. This approach should be applied not only to the REACH Regulation but also to the Stockholm Convention. Exemptions for essential uses should only be allowed restrictively. In order to minimize the negative impacts on the health of humans and the environment, mandatory monitored substance cycles with take-back obligations and after-care measures by the manufacturing companies and users should be introduced for essential uses. These governance reforms must be combined with the legal enshrinement of comprehensive guiding principles that aim not only at short-term reactions, but also at the long-term safe handling of chemicals. Existing guiding principles such as zero pollution and the circular economy (Section 5.2.1.2) indicate that a long-term perspective and a regulatory framework for chemicals governance that is as uniform as possible are required at the international level.

5.2.3

Pharmaceuticals and pharmaceutical residues: comprehensive management in cycles is not possible

Pharmaceuticals and medical products are indispensable for the treatment of diseases and the maintenance of human health. At the same time, inappropriate

Box 5.2-3

Exemptions for essential uses

The concept of ‘essential uses’ is regarded as a novel regulatory approach. It is under discussion particularly for PFAS, but could also be transferred to other chemical substances with hazard potential (Cousins et al., 2019; Garnett and Van Calster, 2021; European Commission, 2020d).

Here, permission for using certain groups of substances that are hazardous to health is made dependent on the designated use and only granted for essential uses. Bans relating to groups of substances are to be implemented accordingly. The concept of ‘essential uses’ originated in US law (Garnett and Van Calster, 2021). Such an approach also plays an integral role at the international level in the Montreal Protocol on Substances that Deplete the Ozone Layer. Since the Fourth Conference of the Parties to the Montreal Protocol in 1992, exemptions have been made possible for essential uses, subject to special conditions and criteria. Accordingly, a use qualifies as essential “if:

1. it is necessary for the health, safety or is critical for the functioning of society (encompassing cultural and intellectual aspects); and
2. there are no available technically and economically feasible alternatives or substitutes that are acceptable from the standpoint of environment and health”.

Permission can only be granted “if:

1. all economically feasible steps have been taken to minimize the essential use and any associated emission of the controlled substance; and

2. the controlled substance is not available in sufficient quantity and quality from existing stocks of banked or recycled controlled substances, also bearing in mind the developing countries’ need for controlled substances”.
- (Dec. IV/25 of the 4th Conference of the Parties to the Montreal Protocol).

The concept of ‘essential uses’ is already implicitly used to determine exemptions to substance bans, e.g. under the Stockholm Convention and the REACH Regulation (Garnett and Van Calster, 2021). However, no criteria comparable to the Montreal Protocol exist there for determining an essential use or for required restrictions. There are proposals from the scientific community to make greater use of the concept for PFAS (Blum et al., 2015; Ritscher et al., 2018), as well as proposals for categorizing different uses (Table 5.2-1). It is becoming clear that consumer products in particular do not generally qualify as essential uses.

Determining whether a PFAS use is essential is by no means a trivial matter, because PFAS are characterized by great diversity, and there is a lack of information on alternative substances (Glüge et al., 2022). Above all in industrial processes, complex trade-offs and an assessment of alternatives are required (Glüge et al., 2022). Apart from which, there is no uniform understanding of which uses are considered essential. In the context of the Montreal Protocol, for example, some countries, including Australia and Canada, are still being granted exemptions to use methyl bromide in strawberry cultivation (Dec. XXXIII/6 of the 23rd Conference of the Parties to the Montreal Protocol). A similarly cautious interpretation of the exemption criteria when applying the essential uses concept to PFAS would significantly limit its effectiveness.

Table 5.2-1

Proposed categorization of uses of harmful substances as non-essential, substitutable and essential. The essentiality should not be considered permanent; rather, constant pressure is needed to search for alternatives in order to move these uses into the category “Substitutable”.

Source: adapted from Cousins et al., 2019

Category	Definition	PFAS examples
‘Non-essential’	Uses that are not essential for health and safety, and the functioning of society. The use of substances is driven primarily by market opportunity.	Dental floss, water-repellent surfer shorts, ski waxes
‘Substitutable’	Uses that have come to be regarded as essential by society because they perform important functions, but where alternatives to the substances have now been developed that have equivalent functionality and adequate performance, which makes those uses of the substances no longer essential.	Most uses of aqueous film-forming foams (AFFFs), certain water-resistant textiles
‘Essential’	Uses considered essential by society because they are necessary for health or safety or other highly important purposes <i>and</i> for which alternatives are not yet established.	Certain medical devices, occupational protective clothing

production conditions, application and disposal can lead to the uncontrolled release of pharmaceutical residues into the environment. This contributes to climate change and threatens ecosystems, which has a negative impact on human health. The pharmaceutical sector has

an important role to play in transformations towards sustainable and resilient health systems in general (Sections 6.3.4, 6.3.5).

5.2.3.1

Pollution from pharmaceutical residues: a growing problem worldwide

Active pharmaceutical ingredients and their degradation products can enter the environment throughout their entire life cycle, from production and use to disposal. In particular, they pollute the aquatic environment, where a total of 992 different pharmacologically active substances have been identified worldwide to date, with regional differences (UBA, 2021). The occurrence of medicines in the environment correlates with local consumption (Berliner Wasserbetriebe, 2019). Depending on the active ingredient, up to 90% can be excreted as active substances during use (European Commission, 2019b). In particular, diuretics, antidiabetics (blood-sugar-lowering medicines), antiepileptics (medicines used to treat epilepsy) and iodinated radiocontrast agents can be found in surface waters globally. In addition to the direct discharge of production wastewater, the most important input pathways for human pharmaceuticals are municipal sewage-treatment plants, and for veterinary pharmaceuticals the application of liquid manure (Fig. 5.2-3). The decisive factors for the environmental relevance of pharmaceutical residues are their toxicity, their persistence, their potential for bioaccumulation and their water solubility.

Since older people on average are prescribed medicines more frequently and in higher quantities, demographic change is likely to lead to an increase in the consumption of medicines and thereby to higher inputs into municipal sewage and thus into the environment.

5.2.3.2

Effects on health and the environment

The environmental risks of many pharmaceuticals cannot be accurately assessed, mainly due to a lack of impact data and long-term studies. However, numerous studies suggest negative impacts on biodiversity. For example, it has been demonstrated that female sex hormones from contraceptive residues can lead to the feminization of male fish (Kidd et al., 2007). It has also been shown that residues of antidepressants lead to behavioural changes in fish (Dziewieczynski et al., 2016). The use of the painkiller diclofenac in cattle has been associated with a drastic decrease in populations of vultures that had ingested the active ingredient via the carcasses of treated cattle (Oaks et al., 2004).

There is also the well-founded concern that an accumulation of pharmaceutical residues in foodstuffs, such as drinking water, can have (long-term) effects on human health. For this reason, several active pharmaceutical ingredients in Germany have been assigned health-orientation values (GOW) by the German Environment Agency, which are intended to limit exposure via drinking water (UBA, 2022c).

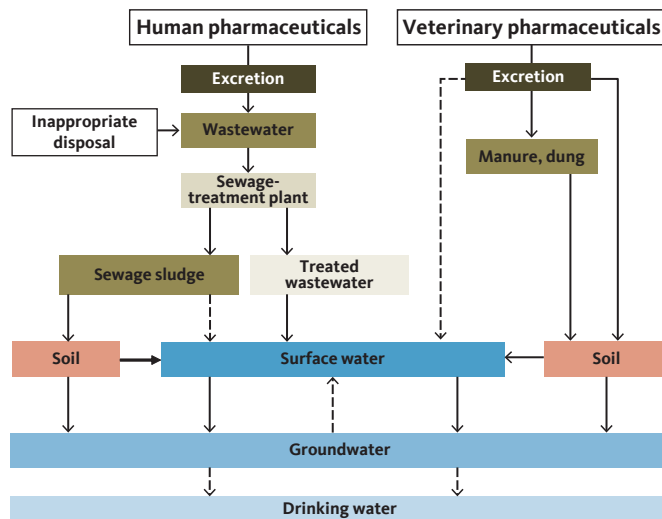
The negative effects of antibiotics are well documented: uncontrolled inputs into the environment can endanger human health through the development of antibiotic resistance. One reason for this is the excessive and incorrect use of antibiotics by humans, which has various causes. In many countries, antibiotics are available without a prescription, and they are often used in cases where there is no bacterial infection, in too low doses or for too short a duration (Shrestha et al., 2018). On the other hand, the development of resistance is promoted by the use of antibiotics in both animals and plants in industrialized food production (SRU, 2023: 65), where they are used not only to prevent and treat infectious diseases, but also to promote animal growth (Shrestha et al., 2018; Davies and Davies, 2010; McManus et al., 2002). Multi-resistant germs that are resistant even to the reserve antibiotic colistin have been detected in the wastewater of slaughterhouses (Exmer et al., 2020). The use of more than 5,500 tonnes of antibiotics in the aquaculture salmon industry was reported between 2007 and 2017; this is the equivalent of approx. 500 g of antibiotic per fish (Higuera-Llanten et al., 2018). In agriculture, the transmission of resistant bacterial strains has been demonstrated both between different livestock species and from animals to humans, e.g. to farm and slaughterhouse employees. Resistant bacteria have also been found in manufactured products such as meat and fresh milk (Parisi et al., 2019; Salyers et al., 2004). According to estimates, approx. 700,000 people die every year from infections with multi-resistant germs, i.e. bacteria against which several classes of antibiotics are no longer effective (Shrestha et al., 2018). Due to the serious resistance situation, there are even warnings that, with regard to infectious diseases, we are well on the way to an era comparable to that before the discovery of antibiotics (Davies and Davies, 2010). The WHO speaks of one of the greatest threats to global health (WHO, 2022s).

Pharmaceuticals also account for an appreciable share of greenhouse-gas emissions in the health sector. In its Net Zero Plan, the UK's National Health Service (NHS) reports that 20% of its CO₂ emissions are related to pharmaceuticals and chemicals (NHS, 2022). In addition, there are direct greenhouse-gas emissions caused by the use of inhalational anaesthetics (gaseous anaesthetics) and from metered dose inhalers (MDIs) used by patients with respiratory diseases such as asthma (Box 5.2-4).

5.2.3.3

Governance of pharmaceuticals: challenges and deficits

Internationally, the manufacture of pharmaceuticals is subject to 'Good Manufacturing Practice' (GMP). Guidelines for its application have been issued by the EU, the

**Figure 5.2-3**

Pathways of human and veterinary pharmaceuticals into the aquatic environment. Human pharmaceuticals can enter sewage via excreta and inappropriate disposal, and from there into sewage-treatment plants. They are then transported via treated wastewater and sewage sludge into the soil, into surface water and from there into the groundwater. Veterinary pharmaceuticals enter the soil, surface water and then the groundwater either directly via excreta or via spread manure. Pharmaceuticals in groundwater can reduce the quality of drinking water.

Source: UBA, 2014

WHO and the International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use (WHO, 2014b; European Commission, 2022g; ICH, 2000). Up to now, however, these guidelines have only given marginal consideration, if any, to environmental aspects. There are initial efforts to fill this void, at least with regard to antibiotic resistance. For example, the WHO Expert Committee on Specifications for Pharmaceutical Preparations (ECSPP) has adopted a paper on the environmental aspects of good manufacturing practices for antimicrobial active ingredients which specifically addresses waste and effluent management (WHO, 2019c).

In the European Union, EU-wide marketing of pharmaceuticals requires authorization from the European Medicines Agency (EMA). Although a systematic survey of side effects for patients is carried out as part of the authorization procedure for a pharmaceutical, data on pharmaceutical residues in the environment and on associated unintended effects are not systematically collected – environmental protection is not currently an objective of the authorization for pharmaceuticals. Similarly, the environmental effects of pharmaceuticals are usually given little or no consideration in the current prescribing practice of doctors. Furthermore, active pharmaceutical ingredients are not covered by the REACH Regulation (Art. 2(5) f. of the REACH Regulation; Box 5.2-2), which is why registration and authorization are not required here.

There have been recent efforts in the EU to reduce the negative impact of pharmaceutical residues on the environment and thus indirectly on human health in the future. One section of the Pharmaceutical Strategy for Europe deals with strengthening resilience, diversified and secure supply chains and the sustainability of

pharmaceuticals (European Commission, 2020f). Further projects at European level can be found in the EU Strategic Approach to Pharmaceuticals in the Environment (European Commission, 2019b).

The EU has taken several measures aimed at avoiding antimicrobial resistance in the European One Health Action Plan against Antimicrobial Resistance and in Regulation (EU) 2019/6 on veterinary medicinal products (European Commission, 2017a). The scope of this regulation also covers animals and animal products imported into the EU. As a further component of the Regulation, in 2022 the EMA made recommendations on which antibiotics should remain reserved for the treatment of specific infectious diseases in humans (EMA, 2022). After the recommendations were published, criticism was voiced that some reserve antibiotics widely used in animal fattening, such as colistin, are not included in the list (HCWH, 2022).

5.2.3.4

Interim conclusion: Documentation and regulation of the environmental impact of pharmaceuticals is in its infancy

The pollution of the environment with pharmaceutical residues is a particular challenge. It is difficult to contain due to the ubiquitous use of medicines, and is likely to increase further in the coming years due to rising consumption. Pharmaceuticals are a frequent exception in legal regulations on the spread of substances in the environment. Environmental aspects are often not, or only insufficiently, taken into account in guidelines and legal regulations that specifically concern pharmaceuticals. Environmental aspects are also given little or no consideration in the use of medicines. In the WBGU's

Box 5.2-4

Medicines with a direct greenhouse effect

Inhalational anaesthetics

Inhalational anaesthetics are often used to maintain a general anaesthetic. They are not metabolized in the body (or only to a very small extent) and are released again through exhalation. Inhalational anaesthetics include volatile anaesthetics (such as sevoflurane, desflurane, isoflurane, enflurane, halothane) and nitrous oxide (N₂O). Sevoflurane and desflurane are hydrofluorocarbons (HFCs); isoflurane, enflurane and halothane are chlorofluorocarbons (CFCs). All these gases have a significantly stronger global warming potential than CO₂. CFCs and nitrous oxide also have ozone-depleting effects (Vollmer et al., 2015; Andersen et al., 2012; Charlesworth and Swinton, 2017; Oyaró et al., 2005; Özelsel et al., 2019).

At present, these substances are released directly into the atmosphere after use in an unregulated manner. The NHS says that inhalational anaesthetics and propellants from MDIs (see below) make up 5% of its total greenhouse-gas emissions (NHS, 2022). Desflurane, which has a much greater greenhouse effect than the other volatile anaesthetics, is the most prevalent of these substances in the atmosphere (Vollmer et al., 2015). Even less attention has so far been paid to emissions resulting from use in animal breeding and fattening (e.g. in piglet castration) and in laboratory animal testing. Significant quantities of volatile anaesthetics are also used there, although no precise surveys exist as yet.

Anaesthesiological societies are calling for a reduction in the use of the inhalational anaesthetics desflurane and nitrous oxide, which have a particularly large greenhouse effect, wherever

possible, and for them to be replaced by less climate-damaging alternatives, which are medically suitable in very many cases. Moreover, volatile anaesthetics could become the first drugs to be reused. It is already technically possible to collect them in filters, and the aim in the future is to recover, recycle and reuse them as medicines (Schuster et al., 2020; Hinterberg et al., 2022). It is also technically possible to capture nitrous oxide; although it cannot be recycled, it can at least be safely disposed of by destruction (NHS, 2022).

Metered dose inhalers (MDIs)

There is as yet no global overview data on MDIs, but the NHS states that they cause 3.5% of its greenhouse-gas emissions (UK Parliament, 2018; DEGAM, 2022). MDIs are used mainly for treating chronic respiratory diseases such as bronchial asthma or chronic obstructive pulmonary disease (COPD). Most MDIs use propellant gases that turn the active ingredient into an aerosol. Either norflurane or apafurane has been used for this purpose since CFCs were largely banned. Neither is ozone-depleting, but both are many times more harmful to the climate than CO₂ (DEGAM, 2022; Myhre et al., 2013). In the meantime, there are numerous efforts to switch to dry powder inhalers (DPIs), which are much less harmful to the climate. For example, a new guideline was published in Germany in 2022 recommending the use of the less climate-damaging alternative in many cases (DEGAM, 2022). Use of MDIs currently differs considerably worldwide: they are used comparatively frequently in the USA and the UK, but much more rarely in other countries such as Japan and Sweden (Janson et al., 2020; Pritchard, 2020). A change in prescribing practices alone could save up to 550,000 tonnes of CO₂ equivalent in England (Janson et al., 2020).

view, initial approaches in the EU to regulate the negative environmental impacts of pharmaceuticals, such as Directive 91/271/EEC concerning urban waste-water treatment, which was amended in October 2022, should be expanded, and existing exemptions for pharmaceuticals re-examined.

5.2.4

Recommendations for action

The pollution of the environment by hazardous substances, together with the biodiversity and climate crises, form a triple crisis. Pollution involves many classic environmental challenges such as soil, air and water pollution. However, overall it is given too low a priority politically. Pollution with persistent, bioaccumulative and mobile toxic substances should be given the same priority in international policy as the fields of climate change and biodiversity loss. Moreover, there is too little pooling of global expertise on the pollution issue.

In order to properly implement the ambitious guiding principles, a new system of chemicals governance is

required which should be established nationally, in the EU and similar regional associations, in club approaches – and best of all internationally.

5.2.4.1

Establish zero pollution and the circular economy as guiding principles internationally

The WBGU recommends agreeing a global framework convention to combat pollution by hazardous compounds and in particular by toxic and persistent chemicals, thereby establishing the guiding principles of zero pollution and a circular economy internationally. In particular, this can establish a long-term perspective in chemicals governance. Current windows of opportunity for strengthening these guiding principles are offered, for example, by the negotiations on the successor instrument to the Strategic Approach to International Chemicals Management (SAICM), the negotiations on the UN Treaty on plastic pollution, and the EU's legislative initiatives in the context of the European Green Deal. Furthermore, the guiding principles should play a prominent and permanent role in the implementation of the 2030 Agenda, as well as in the post-2030 Agenda.

Zero Pollution should be interpreted as shaping a relationship between humans and the environment in which emissions caused by humans do not harm either humans themselves or the environment. This does not mean zero emissions, but that pollution of air, water and soil is reduced to a level that does not pose a risk to health and the natural ecosystems, and respects planetary guard rails, creating a pollution-free environment (based on European Commission, 2021j). This is in line with the planetary guard rail proposed by WBGU to limit “risks posed by long-lived and harmful anthropogenic substances” (WBGU, 2014b: 4).

The guiding principle of the circular economy is crucial to achieving the zero-pollution goal. Many chemicals are essential for economic processes and the functionality of technical products, and for some of them there is – as yet – no substitute. At the same time, their release leads to environmental pollution and health hazards. They must therefore be kept within technical cycles or it must be guaranteed that they do not enter the environment during use. This must be based on international cooperation, as the spread of many chemicals in the biosphere cannot be limited locally. It should be noted here that materials containing pollutants cannot be recycled or reused without restriction (European Commission, 2018; Kummer, 2018). Moreover, the downcycling processes that are used due to recycling limitations can also lead to worrying accumulations of substances that are harmful to health. Keeping materials containing harmful substances and potentially hazardous chemicals in as closed a loop as possible requires a corresponding design of materials and products. In addition, recycling can be improved by introducing take-back obligations for the manufacturing companies. For substances with little prospect of becoming recyclable even in the future, such as pharmaceuticals and household chemicals, the creation of effective sinks is key, e.g. as part of advanced wastewater-treatment systems incorporating the corresponding technology.

5.2.4.2

Implement prevention and precaution as guiding principles for action

The prevention and precautionary principles should guide chemicals governance in order to avoid delayed responses and the need to subsequently repair damage that has been done (Box 3.1-1). The corresponding technical knowledge is needed to identify hazards from new substances in good time, to assess the corresponding risks, and enable early action to be taken (see also SRU, 2023: 131 ff.). The internationally recognized precautionary principle is already laid down in Art. 1(3) of the REACH Regulation and Art. 1 of the Stockholm Convention. However, the precautionary principle should apply

generally to all chemicals and substances that are hazardous to health. The WBGU recommends the following for the design of a preventive and precautionary system of chemicals governance:

- ▶ *Legally binding limit values* that lay down ceilings for measurable concentrations of pollutants in an environmental medium (= immission limits). These should be oriented to the needs of vulnerable groups (e.g. infants, children, senior citizens, chronically ill persons) and fragile ecosystems. The ceilings should be decided on by environmental and health experts in a joint process. They should also be taken into account in the sustainability indicators of the SDG follow-up targets.
- ▶ *Legally binding minimization requirements* that complement the ceilings with regard to the use of harmful substances that are indispensable.
- ▶ *Standardization of the manufacture and marketing of substances and products* that are safe and sustainable by design based on life-cycle analyses (European Commission, 2020j; Caldeira et al., 2022). This includes maximizing the recyclability of materials and products while minimizing risks to people and the environment – during raw-material extraction, production, storage, usage and the recovery of secondary raw materials from end-of-life products. In this context, the use of particularly risky substances must be excluded and their use in unavoidable cases (e.g. pharmaceuticals) reduced as far as possible.

5.2.4.3

Equip new chemicals governance with an international registration regime

The piecemeal regulation by the Basel, Rotterdam and Stockholm Conventions and other sectoral regulations is too incremental, patchy and slow to meet the challenges of a sustainable system of chemicals governance. Successful implementation of zero pollution and a circular economy in the chemicals sector would require a global framework convention to combat pollution from hazardous compounds. A core component should be an international authorization regime for substances of very high concern that can also be implemented nationally, regionally or through club solutions with the mechanisms proposed here.

The new authorization regime should include a preventive ban for particularly hazardous substances, while reserving the option of granting exemptions. Substances with persistent, mobile, bioaccumulative and toxic properties are considered particularly hazardous. The new regime could be based on a further developed REACH system that provides for group-related bans for particularly hazardous groups of substances with the possibility of an exceptional authorization for essential uses. The

German Advisory Council on the Environment (SRU) has presented concrete options for further developing the REACH Regulation, to which reference is made here (SRU, 2023). In particular, criteria must be developed to determine when an essential use can be recognized. It is foreseeable that consumer products will not qualify (Box 5.2-3). Exemptions for essential uses must be subject to a secondary condition covering recycling and protective measures during the phase of use, such as after-care and take-back obligations. In order to meet these requirements, the manufacturing companies must develop processes for treating substances in such a way that they lose their harmful properties. Authorization of a substance with hazardous properties would only be granted if certain authorization requirements were met. The obligation to present facts and the burden of proof, especially with regard to a substance's environmental and health compatibility, should lie with the applicant and not with the authorizing body. The aim here is to conserve regulatory capacity. As a quid pro quo, the approval procedures could be accelerated by setting the approval authorities deadlines for decisions (EEB, 2022). The evidence to be provided by the applicant could, for example, take the form of life-cycle analyses of the products and processes that use the relevant substances. Internationally uniform assessment criteria for testing the hazard potential of substances must be laid down for this purpose.

The adoption of a global agreement is ambitious, but it has the advantage of creating a globally consistent reference point in this specialized area of chemicals development. Joint regulatory capacities could also help low-income countries with the effort of chemicals regulation.

Further steps are needed to make such a regulatory system possible:

- The complete quantification and localization (raw-material production, components) of all substances used for essential uses is necessary. The data obtained should be digitized, e.g. in the form of a product passport containing a substance passport, and also include individual industrial plants with by-products.
- In addition, a reliable database on substances used in production is needed to make a circular economy possible. A key implementation factor is the accessibility of the necessary data for the respective actors at the different points in the life cycle of a product or substance. This requires improved data collection and exchange between the different sectors and competent authorities: both the regulators and the individual actors in supply chains and waste management need comprehensive information about product ingredients, their composition and regenerative properties. For this, suitable digital tools must be created that ensure

accessibility to relevant knowledge while safeguarding intellectual property rights.

- In addition, suitable technical barriers are needed during production and after use, involving advanced forms of wastewater treatment (e.g. ozonation followed by activated carbon filtration) that retain particularly hazardous chemicals or transform them into less hazardous and more biodegradable reaction products.

5.2.4.4 Set up an intergovernmental science-policy platform on pollution

Risk-knowledge structures comparable to climate and biodiversity governance should be created for the scientific monitoring of the corresponding transformation processes. An intergovernmental science-policy platform on chemicals, the circular economy and pollution, modelled on the Intergovernmental Panel on Climate Change (IPCC) and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), could review the state of affairs and provide a knowledge base for different actors. The WBGU welcomes the fact that the UN Environment Assembly has already decided to establish such a body to cover the topics of chemicals, waste and pollution (UNEA, 2022b). In terms of content, this should deal, inter alia, with life-cycle analyses of substances and criteria for essential uses.

5.2.4.5 Expand pharmaceutical regulation to include consideration of environmental aspects

In the case of pharmaceuticals and other substances for which full recycling is difficult to achieve, authorization should only be granted after a positive risk-benefit assessment that also takes environmental aspects into account. Pharmaceuticals that nevertheless pose a high environmental risk should be subject to prescription. Doctors should be specifically informed of the environmental risks of such pharmaceuticals, e.g. in the form of a clear warning in the technical information. Environmental effects should also be included in post-authorization monitoring. Exemptions for medicines in the existing and planned regulation of chemicals and supply chains should be re-examined. Environmental standards for manufacturing should be implemented for pharmaceuticals authorized in Europe, e.g. within the framework of good manufacturing practice.

5.2.5

Research recommendations

Establish internationally standardized criteria for life-cycle assessments of chemicals

Internationally standardized criteria must be established for life-cycle analyses, and more research is needed here. A particularly suitable body for this purpose is the science-policy panel on chemicals, waste and pollution, which the UN Environment Assembly has decided to establish (UNEA, 2022b).

Collect impact and long-term data on hazardous substances

Collecting impact data and long-term studies lays an essential foundation for assessing the environmental risk of hazardous substances (e.g. PFAS and pharmaceuticals).

Develop solutions for the conflict of interests between intellectual property rights and the accessibility of private data

The required accessibility of the necessary data could be hampered by legally protected trade and business secrets as well as intellectual property rights. There is a need for research on the extent to which these subjective rights can limit the transparency and accessibility of data.

Strengthen public research on chemicals governance

National and international research on chemicals governance is largely dominated by practitioners from the chemical sector. It would be desirable to increase publicly funded research in this area to avoid any possible influence on research results by individual economic interests.

Uncover drivers and barriers to PFAS regulation

There is a deficit of research on drivers of and barriers to PFAS regulation at the international level (Brennan et al., 2021).

Develop cross-regulatory instruments

Overarching instruments need to be developed that interlink sectors instrumentally – e.g. in the form of a PFAS regulation under water law, in relation to air pollution or via the REACH Regulation – both in the EU and globally. Exactly what this might look like is open and should be researched.

Compare chemicals law internationally

Comparative legal and policy research on chemicals law (especially on the REACH approach) is needed to facilitate mutual learning effects and understand the effects of European legal changes on other countries.

Characterize PFAS toxicologically

A comprehensive toxicological characterization of PFAS that have been less well studied up to now (e.g. short-chain PFAS and substitutes) should be carried out, which can be used as a basis for suitable assessment values.

Develop substitution possibilities

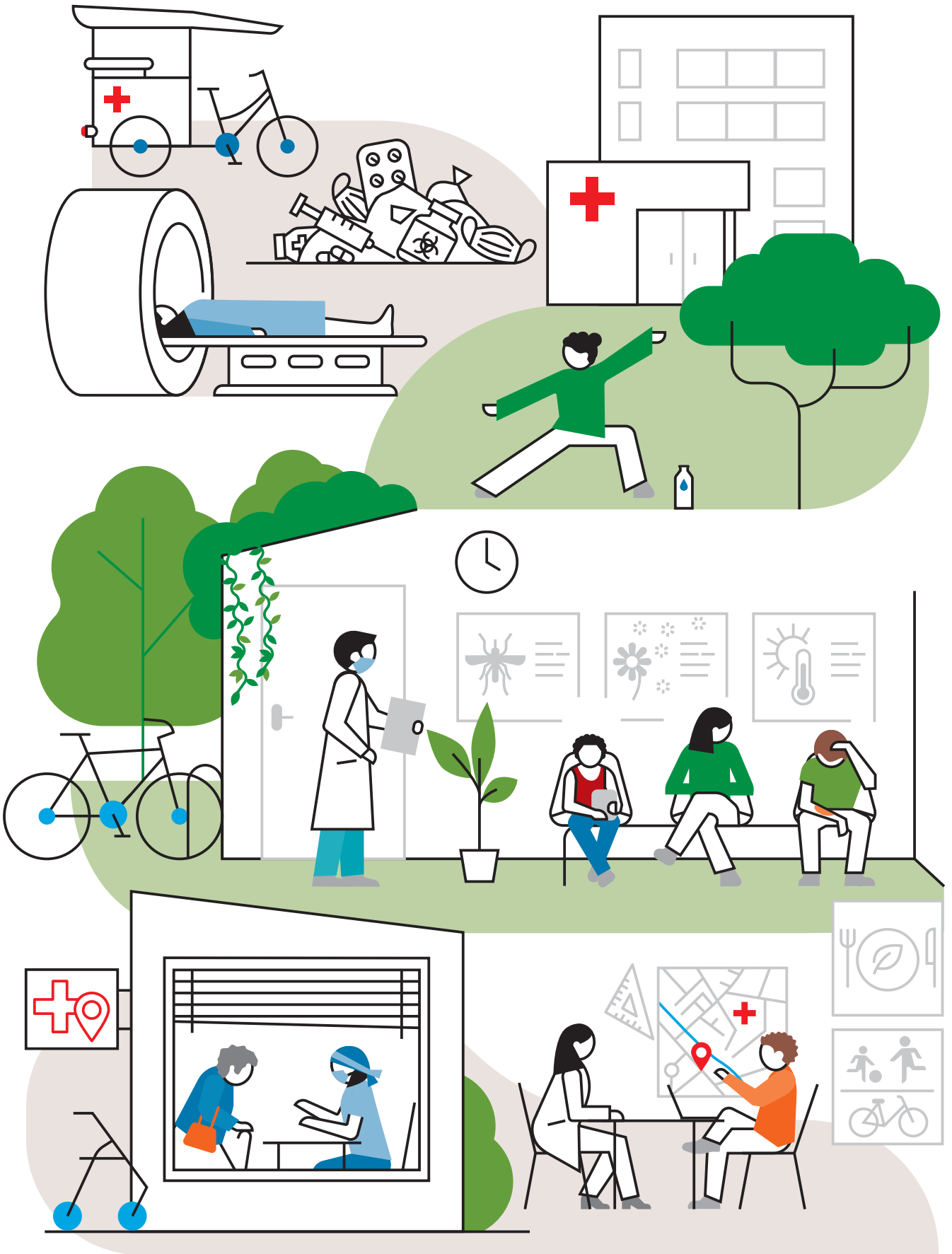
Research should be conducted on the development of sustainable substances and materials to replace substances that are hazardous to health; there should also be research on the efficient, emissions-free recycling of infrastructure that is hazardous to health and the environment and needs to be replaced.

Research conditions for the use of secondary materials

To enable the implementation of after-care obligations, conditions for the use of secondary materials containing harmful substances should be researched. In addition, processes should be developed to remove already released substances from natural cycles (e.g. using advanced water-treatment processes).

Research consumer behaviour with regard to chemicals and pharmaceuticals

In addition, research should be conducted on the promotion of behavioural changes in the use of chemicals and pharmaceuticals by consumers of different age groups.



Harnessing the transformative potential of health systems

Sustainable and resilient health systems aim to protect and improve health while respecting planetary guard rails. They are prepared for shocks, have strong public health departments, and use integrated environment- and health-information systems. They initiate transformations in other sectors by promoting healthy and sustainable lifestyles and helping to shape health-promoting living conditions. Key to this is the integration of environmentally sensitive prevention and health promotion as guiding principles that acknowledge the importance of healthy ecosystems.

The global health crises (Section 2.2) confront health systems with new challenges that need to be addressed. At the same time, further developing health systems has the potential to unfold leverage effects for transformation processes in other fields of action. This chapter first defines and delimits health systems as a topic; it then describes the basic, classic demands they must meet, and explains the concepts of universal health coverage and primary health care, which address these demands. Next it describes new challenges for health systems arising from global environmental changes, and identifies barriers to addressing these challenges. It develops five guiding principles as a possible solution approach which the WBGU regards as key for the further development of health systems. These provide orientation so that health systems can continue to fulfil their core tasks in the future and also initiate transformations in other sectors, e.g. through structural prevention in urban planning. This is followed by strategies on how health promotion and prevention can be used as transformative levers to promote healthy and sustainable lifestyles and living conditions. Options are then developed to systematically implement sustainability and resilience in health systems. Finally, recommendations for action and research are derived from the preceding analyses.

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6.1 Description of health systems

There are many different definitions of health systems. The demands placed on them vary, depending on the context. Furthermore, there is a great diversity of objectives, priorities and approaches aimed at protecting and improving health worldwide. The following subsection explains the understanding of health systems underlying this report.

6.1.1 Definition and tasks of health systems

The core tasks of health systems are to protect and improve human health (see Section 2.2.4 for the WHO's definition of health), which forms a basis both for social and economic development and for a life in dignity and prosperity (Declaration of Alma-Ata; WHO, 1978). These aims cannot be achieved without efficient and stable health systems (Winkelmann et al., 2021). These serve to safeguard health as a human right, which is enshrined e.g. in Article 12 of the International Covenant on Economic, Social and Cultural Rights (ICESCR) and Article 2 (2) sentence 1 of the Basic Law for the Federal Republic of Germany, and like healthy living conditions they are a prerequisite for health equity (Section 3.2). Their focus

on human health makes it clear that current health systems are made for humans. Current health systems do not give sufficient consideration to the health of other species or to the health of ecosystems.

People's living conditions and lifestyles, and thus social, economic, political and ecological determinants of health, also depend on factors that are not directly influenced by health systems (WHO, 2022m). Fields of action outside of health systems include, for example, areas of life such as what we eat (Section 4.1), how we move (Section 4.2), where we live (Section 4.3), and the way we manage the planetary risks of climate change, biodiversity loss (Section 5.1) and pollution (Section 5.2), global governance (Chapter 7), as well as education and science (Chapter 8).

According to a framework set up by the WHO health systems are characterized by six core components (WHO, 2010b):

1. Health-service delivery,
2. Health workforce,
3. Health-information systems,
4. Access to essential medicines and technologies,
5. Health-systems financing, and
6. Leadership and governance.

Health services can be further divided into health-promotion activities and preventive, curative, rehabilitative and palliative health services (aimed at symptom relief, mainly in the case of advanced incurable diseases; WHO, 2010b).

In addition to health services targeting individuals, there are public health services that aim to protect and promote health at the population level, e.g. by shaping healthy living conditions. This basically means implementing the public-health approach (Box 2.1-2). A widespread framework has defined ten essential services for public health departments that all communities should ensure. Among others they include assessing and monitoring the population health status and factors that influence health, such as investigating, diagnosing and addressing health problems and hazards affecting the population, and informing and educating people about health, factors that influence it, and how to improve it (CDC, 2023).

The different components of health systems are intertwined and influence each other. The WBGU identifies a particular transformative leverage effect in the components health services and health workforce, which are therefore dealt with below as the main focus. Health-information systems, health-systems financing and leadership and governance are also addressed, as they are also necessary for transformations of health systems towards sustainability, prevention and health promotion. Moreover, it is important to handle medicines and technologies in an environmentally safe manner (Section 5.2.3).

Furthermore, this chapter focuses on health systems in high-income countries where, compared to many

low- and middle-income countries, basic health care is guaranteed in most cases. There is also rigorous steering by the state via the planning, regulation and financing of health systems, as well as the establishment of public health departments (Box 6.2-1). In low- and middle-income countries, the focus is often on fundamental challenges such as the adequate provision of health services – challenges which are not caused specifically by global environmental changes, although their management is made more difficult by them (Section 6.2.2). Challenges specifically caused by global environmental changes for well-developed and differentiated health systems, as well as solution strategies that require effective governance, can therefore be better illustrated by the example of HICs. With appropriate adaptations to country-specific overall conditions, these solution strategies can also be transferred to low- and middle-income countries. Specific options for action for this group of countries with regard to coping with global environmental changes are described in a separate section (Section 6.5.1.3).

6.1.2 Demands on health systems

Well-functioning, effective health systems should, among other things, provide a quantity of health services that is in line with demand. The health services should also be equally accessible to everyone, i.e. physically accessible, barrier-free, within reasonable distances and free of discrimination; they should be affordable for all and offer free access to information on the health services. Furthermore, they should be provided in adequate ways, according to the principles of medical ethics, with respect for and consideration of specific socio-cultural, gender-related and individual health needs. In addition, the health services provided should meet current scientific and medical standards (WHO, 2017c; Toebe, 1999; Broerse and Grin, 2017). The extent to which health services are able to meet these demands requires a corresponding design of all other components of health systems, for which specific requirements apply in each case.

6.1.2.1 Goal of the WHO: universal health coverage

Universal health coverage (UHC) is an essential objective of global health policies and addresses the demands just described. UHC means “that all people have access to the health services they need, at high quality, when and where they need them, without financial hardship across the life course [...]” (WHO, 2021q). Also one of the SDG sub-targets is to “achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe,

effective, quality and affordable essential medicines and vaccines for all” (SDG 3.8; UNGA, 2015). There is growing criticism that UHC is taking on a hegemonic role in the global health discourse, pushing other solution approaches into the background (Smithers and Waitzkin, 2022). However, the WHO has assigned UHC a strategic priority: the aim is for one billion people to benefit from UHC by 2025 (WHO, 2023f). How UHC can be achieved varies between different countries and depends on specific local needs and resources (WHO, 2023f).

6.1.2.2 Strategy of the WHO: primary health care

Primary health care (PHC) is seen as a key strategy for achieving UHC (WHO, 2022a). PHC was internationally adopted as a goal in the Declaration of Alma-Ata in 1978 (WHO, 1978) and has since been reinterpreted many times. The conceptual focus was initially on basic medical care for the entire population, health promotion and prevention (Section 6.3.2), as well as on social and environmental determinants of health, especially in low- and middle-income countries. Communities and municipalities were to be directly involved in planning and providing health services. The ethical basis was the interpretation of health as a human right (Section 7.1), with the key goals of social justice and equitable access to health services for all (Hone et al., 2018; WHO, 1978). At that time, this holistic view first described what is now called the Health in All Policies approach: the demand that the health promotion of the population must take place within all sectors (Hone et al., 2018; Box 7.1-5).

PHC was quickly criticized as being too vague, too idealistic and too difficult to measure, and the focus shifted to selective health programmes (‘selective PHC’), which concentrated on tackling certain widespread diseases for which effective prevention and intervention measures are available (Amofah, 1994). These programmes were clearly delineated and easily measurable (Hone et al., 2018; Walraven, 2019). An increasingly neoliberal approach to development policy, driven by the World Bank and the International Monetary Fund, encouraged the emergence of free health markets and private foundations, as well as a further focus on measurable and achievable disease-specific targets. These are now referred to as vertical goals, as opposed to the horizontal approach of generally promoting functioning health systems. In the absence of such health systems in many low- and middle-income countries, the selective health programmes increasingly reached their limits; they came under growing criticism, and calls for horizontal programmes grew louder.

In 2018, PHC was finally reaffirmed and defined more broadly with the Declaration of Astana 2018 (WHO, 2018h; Kraef and Kallestrup, 2019). The term PHC is

now defined as an “overall approach to the organization of health systems which encompasses the three aspects of [1] multi-sectoral policy and action to address the broader determinants of health, [2] empowering individuals, families and communities, and [3] meeting people’s essential health needs throughout their lives” (WHO, 2021b). Three main pillars of PHC were identified: strengthening communities and municipalities, multi-sectoral political strategies and implementation approaches, and integrated delivery of primary-care and public-health services (WHO, 2018a; Kraef and Kallestrup, 2019). Germany’s Federal Centre for Health Education (BZgA) defines PHC as the “first, low-threshold level of contact for patients with diseases that a) occur frequently, b) affect large parts of the population and c) are either temporary or chronic in nature” (Zimmermann, 2021). In concrete terms, corresponding outpatient medical and psychosocial health services are provided in GP practices, community health centres or clinics, polyclinics or outpatient departments in hospitals, depending on the health system (Zimmermann, 2021).

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6.2 Health systems in the context of global environmental changes

The following section embeds the health systems defined in Section 6.1, along with their tasks and the demands on them, in the context of global environmental changes; it describes the resultant new challenges they face and identifies existing barriers to addressing them.

6.2.1 New challenges for health systems

Global environmental changes such as climate change, biodiversity loss and pollution, as well as the ongoing proliferation of unhealthy lifestyles worldwide, are increasingly creating health risks that are currently not being specifically taken into account in international goals such as UHC or SDG 3.8 (Section 6.1.2.1). These risks relate to various diseases and involve greater vulnerability to them, their higher and more widespread occurrence and the increase in symptoms and deaths caused by them (Sections 2.2, 5.1). This is affecting almost all medical disciplines (Traidl-Hoffmann et al., 2021). Global environmental changes reinforce existing social and health inequities. As so-called ‘threat multipliers’, they can worsen the individual socio-economic status of affected persons as well as the overarching political situation, thus threatening livelihoods, security and peace (Baunach, 2023; Romanello et al., 2021). Although health systems

are already dealing with shocks, acute and sometimes overlapping shocks (e.g. pandemics, heat waves, violent conflicts) will occur even more frequently in the future, and this could push health systems to the limits of their capacity or even to the point of complete collapse. Furthermore, changes in climate the loss of natural life-support systems and the impending uninhabitability in some regions of the world (Section 5.1) are increasingly endangering the functioning of societal systems in general, which also directly affects health systems and their various components (Section 6.2.2.2). The accumulation of increasingly frequent crises means that health systems have less and less time to recover and rebuild. Because of the urgent need to reduce resource consumption and emissions (Section 5.1), transformations towards sustainability must also be implemented in health systems. These are therefore challenged threefold by environmental changes: they are themselves structurally affected (e.g. by the destruction of health infrastructure; Baunach, 2023; WHO, 2015a), they are experiencing an increasing workload caused by an increased burden of disease in the population, and they are themselves in need of systemic transformations towards sustainability.

6.2.2 Three barriers impeding health systems worldwide in addressing environmental challenges

In the WBGU's view, there are three aspects impeding health systems in addressing the new challenges described above. They exist in different forms in different countries. *First*, health services in many health systems have a strongly curative orientation, i.e. they focus mainly on treating diseases and do too little to prevent them and promote health. *Second*, health systems are often poorly prepared for the new health risks posed by environmental changes. *Third*, many health systems in their current form have a large ecological footprint and thus themselves contribute to global environmental changes. In principle, these barriers affect both well-developed health systems and those that do not yet provide sufficient and appropriate basic healthcare. In many low- and middle-income countries, inadequate basic healthcare is often the most important barrier of all; furthermore, the new health risks will be even more difficult to manage, as they are sometimes even more pronounced in those countries and only limited resources are available (Section 6.2.2.2). Further challenges for health systems in low- and middle-income countries are presented in Box 6.2-1. These three barriers impeding health systems in addressing global environmental changes are explained in more detail below.

6.2.2.1

Curative focus of health services

Especially in western health systems, the focus of medical treatments and diagnoses is more on biological parameters, e.g. laboratory values, than on behaviours and living conditions (Greene, 2007; Kleinman, 1997). Based on a pathogenetic understanding of health, medicine is supposed to repair and correct pathological conditions. The many available treatment options have the effect that methods of maintaining health and preventing disease fade into the background. It can be assumed that people's understanding of health and disease is reflected in what patients expect of health services, e.g. in different assessments of doctors – depending on whether they mainly use drugs and medical technology to aid recovery or symptom relief, or whether they are also active in disease prevention and focus on patients' lifestyles for the purpose of holistic treatment. There is a lack of conclusive evidence here, however.

Conclusions can be drawn on the focus of the respective health system from the distribution of expenditure within a health system on different types of health services (Section 6.1.1). Such data are currently available mainly for high-income countries. Although disease-prevention measures can help improve health at comparatively low cost (Gmeinder et al., 2017), on average such spending accounts for only 2.7% of total expenditure in health systems in OECD countries (OECD, 2021). The situation is similar in the case of primary health care (Section 6.1.2.2): according to the OECD, PHC's full potential for improving human health is not being realized at present (OECD, 2019). In OECD countries, only 14% of total health expenditure is spent on primary health care (OECD, 2019). Similarly, the German Federal Centre for Health Education (BZgA) states that the potential of health promotion and disease prevention in primary health care has not yet been exhausted (Zimmermann, 2021). For Germany, it has been noted that a systematic approach to safeguarding and promoting health is also lacking at the population level, although it is urgently needed (Zukunftsforum Public Health 2021). By contrast, much more money is spent on (curative) hospital treatment (OECD, 2021). The latter is also very resource-intensive (Reddemann, 2021). In addition, spending on disease prevention in OECD countries fell more sharply than other health spending as a result of the financial crisis in 2008 (Gmeinder et al., 2017).

There is also overuse of health services in some places in the existing curatively oriented health systems, especially in high-income countries (OECD, 2017; Schenk et al., 2019). Overuse is defined in different ways, for example as "when a health care service is provided under circumstances in which its potential for harm exceeds the possible benefit" (Chassin and Galvin, 1998). These and

Box 6.2-1**Diversity of health systems worldwide**

Health systems can be organized very differently (Winkelmann et al., 2021). There are differences between high-income and low- and middle-income countries, but also between different countries within these groups. In order to understand the significance of the new challenges for different health systems and their specific deficits, and to develop targeted solutions for them, knowledge of their respective characteristics is necessary.

Health systems in high-income countries

In high-income countries, health services are usually planned, regulated, financed and sometimes provided by the state itself. However, their actual organization varies and can be in public or private hands. A rough classification can be made into six models or country groups (Schölkopf and Gimmeisen, 2021): (1) countries with a national health service, government-managed and tax-funded health facilities (e.g. UK, Ireland, Portugal); (2) countries with regionally organized, tax-funded health services (e.g. Spain, Australia, Canada); (3) countries with municipally organized, tax-funded health services (e.g. Denmark, Finland, Norway); (4) countries with social insurance systems (e.g. statutory health insurance funds) and service provision by both public and private institutions (e.g. Germany, France, Japan); (5) countries with insurance systems financed independently of income and service provision by both public and private institutions (e.g. Switzerland, Netherlands); (6) countries with voluntary, partly tax-subsidized private insurance and tax-financed insurance for certain population groups and service provision by both public and private institutions (e.g. USA).

Health systems in low- and middle-income countries

Low-income countries often have weaker state-run health services. In some cases, much or even most of the population has no access to adequate healthcare; often there is no adequate health or long-term-care insurance (Berkhout and Oostingh, 2008). In many cases, the population itself bears the financial risks of illness, and patients have to pay for health services themselves (WHO, 2010c). This necessity can contribute to

affected individuals or families actively driving environmental changes themselves, e.g. through illegal deforestation. This can be counteracted by improving basic healthcare, along with disease prevention and education (Duff et al., 2020a; Section 6.4.1.2). Increasingly, conservation projects in low- and middle-income countries are additionally implementing interventions that directly aim to improve health. In middle-income countries, state-run services are often better positioned, but here too, comprehensive, high-quality healthcare is often not guaranteed (Egger and Habermann-Horstmeier, 2021; Kumah, 2022).

Role of private health facilities

Private health facilities that are neither integrated into state structures nor subject to their direct control are becoming increasingly important, especially in low- and middle-income countries, where they contribute significantly to the provision of health services (Mills, 2014; Kumah, 2022). They can be categorized according to the criteria profit-oriented/non-profit-oriented, formal/informal and national/international (Klinton, 2020). In low- and middle-income countries, private health facilities are often used by poorer people for financial and cultural reasons and because of a low supply threshold (Patouillard et al., 2007; Sudhinaraset et al., 2013). At the same time, however, the influence of private actors on the healthcare markets, limited state regulation possibilities and, in some cases, inadequate qualifications create risks for primary care (Cross and MacGregor, 2010). The increasing importance of private health facilities in low- and middle-income countries creates an urgent need for effective regulatory mechanisms based on regulatory law and fiscal-policy instruments to manage the provision of health services in the public interest (Clarke et al., 2019; WHO, 2018f). There is occasional cooperation with public health facilities, but there are also competitive situations between the two sectors (Patouillard et al., 2007; Mills et al., 2002). There are no standards or frameworks for integrating the private sector into the public sector of health systems that could serve as orientation (WHO, 2018f). Other challenges in mixed health systems in low- and middle-income countries are the large variations in the quality of care, difficulties in evaluation and insufficient self-monitoring (WHO, 2020c).

other, narrower definitions of overuse relate primarily to the well-being of the patients affected. Since overuse is also associated with avoidable economic and ecological burdens, broader definitions include societal aspects. One example is the definition as “care that can lead to harm and consumes resources without adding value for patients” (Levinson et al., 2015). It becomes clear that the existing overuse contributes to the large ecological footprint of many health systems (Section 6.2.2.3) without providing any additional benefit for the protection and improvement of health.

6.2.2.2**Lack of preparation for global environmental changes**

Most health systems are currently inadequately prepared for the health risks posed by global environmental changes, especially in low- and middle-income countries (Baunach, 2023). Extreme weather events like heat waves, as well as other health shocks such as pandemics or violent conflicts, can cause failures in health systems, e.g. through power outages, destroyed health facilities, disruption of delivery and supply routes, a shortage of essential medical products, medicines and technologies, and staff absences as a result of impaired and unsafe working conditions (Baunach, 2023; WHO, 2015c). Moreover, there is often a lack of data-collection systems to record the current epidemiological status of

the population. Environmental and climate data are often not available, not sufficiently interlinked or not accessible to health systems. In low- and middle-income countries, health systems often operate at the limits of their capacity and suffer from a lack of resources and funding (Box 6.2-1; Baunach, 2023). They are also affected by a double burden of disease due to both infectious and non-communicable diseases (Section 2.2.1), and in their populations overweight, underweight and micronutrient deficiencies often exist in parallel (triple burden of malnutrition; Section 4.1), resulting in additional vulnerabilities to environmental changes. In addition, there is often a lack of sufficient availability and equitable access to high-quality and appropriate health services (Box 6.2-1), making it even more difficult for these health systems to address the new challenges (Baunach, 2023). Overlapping environmental changes and health crises can lead to an acute or long-term overloading of health systems, especially in low- and middle-income countries (Baunach, 2023; MSF, 2021). Corresponding countermeasures are therefore particularly urgent in these countries (Section 6.5.1.3).

According to the WHO Health and Climate Change Global Survey covering a total of 95 countries from all WHO regions and all income groups, 51% of the countries surveyed have so far conducted a vulnerability and adaptation assessment. Yet this only had a significant impact on resource allocation within the ministry of health of nine countries, and in only one country were the findings transferred to the level of the health facilities (WHO, 2021r). Low- and middle-income countries in particular are confronted with limited data availability and a lack of resources for conducting the assessments. 27% of the countries surveyed assessed the climate resilience, i.e. resilience to the impacts of climate change (Section 6.3.5), of at least one of their health facilities. Health early-warning systems using climate data exist, depending on the disease group, in 10% (for mental illnesses) to 35% (for vector-borne diseases) of the countries surveyed. Furthermore, while 52% of countries surveyed have a national health and climate-change strategy, 70% report that a lack of funding is a barrier to implementation (WHO, 2021r). 62% of low- and lower-middle-income countries surveyed by the WHO state that they are dependent on international support in order to implement their national climate and health strategy; 29% report having no funding for this at all.

Also in high-income countries, health systems are often not adequately prepared for health crises – for example in Germany: the German Advisory Council on the Assessment of Developments in the Health Care System (SVR) states that Germany's health system is neither sufficiently prepared for the impacts of climate change nor for pandemics, although this could be expected in view

of the generally good financial resources of the health system (SVR, 2023). Hence, good funding alone is not enough to prepare health systems for global environmental changes. Political will and good governance with a strategic orientation are critical determinants (Baunach, 2023). Furthermore, the effects of global environmental changes are usually not taken into account in medical guidelines (Herrmann et al., 2022), and health workers often lack crucial competence, as the links between environmental changes and health are not considered in existing curricula and therefore not taught (Section 8.1).

6.2.2.3

Large ecological footprint of health systems

The resource use of health systems is considerable: in Germany, for example, approx. 107 million tonnes of raw materials per year are consumed by the health sector, the equivalent of about 5% of total German raw-material consumption (Ostertag et al., 2021). As a result, health systems themselves contribute to the very environmental changes that are increasingly endangering health (WHO, 2017e). This applies not only (but especially) to health systems in high-income countries, and is essentially caused by four mechanisms: (1) their high energy consumption and the associated greenhouse-gas emissions, (2) their high level of water consumption and the large quantities of wastewater generated, especially in the health services and drug-manufacturing sectors, (3) the generation of large quantities of waste, some of it medical, and (4) the use of toxic chemicals (WHO, 2017e). Pollution by pharmaceuticals and pharmaceutical residues and their environmental and health impacts are described in detail in Section 5.1.2.3. The scale and the environmental and health risks of medical waste are discussed in Box 6.2-2. This section therefore concentrates on the contribution of health systems to climate change and air pollution.

The health systems of the OECD countries, China and India together accounted for 1.6 Gt, or about 4.4% of global CO₂ emissions in 2014 (Pichler et al., 2019). The health systems of China (601 million tonnes of CO₂) and the USA (480 million tonnes of CO₂) had the largest absolute CO₂ footprint (Pichler et al., 2019); per-capita emissions (divided by the total population) of 1.5 tonnes of CO₂ per person in the USA were markedly higher than in China, where they amounted to 0.44 tonnes of CO₂ per person (Pichler et al., 2019). The health system in the USA was responsible for 8% of the nation's greenhouse-gas emissions in 2007 (Chung and Meltzer, 2009). By 2018, emissions had increased even further (Eckelman et al., 2020). Greenhouse-gas emissions from the US health system are responsible for a burden of disease of approximately 209,000 DALYs (disability-adjusted life years; Box 2.2-1) per year (Eckelman and Sherman, 2018). Added to this are approx. 405,000 DALYs caused

by the health consequences of the air pollution produced (Eckelman and Sherman, 2018). Half of the variance in the per-capita CO₂ emissions between different countries can be explained by differences in the respective energy systems, the energy intensity of the respective economic systems and the differences in per-capita health expenditure; from this it can be deduced that important starting points for reducing their carbon footprint exist both inside and outside health systems (Pichler et al., 2019). Up to now, greenhouse-gas emissions from health systems worldwide have continued to rise, most recently by about 5 % from 2018 to 2019 (Romanello et al., 2022). At the same time, the health systems of most countries do not systematically record their own carbon footprint. One exception is the National Health Service in the UK, which has drawn up a detailed roadmap for achieving CO₂ neutrality by 2040 (NHS, 2020); the obligation to reduce emissions has been enshrined in law since 2022 (NHS, 2022). Most recently, 62 % of the UK health system's greenhouse-gas emissions came from the production and transport of pharmaceuticals, medical equipment and other goods (NHS, 2022). In addition, GHG emissions specific to health systems from the use of certain pharmaceuticals, particularly inhalational anaesthetics and metered dose inhalers (MDIs), must be taken into account (Box 5.2-4). The latest Lancet Countdown report, which compares the per-capita greenhouse-gas emissions of different health systems and average life expectancy in the respective countries, finds that high-quality healthcare can be achieved with lower emissions (Romanello et al., 2022).

6.3 Vision for the further development of health systems

The previous sections discussed challenges to health systems from global environmental changes, and identified three major barriers which, in the WBGU's view, stand in the way of addressing those challenges: the strongly curative orientation of health services, the inadequate preparation of health systems for health risks caused by environmental changes, and their large ecological footprint. This section offers a contrasting vision for the further development of health systems to enable them to address the new challenges. This vision ties in with existing strategies for the future of health systems such as the public health strategy for Germany (Zukunftsforum Public Health, 2021) and places them in the context of global environmental changes. It is in line with the overarching vision of 'healthy living on a healthy planet' (Chapter 3), picks up on its cornerstones (Section 3.1) and is based on five guiding principles, which are explained in more detail below.

6.3.1 Acknowledging the importance of healthy ecosystems

A cornerstone of the overarching vision of 'healthy living on a healthy planet' is that the natural life-support systems are acknowledged as the basis of human health (Section 3.1) and therefore any change or destruction has an impact on human health. This recognition is particularly important for health systems, as their core tasks are to protect and improve human health. For health systems to contribute to systemic approaches that address unhealthy and environmentally harmful lifestyles and help design healthy living environments (Box 3.1-1), they must acknowledge the interdependence of human health and the health of other species and of ecosystems, and take sufficient account of environmental changes. The importance of healthy ecosystems for human health was already pointed out in the WHO's Ottawa Charter for Health Promotion (WHO, 1986), which addressed determinants such as the overexploitation of natural resources, emissions of substances hazardous to health and air pollution (Box 3.3-1). This was later taken up in the Geneva Charter for Well-being (WHO, 2022a). Which determinants of health are attributed the greatest importance depends on societal influences, conventions, values and norms. In some indigenous cultures, human health is understood as being connected with the environment and other forms of life, and related to plants and animals on which people and their well-being depend (Escobar, 2019, Duff et al., 2020b). This perspective and the importance of healthy ecosystems for human health should be fully recognized as a matter of urgency. The growing scientific evidence for this, as well as existing integrative and transdisciplinary health concepts such as One Health and Planetary Health (Section 3.3), must be systematically taken into account.

6.3.2 Environmentally sensitive prevention and health promotion

Because of the complex interactions between global environmental changes, living conditions, lifestyles and health, there is a need to systematically address all determinants of health. Prevention and the comprehensive promotion of resilience and development potential should be strengthened; this is a cornerstone of the overarching vision of 'healthy living on a healthy planet' (Section 3.1). This means that health systems must integrate and implement environmentally sensitive prevention and health promotion as key guiding principles. While health promotion focuses on strengthening

Box 6.2-2**Waste from health facilities**

Health systems contribute to environmental pollution, i.a. through their production of large amounts of waste. The amounts generated vary considerably from country to country. The leaders are the USA and Canada with 8.4 and 8.2 kg of waste respectively per hospital bed per day. In Europe, Spain leads the way with 4.4 kg per bed per day. The figure in Germany is 3.6 kg per bed per day. In Africa and Asia, the range extends from 0.3–0.5 kg per bed per day (in Pakistan, Korea, Laos, Mauritius, Morocco) to 3.7 and 5.4 kg per bed per day in Iran and Kazakhstan (Singh et al., 2021). The COVID-19 pandemic has led to an increase in hospital waste worldwide, mainly due to the large amounts of personal protective clothing used. This posed major problems for many countries and their infrastructures, overloading local waste-management systems and threatening to create an environmental and health crisis, especially in some low- and middle-income countries (Singh et al., 2020; Ogunseitán, 2020).

Waste from health facilities has the particularity that it contains not only waste comparable to domestic waste (approx. 85%) but also hazardous waste (approx. 15%; WHO 2018g). In addition to pharmaceuticals and cell-damaging substances that pose particular environmental and health risks, the hazardous waste contains other toxic substances and chemicals, radioactive materials, pointed and sharp objects, body parts and blood reserves, as well as infectious waste.

Challenges in the disposal of waste from health facilities

Since there are no global standard procedures for the disposal of medical waste (with the exception of special waste and waste containing mercury), national guidelines differ considerably. There are no specific requirements for waste comparable to domestic waste. It can be disposed of or recycled in the same way as any other kind of waste, but many hospitals have failed to do this adequately up to now (Richter and Pecher, 2021, Wyssusek et al., 2019, Axelrod et al., 2015, Azouz et al., 2019). There are problems of mis-categorization worldwide,

however. In Germany, considerable amounts of hospital waste comparable to domestic waste are incorrectly assigned to hazardous waste and produce unnecessary CO₂ emissions due to the strict disposal requirements that then apply (Richter and Pecher, 2021, WHO, 2018g). Hazardous waste is incinerated at very high temperatures; it also requires additional waste-gas cleaning and therefore has a carbon footprint that is 3–6 times higher (data from the UK) than domestic waste in conventional incinerators (Rizan et al., 2021).

However, the opposite problem can be observed in many countries where there is no well-regulated management system for hospital waste. All the waste, including the hazardous waste, is mixed with conventional municipal waste and incinerated together or disposed of in conventional landfills. A survey of 24 low-income African, American and Southeast Asian countries found that only 58% of the health facilities studied managed their waste safely (WHO, 2015). In many low- and middle-income countries, incineration plants are outdated, and inappropriate technologies cause pollution from heavy metals or dioxins (Singh et al., 2021, Singh et al., 2020). Overall, high-income countries produce more medical waste, but implement better regulated and thus more environmentally sound disposal strategies (Singh et al., 2021).

Health and environmental risks from hospital waste

Improper disposal of hospital waste poses numerous specific environmental and health risks (Singh et al., 2021; WHO, 2018g). Although the number of improperly disposed cannulae is falling in low- and middle-income countries, they are still responsible for a significant number of HIV, hepatitis-B and hepatitis-C infections, putting people who sift through landfills or sort waste by hand at particular risk (WHO, 2018b). Infectious waste can cause or spread infections and antibiotic resistance. Many of the substances used in health systems, such as medicines, cytotoxic products and mercury, can contaminate surface, ground and drinking water when disposed of in landfills. The improper incineration of waste (e.g. due to outdated equipment or too-low temperatures) or the incineration of materials not intended for this method leads to air pollution, e.g. with carcinogenic substances (WHO, 2018g; Shen et al., 2022).

health resources and potential, disease prevention is concerned with preventing the development and progression of diseases and reducing the burden of disease. In relation to these two approaches, the term ‘environmentally sensitive’ means, for health promotion, that healthy ecosystems are regarded as an important prerequisite and resource for health, while disease prevention sees environmental changes as major determinants of disease. In the following, the two approaches are first described in general terms. Examples of concrete measures of environmentally sensitive prevention and health promotion are then described in Section 6.4.

Health promotion is defined as “the process of enabling people to increase control over, and to improve their health” (WHO, 2021q). It helps strengthen and maintain people’s health and avoid disease. It is based

on the concept of salutogenesis (Antonovsky, 1987; Box 3.3-1), which focuses on the factors that protect and promote health – unlike pathogenesis, which focuses on the emergence and development of disease. The three key areas of salutogenesis are resilience resources, the individual’s sense of coherence, and societal conditions and resources. Health promotion was defined in the Ottawa Charter in 1986 (WHO, 1986) and today plays a key role as a guiding health-policy principle of the WHO. However, it should urgently be brought more into focus and properly implemented in health systems by creating health-promoting structures and making health-promoting action possible (Box 3.3-1). Sustainability was already named as an important area of health promotion in the Ottawa Charter (WHO, 1986) and plays an even bigger role in the Geneva Charter for Well-being,

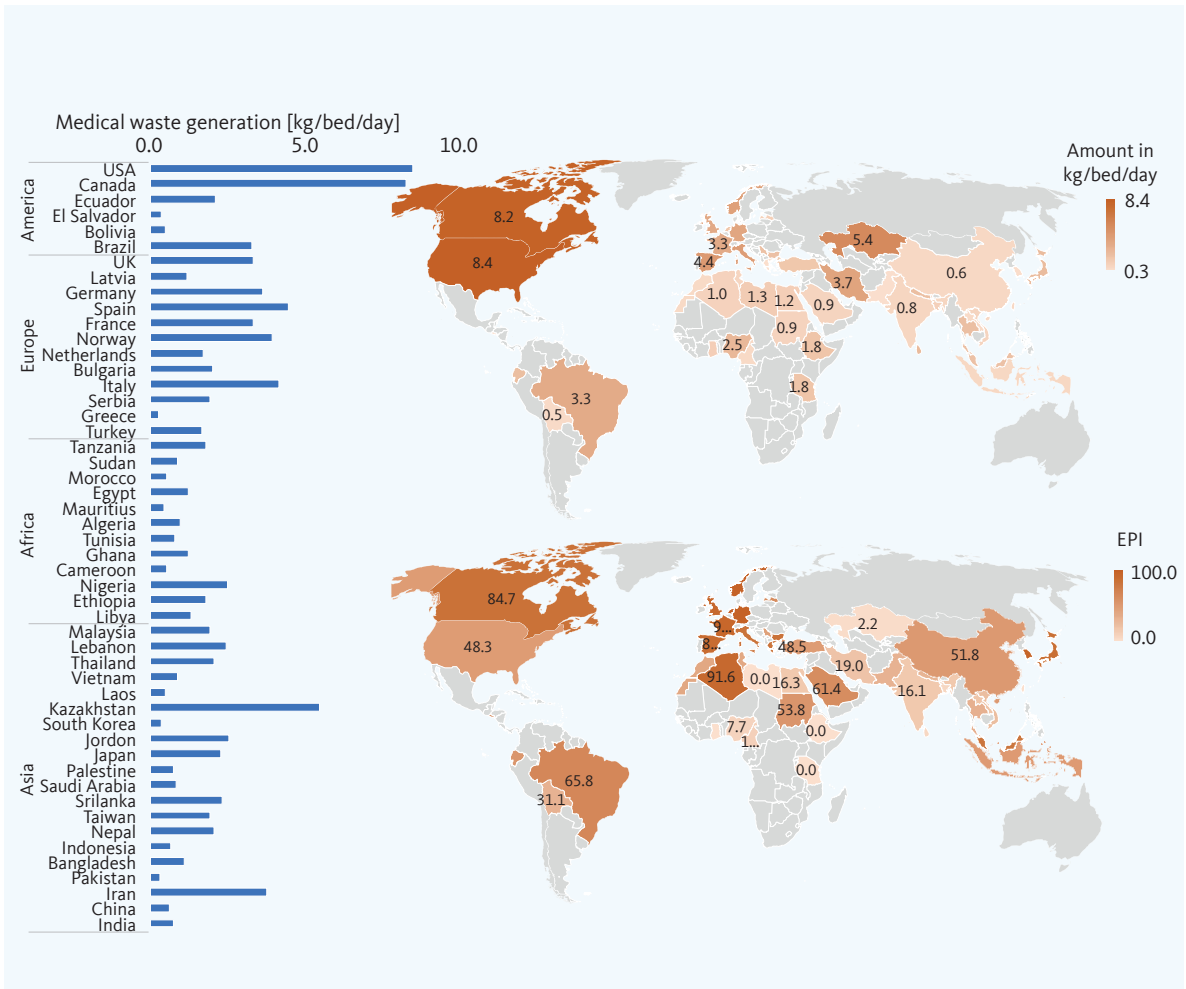


Figure 6.2-1 Waste volumes from the health sector per country (top) and the Environmental Performance Index (EPI, bottom). The EPI can take values from 0 to a maximum of 100 for the best ecological implementation. Source: Singh et al., 2021

which develops the concept of health promotion further (WHO, 2022a). “Contributing to the preservation of the natural life-support systems with regard to their importance for human health” is also laid down as a task of physicians working in Germany in the professional code of conduct issued by the German Medical Association (Bundesärztekammer, 2011).

Disease prevention refers to “measures to reduce the occurrence of risk factors, prevent the occurrence of disease, to arrest its progress and reduce its consequences once established” (WHO, 2021q). Depending on when (relative to the disease) they are deployed, a distinction is made between primary, secondary and tertiary disease prevention. Primary disease prevention refers to measures such as vaccinations, which are applied to healthy people who do not show any disease symptoms.

Secondary disease prevention includes measures that prevent the progression of diseases at an early stage that is clinically still unremarkable but already detectable. Examples include newborn-screening and cancer-screening examinations. Tertiary disease prevention refers to measures taken where a disease is already present or advanced, e.g. a rehabilitation measure after a heart attack. However, these different areas cannot always be clearly separated. A primary preventive measure, e.g. reduced heat exposure, can have a tertiary preventive effect at the same time, because pre-existing cardiovascular diseases can worsen during heat. Knowledge of risk factors affecting the development of diseases is crucial when it comes to disease prevention. Measures can be taken both in the field of behavioural disease prevention (targeting the behaviour of individuals) and structural disease

prevention (targeting the living conditions of a large number of people) to reduce factors that cause illness (Habermann-Horstmeier and Lippke, 2021). Combined strategies such as those applied in disease prevention in the workplace or in kindergartens and schools are particularly effective (Box 6.4-3; Habermann-Horstmeier and Lippke, 2021; Lippke and Hessel, 2018). It is also known that measures that specifically focus on risk populations or refer to younger age groups such as children or adolescents are particularly effective (Walter et al., 2011; König et al., 2011).

The two approaches of health promotion and disease prevention can be mutually beneficial (Habermann-Horstmeier and Lippke, 2021). When it comes to their implementation, they should not be discussed as conflicting concepts, as was the case for a long time in the past. Based on the common goal of improving health, they should be seen in an integrated manner and be transformed into a holistic strategy (Prümel-Philippsen and Grossmann, 2021) – dovetailed with the guiding principle of sustainability (Section 6.3.4).

6.3.3 Solidarity and inclusion

Another cornerstone of the ‘healthy living on a healthy planet’ vision is that vulnerable groups experience global solidarity, and that there is a reduction in inequities relating to material, economic and political inclusion (Section 3.1). These inequities are not least related to unequally distributed health opportunities, so that the further development of health systems should definitely be oriented towards the guiding principle of solidarity and inclusion. In concrete terms, this means that the goal of universal health coverage is to be achieved worldwide (Section 6.1.2.1) and that all people share in the health benefits of medical progress. Furthermore, all people should be enabled to participate actively and responsibly in improving, maintaining and restoring their own health. To achieve this, health systems should be designed inclusively, and health workers should interact with patients at eye level.

Moreover, health systems should be financed on the basis of solidarity: health inequities are largely generated by social inequities; at the same time, illness cannot be planned, is existentially threatening and can in principle affect anyone. Therefore, the financial risks associated with illness and the resulting use of health services should be justly distributed among the entire population and thus among all income groups. Solidarity is already enshrined as a guiding principle in some health systems, in Germany for example. Here, health insurance is defined as a community of solidarity (Section 1 of Volume V of

the German Social Insurance Code, § 1 SGB V). However, in many health systems around the world, there is a need to embed and implement solidarity more firmly.

Because of their particular vulnerabilities, smaller health resources and the threat of worsening health inequities as a result of global environmental changes, socially disadvantaged people should be given special consideration and be actively involved in all health-promotion and disease-prevention measures, as well as in strengthening adaptation and resilience.

6.3.4 Transformations towards sustainability

The overarching vision of ‘healthy living on a healthy planet’ includes respecting planetary guard rails in order to protect the health of humans, species and ecosystems (Section 3.1). At the same time, health systems themselves often have a large ecological footprint (Section 6.2.2.3) and thus themselves contribute to environmental changes that are harmful to health. Profound transformations towards sustainability are needed to make sure they do not counteract their core task of protecting and improving health. For this purpose, three aspects should be taken into consideration with regard to the provision of health services, as formulated, for example, by MacNeill et al. (2021): (1) reduce the demand for health services (which can result as an additional benefit from the implementation of the guiding principles of environmentally sensitive prevention and health promotion; Section 6.4.1.4), (2) match the supply of health services to demand, ensuring adequate care and avoiding unnecessary examinations and treatments (Section 6.5.2.1), and (3) reduce emissions and optimize the efficiency and environmental performance of the health services provided (Section 6.5.2.2). In addition to the provision of health services in health facilities, the other components of health systems also contribute to their emissions, especially the field of medicines and technologies. Sustainable transformations are therefore absolutely necessary in medical drug development, production and supply. This includes, for example, the consideration of sustainability criteria in the production of medicines as part of good manufacturing practice, or the consideration of environmental effects in the authorization of medicines (Section 5.2).

Sustainable health systems can also initiate sustainable transformations in other fields of action, e.g. via their role-model function, which could motivate behavioural changes among patients, and effects on the demand side, e.g. if ecological criteria are taken into consideration in the prescription of medicines or in the procurement of medical products (Section 6.5.2.3).

Particular challenges involved when it comes to transformations towards sustainability are, on the one hand, that the availability, access, adequacy and quality of health services must not be reduced (Section 6.1.2) and, on the other hand, that special hygiene requirements have to be met in health facilities. The fundamental principle that must always apply to all transformations is that at no time may action be taken against the well-being or health of patients and staff in order to save resources and emissions. Necessary and reasonable medical measures must always be carried out properly. Moreover, taking sustainability criteria into account makes it possible to prevent negative environmental impacts and illnesses caused by them, and thus to generate additional multiple benefits.

6.3.5 Strengthening adaptation and resilience

These two fields of action – adapting to environmental changes and building up resilience – cannot be separated from each other, as they overlap substantially. However, they do set different priorities (WHO, 2015c), as explained below. Strengthening adaptation and resilience should serve as a guiding principle for the further

development of health systems, as this can protect and improve people’s health even in the face of new and future health risks and crises. After all, this is the foundation on which development potential for well-being, diversity and *Eigenart* is made possible, which is an essential aspect of the overarching vision of ‘healthy living on a healthy planet’ (Section 3.1).

Adaptation aims to prepare health systems for continuously changing environmental conditions and the associated health risks and challenges, thus averting damage and also using advantageous opportunities (co-benefits) generated by the corresponding measures in relation to other objectives, e.g. the preservation of the natural life-support systems. Adaptation measures affect both the direct provision of health services and technical structures, as well as organizational processes in health facilities. For example, in view of rising average temperatures, changes in the probability of developing certain diseases and specific vulnerabilities should be taken into account. In addition, the structural and technical conditions as well as diagnostic procedures should be adapted, i.a. in order to continue to guarantee a room climate that is conducive to health, and to ensure that laboratory tests still work properly.

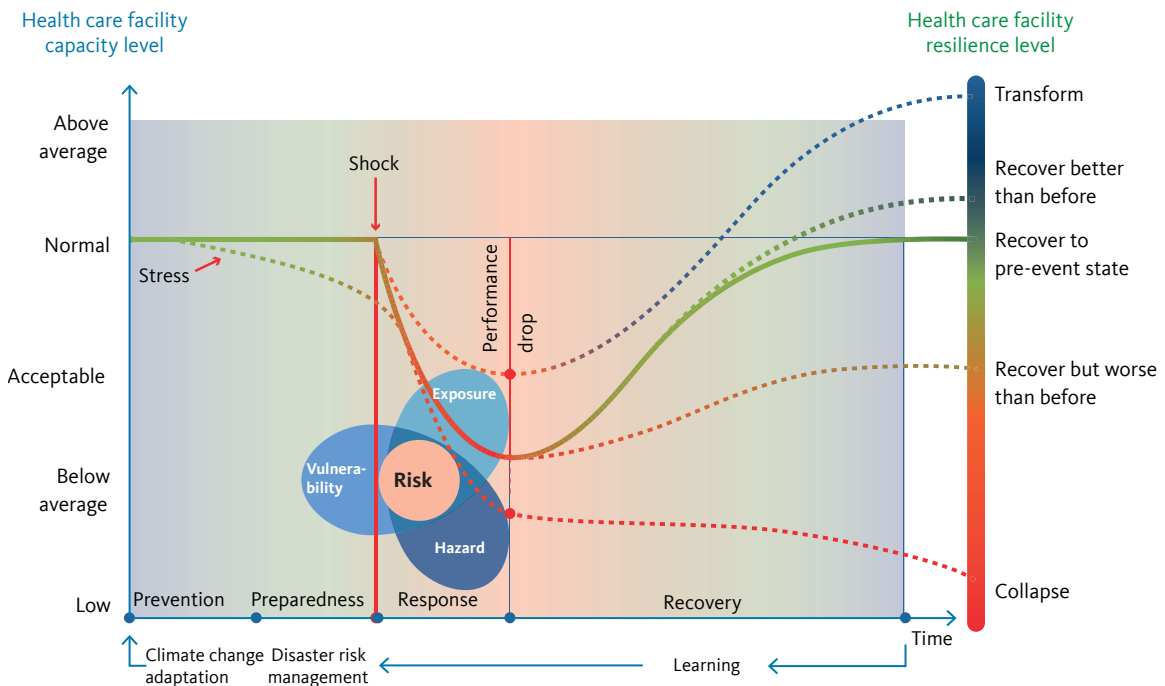


Figure 6.3-1 Climate resilience in healthcare facilities. The chart shows different phases before, during and after a shock, as well as possible development paths that depend on the resilience of the health facility. The system states and development paths depicted can also be transferred to health systems in general.

Source: WHO, 2020h based on WHO, 2020d; IPCC, 2012; Cimellaro et al., 2010

Resilience primarily relates to crisis situations and shocks. According to the WHO, resilience in health systems is the “capacity of health actors, institutions and populations to prepare for and effectively respond to crises; maintain core functions when a crisis hits; as well as stay informed through lessons learned during the crisis and reorganize if conditions require it” (WHO, 2020h). The aim of strengthening resilience is therefore to ensure that health systems remain sufficiently efficient in the face of crises and then recover at least to their previous state, or, better still, emerge stronger by learning to cope with future crises (Fig. 6.3-1; WHO, 2020h; Hanefeld et al., 2018). In addition to a secure energy supply (Section 4.3.4.2), the security of the supply of medicines and medical products should still be guaranteed during shocks; this can be achieved, for example, by diversifying global supply chains and securing local production capacities (SVR, 2023). Existing WHO climate-resilience strategies (WHO, 2020h), which specifically address resilience to the impacts of climate change, need to be expanded inasmuch as they should also address health risks associated with pollution, biodiversity loss and other environmental changes. Examples include large-scale smog and haze events, such as those caused by massive peat fires, and pandemics, e.g. of zoonotic infectious diseases (Section 6.5.1.1).

Continuous adaptation of health systems to climate and environmental changes contributes to improving resilience to shocks. For this reason, adaptation and resilience should always be addressed together and synergies exploited (Fig. 6.3-1). The simultaneous necessities of continuous adaptation to dynamic environmental changes and the improvement of resilience to acute health crises and shocks should nevertheless always be borne in mind despite all overlaps and synergies. Adaptation and resilience go beyond a mere reaction to environmental changes and also include anticipatory preparation for likely risks and crises and the reduction of vulnerabilities.

6.3.6 From vision to implementation – from guiding principles to recommendations

Five guiding principles were explained in the preceding sections: acknowledging the importance of healthy ecosystems; environmentally sensitive prevention and health promotion; solidarity and inclusion; transformations towards greater sustainability; and strengthening adaptation and resilience. These principles interact closely with each other, and the implementation of one can promote the realization of the other guiding principles respectively. Furthermore, a concerted

implementation of the guiding principles can open up additional synergy effects. They can become transformative driving forces in health systems and, from there, have an impact on other fields of action, such as what we eat, how we move and where we live (Chapter 4). Cross-system cooperation is essential for this and is also embedded as a cornerstone of the overarching vision of ‘healthy living on a healthy planet’ (Section 3.1). The guiding principle of acknowledging the importance of healthy ecosystems’ is a necessary prerequisite for the implementation of the other guiding principles throughout, and is recurrently addressed in the following sections. The guiding principle of ‘solidarity and inclusion’ should always be consistently realized in the implementation of the other guiding principles. The guiding principles ‘environmentally sensitive prevention and health promotion’, ‘transformations towards sustainability’ and ‘strengthening adaptation and resilience’ serve to highlight multiple benefits and develop implementation strategies in the following sections (Sections 6.4, 6.5), concluding with recommendations for action and research (Section 6.6). They can help health systems to also leverage sustainable transformations in other societal systems.

6.4 Use health promotion and disease prevention as transformative levers

To ensure that health can be protected and improved even in the face of global environmental changes, the WBGU proposes environmentally sensitive prevention and health promotion as a general guiding principle for the further development of health systems (Section 6.3.2). In addition to this, health promotion and disease prevention can be used as transformative levers, since they can also promote transformations towards sustainability in other fields of action. In order to harness the transformative potential of health promotion and disease prevention, adjustments are needed in the areas of health services, health workforce, governance and financing structures, which are addressed first and foremost in this subsection; health-information systems also need to be adapted (Section 6.5.1.2; Box 6.5-1). In the following section, first the multiple benefits are described that can result from environmentally sensitive prevention and health promotion (Section 6.4.1); then strategies are outlined that can be used to promote the generation of these multiple benefits (Section 6.4.2).

6.4.1 Multiple benefits of environmentally sensitive prevention and health promotion

Three complementary strategies are key to implementing the overarching vision of ‘healthy living on a healthy planet’ (Box 3.1-1): first, promoting and strengthening resilience and development potential; second, preventing risks and dangers; and third, reacting to and repairing damage. For health systems, these strategies correspond to the implementation of health promotion and disease prevention and the treatment of diseases (Fig. 3.1-1). With regard to the new challenges posed by global environmental changes (Section 6.2.1), extensive measures to adapt various components of health systems are necessary also for the successful treatment of diseases (Section 6.5.1). In addition, many people worldwide currently do not have access to adequate healthcare (Section 6.2.1). In principle, however, the treatment of diseases is already addressed by health systems because of their curative focus (Section 6.2.2.1). On the other hand, the strengthening and targeted implementation of health promotion and disease prevention in particular are key for the promotion of healthy and sustainable lifestyles and living conditions with their numerous multiple benefits for the health of people and ecosystems (Sections 6.4.1.1, 6.4.1.2). In addition, the application of environmentally sensitive prevention and health promotion in health systems would also result in multiple benefits for strengthening adaptation and resilience in the population (Section 6.4.1.3). Moreover, there is the potential to reduce the demand for resource-intensive medical treatments, which could contribute to reducing the ecological footprint of health systems (Section 6.4.1.4). These multiple benefits will be explained in the following sections.

6.4.1.1 Promoting healthy and sustainable lifestyles

By promoting healthy and sustainable lifestyles in the context of environmentally sensitive prevention and health promotion, people can be enabled to act sustainably in different areas of life. This can happen, for example, in the context of individual counselling sessions by health professionals, in which people’s life situations are addressed, and they are given personally tailored suggestions for health-promoting and sustainable behaviour (Sections 6.4.2.1, 6.4.2.2). Corresponding education is also conceivable in group settings with a connection to people’s living environments, perhaps in community centres.

For example, information can be provided on the nutritional recommendations of the Planetary Health Diet: these include daily maximum amounts for the

intake of meat, fish and dairy products that should not be exceeded, as well as minimum recommendations for the consumption of fruit, vegetables, pulses, nuts and whole grains (Box 4.1-1). A plant-based diet is both healthier and more sustainable: a considerable proportion of diet-related premature deaths from non-communicable diseases is due to an excessively high proportion of meat and too low proportions of plant-based foods in the diet (Micha et al., 2021; Section 4.1.1.1). In addition, animal food production contributes disproportionately to the environmental changes caused by global agriculture (Box 4.1-3). In the context of environmentally sensitive nutrition counselling, attention can also be drawn to the health-related and ecological benefits of consuming organic food, e.g. resulting from avoiding synthetic pesticides (Sections 4.1.1.2, 4.1.1.3). In addition, information could be provided on the health risks of physical inactivity (e.g. long and uninterrupted sitting increases the risk of developing cancer and fatal cardiovascular diseases (Ekelund et al., 2019; Hermelink et al., 2022; Section 4.2.1.2), and on the ecological and health risks of car traffic (e.g. due to climate change and air pollution; Section 4.2.1.3). If the ecological and health benefits of active mobility (e.g. cycling) are also addressed and references to a person’s individual health and disease history are made, a corresponding change in behaviour can be initiated.

Another example is the recommendation to use green spaces as a personal health resource: spending time in the park, preferably in conjunction with physical activity and social activities, can improve immune system function, lead to better social cohesion, provide mental-health benefits and contribute to the prevention of cardiovascular disease (Section 4.3.3.4; Fig. 4.3-1). The conscious use of green spaces or consciously spending time in nature, as well as knowledge of its positive effects, can then contribute to an increased appreciation of other living beings and an intact biosphere, which can enhance the motivation to behave sustainably or to become active in promoting sustainability.

Furthermore, there is a wide range of possible activities that can be applied in the context of environmentally sensitive prevention and health promotion, which serve the health of the participants and contribute to environmental protection at the same time (e.g. in the context of ‘green care’ or ‘nature-based interventions’; Cook et al., 2019). Examples range from health-promoting activities in biodiverse and ecological community gardens to activities in nature conservation as a form of physical exercise; there are also increasing efforts to directly prescribe nature-related activities to patients (‘nature’ or ‘green prescriptions’). A range of activities in contact with nature, examples of nature prescriptions, and interactions with biodiversity protection and promotion are

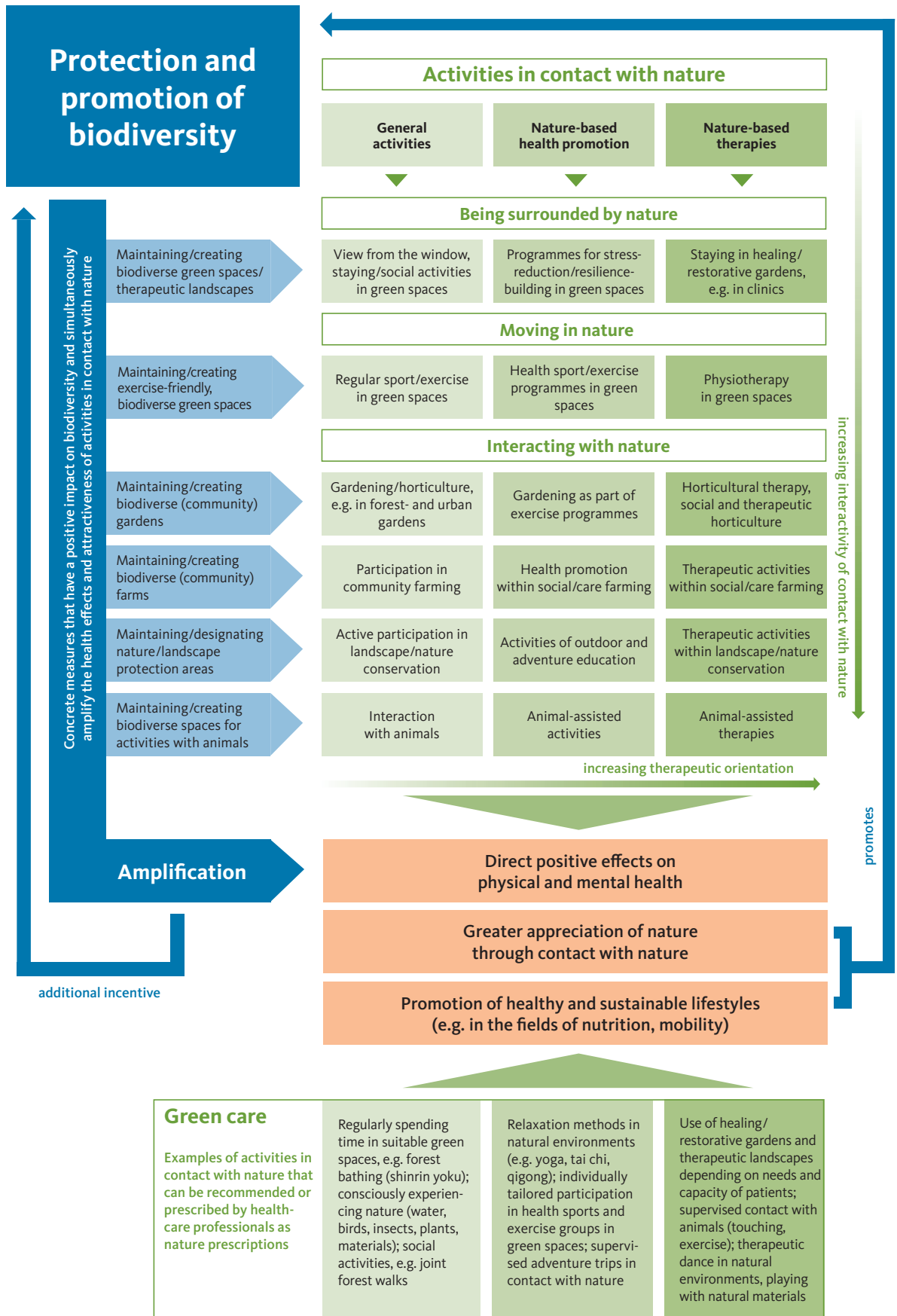


Figure 6.4-1

Possible synergies between the protection and promotion of biodiversity (blue) and activities in contact with nature (green). Various measures that have a positive impact on biodiversity (light blue arrows, left) can simultaneously amplify the health effects and attractiveness of activities in contact with nature (right), which represents an additional incentive and multiple benefit (narrow blue arrow, left). Activities in contact with nature (general activities, nature-based health promotion and nature-based therapies; green boxes, right) can, in addition to positive physical and mental health effects, also promote the appreciation of nature, closeness to nature and healthy and sustainable lifestyles (orange). This can again contribute to the protection and promotion of biodiversity (narrow blue arrow, right). In principle, most of the activities mentioned are suitable for nature prescriptions by health professionals. The choice of activities as well as their duration, frequency and intensity should be based on the individual needs and preferences of patients and the medical assessment of their state of health.

Source: WBGU, based on Cook et al., 2019 (original image published under CC-BY license), modified according to: Aerts et al., 2018; Barragan-Jason et al., 2022; Bikomeye et al., 2022; Bratman et al., 2019; Coventry et al., 2021; DeVille et al., 2021; Fisher et al., 2023; Frumkin et al., 2017; GKV-Spitzenverband, 2023; Litt et al., 2023; Liu et al., 2022; Marselle et al., 2021; Martin et al., 2020; Mathers und Brymer, 2022; Nguyen et al., 2023; Pérez-Ramírez et al., 2021; Razani et al., 2018; Thompson, 2018; White et al., 2019; Wood et al., 2018

shown in Figure 6.4-1. Furthermore, Chapter 4 discusses healthy and sustainable lifestyles and the necessary framework conditions for them in more detail, using as examples the areas of life ‘what we eat, how we move and where we live’.

6.4.1.2

Initiation of measures for structural prevention

Environmentally sensitive prevention and health promotion can contribute to healthy living conditions not only by promoting sustainable lifestyles and the positive ecological effects of activities at the interface with nature conservation. Within information and counselling services, people could also be informed about the possibilities of the sustainable and health-promoting design of their living environments, thus activating their corresponding creative potential in a targeted manner. For example, in the context of preventive medical check-ups for their children, parents could be informed that spending time in green spaces and in contact with nature has a positive effect on the well-being and physical and mental development of their children (Dadvand et al., 2019). In this context, information could be provided on how parents (and children) can actively engage or participate in the health-promoting and sustainable design of their neighbourhood (e.g. planning and community maintenance of urban green spaces).

Such participatory activities of sustainable urban design (Section 4.3) can be promoted, initiated and guided by municipal public health departments: they can initiate cross-sectoral measures to create health-promoting and sustainable urban spaces and guide specific projects for structural prevention in the neighbourhoods, e.g. on issues such as traffic calming and expanding or upgrading green spaces. Participatory instruments can be used for demand-oriented planning (e.g. Place Standard Tool), and municipal public health departments can benefit from transnational networking. For

example, the city of Dresden is a member of the European WHO Healthy Cities network; the coordination of corresponding measures is based in the strategic health planning department of the office of health and disease prevention, which is the city’s municipal public health department (Landeshauptstadt Dresden, 2023).

If, in addition, public health departments are established as an interface between health systems and the administration, policy-makers and other sectors, they can also initiate further interdepartmental cooperation to promote structural prevention in the sense of the Health-in-All-Policies approach (Box 7.1-5), which goes beyond the immediate shaping of municipal living environments, e.g. in the areas of nutrition systems, in industry or transport planning.

Individual health facilities can also actively contribute to structural prevention – beyond reducing their ecological footprint – by directly addressing local nature conservation in addition to providing health services.

One example is the medical clinic of two NGOs (Alam Sehat Lestari and Health in Harmony) in the Gunung Palung National Park, Borneo (Indonesia), which, on the one hand, provides basic health services and, on the other, is committed to the protection and restoration of the local rainforest (Duff et al., 2020a; Webb et al., 2018; Jones et al., 2020). The clinic’s patients can also contribute indirectly to reforestation, e.g. by paying for their medical treatments with seedlings they have grown themselves. In addition, they are given information in the waiting room and during counselling sessions about the health benefits of an intact rainforest (Duff et al., 2020a). As a further measure, people are trained in organic agriculture, which was identified as a wish of the local population during participatory consultations (‘radical listening’: Duff et al., 2020b). Moreover, it was found that one motivation for local people to illegally clear rainforest had previously been the need to pay for medical treatment (and associated travel costs; Duff et al., 2020a), and many of the

communities interviewed stated that they could stop clearing if they had access to quality, affordable health-care and were trained in alternative livelihoods (Webb et al., 2018; Duff et al., 2020a). Deforestation has been greatly reduced since the clinic was established and primary care improved; moreover, significant health benefits among the local population have been measured (Jones et al., 2020). Such projects at the interface of health and nature conservation sometimes have to overcome funding problems related to their multi-sectoral orientation (Duff et al., 2020c).

6.4.1.3 Reducing vulnerability and strengthening adaptation and resilience in the population

Health promotion and disease prevention can reduce people's vulnerability to health risks from environmental changes. For example, people with pre-existing lung or cardiovascular diseases are particularly vulnerable to heat stress, which can exacerbate these conditions. If the prevalence of such pre-existing conditions were reduced by health-promotion and disease-prevention measures (e.g. lifestyle interventions such as programmes aiming at weight loss, physical exercise promotion and tobacco withdrawal; Box 6.4-3), this would reduce the size of vulnerable populations and protect people from disease. This also applies to other health risks associated with environmental changes, such as pandemics of infectious respiratory diseases like COVID-19, for which similar risk factors exist (e.g. chronic lung disease from tobacco smoking, overweight, poor general health). In addition, individually adapted health-promotion and disease-prevention offers make it possible to educate people in a targeted manner tailored to their individual needs about environmental health risks that are particularly relevant to them, and to inform them about options for adapting their behaviour. One example is advising pregnant people about the harmful effects of air pollution in the wake of forest fires during heat waves. Such education measures and the reduction of pre-existing conditions would strengthen adaptation and resilience in the population to the health risks of global environmental changes. The ability of population groups to prepare for and respond effectively to crises is explicitly included in the WHO's description of climate resilience in health systems (Section 6.3.5).

6.4.1.4 Reducing the demand for resource-intensive treatments

A further multiple benefit of the comprehensive implementation of health promotion and disease prevention could be a reduction in the number of resource- and emissions-intensive diagnostic and therapeutic measures.

On the one hand, this could generate economic advantages; on the other, it would reduce health systems' ecological footprint (MacNeill et al., 2021). The National Health Service (NHS) in the UK, for example, has shown that although greenhouse-gas emissions per hospital stay fell by 64% from 1990 to 2019, this only resulted in a 26% reduction in total NHS emissions (Tennison et al., 2021). An increasing demand for health services could be one reason for this (MacNeill et al., 2021). It is hardly conceivable that the environmental impact of health systems can be drastically reduced unless there is a long-term reduction in the use of medical services (SAMW, 2022). Although it is generally accepted that disease prevention is the most effective way to improve the sustainability of health systems (Sherman et al., 2020), there is currently a lack of concrete projections or empirical evidence on the potential savings in resources and emissions that could be made by reducing the demand for health services. Furthermore, ecological aspects have not yet been comprehensively included in considerations of the benefits of more health promotion and disease prevention.

6.4.2 Strategies for generating multiple benefits

In the WBGU's view, the implementation of environmentally sensitive prevention and health promotion in health systems, and the generation of the multiple benefits described above can be promoted in particular by four key strategies: the targeted adaptation of the primary health care approach promoted by the WHO, enabling health professionals to promote healthy and sustainable lifestyles, the corresponding adaptation of remuneration systems, and the expansion of public health departments so that they can make a greater contribution to structural prevention. These four strategies are explained in more detail and illustrated with examples below.

6.4.2.1 Adapt the primary health care approach in a targeted way

Primary health care (PHC) is seen as a key approach to achieving the goal of universal health coverage (UHC); its implementation is being promoted by the WHO, among others (WHO, 2022a), although the approach is the subject of critical discussion (Section 6.1.2). In the WBGU's view, the existing PHC approach should be modified to specifically step up environmentally sensitive prevention and health promotion, while addressing global environmental changes and promoting healthy and sustainable lifestyles. The PHC approach offers various starting points for this, and these are described below.

Basic health services with a focus on environmentally sensitive prevention and health promotion

Primary health care (PHC) focuses on improvements in the availability, access and quality of basic health services. Primary care should be complemented by individual and population-based health promotion, and should be regional, patient-centred and holistic, taking into account living conditions and environmental factors. Global environmental changes and their health risks must be explicitly taken into consideration. By improving primary care, it is furthermore possible to actively protect the environment, as has been shown in a case study (Duff et al., 2020a; Section 6.4.1.2).

In order to improve primary care, easily accessible and low-threshold care structures should be expanded within communities instead of relying only on centrally located hospitals that are more difficult to reach. This can be done, for example, through integrated regional health centres whose range of services can be adapted to regional needs; this would also strengthen structural resilience (SVR, 2023). Thus, unnecessary hospital admissions and the associated burdens for the people affected can be avoided, as can financial costs for the general public and external costs for the environment (Section 6.4.1.4). Another example of low-threshold community care structures is community health nursing, which is already being used in some countries (Box 6.4-1). In addition to outpatient community care structures, hospitals can also contribute to health promotion, and thereby take global environmental changes into account, e.g. by offering patients counselling on healthy and sustainable nutrition during their stay, or by initiating measures in their community to promote structural prevention such as the expansion of green spaces (Box 6.4-2).

Within the various facilities and services of primary care, individual lifestyle-specific counselling should be offered, explicitly including possible multiple benefits for avoiding global environmental changes and for protection from their health risks (Section 6.4.1). In addition, individually adapted disease prevention could ward off environment-related diseases or detect them at very early stages and thus treat them more cost-effectively. Interdisciplinary cooperation (e.g. with social workers, psychosocial and psychotherapeutic care structures, public health departments and nature conservation) can be helpful in making this possible. Moreover, a corresponding adaptation of health-information systems is necessary because these can provide data for personalized risk assessments and early-warning systems (Section 6.5.1.2). In order to specifically address patients in an uncomplicated way and recruit them for measures of environmentally sensitive prevention and health promotion, a close linkage with curative treatments would

make sense (Werdecker and Esch, 2021). In addition, approaches to patient care such as integrative medicine can be used, which already contain suitable starting points for addressing global environmental changes and their health risks more strongly: integrative medicine “is informed by evidence and uses all appropriate therapeutic, preventive, health-promoting or lifestyle approaches, professionals and disciplines in health systems to achieve optimal health and healing” and “is based on a social and democratic, natural and healthy environment” (Esch and Brinkhaus, 2020). Thus, integrative medicine also offers starting points for incorporating traditional and indigenous knowledge or healing methods in different local contexts, provided that there is evidence for their effectiveness; however, corresponding research projects are still lacking in many cases. The traditional medicine of Indonesia, called *Jamu*, is described in Box 8.1-5 as an example of a local knowledge system at the interface between environment and health. The systemic and multidisciplinary approach of integrative medicine, which aims to address not only the treatment of disease symptoms but also their causes, and recognizes the interconnectedness of different – including ecological – preconditions for health, has similarities to the approach of transdisciplinary health concepts (e.g. One Health, Planetary Health; Section 3.3).

Empower people and societies to make health-promoting and sustainable choices

The primary health care approach includes empowering individuals to maintain and improve their own health, i.e. boosting their health literacy, which also promotes their opportunities for societal participation and their political inclusion. This is in line with one of the guiding principles for the further development of health systems (Section 6.3.3) and also represents a dimension of the WBGU’s normative compass (Section 3.2). Empowering people to advocate for their health concerns can initiate transformative action if it is accompanied by comprehensive education about global environmental changes, their causes and health risks – in the sense of planetary health literacy (Section 8.1.3). Health professionals can play a key role in such an empowerment of people and initiate transformative change in the population, especially in the context of promoting healthy and sustainable lifestyles (Section 6.4.2.2). Furthermore, inclusion and planetary health literacy can also enable people to get involved in sustainability politically and professionally, and to contribute to the health-promoting and sustainable design of their living environments.

For orientation, Box 6.4-3 describes some practical examples of existing health-promotion and disease-prevention measures in different areas that are financed by the statutory health insurance funds in Germany. It

Box 6.4-1

Community health nurses

The term community health nurse refers to a nurse whose responsibilities go beyond traditional nursing activities. Community health nurses often work in local primary care outside hospitals, as well as in public health departments, currently, for example, in many Scandinavian countries and also in Canada and Australia (Iversen et al., 2022; Hartzler et al., 2018; Agnes-Karll-Gesellschaft für Gesundheitsbildung und Pflegeforschung, 2018). These specialized professionals often serve as the first point of contact and the first line of primary care. They are also responsible for coordinating the care and treatment of patients with (multiple) chronic diseases. They form an interface for the multidisciplinary care process involving

different medical disciplines as well as other health-relevant professional groups. In addition, they carry out health-promotion and disease-prevention measures (e.g. screening programmes, tobacco withdrawal programmes, promotion of physical activity), including health-education services. This not only promotes health literacy in the population, but also empowers patients to take responsibility for their own health (Sections 6.3.3, 6.4.2.1). In addition, community health nurses can collect epidemiological data and identify specific health risks or care deficits at an early stage. They are based in the local community and thus offer low-threshold access to the health system for all population groups. This makes it possible to reach marginalized groups particularly well, for whom outreach strategies for education and information are especially important, e.g. with regard to environmental changes (SVR, 2023; Section 6.4.1.3).

Box 6.4-2

Health-promoting hospitals

The Health Promoting Hospitals network aims to expand the range of tasks carried out by hospitals to include health-promotion services in addition to curative health services (Pelikan et al., 2022). The corresponding approach is already being implemented in numerous hospitals; other types of health facilities are also being addressed in the meantime (HPH Network, 2023). The aims are to: (1) promote the health of patients and (2) employees, (3) change the organizational structure of the hospital to create a health-promoting environment, and (4) establish health promotion in the community where the hospital is located. In this way, individual medical measures and measures focused on personal behaviour (i.e. relating to lifestyles, e.g. smoking, nutrition, physical exercise) including information and health education are

integrated with other strategies at the community level. The conditions relating to staying and working in hospitals themselves are also addressed. Hospitals often endanger the health of their own employees by encouraging overwork, creating high levels of stress and thus promoting illness and absence from work or reducing the personal commitment of employees in the long term (WHO, 2005). With regard to the consideration and mitigation of environmental changes, the concept could be favourably expanded by combining it with approaches for more resilience and sustainability in health facilities (Sections 6.5.1, 6.5.2), and by adding corresponding aspects on different levels of action, e.g. the effects of heat on staff in hospitals as well as on the healing process of patients, the promotion of sustainable behaviour with accompanying health co-benefits and the establishment of the Planetary Health Diet (Section 4.1). In this way, health-promoting hospitals could become role models for sustainable and healthy lifestyles.

also reveals ways in which existing measures could do more to promote healthy and sustainable lifestyles and living conditions. For example, structured treatment programmes for people with chronic cardiovascular diseases could address the environmental benefits of a plant-based diet in addition to its health benefits. In kindergartens (parents and children) and senior citizens' centres, education could be offered on the health and ecological benefits of biodiverse green spaces, and, through companies, free bicycles could be provided for employees as part of company health management.

6.4.2.2

Enable health professionals to promote healthy and sustainable lifestyles

Health professionals are regarded as a trustworthy professional group (GfK Verein, 2016), who reach people from all sectors of society in the course of their work.

As multipliers of planetary health literacy, they can address not only their own patients but also the entire health sector and the public, which is why they can be seen as playing a key role in initiating sustainable transformations (Broerse and Grin, 2017). In this role as change agents, they should be institutionally supported in health systems:

Doctors, care staff, midwives, pharmacists, nutritionists, physiotherapists, medical assistants, community health nurses and other health professionals play crucial roles in the implementation of health promotion and disease prevention (SAMW, 2022). Specific primary and secondary preventive measures are mainly provided in outpatient care structures (e.g. vaccinations, lifestyle counselling on prediabetes). In Germany, many of the measures are carried out by GPs, who could continue to play a key role together with their practice teams (e.g. medical assistants). In addition, however, all other health professions should

Box 6.4-3**Examples of health-promotion and disease-prevention measures in Germany**

In Germany, reducing existing disease risks for healthy people (primary prevention) and supporting healthy living environments and conditions at the workplace (workplace health promotion) are among the tasks of the health insurance funds (Wanek and Schreiner-Kürten, 2021). The following section describes examples of health-promotion and disease-prevention measures which are currently financed by the statutory health insurance funds in Germany, and options for giving global environmental changes and their health risks more consideration.

Services in the field of individual behavioural prevention

Courses and counselling are currently offered based on known risks and protection factors, as well as the population's known health problems: for example, lifestyle interventions such as weight reduction and tobacco-withdrawal programmes aimed at preventing non-communicable diseases. In 2017, however, only 2.3% of insured persons were reached by such courses (Wanek and Schreiner-Kürten, 2021).

Existing measures for individual behavioural prevention could address global environmental changes by addressing environmental-health risks that are relevant to specific target groups (e.g. education on the particular risks of heat and air pollution for people with cardiovascular diseases) and including education on individual adaptation measures (e.g. avoiding urban areas particularly affected by heat and air pollution). Existing structured treatment programmes for patients with chronic diseases (e.g. disease-management programmes) can be supplemented accordingly, and new 'health-management programmes' (Section 6.6.1.2) established.

Health promotion and disease prevention in living environments

These services are oriented towards people's living environments and can be offered in local communities, educational institutions, youth, women's and senior-citizens' centres, associations/clubs, facilities for people with disabilities or in care facilities. In fact, however, they are mainly implemented in kindergartens and primary schools, and overall only about 6% of all insured persons are reached (Wanek and Schreiner-Kürten, 2021). Examples in kindergartens include the active and supervised participation of children in the preparation of meals to provide them with opportunities to make learning experiences regarding food handling, as well as the provision of diverse, safe and natural spaces for physical exercise by the kindergarten provider (GKV-Spitzenverband, 2023). In the local communities, for example, the aim is for job centres to sensitize unemployed people to the relevance of health for

improving individual opportunities for (re)integration into working life, and to motivate them to adopt a healthy lifestyle (GKV-Spitzenverband, 2023).

In principle, the outreach approach of living-environment oriented measures offers an opportunity to reach socially disadvantaged or vulnerable groups, e.g. those affected by access barriers to the health system and/or with higher health risks. For these groups, outreach strategies to educate and inform them about the health risks of environmental changes are particularly necessary (SVR, 2023). Existing services in the living environments could address health risks and adaptation measures as well as health-promotion measures that are particularly relevant for the specific target groups. In senior-citizens' centres, for example, people could be informed about the need to adjust their medication (on doctor's orders) in hot weather, and about the health benefits of social activities in green spaces. In addition, information could be provided on the possibilities of designing living environments in a sustainable and health-promoting way, specifically activating the corresponding creative potential of the actors involved, for example by educating parents in kindergartens about the health benefits of more green spaces for their children.

Workplace health promotion

The strategies for workplace health promotion by the health insurance funds go beyond the legally required occupational health and safety measures. Currently, they are designed as a complex of voluntary measures with the aim of improving health and well-being at the workplace. One focus is the health-promoting design of work activities and working conditions, and encouraging health-promoting work- and life-styles (GKV-Spitzenverband, 2023). Examples include courses to teach resource-strengthening methods such as mindfulness training and 'self-care', and the provision of healthy catering for the workforce, combined with information campaigns about its health benefits (GKV-Spitzenverband, 2023). In this area, too, only a few people (2.6% of those insured) have been reached so far (Wanek and Schreiner-Kürten, 2021).

In Germany, workplace health promotion is part of workplace health management (WHM). There are already efforts by some statutory health insurance funds to make WHM sustainable and climate-sensitive, e.g. the 'BBK Green Health' initiative of the company health insurance funds, their regional and umbrella associations (Philippi and König, 2022). Recommendations for action are currently being developed as part of a project. For example, companies could address the possibilities of sustainable and resource-saving work as well as health-promoting options for work breaks. It would also be possible to promote active mobility by providing bicycles and shower cabins free of charge, and to educate people about the ecological benefits of a healthy diet.

be included, as is already the case in many countries (e.g. community health nurses; Box 6.4-1). The tasks of health professionals should urgently be expanded to include lifestyle counselling in the sense of holistic health education (planetary health literacy; Section 8.1.3), which takes into account people's individual life situations and

special needs. Depending on the region, this includes, for example, comprehensive information for patients on the topics of heat and heat protection, allergies, air pollution or newly emerging infectious diseases, as well as measures for individual environmental and climate protection that can simultaneously benefit one's own

Box 6.4-4

Climate-sensitive health counselling

Initial studies show that targeted counselling by doctors has a positive influence on patients' knowledge of climate-change-related health risks and on their climate-specific health literacy (Reismann et al., 2021). This can promote healthy and sustainable behaviour. In Germany, the general practitioner Dr Ralph Krolewski has developed a type of 'climate-sensitive health counselling' and integrated it into the everyday counselling and care of his patients (Krolewski, 2022). His concept of 'climate consultation' ('Klima-Sprechstunde') is based on a salutogenetic and patient-centred approach and involves a

motivating, non-directive conversational approach (Krolewski, 2022). The topics covered in such consultations include the benefits of climate-friendly and healthy lifestyles (especially with regard to nutrition and physical exercise). But the climate consultation also aims to educate and prepare risk groups as regards heat waves and extreme weather events. A case study: a 54-year-old female patient suffering from obesity, high blood pressure and type-2 diabetes mellitus is informed about the benefits that physical exercise in everyday life, active mobility (Section 4.2) and a diet in line with the Planetary Health Diet (Section 4.1) can have for her individual health but also for environmental and climate protection. She is also given tips on behavioural measures during heat.

health (Section 6.4.1.1), e.g. plant-based nutrition. An example of such lifestyle counselling and education is the concept of offering 'climate-sensitive health counselling' (Box 6.4-4). In order to make this possible, it is necessary to integrate the relevant content into the education, training and further training of health professions (Section 8.1), as it is also recommended by the German Advisory Council on the Assessment of Developments in the Health Care System (SVR) in its report on resilience in the health system (SVR, 2023). Also necessary are adjustments to remuneration systems (Section 6.4.2.3) and a significant improvement in the personnel situation.

A key lever for enabling health professionals to implement environmentally sensitive prevention and health promotion is to comprehensively consider the topics in clinical guidelines. These are generally accepted in health systems as guidelines defining standards of action that provide orientation in the practical day-to-day provision of health services. Guidelines can play an essential role in determining how much importance is attached to health promotion and disease prevention. The same applies to the consideration of sustainability criteria in the choice of diagnostic and therapeutic measures, and to the consideration of the effects of environmental changes. Eight dimensions are proposed for such an integration into guidelines (Herrmann et al., 2022), e.g. the inclusion of co-benefits, patient-centred care and the preferential use of medical therapies and interventions with fewer negative environmental effects.

6.4.2.3

Adapt remuneration systems and expand cost-benefit analyses

Remuneration systems that favour a curative focus of health services are an obstacle to the implementation of health promotion and disease prevention (Section 6.2.2.1). An example from the German health system is the inadequate remuneration for counselling activities

and conversations on health promotion and disease prevention as compared to curative medical interventions (Osterloh, 2022). In Germany, current remuneration systems also include unfortunate incentives for providing inappropriate care (including the overuse and underuse of health services) and lead to staff retrenchments (German Medical Association, 2022). Inappropriate care including over- and underuse can impede the targeted implementation of health promotion and disease prevention, and increase the emissions of health systems either directly (through unnecessary medical interventions) or indirectly (through the need for resource-intensive follow-up treatments; Section 6.5.2.1). Remuneration systems should be adjusted in a way that avoids these misdirected incentives. Staff shortages and the great time pressure that health personnel are often under are also relevant implementation barriers for health promotion and disease prevention that need to be addressed (Section 6.4.2.2). While the economical use of limited resources in health systems is certainly advisable, economic objectives must not be allowed to influence medical actions to the detriment of patients' health.

The (economic) evaluation of health promotion and disease-prevention measures involves challenges (significant delays before effects are detectable; different actors bearing the costs of the measures, or saving costs by using them; Krauth and Oedingen, 2021; Walter et al., 2011); as a result, there is often a lack of well-founded cost-benefit estimates that would support the adjustment of remuneration systems. Yet such estimates could complement the health and quality-of-life benefits gained by delaying and preventing disease, which are the primary arguments in favour of such adjustments. The evidence on the cost-effectiveness of health-promotion and disease-prevention measures is limited to selective measures, such as medication for preventing cardiovascular diseases or smoking withdrawal programmes (Brown and Garber, 1998; Schwappach et al., 2007;

Walter et al., 2011). More complex approaches that address patients' living environments, lifestyles and living conditions more comprehensively are evaluated less frequently (Schwappach et al., 2007; Walter et al., 2011). Cost-benefit analyses should be expanded accordingly.

6.4.2.4 Expand public health departments and equip them for structural prevention

Public health departments (Section 6.1.1) observe the population's health and can make decisive contributions to the use of health promotion and disease prevention as transformative levers. The capacity and facilities at their disposal should be significantly improved for this purpose. In Germany, this was achieved during the COVID-19 pandemic via the 'Pact for the Public Health Service', which aims to "boost staffing, and modernize and network" municipal public health departments (BMG, 2023). Concrete goals, areas of responsibility and measures must now be defined for the strengthened public health departments: with regard to environmentally sensitive prevention and health promotion, for example, they can be established as an interface with politics and the administration in order to initiate and coordinate interdepartmental and cross-sectoral initiatives for structural prevention and the health-promoting design of living environments (Section 6.4.1.2).

They can also contribute to making individual health-promotion and disease-prevention measures (e.g. outreach services for lifestyle counselling) more strongly oriented to the needs of particularly vulnerable groups of people, both by providing the necessary resources and via the option of direct contact (SVR, 2023). Furthermore, public health departments have a key role to play in strengthening environmental resilience (resilience to anthropogenic environmental changes; Section 6.3.5). They should operate integrated environment- and health-information systems, regularly conduct exposure, vulnerability and adaptation assessments, and implement targeted early-warning and information systems (Section 6.5.1.2).

In Germany, the Conference of Health Ministers adopted guiding principles for a modern public health service in 2018, according to which the public health service is to work in a way that is "oriented towards priority needs of population health, ethically reflected and with respect for the dignity of the individual, with a view to health equity, free of commercial interests, on a current scientific basis, citizen-centred, networked and in partnership with many other actors, multi-professional and interdisciplinary, results-oriented, responsible and transparent" (BVÖGD, 2018). This guiding principle should be supplemented in line with the above-mentioned tasks. The cornerstones of a public health strategy for

Germany, which have been developed over four years in a participatory process by the 'public health community' (Zukunftsforum Public Health, 2021), should also be taken into account: these include, among other things, better interlinkage between multi-sectoral health protection, the creation of preconditions for competent professionals and for solid data bases, a more comprehensive consideration of disease prevention and the establishment of a public health strategy based on the Health-in-All-Policies approach (Box 7.1-5). In implementing these cornerstones, particular attention should be paid to health risks from environmental changes and to environmentally sensitive prevention and health promotion, as explained in this chapter.

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6.5 Create sustainability and resilience – initiate transformations

Transformations towards sustainability (Section 6.3.4) and strengthening adaptation and resilience (Section 6.3.5) require comprehensive structural measures that affect all components of health systems (Section 6.1.1). The measures can also have an impact on other sectors and across national borders, where they can initiate transformations as well. These fields of action – sustainability, adaptation and resilience – should always be addressed together in order to release synergies and improve the resource efficiency of the implemented measures (WHO, 2020h). There are many detailed recommendations on how health systems can prepare for environmental changes and health risks (Section 6.5.1) and improve their sustainability (Section 6.5.2); these are starting points for the following sections.

6.5.1 Be prepared for environmental changes and health crises

For health systems, being prepared for environmental changes and health crises means making continuous adjustments to changing environmental conditions and strengthening their resilience to shocks (Section 6.3.5). As both fields of action overlap and there are potential synergies, they are discussed together in the following.

6.5.1.1 Resilience of health systems to all anthropogenic environmental changes

In recent years, there has been increasing discussion on the concept of climate resilience in health systems, i.e. resilience to the impacts of climate change (Section 6.3.5).

In the WBGU's view, however, resilience in health systems should refer not only to the impacts of climate change, but also, in the sense of an all-hazards approach, to the consequences of the other two key environmental crises – pollution and biodiversity loss (Chapter 2) – as these can also lead to health crises and shocks. Examples include large-scale smog and haze events (episodes of massive and long-term increased air pollution, e.g. from slash-and-burn agriculture or forest and peat fires) as well as epidemics and pandemics of newly emerging or re-emerging infectious diseases such as COVID-19, Ebola or malaria, which are favoured by human influence on ecosystems (Section 5.1.3). Therefore, supplementing the comprehensive recommendations on strengthening climate resilience in health systems (WHO, 2020h), the WBGU proposes a more comprehensive guiding principle of 'environmental resilience', which means resilience to all anthropogenic environmental changes and includes their impacts on human and ecosystem health as well as their interactions with each other. This guiding principle should be comprehensively integrated and implemented. A general conceptualization of resilience in health systems was recently undertaken by the Advisory Council on the Assessment of Developments in the Health Care System (SVR, 2023). Health risks resulting from various environmental changes should definitely be comprehensively taken into account in crisis preparation in the sense of the SVR report. Fields of action in health systems for strengthening environmental resilience and relevant actors are described below. Public health services and health-information systems play a key role in this context.

6.5.1.2

Fields of action in health systems

Collect and analyse environmental and health data

Analogous to the WHO, the SVR divides a comprehensive resilience strategy for health systems into the following phases: preparation phase, timely recognition of the shock, impact of and coping with the shock, recovery and learning (SVR, 2023; Section 6.3.5; Fig. 6.3-1). Based on the dominant determinants in the respective phases, three groups of indicators can be defined that are relevant for evaluating resilience in health systems: (1) upstream determinants of exposure and vulnerability (environmental factors, exposure pathways, socio-economic factors, vulnerability factors), (2) capacities and measures taken in health systems (according to their components as per the WHO, 2015c; Section 6.1.1), and (3) outcome in relation to environmental health risks (epidemiological indicators). In order to be able to draw conclusions about these indicators in analyses and monitoring, it is necessary to document and

interlink environmental and health data in a spatially and temporally differentiated manner. Approaches for improving the provision, interlinking and use of environmental and health data in Germany are described in Box 6.5-1. The German Advisory Council on the Environment has also developed recommendations in this regard (SRU, 2023: 116 ff.). The emerging integrated environment- and health-information systems could be hosted by public health departments.

Develop specific adaptation and resilience strategies

Health systems worldwide are characterized by a great diversity of organizational forms, as well as significant differences in terms of material and personnel resources (Box 6.2-1). Furthermore, health risks from environmental changes vary significantly between different regions and population groups (Chapter 2 and Section 6.2). Strategies for strengthening adaptation and resilience, and measures to be implemented accordingly, must therefore be tailored to local, regional and national conditions. Moreover, they should address the impacts of unhealthy lifestyles and living conditions on individual vulnerabilities, and take into account the specific characteristics and needs of different population groups. Resilience strategies in health systems should in particular ensure security of supply during health crises or shocks, also with regard to so-called 'black swan' events (SVR, 2023), i.e. unexpected and improbable future events that nevertheless could have a significant impact; here, it is particularly important to aim at minimizing the risks of failure of global supply chains as well as ensuring a secure energy supply (Section 4.3.4.2).

Implement measures to strengthen adaptation and resilience

When implementing measures to strengthen adaptation and resilience in health systems, existing structures should be used and further developed, and all essential components of health systems should be taken into account, i.e. health-service delivery, health workforce, health-information systems, medicines and essential technologies, financing structures and governance (Section 6.1.1). The WHO identifies a large number of relevant fields of action: leadership and governance; health workforce; vulnerability, capacity and adaptation assessment; integrated risk monitoring and early warning; health and climate research; climate-resilient and sustainable technologies and infrastructure; management of environmental determinants of health; climate-informed health programmes; emergency preparedness and management; climate and health financing (WHO, 2015c). Public health departments equipped with the required capacity should take on a coordinating role,

e.g. in population-wide risk evaluation and in establishing national disaster-management plans (Starke and Arnold, 2021). Comprehensive recommendations on concrete measures relating to different components can be found in current documents from the WHO (WHO, 2020h) and the Advisory Council on the Assessment of Developments in the Health Care System (SVR, 2023). In accordance with the guiding principle of environmental resilience (Section 6.5.1.1), all climate-specific measures should be complemented with measures relating to other environmental factors and changes (Section 6.6.1.4).

6.5.1.3 Opportunities for low- and middle-income countries

Due to particular health risks and vulnerabilities as well as a lack of resources, low- and middle-income countries need to address particular challenges when it comes to strengthening adaptation and resilience in health systems (Section 6.2.2.2). The implementation and improvement of basic health services and public-health measures have been described by the IPCC as effective measures for reducing vulnerability to environmental health risks for low- and middle-income countries (IPCC, 2014). However, concrete adaptation measures are also necessary and particularly urgent in these countries, to prevent the already fragile health systems from becoming overburdened. The urgent need to implement such measures can simultaneously drive forward improvements in basic healthcare and help reduce global health inequities. This represents a special opportunity in that available international funding, e.g. from GCF and GEF funds, the UN Adaptation Fund and bilateral donors, can be used to close existing funding gaps in efforts to strengthen adaptation and resilience in health systems in these countries (Section 6.2.2.2; WHO, 2015a). Creating unsustainable path dependencies should be avoided by all means when developing and expanding health systems in low- and middle-income countries.

6.5.2 Reduce overuse and improve sustainability

Transformations towards sustainability are urgently needed in health systems (Sections 6.2.2.3, 6.3.4) and are increasingly gaining political attention. On the margins of COP 26 of the UN Framework Convention on Climate Change in Glasgow in 2021, 50 countries committed to making their health systems more sustainable and reducing their emissions, and 14 countries set themselves the target of reducing net greenhouse-gas emissions from their health systems to zero by 2050 (Wise, 2021). A comparative analysis of health systems in different

US states has shown that the ecological footprint of health systems can be reduced without compromising their quality: there was considerable variability of the respective GHG emissions which were not highly correlated with the quality of the different health systems (Eckelman et al., 2020). The ecological footprint of health systems can be reduced by avoiding unnecessary examinations and treatments (Section 6.5.2.1) and by reducing the resource consumption and emissions associated with the health services provided (Section 6.5.2.2). Medical products and technologies are especially relevant here.

6.5.2.1 Avoid unnecessary medical measures

Even with comprehensive efforts to strengthen health promotion and disease prevention, many cases of illness requiring the use of health services will continue to occur. Necessary and reasonable medical measures should always be carried out properly. However, unnecessary diagnostics and therapeutics (overuse; Section 6.2.2.1) should be avoided. In this way, emissions can be reduced, along with the avoidable side effects and stress for patients caused by unnecessary measures. Furthermore, economic savings could be invested in health-promoting, preventive and transformative measures. Preventing overuse is sometimes referred to as ‘quaternary prevention’ (Güzel-Freudenstein and Robra, 2022).

Up to now, avoidable ecological burdens have not been addressed in studies on overuse, or are only addressed indirectly when avoidable resource consumption is mentioned, for example in an OECD report on the topic and in a study by the Bertelsmann Stiftung (OECD, 2017; Schenk et al., 2019). That said, these documents discuss in detail influence factors on overuse in areas such as systemic framework conditions, medical knowledge, societal trends, patient behaviour and the behaviour of health professionals (Schenk et al., 2019). This makes it clear that reducing overuse requires comprehensive transformations and that there are many starting points for this. Strategies for action and packages of measures to reduce overuse have been developed in the recent past (OECD, 2017; Schenk et al., 2019). For example, a need for action was identified in the areas of “optimizing planning and remuneration”, “clarifying evidence”, “assuming ethical responsibility”, “refraining from unnecessary treatments” and “sensitizing the population” (Schenk et al., 2019). However, there has been a lack of systematic analyses and quantifications of the savings potential in resources and emissions, and the challenge of reliably identifying overuse in the first place must be met.

Box 6.5-1**Approaches for an improved provision, interlinking and use of environmental and health data in Germany**

Already today, environmental and health data are being collected and analysed in Germany by different institutions on different regional scales, for different purposes and with different access possibilities. However, the potential for collecting and interlinking these data, and for further developing the methodological approaches and capacity for analysing them, are far from exhausted to date. Furthermore, the opportunities offered by digitalization could be better utilized.

Examples of the collection and evaluation of environmental and health data

In Germany, the Federal Government, among others, collects environmental and health data, the former via the German Environment Agency (UBA), the latter as part of health monitoring by the Robert Koch Institute (RKI). Interlinking of environmental and health data does take place in beginnings, e.g. in the form of the UBA's collection of health-related environmental data, but it should be intensified. The UBA uses in particular two instruments to collect and evaluate health-related environmental data: the German Environmental Survey (GerES) and the human-related part of the German Environmental Specimen Bank (BMUV, 2023).

However, data are not only collected by federal institutes and authorities but also by other actors, e.g. in research. An important interdisciplinary study that makes it possible to link environmental and health data is the German National Cohort (GNC, in German: 'NAKO Gesundheitsstudie'), supported by an association of 27 research institutions in Germany (Helmholtz Association, Leibniz Association, universities, other research institutes) and financed by the Federal Ministry of Education and Research, the Helmholtz Association and the participating federal states.

German Environmental Survey

According to the UBA, the GerES is the largest study of the population's exposure to pollutants in Germany, with around 5,000 participants. Within the framework of the GerES, blood and urine samples from the study participants, drinking water, indoor air and house dust samples are collected and analysed for pollutants. In addition, the participants are asked about their home living conditions and environmentally relevant behaviour. This enables the UBA to check which potentially harmful substances and environmental influences (such as chemicals or noise) people in Germany are exposed to. The UBA analyses how high the exposure to individual environmental influences is, and under which circumstances certain environmental influences can have a negative impact on people's health. It also investigates where detected pollutants come from and the pathways through which they enter the human body. All GerES participants also take part in the RKI's health monitoring surveys. The UBA can draw on these data and cooperates with the RKI in evaluating the data collected in the GerES. In the future, there are plans to cooperate with the Max Rubner-Institut and include nutrition-related issues, since many pollutants are absorbed through food (UBA, 2017a; BMUV, 2023).

German Environmental Specimen Bank

The German Environmental Specimen Bank (UPB) is an archive of samples from typical ecosystems throughout Germany (e.g. coastal regions, urban areas, mountainous regions). They have been collected regularly since the 1980s, so that both the quality of the environment at a given point in time and changes in environmental (pollutant) loads over time can be documented and evaluated. The samples are representative of the respective region. In addition to samples from representatives of different stages of the food chain, such as algae, mussels, fish and seagulls, human samples (blood, blood plasma, urine, saliva and hair) are also taken for the UPB from students at four locations: Münster (since 1981), Halle/Saale (since 1995), Greifswald (since 1992) and Ulm (since 1997; UBA, 2017b; UBA, 2023a; UBA, 2023b).

German National Cohort (GNC)

The GNC collects data on the health status and lifestyle habits (smoking, diet, occupation, physical activity) of 200,000 participants aged 20–69 years over a period of 20–30 years at 18 study centres distributed across Germany. The GNC focuses on widespread diseases such as cardiovascular diseases, cancer, diabetes and various infectious diseases. The study aims to shed light on how these diseases develop and what factors favour their development. In addition to the role of genes, individual lifestyle and social factors, the study also investigates environmental influences. For this purpose it uses existing data, e.g. on noise or air pollutants, and interlinks them with the collected health data (Hoffmann et al., 2012). Understanding which factors drive the emergence of which diseases helps to develop effective prevention mechanisms and to improve the early detection of diseases. The GNC examinations are standardized and selected in accordance with other studies in Europe to ensure the best possible comparability of the data collected (NAKO e. V., 2023).

Approaches for improving the provision, interlinkage and use of health and environmental data

GerES, the German Environmental Specimen Bank and GNC all provide data documenting environmental influences and, partly, their effects on human health. However, the existing potential for providing, interlinking and using health and environmental data should be more fully exploited, and better use should be made of the possibilities of digitalization, e.g. big data and machine learning. The WBGU regards mainly the following starting points as particularly relevant, especially with regard to the necessary change in health policy from a short-term focus on disease control to a medium- to long-term focus on health promotion and disease prevention:

Open provision of data

The open provision of environmental and health data can substantially expand the possibilities for its use, linkage and analysis. If these data are made accessible on digital platforms for which the state is responsible, a joint, easily available data basis can be created for national institutions and authorities at different levels, for multilateral exchange and research. Personal data protection must of course be guaranteed at all times (WBGU, 2019). Cloud-based storage and processing solutions offer a lot of flexibly retrievable capacity and thus make the storage, exchange and processing of even large amounts of data possible.



Central management of environmental and health data from different fields

Data on human health are collected in different areas, e.g. for implementing legislation on chemical substances (REACH Regulation; Box 5.2-2) and immission control law (air pollutants, noise). There is often no exchange between these decentralized collections of data or with the health system (Löffler, 2020). Centralized aggregation and management of these and other environmental and health data would create a broader data basis that would make it possible to identify influencing factors (e.g. loss of biodiversity) that have not yet been taken into account in health-related environmental monitoring.

In Germany, the National Research Data Infrastructure (NFDI) is already working on the aggregation of decentralized data from different sources and their intra- and interdisciplinary provision for research purposes. The NFDI is subdivided into so-called consortia, each of which unites different institutions from a specific research field, e.g. in relation to personal health data (NFDI4Health) or biodiversity (NFDI4Biodiversity). The aim of the consortia is to provide data for the respective research field in a way that is findable, accessible, interoperable and reusable. In addition, a cross-disciplinary exchange is to be made possible between the consortia. The FAIR Data Spaces project furthermore demonstrates cloud-based data exchange between science and industry. The NFDI offers starting points for harmonizing and merging environmental and health data, and for exchanging data with actors outside the scientific community.

Geo-referencing of environmental and health data

There is great potential for merging decentralized environmental and health data in the use of geo-information systems, which store data with a geographical reference, making it possible to spatially and temporally relate data from different areas. Geo-information systems could help identify health and environmental interdependencies and make a corresponding risk assessment. They could be used, for example, to gather more data on the migration and spread of disease vectors, such as the Asian tiger mosquito, in the course of climate change (UBA, 2019). Other countries in Central Europe, e.g. Denmark and Switzerland, already use such systems. In Germany, geo-coded environmental data are used e.g. in the GNC with regard to air pollution, noise and temperature, and are linked to the health data collected in the study.

Prospective analysis of environmental impacts on health

The analysis of environmental impacts on health in Germany is characterized by a retrospective approach. However, in view of very rapidly changing overall conditions (e.g. climate impacts and adaptation), what is needed is a prospective approach. For example, the data on the spread of disease vectors mentioned in the previous section should be used specifically to develop disease-prevention measures. New methods such as ‘predictive analytics’, which can make forecasts based on historical data using big data and machine learning, could be used in the future to identify environmental risks (Pagano and Krause, 2019). They could also help identify conflicting goals and multi-benefit strategies.

Person-related data collection, risk assessment and disease prevention

The process of recording environmental influences on human health, any risk analysis based on this and the development of suitable preventive measures should be more person-related than it has been to date. It is not enough to record air quality at certain fixed locations and draw conclusions about the continuous exposure of individuals. Person-related monitoring is required in order to record individual stress loads and risks. Personal samplers, for example, can determine pollutant concentrations in the air a person breathes. Wearables (recording devices worn directly on the body, e.g. smart watches and fitness bracelets) continuously record data such as pulse, heart rate or physical activity. There are even toilet seats that can measure blood pressure and oxygen saturation in the blood, for example. By using this personal data, machine learning could be used to create an individual risk assessment. On this basis, it would be possible to send a person an individually tailored risk warning (e.g. via their smartwatch) and recommend preventive measures, or even initiate personalized treatment (Dolson et al., 2022; Wu et al., 2022). This approach is called ‘personalized medicine’ (‘precision health’). Personal data protection must be ensured here.

6.5.2.2

Reduce resource consumption and emissions

Resource consumption and the generation of emissions should be reduced as much as possible without compromising the fulfilment of the basic demands on health systems (Section 6.1.2). The special challenges in health systems regarding transformations to sustainability should be considered in this context (Section 6.3.4). In addition, unavoidable emissions should be compensated as far as possible. These requirements apply to all types of health facilities, health services, medical products, technologies, manufacturing processes, supply and transport chains – including those whose primary purpose is health promotion and disease prevention.

Measures to reduce either resource consumption or emissions often contribute towards achieving the other goal, respectively; however, they offer different starting points and opportunities for action. This becomes evident from current recommendations that partly differ in their approaches and points of emphasis (WHO, 2020h; Ostertag et al., 2020). These should each be implemented comprehensively. In order to be able to use as many synergies between both fields of action as possible, the measures should always be approached in an integrated way and combined with each other. To reduce the ecological footprint, both resource consumption and emissions must be reduced.

The German Environment Agency has identified four priority sectoral fields of action for the reduction of resource consumption by health systems, and has developed recommendations for action and research for each: pharmaceuticals, medical products, building construction in the health sector, and food and beverage supply (Ostertag et al., 2020). The more efficient use of energy and other resources in health systems would also result in significant potential for cost savings (WHO, 2017e), which can be used as an incentive to implement concrete measures to conserve resources (Ostertag et al., 2020). In particular, the universal introduction of healthy and sustainable diets in hospitals, e.g. pursuant to the Planetary Health Diet (Section 4.1), would have not only ecological but also direct health benefits for patients and healthcare staff (Guinto et al., 2022). Specific guidelines for establishing sustainable catering have already been published (Hünninghaus and Dobos, 2022).

To reduce emissions from health systems, the WHO proposes measures in four main areas, which overlap with the above-mentioned areas of action to reduce resource use, but have different points of emphasis (WHO, 2020h): (1) health workforce (human resources, capacity development, communication and awareness raising), (2) water, sanitation and healthcare waste, and (3) energy (monitoring and assessment, risk management, health and safety regulation, respectively), and (4) infrastructure, technology and products (adaptation of current systems and infrastructures, promotion of new systems and technologies, adoption and procurement of technologies, processes and products with a low environmental impact). Extensive and detailed catalogues of measures for the various fields of action exist (WHO, 2020h) and must be implemented. In addition, numerous examples from practical experience are known that can offer orientation for implementation (Graalman et al. 2022). When reducing emissions, it should be noted in particular that the aim should be to reduce not only greenhouse-gas emissions but also other emissions at the same time (Section 6.2.2.3). Examples include chemical pollution (Section 5.2.3), waste (Box 6.2-2) and emissions related to non-sustainable catering in hospitals (Section 4.1). Challenges and opportunities for reducing the environmental damage caused by pharmaceuticals and pharmaceutical residues are discussed by way of example in Section 5.2.3.

The implementation of circular-economy principles and approaches in health systems would yield savings in both resources and emissions; however, in health facilities it is essential to follow the guidelines on hygiene that are medically required. Specific options for action to improve sustainability in the provision of health services include, for example, optimizing the amounts of medicines and materials used in line with medical

guidelines (e.g. checking dosage reduction), minimizing the use of disposable products, using the possibilities of digitalization (e.g. electronic patient files), reducing inefficient processes and, as far as possible, outsourcing health services from the inpatient to the outpatient sector ('outpatientization' to avoid hospitalization).

In the meantime, there are numerous international, national and regional NGOs and initiatives advocating sustainability in health systems (e.g. the Global Green and Healthy Hospitals initiative of the NGO 'Health Care Without Harm' (Health Care Without Harm, 2023) or the KLIKgreen project led by the German BUND e.V. (BUND, 2023). In addition, there are instruments that can be used, such as GreenHospitalPLUS of the Bavarian State Ministry of Health and Care (Bayerisches Staatsministerium für Gesundheit und Pflege, 2023). Public health departments equipped with sufficient capacity could link up with existing initiatives and help scale up measures.

6.5.2.3

Use opportunities to initiate transformations

The comprehensive implementation of measures to reduce resource consumption and emissions could also initiate transformations towards sustainability in other economic sectors because of the health systems' high turnover of resources. This seems plausible, although how the corresponding potential has not yet been quantified. When procuring resources, medical products and technologies, attention should be paid to sustainability all along the supply chains. A corresponding data basis is urgently needed for this.

The financial resources available in some health systems, e.g. within large insurance companies or the professional pension funds for physicians in Germany (the latter with approx. €110 billion; Schulz et al., 2019), should be invested in sustainable capital investments. In 2019, the 122nd German Medical Assembly asked the pension funds for physicians to be guided by the ESG criteria when making investments (Bundesärztekammer, 2019). However, this has not been sufficiently pursued to date (Section 7.6.3). At the international level, already in 2016 the World Medical Association called on all health organizations to withdraw their investments from the fossil-fuel sector (WMA, 2016).

Sustainable health systems and especially health facilities can also serve as role models for other institutions, organizations and private households. To achieve this, sustainability as a guiding principle and successes in reducing resource consumption and emissions should be consistently communicated internally and externally.

6.6 Recommendations for action and research

To enable health systems (Section 6.1) to address the new challenges posed by global environmental changes (Section 6.2.1) and overcome existing barriers (Section 6.2.2), they should be further developed according to five guiding principles (Section 6.3): (1) recognition of the importance of healthy ecosystems, (2) environmentally sensitive prevention and health promotion, (3) solidarity and inclusion, (4) transformations towards sustainability, and (5) strengthening adaptation and resilience. Environmentally sensitive prevention and health promotion can be used additionally as transformative levers, by promoting healthy and sustainable lifestyles, reducing vulnerability, strengthening adaptation and resilience in the population, and reducing the need for resource-intensive treatments through their targeted implementation (Section 6.4). Furthermore, comprehensive structural measures for more sustainability and to strengthen adaptation and resilience in health systems are needed, which can additionally initiate transformations in other sectors (Section 6.5). Based on the previous sections, recommendations for action and research are made in the following. Some of the recommendations for strengthening resilience in health systems are also described in the current report of the Advisory Council on the Assessment of Developments in the Health Care System (SVR, 2023), and are emphasized here in the context of global environmental changes.

6.6.1 Recommendations for action

The following recommendations for action concern, in addition to health services, also the other components of health systems. Health professionals should be made aware of the importance of environmental changes and healthy ecosystems for human health (Section 6.6.1.1), as they can play an important role in promoting healthy and sustainable lifestyles. Financing structures and remuneration systems must be adapted accordingly (Section 6.6.1.2). Public health departments should be strengthened and transformed to play a stronger role in environmentally sensitive health governance (Section 6.6.1.3). In the context of strengthening environmental resilience, health-information systems should be given greater prominence by expanding them and including environmental data (Sections 6.6.1.3, 6.6.1.4). Medical products and technologies should be designed to be as environmentally friendly as possible (Section 6.6.1.5).

6.6.1.1 Acknowledge the importance of environmental changes and healthy ecosystems

Understand environmental changes as a risk and healthy ecosystems as a resource

The growing scientific evidence on the importance of environmental changes and healthy ecosystems for human health should be systematically and comprehensively implemented in health systems. Existing integrative and transdisciplinary health concepts such as One Health and Planetary Health (Section 3.3) can be applied here. Holistic approaches to patient care, such as integrative medicine, which already contain suitable starting points, can be used to take greater account of the health risks of global environmental changes in the provision of health services.

Consider environmental changes in medical guidelines

By taking into account environmentally sensitive prevention and health promotion, sustainability and measures for adapting to environmental changes in clinical guidelines, specific standards of action should be made available for health professionals in various medical specialities. Existing recommendations should be included in this context that, for example, encompass the inclusion of co-benefits, patient-centred care and the preferential use of medical therapies and interventions with fewer negative environmental effects (Herrmann et al., 2022).

6.6.1.2 Promote healthy and sustainable lifestyles and living conditions

Boost environmentally sensitive prevention and health promotion

Health promotion and disease prevention should be transformed into a holistic strategy that explicitly addresses environmental changes, their causes and impacts. In their implementation, a close interlinkage of activities and cooperation with various actors in other fields of action should be pursued (Chapter 4), in the sense of the Health-in-All-Policies approach (Box 7.1-5). Health promotion should regard intact ecosystems as an important prerequisite and resource for health, and disease prevention should regard environmental changes as major determinants of disease. Complex health-promotion and disease-prevention measures should also be evaluated in cost-benefit analyses by the relevant funding or responsible institutions. In addition to direct health and economic effects, this should include health and environmental benefits resulting from the reduction of vulnerabilities, the promotion of healthy and sustainable lifestyles, and education on measures for adapting to environmental changes.

Enable health professionals to promote planetary health literacy

When providing health services, health professionals should help improve the population's planetary health literacy (Section 8.1) by addressing in counselling sessions the disadvantages of behaviour that is harmful to health and the environment, as well as the opportunities and multiple benefits, for example, of healthy and sustainable diets in the sense of the Planetary Health Diet (Section 4.1), active mobility (Section 4.2) and the use of green spaces as a health resource. They should also provide information on health risks caused by environmental changes, as well as appropriate behavioural recommendations; existing information services, such as those of the Germany's Federal Centre for Health Education (BZgA) on the topic of heat adaptation, can also be included in this context. The promotion of planetary health literacy should be pursued in counselling sessions in the context of health promotion and disease prevention – and, where appropriate, in consultations with patients within curative health services. Health professionals can thus play a decisive role in empowering people to make health-promoting and sustainable choices in all relevant areas of life, thereby increasing their level of inclusion and promoting healthy and sustainable lifestyles. This requires giving health professionals targeted education, training and further training (Section 8.1). Sufficient knowledge of other policy fields involved is also necessary to enable them to initiate and coordinate multi-sectoral measures for structural prevention. Health professionals should furthermore be fully informed about ways to improve sustainability in their professional activities. All health professions should be included in health-promotion and disease-prevention measures, and sufficient human resources should be created for this purpose, for example by expanding training capacity and making working conditions more attractive, especially in nursing.

Targeted modification of the primary health care approach

The primary health care approach (Section 6.1.2.2) should be specifically supplemented by a focus on environmentally sensitive prevention and health promotion; its implementation should take into account the respective country-specific health systems, resources, vulnerabilities and health risks, and the corresponding health services should be financed on a solidarity basis. In improving primary health care, easily accessible and low-threshold care structures should be established within communities, and a focus should be placed on environmentally sensitive prevention and health promotion. The reach of the measures would be increased by interlinking such services with curative health services and setting up fixed contact points where appointments

are not required (e.g. health kiosks, community health nurses), outreach services (especially for particularly vulnerable or marginalized groups) and regular and structured contacts (e.g. in the form of preventive check-ups in schools). In particular, healthcare in remote areas should be improved. In interdisciplinary cooperation between different health professions, individual lifestyle-specific counselling and individually adapted forms of prevention should be provided within primary care, using data from integrated environment- and health-information systems (Section 6.6.1.3).

Adapt, expand and interlink existing health-promotion and disease-prevention measures

Existing health-promotion and disease-prevention measures should be complemented by promoting healthy and sustainable lifestyles, with close intersectoral cooperation between the actors involved. Existing measures for individual behavioural health promotion and disease prevention could take global environmental changes into account by addressing relevant environmental health risks in a target-group-specific manner, and including education on individual adaptation measures. Structured treatment programmes (e.g. disease-management programmes) can be supplemented accordingly for this purpose, and structured 'health-management programmes' can be created that are aimed at everyone. In particular, people should be targeted who are at risk, but have not yet developed a manifest chronic disease. Existing services in the living environments (Box 6.4-3) could address health risks and adaptation measures that are particularly relevant for the specific target groups. In addition, information could be provided on possibilities for the sustainable and health-promoting design of living environments, such as the residential environment, and the corresponding creative potential of the actors involved could be specifically activated. Workplace health management should be designed to be sustainable and climate- and environment-sensitive. Bonuses for participation in courses on environmentally sensitive prevention and health promotion, cooperation between different health-insurance funds and companies, and improved possibilities for receiving financial compensation would boost the reach and scale of the measures. In addition, other actors besides the health insurance funds – such as public health departments – should be entrusted with health promotion and disease prevention (Section 6.6.1.3).

Adapt remuneration systems to encourage more health promotion and disease prevention

Remuneration systems in health systems should be adapted in such a way that they encourage – and do not inhibit – health promotion and disease prevention, as

well as sustainability and resilience (Section 6.6.1.5). Furthermore, they should not lead to disproportionate staff retrenchments and inappropriate care, including over- and underuse. In order to further environmentally sensitive prevention and health promotion, it is conceivable, for example, that a fee-for-service remuneration for corresponding counselling sessions might be offered outside the usual budgets provided for practices and hospitals. In order to motivate appropriate further training, the counselling should require a specific qualification. Health facilities could also be provided with additional budgets for corresponding supplementary services by various health professions, e.g. within the framework of structured ‘health-management programmes’. Remuneration systems should, on principle, be regularly and systematically evaluated with regard to existing (dis-)incentives and adjusted accordingly. In order to be able to react to dynamic developments, flexibly adjustable combinations of single-service-based and case- or patient-related flat-rate remuneration as well as flexibly adjustable budgets for certain health facilities or health professionals are conceivable; specific research is urgently needed for the targeted adaptation of remuneration systems (Section 6.6.2.2).

6.6.1.3 Strengthen public health departments and use their potential

Equip public health departments better and expand their remit

The financial, material and personnel resources of public health departments should be greatly improved overall. At the same time, concrete goals, tasks and measures should be developed and defined in transdisciplinary and transsectoral cooperation that address the health risks posed by global environmental changes, and take into account the outstanding importance of environmentally sensitive prevention and health promotion in this context. In Germany, the guiding principles for a modern public health service could be explicitly supplemented by strengthening sustainability, adaptation and resilience in health systems and established as a compulsory basis for the work of public health departments and other relevant actors in this field. Public health departments themselves should also be made resilient; structural prerequisites and challenges for this are described in detail in the current SVR report (SVR, 2023).

Public health departments contribute to structural prevention

In order to play a coordinating role in the implementation of health promotion and disease prevention and in the strengthening of sustainability, adaptation and resilience in health systems, the public health departments should

be networked with all relevant public and private institutions both inside and outside health systems, at the local, regional, national and international levels. In particular, transnational cooperation at the city or municipal level should be promoted, for example in the form of networks linking the public health departments of several cities. Communication between the public health departments and individual actors of health systems, e.g. medical practices, should be facilitated and strengthened. A digitalization offensive in particular should be launched. If public health departments are established as an interface between health systems and the administration, politics and other sectors (in cities e.g. by establishing an Urban Chief Health Officer; Section 4.3.4.1), they can initiate interdepartmental cooperation to further health-promoting and sustainable living environments in the sense of the Health-in-All-Policies approach (Box 7.1-5). An example of a tool for cross-policy cooperation from Germany is the ‘Good Practice Criteria’ (Kilian et al., 2020). In this way, the promotion of healthy and sustainable lifestyles and living conditions can be driven forward across sectors. The new Federal Institute of Public Health in Germany could play a key role at the national level here. Furthermore, public health departments could play an important role in the health-impact assessment (HIA; Mekel, 2020) of measures in other policy fields. Municipal public health departments can also contribute to adapting health-promotion and disease-prevention measures to the needs of particularly vulnerable groups of people.

Conduct regular exposure, vulnerability and adaptation assessments

Public health departments – e.g. the Federal Institute of Public Health at the national level in Germany – can take on a coordinating role in population-wide risk and adaptation evaluation and the establishment of disaster and pandemic preparedness plans. National efforts could be coordinated at the international level by the WHO (Section 7.2). Vulnerability and adaptation assessments, which are partly already being carried out (WHO, 2020h), should be more targeted and informative with regard to the health risks of different environmental changes, and not just refer to the consequences of climate change. In order to draw conclusions about possible, imminent and already existing environmental health risks and crises and to inform health systems about them, it is necessary to use findings and models from earth-system analysis and ecosystem research. In addition, cross-system, international and transnational cooperation between all relevant disciplines and institutions should be sought, promoted and financed (Chapter 7) in order to make appropriate countermeasures possible and to sufficiently take into account the global interactions and exposure pathways of environmental changes.

Establish integrated environment- and health-information systems

Nationally and internationally networked, integrated environment- and health-information systems should be established. These could link up with existing projects (e.g. the EU health-information system, health monitoring by the RKI in Germany, environmental monitoring and the collection of health-related environmental data by the German UBA). Within the framework of such integrated systems, health and environmental data and stressors should be continuously recorded and merged in a spatially and temporally differentiated way, and subjected to a multi-dimensional analysis. The systems can be located in public health departments, which means enabling them to carry out this task and providing them with the necessary resources. Public health departments should be the recipients of mandatory reporting of diseases associated with environmental stressors (e.g. reports by health professionals on cardiovascular and pulmonary diseases during a heat wave) and of environmental stressors that could cause disease (e.g. reports by environmental authorities on increased air pollution or pollen exposure). Comprehensive morbidity monitoring could draw on existing data from emergency departments and ambulance services, among other sources, in the sense of a continuous sentinel survey, as conducted in Germany by the RKI's SUMO system, which provides routine data from the health system in real time (SVR, 2023). Environmental monitoring should consider all stressors from different environmental media and cover both anthropogenic (e.g. ultrafine particles, PFAS, volatile organic compounds) and biogenic (e.g. pollen, spores) substances. The collected data should be comprehensively available regionally, nationally and, wherever possible, internationally. In Germany, only Bavaria has an online pollen monitoring system to date.

In addition, more use should be made of innovative methods, e.g. recording the epidemiological situation by means of waste-water monitoring, which can serve as an orientation. The inclusion of geo-information systems, e.g. in the form of the geo-referencing of environmental and health data, could help identify health and environmental interdependencies and make a corresponding risk assessment. The GNC in Germany (Box 6.5-1) already uses geo-referenced data to correlate environmental, health and disease data over space and time; this should be further developed in the future. Reporting and the transmission of environmental and health data could be simplified in this context by automated systems, which would require a comprehensive digitization of the collected data. Data collection and monitoring should, in any case, be established before crises occur (SVR, 2023). Possible environmental health risks should be analysed prospectively, e.g. using new methods such as predictive

analytics. In the multidimensional analyses of risk factors and epidemiological developments, the potential of digitalization (e.g. big data, machine learning) should be exploited to a greater extent in order to identify environmental health risks as efficiently as possible, and to inform early-warning and information systems quickly and in a targeted manner. Environmental and health data from different sectors should be centrally managed and made openly accessible while guaranteeing personal data protection, e.g. on state-controlled digital platforms with cloud-based storage and processing solutions, in order to substantially expand the possibilities of their use, linkage and analysis.

Implement targeted early-warning and information systems

Both health professionals and people at risk should be informed in a targeted and automated manner of imminent or existing health risks, making use of digital possibilities. This applies both to direct environmental health risks (e.g. heat) and to health risks indirectly related to environmental changes (e.g. pandemics of infectious lung diseases). Such early-warning and information systems should consistently take into account personal information needs (e.g. differences in the use of different communication channels), the influence of unhealthy lifestyles and living conditions (e.g. unhealthy diet, disadvantageous living environment) on the vulnerability of persons, as well as individual vulnerability factors in general. Digitizing relevant patient data and making it available to public health departments, as practised in Denmark and Israel, would help in this regard, whereby it is essential to respect personal data protection, e.g. by encrypting and anonymizing the relevant data. In addition, it would be helpful to have national electronic registers, such as a heat register, where particularly vulnerable and hard-to-reach people are registered (SVR, 2023). Person-related data collection would enable personalized risk assessment and prevention using innovative methods (e.g. smart watches), in the sense of personalized medicine or 'precision health'. The digitally controlled early-warning systems should also be resilient, e.g. with regard to shock events that limit the availability of electricity and telecommunications. Early-warning systems should be nationally and internationally networked; in Germany this could be done by the new Federal Institute of Public Health, which could also take over coordination and communication during nationwide shocks, or support affected municipalities in this task (SVR, 2023).

Continuously evaluate the ecological footprint of health systems

Public health departments should be given the task of continuously monitoring the environmental footprint of their respective national health systems and identifying any need for action to reduce resource use and emissions. Municipal actors in public health services can, for example, regularly survey the ecological footprint of individual health institutions in a standardized procedure. These data can then be compiled by regional and national public health actors and combined with data describing the environmental impacts from other components of health systems, such as pharmaceutical production and transport. Existing practical examples can serve as an orientation when implementing such a monitoring system (e.g. NHS Carbon Footprint; NHS, 2022). In addition, public health departments can help scale up successful measures to improve sustainability. This requires the provision of tools to promote the sustainability of health facilities and services, incorporating and promoting existing best practices of governmental instruments and non-governmental initiatives.

6.6.1.4

Implement targeted adaptation and resilience strategies

Integrate and implement environmental resilience in health systems

Complementary to existing strategies and recommendations for strengthening climate resilience in health systems, the WBGU proposes a more comprehensive guiding principle of 'environmental resilience'. The strategies and recommendations for strengthening climate resilience should be taken up in this context and extended insofar as they also take into account all other anthropogenic environmental changes relevant to health in the sense of an all-hazards approach – especially pollution and biodiversity loss, which can also favour health crises and shocks (e.g. large-scale smog and haze events, pandemics). In order to recognize these at an early stage, in line with the German Strategy for Strengthening Resilience to Disasters, regular trend analyses (horizon scanning) should be carried out, in order to identify new developments that have a significant impact on the state of the environment, but are not (yet) on the political agenda (SVR, 2023). In order to learn from crises, an organizational 'learning-and-error culture' is needed within health systems (SVR, 2023). In Germany, a national competence centre for climate and environmental resilience should be set up to coordinate efforts in science, politics and health systems in a narrower sense, and to provide advice backed by the relevant expertise. Together with the EU, a global

programme to promote environmentally resilient and sustainable health systems should be established; this should follow WHO recommendations and involve cooperation on an equal footing with supranational institutions of low- and middle-income countries (e.g. ASEAN, African Union), and with additional financial resources beyond those pledged so far for the global promotion of adaptation and resilience. Germany could furthermore take on an international leadership role in promoting environmentally resilient and sustainable health systems.

Develop country-, discipline- and target-group-specific adaptation and resilience strategies

Transdisciplinary and transsectoral cooperation should develop adaptation and resilience strategies for health systems that take sufficient account of all the relevant determinants (e.g. various environmental changes and health risks, vulnerability factors, available capacity), building on existing recommendations and frameworks (e.g. WHO, 2020h; SVR, 2023). The process should be made participatory and involve all affected groups of people. The strategies should comprehensively take into consideration country-specific historical, political, social, economic and ecological conditions. They should be based on an anticipatory approach and continuously take into account future dynamic developments of environmental changes and, in particular, to be prepared for so-called 'black swan' events, i.e. unexpected and improbable events that can nevertheless have a significant impact. For this purpose, quickly deployable reserve capacity – e.g. material, human and financial resources – should be available as a buffer, as it is also recommended by the SVR (SVR, 2023). Beyond crises and shocks, the additional capacity could be used, for example, for environmentally sensitive prevention and health promotion. Particular attention in adaptation and resilience strategies should be paid to vulnerable population groups in order to specifically protect and strengthen them. Implementation of adaptation measures (e.g. heat-protection plans) should be legally binding, e.g. via corresponding federal framework legislation in Germany (SVR, 2023).

Concrete measures to strengthen adaptation and resilience in health systems should be comprehensive, implemented in an integrated and discipline-specific way, and take climate-change mitigation and environmental protection into account from the outset. They should build on existing structures in order to make full use of their potential, and address all relevant components of health systems. In this way, synergies can develop and conflicting goals can be resolved; adaptation gaps that might reduce overall resilience can be avoided. In particular, the security of supplies should be ensured

during health crises or shocks – for example with regard to pharmaceuticals and other medical products, which can be achieved by diversifying global supply chains and safeguarding local production capacity (SVR, 2023). To strengthen resilience in health systems, structural adaptations to buildings, such as heat-protection measures or the installation of isolation rooms, are necessary in health facilities, e.g. in long-term care. In line with the recommendations of the SVR (SVR, 2023), state financial support for construction and investment in health facilities could in future be made dependent on the impact of the measures on the environment, and on the extent to which they take into account effects of global environmental changes.

Strengthen adaptation and resilience in health systems in low- and middle-income countries

The task of improving basic health services and achieving universal health coverage should be pursued in low- and middle-income countries (LMICs) as a key measure to reduce vulnerabilities. In order to manage health services provided by private actors in the public interest, regulatory mechanisms based on regulatory law and fiscal-policy instruments can be used and optimized, paying particular attention to climate-change mitigation, environmental protection and the strengthening of resilience. In addition, frameworks can be developed to integrate the private and public sectors of health systems. High-income countries should offer financial and technical support to low- and middle-income countries to expand research capacity and develop environmentally resilient and sustainable public health departments that can drive forward the implementation of ‘Health National Adaptation Plans’ (H-NAPs). Available international funding, e.g. from GCF and GEF funds, the UN Adaptation Fund and bilateral donors, could be used to finance measures to strengthen adaptation and resilience in health systems in these countries. When strengthening adaptation and resilience in low- and middle-income countries, measures should be favoured that additionally generate particularly large multiple benefits for improving basic health services. In doing so, it is important to avoid unsustainable path dependencies. Furthermore, the implementation of multi-sectoral projects at the interface of health systems and nature conservation, e.g. in the context of development cooperation, should be promoted and their funding facilitated, since valuable synergies can result from a combined approach.

6.6.1.5

Improve sustainability in health systems

Reduce and avoid inappropriate care including over- and underuse

Existing recommendations to reduce overuse should be implemented (OECD 2017; Schenk et al., 2019); in doing so, ecological benefits and their effects on health should also be considered. In order to avoid inappropriate care including over- and underuse, adjustments to remuneration systems are needed. Inappropriate care should also be consistently avoided in health-promotion and disease-prevention measures. The funds saved should be invested in health-promoting, disease-preventive and transformative measures. Existing initiatives by health professionals to reduce overuse (e.g. ‘Choosing Wisely’ in the USA and Canada and ‘Smarter Medicine’ in Switzerland), as well as for climate-change mitigation and environmental protection should be given institutional support.

Reduce resource use and emissions in health systems

The existing recommendations on reducing resource use (e.g. Ostertag et al., 2020) and emissions (e.g. WHO, 2020h) should be implemented consistently and, above all, promptly. In order to exploit as many synergies between the two fields of action as possible, the respective measures should always be approached in an integrated way and combined with each other. Specific national and local conditions, resources and requirements should be taken into account. When reducing emissions, it should be noted in particular that the aim should be to reduce not only greenhouse-gas emissions but also other emissions at the same time. Existing recommendations for implementing the circular economy in health systems should be followed.

In addition, sustainable medical products and technologies should be used wherever possible; there is an urgent need for research into their development (Section 6.6.2.4). Among other fields, there is a short-term need for action in pharmaceuticals (Section 5.2.3) and medical waste (Box 6.2-2). Healthy and sustainable catering for patients and staff should be introduced across the board in health facilities, e.g. in the sense of the Planetary Health Diet (Section 4.1). There are already useful guidelines for this (e.g. Hünninghaus and Dobos, 2022). In order to improve the sustainability of health facilities in general, ongoing performance-based bonuses are conceivable – in addition to regular remuneration – which are calculated on a graduated scale based on the fulfilment of fixed sustainability criteria. This requires additional funding in health systems. The bonuses should be paid out quickly to increase motivation. Furthermore,

an international and transdisciplinary expert commission should be set up to promote sustainability in health systems, e.g. within a global programme to promote environmentally resilient and sustainable health systems (Section 6.6.1.4). Binding emissions-reduction targets in health systems could be enshrined in law at the national and supranational level.

Make use of opportunities for influence beyond health systems

Health facilities should consistently communicate their orientation towards sustainability both internally and externally, and follow existing recommendations for successful sustainability communication in order to put into effect their role-model function in a targeted manner. When procuring resources, medical products and technologies, attention should be paid to sustainability all along the supply chains, including relevant suppliers located outside health systems. Financial resources in health systems, especially from health insurance funds and companies and professional pension funds for physicians, should be invested in line with appropriate sustainability criteria.

6.6.2 Research recommendations

To ensure that the recommendations for action made in the previous section can be implemented on a scientific basis, the WBGU recommends working on a number of research topics.

6.6.2.1 Interactions between environmental changes, ecosystems, health and health systems

Impact of environmental changes on medical disciplines

In order to be able to comprehensively take environmental changes into account in the provision of health services, extensive medical studies are needed that systematically investigate the precise effects of environmental changes on the respective diseases, diagnostic measures and therapies specific to medical disciplines and across disciplines. In particular it should be attempted to explore causal relationships between environmental impacts and diseases. These studies must cover all ages and should be gender-sensitive. Children's health needs to be given more priority in the context of environmental changes because children are among the most vulnerable groups. Clinical trials, especially in phase 2 and phase 3, should always take environmental factors into account when assessing efficacy. Aspects such as temperature,

weather, pollutant exposure, nutrition and psychosocial factors must certainly be taken into account for a personalized therapy. For example, gender-sensitive research on drug treatment during heat waves is necessary for this purpose, as recommended by the SVR (SVR, 2023).

In addition, the sustainability of discipline-specific diagnostic and therapeutic measures and treatment plans should be systematically examined, and the need and possibilities for action identified and evaluated. In this sense, a sound scientific basis should be developed for implementation in guidelines and other recommendations from medical societies and other relevant actors. In addition, specific health benefits of intact ecosystems should be systematically investigated so that they can be taken into account as a health resource in health promotion.

Measures for integrated environmental and health protection

Integrated and intersectoral solutions for environmental health risks should be developed that include health systems and promote the health of humans, other species and ecosystems at the same time. All research on the interactions of environmental changes, ecosystems and human health should be transdisciplinary. Existing integrative and transdisciplinary health concepts such as One Health and Planetary Health (Section 3.3) should serve as a guide. For the coordination and coordinated promotion of such transdisciplinary and transformative research projects, supra- or transnational competence centres or research networks should be established with appropriate funding to ensure a sustainable and efficient research infrastructure. In Germany, the new Federal Institute of Public Health could coordinate research projects in the health sector (SVR, 2023).

6.6.2.2 Prerequisites for transformations in health systems

Evaluation of health systems and development of targeted financing structures and remuneration systems

Systematic evaluations are helpful for identifying the characteristics of health systems that lead to a good health status and well-being, and to a high level of resilience, while having a low ecological footprint. Existing deficits can also be identified in the process. These evaluations are also useful for informing policy-makers and are a benchmark for the UN and the WHO in policy development, e.g. with the aim of achieving the SDGs. Evaluation tools should cover all components of health systems. An evaluation of the role of health promotion and disease prevention in health systems is also useful,

6 Harnessing the transformative potential of health systems

as is an evaluation of different remuneration systems and financial incentive structures. Existing financing structures should be scientifically evaluated with regard to identifying disincentives that favour overuse and the use of resource- and emissions-intensive measures. On this basis, it is necessary to develop financing structures and remuneration systems that promote adequate and sustainable healthcare.

Legal, political and societal preconditions for transformations in health systems

Systematic evaluations of health systems should examine their respective legal, political and societal framework conditions. This makes it possible to investigate the necessary preconditions for transformations in health systems. Such research should also examine how health systems contribute (and could contribute) to transformations towards sustainability in other areas. In this context, it should be clarified whether a fundamentally new general understanding of health is needed to make transformations of health systems and beyond possible – and what such an understanding would have to look like. It would also be helpful to find out to what extent patients' personal understanding of health and illness influences what they expect of health services and health professionals, and how they evaluate them.

6.6.2.3 Effectiveness and multiple benefits of environmentally sensitive prevention and health promotion

Effectiveness of health-promotion and disease-prevention measures

A shift in the focus of health systems towards more health promotion and disease prevention could also be further justified by the effectiveness of specific measures and programmes, but there is often a lack of large population studies with sufficiently long observation periods and the inclusion of a sufficiently large range of variables. It would be conceivable to integrate vulnerability and effectiveness parameters into existing population studies. In particular, effectiveness studies should examine complex measures and programmes, and appropriate research methods, indicators and parameters should be developed and validated for this purpose. They should assess health-related, social, ecological and economic effects achieved with the measures studied, especially those resulting from the promotion of healthy lifestyles, living conditions and the successful strengthening of adaptation and resilience. On this basis, the evidence on the (cost-)effectiveness of health-promotion and disease-prevention measures should be expanded, among other things to generate additional economic

arguments for adjusting remuneration structures. In addition, research should be conducted to help address the existing challenges in evaluating the effectiveness of such interventions.

Multiple benefits of health-promotion and disease-prevention measures

Furthermore, there should be research into exactly how many resources and emissions can be saved by reducing the burden of disease caused by various illnesses, if possible attributing respective savings potential to precise health-promotion and disease-prevention measures. Moreover, specific diagnostic and therapeutic measures should be identified, the demand for which could be reduced especially advantageously in terms of saving resources and emissions by means of health-promotion and disease-prevention measures. In addition, there is a need to identify health-promotion and disease-prevention measures that can yield significant multiple benefits for strengthening adaptation and resilience, as well as research to quantify their health and economic benefits.

6.6.2.4 Measures, instruments and data for strengthening sustainability and environmental resilience

Instruments and data for implementing environmental resilience

In order to be able to carry out regular transdisciplinary exposure, vulnerability and adaptation assessments and monitoring, to develop country- and target-group-specific adaptation and resilience strategies, and to implement effective early-warning, monitoring and surveillance systems, validated methodological principles and a comprehensive data basis are needed, and these should be provided, among other things, by specific research. The demands on the corresponding instruments and data needed are described in Sections 6.6.1.3 and 6.6.1.4. Prospective epidemiological studies, such as the GNC in Germany, should be expanded, and the inclusion of climate- and environment-related indicators significantly extended. If possible, these data should be collected within the framework of these studies themselves (SVR, 2023). Here, a special focus could be placed on personal exposure instead of only investigating correlations with environmental data collected at a different location than the location of the person concerned. Research should be funded that helps develop personal environmental monitoring (personal samplers) and personalized digital early-warning systems.

Practice-oriented and transdisciplinary early-warning, monitoring and surveillance systems should be developed, including new dynamic approaches that make comprehensive use of the available digital possibilities.

In this way, the rapidly and constantly changing conditions in environmental and societal systems can be adequately documented. In addition, studies are needed on the effectiveness of different adaptation measures on the health of the population, taking into account differences in the adaptive capacity of population groups, vulnerability factors and the influence of living conditions on individual vulnerability. In particular, adaptation measures should be identified or developed that realize multiple benefits and avoid conflicting goals. The methods and findings generated can serve as a basis for Health National Adaptation Plans (H-NAPs) and for their evaluation and further development.

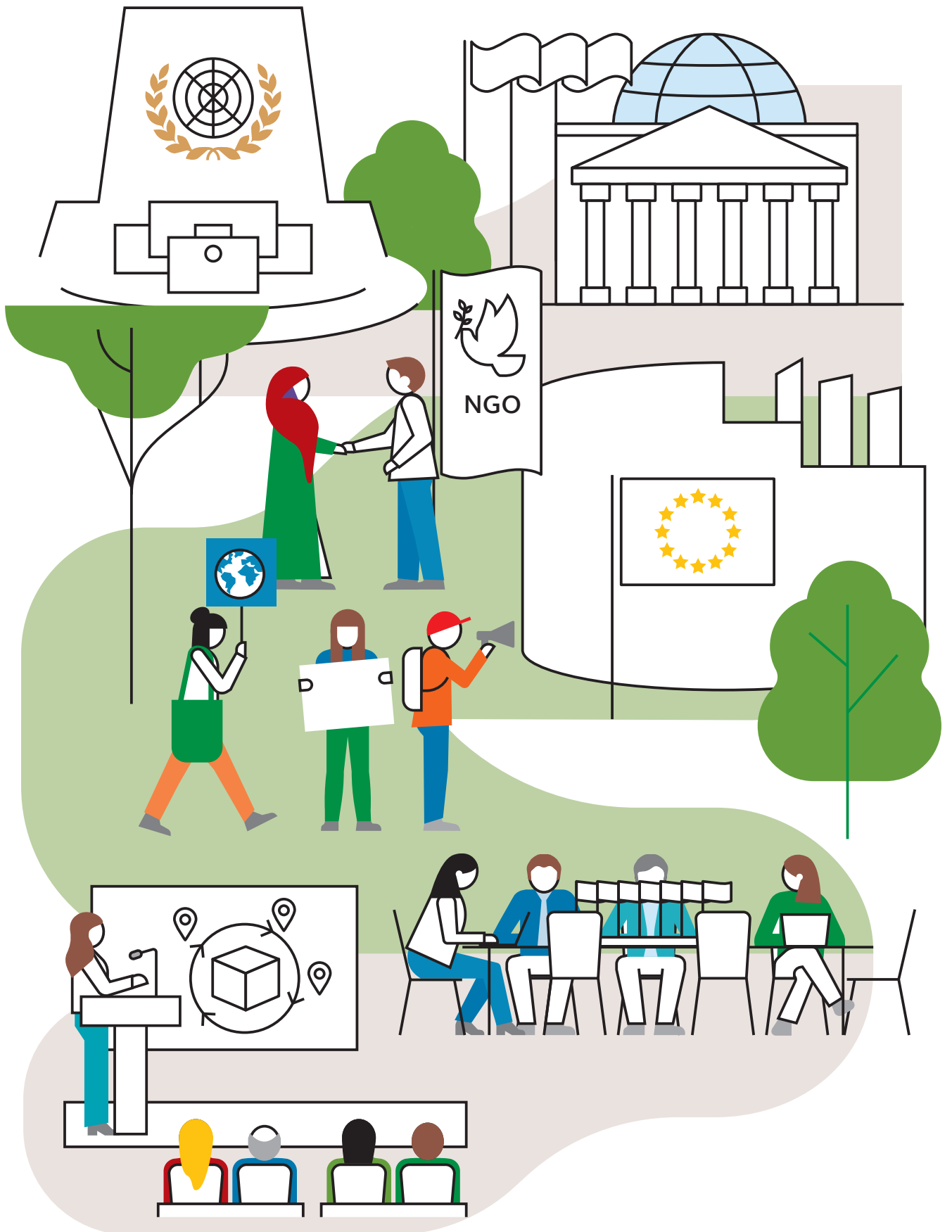
Effective measures for strengthening adaptation and resilience in low- and middle-income countries

Studies should be carried out to determine which measures can protect particularly vulnerable population groups in low- and middle-income countries from health risks caused by environmental changes as quickly and effectively as possible, especially taking into account regional and socio-cultural differences, limited resources and capacity. Potential multiple benefits for improving primary care and the general health of the population should be quantified, and measures identified that maximize benefits in this regard, while being as sustainable as possible and capable of being implemented in a resource-saving way. Evaluations should be carried out to determine how to avoid unsustainable path dependencies in the development and expansion of health systems in low- and middle-income countries. The effectiveness of health services provided by private actors should also be better researched. Existing projects which aim to simultaneously improve human health or healthcare and to protect and improve the health of ecosystems should be identified and evaluated. Furthermore, scientific criteria should be devised for the development of more such projects.

Improve sustainability in health systems

Criteria and instruments should be developed for systematic analyses of the sustainability of health systems, health services and health facilities. Moreover, research should be conducted to determine precisely how much (in terms of resources and emissions) can be saved by reducing overuse, including country-specific quantifications. Specific, overused diagnostic and therapeutic measures should be identified, whose reduction would save the most in resources and emissions. Research should be conducted on environmentally sound pharmaceuticals, medical products and technologies; this would include safe, reusable alternatives, e.g. surgical materials and instruments, as well as methods for their environmentally friendly sterilization. Pointless

hygiene requirements should be identified. There is also a need to develop scientific criteria for the implementation of emissions-reduction targets by companies supplying pharmaceuticals, medical technologies and other products. Finally, research should be conducted on known and hitherto unknown emission sources in health systems in order to quantify their environmental effects, evaluate reduction potential and develop more environment-friendly alternatives.



Healthy living on a healthy planet requires globally coordinated, accelerated, long-term governance that responds to the urgent need for effective action. It should oblige all policy areas to take responsibility, drive the implementation of the 2030 Agenda forward and enshrine in national constitutions a human right to a healthy environment. The German Federal Government should assume political, economic and intellectual leadership in international forums such as the UN and the EU. Policies on health and the environment should be more closely interlinked, for example via a G7 Planetary Health Task Force.

In 2015, the international community agreed on the 2030 Agenda with its universal catalogue of 17 Sustainable Development Goals (SDGs). It represents an international, medium-term mandate for action to make the vision of ‘healthy living on a healthy planet’ a reality. The implementation of the 2030 Agenda has been inadequate up to now, and the implementation gap has widened as a result of the COVID-19 pandemic. In the words of Jennifer Morgan that she used in the context of the energy transition (UNHRC, 2022), a ‘radical acceleration’ is urgently needed to achieve the goals. However, it is necessary to think and act beyond this: discourse spaces and actor networks must already be created now to prepare a post-2030 Agenda and thus ensure the vision of ‘healthy living on a healthy planet’ for future generations. Building on the 2030 Agenda, the international community of states must now prepare a joint agenda for the time after 2030. It cannot be taken for granted that the foundation will be laid for a joint post-2030 Agenda. It will require considerable political commitment, and the corresponding discourse spaces will have to be initiated and shaped at the multilateral, regional and local levels.

This is all the more urgent as the international community and many states today are not on a path that will ensure healthy living on a healthy planet and ultimately the achievement of the 17 global Sustainable Development Goals (SDGs) (Box 7.1-1). Knowledge of the dramatic worldwide negative consequences for the environment

and health if sufficient action is not taken is (largely) available. The instruments for achieving the goals have been known for a long time; however, they were only partially made binding or implemented (Chapters 4, 5, 6).

Furthermore, the rising number of global crises, which seem to be overtaking humanity at ever shorter intervals, increasingly requires short-term ad-hoc responses, which, while sometimes dealing successfully with acute problems such as bottlenecks in gas supplies, also mean that we lose sight of medium- and long-term sustainability goals. In addition, there are path dependencies like the institutionally determined separation of environmental and health-protection policy, which are characterised by a policy that is fragmented in political, administrative and legal ‘silos’. Such path dependencies often prevent cross-system, medium- and long-term and sustainable solutions. Yet, in view of the planetary guard rails, what is required is transformative action that does not get bogged down in making incremental improvements, but develops systemic, synergistic and solidarity-based solutions.

There is therefore an urgent need for global environmental and health governance that overcomes these constraints and portrays the vision of ‘healthy living on a healthy planet’ not as a utopia but as a realizable vision. Such a form of urgency governance should be based on inclusive values that respect human dignity and an international order. It should keep open room for manoeuvre in the medium to long term, and, at the same time, be in a

position to manage interdependent global crises decisively, vigorously, ever faster by involving different government departments and across different levels of scale, while applying effective crisis management.

There are no blueprints for such urgency governance. Rather, it should be adjusted to local, national and regional circumstances and conditions and be adaptive, i.e. capable of learning. The focus of urgency governance is not on taking emergency measures in crises. It is characterized by an assumption of responsibility by international, governmental and private actors who keep the vision of ‘healthy living on a healthy planet’ firmly in mind over the long term, and orient their decisions to the mandate for action set out by the SDGs. This assumption of responsibility is characterized by the implementation and enforcement of transformative measures.

Governance encompasses structures, processes and other actions taken by private and public actors to address societal goals. Governance thus concerns formal and informal institutions, as well as norms, rules, laws and procedures for deciding, managing, implementing and monitoring policies and actions at all geographical and political levels, from global to local (IPCC, 2022d).

Global urgency governance includes both known and new core elements (Section 7.1):

- ▶ the implementation of the 2030 Agenda as a global orientation framework and mandate for action on sustainability, as well as efforts to boost the Agenda’s (geo)political impact;
- ▶ enshrining the human right to a healthy environment as a guiding principle and in countries’ constitutions as a benchmark that can be monitored, especially in Germany’s Basic Law and the EU Charter of Fundamental Rights, enabling civil societies to take the state to court to force it to take or stop certain actions;
- ▶ the development of a cooperative assumption of responsibility oriented, inter alia, towards the guiding principle of ‘Health in All Policies’;
- ▶ the assumption of political, economic and intellectual leadership in UN forums, the European Union, the G7, G20 and multi-stakeholder alliances, as well as vis-à-vis companies and civil society;
- ▶ securing discourse spaces and actor structures for global society’s shared conception of a post-2030 Agenda and thus the basis of the vision of ‘healthy living on a healthy planet’.

As a state actor, Germany’s Federal Government can actively assume responsibility for the development of urgency governance in various forums: suitable examples include the WHO (see Section 7.2), transregional governmental associations such as the G7 and G20, as well as multi-stakeholder alliances (Section 7.3) and the European Union (Section 7.4). Furthermore, the German Federal Government can and should mobilize international

funding (Section 7.5) and corporate responsibility (Section 7.6) to make its contribution to healthy living on a healthy planet.

7.1 Principles of urgency governance for ‘healthy living on a healthy planet’

Urgency governance is a guiding principle and a search process; it should be backed by scientific advice and democratically legitimized. It aims to comply with planetary guard rails and to maintain and improve healthy living conditions for humans and other living organisms. This requires decisive and accelerated implementation of the 17 Sustainable Development Goals, the Paris Climate Agreement and the Kunming-Montreal Framework on Biodiversity, i.e. (a) across-the-board, multi-level, coherent policy-making based on systematic coordination processes between external and internal policy fields and oriented towards the guiding principle of ‘healthy living on a healthy planet’. Furthermore, this urgency governance stands (b) for governance and process design that substantially accelerate transformation processes towards sustainability. Its features range from regulatory approaches, measures like setting incentive structures and reducing bureaucracy, to actor mobilization through involvement and participation (Chapter 4). Ultimately, urgency governance is characterized by (c) a long-term, future-shaping perspective that is simultaneously radically effective in the short term. It is important to maintain room for manoeuvre in the medium to long term. At the same time, the dynamics arising from the interplay of interdependent global crises should be dealt with vigorously, with intelligent reflection and by democratic dispute.

The urgency of and need for transformative change involving cross-system cooperation is already recognized by the relevant international organizations (Box 7.1-1). The joint mandate for action includes the implementation and strengthening of the 2030 Agenda as a common orientation framework beyond 2030 (Section 7.1.1). The human right to a healthy environment can serve as a justiciable monitoring benchmark for governmental or European actions and omissions. It not only makes a certain – i.e. healthy – level of environmental and health protection enforceable, but also serves as a guiding principle for healthy living conditions, which can also contribute to the higher political prioritization of healthy and sustainable structural prevention (Chapters 4, 6; Section 7.1.2). Particularly important for urgency governance is the cross-departmental, cross-sectoral and cross-actor international and cooperative assumption of responsibility aimed at launching a transformative

dynamic (Section 7.1.3). Accordingly, countries and other actors are needed that assume political, economic and knowledge-based leadership (Section 7.1.4).

7.1.1 2030 Agenda and SDGs as an orientation framework and mandate for action

The 2030 Agenda is the first joint agenda of the international community of states that comprehensively addresses global ecological, social and economic challenges and represents a consensus of the global community of states. However, in view of the current global health and environmental crises and international conflicts, their unifying importance for the guiding principle of ‘healthy living on a healthy planet’ has increased even more. Three principles of the 2030 Agenda should always be emphasized in this context: (1) recognition of the universality of these global challenges, which can only be addressed through sustainability transformations in all societies on all continents, (2) the inseparability of the goals and their interdependence, and (3) the comprehensive global consultation process that led to the formulation of the 17 Sustainable Development Goals (SDGs) and underpins the 2030 Agenda for their adoption and implementation. However, these three achievements of the 2030 Agenda urgently need the attention of global society in the spirit of the ‘healthy living on a healthy planet’ vision. Today, our international community of states is marked geopolitically by much more serious tensions than in 2015. Against this background, the consensus on sustainable development enshrined in the 2030 Agenda should be strengthened both within all countries and globally as a key part of the international community’s self-image and as an important driver of multilateral cooperation. Accordingly, its further development should be given a high priority (Section 7.1.1.1).

At the same time, the record on the implementation of the 2030 Agenda at the halfway stage is sobering: at the current rate, both the global community and individual countries are in danger of missing most of the 17 SDGs; in some areas, things have actually worsened (UN, 2022b). In order to still do justice to the 2030 Agenda, the UN declared the ‘Decade of Action’, but its success was severely hampered by the COVID-19 pandemic, among other things (UN, 2022b). The SDG Summit in September 2023 and the Summit of the Future in 2024 are opportunities to raise ambitions for implementation and strengthen corresponding multilateral capacity (Beisheim and Weinlich, 2022). A perspective on its further development beyond 2030 is an important prerequisite for maintaining and boosting the Agenda’s momentum.

On the one hand, more effective implementation of the 2030 Agenda (Section 7.2.2.2) requires in particular country-specific strategic priorities, which should take into account synergies between human health and healthy nature (e.g. by designing healthy living conditions that are near to nature; Section 7.1.1.2). Corresponding structures for cooperation between government departments in Germany to implement the Sustainable Development Goals are addressed in more detail in Section 7.1.3.2. On the other hand, more effective implementation also depends crucially on improving the international framework conditions and significantly intensifying partnership-based cooperation between all states (Box 7.1-1).

7.1.1.1 Implementation and further development of the 2030 Agenda as a unifying project of international politics

The 2030 Agenda and its 17 Sustainable Development Goals (SDGs) (UNGA, 2015a) were drawn up during a two-year participatory negotiation process at UN level, which involved numerous representatives of civil society and science; it was adopted by all 193 UN member states (Donoghue, 2020). Its high level of ambition is already expressed in its title ‘Transforming our World’. The 2030 Agenda is made up of a large number of goals which are supposed to interact in an ‘integrated’ implementation. At the same time it is universal and addresses all countries (Biermann et al., 2022a). The 2030 Agenda brought together the discourses and programmes on the environment (Stockholm Conference 1972 and Earth Summit of Rio de Janeiro 1992 with its follow-up process) and development (international development decades and Millennium Development Goals 2000), which had been running in parallel for many decades (Kloke-Lesch, 2022). Thus, the 2030 Agenda is a political programme that reflects a jointly developed definition of the international community’s goals with regard to sustainable development. While the Sustainable Development Goals are fleshed out at the national level in interaction with the respective identity and change processes, the 2030 Agenda functions as an action-guiding communicative framework that brings together these culturally different processes and defines joint target corridors for all countries.

The unifying importance of the 2030 Agenda has increased even more in view of the current global health and environmental crises, as well as international conflicts (Chapter 2), and it offers diverse stimuli and starting points. Health and environmental goals (SDG 3 and especially 13, 14, 15), the design of governance (SDG 16) and the associated indicators can provide important guidance in dealing with the many SDGs and their interactions

Box 7.1-1**Health protection and environmental protection: state of the international debate**

The connection between human health and the state of the environment has been the subject of increasing international discussions for some years. This is evidenced e.g. by the 'WHO global strategy on health, environment and climate change: the transformation needed to improve lives and wellbeing sustainably through healthy environments', which was adopted in 2020 (Box 7.2-1). The strategy offers some good starting points for a form of global governance that integrates and interlinks health-related and environmental challenges. Reports published by global institutions on the topic of health and the environment/sustainability in recent years (UNEP, 2019c; EEA, 2019b; APCC, 2018; WHO and CBD, 2015; WHO, 2020j, 2021c; Watts et al., 2021; Whitmee et al., 2015; WHO and UN Habitat, 2016; WHO, 2020f) contain three key recommendations on how to shape such an integration and interlinkage for an overarching policy:

- ▶ accelerate the implementation of (transformative) measures to mitigate environmental health risks,
- ▶ give preference to options of governance offering high levels of synergy (multiple gains, co-benefits) and leverage, as well as
- ▶ a systemic, cross-sectoral approach that embeds the issue of environment and health in all policy areas.

Urgency of accelerating the implementation of measures

Health protection and the protection of the environment are not new topics in global sustainability policy (Section 2.4.2). However, the increasingly noticeable consequences of climate change (IPCC, 2022d), the drastic increase in damage to and pollution of the biosphere (IPBES, 2019; Sections 5.1.1, 5.1.2) and, not least, the COVID-19 pandemic have impressively illustrated the linkage between these crises and the urgency of combating them. The UN Special Rapporteur on the Issue of Human Rights Obligations Relating to the Enjoyment of a Safe, Clean, Healthy and Sustainable Environment (UN, 2020b) emphasizes the urgency of political action: "It is not too late to respond to the global nature emergency, but time is running out. The ongoing failure to conserve, protect and sustainably use the Earth's ecosystems has catastrophic consequences for the enjoyment of a sweeping range of human rights. With COVID-19, humanity has paid a terrible price for ignoring scientists' warnings. We must not make the same mistake with the risks posed by future pandemics, biodiversity loss and climate change." (UN, 2020b). Because any increase in the global average temperature, however small, exacerbates health risks, and the demands on adaptation increase with every delay in GHG reduction (Section 5.1.1.4), most global reports on this issue emphasize rapid policy action, accelerating governance innovations and political commitment as key conditions for success (WHO, 2015; IPCC, 2014a; Ebi et al., 2018, IPCC, 2022d).

Policy areas with potentially high leverage and synergies

Numerous global reports on health, the state of the environment and sustainable development identify policy areas with potentially high leverage, especially in terms of effectiveness and synergies. Climate-change mitigation and adaptation, for example, is one of these key policy areas: achieving the target

of the Paris Climate Agreement could save millions of lives and bring billions of US dollars in health and environmental benefits every year, according to an estimate by the Special Rapporteur on human rights and the environment (UN, 2019b). Policy-making should therefore be geared towards exploiting synergies (UNEP, 2019c; EEA, 2019b; APCC, 2018; WHO and CBD, 2015; WHO, 2020j, 2021c; Watts et al., 2021; Whitmee et al., 2015). The integration of the topic of health into urban and spatial planning is seen as an example with high synergy potential as interrelated health problems are addressed in a bundled and integrated way (WHO and UN Habitat, 2016). Cross-sectoral coordination and the participation of stakeholders (e.g. the population of an urban neighbourhood) in decision-making processes in planning is essential, as health and health equity in cities are influenced not only by the infrastructure but also by many other factors and actors. Health should therefore be considered at all planning stages (WHO, 2018e). Instruments for integrating health issues into urban planning already exist to support local authorities and civil society in planning responses to health inequity. One example is the WHO Urban Health Equity Assessment and Response Tool (Urban HEART). Furthermore, improving the quantity and quality of health data at the urban level is highlighted as an important governance issue ('urban data revolution') (WHO and UN Habitat, 2016; WHO, 2020). In addition to health-promoting urban and spatial planning, according to the WHO urban health can be achieved above all by reducing urban health inequity. Greater attention should therefore be paid to urban poverty groups in order to improve health conditions in cities on a broad scale (universal health coverage).

Another example with a lot of potential leverage is the integrated management of Neglected Tropical Diseases (NTDs) (Section 2.3), which should be implemented together with interventions on intersectoral or multisectoral water quality, sanitation and hygiene (WASH) (such as data use, performance measurement and best practices) (WHO, 2021c). Since NTDs are often directly influenced by water-supply quality, climate change, environmental degradation and socio-economic factors, the WHO has established a Strategic and Technical Advisory Group because of their particular importance. The WHO estimates that more than one billion people worldwide suffer from one or more of these NTDs. According to the WHO, the economic damage to the developing countries affected totals several billion US dollars every year (BMZ, 2022c).

Cross-sectoral and transformative governance

There is a broad consensus that incremental policy-making will not be enough and that transformative changes will be needed in many areas of life to address the challenges at the interfaces of health, climate change, biodiversity loss and pollution. To achieve this, the WHO believes that the way people live, work, produce, consume and govern should be reviewed (WHO, 2020i; Box 7.1-1). According to UNEP (2019c), environmental health risks should therefore be addressed as a transformative human challenge. Speaking in the same vein, the UN Special Rapporteur on human rights and the environment embeds the description of transformative change in a new understanding of quality of life, in the sense of well-being: "Transformative change requires rethinking the goals of society, what makes us happy and what it means to live a good life, how we generate and use energy, the food that we eat and how we produce it, the way that we manufacture goods, how we design our cities and how we can reduce and eliminate waste" (UN, 2020b). The societal transformations towards a good quality of life in harmony with nature for everyone therefore requires more

commitment to biodiversity conservation, the large-scale restoration of degraded ecosystems, a rapid shift to renewable energy, the transition to a circular economy, the reduction of material consumption by wealthy people, and the creation of sustainable supply chains (UN, 2020b).

Systemic cross- or multi-sectoral approaches

One insight that can be found formulated almost everywhere in the evaluated Global Assessment Reports is the need for systemic measures and collaboration across sectors (usually meant more broadly in the sense of areas or sub-areas) and disciplines, including the cross-sectoral embedding of health and environmental considerations (EEA, 2019a; UNEP, 2019c; Whitmee et al., 2015; WHO and CBD, 2015) or simultaneously in several sectors (multisectoral) (EEA, 2019a; UN-Habitat and WHO, 2020; WHO, 2020e, 2021c; WHO and UN Habitat, 2016). This cross- and multi-sectoral approach is reflected in the Health in All Policies (HiAP) approach (Section 5.2; Box 7.1-5), which has also been adopted as a guiding concept in international discourse (Watts et al., 2021; WHO, 2020i). In parallel – and in part synonymously – there is also talk of systemic challenges, systemic approaches and policies, systemic change and systemic implementation in the context of the debate on health and sustainable development from a predominantly overarching perspective (EEA, 2019a; UNEP, 2019c; UN, 2019d; WHO and CBD, 2015; UN-Habitat and WHO, 2020). The necessity of a cross-sectoral and/or systemic approach is justified by the observation that several factors always interact in the case of environmental-health effects – factors which are influenced by social and demographic constraints. This means that climate-change-mitigation measures, for example, can expedite progress in achieving several SDGs simultaneously, including e.g. air-pollution reduction, clean energy for all, better health, less inequality and poverty, and a better infrastructure (UN, 2019b). UNEP's sixth Global Environment Outlook report (UNEP 2019c) therefore focuses on identifying

synergies between fields of action and minimizing conflicting goals. The European Environment Agency (2020) follows an identical approach; in its report 'Healthy environment, healthy lives' it proposes measures that either have a triple impact (health, society and environment) or address the cause of several environmental stressors at the same time. According to the EEA, these include in particular the promotion of public blue and green infrastructure (especially in poorer urban neighbourhoods), the development of low- or zero-emission mobility, the promotion of sustainable agriculture, and support for a plant-based diet (EEA, 2019b).

Conclusions

All the reports from global institutions reviewed here agree that systemic/cross-sectoral and transformative governance are key conditions for success in maintaining and promoting a healthy environment and healthy living. The promotion of synergies is equally key in this respect. Shaping transformative governance means aiming for systemic change and leaving unsustainable development paths behind. However, this requires not only courage to take disruptive measures, but also visions for systemic innovations (e.g. energy-storage technologies for a global energy transition) as well as social and political innovations (e.g. for acceleration, leverage). Also required is a willingness to experiment (e.g. real-world laboratories, promotion of niche actors) as well as improved participation and the empowerment of actors and interest groups that can act as pioneers of change (UNEP, 2019c; WBGU, 2011a). Most of the evaluated reports lack a long-term perspective beyond 2030. If one does exist, the corresponding sequential steps to realistically working towards the realization of such a long-term perspective are often lacking. Similarly, there are usually only vague answers to the question of how interfaces between individual areas of governance can be better organized and coordinated between actors.

(Box 7.1-2). They are highly and directly relevant for most people; they are closely linked to goals and measures in other SDG areas and ultimately to the entire 2030 Agenda. The 2030 Agenda emphasizes the aim that all people can fulfil their potential in a healthy environment (Preamble), with equal and universal access to healthcare for their physical, mental and social well-being (par. 7, 26). SDG 3 on health and well-being and its sub-targets describe fundamental areas of action for sustainable health systems (Chapter 6), which are now increasingly challenged by the lack of progress on climate change (SDG 13), environmental protection (SDGs 14, 15) and pollution (sub-targets 12.4, 12.5, together with 3.9). The great relevance of SDG 14 on the protection of terrestrial ecosystems and sub-target 12.2 on the sustainable use of natural resources, e.g. for the prevention of zoonoses, was demonstrated during the COVID-19 pandemic (Section 5.1). In combating the pandemic, however, the continuing nation-state focus and the limits of solidarity, especially on the part

of high-income countries or their own pharmaceutical industry, vis-à-vis low-income countries, also became apparent, contrary to the partnership approach called for by SDG 17 and sub-targets 3.b, 3.8 and 3.d on vaccine development, supply and risk reduction, among other things (Section 8.2). Pandemic prevention can only succeed if the globally and locally sustainable handling of nature is combined with a strengthening of national health systems and, at the global level, with a sufficient and equitable distribution of vaccines. Like solving the global climate and environmental crises and the implementation of the 2030 Agenda as a whole, effective global pandemic prevention also depends on whether high-income countries – whose national consumption, production and/or trade have a significant influence on other countries and the natural life-support systems – are prepared to co-create solutions in reciprocal cooperation and to adapt the structures of international cooperation accordingly (Kloke-Lesch, 2021). A key idea here is reciprocity, i.e. economically poorer countries

Box 7.1-2**Environment and health in SDG transformation fields**

A focus on strategic transformation fields has been proposed for implementing the 2030 Agenda more effectively (TWI2050, 2018; UN, 2019a); these have now found their way into national sustainability strategies in Germany and Finland, for example. Environment and health already have a high profile here, but their linkages, common causes of problems and solution approaches (Chapters 2, 3), and the role of healthy living conditions (Chapters 4, 5) are still being neglected.

'The World in 2050 Initiative' (TWI2050, 2018) assigns health to the 'Human Capacity and Demography' transformation field together with education and other topics; although it emphasizes medical care, environmental influences on health are neglected, while environmental aspects are addressed in other transformation fields.

Following further development by Sachs et al., 2019, 'Transformation 2: Health, Well-being, and Demography' is concerned, first, with universal health coverage and health systems, and, second, with social determinants of health. But here again the focus is on individual behaviour and risk prevention and health ministries are the only responsible ministries (unlike all the other transformation fields mentioned). Healthy conditions are indirectly addressed in other transformation fields.

Germany's sustainability strategy (Bundesregierung, 2021) primarily assigns health aspects and e.g. education (SDG 4) to the area of 'Human Well-Being and Abilities, Social Justice', where it aims to promote the health system, 'research on prevention', One Health approaches and environmental justice, among other things. However, the specific measures, e.g. the 'Pact for the Public Health Service', do not include any extension of tasks for establishing healthy living conditions. Research funding under the FONA programme remains unspecific, and the One Health section cites mainly existing international structures and measures on diseases and the prevention of zoonotic pandemics (e.g. by conserving natural habitats), while specific measures on healthy living conditions for people (also in Germany) are missing. The link between health and educational measures remains unclear overall, even though it could certainly be established, for example, via holistic health and environment in the school environment (Section 8.1); no link is established, for example, with SDG 11 (sustainable cities and communities), which has a major influence on healthy living environments (Sections 4.2, 4.3).

Finally, the Finnish sustainability strategy (Finnish National Commission on Sustainable Development, 2022) is consistently structured according to 'areas of change'; it defines the health-relevant field of action more narrowly ('Well-being, health and social inclusion') and strongly emphasizes preventive approaches and the connection with social inequity, although the reference to environmental goals is largely missing here (with the exception of nutrition guidelines and price incentives for a 'planetary health diet'; Section 4.1).

should also have a chance to influence conditions in richer countries. This could be implemented on the one hand in bilateral transformation partnerships, but also on the other hand by giving multilateral organizations a stronger role in the transformation processes of richer countries, as already is (or could already be) the case in certain areas such as climate politics or at the International Monetary Fund. The world of the 2030 Agenda needs mutually transformative cooperation (Kloke-Lesch, 2021) which respects the dignity of all partners and strengthens mutual trust.

At present, the focus must clearly be on implementing the 2030 Agenda (UN, 2022b; Lafortune et al., 2022; UN DESA, n.d.). However, a perspective beyond 2030 is an important prerequisite for this. Half of the implementation period of the 2030 Agenda has already passed and the closer the target year approaches, the more important expectations on further developments beyond 2030 become for the political attention devoted to it in the final phase of implementation (Nilsson et al., 2022). Also in view of the expected slowness of a post-2030 process, it seems sensible to already start thinking about this now. To ensure a smooth transition in 2030, the detailed exchange of ideas on a successor programme should be initiated in 2027 at the latest. The groundwork for this can and should begin by 2024 at

the latest. The Independent Group of Scientists to be newly appointed by the UN General Assembly for the 2027 Global Sustainable Development Report should therefore be tasked, among other things, with developing corresponding principles and proposals. Apart from a review of what has been achieved and proposals on how to make up for what has not yet been achieved, more recent developments – e.g. digitalization (which was practically ignored in the 2030 Agenda) and the pandemic – must be taken into account, as well as normative developments and international agreements on climate, oceans and biodiversity. It will be particularly important to link the processes on climate and sustainable development even better. It should be taken into account here that, due to accelerating effects, e.g. in the area of global warming, some targets will be out of reach if they are not achieved in the coming years (IPCC, 2021b, 2022e).

The first steps towards a perspective beyond 2030 can be taken at the preparations for the SDG Summit in September 2023 and the UN Summit of the Future in 2024. Here, the 2030 Agenda should be reaffirmed as a political guideline for a global community that is once again more focused on its joint concerns, as well as for strong multilateralism. The SDG Summit in particular offers an opportunity to reflect on the SDGs, bundle discussions, hear voluntary reporting and mobilize the international

community and non-state actors – also in the run-up to the UN Summit of the Future, which is intended to strengthen multilateral capacities that are also key to SDG implementation (Beisheim and Weinlich, 2022).

As these points are developed further, the linkages between the individual SDGs and, in particular, with environment, climate, health and governance (SDGs 3, 13, 14, 15, 16, 17) should be emphasized even more strongly. In addition to achieving minimum standards and averting dangers, which is reflected, for example, in the focus of SDG 3 on specific diseases and universal healthcare, the focus should also be on diversity and the potential for societal and individual development, which are included in the vision of ‘healthy living on a healthy planet’ (Chapter 3; Box 3.1-1). Overall, it is important on the one hand to formulate ambitious, quantified and time-bound goals. On the other hand, in line with the 2030 Agenda’s ideas on universality, the instruments of implementation, cooperation and review must be significantly strengthened with a view to countries at all income levels, and further developed in the direction of globally oriented international cooperation for sustainable development.

7.1.1.2

Health and environment as an integrative focus

With the 2030 Agenda, countries have committed themselves to a guiding framework that they must flesh out within the context of their respective national characteristics. The lack of progress shows (UN, 2022b) that implementation needs to become more effective. There is a risk that many countries, including Germany, will fail to achieve the goals of the 2030 Agenda: according to the Indicator Report on the German Sustainability Strategy, only about half of the indicators assessed in the 2021 are likely to reach their targets (Destatis, 2021). The situation is similar in the European Union: here, there has been little overall progress on the SDGs since 2020. In many EU countries things have even worsened, especially in poverty reduction (SDG 1), health goals (SDG 3) and work and growth (SDG 8); the greatest sustainability challenges are still food systems, consumption and production, and interacting with nature (SDGs 2, 12–15). Social and economic inequities have worsened in several countries (Lafortune et al., 2022), while inclusive, transparent and democratic governance has been experiencing substantial setbacks in many countries for years (Boese et al., 2022). The fact that the performance of many EU countries on the SDGs was nevertheless good overall by international comparison must be seen in the context of the EU’s imports from other regions of the world; and these are associated, for example, with considerable environmental destruction and GHG emissions in the source countries: many European countries are at the

bottom of the rankings in the ‘International Spillover Index’ of the Sustainable Development Solutions Network (SDSN) (Lafortune et al., 2021). This is also due to the fact that effects of the SDGs on the behaviour of international organizations, national and sub-national state actors, civil society and business have hitherto been mainly limited to changes in political and public discourses, while there have been few demonstrable effects on explicit policy goals, finances or institutional structures, e.g. involving inter-departmental cooperation and integrated, coherent policy measures (Biermann et al., 2022c; Bogers et al., 2022). Better institutional integration and policy coherence therefore require further political leadership and pressure from civil society (Biermann et al., 2022c; Box 7.1-1).

The vision of ‘healthy living on a healthy planet’ can be helpful and provide orientation for some implementation challenges, such as the complexity and reciprocal impacts of the goals and the policy integration this requires, as well as communication and the involvement of society: it can be helpful, first, when using environmental and health targets and indicators as meta-indicators and an evaluation benchmark for measures in other policy areas; second – and this involves a clear intention to achieve change – in the choice and design of strategic implementation priorities. Other challenges that affect all the SDGs and/or their national implementation must also be addressed; these include lacking or insufficiently ambitious quantitative targets, unsuitable indicators and missing data (UN, 2019a).

Make the most of synergies between health and the environment in strategic transformation areas

Strategically reflective, systemic approaches to operationalizing the 2030 Agenda have been proposed in recent years in order to do justice to its transformative aspirations, the interactions between the 17 SDGs and the corresponding need for policy integration (Box 7.1-2). In this context, key activities, most of which have a synergistic effect on several SDGs, have been bundled together to form a smaller number of fields of action (TWI2050, 2018; Sachs et al., 2019; UN, 2019a). Also referred to as ‘SDG transformations’ or ‘entry points to transformation’, this concept “requires and enables governments, business and civil society to work together in new ways across sectors to define goals and put integrated solutions into practice. Above all, this opens up opportunities to advance the concerns of sustainable development not in institutional niches but, as already called for by the Brundtland Commission, on the key societal and political stages” (Kloke-Lesch, 2022: 113). This structuring into transformations and levers, which was initially developed by the Independent Group of Scientists convened by the United Nations Secretary-General (UN, 2019a) in the

Global Sustainable Development Report 2019, was taken up by the German Sustainability Strategy 2021 (Bundesregierung, 2021; SDSN Germany, 2021). Since 2022, implementation has been ensured by interdepartmental ‘transformation teams’, six thematic and one internationally oriented. Scientific policy advice is provided by the (BMBF-funded) Science Platform for Sustainability.

The WBGU welcomes these approaches for operationalizing the 2030 Agenda. The issues of environment and health are already prominently considered in the scientific advice and national implementations of the SDG transformations to date. However, compared to the vision of ‘healthy living on a healthy planet’ (Chapter 3), still far too little attention is being paid to illuminating the linkages between and/or common causes of environmental and health problems – and to possible synergies in solving them – or to the role of healthy living conditions (Box 7.1-2). As the strategic transformation areas (and similar concepts in other countries) are fleshed out and implemented further, these cross-references should be given much greater consideration, also in the interdepartmental exchanges between BMG, BMUV and BMZ.

Low-income countries should be given support with capacity building for such strategy-development and implementation processes concerning the 2030 Agenda, also to develop a common language and launch joint activities during the implementation phase and the process of designing a post-2030 Agenda. In this context, interrelated learning processes should be included and specifically promoted. High-income countries also need to undergo a learning process here: by exchanging information with middle- and low-income countries, they can gain new insights into how to reduce the local social and ecological effects of production processes caused by the spillover effects of European practices. In addition, the reciprocal exchange between the countries will promote a learning process that will help achieve a more effective realization of cooperation formats. There is an urgent need for research and advice on the promising development of transformation areas and the overall effectiveness of various institutional structures for policy integration in SDG implementation (Breuer et al., 2019; Niestroy and Meuleman, 2020; Nilsson et al., 2022). The response should come from internationally constituted scientific consortia with scientists from regionally differently characterized scientific systems, working empirically in different societies all over the world. This international, interdisciplinary and transformative formulation of scientific answers ensures, on the one hand, that the transformation pathways developed are suitable for the local contexts and, on the other hand, that the expertise and networks necessary for implementation have been established as part of the research processes in the different countries (Section 8.2).

Emphasize synergies between environment, health and other SDGs when communicating the 2030 Agenda

The 2030 Agenda is sometimes ‘difficult to sell’ and enjoys little political ownership (Nilsson et al., 2022). At the same time, it is the first joint agenda of the international community that comprehensively addresses the global ecological, social and economic challenges and represents a consensus of the world community. Against this background, it is all the more urgent to ensure that the international community in 2030 again succeeds in agreeing on a joint agenda for the future. Since health and the environment are tangible issues and quite relevant for most people, emphasizing the synergies between these areas and joint solutions in the sense of the guiding principle of ‘healthy living on a healthy planet’ (Chapter 3) can make the 2030 Agenda significantly more communicable and politically attractive. This is also suggested by the fact that health and environmental goals (SDGs 3, 13–15) represent long-term thinking and the ideas of prevention and resilience in a direct way that is relatively easy to understand. After all, these SDGs and their associated indicators are closely linked to targets and actions in other SDG areas and ultimately to the entire 2030 Agenda, and progress and failures are inevitably reflected here (WHO, 2017b; UN, 2019a; Fonseca et al., 2020), albeit sometimes with a delay.

7.1.2 Guiding principle and instrument for implementation: the human right to a healthy environment

Although the guiding principle of ‘healthy living on a healthy planet’ is embodied in the 2030 Agenda and corresponding local, national and regional sustainability strategies, it should also be included in national constitutions, i.e. it should be given legal character. In this respect, the WBGU recommends enshrining the human right to a healthy environment (Boxes 7.1-3, 7.1-4) in Germany’s Basic Law and the EU’s Charter of Fundamental Rights, defined inter alia as a right to healthy and sustainable living conditions, thus contributing to its implementation worldwide. Such a human right not only has an overarching function as a guiding principle, it also empowers individuals and, where appropriate, associations to monitor (inadequate) state measures or state inaction and thus strengthens a bottom-up approach to the implementation and enforcement of urgency governance for ‘healthy living on a healthy planet’.

In 2022, the UN General Assembly recognized the human right to a clean, healthy and sustainable environment (abbreviated to ‘human right to a healthy environment’)

in a non-binding resolution (UNGA, 2022; Boxes 7.1-3, 7.1-4). This symbolic recognition is an expression of the growing awareness of how interconnected humans and nature are and how dependent human development is on an intact environment. However, this is only an intermediate stage in a lengthy negotiation process (Box 7.1-3; Limon, 2022), which now requires the legal enshrinement of this human right by more nation states and regional human-rights agreements, as well as the implementation and enforcement of legal protections

under the ecological human right by governments, authorities and courts.

This is all the more true as resolutions of the UN Human Rights Council and the UN General Assembly do not have any binding effect and therefore do not go beyond the goals of the 2030 Agenda and the SDGs (Section 7.1.1); in fact, they even threaten to fall short of them. Enshrining human rights in national constitutions and regional human-rights declarations with enforcement mechanisms, on the other hand, elevates

Box 7.1-3

Developing the codification of a human right to a healthy environment

In total, at least 155 states are already legally bound under international law by international treaties, constitutions and laws to respect, protect and achieve a healthy environment (Fig. 7.1-1). This means that more than 80 per cent of the member states of the United Nations (implicitly) recognize this obligation (UNHRC, 2019a). However, not everywhere is the right explicitly enshrined in a constitution on an equal footing with other human rights, such as the right to life. Only about 100 constitutions explicitly mention the right to a healthy environment, many of them in so-called developing countries (UNHRC, 2019a). This right has not hitherto been recognized or enshrined in the German legal system or in international human-rights conventions.

The universality of 'sustainable development' (basic principle of the 2030 Agenda) is expressed here: with regard to the human right to a healthy environment, it is not low-income countries that are called upon to develop their legal systems but high-income countries such as Germany, the UK or the USA.

The role of a safe, clean, healthy and sustainable environment in human rights has again been on the international agenda since 2011 and is a focus of activity for the UN Human Rights Council. Since 2018, the UN Special Rapporteur appointed in this context has called for the international recognition of a human right to a safe, clean, healthy and sustainable environment (UNGA, 2018). As a result, the UN Human Rights Council recognized the human right to a healthy environment for the first time in 2021 with its Resolution 48/13. The resolution was adopted with 43 votes in favour; China, India, Japan and Russia abstained. It calls on all states to take this human right into account by implementing appropriate policies, and urges the UN General Assembly to address the issue (UNHRC, 2021a). The UN General Assembly adopted the recommendations of the UN Human Rights Council with abstentions from China, Russia, Belarus, Cambodia, Iran, Syria, Kyrgyzstan and Ethiopia (UNGA, 2022).

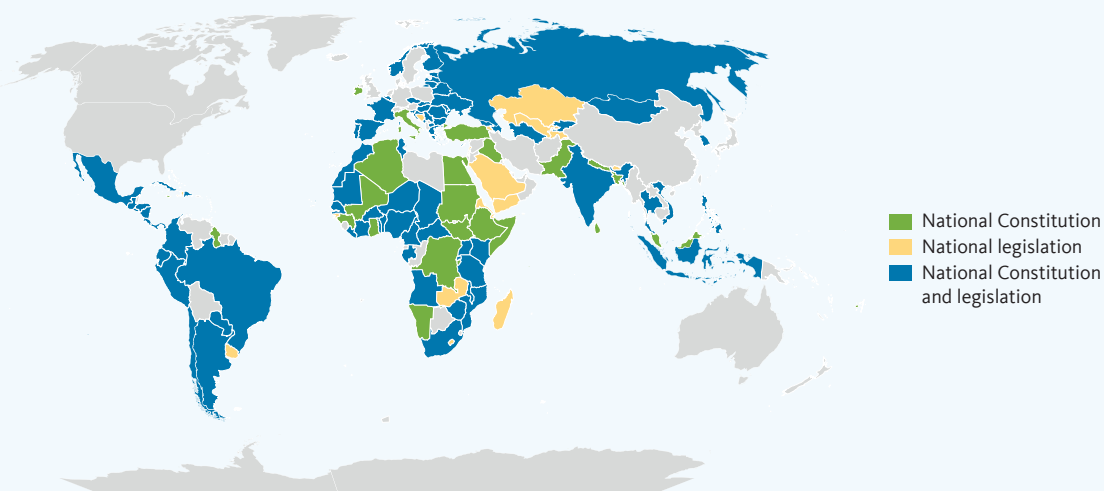


Figure 7.1-1

Overview of states that have already enshrined the human right to a healthy environment in their respective constitution or national legislation. Data from 2017.

Source: WBGU, based on the figures from UNHRC, 2019a

Box 7.1-4**Added value of a human right to a healthy environment for human-rights catalogues**

Enshrining an explicit right to a healthy environment in a nation's constitution leads to environmental protection finding its way into human-rights catalogues as a key determinant of human health.

An explicit right to health is almost always enshrined in international, regional and national human-rights catalogues (e.g. Art. 12 of the International Covenant on Economic, Social and Cultural Rights (ICESCR), a global human-rights treaty). In addition, many determinants of health are covered by human rights. Relevant to global health are, among others, the right to sufficient food, clothing and shelter (Art. 11 (1) of the ICESCR); the right to maternity protection before and after childbirth

(Art. 10 no. 2 of the ICESCR); the right to education (Art. 13 of the ICESCR); prohibitions of discrimination based on sexual orientation, gender, social class (Murphy, 2018: 85); the right to science (Art. 15 of the International Covenant on Civil and Political Rights (ICCPR) (Murphy, 2018: 94). Defence against injuries is part of the right to life under human-rights law (Art. 3 of the Universal Declaration of Human Rights (UDHR)); Art. 6 (1) of the ICCPR.

Ecological determinants are not universally and comprehensively protected under human-rights law, apart from the right to water (non-bindingly recognized by UNGA, 2010) and the right to healthy and safe working conditions (Art. 7 of the ICESCR). Where no human right to a healthy environment has yet been enshrined, the protection of ecological determinants of health must be read into the right to health or the right to life (Vöneky and Beck, 2022: margin number 15.).

human rights to a binding standard for state action. To this extent, there is a need for legal recognition (Section 7.1.2.1). The interpretation of the level and content of protection is crucial if the human right is to become a suitable standard of control. It should include the applicable environmental law in cases where people are affected, a right to healthy living conditions and rights to information, participation and legal protection in environmental matters (Section 7.1.2.2.). A strengthening of civil society, judicial systems and state environmental and health-protection agencies is necessary for implementation (Section 7.1.2.3).

7.1.2.1**Need for legally binding recognition**

A human right to a healthy environment only becomes legally effective when it is enshrined in binding human-rights catalogues or national constitutions with enforcement mechanisms, especially the right to take an issue to court. The UN General Assembly resolution is not binding on the members of the United Nations. Furthermore, important geopolitical powers, such as China and Russia abstained (Tang and Spijkers, 2022).

Although the right to a healthy environment is not a 'silver bullet' against global environmental degradation (UNGA, 2018; de Vilchez and Savaresi, 2023), it contributes – symbolically, as a guiding principle as well as materially and procedurally – to the interlinking, implementation and enforcement of health and environmental protection: with a human right to a healthy environment, the international community symbolically recognizes a model in which human well-being depends significantly on an intact, healthy and clean environment and nature. It thus incorporates the systemic view of One Health or Planetary Health into the legal system. It recognizes the interconnectedness and interrelatedness of every

individual's health with the health of the built-up and natural environment around them. Recognition of this right would support global civil-society movements in their work to safeguard human rights through environmental protection (UNGA, 2018: margin number 59). Moreover, it is a right (an individual claim against the state) that is already embedded in many regional human-rights conventions and constitutions of low-income countries; it thus takes a legal development of non-Western states and scales it worldwide.

More important than the symbolic recognition, however, is the practical added value. As an enforceable right, the human right to a healthy environment can become an important benchmark for realizing a healthy life on a healthy planet. Embedding it in state constitutions or regional human-rights declarations would close material and procedural gaps: in substantive terms, the recognition of a claim strengthens the interests of environmental protection in governmental deliberation processes via health protection. In the environmental field, there is usually no lack of corresponding, simple-law regulations and laws to protect the environment. However, state institutions often do not sufficiently exercise environmental protection as a state task. Far-reaching enforcement deficits, i.e. deficiencies in the application of the law, can already be observed for the environmental sector (World Bank, 2017: 259). Moreover, ecological concerns and, to some extent, health protection have been given too little weight in deliberation processes up to now. A sufficient level of environmental protection is usually not enforceable by individuals because many jurisdictions lack a corresponding fundamental right. For example, in the context of legal actions on climate issues, a positive influence of human rights on a healthy environment has been observed, insofar as these were recognized in the respective legal system, although this

needs to be cautiously assessed (Varvastian, 2019; de Vilchez and Savaresi, 2023). For states and their authorities, a binding duty to protect – and not merely a legal justification for environment-related interventions by the state – is established to bring together environment and health at all levels and areas, especially in the area of decisions that offer creative leeway. Legislators are required to create special regulations to express the vision of ‘healthy living on a healthy planet’. The human right to a healthy environment expresses the importance of environmental protection in securing human rights and may encourage the adoption of more stringent environment-protection laws (UNHRC, 2018 margin number 13) as well as providing a ‘safety net’ for environmental hazards not otherwise already addressed in law (UNEP, 2019a: 157). The recognition of a right to a healthy environment is seen as a comprehensive way to make environmental law and environmental-law principles beneficial for human-rights protection, and to use human-rights protection to enforce environmental law and its principles (Cima, 2022: 39).

Finally, the human right makes it possible for individuals to exercise environmental rights before the courts and to assert them for themselves and the environment. The right to a healthy environment grants individuals the right to complain, even if it cannot be proven in individual cases that their health is affected by environmental pollution, which is why environmental lawsuits have failed up to now. For courts, such lawsuits can make it possible to identify gaps in state environmental protection and its implementation (UNHRC, 2018: margin number 13); these gaps would then have to be closed by legislators taking into account the separation-of-powers principle. The recognition of such a subjective right to environmental protection could promote better access to the courts as well as accountability of courts and other actors (UNEP, 2019a: 159). The human right also benefits environmental justice: today, unhealthy environmental conditions (e.g. noise, air pollution) particularly affect vulnerable groups living in places with poor environmental conditions or those unable to protect themselves from environmental damage (UNGA, 2018: margin number 56). The right to a healthy environment gives them an explicit right to address this injustice.

7.1.2.2

Content of the human right to a healthy environment

Irrespective of whether one recognizes a fundamental right to a ‘clean’, ‘healthy’ or ‘sustainable’ environment, these are highly indeterminate legal terms, i.e. terms that must be fleshed out by interpretation in order to be effective. The content and dogmatic structure of a human right to a healthy environment have already

been developed in a rudimentary form by case law and legal practice in legal systems that have recognized this right (UNHRC, 2019a; Cima, 2022: 44). On this basis, the UN Special Rapporteur on Human Rights and the Environment has presented framework principles on human rights and the environment that could also constitute the content, scope and further parameters of a human right to a healthy environment (UNHRC, 2018; Cima, 2022: 44). The WBGU proposes enshrining the following content in an interpretative guideline, for instance by the UN Human Rights Council, and using it as a basis in national legislations and constitutional amendments.

Materially, the right to a healthy environment in various legal systems covers clean air, a safe climate, healthy and sustainably produced food, a non-toxic environment in which to live, work and play, as well as healthy ecosystems and biodiversity (UNHRC, 2018: 38 ff.). On the one hand, this can involve guarantee obligations undertaken by states, for example for clean air and clean water, as well as rights of defence against specific forms of pollution (UNEP, 2019a: 154 ff.). Following the conception of Article 31 of the European Charter of Fundamental Rights, the measure could be based on already existing international, European and national standards. Courts can fall back on existing thresholds in environmental and health-protection law. This does not improve the standard of protection, so that no further development and distinction from legal action by an association under environmental law is apparent, nor can it be expected. It is therefore important to further develop the level of protection and the instruments of simple environmental law. The incorporation of environmental-law principles into the scope of protection of the human right to a healthy environment could open up a precautionary interpretation of human-rights protection that protects the common good (Cima, 2022: 46 ff.). This includes the protection of nature for its own sake, insofar as it can be established that humans are also affected. However, in order to assert a claim in court, it is likely an individual will have to prove they have been affected. Being affected is conceivable in cases of mental-health consequences of environmental changes, for example as a result of feelings of loss at the disappearance of characteristic species and ecosystems, the loss of a characteristic environment or a near-natural landscape (Section 5.1.4). Whether a person can claim to be personally affected depends on the geographical reference: claims relating to local environmental pollution (e.g. air and soil pollution) are only possible locally, i.e. by the local population before the local courts, invoking the human right to a healthy environment. Regional environmental pollution with transregional impacts (e.g. water pollution, soil sealing) can correspondingly be claimed regionally. However, global environmental challenges, such as climate change,

can also be asserted transnationally-globally, as well as in other countries.

A right to healthy and sustainable living conditions could also be derived from the human right to a healthy environment. The WBGU bases this idea on the importance of external conditions for healthy and sustainable living, which became clear in Chapter 4. A right to healthy and sustainable living conditions is also based on the right to healthy working conditions. It should be possible for people to live healthily for themselves and the planet. A corresponding right includes a responsibility of the state to guarantee healthy as well as sustainable structural prevention (Chapter 4). States would be obliged by this content of the human right to enable (or not to deny) their citizens a sustainable and healthy life. Accordingly, guarantee obligations for sustainable mobility infrastructures, food systems or settlement development could be derived from the fundamental right.

The scope of protection of the human right to a healthy environment can ultimately also be directed towards participatory elements, namely access to environmental information, participation in environmentally relevant procedures and legal protection in environmental matters (UNHRC, 2018: margin number 14–37; Callies, 2021: 328). These rights are enshrined in regional environmental conventions such as the Aarhus Convention and the Escazū Agreement. All the elements of the human right should be adopted by an interpretative guideline of the fundamental right by the UN Human Rights Council or directly expressed in the wording of the human right in the legal instrument.

7.1.2.3

Enforcement requirements

Human rights complement national environmental law and its enforcement, but they do not replace it (UNEP, 2019a: 154). The legal recognition of a human right must also be safeguarded against deficits in implementation and enforcement. Many countries lack the resources and political will to pursue social and ecological rights (UNEP, 2019a: 153). The reference to the historical responsibility of high-income countries for many cases of transregional environmental pollution repeatedly leads to only limited measures being taken by middle- and low-income countries. In order to counteract this potential blockade, it is important that the human right makes contributions to a healthy environment by being enforceable when plaintiffs are affected and based on the defendants' ability to act (agency), not according to which country is involved. It should be noted, however, that every national government has the agency to protect the environment and healthy living conditions in its own country.

To ensure that the recognition of human rights does not remain symbolic politics, it should be accompanied

by an enforcement initiative. This initiative should be directed at strengthening the capacity of civil society, the media landscape, the courts and environmental and health authorities where corresponding deficits exist (UNEP, 2019: 182 ff.). Decisive hurdles can be the risk of litigation costs and representative actions (UNEP, 2019a: 191).

Retain and increase civil society's scope for action

A human right to a healthy environment recognizes the achievements of existing initiatives working for a healthy environment for people, thus expressing appreciation for the commitment of a wide range of civil-society actors and pioneers of change (UNA, 2018: margin number 59).

Civil society is seen as playing a key role in sustainability transformation (Ciplet et al., 2015; UNHRC, 2019c; UN, 2015; WBGU, 2011b). Civil-society actors and organizations can take on different functions, including in particular: generating attention for underexposed issues, contributing to the dissemination of scientific knowledge and to a change in norms, capacity building, engaging in the development of solutions and their implementation, reviewing progress, denouncing undesirable developments, and enforcing valid legislation (Chasek and Downie, 2020; Eilstrup-Sangiovanni and Bondaroff, 2014; WBGU, 2011b). Médecins Sans Frontières, for example, has been combating neglected tropical diseases for decades; the Fridays for Future movement has helped the IPCC's 1.5°C report to unexpected global prominence by, among other things, criticizing inadequate measures to meet climate targets; Sea Shepherd fights illegal whaling.

In the implementation of the human right to a healthy environment, civil society is necessary to raise awareness of the right and its value for human health and the environment. To this end, countries should strengthen a free civil society and media landscape capable of taking action, educate individuals about their rights and support them in enforcing the law (UNEP, 2019a: 182). They can build on, and connect with, the successes of both collective and strategic litigation.

However, civil society's freedom of action is increasingly under threat. Repression is particularly pronounced in the environmental and human-rights sectors and especially affects women and society's minority groups, such as LGBTQI+ persons and people of indigenous descent (CIVICUS, 2022; Global Witness, 2022; UNHRC, 2019c, 2021c; UNGA, 2020). Half of European human-rights NGOs responding to a survey about their experience in 2019 reported having been threatened, both verbally and online; almost 20% mentioned physical attacks against staff or volunteers (FRA, 2020; Fig. 7.1-2). In 2020, more than 200 murders of environmental activists were registered worldwide; most had campaigned for forest protection (Global Witness, 2021; Fig. 7.1-3).

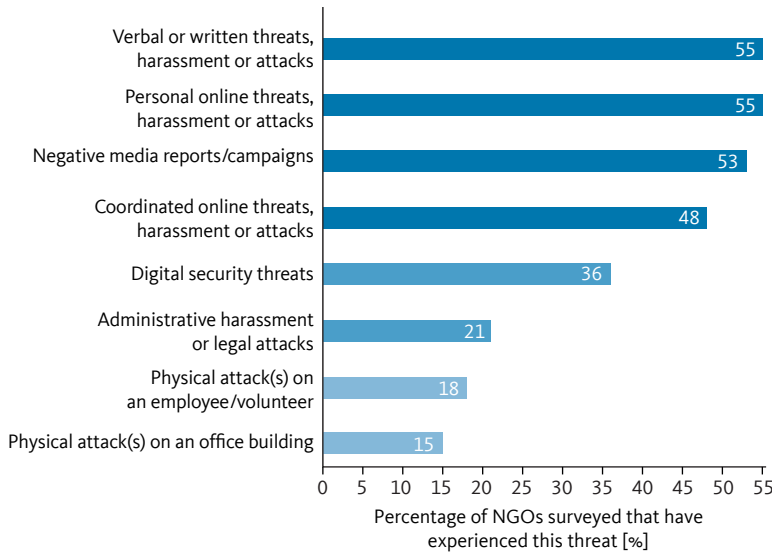


Figure 7.1-2
Experience of threats and attacks in 2019 among NGOs working for human rights in the EU. Multiple choice survey by the European Union Agency for Fundamental Rights. Several answers were possible. 159 NGOs participated in the survey. Source: FRA, 2020

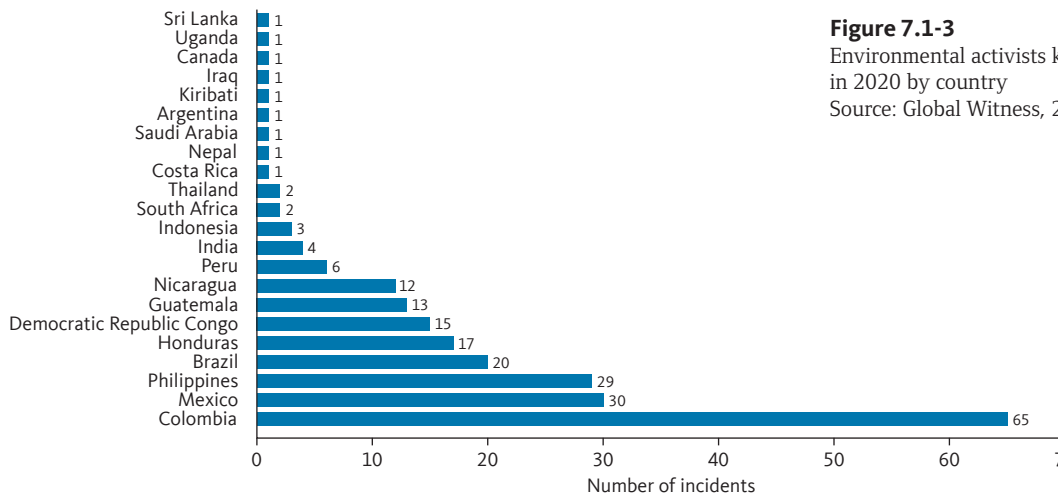


Figure 7.1-3
Environmental activists killed in 2020 by country. Source: Global Witness, 2021

This trend is extremely worrying. It makes it all the more important to preserve and strengthen civil society’s freedom of action, both nationally and internationally. This is indispensable, especially in view of the considerable efforts required to reach the 2030 Agenda goals. The necessary transformations will not succeed without societal support. Accordingly, civil-society initiatives should be highly valued. Democratic states, in particular, should be concerned to set a good example and promote participation and deliberation.

Strengthening of judicial systems, environmental agencies and health-protection authorities

Both judicial systems and state environmental and health-protection agencies need to be better prepared to deal with cases related to the environment. Therefore, further training for courts and special chambers, or even special courts for environmental cases should

be considered to build up appropriate expertise (UNEP, 2019a: 199), and there is a fundamental need for better resources for the relevant authorities. Last but not least, the human right to a healthy environment should serve as an appeal for international cooperation. The promotion and preservation of human and natural health are cross-border issues that call on the international community to develop and expand instruments of transregional solidarity. The international assumption of responsibility in multilateral forums (Section 7.3) and specific alliances (Section 7.4) should be expanded accordingly.

7.1.2.4 Conclusions

In addition to its symbolic and guiding function, the human right to a healthy environment is primarily an instrument in the sense of a rights-based enforcement mechanism. The right should be enshrined at the

7 Global urgency governance

constitutional level, especially in Germany's Basic Law and in the EU Charter of Fundamental Rights. In order for the right to have its full effect, it is crucial to flesh out its scope of protection. The right should be directed not only towards the material preservation and restoration of an environmental quality that has already been legally established in part but also towards environmental information, participation and access to legal protection in environmental matters. It should furthermore – and this is new – be interpreted as a right to healthy and sustainable living conditions in the sense of a right to healthy and sustainable structural prevention. A strong civil society and sufficient capabilities and resources for the judicial systems are basic prerequisites for the legal effectiveness of the fundamental right to a healthy environment.

7.1.3 Cooperative assumption of responsibility

A cooperative assumption of responsibility is a key prerequisite for making the vision of 'healthy living on a healthy planet' possible. This insight is not new: the WBGU has already repeatedly recommended giving it consideration (WBGU, 2020). In order for a transformative dynamic to develop, numerous individual decisions are required that interact to advance the sustainable transformation of economic and societal systems. Given the current urgency, cooperation between states (Section 7.1.3.1) and across policy fields (Section 7.1.3.2) is necessary, and no actor group (Section 7.1.3.3) should shirk its responsibility.

7.1.3.1 Cooperative assumption of responsibility between countries

There is no question that global challenges require intergovernmental cooperation. Recognition of this fact forms the basic motivation for multilateral collaborations in the context of the United Nations and conventions under international law (Section 2.4). Against this background, however, the question of what concrete form this cooperation should take remains a constant point of discussion and negotiation. To what extent will individual countries be obliged to make a contribution to joint problem-solving? What is the basis for defining which states should make transfer payments to support others in solving problems? Two aspects play a key role in answering these questions: who caused a problem and who has the capacity to act? Another important aspect is how different country groups are dealt with: should a binary classification (e.g. division into a group of developing and emerging countries or industrialized countries) or something more nuanced be adopted; should a static

classification be used or a dynamic one that takes progress in economic development into account?

The climate negotiations are a prime example of how politically charged this issue is. Here, there are debates in particular about historical and current greenhouse-gas emissions, the role of emerging economies such as China and India, and the particular vulnerability of small island states and low-income countries. The climate negotiations are characterized by a largely binary and static interpretation of responsibility. It is based, among other things, on the fact that the principle of "common but differentiated responsibilities and respective capabilities" (CBDR-RC) (Art. 3 (1) and 4 (1) of the United Nations Framework Convention on Climate Change (UNFCCC), Art. 2 (2) of the Paris Agreement) has hitherto been interpreted defensively in order to avert a greater assumption of responsibility at the multilateral level. For a long time, the dominant classification was into Annex I and non-Annex I countries. This had been laid down in 1992 in the Framework Convention on Climate Change and only involved emissions-reduction obligations for a small group of countries with historically high emissions and a high income (Pauw et al., 2014). It was not until the Paris Climate Agreement of 2015 that more attention was paid to changed responsibilities for emissions and the need for a transformation of the international community towards greenhouse-gas neutrality, although a division into industrialized and developing countries is still retained here. Changing development pathways are now reflected in discussions on the provision of climate finance in that, although demands are still directed only at industrialized countries, other member states are invited to provide such funds voluntarily. This is an attempt, albeit a tentative one, to overcome the binary and static design of multilateral cooperation on climate-change mitigation.

The principle of "common but differentiated responsibilities and respective capabilities" (CBDR-RC principle) is increasingly being discussed in other policy fields. The Post-2020 Biodiversity Framework (Tomoi et al., 2022) and the negotiations on a pandemic treaty (Section 7.2.2; WHO, 2023) deserve particular mention with regard to the vision of 'healthy living on a healthy planet' (Chapter 3). The CBDR-RC principle is enshrined in Principle 7 of the Rio Declaration (UNCED, 1992a) and in Articles 3(1) and 4(1) of the Framework Convention on Climate Change (UNFCCC, 1992); it is also referred to in Article 2(2) of the Paris Agreement. The CBDR-RC principle was developed to incorporate equity considerations and the special needs of low-income countries into the justification of obligations based on international environmental law, particularly in the climate field (Sands et al., 2018).

Against this background, it should be possible within the framework of urgency governance to agree on a fair

distribution of responsibility based on solidarity that leads to more, not fewer implementation measures. A static, binary view of problem causality and capacity for action does not lead to the desired results, nor does it take sufficient account of the urgency of such global challenges as climate change and the increased occurrence of zoonoses with pandemic potential.

In line with the 'polluter-pays principle', it is essential that the countries that are the main drivers of these challenges assume responsibility. The distribution of responsibility should not be determined statically, but should correspond to the actual dynamics of the problem situation. This is not about removing responsibility from the countries that have historically caused much of the greenhouse-gas emissions or biodiversity loss. However, in view of the fact that global challenges such as pollution by persistent substances continue to be made worse by contemporary actions, all states must face up to their respective and current responsibilities and contribute to a global trend reversal.

In addition to this, the WBGU recommends increasing the focus on individual countries' capacity to act. On the one hand, there are considerable differences in capacity between countries in the different income groups, which are obscured by a division into 'industrialized and developing countries', e.g. in many multilateral processes. For example, there are marked income differences between low-income countries (US\$1,085 or less gross per-capita income) and upper middle-income countries (US\$4,256–13,205, according to the World Bank's 2023 classification). On the other hand, a country's capacity for action should not be viewed exclusively from a financial perspective. Transfer benefits that help other states combat problems can also take different forms. One important example is knowledge-based leadership. While transfer payments are made by states with higher incomes, broadening the view to different forms of agency (capacity for action) opens up perspectives for other constellations of support. In the case of health-policy challenges, a country's capacity for medical-goods production (such as India's) may be particularly relevant. In the spirit of a cooperative assumption of responsibility, the potential of all states to contribute to problem solving through their specific capacity for action, including non-financial capacity, should be exploited.

7.1.3.2

Cooperative assumption of responsibility across policy fields

Institutions, objectives and legal frameworks of environment- and health-protection policy have emerged independently of each other (Section 2.4). At both local and national level, responsibility for individual policy fields such as the environment, health, agriculture or transport is assigned to independent institutions. Sometimes there

is also a further, finer segmentation of responsibilities. At the UN level, for example, in addition to the WHO (Box 7.2-1) and FAO, there is the UN Environment Programme (UNEP), and, in this field, also independent institutions for climate-change mitigation and biodiversity conservation (Section 2.4). This 'silo-like' structure of political, administrative and legal systems is a barrier to the cooperative assumption of responsibility from the local to the international level and is only partially equal to the challenges of the 21st century. In order to address these adequately, an integrated approach is needed that aims for coherence in policy-making and broad participation by government departments. They must all contribute to achieving the common set of goals through their actions.

In both environmental and health policy, there have long been calls to spread responsibility for environmental and health protection across different departments. The Health in All Policies concept, for example, aims to systemically take human health into account in sectors other than the health sector, thus calling for additional accountability outside the health system (Box 7.1-5; SRU, 2023). Health in All Policies is an established concept of intersectoral health promotion that has up to now only been implemented in a rudimentary form and does not particularly emphasize environmental aspects (see Helsinki Declaration (WHO, 2013c), partial implementations internationally and in some cases in Germany, various WHO conferences and declarations).

Since the idea of overcoming the existing fragmented distribution of responsibilities hardly seems realistic and probably not very expedient, it is advisable to ensure a cooperative assumption of responsibility via cross-sectional mechanisms, including mutual information exchange, coordination and participation, as well as the corresponding further-training opportunities from public institutions. Nationally, one important issue is how different government departments coordinate. It is essential – in the sense of a transition from negative to positive coordination (Box 7.1-6) – that coordination is not pursued as a veto process in which measures of other departments are weakened or slowed down, but as a procedure that works towards consultation processes in which transformative measures are worked on together. To manage this leap, it is fundamentally important to raise awareness among the relevant actors, and to have the space to develop inclusive approaches. One example is the cooperation between the WHO, FAO, WOA and now UNEP in the Tri- or Quadripartite (Box 7.1-7). This suggests the importance of thematic prioritization, regular meetings and a focus on promoting action implementation at the national level.

Box 7.1-5**Health in All Policies**

'Health in All Policies (HiAP) describes the strategy of embedding health in all policy areas (Köckler and Geene, 2022). HiAP has been defined by the WHO as "an approach to public policies across sectors that systematically takes into account the health implications of decisions, seeks synergies, and avoids harmful health impacts in order to improve population health and health equity" (WHO, 2013c). The origins of the strategy go back to the founding period of the WHO, whose constitution stated as early as 1946 that governments can only fulfil their responsibility for the health of their populations through appropriate health and social measures (WHO, 2013c). This statement was formulated in more detail at the 30th World Health Conference in 1978, where the Declaration of Alma-Ata was adopted: when 'Primary Health Care' (PHC; Section 6.1.2.2) was defined as a goal of international health policies, the necessity of multi-sectoral action beyond the health sector was mentioned in order to achieve this goal, e.g. including agriculture, education and housing (WHO, 1978). Finally, the Ottawa Charter on Health Promotion adopted in 1986 (Box 3.2-1) defined health promotion as a guiding principle (Section 6.3.2) and introduced the concept of Healthy Public Policy (WHO, 1986). This can be described as an instrument for shaping living environments in a way that promotes health (Geene et al., 2022). The Ottawa Charter addresses many different determinants of health that are influenced by numerous policy fields (Köckler and Geene, 2022); stable ecosystems and the careful use of existing natural resources are also explicitly mentioned here (WHO, 1986). It was stated that "health promotion is not just the responsibility of the health sector, but goes beyond healthy lifestyles" to other policy areas (WHO, 1986).

In the subsequent decades, multi-sectoral health promotion was addressed at numerous international conferences, until the 8th Global Conference on Health Promotion in 2013 in Helsinki finally placed the concept of Health in All Policies on the international political agenda as an approach for action (Trojan, 2020). HiAP was previously taken up at an EU conference in Rome in 2007 (Trojan, 2020). In the Helsinki Statement, HiAP is described as an essential approach to achieving the Millennium Development Goals (MDGs) (WHO, 2013c); later, health and well-being are described by the WHO as a prerequisite for achieving the 2030 Agenda (WHO, 2017g) and HiAP as a practical strategy for achieving the Sustainable Development Goals (SDGs) (WHO, 2017a). The statement in the Ottawa Charter that the responsibility for health promotion lies in all policy areas is reinforced in the Helsinki Statement in terms of a 'whole-of-government' approach, which points to the need for political will to "commit all government action to health" (Kaba-Schönstein, 2018b). At the 9th Global Conference on Health Promotion in 2016 in Shanghai, the whole-of-government approach was then expanded into a dual strategy by combining it with a whole-of-society approach; here, in addition to all policy fields, the whole of society is to be involved in the process of developing 'health for all' (WHO 2017g; Trojan, 2020). Finally, the 2017 Adelaide Statement II on Health in All Policies states: "We recognize that health is a political choice, and we will continue to strongly advocate for health, well-being and equity to be considered in all policies"; this was followed by a description of the importance of health for all 17 SDGs (WHO, 2017a). The 2021 Geneva Charter for Well-being (Box 3.2-1) emphasizes the importance of multi-sectoral policy approaches in the field of health, and a

whole-of-society approach to achieving well-being, but does not mention HiAP explicitly (WBGU, 2022a).

In 2018, the WHO published a detailed report with numerous case studies on the implementation of the HiAP approach in different countries, some of which include references to the health risks of climate change, e.g. the case study on the California HiAP Task Force (Government of South Australia and WHO, 2018). One example of countries where Health in All Policies has already been comprehensively implemented is Thailand, where a nationally binding health-impact assessment of policy measures has been introduced; another is the state of South Australia, which has a comprehensive HiAP strategy that is furthermore scientifically evaluated and closely monitored by the WHO (Geene, 2020). Overall, examples of the use of HiAP can currently be found primarily in countries with public health systems (Box 6.2-1; Geene, 2020).

The 2018 WHO report notes that HiAP is one way to achieve policy coherence for sustainable development (SDG 17.14); it also points out that there is great potential for further advancing the implementation of HiAP globally, especially in relation to existing WHO cross-cutting frameworks, such as the Social Determinants of Health (SDH Action Framework) and the Health and Climate Action Agenda (Government of South Australia and WHO, 2018). In 2017, achieving the SDGs was a key driver for their use of the HiAP approach for only 30 % of the members of the Global Network on Health in All Policies; the issues of climate change and environmental sustainability played a major role for only 20%; by contrast, addressing the social determinants of health played a decisive role for 95 % (WHO, 2018a).

One conclusion drawn from the case studies in the WHO report is that the success of initiated interventions depends largely on the specific context and the ability of the actors involved to reflect on it (Government of South Australia and WHO, 2018). Learning from experience or existing practical examples is assigned an important role by the WHO for the further development and concrete application of the HiAP approach, as is evident from several documents (WHO, 2013b, 2018a); various conceptual aids are made available for the implementation of the approach (WHO, 2013b; 2014a, 2018a). Health risks caused by air pollution are sometimes discussed as examples here (WHO, 2018a). Based on an analysis of various practical examples, Geene states that "there is not so much one key issue for HiAP but rather overarching principles for equitable, sustainable and future-oriented policies" (Geene, 2020).

In Böhm et al. (2020a) the implementation of the HiAP approach in Germany is discussed in detail in relation to various policy fields and on the basis of many practical examples. Obstacles to the implementation of HiAP are, in particular, the resistance of established interests and existing power structures, (supposedly) opposing voter interests and conflicting objectives of the different policy fields involved (Böhm et al., 2020b). In addition, health authorities are not sufficiently involved in political decision-making processes at the municipal level; sectoral ways of thinking and acting and the fact that health goals are not operationalized are identified as further obstacles (Böhm et al., 2020b). On the other hand, it is stated that the implementation of the HiAP approach is advanced if other policy goals can be achieved at the same time with its help, and health is already laid down as a goal in the policy fields involved, e.g. in environmental protection (Böhm et al., 2020b). Civil-society pressure and corresponding opportunities for participation are named as further facilitating factors (Böhm et al., 2020b). Geene (2020) notes that despite broad civil-society commitment and local integration there is often a

considerable lack of supraregional support, “so that initiatives ‘from below’ often fail because of the legal and allocative framework conditions that come ‘from above’” (Geene, 2020). This describes an imbalance within HiAP’s dual strategy, in which a lack of whole-of-government engagement has an inhibiting effect on existing whole-of-society engagement. This insight also led to the demand for a public-health strategy for Germany, for which cornerstones were established by the Future Forum on Public Health (Section 6.4.2.4), which explicitly include the implementation of the HiAP approach, better interlinkage in multi-sectoral health protection and the creation of strong governance structures (Zukunftforum Public Health, 2021). A crucial prerequisite for the dissemination of HiAP is the commitment of the respective political leadership (Geene et al., 2019). For successful HiAP implementation, health professionals also need sufficient policy knowledge on multi-sectoral cooperation, and actors from other policy fields should be familiarized with a salutogenetic understanding of health (Böhm et al., 2020b; SRU, 2023).

According to Böhm et al. (Böhm et al., 2020b), one challenge for the implementation of HiAP is that health seems to be in competition with other issues such as sustainability and social inequality; at the same time, however, they see integrating these supposedly competing issues as an opportunity to focus attention and the resources deployed. The authors see particular potential for HiAP in a combination of health and ecological concerns, i.e. in interweaving environmental protection with health promotion; this would generate added value for both fields (Böhm et al., 2020b). The approach of looking at environmental protection and health promotion in an integrated way from the outset and consistently taking into account and shaping health-promoting conditions for humans, other species and ecosystems in all policy areas has also been discussed more frequently in recent years under the terms ‘One Health in All Policies’ and ‘Planetary Health in All Policies’ (Hancock, 2019; World Bank, 2018; Section 3.3).

7.1.3.3

Cooperative assumption of responsibility by non-state actors

Global governance for healthy living on a healthy planet also requires the participation of, and the assumption of responsibility by, non-state actors, e.g. businesses, civil-society organizations and individuals. The key condition for success of urgency governance is to mobilize the potential of different actors. In German law and other areas, the principle of cooperation applies, which calls for the joint and cooperative implementation of environmental protection by the state and other societal forces.

The assumption of cooperative responsibility by the private sector (Section 7.5) represents a considerable change of course due to its massive financial power and significant influence on resource consumption. The vision of ‘healthy living on a healthy planet’ cannot be realized without the involvement of the private sector. Fortunately, there is a growing momentum towards sustainability transformations in and by companies, and this should be encouraged. It is also important to support businesses and value chains that are at risk of being overwhelmed by transformation processes.

Because the scope for action is currently narrowing for critical civil societies and NGOs worldwide (Section 7.1.2.3), the disclosure of conflicts and their handling of them is essential for transformation processes. Responsibility is often specifically assumed locally, often without state support or economic funding. In this respect, health governance that is less formalized and lived as part of neighbourhood help or through religious organizational structures develops particular importance (IPCC, 2022d). These informal institutions of governance are often only partially integrated into

state systems. However, depending on the presence of state institutions, they are of key importance for engaging the whole breadth of societies in the analysis and treatment of environmental health crises. Especially in countries with less well-developed health systems and where state and market-based rules are less dominant when dealing with environmental and health challenges, religious or family-based traditional and organized systems are more prominent in people’s everyday lives than formalized ones. In parts of Central Asia, for example, neighbourhood organizations (known as mahallas) play a key role in identifying and treating diseases. Particularly in the agricultural sector, these are often related to environmental change, e.g. reactions to highly saline drinking water, or to the effects of fertilisers and pesticides (Jacobs and Baez Camargo, 2020). In parts of Southeast Asia, traditional female healers take on the role of identifying and treating diseases (Box 8.2-1). In disaster situations, informal institutions often play a pivotal role in supporting marginalized or geographically remote communities.

7.1.4

Political, economic and intellectual leadership

Leadership is required today if the cooperative assumption of responsibility is to become possible in the medium term: pioneers of change are needed who promote solutions and inspire others to also get involved. Such leadership can take on various forms, including, in particular, political, economic, knowledge-based and intellectual leadership, although these are not always distinct and can also positively influence each other.

Box 7.1-6**Cooperative assumption of responsibility by national government departments – from negative to positive coordination**

The way in which departments work together and coordinate with each other can contribute significantly to more effective and efficient target achievement. Ideally, contradictions are eliminated, conflicts of objectives and measures are minimized, and synergies are exploited (Wolff and Jacob, 2021). Forms of coordination in administrations can vary in intensity. Metcalfe (1994) identifies nine ideal-typical levels:

1. “Independent decisions: departments make their decisions completely independently of each other;
2. Exchange of information: departments inform each other about their decisions;
3. Consultations between ministries: ministries seek the opinion of other ministries on planned decisions;
4. Avoidance of contradictions: for political decisions and their justifications, contradictions are avoided;
5. Searching for consensus: for political decisions, consensus is sought;
6. Mediation of conflicts: in order to resolve conflicts, ministries commit themselves to dispute resolution mechanisms and recognize the decisions of these mechanisms as binding;
7. Establishment of common parameters: departments agree on common goals;
8. Agreement on common priorities: the goals are prioritized together;
9. Common strategies: in order to achieve the goals, joint programmes and processes for their implementation are agreed upon” (Metcalfe, 1994 quoted from Wolff and Jacob, 2021).

Levels 1–4 represent a quite basic form of cooperation; levels three and four correspond to the principle of ‘negative coordination’ (Scharpf, 2000). In the German context, particular reference should be made to the practice of interdepartmental coordination. Draft measures and positions for international processes are prepared by the ministry in charge and then submitted to the inter-ministerial consultation process, in the course of which the other ministries can introduce changes during the circulation procedure (Flachsland et al., 2021). The consultation thus begins at a late stage and should be understood as a vetoing rather than a deliberation process.

By contrast, levels 5–9 are clearly aimed at deliberation and are characterized by intensive cooperation. It is assumed that this form of exchange enables more transformative actions to be taken that go beyond a minimum consensus and ‘low-hanging fruits’ (Flachsland et al., 2021; Wolff and Jacob, 2021). This more profound cooperation is particularly necessary to address conflicting goals that are merely circumvented in the context of negative coordination. It is also more suitable for defining integrated long-term strategies (Wolff and Jacob, 2021).

At the German level, the ‘transformation teams’ should be highlighted here. At the end of 2022, the Committee of State Secretaries for Sustainable Development decided to set up seven temporary interministerial project groups, six of which are to be entrusted each with one of the six transformation areas of the German Sustainability Strategy and one with international, multilateral and European transformation issues. The impact of these transformation teams remains to be seen. In principle, however, they represent an interesting experiment, and it is to be welcomed that science (in the form of the German Council for Sustainable Development, the Science Platform Sustainability 2030 and the dialogue group on the German Sustainability Strategy) is to be involved..

Political leadership can and should be shown at all levels, from city governments to nation states and the regional, transnational and multilateral levels. There is no shortage of ways in which to work ambitiously for the vision of ‘healthy living on a healthy planet’: a glance at the status quo shows that (inter)governmental action often fails to live up to this vision, and that attempts to try out even potential solutions that have been known for a long time have been inadequate to date (Chapters 2, 4, 5, 6).

It is important to ensure that legislation is in line with political objectives such as mitigating climate change and protecting public health. Likewise, minimum standards should be laid down by legal frameworks and incentives created for a greater assumption of responsibility (Section 7.6). Political decision-makers should lead by example in their respective areas of responsibility and offer new approaches in cooperation with others. Alliance formats like the G7, G20 (Section 7.3) and transnational city alliances are particularly well-suited for doing this. Decisions taken there can in turn trigger change in multilateral forums. Conversely, political leadership at the

UN level also has a positive impact at the national level, as the work of the Tripartite on antimicrobial resistance shows (Box 7.1-7).

Economic leadership can be assumed by different types of actors. Countries can use taxation systems, subsidies and procurement to exert steering power. They should, for example, adjust tax systems in such a way that economic activities with negative societal impacts are comprehensively subject to higher tax rates without causing social suffering; these activities might include the production or consumption of foods containing particularly high levels of sugar, salt and fat, for example (Von Philipsborn et al., 2021; WHO, 2016a; WBAE, 2020). Similarly, tax systems can also take into account the impact of production and consumption on the climate and biodiversity. Subsidies can promote the development and adoption of sustainable technologies and practices, both nationally and across borders. Some states, especially high-income countries, also act as international financiers. This role should be embraced in order to use investments in such a way that they have a beneficial effect on the implementation of the ‘healthy

Box 7.1-7**Tri- and Quadripartite as prime examples of cooperation between UN organizations**

A tripartite is a cooperation between three institutions. The Tripartite of the WHO, FAO and WOAHA is an outstanding example of effective cooperation between three UN agencies. Recognizing the overlap between their respective objectives, the three institutions are united by a long-standing collaboration that has gradually intensified, become formalized and was recently expanded.

First, the increased occurrence of zoonoses such as SARS in the 2000s led to an intensification of cooperation between the three institutions. The focus of the collaboration was on the reduction of infectious diseases at the human-animal-ecosystem interface; the three institutions, together with others, published a strategic framework on this based on the One Health approach in 2008 (FAO, 2008). Cooperation took place at the global level, also in the Asia-Pacific region (Gongal et al., 2020). One result of this regional cooperation was, for example, the publication of a guide to promoting synergies between national health and veterinary sectors (WHO, FAO and WOAHA, 2008).

In 2010, the three institutions formalized their cooperation under the name of the 'Tripartite'. Cooperation continued to be pursued both at the global level, e.g. through annual executive meetings, and at the regional and national levels, with the aim of helping member states to implement measures (WHO, FAO and WOAHA, 2010). A year later, the Tripartite identified three priority areas: antimicrobial resistance, rabies and zoonotic influenza. These were to be pursued in the context of the 'One Health' approach (WHO, 2017).

In the following years, the issue of antimicrobial resistance (AMR) in particular gained importance. A cornerstone here was the adoption of a global action plan (WHA, 2015b). This made the issue more globally present: in 2016, a political declaration on AMR was adopted on the margins of the UN General Assembly; UNEP addressed AMR in a report on emerging environmental issues in 2017 and published a major report on the environmental dimension of the problem in 2022. After the G7 had already put the issue on the agenda in 2021, the German Federal Government made AMR a priority of its G7

presidency in 2022. By early 2021, 143 countries had drafted national AMR plans (WHO, FAO and WOAHA, 2021) and most of the plans reflect the Tripartite's guidelines with a view to applying a One Health approach to AMR mitigation, with less attention paid to the environmental aspect and more to human and animal health (Munkholm et al., 2021; Overton et al., 2021). The Tripartite's regular monitoring shows progress in the implementation of AMR measures, including, for example, training for human and veterinary health professionals (WHO, FAO and WOAHA n. d.; WHO, FAO and WOAHA, 2021). In addition, the global decline in antibiotics consumption points to the effectiveness of the Global AMR Action Plan (Khouja et al., 2022).

One weakness of the Tripartite was its lack of environmental focus. To address this, UNEP was involved in the development of the AMR work plan 2019–2020 (WHO, FAO and WOAHA, 2019), and in 2022, the Tripartite was expanded to a Quadripartite through the formal inclusion of UNEP as a fourth institution (WHO, FAO, WOAHA and UNEP 2022a). This expansion joins the general efforts of the One Health movement to overcome the strong veterinary focus that had shaped the emergence of the One Health approach (Barrett and Bouley, 2015). These efforts are also reflected in the One Health definition adopted by the One Health High-Level Expert Panel in 2022 (Section 3.3). The Quadripartite adopted a joint One Health action plan in 2022, according to which the four institutions intend to address endemic zoonoses, neglected tropical diseases and vector-borne diseases, food safety and biodiversity protection, among others, in addition to AMR (WHO, FAO, WOAHA and UNEP, 2022b). Another issue to be addressed by the Quadripartite at the UNEP's request is the nexus between animal welfare, the environment and sustainable development (UNEP, 2022). This increased attention to the ecosystem dimension of health is an elementary building block of the vision of 'healthy living on a healthy planet' (Chapter 3). In the WBGU's view, prevention and precaution should be placed at the forefront of the Quadripartite's work.

The Tri- or Quadripartite provides an impressive example of inter-institutional cooperation that emerged from the window of opportunity provided by an epidemic, and has made an impact as a result of regular meetings, the setting of thematic priorities and a clear focus on national implementation opportunities.

living on a healthy planet' vision. Here it is especially important to stop biodiversity loss and the promotion of fossil-fuel extraction (Section 5.1.1). Furthermore, sustainability measures in low-income countries should be promoted in a way that does not contribute to increasing these countries' level of indebtedness (Section 7.5). In view of relatively limited public funds, however, it is vital that companies and investors also take on economic leadership to implement this vision. Civil-society movements can provide important impetus for exiting unsustainable investments.

Knowledge underpins all target-oriented change. Accordingly, knowledge-based and intellectual leadership plays a key role in the context of the transformations

towards sustainability that need to be addressed to preserve the long-term health of people and nature (Chapter 8). This includes science-based, intelligently sound leadership as well as empirically solidly informed and analytical leadership that makes the issues clear: it is about dealing with the major global challenges in the interest of sustainable futures for the people on this planet. The COVID-19 pandemic has once again highlighted the contribution made to crisis management by well-equipped science and innovation systems. However, knowledge-based, intellectual leadership can also be developed by other actors on the basis of experiential knowledge. Especially actors with comparatively little political and economic power, such as indigenous peoples

7 Global urgency governance

and local communities, have a wealth of experience that should be used for the implementation of the ‘healthy living on a healthy planet’ vision. In the context of the cooperative assumption of accountability, it is important to provide platforms for the development of empirically astute, reflective and analytically strong leadership. These platforms can be used to share experience (of successes and failures) in order to accelerate the necessary transformations by disseminating and scaling up meaningful innovations.

7.1.5 Urgency governance as a mandate for Germany’s Federal Government

Urgency governance means that the German Federal Government should now show leadership and actively introduce the 2030 Agenda as an international mandate for action enshrining the human right to a healthy environment in conventions and constitutions, and promoting a form of cooperation across transformation fields with the necessary forcefulness in all upcoming international, European and national processes and decisions. What this may look like will differ depending on the area. The WBGU considers the following forums to be particularly important.

The COVID-19 pandemic has opened a window of opportunity at the WHO to further develop international cooperation on global health. This window should be kept open and the reform of the International Health Regulations (IHR) and the negotiations on a pandemic treaty should be used to boost the content of One Health and Planetary Health and prioritize the health systems of WHO member states (Section 7.2; Box 7.1-7). Section 7.3 analyses a strongly integrated regional alliance: the EU. Other state alliances outside the UN system offer further opportunities to assume leadership in international negotiations (Section 7.4). Cooperative responsibility and leadership are also needed in the generation of international funding (Section 7.5). As an example of an international forum with currently particularly high dynamics, the WBGU examines possibilities for setting up governance measures on corporate responsibility for sustainability transformations in the sense of “healthy living on a healthy planet” in Section 7.6.

7.1.6 Recommendations for action

Assume leadership for urgency governance

The WBGU recommends that the German Federal Government should now show leadership in the form of urgency governance and, first, actively introduce the 2030 Agenda as an international mandate for action, second, anchor the guiding principle of the ‘human right to a healthy environment’ in conventions and constitutions, and, third, promote a form of cooperation across transformation fields with the necessary weight in all upcoming international, European and national processes and decisions (‘cooperative assumption of responsibility’).

SDG Summit and Summit of the Future: initiate the 2030 Agenda as a mandate for action and as a post-2030 process

The SDG Summit in September 2023 should send a clear signal on strong multilateralism and on the importance of the 2030 Agenda as a political framework for orientation and action by a global community that is again more focused on its common concerns. The preparation process for the Summit of the Future in 2024 also offers an opportunity to formulate initial ideas for a perspective beyond 2030. In the further implementation of the 2030 Agenda and with a view to a post-2030 perspective, the linkages between the individual SDGs and the increasingly important transformation areas, particularly with regard to the environment, climate and health, should be emphasized more strongly and brought into focus in conjunction with the promotion of inclusive, transparent governance (SDG 16). In this context, as part of the G20 negotiations Germany, together with France, Italy and the EU, should support the SDG stimulus for a financial package to be initiated by the G20 for globally balanced SDG implementation, which was proposed by Secretary-General Guterres (UNSG, 2022). As regards the stimulus, special focus should be placed on the interfaces between environmental and climate change and human health in line with the vision of ‘healthy living on a healthy planet’.

Effective implementation through more coherent policy, improved framework conditions and intensified partnership-based cooperation

In line with the universality concept of the 2030 Agenda, the instruments of implementation, cooperation and review must also be significantly strengthened and oriented towards countries at all income levels. An important component here is the further development and application of structural-policy approaches, both in the inward-looking sustainability policies of Germany and

the EU, and in the outward-looking policy fields. In the field of international cooperation and development, this means consciously using project-financed formats in a transformative, structure-building way. This requires further expanding the development of cooperation projects based on reciprocal partnership relations.

Set strategic priorities for the 2030 Agenda that are oriented towards synergies

To ensure an effective and country-specific implementation of the 2030 Agenda’s complex system of goals, strategic priorities should be set (‘SDG Transformations’; UN, 2019a). Their design and implementation – in the case of the German sustainability strategy, the implementation and further development of the transformation areas – should take special account of linkages and common causes of problems between environment and health and corresponding synergies in approaches to solutions. This can make it possible for resources to be channelled more efficiently and across government departments; it can also focus political attention, increase commitment, and facilitate societal communication and participation.

Emphasize synergies between the environment, health and other SDGs in the communication of the 2030 Agenda

Emphasizing the guiding principle of ‘healthy living on a healthy planet’ (Chapter 3) and the synergies between environment, health and other SDGs can significantly increase the communicability and political attractiveness of the 2030 Agenda by making it more tangible and relevant to most people.

Support low-income countries in implementing the 2030 Agenda

This would also put them in a better position to play a decisive role in shaping prospects beyond 2030 and is a prerequisite for finding the necessary global solutions. The above-mentioned SDG stimulus proposed by Secretary-General Guterres lends itself to this idea, especially as a joint project to be launched by the G20. However, reciprocal learning processes should also be included, as richer countries could also learn from poorer ones and/or benefit from their perspectives in their own policy-making.

Guiding principle and instrument for implementation: human right to a healthy environment

The human right to a healthy environment is effective when it is embedded as a binding legal norm in state and regional human-rights catalogues, and when individuals can enforce it through the courts (e.g. as a constitutional complaint).

The WBGU recommends:

- › A human right to a healthy environment should be included in national constitutions and regional human-rights catalogues, especially in Germany’s Basic Law and the EU Charter of Fundamental Rights.
- › The judicial or extrajudicial enforcement of this individual right should be guaranteed. It is necessary to strengthen civil society, environmental authorities and courts, to make the law (better) known and to remove barriers to access the courts.
- › The precise content of what the right entails should also be enshrined either in the text version or in guidelines on interpretation. First, compliance with environmental law should be covered in cases where people are themselves affected, whereby regarding global environmental changes, such as climate change, a global concern must also be assumed. Second, procedural rights such as participation, environmental information and legal protection should be covered. Third, the right should extend to healthy and sustainable living conditions that enable people to live sustainably and in a way that promotes health.
- › Finally, there is a need for an evidence- and risk-based approach to setting adequate levels of protection; ideally, these should be harmonized by an internationally recognized institution and controlled and specified by national courts.

Strengthen the cooperative assumption of responsibility

In addition to this, the WBGU recommends increasing the focus on individual countries’ capacity to act. On the one hand, there are considerable differences in capacity between countries in the different income groups, which are obscured by a binary division into ‘industrialized and developing countries’, as in many multilateral processes. For example, there are marked income differences between low-income countries (US\$1,085 or less gross per-capita income) and upper middle-income countries (US\$4,256–13,205, according to the World Bank’s 2023 classification). On the other hand, a country’s capacity for action should not be viewed exclusively from a financial perspective. Transfer benefits that help other states combat problems can also take other forms. One important example is knowledge-based leadership.

What is needed is a willingness on the part of high-income countries to co-create solutions on an equal footing with low-income countries. Furthermore, country-specific ‘meta-indicators’ for environment and health should be developed. It would also make sense to set priorities within the 2030 Agenda’s complex system of goals that are oriented towards synergies. Finally, low-income countries should be supported in implementing the 2030 Agenda.

7 Global urgency governance

Further steps towards a cooperative assumption of responsibility can be as follows:

Promote national and international cooperation across policy fields

- In order to strengthen the cooperative assumption of responsibility within governments, positive coordination mechanisms between government departments should be established, evaluated and further developed. The mutual participation of relevant units in multilateral negotiation processes (e.g. of the BMUV in WHO negotiations) can be used to promote capacity building, information exchange and synergies. Building on this, negotiation spaces should be initiated within multilateral processes in order to offer room for the discussion of cross-references between environmental and health issues. In addition, following the Quadripartite model (WHO, FAO, WOA and UNEP), joint working groups can be set up to develop strategies on priority issues and monitor their implementation.

There are a number of topics at the environment-health interface on which inter-institutional cooperation at the UN level would be particularly useful:

- *Nutrition*: In order to promote healthy, resilient and sustainable food systems (Section 4.1), it would be a good idea to set up an exchange between the FAO, WHO, OIE, UNFCCC, UNCCD, CBD, the International Fund for Agricultural Development (IFAD) and the Committee on Food Security (CFS).
- *Zoonoses*: Cooperation on the issue of zoonoses should be promoted between the Quadripartite and the CBD and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), also with a view to the negotiations on a new pandemic agreement (Section 5.1.2; Section 7.3).
- *Plastic*: Here, cooperation would be meaningful between UNEP, WHO, UNFCCC, CBD, the chemical conventions and the Oceanographic Commission of the United Nations Educational, Scientific, Cultural and Communication Organization (UNESCO-IOC); this should also be promoted against the background of ongoing negotiations on a new plastic waste treaty.
- *Cities*: On this issue, cooperation should be initiated between the United Nations Human Settlements Programme (UN-Habitat) with WHO, UNFCCC, and CBD (Section 4.3; Section 5.1.2).

Establish a new framework for economic activities

Economic leadership by different types of actors should be encouraged and supported to realize the vision of 'healthy living on a healthy planet'. Countries should create corresponding frameworks for economic activities, i.e. targeted taxation, regulatory interventions and subsidies,

to exert the right steering power for the environment and health. Processes should be initiated internationally to coordinate taxation systems, e.g. for a minimum tax on fossil fuels in a similar way to agreements on the minimum taxation of companies, and to abolish or redirect subsidies that are harmful to the environment and health. International barriers to the financing of environment-friendly and health-promoting measures should be overcome and incentives created for the international mobilization of the required private capital.

Human-resources policy: further training for decision-makers

In all public administrations, whether local, national, European or in international organizations, a human-resources policy should be established that enables staff and decision-makers to work and make decisions systematically. As in the case of further-training measures on topics such as corruption prevention, which are already standard at the national and UN level, civil servants and members of parliament should be provided with basic knowledge on the environment-health nexus. France is already setting a good example here.

7.1.7

Research recommendations

Accompany the development and implementation of urgency governance scientifically

The WBGU recommends accompanying the development and implementation of urgency governance scientifically, in the sense of a real-time monitoring.

Scientifically evaluate national implementation of the 2030 Agenda

National implementation processes for the 2030 Agenda and/or the governance structures used for this purpose should be systematically monitored scientifically and compared internationally in high-income, middle-income and low-income countries (Biermann et al., 2022c). One focus could be the guiding principle of 'healthy living on a healthy planet'. In concrete terms, however, the aim here is to examine successful transformation instruments in one local context in terms of their implementation requirements (technological, economic, social, institutional) and to compare them with conditions in other countries. The aim must be to develop transformation instruments that can be individually adapted and applied in different contexts.

For example, it would currently be necessary to empirically examine the 'Just Energy Transition Partnership' instrument, which was agreed with South Africa

at COP 26 in Glasgow, and has since been extended and signed in a slightly adapted form with Indonesia and later Vietnam at COP 27 in Sharm el-Sheikh, and negotiated with Senegal (Hege et al., 2022; Thompson et al., 2022). The aim would be to determine its structural implementation requirements in a local context and possibilities for context-specific adaptation depending on local societal, ecological and economic conditions and in the respective actor structures. On this basis, the instrument will then need to be further developed to secure the signatures of additional countries.

One example that should be mentioned in the area of transformation efforts for a more sustainable positioning of the global health landscape is the establishment of production facilities for vaccines and other pharmaceutical products in four African countries (Ghana, Senegal, Rwanda and South Africa), with support from German bilateral cooperation, multilateral channels and substantial private-sector involvement by vaccine manufacturers. Here, too, systematic empirical-scientific monitoring is recommended, to allow conclusions to be drawn for comparable projects in other countries.

Explore specific rights-based approaches

As the UNEP states, further research into specific rights-based approaches is needed to enable sovereign actors and civil society to take action in an informed manner (UNEP, 2019: 181). How effective are rights-based approaches and how can they be made more effective? Furthermore, studies are needed on how a right to healthy and sustainable living conditions can be defined in terms of content, granted by the state and enforced in court. In this area, transformative research projects are also recommended which, on the one hand, reinforce structures for the implementation of human rights and, on the other, explore how these can be effectively strengthened in different societal contexts.

Develop forms of cooperative assumption of responsibility

Enabling ‘healthy living on a healthy planet’ requires a cooperative assumption of responsibility. This requires cooperation between states and across policy fields. There is a need for research on the design of a cooperative assumption of responsibility, especially under the conditions of the *Zeitenwende* (turning point), which make cooperation difficult, and the strongly diverging international interests of actors. Such research projects should be international and culturally and geographically diverse in their composition.

Evaluate the increase in complexity of political processes

Cooperative assumption of responsibility requires reciprocal information sharing, coordination and the participation of employees of national or international institutions by creating or strengthening cross-cutting mechanisms. Nationally, one important issue is how different government departments coordinate. The establishment of cross-cutting mechanisms confronts political processes and the individuals designing them with a further increase in complexity in their work processes, which makes corresponding evaluations necessary. There should be studies on how to organize and improve coordination processes where people work together on transformative measures.

7.2 WHO: international cooperation for ‘healthy living on a healthy planet’

As a specialized agency of the United Nations, the WHO is the key multilateral institution of global human health governance. Within its framework, countries around the world organize their cooperation in areas such as health protection, setting norms and standards for the health sector, and/or financial and capacity-building support for low-income countries; the WHO is also a partner in various multi-stakeholder initiatives. In addition to philanthropic actors such as the Bill and Melinda Gates Foundation or the Rockefeller Foundation, public-private partnerships such as the Joint United Nations Programme on HIV/AIDS (UNAIDS), the Global Fund to Fight AIDS, Tuberculosis and Malaria (Global Fund) and the Vaccine Alliance (GAVI) are particularly involved (Section 7.4.2). The WHO is seen as an important international actor, providing a binding framework for government action, as well as authoritative guidelines for understanding and dealing with specific problems (von Bogdandy, 2020). Articles 19 and 21 of the WHO Constitution explicitly provide for the possibility of enacting international health law within the framework of the WHO.

The WHO’s overarching goal is “the attainment by all peoples of the highest possible level of health” (Art. 1 of the WHO Constitution). To this end, its role is to act as the leading and coordinating body of international health and to “establish and maintain effective collaboration with the United Nations, specialized agencies, governmental health administrations, professional groups and such other organizations as may be deemed appropriate” (Art. 2 of the WHO Constitution). The WHO sees itself as a leading force for a transformative agenda that helps countries achieve the health-related SDGs (WHO, 2019a: 1). Synergies with other SDGs are also to be sought and to be realized.

The WHO's highest decision-making body is the World Health Assembly (WHA), where the member states meet once a year to decide on details of the WHO's work. According to Articles 19 and 21 of the WHO Constitution, the Assembly of Member States of the WHO has far-reaching legislative authority – which up to now has only been used for the Tobacco Convention and the International Health Regulations (Box 7.2-2; Section 2.4). Unlike the currently widespread non-binding recommendations (Art. 23 of the WHO Constitution), such legal acts are binding under international law.

Compared to the environment sector, hardly any agreements that are binding under international law have been concluded in the health sector (Section 2.4). Whether this means that a quantitatively and qualitatively lower level of protection exists cannot be clearly determined in view of the increasing willingness of states to comply with soft law as laid down in particular by the WHO, and the glaring deficits in the implementation of binding obligations. Certainly, soft law has the disadvantage that there is no obligation on the part of the ratifying states to comply, and therefore no obligation to implement its provisions nor any basis for enforcing them in the courts. In this respect, scientifically justified demands for an expansion and increase in the significance of binding international law within the framework of the WHO have been made time and again (Gostin, 2014; Nikogosian and Kickbusch, 2016). The WHO already includes mitigation of and adaptation to climate change, biodiversity conservation and pollution reduction in its programmatic work (WHO, 2020i; Box 7.2-1).

Nevertheless, given adequate financial and human resources, aspects of Planetary Health and One Health can and should attain greater importance in the WHO's work (Section 7.3.1) and be used in ongoing legislative processes, particularly in the development of the pandemic treaty (Section 7.3.2).

7.2.1

Integrate the vision of 'healthy living on a healthy planet' in the WHO

In order to implement the vision of 'healthy living on a healthy planet', standards and indicators for an integrating perspective on healthy people and healthy nature need to be developed (Section 7.1.1.2). These should be based on the concepts of Planetary Health and One Health, and build on existing indicators such as those of the SDGs (Strupat et al., 2022a; Pongsiri et al., 2019). The WHO plays an important role in setting standards and creating indicators in the health sector with its recommendations, guidelines, strategies and action plans; these are usually issued as soft law pursuant to Article 23 of the WHO Constitution. The WHO guidelines for healthy behaviour and healthy conditions for different areas of life are one example. They contain standards for what is considered healthy, e.g. recommendations on physical activity. These standards should be linked to lifestyle-change requirements in the spirit of more sustainability. One positive example here is the Global Action Plan on Physical Activity, which takes an integrated view of healthy and sustainable physical activity (WHO, 2018d; Box 4.2-2). Such integration should not only be reflected in policies, recommendations and guidelines; specific programmes and measures should also be developed to promote implementation. The Geneva Charter for Well-Being (WHO, 2022a) also points in this direction.

In addition to the content-related integration of Planetary Health and One Health topics, further coordination mechanisms on interface topics with other international organizations should be established in the sense of a co-operative assumption of responsibility (Section 7.1.3.2). The WHO, as a member of the so-called Quadripartite,

Box 7.2-1

The WHO strategy on health, environment and climate change

A guiding function for the integrated design of global health and sustainability policy is carried out by the 'WHO global strategy on health, environment and climate change: the transformation needed to improve lives and wellbeing sustainably through healthy environments', adopted in 2020 (WHO, 2020d). It describes six strategic goals for improving human quality of life and well-being through a healthy environment. These include:

1. Primary prevention: to scale up action on health determinants for health protection and improvement in the 2030 Agenda for Sustainable Development.

2. Cross-sectoral action: to act on determinants of health in all policies and in all sectors.
3. Strengthened health sector: to strengthen health-sector leadership, governance and coordination roles. This includes stricter cross-sectoral, systemic measures (e.g. air quality/climate-change mitigation), better dovetailing of health and environmental policy (traditional health systems alone cannot cope with this task) and embedding the topic of health in all policy areas (Health in All Policies approach).
4. Generating international attention and support, especially by anchoring the issue in high-level political forums and international agreements.
5. Enhanced evidence and communication: to generate the evidence base on risks and solutions, and to efficiently communicate that information to guide choices and investments.
6. Integrative environmental and health monitoring.

is already promisingly active in overarching coordination with other UN agencies (Box 7.1-7). Capacities and resources for these activities can be developed, but should also be subject to evaluation. In particular, intersectoral cooperation could be used to set up integrated early-warning systems, establish global health surveillance based on global health indicators and methodology, and effectively address cross-sectoral challenges such as antimicrobial resistance, food insecurity and climate change (Ruckert et al., 2021; Section 7.1.3.2).

It is foreseeable that the WHO as an institution will face challenges in the coming decades as a result of the interaction of environmental and health crises (syndemics). This makes it all the more important to use ongoing reform processes to boost institutional robustness. Strengthening the WHO thus means strengthening global health governance (Gostin et al., 2019). Yet funding the WHO has been a challenge for decades: compulsory annual contributions from member states, which are calculated in proportion to the GDP of each country, have covered an ever smaller share of the WHO budget over the years, e.g. only 16% in the 2020–2021 budget cycle (WHO, 2022i). The rest is financed by voluntary payments. These are made both some states and some non-state actors. In 2020–2021, the Bill and Melinda Gates Foundation was the second-largest donor to the WHO after Germany (WHO, 2021a). The problem of increasing dependence on voluntary, often earmarked payments is not exclusive to the WHO – many international cooperation organizations are affected (Eichenauer and Reinsberg, 2017). However, it has become particularly striking at the WHO due to the large disparity between

compulsory and voluntary contributions and the weight of non-governmental donors (Gulrajani et al., 2022).

Against this background, the WBGU welcomes the WHA's decision to implement the recommendations of the Working Group on Sustainable Financing (WHO, 2022b, q): in particular, the increase in membership fees, which aims to cover half of the total basic programme segment by 2030–2031 (based on 2022–2023), will create more independence from private donors. In addition, a replenishment mechanism should be set up, as practised by the Global Environment Facility, for example. Member states and other donors are encouraged to cover the basic programme segment with non-earmarked voluntary contributions. As the WHA itself stated in its decision, the collective willingness of member countries to provide funding must be in line with the demands they make on the WHO (WHA, 2022).

7.2.2

Take advantage of the window of opportunity offered by the pandemic treaty

In November 2021, WHO member states set up a negotiating group for an international legal agreement on pandemic prevention, preparedness and response as a reaction to the COVID-19 pandemic (WHA, 2021). The current negotiations on the 'international pandemic treaty' aim to adopt a framework agreement, an international treaty or some other instrument (WHO, 2023). Which aspects will ultimately be included in the agreement is still open (early 2023), especially because of the need

Box 7.2-2

The International Health Regulations and their reform

The International Health Regulations (IHR) of 2005 (WHA, 2005) form the core agreement for the international fight against communicable diseases, and are binding under international law for 196 states, including all 194 WHO member states (Gassner, 2021). The IHR regulate the establishment of national surveillance systems and the provision of information on relevant outbreaks. It is therefore more about early information on outbreaks of communicable diseases than about their prevention or control. Of course, all countries should prepare for possible epi- or pandemic outbreaks. In addition, the WHO's special competences are regulated by the IHR, and these apply when the WHO declares a health emergency of international concern.

The IHR focus in particular on the identification of pathogens and do not adequately regulate the control of an epidemic/pandemic that has already spread internationally.

During the COVID-19 pandemic, WHO member states found that the IHR were too narrow in their regulatory scope and had significant enforcement deficits, some of which had already become evident during other disease outbreaks in the last 20 years, e.g. SARS 2003 and Ebola 2014–2016 (Taylor et al., 2022: 83; Villarreal, 2017: 246; Sirleaf and Clark, 2021). Not only the normative weakness of the regulations – due to a lack of member states' willingness to comply – became clear but also the WHO's political and institutional challenges (Burci et al., 2022).

Reform of the IHR

The IHR are to be reformed on the basis of Article 55 of the IHR at the 77th session of the World Health Assembly in May 2024 (WHA, 2022). The working group on IHR reform has received 307 reform proposals from the member states (WHO, 2023a). The demands include an improvement in and/or digitization of the exchange of information, an improvement in monitoring and reporting systems, the establishment of better compliance, and a more strongly coordinating WHO with more authority vis-à-vis the member states (WHO, 2023a).

7 Global urgency governance

to differentiate from and supplement the International Health Regulations (Box 7.2-2) and global agreements on nature conservation (e.g. CBD and CITES), which are also under revision. This opens a window of opportunity in several respects. Binding international law in the health sector can be strengthened and environmental aspects can be integrated. In addition, the agreement can be used to generate the political will to implement overarching solution strategies in the health sector and beyond, e.g. strengthening the One Health approach, establishing efficient health systems with a stronger focus on health promotion, and strengthening international cooperation on nature conservation.

To take advantage of the window of opportunity, pandemic cooperation should start from a broad understanding on issues ranging from pandemic prevention to cooperation in post-pandemic recovery (Section 7.2.2.1). With regard to institutional design, there should be efforts to find a sensible division of tasks between nature-conservation conventions, the International Health Regulations (Box 7.2-2) and the pandemic treaty; compliance, funding and inter-institutional cooperation should be secured (Section 7.2.2.2).

7.2.2.1

Elements of international cooperation on pandemics

According to its working title, the pandemic treaty aims at pandemic prevention, preparedness and response; the preparatory documents also include post-pandemic recovery and the recovery of health systems after pandemics (WHO, 2022n; WHO INB, 2023). This comprehensive approach is to be welcomed. While pandemic preparedness and response are established concepts of international cooperation and already the subject of the IHR, the aspect of pandemic prevention is only beginning to be conceptualized and has not yet been given final shape in international cooperation. Post-pandemic recovery is also a potentially new element of international negotiations. In the negotiations on the pandemic treaty, equity considerations are also of particular importance, as shown by the demand that the principle of common but differentiated responsibilities and capacities be recognized in the treaty.

Pandemic prevention

The WBGU recommends interpreting pandemic prevention broadly by adopting a long-term perspective that also includes the promotion of the resilience and development potential of people and nature (Section 3.1).

Pandemic prevention should include ‘spillover prevention’ (prevention of transmission across species boundaries) (Section 5.1.1.2). The One Health High Level Expert Panel (OHHLEP), which was commissioned

by the Quadripartite of the WHO, FAO, WOA and UNEP (Box 7.1.7) to propose a definition for the prevention of so-called zoonotic spillovers, defines spillover prevention from animals to humans as primary prevention of infectious diseases, shifting the focus of action from reactive to proactive prevention. This form of prevention includes the reduction of drivers of disease occurrence, i.e. environmental, weather-related and anthropogenic factors and activities that promote spillover. Such measures require biosurveillance of natural hosts, humans and the environment to better understand pathogen transmission and develop appropriate responses (OHHLEP, 2023). Spillover prevention thus reduces transmissions of particularly dangerous pathogens between animals and humans with the aid of Planetary Health approaches, One Health approaches and zoonotic risk assessments (Phelan and Carlson, 2022; Vinuales et al., 2021; Strupat et al., 2022a). This means that global environmental crises such as climate change, biodiversity loss and pollution need to be addressed effectively, as do other drivers of land-use change such as food insecurity, poverty and socio-economic inequality (OHHLEP, 2023). Spillover-prevention measures are mainly related to nature conservation and have corresponding benefits that go hand in hand with biodiversity-conservation objectives (Section 5.1.3). Up to now, they have not been regulated by the IHR (Labonté et al., 2021; Vinuales et al., 2021). In the sense of a One Health approach, animal health and human health should be thought of together in their interdependence and interaction with environmental changes, such as land-use change and climate change (Ruckert et al., 2021).

In addition to spillover prevention, health promotion should be mentioned as an element of pandemic prevention. Pandemic prevention in a broad sense should also focus on ensuring that people and animals are as healthy as possible so that they can cope with new pathogens as well as possible. To achieve this, health systems and living environments must be designed to be as health-promoting as possible (Chapter 4; Chapter 6). The focus should not only be on preventing human and animal diseases, but also on enabling healthy and sustainable lifestyles. In this sense, pandemic prevention not only includes the dissemination of vaccines for diseases that are already known (WHO, 2022j), but also designing and planning healthy living environments both inside and outside settlement areas. This point is not pandemic-specific, but can also be strengthened by a pandemic treaty.

Pandemic preparedness

Effective pandemic preparedness depends on planning processes that involve not only the health sector but also all relevant public and private actors. In this

way, measures are negotiated, defined and tested to ensure that a new or known pathogen with epidemic or pandemic potential does not spread. To achieve this, monitoring and reporting systems must be in place – locally, nationally, across borders and internationally. The standardization of reporting and early-warning systems should be improved, as should data sharing (not only on pathogens) (Strupat et al., 2022a). What is needed is the establishment and expansion of research and development capacity, the training and further education of specialized personnel, educational measures for the population, and public health services that share relevant data.

Overall, strong social systems are a prerequisite for overcoming societal crises (Strupat and Marschall, 2020). In order to deal with pandemics, health systems are needed that can cope with increased patient numbers and can expand their capacity at short notice (surge capacity). This point, too, is not pandemic-specific, but it can also be strengthened by a pandemic treaty (Phelan and Carlson, 2022). The more comprehensively universal health coverage and primary healthcare (Chapter 6) are ensured, the less vulnerable humanity will be to pandemics.

Pandemic response and recovery

Pandemic response requires resources within the health sector, such as the ability to develop and distribute the required medicines and medical products. This also includes the development of joint regulations and procedures for what is known as pathogen sharing. Overall, the pandemic treaty should establish a solidarity-based system with regard to pandemic response that is directed towards international distribution mechanisms. For example, there is a great need to distribute existing resources equitably worldwide to ensure an acute supply of vaccines, medicines and medical products during a pandemic or epidemic, which failed during the COVID-19 pandemic because of nationalization tendencies (Stamm et al., 2021; Wenham et al., 2022; Labonté et al., 2021; De Paula and Brown, 2021; Villareal, 2023). Interfaces to WTO law with the TRIPS Agreement must also be developed in this context (Nikogosian and Kickbusch, 2021b). Finally, a conceptual change towards a 'global health commons approach' could possibly also counteract deeper-rooted phenomena, such as a lack of willingness to be vaccinated or to pay for vaccinations (Ramchandani et al., 2021: 1; Strupat et al., 2022b). State-imposed measures involving severe restrictions on freedom may also become necessary to overcome pandemics. Instead of trying to tackle pandemics by means of an unbalanced restriction of civil liberties, good emergency legal preparedness should be installed in all states, also as a strategy for public-health protection during pandemics (Phelan and Carlson, 2022).

The zero draft for a pandemic treaty currently (early 2023) provides for the recovery of health systems at the local, national, regional and global level (WHO INB, 2023), but not for the recovery of other societal systems, such as education or the economy. It is unclear in this context what is meant by a recovery of the health systems. In any case, international cooperation during acute pandemics with as large a scope as the COVID-19 pandemic should also include the recovery of other societal components of pandemics and pandemic-containment measures. In the context of crisis management, states have very unequal means to compensate at the national level for losses in the economy and society resulting from pandemic-response measures. In some cases, these inequalities correlate with and exacerbate vulnerabilities and hegemonic continuities (Section 2.1). However, it is beneficial for the motivation of countries to cooperate internationally if, in crisis situations, reconstruction measures based on solidarity are made possible worldwide. Furthermore, it is necessary to align government aid and recovery measures with the 2030 Agenda and the Sustainable Development Goals, even in crisis situations caused by pandemics (Section 7.1.1).

Principles of equity in international cooperation on epidemics and pandemics

Also in the context of the pandemic treaty and the IHR reforms, there is a discussion on agreeing on the principle of 'common but differentiated responsibility', in a similar way to international climate law (Section 7.1.3.1; WHO, 2023b; WHO INB, 2023). Overall, the negotiations on the IHR and the pandemic treaty are very much characterized by demands for equity (Dentico et al., 2021: 35). Precisely because of the experience with the COVID-19 pandemic, it is important for European countries and other high-income countries to win back the trust of low-income countries with a pandemic treaty. In this sense, specific commitments and binding obligations by high-income countries to create global pandemic-containment resources are more meaningful than adopting principles. However, any synopsis of the principles agreed for the pandemic treaty should emphasize and implement the solidarity principle in particular. This can also be used for interpreting joint and, where necessary, differentiated responsibilities based on capacity. In the context of pandemic cooperation, too, a historically and currently increased responsibility of high-income countries for the destruction of nature – and thus a differentiated responsibility for the causes of pandemics – can be justified (Verma, 2020). There are also very large differences across the world in capacity for developing and producing medical products. However, responsibilities and capacities only partially overlap, so that an assessment of responsibilities and scope for action should be

7 Global urgency governance

dynamic and nuanced rather than static (Section 7.1.3.1). Integrating a principle of common but differentiated responsibility is therefore only to be recommended if an increase in the assumption of responsibility can be generated in a solidarity-based interpretation.

7.2.2.2

Design of institutions

The results of the negotiations on a pandemic treaty should be translated into binding international law, and this is not assured until the treaty and the reform of the International Health Regulations (IHR) have been adopted – despite an agreement to this effect by the cross-national negotiating group on the pandemic treaty (Wenham et al., 2022).

The WBGU advocates an explicit division of tasks between the pandemic treaty, the IHR, the climate-protection agreements and the biodiversity-related conventions. At the same time, compliance and funding should be ensured and these institutions interlinked via cooperation and coordination mechanisms.

The intergovernmental negotiation forums should take into account the inclusion of stakeholders, businesses, local and regional actors (e.g. cities), academia, philanthropic foundations and non-governmental organizations in order to identify problem-appropriate solutions (Duff et al., 2021). The limited negotiating resources of smaller countries and low-income countries must also be taken into account, especially since they currently have to negotiate the pandemic treaty and the IHR reform simultaneously within the framework of the WHO.

Implementation of the climate and environmental conventions as an indispensable prerequisite

Implementation of the climate and environmental conventions, achievement of the agreed goals for climate-change mitigation, life on land and life below water (SDGs 13, 14, 15) and adaptation to climate and environmental changes that can no longer be prevented – these are basic prerequisites for the vision of ‘healthy living on a healthy planet’ (Chapter 5). The prevention of future pandemics depends very much on the implementation of various environmental conventions (Paris Climate Agreement, Biodiversity Convention) and the integration of ecosystem approaches into policy-making (Gibb et al., 2020b; OHHLEP, 2023; Section 5.1.1.2). A pandemic treaty cannot be a substitute for a lack of will on the part of the signatory states to flesh out and implement the climate and biodiversity agreements. However, arguments of health protection could be used to generate political will and possibly funding for the implementation of biodiversity conservation via the pandemic treaty. Vinuales et al. (2021) advocate a so-called deep prevention

approach, which includes the drivers of environmental changes that cause zoonoses to spread to humans. While it is imperative that these links be recognized in the pandemic treaty, tangible international cooperation on nature conservation, protected-area designation, sustainable use and wildlife trading should remain within the scope of the biodiversity-protecting conventions (especially CBD, CITES) (Section 5.1.3). These elements are subject to the unequivocal jurisdiction of these agreements. Corresponding measures cannot be attributed solely to pandemic prevention. Moreover, the respective technical expertise lies there.

Even if pathogen sharing touches on the scope of the Nagoya Protocol, it makes sense to regulate pathogen sharing within the framework of international health law, and to provide for an exception here to the Nagoya Protocol under the CBD. However, the approach of access and benefit sharing, i.e. linking the sharing of a pathogen to a *quid pro quo*, could be transferred as an incentive structure.

Meaningful division of tasks between the IHR and the pandemic treaty

It is particularly challenging to establish a meaningful division of responsibilities between the pandemic treaty and the International Health Regulations (IHR) (Labonté et al., 2021 Box 7.2-2).

As things stand at present (February 2023), the pandemic treaty could be adopted as a framework agreement under Article 19 of the WHO Constitution (WHA, 2021). The IHR and the pandemic treaty could be set up differently in line with their legal bases in the WHO Constitution (Villareal, 2023). The IHR were enacted on the basis of Article 21 lit. a of the WHO Constitution, which allows the WHA to create regulations on sanitary and quarantine measures and other precautions to prevent the spread of disease from one country to another. The scope of application of the IHR is limited by this. On the other hand, the regulations apply to all member states of the WHO “after due notice has been given”, unless a state rejects the regulations by explicit notification within a period of time (opt-out) or declares corresponding reservations (Art. 21 and 22 of the WHO Constitution). By contrast, the pandemic treaty, if agreed pursuant to Article 19 of the WHO Constitution, could regulate any content of the agreement relating to the WHO’s authority, i.e. more than simply measures to prevent the international spread of disease. However, the contents of the agreement then only apply to states that actively sign and ratify it (opt-in). While this creates the risk of weakening international cooperation on pandemic control by not having all states sign and ratify a new agreement (Wenham et al., 2022; Ramakrishnan and Gopakumar, 2021), at the same time it offers willing

states the opportunity to agree on a progressive framework on pandemic cooperation, while basic cooperation can continue to be regulated by the IHR. Although there is political leeway as to which contents are regulated by the IHR and which by the pandemic treaty, the WBGU recommends the following scenario:

The IHR should regulate everything that reflects the minimum international consensus on pandemic prevention, preparedness, response and recovery, in particular provisions on national pandemic preparedness planning that is as digitized as possible, surveillance and reporting systems, international data exchange, pathogen sharing and a (greater) responsibility of the WHO in global health emergencies.

The pandemic treaty remains responsible for structuring fields of cooperation that go beyond this, creating synergies with other areas of law and designing interfaces (Nikogosian and Kickbusch, 2021a) without creating unnecessary parallel structures (Labonté et al., 2021; Ramakrishnan and Gopakumar, 2021). The responsibilities between the different legal acts in the area of pandemic prevention, preparedness, response and recovery should be explicitly stated in the reformed IHR and the pandemic treaty. Guiding principles for action should include pandemic prevention in the form of spillover prevention, health promotion, One Health and Planetary Health, research and development, and solidarity in pandemic response by member states. If possible, all contents should also be backed up with measures and cooperation formats. Initial examples can be found in the zero draft of the pandemic treaty (WHO, 2023), e.g. the WHO Global Pandemic Supply Chain and Logistics Network (Art. 6 of the zero draft). The pandemic treaty could serve as a framework for pandemic response, particularly for regulating policy planning in a way similar to the Nationally Determined Contributions for pandemics, which is known in the climate sector and broadly covers pandemic prevention by means of nature conservation, health promotion, implementation of the IHR and activities in research and development. This instrument could increase transparency on the implementation of the IHR as well as generate voluntary contributions.

Another focus of the pandemic treaty should be on crisis management complementing the IHR. In particular, the request of low-income countries for distribution mechanisms and equity should be taken into account. Here, the most concrete mechanism possible should be created that integrates, improves and ensures the realization of the (failed) ACT-A and COVAX initiatives and the planned platform for equitable access to medical countermeasures in pandemics (WHO, 2023a). However, it would also be possible in the IHR to regulate solidarity in pandemic response, for example on specific vaccines, medicines and other medical products. On the

other hand, a pandemic treaty could regulate recovery measures in the broader sense, e.g. in economic aid. These could technically be handled via the World Bank and the International Monetary Fund. Furthermore, pandemic-specific cooperation should be agreed in research and development. For example, an international understanding should be sought on what percentage of GDP countries worldwide should invest in research and development with a focus on the dynamics of healthy living in a healthy environment. Taylor et al. (2022), for example, mention setting up a phased plan for the introduction of a funding quota of 0.5% of GDP for environmental health research.

Compliance

There is unanimity that strong compliance mechanisms would be necessary and desirable to ensure adherence to joint pandemic prevention, preparedness and response regulations (Wenham et al., 2022; Phelan and Carlson, 2022; Labonté et al., 2021; Schwalbe and Lehtimäki, 2021). However, functioning enforcement mechanisms in international law tend to be rare. Instead of a sanction mechanism, it would be possible to work with an incentive-based system in which money from a joint fund or a joint insurance for pandemic response is made dependent on compliance with preventive measures and reporting obligations (Wenham et al., 2022).

Finance

To facilitate the financing of pandemic prevention, preparedness and response in low- and middle-income countries, a new fund for pandemic prevention, preparedness and response (Financial Intermediary Fund) has been established at the World Bank under the technical guidance of the WHO. Its focus is on bolstering the core areas needed for the national implementation of the IHR, such as disease surveillance, laboratory systems, emergency communication, coordination and management, the relevant skills of health workers, citizen involvement, building regional and global capacity for PPR and supporting technical cooperation, analysis, education and meetings (FIF, 2022). However, the new financing structure could also be used for pandemic-prevention measures under the CBD, strengthening health systems and implementing other elements of the pandemic treaty. This requires making corresponding funds available.

Inter-institutional cooperation mechanisms

With such a multitude of legal acts, negotiating forums, mechanisms and funding institutions, successful cooperation mechanisms are key to ensuring a synergistic development of pandemic governance. Special attention should be paid to giving cooperation mechanisms as detailed a structure as possible. Regular meetings

7 Global urgency governance

working towards specific goals instead of just exchanging information are helpful (Section 7.1.3.2).

Coordination between the negotiating groups on reforming the IHR and the negotiation of the pandemic treaty is necessary to avoid the danger that controversial content is attributed to different areas of responsibility and ignored (WHO, 2023b).

A pandemic treaty should regulate cooperation between the WHO, the World Organization for Animal Health (WOAH), the FAO, UNEP, CITES, UNCCD and the CBD (Labonté et al., 2021; Vinuales et al., 2021; Section 5.3.2). The work of the Quadripartite (Box 7.1-7) and commissioning the One Health High Level Expert Panel (OHHLEP) with clarifying fundamental issues such as defining One Health or spillover prevention are steps in the right direction.

The Pandemic Hub in Berlin, a cross-cutting mechanism, is an institution that should be expanded through data integration. This institution should not become an empty shell; it could serve as an interface for data collection in both the IHR and the pandemic treaty (Villareal, 2023), so that relevant information can be brought together where it is useful and permissible.

7.2.2.3

Outlook

The pandemic treaty is intended to strengthen the assumption of political responsibility for global cooperation on infectious diseases (Kickbusch and Holzscheiter, 2021). However, there are doubts as to whether a new treaty can compensate for a lack of political will (Wenham et al., 2022), a lack of funding and other inadequate WHO and national resources for public-health interventions (WHA, 2022; Labonté et al., 2021; Ramakrishnan and Gopakumar, 2021). A treaty should serve as a framework for ambitious states in particular to shape their cooperation for pandemics.

As the regulations that apply to all WHO countries, the IHR should continue to determine the core contents of pandemic prevention, preparedness and response, and be equipped with a compliance mechanism. The pandemic treaty should in particular regulate a reporting mechanism as well as contents that go beyond the authority of Article 21 of the WHO Constitution, e.g. strengthening global health systems with regard to health promotion and recovery measures. The biodiversity-protecting conventions (CBD, CITES) should be strengthened and implemented as a basic prerequisite for pandemic prevention (Section 5.1-3).

7.2.3

Recommendations for action and research

As the key international organization in the field of health, the WHO is largely responsible for shaping international cooperation on 'healthy living on a healthy planet'. Both its known and its new forums should be used in the sense of urgency governance.

Recommendations for action

- *Integrate structural prevention for healthy human and non-human life:* Standards, indicators and guidelines developed by the WHO should increasingly combine approaches of structural and behavioural prevention to promote healthy lifestyles with settings promoting ecologically sustainable lifestyles. Tangible programmes and measures should be set up to promote implementation. In particular, interfaces with mandates of other organisations and institutions under international law should be more closely interlinked and joint financing ensured.
- *Use negotiations on pandemic prevention to integrate overarching issues:* The international negotiations on pandemic prevention, preparedness and response in the context of the IHR reform and the new pandemic treaty should be used to noticeably integrate overarching needs; these include boosting the One Health approach, the transformation towards efficient and sustainable health systems, strengthening health promotion, principles of solidarity and the cooperative assumption of responsibility. In this context, a division of responsibilities between the various legal acts should be established. The IHR should reflect a minimum consensus of all states. The pandemic treaty can also be used for more ambitious cooperation. Pandemic prevention by means of nature conservation and the regulation of wildlife trading should be negotiated under the conventions on biodiversity conservation, which should be upgraded. The implementation of the climate and environmental conventions is a basic prerequisite for reducing future pandemics.

Research recommendations

- *Governance implications of One Health and Planetary Health:* Pandemic cooperation is a key area where the comprehensive implementation of a One Health approach is recommended. It might be a good idea to use this example to further explore governance implications of One Health and Planetary Health, such as how different sectors and levels of work can cooperate better to really implement One Health and Planetary Health concepts so as to achieve sustainable pandemic prevention. If necessary, lessons can be learned here for further crisis-management mechanisms.

- › *Analyse compliance mechanisms for international treaties*: The WBGU believes it is a good idea to study incentive-based compliance mechanisms (Wenham et al., 2022) for international treaties that can contribute to the implementation of the IHR and the pandemic treaty but also other international treaties.

7.3

From exclusive clubs to inclusive alliances: G7, G20 and multi-stakeholder alliances

Political leadership for the implementation of the vision of ‘healthy living on a healthy planet’ is needed not only in the forums of international organizations (Section 7.2) and state regional organizations such as the European Union (Section 7.4), but also in or with supraregional state associations like the G7, G20 and G77, as well as through multi-stakeholder alliances. The latter include not only nation states but also other (mainly private-sector) actors and have grown strongly in recent years in the context of dealing with global challenges in the field of health and the environment. This important role of inclusive alliances is illustrated, for example, by the Coalition for Epidemic Preparedness Innovation (CEPI), which was also active during the COVID-19 pandemic, and its commitment to vaccine development, as well as the Alliance for Global Food Security initiated under the German G7 Presidency, which has made it possible to secure wheat exports from Ukraine despite Russia’s war of aggression (CEPI, 2023; Hornidge and Brüntrup, 2022) (Box 7.3-1). What is needed, therefore, in addition to a well-designed and financed interface between health and the environment, a well-networked WHO and a European Union that is united both internally and externally on health-policy issues and has a greater aspiration to shape them, is continuous transnational and transregional cooperation. Issue- or country-specific alliances (also referred to as clubs and alliances) play a special role here, as they enable agenda setting and commitment at the highest political level, effectively implement their own goals, and can influence international organizations in the implementation of decisions (Kamradt-Scott et al., 2022; Beisheim et al., 2022; Berger et al., 2019). Multi-stakeholder alliances in particular provide an important platform for executing political leadership for the vision of ‘healthy living on a healthy planet’, as they open up new opportunities to mobilize a diversity of actors – including private-sector actors such as international development banks – in order to jointly address global issues at the interface of the environment and health.

7.3.1

Transformative potential of club governance: G7 and G20

Club governance is associated with ‘modular multilateralism’. This means that clubs and alliances are more flexible mini- or plurilateral forms of cooperation, complementing the formalized multilateralism of international organizations (Beisheim et al., 2022; Sonobe et al., 2023; Brandi et al., 2015). These club-governance formats have potential advantages over multilateral cooperation, e.g. in terms of speed, level of ambition, effectiveness, enforcement mechanisms, participation and resource mobilization (Naim, 2009; Weischer et al., 2012; Falkner, 2016). The limited membership and informal nature of clubs and alliances make it quicker and easier to identify common denominators and drive forward joint approaches to solutions. They also promise to be more in-depth and thus more ambitious than measures that cover the heterogeneous interests of a larger number of members (Brandi, 2019; Blümer et al., 2020). Furthermore, the focus on relevant actors, club advantages and sanctions (such as the threat of exclusion to prevent ‘free riders’) tends to ensure that jointly agreed goals are implemented more effectively (WBGU, 2014a: 80). In addition, the smaller size of clubs can also enable smaller or less powerful actors to have their interests and positions incorporated into the approaches that are developed. Since these are more readily bypassed by large countries in larger formats such as international organizations, club governance promises to be more participatory and equitable (Brandi, 2019; Blümer et al., 2020).

Club-governance formats thus have a transformative potential that offers an opportunity to strengthen the health and environment nexus. For example, if actors with high climate-policy ambitions join forces, they can help accelerate the transformation to sustainability. In particular, reciprocal learning can be made possible and incentives created for further success in decarbonizing production systems – via a positive incentive structure, i.e. non-restrictive measures (Stern and Lankes, 2022). These actors can support and complement the multilateral process at the UN level by participating in the international negotiations with more ambitious national goals, thus spurring the negotiations on (Berger and Hornidge, 2023). For example, the targets announced by the G8 in 2007 and 2009 to halve global greenhouse-gas emissions by 2050 and to keep global warming below 2°C had a significant impact on the UNFCCC process and the Major Economies Forum on Energy and Climate Change (MEF), which adopted the 2°C target in its Declaration of Heads of State and Government (Weischer et al., 2012: 180). This illustrates how the unity of a

Box 7.3-1**Clubs and alliances: definitions and examples from international climate and health policy**

Clubs are defined as small groups of relevant actors that come together on a voluntary basis to pursue common goals (Hovi et al., 2019: 1072). Their members can be both governmental and non-governmental. Club membership requires meeting specific criteria and allows access to club assets. Club assets are advantages of the club that make it desirable to join (Buchanan, 1965; WBGU, 2014a: 79). The structure, financing and purpose of the club are not fixed by definition (Naim, 2009; Weischer et al., 2012; Falkner, 2016). Alliances, like clubs, are a form of issue-specific cooperation between several actors; however, they differ from clubs in terms of their degree of institutionalization and inclusiveness.

While both clubs and alliances are less institutionalized cooperation formats than those of the UN system (e.g. the WHO) and regional organizations (e.g. the EU), alliances are at the extreme end of the institutionalization spectrum. Clubs lie roughly between these two forms and are thus more formalized than alliances (Schneckener, 2009: 4). Compared to clubs, alliances are also more open. The admission and elimination criteria of an alliance are less static than those of a club and thus more flexible for new actors to join (Stewart et al., 2017). Because of their similarities, both cooperation formats can be classified under 'club governance' (Unger and Thielges, 2021: 5).

Examples of issue-specific club governance formats are discussed in particular in the field of economic and financial policy, as well as in international climate policy (Blümer et al., 2020). In economic and financial policy, the G7 and the G20 are particularly worthy of mention. The G7 was founded in response to the 1975 oil crisis (Gronau, 2015) and the G20 at the level of finance ministers and central bank governors in 1999, following the Asian financial crisis, and was raised to the level of heads of state and government during the 2008 financial crisis (Unger and Thielges, 2021: 7). As a small group of like-minded democratic industrialized nations, the G7 represents a classic example of club governance, which, due to its small size and similar interests, can push through decisions quickly and effectively. In turn, the G20, whose members (including the G7) represent different political systems and income groups, represents 80% of the world's gross domestic product and more than 60% of the world's population; it thus constitutes a representative decision-making forum with a high problem-solving capacity, especially in times of a frequently blocked UN Security Council (Berger and Liu, 2021).

Multi-stakeholder alliances in the field of international climate policy include, for example, the Climate and Clean Air Coalition (CCAC) and the Under2Coalition (U2C), which were formed in response and as a complement to the international climate negotiations of the UN Framework Convention on Climate Change (UNFCCC) and bring together governmental and non-governmental actors committed to ambitious action against climate change (Unger and Thielges, 2021). Another multi-stakeholder alliance is the initiative for a Global Shield against Climate Risks, which was officially launched by the Vulnerable 20 Group of Finance Ministers (V20) and the G7 in cooperation with multilateral institutions, non-governmental and private actors at COP27 in Sharm el-Sheik. It aims to ensure financial support for vulnerable populations in times of climate disasters and thus promote adaptation to climate change (V20, 2023). Another example of an innovative cooperation format for combating climate change between states involving international and private actors is the joint agreement of Just Energy Transition Partnerships (JETPs) between emerging economies and a broad alliance of partners – including bilateral donors such as G7 countries, multilateral development banks and the private sector – to finance a just transition to renewable energy in emerging economies (Hege et al., 2022; Flasbarth et al., 2022).

A large number of alliance-based cooperation formats already exist in international health policy, especially for combating infectious diseases; one example is the Global Fund to Fight AIDS, Tuberculosis and Malaria (Section 7.5; The Global Fund, 2021). Also worthy of mention are the Global Alliance for Vaccines and Immunization (Gavi, the Vaccine Alliance) (Section 7.2.4; Kickbusch et al., 2022) and the Coalition for Epidemic Preparedness Innovation (CEPI) founded in 2017 (Kamradt-Scott et al., 2022; Kickbusch et al., 2022). The Gavi is an alliance of public and private groups that provides low-income countries with rapid and widespread access to immunization against diseases such as polio. Children are a special focus group for Gavi (Gavi, 2023). Similarly, the global multi-stakeholder alliance CEPI, which brings together governments (including Japan, the UK, Germany and the United States), private, non-profit and civil-society organizations, advocates for the production of vaccines to counteract future epidemics and pandemics (CEPI, 2023). Similarly, the Alliance for Global Food Security, which was launched during the German G7 Presidency and brings together states, international organizations and donors, also demonstrates the potential to coordinate and unite different actors with the aim of supporting the long-term transformation of agricultural and food systems, and thus promoting both food security and climate-change mitigation (Flasbarth et al., 2022).

small group of like-minded states can lead to ambitious agreements that can subsequently point the way ahead for other states and international organizations (Weischer et al., 2012). The G7 also played a decisive role in the preparatory phase of the 2015 Paris Climate Agreement. As multilateral agreements such as the 2009 Copenhagen Accord under the UNFCCC failed to reach international agreement, the importance of global climate governance via G7 summits grew. The G7's influence

on global climate governance in 2015 was also boosted by the greater similarities between the G7 countries in terms of their basic democratic orientation and climate policy compared to the G20, as well as the trust that has evolved among the G7 countries and their perceived stronger domestic political steering capacity (Kirton et al., 2022: 5 f.; Jacob et al., 2022). In 2022, the G7 and G20 were again able to reaffirm the 1.5°C target of the Paris Climate Agreement and the 2030 Agenda in the summit

declarations, despite geopolitical tensions due to the Russian war of aggression in Ukraine and the aftermath of the COVID-19 pandemic (G7, 2022; G20, 2022). The 2030 Agenda thus also served as a unifying discourse space in 2022, a year marked by geopolitical tensions.

While the G7 and G20 were set up in the context of economic and financial policy, in the meantime they address a wider range of issues, including climate change and health issues. At the G7 level, for example, health-policy measures have been supported financially and by providing health experts. On the one hand, G7 members' Official Development Assistance (ODA) spending on general health increased from US\$0.9 billion in 2015 to US\$1.7 billion in 2020 (BMZ, 2022a: 66); on the other hand, the G7 supports strengthening health systems in multilateral organizations, such as the Global Fund, the WHO and the Global Financing Facility (BMZ, 2022a: 79). As a result of its effective handling of the 2008 financial crisis, the G20 has been able to establish itself as an important global player (Drezner, 2014). Since its foundation, the G20 has successively expanded its portfolio and, in addition to financial crises, now also addresses issues of environmental and climate policy (for example, the ongoing G20 discussions on the Just Energy Transition Partnership instrument for the decarbonization of economies) and social justice (Berger et al., 2019). Moreover, these initially small associations can grow and thus develop an inclusive dynamic until, for example, all UN states become members of an association, and a global alliance is achieved (WBGU, 2014a). An example of this is the GATT of 1949, which started as a plurilateral tariff and trade agreement, set strong incentives to successively expand its membership and finally established itself as an institutionalized international organization (WTO) (Berger et al., 2019). An example from Germany's G7 Presidency is the Alliance for Global Food Security, founded in 2022, which made it possible to secure wheat exports from Ukraine despite Russia's war of aggression. The further development and thus the future of the alliance will become clear in the coming years.

7.3.2

Limits of club governance: G7 and G20

However, these formats also have some disadvantages. On the one hand, clubs are often criticized for being less inclusive and for neglecting smaller actors. Other critics cite their lack of efficiency. Both aspects call the legitimacy of these formats into question. In the case of the G7, apart from its declining economic and formative power, it is its small number of members and their homogeneity that pushes the G7 to its limits and contributed

to the creation of the G20. Against the backdrop of global power shifts and rising greenhouse-gas emissions in middle-income countries, the small group of the G7 increasingly lacks legitimacy and effectiveness. The G20, by contrast, brings together leading industrial nations as well as emerging markets such as Brazil, South Africa, India, Indonesia and China, and is much more representative. At the same time, critics argue that the G20 lacks efficiency precisely because of its size (Brandi, 2019).

Alongside effective power, the question of membership is also closely linked to legitimacy. What can be learned from the experience of the G20 is that an arbitrary but limited number of members can lead other actors to question the legitimacy of the alliance and consequently view its actions less as a point of reference for their own actions (Berger et al., 2019: 494). Therefore, the alliance must pursue a clearly defined goal that is of interest to all members and whose implementation promises clear gains. It is important that the stated objective(s) are of a long-term nature to prevent the alliance from becoming important solely in times of crisis (Benson and Zürn, 2019: 555). This criticism must be faced by the G20, which has been described by Bishop and Payne, 2021, as an "empty freighter" that lacks fundamental political direction and is only periodically refuelled with new initiatives and priorities.

7.3.3

Advantages of 'alliances' over 'clubs': examples of health and climate alliances

In recent years, an inclusive design of club governance formats with regard to membership has prevailed; these formats also emphasize a variety of policy instruments that are used differently depending on the national context (Stern and Lankes, 2022). Against this backdrop, the seemingly exclusive concept of clubs has been intensively reflected upon and partially replaced by the somewhat more flexible concept of alliances.

Indeed, studies on the impact of climate clubs and the G20 show that the club formats studied do not take primary responsibility for emission reductions and the implementation of existing agreements, and thus cannot replace established multilateral formats (Berger et al., 2019; Unger and Thielges, 2021). Rather, they can help put new issues onto the international political agenda. A recent example is the climate negotiations in Sharm el-Sheikh, where the G77, a club-governance format, skilfully managed to put the issue of loss and damage onto the agenda via broadening alliances, and successfully established it as the third pillar of the UNFCCC international climate regime.

Exclusive formats such as health clubs do not lend themselves to the field of global health policy. Like

7 Global urgency governance

climate change, communicable diseases do not stop at national borders, while most non-communicable diseases are not singular phenomena but expressions and concomitant features of human development patterns (UNDP, 2022: 3). The treatment of those affected is in accordance with the fundamental principles of human rights and medical ethics. The legitimacy and impact of such a club would thus be almost impossible to establish in a world affected by global environmental change. These global challenges in the field of human and planetary health therefore require a response that is shared by the entire international community.

Consequently, inclusive forms of multi-stakeholder alliances are ideal for accompanying and promoting global health policies for healthy people on a healthy planet. An example worth mentioning of such an issue-specific multi-stakeholder alliance in the health sector is the Global Alliance for Vaccines and Immunization (Gavi) (Section 7.2.4). The Global Alliance for Food Security (GAFS), adopted under the German G7 Presidency in 2022, highlights the role of state club-governance formats in establishing these issue-specific, inclusive global alliances in dealing with global challenges: in cooperation with the World Bank, the World Food Programme, the FAO and the IFAD, and as part of Germany's G7 Presidency, it was possible, in view of the urgent needs involved, to put people's health above disputes and to avert hunger despite geopolitical hardening. In this case, the G7 level made global governance possible through strategic alliances (Hornidge and Brüntrup, 2022; Flasbarth et al., 2022).

In the field of climate policy, too, the G7 has signalled (at its 2022 summit in Elmau) its willingness to stimulate more effective and far-reaching action to support the Paris climate goals by establishing a climate club. The report by Stern and Lankes offers important guiding principles for a detailed design of the club (Stern and Lankes, 2022). Of these, the WBGU regards the following as key: (1) an inclusive design with a diverse composition of member states. Against this backdrop, the WBGU welcomes the call by Federal Chancellor Olaf Scholz explicitly pointing out that the club was not a G7 initiative, but had to be "widely supported globally". Corresponding discussions on further elements of design have been held as part of the climate negotiations in Sharm el-Sheikh and continued in the G20 under the Indian Presidency; (2) a variety of political programmes and measures to implement the Paris and Glasgow goals; and (3) a focus on incentives (instead of sanctions) for socially responsible climate-change mitigation and thus on a positive framework that looks to the future and lays out design options. This includes, for example, supporting lower-income member states in driving forward industrial decarbonization or agreeing on joint

international frameworks for industrial sectors. These incentives promise to encourage more member states of different income groups to join and thus to strengthen the club's reach and power to act (BPA, 2022). As the authors note, this climate club "is not really a 'club' in the formal sense of the term (... but...) an Alliance of Leaders for Climate Action and Sustainable Growth" (Stern and Lankes, 2022: 8). The WBGU advocates establishing the term 'alliance' here in order to highlight its inclusiveness. Meanwhile, the question remains open as to whether such an alliance can also help facilitate the application of agricultural innovations in developing countries. In addition, research should be carried out to identify how the Just Energy Transition Partnerships (Box 7.4-1) can support the transformation of production systems in LMICs alongside a possible climate alliance.

Based on these findings and the experience of the G7, G20 and climate- and health-policy alliances, an inclusive health alliance should be established following the guiding principle of 'healthy living on a healthy planet'. Such a health alliance should bring together willing governmental and non-governmental actors to jointly address global health issues. A key goal should be the creation of a "health knowledge sharing economy", through which states can better prepare for – or even prevent – future global health challenges (WHO, 2021; Kickbusch et al., 2022). To achieve this, governmental and non-governmental members (Section 7.1.3.3) of the alliance would have to agree to share health data and pool financial, material and human resources. Within the framework of the health alliance, research and development for new diagnostic and therapeutic agents, as well as for infrastructure could be promoted, and training and further education for health workers (Section 8.1) could be offered. With their voluntary membership, members would agree to develop surveillance mechanisms and find out about emerging potential health risks. In turn, they would benefit from new data and knowledge and be able to respond more quickly to emerging health risks (Kickbusch et al., 2022). It would also be particularly advisable for a corresponding health-focused cooperation to pursue approaches that integrate the environment and health from the outset (concepts such as Planetary Health or One Health) and to address not only human health but also other environment-specific factors (Section 7.3.1). Here, the format of issue-specific partnership formats and alliances is particularly advantageous, as membership can be flexibly designed; both governmental and non-governmental actors from different sectors can be brought together in this way. Closer cooperation between, for example, willing states, NGOs, pharmaceutical companies and environmental researchers could thus come closer to the goal declared by the WHO Council on the Economics of Health for All and begin restructuring

the global health system; the aim would be that not only the market, but also “public, private and community actors work together for the shared purpose of delivering health innovation for the common good” (WHO Council on the Economics of Health for All, 2021:10). A global health alliance could be initiated, for example, within the framework of existing clubs (G7, G20) and expanded to include other countries and actors from civil society, science and the private sector.

7.3.4 Recommendations for action

Advocate for more attention to the health and environment nexus in G7 and G20 negotiations

The WBGU recommends advocating the following in the negotiations at the G7 and G20 level:

- Further strengthen the WHO as the coordinating body for global health cooperation. This includes further developing the financial structure, especially in the area of non-earmarked funding. Moreover, this means strengthening the WHO as a coordinating force, as an advocate for under-resourced health systems and under-represented societal groups, and as a key knowledge actor.
- Actively counteract fragmentation trends in the global health architecture. With the guidance of the 2030 Agenda goals, it is now more urgent than ever to systemically identify, prevent and address environmental-change and health risks. In order to ensure this in a highly differentiated institutional landscape in multilateral, regional and national forums, the WBGU advocates setting up an Inter-Agency Global Health Standing Committee in a similar way to the recommendations of the Think7 process under the German G7 Presidency (Kickbusch et al., 2022). The aim of such an agency would be to ensure coordination between global health organizations and alliances, their mandates and funding needs.
- Strengthen transregional dialogue and cooperation between health systems and international policy on the climate, biodiversity and the environment. Here, the WBGU advocates establishing high-level multi-stakeholder dialogues, for example within the framework of the Alliance for Multilateralism, and/or in connection with the preparations for and the follow-up to the United Nations Summit of the Future.
- Gear the (further) training of health-sector personnel worldwide to the environmental-change-related health risks and the vision of ‘healthy living on a healthy planet’. In the context of the G7 negotiations, the WBGU recommends introducing a Planetary

Health Task Force at the level of the WHO to meet the challenges of systemically bringing together expertise on environmental change and health. During Japan’s current G7 Presidency, Japan’s explicit Universal Health Coverage focus enables the systematic embedding of the One Health and Planetary Health debates in health-system development worldwide.

- Prepare and successively push forward the establishment of a phased plan on internationally agreed funding for science and innovation systems at the environment-health interface. As in international climate financing, the SDG Stimulus Fund recently proposed by UN Secretary-General Guterres, or the Official Development Assistance that has been practised for decades, a system of shared – albeit differentiated – responsibility and funding developed by the international community is also needed in the preventive approach to environmental-health challenges.

In the context of the G20 and in order to productively shape the G7 as part of the G20, the WBGU recommends consciously working out a Team Europe approach to global health policy – as part of the G20, not as a pure G7 approach. The reason for this is that the division of the G20 into G7 and non-G7 members of the G20 has repeatedly been problematic. The role of European coordination and alliance building is growing, especially against the background of increasing geopolitical tensions. This applies to the EU’s global cooperation and security policies (Kloke-Lesch and Hornidge, 2023) and also in the field of global health policy, which depends on transregional cooperation. Europe is challenged to find its own answers here by relying on trust-based partnerships on all continents and in all country income groups (Africa Strategy of the BMZ; BMZ, 2023b). The dynamic challenges of environmental change and health are examples of further future challenges in which Germany and Europe are dependent on partnerships worldwide and beyond the classic geographical, economic and political boundaries. In preparation for this, it is important to invest today in their own credibility, partnerships and impact. The area of health policy is particularly suitable for practising future-oriented solidarity.

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7.4 European Union: moving towards an environmental and health union?

The European Union represents a close cooperation of states with a strong institutional framework and a transfer of authority from the Member States to the European level that is far-reaching by international comparison. Many, if not all, of the challenges addressed in the previous sections at the interface between the

environment and health require not only the systematic consideration of both topics but also closer cooperation across national frontiers. In principle, the EU with its institutional framework offers great potential for initiating a more effective protection of the environment and health and more comprehensive (and solidarity-based) preparedness for health threats and environmental crises within the EU. What follows in this section is an overview of EU policies and measures at the interface of environment and health, and thus of existing cooperation and collaboration between the Member States. The starting point for the discussion is the EU's health policy and its health-policy competences.

Furthermore, the EU, not least as a major economic area, can take on a leadership role and contribute to implementing the vision of 'healthy living on a healthy planet' and, across the board, the SDGs. With Team Europe, the Global Gateway Initiative and the new Global Health Strategy, the second part of the section presents current EU initiatives that are intended to have an external impact and reveal an enhanced claim by the EU to shape the future. Such outward action, as well as the direct consideration of the impact of European action on third countries, is urgently needed in view of the global nature of many environmental problems and international economic interdependencies. Also, due to its economic strength and the decisive importance of its Member States for its development paths to date, the EU has a special, also historical, responsibility to offer solutions for the implementation of the vision of 'healthy living on a healthy planet', to seek diverse collaborations in an increasingly multipolar world, and to involve and support poorer regions. However, the EU is currently only fulfilling this responsibility to a limited extent.

7.4.1 Health-policy competences and relevant EU policy areas

In the area of environmental and climate policy, the EU has been generating important ideas and setting ambitious EU-wide targets for some time now, and lays down extensive framework conditions for Member States' policies, or even directly for companies and households. The example of EU activities in the area of chemicals is presented in detail in Section 5.2. As recently as October 2022, the EU Commission proposed new rules and thresholds for improving air and water quality to protect health (European Commission, 2022b). The European Green Deal is probably the most prominent current example, as are the various more far-reaching strategies such as the 'from stable to table' strategy for a fair, healthy and environment-friendly food system

(European Commission, 2020l) or the new European Adaptation Strategy (European Commission, 2021c) and comprehensive legislative packages such as the 'Fit for 55' package (European Commission, 2021h), which were developed to flesh out and implement the Green Deal.

European action and close cooperation between Member States is necessary in these areas, for example to establish uniform environmental standards for the European internal market, to ensure fair competition between companies in the Member States and to protect transboundary ecosystems (WBGU, 2020). In some areas, such as the necessary restructuring of energy-supply systems, they can and should be further deepened with a view to using renewable energies or in the context of European (grid) infrastructures.

The EU often refers to health in its environmental and climate-policy actions, e.g. explicitly in the Green Deal. On the one hand, the Green Deal as a whole is intended to protect people's health and well-being from environmental risks and impacts. On the other hand, its implementation is supposed to aim for "the greatest possible benefits in terms of health, quality of life, resilience and competitiveness" (European Commission, 2019a). The new European Climate Adaptation Strategy (European Commission, 2021c) also focuses on the threats to health posed by climate change; a dedicated European Observatory on Climate and Health has been created for this in the context of the Climate-Adapt platform (ClimateADAPT, 2023).

7.4.2 Non-communicable diseases as a field of action

The COVID-19 pandemic sharpened the focus on the EU's core health-policy fields of action (Box 7.4-1) in dealing with communicable and also non-communicable diseases.

In the area of non-communicable diseases, EU health policy is generally limited to non-binding support programmes and recommendations. An important exception here is its very strict policy on dealing with tobacco, where its own competence to act is also explicitly based on Article 168 (5) of the TFEU. Relevant, more binding regulations with an effect on non-communicable diseases, on the other hand, rely more heavily on other competences to act, such as the EU's strong competences in environmental policy or consumer protection.

Yet there are also good reasons for cooperation at the European level on non-communicable diseases such as lifestyle-related or mental diseases, even if these initially seem less obvious than communicable, cross-border threats to health. Cooperation here serves to exploit synergies brought about by the closer exchange of knowledge and experience via effective programmes

Box 7.4-1**The role of the EU in its Member States' health policies**

Although the responsibility for health policy in the EU lies primarily with the Member States, the EU's actual influence on health and health systems goes further than initially suggested by its rather limited supporting competence to act in health policy.

The EU is only expected to complement the health policy of the Member States, i.e. instead of shared competence it only has a complementary authority to act (Art. 168 (1) *Treaty on the Functioning of the European Union* (TFEU)). In this sense, however, it can be active in a broad range of areas, from improving public health to prevention and research, to combating health threats and diseases; above all, it can promote health-policy topics through initiatives, recommendations and support programmes, and work towards the coordination and harmonization of national health policies (Art. 168 (1) of the TFEU). In addition, the EU aims to ensure and promote a high level of protection of human health in all its other relevant policies and activities (Art. 168 (1) of the TFEU and Art. 9 of the TFEU). This so-called integration clause corresponds to the health-in-all-policies principle (Box 7.1-5).

The EU's health-policy measures and influence encompass a wide range of programmes, strategies and legislative

frameworks. In an overview, Bucher (Bucher, 2022), for example, distinguishes five fields through which the EU directly or indirectly shapes and addresses health, the determinants of health or health systems in the Member States. In addition to the implementation of the health-in-all-policies principle in other EU policy areas, these include the management of communicable and non-communicable diseases – whereby the EU's room for manoeuvre is, however, rather limited by its health-policy competence – as well as research policy and research funding. Furthermore, although the organization of healthcare systems is explicitly the responsibility of the Member States (Art. 168 (7)), here, too, the EU influences access, funding, personnel and even medicines and medical products through legislation that enforces the freedoms of the internal market as well as through cohesion policy, the European Pillar of Social Rights and the framework for economic or fiscal governance (Greer et al., 2019).

The EU pursues the integration clause systematically and consistently in many policy areas (Bucher, 2022) in which health protection plays a key role and where it often has a stronger competence to act than in actual health policy. These include, for example, consumer protection, occupational health and safety and – very intensively – environmental policy, where health protection is a very explicit objective of the EU's corresponding competence to act (Art. 191 (1) of the TFEU).

and measures and the pooling of corresponding research funds and efforts. The EU is following this idea and currently also increasingly addressing the field of non-communicable diseases in general, even where they do not concern environmental health risks. This is reflected in particular in the increased funding of the EU4Health programme under the current financial framework and the EU's 'Healthier Together' initiative (European Commission, 2022k).

This EU initiative aims to support Member States in reducing the burden of disease from non-communicable diseases by focusing on disease prevention and health promotion. It complements the European focus on cancer control through the Beating Cancer Plan as part of the European Health Union initiative (European Commission, 2021e). The initiative provides financial support (from the EU4Health programme) for Member State programmes. With its focus on prevention and health promotion, the initiative certainly follows a similarly systematic, overarching approach to creating healthy living environments and encouraging and enabling health-conducive behaviour (Chapter 4).

7.4.3**Communicable diseases and cross-border health risks: the European Health Union**

In the field of communicable diseases and cross-border health risks, cooperation between Member States at all levels – from the identification and assessment of potential health risks to their containment – is of great importance. The same applies to preparing for such health risks, for example by the jointly organized and financed provision of capacity to defend against health risks and for (solidarity-based) support for Member States that are particularly hard hit by a health crisis. The EU was already active in these fields before the COVID-19 outbreak, in line with its competence to act in health policy essentially in a coordinating capacity, for example to ensure the necessary exchange of information between Member States (Box 7.4-1). Shortly before the outbreak of the pandemic, the European Civil Protection Mechanism was revised ('rescEU'), under which the EU and seven participating non-EU states organize their preparedness capacity for crisis situations, including those caused by natural disasters (EU, 2019).

In 2020, however, it soon became apparent that the structures in place at the European level for coordinated capacity building in preparedness and for coordinated and effective responses by Member States were insufficient. Despite early political affirmations of the

importance of joint and united action in the COVID-19 crisis, national thinking patterns and strategies quickly prevailed, for example when the shortage of medical protective equipment became apparent. Together with incomplete information sharing and inconsistent data collection, this led to national go-it-alone efforts that prevented a more effective defence against health risks, and a focus of defence on the regions and individuals that were particularly affected. Last but not least, the national solo responses affected a cornerstone of the EU: the freedoms of the European internal market (for an overview of the EU reactions to COVID-19, see Forman and Mossialos, 2021). The recently established rescEU capacity under the European Civil Protection Mechanism was overwhelmed by the response to a crisis affecting many Member States at virtually the same time.

The EU responded to the perceived deficits in crisis preparedness and crisis management by increasing funding for rescEU and the European Civil Protection Mechanism (Council of the European Union, 2021) and structurally with the initiative for a European Health Union (European Commission, 2020c), which basically involves:

- a new legal framework for preparing for and the prevention of cross-border health risks (EU, 2022a),
- a stronger mandate for the European Centre for Disease Prevention and Control (EU, 2022b),
- a stronger mandate for the European Medicines Agency (EMA) (EU, 2022c) and a new strategy on medicines (European Commission, 2020f), and
- the establishment of a new Health Emergency Preparedness and Response Authority (HERA) (European Commission, 2021d) – within the EU Commission (as a Directorate General).

These elements of the Health Union have already been adopted and implemented (European Commission, 2022i). They are to be complemented by a legal framework for the creation of a European Health Data Space, which is currently still being negotiated (European Commission, 2022c), and the Beating Cancer Plan (European Commission, 2021e).

While the European Health Union does not change the EU's fundamentally complementary competence in health policy, it does strengthen its role in promoting and coordinating cooperation between Member States. As core elements, the European Health Union will establish stronger, more uniform monitoring and information systems across Europe for identifying, monitoring and assessing (cross-border) health risks, as well as systematic planning and reporting processes on prevention and response measures at the European and national level, through which these measures will be more closely coordinated and, at the same time, reviewed by means of regular reports and stress tests. A clear procedure

and framework will be defined for the (voluntary) joint procurement of medical countermeasures, which at least also provides for the possibility of excluding competing parallel procurements by participating countries. In crisis situations, the ability to declare a public-health emergency increases the EU's room for manoeuvre and allows its authorities to take quicker decisions. HERA and EMA are also working to strengthen the EU's strategic autonomy in the provision and allocation of medicines, protective medical equipment and other countermeasures identified as necessary in the face of possible future health risks. To this end, the corresponding stocks are to be expanded, supply chains checked for possible bottlenecks, the EU's own production capacities extended, and global partnerships strengthened.

COVID-19, i.e. an infectious disease, was the starting point for this welcome closer cooperation between Member States and stronger coordination by the EU in the European Health Union. However, the EU's own approach to strengthening crisis prevention, preparedness and response is based on a broader systemic understanding of future health risks, under which not only infectious diseases are considered cross-border health risks in the sense of the Health Union and the new legal order. They are now broadly defined to include health risks of a biological (e.g. antimicrobial resistance) or chemical origin, as well as environment- and climate-related hazards or even risks of unknown origin, and other events that may constitute a public-health emergency of international concern under the International Health Regulations (Box 7.2.2) (Article 2(1) Regulation 2022/2371/EU). In the communications and decisions on the Health Union, the EU also refers several times to the One Health concept and sees the Health Union in interaction with its environment- and climate-policy efforts, particularly also with the European Green Deal.

7.4.4 EU's external and international stimuli and initiatives

At the international level, the EU could in principle, based on its economic power alone, provide influential ideas to protect and promote health in the sense of this report, and to advance the implementation of the SDGs. Not least because of the EU's limited competences to act vis-à-vis the Member States, the EU's external presence and actions as a community have seldom been as consistent and strategic, particularly in the area of health, as would correspond to Europe's economic and political weight in an increasingly multipolar world. In essence, this lack of strategic ambition in health policy only changed with the outbreak of the COVID-19 pandemic (Kickbusch, 2023).

The EU Commission proclaimed Team Europe as a new joint European approach (European Commission, 2020e) in response to the COVID-19 pandemic and to combat its effects in partner countries. Team Europe aims to provide faster and more effective support by pooling the resources and expertise of the EU, its Member States and the European financial institutions, especially the European Investment Bank and the European Bank for Reconstruction and Development, and by providing joint and coordinated support. Externally, Europe's stronger integration and its coordinated approach are also intended to express the EU's claim to global leadership in the fight against pandemics. In addition to emergency responses, supplying vaccines, medical protective and countermeasures, and strengthening local health systems, the support is also aimed at helping businesses and building local knowledge and local production capacity. Up to now, €47.7 billion in financial support has been provided to partner countries under the Team Europe scheme, with total financial commitments increasing significantly from an initial €20 billion to a current total of €53.7 billion (European Commission, 2022a, g).

Beginning with the pandemic response, the Team Europe scheme with its 'Team Europe Initiatives' has since also become a core element of the development-policy programmes and priorities for the current 2021–2027 support period. More than 150 Team Europe initiatives around the world aim to overcome critical development obstacles in partner countries and regions, and to contribute to the implementation of the SDGs by pooling support and expertise from Europe. About €79.5 billion has been earmarked for this (European Commission, 2021c).

The EU's new foreign- and development-policy aspirations are also evident in the Global Gateway Initiative, which was launched at the end of 2021 in response to China's Global Development Initiative. The EU initiative takes up agreements made by the G7 to close the global investment gaps in the field of infrastructure. Key priorities were developed at the EU-AU Summit 2022 in close consultation with African partners. A dedicated Africa-Europe Investment Package of at least €150 billion was announced at the summit to support the joint goals of the 2030 Agenda and the AU Agenda 2063 (EU, 2022e). In general, the Global Gateway Initiative aims to promote infrastructure development in partner countries through value-based, transparent and trust-based infrastructure partnerships on equal terms that are in line with the 2030 Agenda and the goals of the Paris Agreement. The EU uses a broad understanding of the infrastructure concept that includes structural projects in the areas of digital developments, climate and energy, education, transport and health (European Commission, 2021i). The aim is to mobilize up to €300 billion over the 2021–2027 period from the EU, EU Member States

and the EU's financial and development institutions (EIB and EBRD). However, few tangible proposals have been forthcoming since the initiative was adopted and critical voices are on the increase, especially on the African continent. It seems fair to ask whether this really is a trust-based partnership project or merely the renaming and re-budgeting of initiatives that are already in place.

In the field of health, Global Gateway explicitly refers to the European Health Union, which in turn is based on international cooperation and support: the strengthening of the Union's crisis resilience and strategic autonomy is to be achieved not only through industrial policy or inward-looking measures but also in cooperation with international partners. In addition, it aims to support global partners' preparedness for health crises by supplying them from EU stocks, and in their preparedness for future health crises by developing local skills and production capacity (European Commission, 2021a, d).

With its new Global Health Strategy (European Commission, 2022h), the EU Commission describes key cornerstones, principles and lines of action for implementing the European Health Union's external dimension. The strategy links the European Health Union initiative with the EU's Global Gate initiative and also ties in with the Team Europe approach in European development policy. It explicitly underlines the EU's new aspiration to play a more decisive role in shaping European values not only internally but also at the international and global level, in addition to playing a leading role in financial terms in the implementation of development and health-policy goals. In this way, the strategy makes global health a key pillar of EU foreign policy and an issue of key geopolitical relevance in terms of both cooperation with international partners and the strategic autonomy of the EU itself.

The Global Health Strategy sets three broad and not clearly definable policy priorities: to "(1) deliver better health and well-being of people across the life course; (2) strengthen health systems and advance universal health coverage; and (3) prevent and combat health threats, including pandemics, applying a One Health approach."

The strategy recognizes that, compared to the previous EU Global Health Strategy adopted in 2010, which was considered to have had little influence (Veron et al., 2022:1), new requirements in terms of content and new approaches to implementation are necessary. New causes of disease such as climate change, environmental degradation or humanitarian crises must be taken into account, as must new or growing challenges from antimicrobial resistance, mental illnesses or personnel and material bottlenecks in health and care systems, as well as the challenges and opportunities generated by digitalization. Finally, the strategy must bear in mind the changing geopolitical situation and, following the experience of the COVID-19 pandemic, address issues

Box 7.4-2**Guiding principles of the new EU Global Health Strategy**

1. Prioritise tackling the root causes of ill health, paying particular attention to the rights of women and girls, and to vulnerable populations and disadvantaged groups.
2. Improve equitable access to a full range of essential health services from health promotion to disease prevention and affordable quality treatment, rehabilitation and palliative care to fight communicable and non-communicable diseases.
3. Improve primary healthcare with built-in surge capacity, and enhance core public health capacities to meet the requirements of the International Health Regulations.
4. Foster digitalisation as a fundamental enabler.
5. Boost global health research to develop the technologies and countermeasures which are necessary to improve health.
6. Address workforce imbalances and foster skills.
7. Strengthen capacities for prevention, preparedness and response and early detection of health threats globally.
8. Work towards a permanent global mechanism that fosters the development of and equitable access to vaccines and countermeasures for low- and middle-income countries.
9. Negotiate an effective legally binding pandemic agreement with a One Health approach and strengthened International Health Regulations.
10. Build a robust global collaborative surveillance network to better detect and act on pathogens.
11. Apply a comprehensive One Health approach and intensify the fight against antimicrobial resistance.
12. Link effectively all policies and measures that have an impact on global health within the Commission, EU agencies and EU financing institutions.
13. Better link and coordinate policies and measures of the EU and its Member States to speak with one voice and deliver effective action worldwide.
14. Support a stronger, effective and accountable WHO.
15. Steer the new global health governance by filling gaps and ensuring coherence of action.
16. Ensure a stronger EU role in international organisations and bodies.
17. Expand partnerships based on equal footing, co-ownership, mutual interest and strategic priorities.
18. Strengthen engagement with key global health stakeholders.
19. Enhance EU finance for global health with maximum impact.
20. Assess progress and ensure the accountability of the EU's global health action through permanent monitoring and assessment.

Source: European Commission, 2022h

of equity and sovereignty (in the sense of strategic autonomy and resilience) in the health sector.

The strategy outlines a comparatively detailed and comprehensive picture of the goals of global health policy in twenty guiding principles and further differentiated lines of action (Box 7.4-2). The strategy addresses internal cooperation within the EU Commission and between the Commission and Member States but also multilateral health governance and partnerships, with which the EU would like to become more involved in global health policy in the future. In the strategy, the EU clearly positions itself in favour of concluding a legally binding pandemic treaty (Section 7.3) and strengthening the WHO as a key multilateral actor. At the same time, the EU itself is seeking a more influential, autonomous role in the WHO (and also in other international organizations in line with its financial contributions) and is seeking the support of the G7, G20 and other international partners to achieve this. In addition, strategic 'real' EU health partnerships with other countries and regions will be expanded, in which both sides assume their respective responsibilities for global health, and health will be reinforced as a key pillar of the Global Gateway Initiative. Economically weaker countries and regions and those with weaker health systems are to be specifically supported in achieving sovereignty in the health sector, and enabled to contribute to the implementation of the global

health goals. A separate section on financing announces an increase in funding and the generally stronger orientation of EU programmes towards funding global health. The application of innovative financing models involving private investors is also addressed.

As the Global Health Strategy was only presented at the end of 2022, its implementation cannot yet be assessed. Initial reactions criticize the relatively strong focus on health security and, correspondingly, on human health, and the fact that only weak references are made to ecosystems or climate-change mitigation (van den Pas, 2022; Kickbusch, 2023), although climate-change mitigation, biodiversity protection and environmental pollution are mentioned in the strategy in principle. The strategy also aims at a stronger role for private investors in financing issues, which is criticized by some (van den Pas, 2022) and praised by others (Veron et al., 2022). The rather general statements on international trade and on the discussion of intellectual property are viewed critically, as they leave open whether the EU consistently lives up to its own claim of cooperation with sovereign partners in the field of health through corresponding transfers of knowledge and technology (Kickbusch, 2023; Veron et al., 2022: 7 f.).

Overall, the Global Health Strategy nevertheless offers numerous welcome and important stimuli and ideas. The guiding principles (Box 7.4-1) embrace essential elements also formulated in the vision (Chapter 3), such as a focus on disease prevention and health promotion, fairer and more autonomous access to medical care, and the recognition that future diseases and health challenges will affect a large number of policy areas and require cooperation between many different policy areas.

The EU's aspiration to shape global health should also be seen in a positive light. It is underlined by the Global Health Strategy and its implementation by means of targeted partnerships with countries, regions and increased cooperation with other influential actors in the field of global health. However, it remains to be seen how sustainable these stimuli will be. Initially, the strategy is formally a Communication from the Commission which does not bind the Member States. Precisely because of its far-reaching European ambition to shape and integrate, and the EU's simultaneously limited competence to act in the field of health, much also depends on what conclusions the European Council will draw from this Communication; these could have a more binding effect on the Member States (Kickbusch, 2023; Veron et al., 2022: 10). It is therefore all the more important that the strategy provides for a dedicated framework for monitoring and evaluating its implementation and impact, as well as for a regular and structured exchange with stakeholders, the European institutions, the European Council and Europe's civil society on the progress made.

However, economically weaker countries and trading partners in particular are currently looking with a certain degree of scepticism at the EU's stronger aspiration to orient its foreign policy and economic relations more towards climate-change mitigation and sustainability. They see this aspiration as an attempt to push through the EU's own economic interests and to seal off European markets by further integrating climate-related and general sustainability policy objectives and standards (Youngs and Ülgen, 2022). Particular criticism has been directed at the EU's CO₂ border-adjustment mechanism, which in future aims to offset cost and competitive disadvantages for European companies that may arise as a result of European climate policy vis-à-vis foreign competition from countries with less ambitious climate policies. Irrespective of whether this is seen as a deliberate economic-policy strategy on the part of the EU or not, it can at least be criticized for the fact that, although the EU has pursued important goals with initiatives such as the Green Deal, it has for a long time paid only little attention to the effects on other countries, and in particular on Africa as a neighbouring continent (Messner, 2022).

Overall, the EU has hitherto lacked an overarching foreign-policy strategy that consistently refers to the

2030 Agenda and formulates corresponding guidelines for partnerships in a multipolar world (Kloke-Lesch and Hornidge, 2022). The recently presented Strategic Compass for Security and Defence in Europe does not do this, as it lacks both a clear concept on partnerships and a reference to the 2030 Agenda. A foreign-policy strategy that addresses these deficits, on the other hand, could respond to the criticism and concerns from developing countries and counter them with offers of partnerships based on respect. In this way, the EU could also fulfil its part of the necessary cooperative assumption of responsibility for the implementation of the global sustainability agenda.

7.4.5 Recommendations for action

Despite its limited competence to act on health policy, the EU is already very active at the interface of health and the environment. Many of its legislative packages, programmes and initiatives already take up essential elements described in the previous chapters of this report. This policy course should be consolidated and health protection and promotion taken into account even more extensively and systematically than it has been up to now.

Maintain the level of ambition

Despite the economic challenges posed by high energy prices and high inflation, the EU should not scale back its current level of climate and environmental ambition, or give in to pressure from Member States. Germany should work decisively to advance the implementation of the Green Deal, while encouraging cooperation and social equity among Member States.

Expand intra-European solidarity

Strong intra-European solidarity is necessary, especially in view of the current geopolitical and economic challenges. Poorer Member States should be given sufficient support, also to enable them to expand and strengthen their health systems. For example, to promote societal resilience in all Member States, it should not be possible for financial resources to be diverted from long-term prevention and health-promotion measures by short-term savings constraints.

Set up and expand EU-wide transparency mechanisms, evaluation systems and monitoring systems

The surveillance and reporting systems on health-risk factors and health envisaged under the European Health Union should be implemented and extended to

7 Global urgency governance

include non-communicable diseases and their risk factors (Bucher, 2022). In this context, long-term platforms and research infrastructures should be created and expanded wherever possible, to pool and exchange existing knowledge on diseases, risk factors and effective (preventive) countermeasures. Furthermore, in order to enhance its credibility in health-policy fields, the EU should be more transparent and explicit about the extent to which it is active in the field of health protection and promotion, and how it takes health issues into account in its decisions. This also includes the development of a common, more consistent framework for assessing the state of health systems in Member States (Bucher, 2022).

Provide and merge health and environmental data

The EU is currently negotiating the creation of a European Health Data Space. There should be research on whether the initiatives launched in this context are already sufficient to exploit the potential of broader data use for policy, health-system operations and research. In particular, the question should be asked as to whether, in view of the future health challenges as a result of climate change, biodiversity loss and pollution, not only health- and environment-related data but also data on behaviour and socio-economic factors are already sufficiently integrated. The question also arises as to whether data collected by private companies are already sufficiently accessible, especially for research purposes. Attention should be paid in this context not only to the national availability and accessibility of data in the individual Member States but also to cross-border availability for research purposes in the EU (Bucher, 2022).

Expand partnerships and integrate them strategically

As announced in the Global Health Strategy, the EU should seek and strengthen environmental and health partnerships based on mutual cooperation and clear ownership of joint objectives by both sides. Such partnerships should be embedded in an overarching foreign-policy strategy that, unlike the recently presented Strategic Compass for Security and Defence in Europe, explicitly takes up and classifies the 2030 Agenda as a frame of reference. Partnerships should be in line with the goals of the 2030 Agenda and contribute to the implementation of, for example, European climate-change-mitigation goals at the global level. At the same time, the EU should be careful not to exclude economically weaker countries and partners through this strategic approach. Especially in the current (economic) crises, it should support weaker partners ('healthy recover forward') so that they do not have to restrict their own health, climate and sustainability goals or postpone their implementation as a

result of price increases and supply bottlenecks, which restrict financial leeway and/or undermine acceptance for longer-term measures.

7.4.6 Research recommendations

The EU's competences in the health context

Up to now, the EU's has had relatively limited competencies on policy in the health field, although it does have a broader impact on health through other fields of action than might initially be assumed. Nevertheless, there should be research on whether an expansion of competences would have substantial additional benefits in the health sector beyond the decisions on the implementation of the European Health Union, or whether decentralized responsibilities should be retained in accordance with the subsidiarity principle.

Examine sanctioning mechanisms

The newly created mechanisms for preventing and combating health crises in the EU are important steps in principle, but their impact should be scientifically evaluated in detail. In particular, it remains to be seen whether the Member States are actually required to cooperate sufficiently in the event of a crisis. Against this background, it should be examined whether more specific sanctioning mechanisms are necessary and how they could be designed.

Evaluate the EU's 'Healthy together' initiative

The EU's new 'Healthy together' initiative on non-communicable diseases already goes quite a long way in addressing long-term behavioural aspects and prevention, while the Health Union is relatively strongly focused on infrastructures, medicines, medical equipment, etc. Is there anything missing, and if so, what? Where do behavioural aspects and prevention need to be more firmly embedded?

7.5 International funding: overcome barriers

The IPCC's Working Group II regards financial barriers as an important obstacle to adapting the health sector to the consequences of climate change. Adaptation funding often does not reach the areas most affected by the consequences of climate change (IPCC, 2022d). In order to generate the capital needed to achieve multilateral sustainability goals, various financing instruments that combine state development financing and private capital

flows with sustainability goals are being discussed by academics and at the level of multilateral organizations (UN, 2022a). At the same time, UNCTAD and the IMF forecast an annual SDG financing gap of US\$4,300 billion for the period 2020–2025. Many high-income countries are currently falling short of their targets in terms of the level of their contributions to development finance. Low-income countries in particular may be forced by these high financing requirements to take on more debt, which would further worsen their financial position (OECD, 2022a). Even though it is said that the private sector plays an important role in financing this gap, its participation has to date failed to meet the expectations of the 2030 Agenda (OECD, 2022a). Yet the mobilization of private capital is urgently needed, and not only because of global crises such as climate change and biodiversity loss (Mélonio et al., 2022). The Least Developed Countries (LDCs) in particular are not benefiting from private investment at present. From 2012–2018, only 6% of development finance from private sources was directed to LDCs, mainly through multilateral development banks (OECD and UNCDF, 2020).

The following describes instruments which, due to their scalability, can facilitate and accelerate the raising of the necessary amounts of capital and, at the same time, address existing global inequalities with regard to access to capital and the investment opportunities that can be realized from it. Other approaches, such as global public investment, could also be of great importance, but they are currently only used to a very limited extent. The concept of Global Public Investment (GPI), an approach to international development finance proposed by Reid-Henry (Reid-Henry, 2019), can help strengthen the international provision of public funds to promote sustainable development (Glennie, 2019). In contrast to the existing understanding of development finance, GPI seeks to involve a larger number of countries – within their means – in the process of raising and allocating funds. Individual performance would be measured against standardized criteria that have yet to be defined, for example per-capita income or economic growth. Here, as a first step, further research is needed on what factors are necessary to encourage greater use and on how the instruments can be used to promote the vision of ‘healthy living on a healthy planet’.

7.5.1

Debt swaps: reduce debt burdens, strengthen environmental and health protection

Debt swaps have long been seen by academics as a way to encourage investment in areas such as environmental protection or biodiversity conservation while relieving

low- and middle-income countries of some of their debt (WBGU, 2002; WBGU, 2020). At the G7 level, there are calls for greater use of debt-conversion instruments due to the high debt burden of many countries, especially as a result of the economic impact of the COVID-19 pandemic (Deutz and Hansen, 2022). In a debt swap, a lender – usually a state – waives its claim to repayment of a loan that has been granted. In return, the borrowing state agrees to use a predetermined sum to finance a domestic development project. Since debt swaps simultaneously reduce a country’s debt volume and allow investments in areas such as environmental or health protection, they are seen as an attractive instrument of development finance (Essers et al., 2021). For a long time, so-called debt-for-nature swaps were a frequently considered instrument. More recently a wider discussion has developed on debt-for-climate swaps (Volz et al., 2022a), which are intended to enable highly indebted low-income countries to adapt to the consequences of climate change. One of the first debt-for-climate swaps of US\$21.6 million was carried out in 2015 with the participation of Seychelles and the Paris Club, an informal grouping of countries to resolve sovereign debt difficulties (Silver and Campbell, 2018).

In the area of health, too, so-called debt-for-health swaps have been discussed since 1992 within the framework of the WHO (WHO, 1992a). The Global Fund to Fight AIDS, Tuberculosis and Malaria, or Global Fund for short, has been running a programme called Debt2Health since 2007, in which debts are cancelled and redirected into investments in national health systems and disease control. The Global Fund is an initiative of the G8 countries and is funded by donations from governments and the private sector. Germany is one of the countries making the largest contributions to the Debt2Health programme (The Global Fund, 2021). However, the amount of funding available for the programme is limited: in total, only US\$232 million has been raised since 2007 to support national health programmes. Before the Global Fund’s last Replenishment Conference in September 2022, however, Germany pledged a contribution of €100 million for debt swaps in the coming 2023–2025 funding period. Overall, though, funding obtained via debt swaps is only of secondary importance for the Global Fund, which was able to distribute US\$4.2 billion in 2020 alone. The small scale of the Debt2Health programme for financing the Global Fund suggests that the programme does not yet seem to be worth implementing in many countries. At the same time, there has been no assessment of the experience of the countries participating in the Debt2Health programme to date, so that an evaluation of this programme could provide ideas for future improvements (Tandon et al., 2021). There are proposals for measures such as including

sustainability goals and risks in the evaluation of public debt, or offering private investors better incentives to participate in restructuring; one idea is to involve the World Bank in restructuring processes (Volz et al., 2021).

However, this low level of usage of debt swaps does not only apply to debt-for-health swaps. Many of the other debt-swap programmes have also fallen short of initial expectations, so that debt swaps play only a marginal role in international development finance overall; up to now they have done little to alleviate the debt burden of low-income countries (Caliari, 2020). It often remains unclear what additional contribution in terms of funds a debt-swap generates, and what contribution would have flowed into a development project even without the use of this instrument. Parallel structures, such as the Global Fund's Debt2Health programme, are often set up to distribute funds; it would therefore be possible for funds to bypass systems and decision-making processes in the borrowing country (Essers et al., 2021). The process of carrying out a debt swap is still hardly standardized, so that high transaction costs relative to the volume are incurred.

In total, high transaction costs and lengthy processes mean that the volume of debt-swap transactions to date has been negligible, especially in relation to the existing total debt volume of low- and middle-income countries. Parallel to this, a critical academic discussion on the debilitating effects of high public debt in low-income countries should be noted: these effects result in the emergence or continuation of dependencies and unequal power relations and cannot be solved by debt swaps (Penet and Flores Zendejas, 2021).

On the other hand, the ongoing academic debate on debt swaps from different viewpoints shows that the instrument is still seen as having the potential to become more widespread (Caliari, 2020). The combination of financial relief for indebted countries and investment in their health systems or adaptability to global environmental changes is one of the main arguments in favour of debt swaps. To encourage greater use, it is important to avoid too much fragmentation (debt-for-health, -climate, -nature) of programmes and, where possible, to standardize the associated processes to reduce the currently high transaction costs (Sirimaneetham, 2021). It should be taken into consideration that such processes take place at a global level, so that debt swaps are not focused on the claims of high-income countries as in the past. Standardizing the processes for implementing debt swaps, regardless of the individual use in each case, can help to promote their dissemination. A scientific evaluation of existing debt-swap programmes, especially the Debt2Health programme, can help identify best practices. For debt swaps related to climate change and SDGs, the UN Economic and Social Commission for Western Asia

has developed an initial proposal on how debt swaps can also be used more frequently in middle-income countries by means of regional cooperation (UN ESCWA, 2022).

7.5.2

International Finance Facility for Immunisation as a model for climate finance

The International Finance Facility for Immunisation (IFFIm) is an institution founded in 2006 that raises funds from private investors for the goals of the Global Alliance for Vaccines and Immunization (Gavi) by issuing so-called vaccine bonds (Fig. 7.5-1). Gavi is an alliance of public and private groups that provides low-income countries with rapid and widespread access to immunization against diseases such as polio. Children are a special focus group for Gavi. Using the IFFIm was also discussed for the distribution of a vaccine against COVID-19 (Stamm et al., 2021). The IFFIm is one of the most successful innovative financing instruments in the field of global health (Atun et al., 2017). Thanks to payment commitments by high-income countries that guarantee repayment of the funds raised, the IFFIm raises funds on international capital markets to subsequently on-lend to Gavi. These guarantees from countries with high credit ratings also lead to a high credit rating for IFFIm's vaccine bonds, which makes an investment attractive and low-risk (Fig. 7.5-1).

Raising private funds makes it possible to front-load necessary investments (Barder and Yeh, 2006). Front-loading here means the implementation of programmes – immunization programmes in the case of the IFFIm – within a short period of time by raising private capital, instead of spreading the programme over a longer period of time. The successful approach of front-loading investments by attracting private funds backed by repayment commitments from high-income countries could also be used for climate finance (Ketkar, 2014; Kraemer et al., 2022) or for implementing the SDG Fund proposed by UN Secretary General, António Guterres. In this way, high-income countries could share the great financing requirements for climate-change adaptation and mitigation measures in low-income countries without any short-term impact on their current budgets. Kraemer et al. (2022) propose a Finance Facility against Climate Change (F2C2), which could be set up under the auspices of the G20. As with IFFIm's vaccine bonds, the favourable financing conditions achieved through the high credit rating could also help low-income countries, which would have been offered significantly worse conditions if they had tried to raise private funds directly.



Figure 7.5-1

Structure of the International Finance Facility for Immunisation (IFFIm), which generates funding for the Gavi immunisation alliance.

Source: IFFIm, 2022

7.5.3

Mobilize private capital: identify instruments

In recent years, several other instruments have been developed which international institutions or companies can use to mobilize private capital for implementing sustainability goals. Social impact bonds are just one instrument; it is examined here as an example.

Social impact bonds are bonds that link the amount of repayment from a loan taken out to the achievement of predefined sustainability goals. The funds raised through the bonds are used to combat social problems and usually involve savings for the borrowing side; these are then available to repay the loan (Edmiston and Nicholls, 2018). When social impact bonds are aimed at projects in low-income countries, they are also called development impact bonds (Clarke et al., 2018). However, social impact bonds in the health sector, e.g. with reference to non-communicable diseases, are currently not widespread, and their success has not yet been sufficiently scientifically evaluated. This low level of use does not only apply to the health sector, so there is as yet no verified empirical evaluation of the success of social impact bonds (Fraser et al., 2018). At the same time, due to the sharp increase in the use of green bonds in recent years, bonds with sustainability characteristics have become known to a broad mass of investors, which could also increase the future acceptance of social impact bonds. Points of criticism must also be considered in an analysis of social impact bonds, such as the consequences of a possible economization of charitable and social purposes and processes (Broccardo et al., 2020).

7.5.4

Recommendations for action

Reduce the debt burden of low-income countries

Many middle- and low-income countries suffer from a crushing debt burden that severely limits their ability to act. Due to the considerable financing gap for the necessary implementation of multilateral sustainability goals, there should be more discussion on restructuring these debts (Volz et al., 2021).

Increase the use of debt swaps as an instrument of development cooperation

The WBGU recommends making greater use of debt swaps as an instrument, and advocating the international standardization of debt-swap processes. Debt swaps can reduce the high debt burden of low-income countries while promoting the achievement of multilateral sustainability goals. Programme-specific debt swaps (e.g. debt-for-climate swaps) can ensure that the released funds are used for the intended purpose. To ensure widespread use, the processes should take place at a global level and excessive fragmentation should be avoided.

Create a Finance Facility against Climate Change

Following the example of the International Finance Facility for Immunization, a programme for frontloading investments with the participation of private investors should also be set up for climate finance.

7.5.5

Research recommendations

Evaluate and standardize debt swaps

A scientific evaluation of existing debt-swap programmes, especially the Global Fund's Debt2Health programme, can help identify best practices. In particular, standardized processes should be identified that avoid a fragmentation of programmes (debt-for-health, -climate, -nature) and reduce transaction costs.

Explore options for private participation in debt swaps

Debt swaps currently take place largely at the intergovernmental level, but there are also substantial debt claims on low- and middle-income countries in the hands of private investors (Volz et al., 2022a). In order to encourage them to participate in debt swaps, suitable measures and incentives should be researched and identified so that these investors also use their claims on debtor countries for debt swaps.

Identify further instruments and approaches for increased development financing

Although there is a range of different proposals for financing instruments, they are often only used to a limited extent. Instruments should in particular attract private funding and be used at state level by a large number of countries. The Global Public Investment approach and social impact bonds are two possible starting points.

Design of Global Public Investment

The Global Public Investment approach seeks to involve a larger number of countries in the distribution of funds raised via international development finance. The approach sees not only high-income countries as responsible for contributing to financing but also low-income countries within the framework of their respective individual capacity. Currently, however, there are no structures under which such international cooperation can be carried out. The aim is to identify the criteria that can be used to determine the performance of individual countries, how the decision-making processes can be structured, and which problems should be prioritized using the Global Public Investment concept (EWG-GPI, 2022).

Social impact bonds as a financing instrument

Social impact bonds link the repayment amount of a loan to the achievement of predefined sustainability goals, but are currently only used to a very limited extent, both in terms of the number of bonds and the amount of funds acquired. In order to make greater use

of them, there is a need for a scientific analysis of the success or failure of past social impact bonds and of the best possible design, for example in the health sector. At the same time, the existing points of criticism – e.g. the consequences of a possible economization of charitable and social purposes and processes – must be examined (Broccardo et al., 2020).

7.6

Corporate responsibility: from voluntary commitments to legal due-diligence obligations

The private sector has an important role to play in achieving multilateral sustainability goals, especially in providing financial resources, developing innovative technologies and restructuring or exiting unsustainable value chains. In addition to the urgently needed implementation of measures to finance climate-change mitigation, companies can be encouraged by various instruments to link the areas of environment and health, which have hitherto largely been considered separately both in reporting and in their internal analysis of the impacts of their corporate actions (Sajjad, 2019). This section analyses options on how companies can live up to their own responsibilities, and how investors and countries can demand corporate responsibility. This begins with low-threshold measures such as reporting, and extends to internationally agreed and legally binding due-diligence obligations on compliance with human rights and environmental protection in the supply chain. The measures also address various actors. Looking at a company's responsibility for health and environmental protection, it can be seen that influence is not only exerted within a company (e.g. protecting its own employees' health or avoiding direct environmental pollution), but that corporate action in particular also affects upstream and downstream areas (Fig. 7.6-1). Accordingly, ways must be identified to promote indirect corporate responsibility, which includes upstream impacts and the effects of the goods produced.

The indirect and direct consequences of corporate action for the environment, health and climate are illustrated by the example of lithium (Box 7.6-1). In the course of the transition to electromobility, the material flows of modern technical metals such as lithium, cobalt and rare-earth elements will increase significantly because of the energy transition and the necessary production of lithium-based batteries (Buchert et al., 2019; European Commission, 2020b; Marscheider-Weidemann et al., 2021). In 2022, approx. 130,000 tonnes of the raw material lithium were mined worldwide, about 80 % of which was used for batteries. By 2050, demand for lithium is expected to increase to 1.1 million tonnes

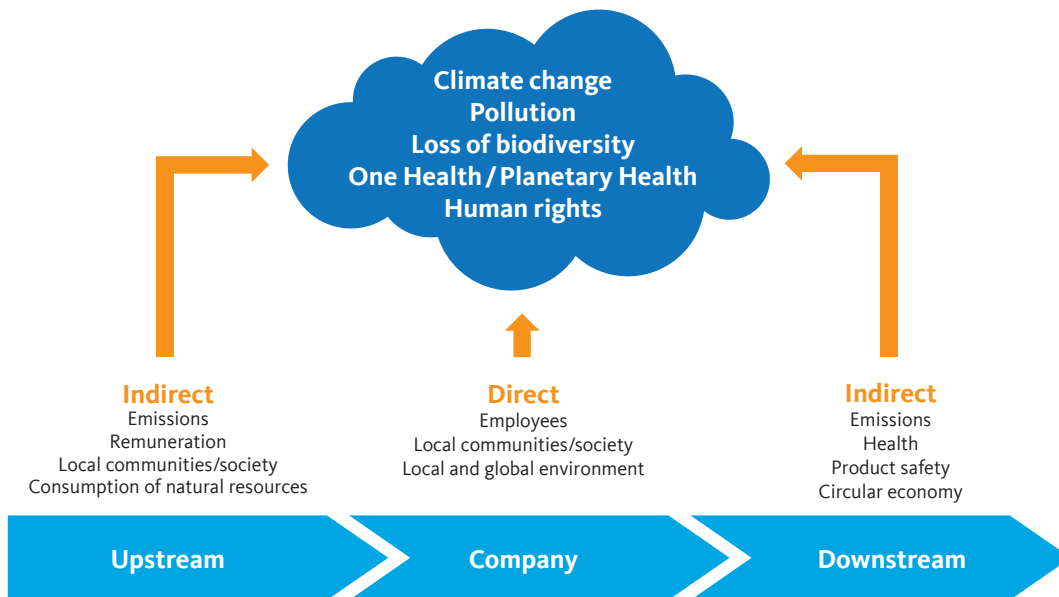


Figure 7.6-1

Effects of entrepreneurial action on environmental and health protection and climate-change mitigation. Effects are caused both by a company's direct actions and by upstream and downstream processes.

Source: WBGU based on UN Global Compact, 2019

(U.S. Geological Survey, 2023; Buchert et al., 2019, 2020). On the one hand, this is problematic because the supply of lithium is already classified as critical (European Commission, 2020k). On the other hand, a prescient approach to this valuable resource is necessary in order to identify in good time potential hazards for humans and the environment due to the complex interacting effects of the use of lithium-based batteries.

7.6.1

Corporate social responsibility: voluntary commitment and reporting

Terms such as corporate social responsibility, corporate responsibility, corporate social responsiveness and corporate sustainability are defined in different ways and can therefore not be clearly distinguished from each other. An originally narrow understanding of corporate responsibility with a focus on social concerns, such as towards the company's own employees, has been expanded over time to include ecological aspects in particular. The EU understands CSR as "the responsibility of enterprises for their impact on society" (European Commission, 2011). The prerequisite for being able to hold companies accountable for sustainability transformations is transparency about corporate actions. This is mainly achieved by means of reporting on compliance with environmental and human-rights standards in the value chain. Many

studies show the diverse positive effects of increased transparency achieved through corporate sustainability reporting (Dhaliwal et al., 2012). These positive effects are both financial and non-financial, and benefit both the companies themselves and the general public. For example, companies benefit from easier financing options due to lower capital costs (Cheng et al., 2014; Christensen et al., 2021a; She, 2021), and the general public benefits from the increase in corporate efforts and activities on sustainability (Jackson et al., 2020).

In order to meet the great demand for sustainability information, various laws and processes have been initiated aimed at increasing sustainability reporting (Bassen et al., 2020). The publication of sustainability reports was voluntary for a long time in the EU; then new guidelines on non-financial reporting (EU, 2014) made sustainability reports mandatory for the first time for capital-market-oriented companies, as well as for banks and insurance companies with more than 500 employees. To achieve this, an extension of the reporting obligations was decided in 2022 (EU, 2022d).

Outside the EU, there are no internationally uniform and mandatory reporting standards or obligations. Instead, initiatives launched by non-governmental or international organizations exist in various areas, which companies can join. The UN's Guiding Principles on Business and Human Rights (UN, 2011) and the UN Global Compact Initiatives aim, among other things, to motivate companies to assume responsibility voluntarily, especially

Box 7.6-1**Case study: environmental and health impacts of the economic use of lithium**

The life cycle of lithium products begins with raw-material mining, which causes significant negative environmental changes such as water shortages in already dry regions where lithium is mined from salt lakes using evaporation processes (Harper et al., 2019; Liu and Agusdinata, 2020; Schmidt et al., 2023). This amplifies the effects of the climate crisis and can have significant impacts on the fragile ecosystem (Gutiérrez et al., 2022; Sonter et al., 2020). Furthermore, the decline in water resources affects the local population and their agriculture and livestock (Buchert et al., 2020; Schüler et al., 2018; Friends of the Earth Europe, 2013; Agusdinata et al., 2018). During lithium extraction from salt lakes, the emission of toxic process chemicals into the air, water and soil also poses a risk to human and environmental health (Friends of the Earth Europe, 2013). The main lithium-extraction method in Australia is mining from rock, but this also involves risks. Residues could be unintentionally released through fractures in the tailings ponds or as a result of seepage, and thus contaminate the groundwater (Buchert et al., 2020). In addition, the process waste, which is hazardous to health and is discharged into rivers, has serious consequences for the environment. For example, the mass death of fish in the Lichu River in Tibet is attributed to contamination from lithium mining (Tibet Policy Institute, 2016). The consequences for humans and the environment caused by the future increase in demand for lithium and other raw materials are predictable.

Further hazards occur at the end of the life cycle of lithium-based products. 700,000 tonnes of lithium-ion batteries are expected to be recycled worldwide in 2025 (Melin, 2019; Neumann et al., 2022). However, current recycling processes for lithium extraction are too energy-intensive and often emit higher greenhouse gases than mining the primary raw material (Ciez and Whitacre, 2019; Harper et al., 2019). Moreover, storage in landfills and the recycling process entail risks such as the explosion of battery cells, causing the emission of pollutants into the environment (Winslow et al., 2018; Christensen et al., 2021b). During dismantling, toxic gases, flammable electrolyte and toxic additives, among other things, become health hazards (Harper et al., 2019; Wagner-Wenz et al., 2023). Lithium itself can be absorbed through the air, for

example during the dismantling of e-waste, and is suspected of causing lung damage in this form (Grant et al., 2013; WHO, 2021g). Dissipation of dissolved lithium in water and soil from EOL products and associated problems for humans and the environment are also possible (Weidenkaff, 2019; Avila-Arias et al., 2019; Li and Achal, 2020; Bolan et al., 2021). Elevated concentrations of lithium of anthropogenic origin have been found, for example, in drinking water and rivers in Seoul (Choi et al., 2019). Although lithium concentrations in the range of 0.8–2mmolL⁻¹ in blood serum are used to specifically treat bipolar disorders, for example (Sproule, 2002; Léonard et al., 1995; Aral and Vecchio-Sadus, 2008), higher doses have been observed to cause toxic effects in plants (Aral and Vecchio-Sadus, 2008; Tanveer et al., 2019; Shahzad et al., 2016; Bolan et al., 2021), in aquatic systems (Kszos and Stewart, 2003; Bolan et al., 2021) and in humans, ranging from drowsiness and confusion (>1.5mmolL⁻¹) to coma (>3mmolL⁻¹) (Simard et al., 1989; Sproule, 2002; Aral and Vecchio-Sadus, 2008; Bolan et al., 2021). The sequence from the collection process to storage, recycling and the recycling process itself, or the preparation of the products for reuse, must therefore be safe and well organized. It requires the provision of information for the relevant actors along the supply chain. One approach to this is a battery passport and the EU product passport (Plociennik et al., 2022; European Commission, 2020a, 2022j). Although work is also being done on alternatives to lithium-ion batteries, e.g. on the basis of sodium, which occurs in large quantities and is recyclable, their limited energy density and charging rates make them unsuitable for mobile applications; they are mainly used for stationary energy storage. Thus, lithium will be needed in future battery applications, and research is being conducted into variants that are more resource-efficient (Fichtner et al., 2021).

The technical applications needed for sustainability transformation are characterized by inequalities along the supply-chain process. The mobility turnaround made possible by lithium batteries has a positive impact, at least initially, especially in high-income countries, which benefit from reduced air pollution. Globally speaking, everyone benefits from reduced greenhouse-gas emissions. However, these gains are achieved at the expense of the mining regions. The deficits have not been sufficiently analysed, and there is a lack of guidelines for transparent supply chains to protect the life-support systems of people and the environment.

with a focus on human rights, workers' rights and the prevention of corruption. The SDGs are now increasingly being taken into account in companies' non-financial reporting (Elalfy et al., 2021), although quality varies considerably (Hummel and Szekely, 2022). Companies often only report in general terms on possible contributions to the SDGs, mostly limited to a few selected goals, and rarely declare concrete SDG-related goals of their own (Hummel and Szekely, 2022; Section 7.2.2).

The large number of ongoing processes on sustainability reporting – such as the development of uniform standards in the EU or the reporting on climate risks by companies in the USA – underline how important it

is to achieve an internationally uniform and consistent method of collecting and reporting non-financial data (UN, 2022a). Without neglecting region- and sector-specific characteristics, a uniform orientation of reporting requirements can simplify investors' decision-making processes and improve the comparability of different companies' sustainability efforts.

Obligatory and clearly defined reporting obligations overcome the accusation made against voluntary reporting that companies only publish information that shows the company in a positive light and conceal possible risks in relation to sustainability (Christensen et al., 2021a). When implementing mandatory sustainability reporting,

special attention must be paid to four points, to which the WBGU also attaches great importance (Christensen et al., 2021a). First, it should be taken into account that CSR reporting is used by a broader group of stakeholders, such as non-governmental organizations, than pure financial reporting, so that different interests have to be served in terms of information requirements. Second, due to the manifold impacts of corporate activities on the environment and health, a focus should be placed on double materiality, as currently practised in the European Union. Double materiality, as opposed to single materiality, takes into account both the factors that have a financial impact on the company itself and the impact of corporate action on society (e.g. in relation to climate, biodiversity, the human right to health). Third, mandatory reporting obligations should be as detailed as possible, ideally by including quantitative indicators. Fourth, external verification of information published by companies is important to ensure its stringency.

The current status of the European Sustainability Reporting Standards (ESRS) reflects the division into direct and indirect effects of corporate action (Fig. 7.6-1). The social reporting obligations are divided into the four areas: own employees, employees in upstream and downstream value-creation processes, and customers and communities affected by entrepreneurial activities. Some of the environmental and health impacts of corporate activities are already considered together in the current reporting obligations and placed in context. For example, companies are expected to report on environmental health impacts resulting from business activities such as pollution or access to clean water (EFRAG, 2022). However, these descriptive reporting obligations could be supplemented in the future with quantitative indicators that combine environmental and health information. The first step here is to identify which areas are of particular importance, e.g. the health impact of pollution caused by corporate activities, and how these can be summarized in an indicator.

7.6.2 Demand corporate responsibility in the supply chain through ambitious legal due-diligence obligations

A legal development can be observed in Europe that obliges companies to comply with environmental and human-rights protection (including health protection) via legally regulated due-diligence obligations when a company manufactures products outside its country of domicile (Box 7.6-2). In February 2022, the European Commission submitted a proposal for a directive on corporate due diligence with regard to sustainability, amending

Directive (EU) 2019/1937 (European Commission, 2022e; Box 7.6-2), in order to harmonize the due-diligence requirements that already exist in some Member States.

In the case of due-diligence requirements, those subject to the regulation are only required to act diligently (“obligation to try” Beckers, 2021), but not to achieve a specific result (Bäumler, 2020). This accommodates an economic reality in which companies often have neither an overview of, nor control over, the origin of their materials. For example, an analysis of disclosures on the use of conflict minerals in the USA shows that 80% of all companies cannot rule out using conflict materials (Kim and Davis, 2016). In addition to reporting obligations, companies are required to take measures to regulate their supply chains (Beckers, 2021), i.e. to gain a better overview and control of the origin and manufacturing conditions of the raw materials and products supplied, in order to avoid human-rights violations and environmental destruction in the supply chain (Box 7.6-2).

In addition to legal developments within the EU, international negotiations are being held on a binding legal instrument for the protection of human rights at the multilateral level. As early as 2014, the UN Human Rights Council, on the initiative of Ecuador and South Africa, convened an “open-ended intergovernmental working group on transnational corporations and other business enterprises with respect to human rights” with the mandate to negotiate an international, legally binding instrument regulating the activities of transnational corporations and other business enterprises for the protection of human rights – against the votes of all ‘developed’ countries and with the abstention of many so-called developing countries (UNHRC, 2014). This working group is already the third attempt to agree on a binding instrument under international law on the protection of human rights in international business activities: in 1977–1990, work was done on a draft code of conduct for transnational corporations, and in 1999–2003, a draft was prepared for binding guidelines on the working methods and activities of transnational corporations; both of these attempts failed (Deva, 2022). In 2022, there were negotiations on a third revised draft for a binding instrument under international law on corporate responsibility for human rights and the environment (UNHRC, 2022a; Box 7.6-3). It is still unclear whether and with what content broad support for the proposal can be generated. Although the EU has backed the process in the meantime, the German G7 Presidency in 2022 did not succeed in rallying the G7 decisively behind the process.

The transformation of international supply chains should be understood as a (design) task of the international community in which national, internationally binding and internationally non-binding standards and instruments interact in the transnational space

Box 7.6-2**European supply-chain laws and the EU Commission's draft due-diligence directive****Development in the EU Member States and the EU**

Several countries in Europe have enacted laws that address corporate responsibility for the environment and human rights in supply chains. Examples are the Modern Slavery Act (UK Parliament, 2015), the *Loi de vigilance* (Assemblée nationale, 2017), the Child Labour Due Diligence Act (Ministerie van Buitenlandse Zaken, 2019), the Supply Chain Due Diligence Act (Deutscher Bundestag, 2021) and the Transparency Act for the Protection of Human Rights and Fair Working Conditions (Ministry of Children and Families, 2021). With the Timber Trade Regulation (EU, 2010) and the Conflict Minerals Regulation (European Commission, 2017b), the EU has adopted corresponding legal acts that have a direct effect in the Member States. A proposal for a regulation banning imports and exports of products linked to deforestation and forest degradation is also currently in the legislative process. The way in which supply chains are regulated by European states is currently complex and confusing. A distinction must be made between legal acts that provide for sector-specific obligations (e.g. human-rights obligations for conflict minerals in the European Conflict Minerals Regulation or environmental standards for imports of timber products in the European Timber Trade Regulation) and obligations specific to protected goods, such as the avoidance of child labour (e.g. the Dutch Child Labour Due Diligence Act of 2019). Other laws establish general due-diligence requirements, e.g. the French *Loi de vigilance* or the German Supply Chain Due Diligence Act. There are also differences in the planned enforcement of the due-diligence obligations that have been laid down. One group of supply-chain due-diligence laws provides for purely public-law enforcement (e.g. German Supply Chain Due Diligence Act), another also includes private-law enforcement mechanisms, i.e. liability regulations between private parties (e.g. *Loi de vigilance*).

Proposal for a Directive on corporate due diligence with regard to sustainability, amending Directive (EU) 2019/1937

On the initiative of the European Commission, a proposal for a Corporate Sustainability Due Diligence Directive (CSDDD) is currently passing through the legislative process in the EU.

The proposed directive contains obligations for companies with regard to actual and potential negative impacts on human rights and the environment, as well as liability rules on violations of these obligations. The scope covers companies incorporated in the EU with more than 500 employees and a worldwide net turnover of more than €150 million. In the sectors classified as high-impact – ‘production of and trade in textiles’, ‘production and trade in agriculture, forestry and fisheries’ and ‘handling of mineral resources’ – companies with more than 250 employees and a worldwide net turnover of more than €40 million are already covered. Non-EU companies fall within the scope of the Directive if they have an annual net turnover within the Union of more than €150 million, or €40 million in turnover in the sectors mentioned.

The target of the due-diligence obligations is the negative impact on the environment and human rights of both the company's own business activities and those of subsidiaries and companies in the value chain with which established business relationships are maintained. Negative impacts on human rights are defined by the Directive as adverse impacts on protected

persons resulting from violations of the rights and prohibitions contained in international human-rights conventions. Environmental obligations arise from a breach of internationally recognized objectives and prohibitions included in environmental agreements. These include the Convention on Biological Diversity and its protocols, the Washington Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Minamata Convention on Mercury, the Stockholm Convention on POPs, the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, the Vienna Convention for the Protection of the Ozone Layer and the related Montreal Protocol, and the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal.

Climate-change mitigation is not covered by the environment-protection provisions listed in the Annex to the Directive. Article 15 of the draft Directive provides for a special rule: companies within the scope of the Directive should set out a plan to ensure that the company's business model and strategy are compatible with the transition to a sustainable economy and with limiting global warming to 1.5°C in accordance with the Paris Agreement (Art. 15 of the draft Directive). Companies should identify to what extent their operations constitute a major risk to or have a major impact on climate change. Emission-reduction targets should be included in the plan if the company's operations have been identified as presenting a major risk to or having a major impact on climate change. This provision can be described as a foreign body in the Directive, but it does justice to the urgency of climate-change mitigation.

Companies are not held responsible for every violation of environmental or human-rights law, but only for those through which they ignore more specifically formulated due-diligence obligations. According to Article 4–11, due-diligence obligations are deemed to be met (a) if companies integrate compliance with environmental and social standards into company policy by (long-term) strategy formation, codes of conduct and their implementation in measures, (b) if they identify actual or potential negative impacts on human rights and the environment, avoid and mitigate potential negative impacts, and remedy actual negative impacts and minimize their extent. Complaint procedures should be set up and maintained for affected persons, workers' representatives and civil-society organizations active in this field so that they can make claims on the company for due-diligence violations. The effectiveness of its due-diligence policies and measures is to be monitored by the company itself. Public communication on due diligence must take place via corresponding reporting.

Companies with a turnover of more than €40 million and less than €250 million that are active in critical sectors (textiles, agriculture, mineral resources) only have to account for severe negative impacts, i.e. impacts that are particularly serious by their nature, affect a large number of people or a large area of the environment, are irreversible or particularly difficult to remedy (Art. 3 lit. 1).

In order to ensure enforcement of the Directive, Member States are expected to create or equip supervisory authorities to ensure compliance with the provisions adopted in implementation of the Directive (Art. 18). Natural and legal persons are to be entitled to raise substantiated concerns about compliance with the Directive with the supervisory authorities (Art. 19). Effective, proportionate and deterrent sanctions are to be imposed (Art. 20). Furthermore, civil liability for breaches of duty under Articles 7 and 8 of the Directive is to be ensured (Art. 22).

Box 7.6-3**Draft for a binding instrument under international law on the protection of human rights by business enterprises (3rd draft)**

In October 2022, the third revised draft was available of a binding international instrument on the protection of human rights by corporations with comments by the negotiating states (UNHRC, 2022b).

The primary objectives of the agreement are to clarify and simplify the effective enforcement of state obligations to respect, protect, ensure and promote human rights in the context of business activities, and to establish corresponding corporate responsibilities (Art. 2 lit. a and b).

The scope of application of the treaty is controversial. Some states intend to restrict the requirements only to transnational companies, others want to include all companies in principle (Art. 3.1). In any case, the states are to be given the option of distinguishing between enterprises of different sizes and sectors in the acts of transposition (Art. 3.2). With regard to the material scope of application, it still seems open which violations of human and environmental rights are to be included (Art. 3.3). Much of the text refers only to human-rights violations, owing to the origins of the process in the negotiations on business and human rights. Some states intend to limit the

scope of application to serious violations only, but it would also be possible to open the scope to all violations, and to differentiate between violations and the severity of the due diligence required on the legal consequences side (Deva, 2022).

Articles 4 and 5 of the draft contain provisions to ensure that the rights under the Directive are indeed exercised: information rights, right to legal assistance and protection rights of the persons concerned, their representatives, families and witnesses.

Article 6 obliges states to regulate business activities in such a way as to prevent violations of human and environmental rights. Similar to the draft of the European Corporate Sustainability Due Diligence Directive (CSDDD), reasonable due-diligence obligations are to be imposed on companies depending on their size, including impact assessments, monitoring and avoidance measures. The exact scope of these due-diligence obligations is still unclear.

Articles 7 and 8 contain detailed provisions on legal remedies as well as civil, administrative and criminal liability provisions for corporate human-rights violations. It is controversial whether compensation payments for people affected should also be included (Art. 8.4). Articles 9-13 of the draft contain further provisions to reduce barriers to access to legal remedies for affected persons.

This instrument of international law is to be further developed by means of protocols (Art. 17), and amendments require a two-thirds majority (Art. 21).

(Peters et al., 2020). An ambitious and coherent legal development of international and European due-diligence obligations or requirements for supply chains could trigger the transformation of global supply chains towards sustainability with numerous added benefits for the environment and health. The international negotiations on corporate responsibility are an important instrument for breaking down political silos on companies' human-rights responsibility on the one hand, and sustainability and environmental protection by companies on the other (Deva, 2022; Box 7.6-3).

European and international legal development should be understood as complementary, mutually reinforcing processes that differ in terms of legal nature, objectives and scope of application, but complement each other (Bernaz et al., 2022). In order to create a level playing field, the European Due Diligence Directive should see itself as an act that implements international agreements and provides international stimuli. At the same time, the EU and Germany should engage constructively in the international negotiations on binding due-diligence obligations for environmental and human-rights protection. This is particularly necessary because Europe's economic power is linked to historically developed dependencies (Section 2.1). In addition, displacement effects can be avoided in this way (Deva, 2022).

Transforming supply chains towards sustainability will require progressively assigning more and more

responsibility for supply relationships to companies. In the long term, this will require not only formal due diligence – as has been the case up to now only in relation to behaviour – but also material, performance-related due diligence. Moreover, binding product and import standards should be considered. For example, European Commission draft deforestation legislation provides for a general ban on marketing, supplying and exporting products related to deforestation. The associated due-diligence obligation is described in detail. A benchmarking system that identifies countries or regions with a particularly high risk of deforestation is to be introduced to facilitate implementation (European Commission, 2021b).

Companies should not be able to avoid their due-diligence obligations too easily by means of reporting and established procedures. On the other hand, research needs to be carried out on what exactly a material claim can look like: for example, different obligations and standards could be established for different types of supply chains (Beckers, 2021). One example here is the regulation of lithium supply chains with respect to extended corporate responsibility for product recyclability (Box 7.6-4).

Finally, in order to ensure the broadest possible monitoring of how the relevant regulations are implemented, it is necessary to provide for the broadest possible enforcement mechanisms and legal protection options. This includes sanctions under public law and criminal law (for particularly serious violations) as well as civil liability

Box 7.6-4

Case study on lithium – extended corporate responsibility for circular economic activity

In view of the large amounts of end-of-life (EOL) lithium products expected in the future, it is important for environmental and health protection to manage the way these products will be handled. Key to this is the concept of Extended Producer Responsibility (EPR), which transfers the physical (recycling, etc.) and financial responsibility for EOL products to the producer. In the case of battery recycling, for example, regulations on the handling of batteries at the end of their life cycle were introduced in the USA as early as 1995 and 1996 (Resource Conservation and Recovery Act, Battery Act). China has also passed various regulations on battery handling since 2016 (Neumann et al., 2022).

In the EU, the Battery Directive 2006/66/EC (EU, 2006) and Directive 2012/19/EU on Waste Electrical and Electronic Equipment (EU, 2012) are the key pieces of legislation, with a proposed amendment to the Battery Directive already on the table (European Commission, 2020i). According to these

directives, the EU takes the following approach: EPR, minimum use of recyclates, collection targets, labelling, battery passport with information on the life cycle, carbon footprint of batteries used in e-mobility, stricter social and environmental standards along the supply chain including corporate due diligence in international raw-material chains (European Parliament, 2022; Neumann et al., 2022; BMUV, 2022). Germany's Battery Act provides, among other things, for nationwide, manufacturer-centred take-back systems and an expansion of collection points to ensure compliance with the EU Directives. In this context, an ecological design of the take-back systems is obligatory in order to minimize emissions of hazardous substances. Reusability, for example, can contribute to this and should be rewarded. The producer's obligation to inform end-users about risks and uses of spent batteries now includes, i.a., the effects of the substances they contain on the environment and health, as well as measures to prevent waste. The act did not include a deposit obligation – like the one between the distributors and end-users of vehicle batteries (Section 10 of the Battery Act [BattG]) – for all types of batteries to avoid improper disposal and the resulting safety risks (hesselmann service GmbH, n.d.; Batteriegesetz, 2009, last amended 2020).

options (Bernaz et al., 2022; Deva, 2022; Peters et al., 2020). In order to enforce civil liability, for example, it is necessary to design international civil procedural law in such a way that legal action is made possible for those affected. One strength of the international draft is that – unlike the European draft directive – specific barriers to asserting due-diligence violations are addressed (Bernaz et al., 2022). Opportunities for legal action should be as broad as possible, i.e. not only for those affected by human-rights and environmental-rights violations but also for recognized associations (e.g. nature-conservation associations). It would be possible to enable competing companies to take legal action. The introduction of a competitor's lawsuit could ensure that globally uniform conditions (level playing field) are created without distortions of competition. In addition, the burden for implementation control would be distributed among all actors.

7.6.3

Sustainable finance: levers for corporate sustainability

Private capital flows can act as a further lever for triggering change in companies and encouraging them to assume responsibility. Several studies show that investors have a significant influence on corporate sustainability efforts (Chen et al., 2020; Dyck et al., 2019). This influence on corporate action can be exercised via various channels, such as exiting certain investments, or a private or occasionally public exchange of views with

a company's management ('voice'). Increased engagement through interaction with management on aspects of corporate action within public capital investments is also a demand of the Sustainable Finance Advisory Committee (SFB, 2021). In order to better incorporate the above-described reporting obligations and the resulting increased transparency into investors' decision-making processes, the European Commission adopted Regulation (EU) 2019/2088 on sustainability-related disclosure requirements in the financial services sector: the Sustainable Finance Disclosure Regulation. It is aimed at capital-market participants who, among other things, must increasingly provide information to end customers on the extent to which sustainability aspects are taken into account in financial products or processes. The announcement of the regulation already showed initial effects on the composition of the affected funds and their cash inflow (Becker et al., 2022). Furthermore, many investor groups have joined forces in recent years in various environment-protection and climate-change-mitigation initiatives. Examples include the Net-Zero Asset Owner Alliance, which is based on a UN initiative, and the Institutional Investors Group on Climate Change.

The UN Principles for Responsible Investment (UNPRI) is one of the sustainability initiatives most widely used by institutional investors (Bauckloh et al., 2021). Its high prevalence is due, among other things, to the low barriers to entry and the lack of an exclusion option until 2018, which is why UNPRI is criticized as an initiative that only makes a minimal effort to take sustainability criteria into account (Schulz et al., 2019). While early groups of

institutions that joined the initiative changed their investment behaviour, later signatories benefited from the high profile of the PRI initiative without having to change their investment behaviour after signing (Bauckloh et al., 2021). The PRI initiative is attempting to address the criticism of the lack of verification in its framework (PRI, 2017) and the strategy derived from it (2021).

Publicly managed investments can play a pioneering role with regard to the consideration of sustainability criteria. The same applies to the consideration of these criteria within financial investments made on behalf of health-sector employees. In Germany, for example, these are not yet sufficiently taken into account, especially in the investments managed by private pension funds and other pension schemes (Schneider et al., 2021; Schneider et al., 2022). This neglect of sustainability criteria is at odds with the precautionary approach of insurance companies and the societal responsibility of the respective professional groups (Schneider et al., 2021). For example, the German Climate Change and Health Alliance (KLUG) has a working group looking into a stronger consideration of sustainability criteria within the investments of the pension funds in the health sector, and possible divestment. It also points to a low level of transparency with regard to the sustainability criteria used (Schulz et al., 2019). Furthermore, only a small minority of the institutions surveyed have stopped investing in companies that extract or burn fossil fuels. Yet several studies show that this 'divestment' strategy can have positive effects, in that impacted companies, among other things, reduce their emissions (Rohleder et al., 2022).

With regard to flows of capital into financial products with sustainability criteria, it should be noted that these are used for the most part only in high-income countries, and that their investments are mostly limited to the same group of countries as for other financial products. However, since low-income countries in particular are facing major challenges and need capital to overcome them, they should become more of a target for sustainability-oriented capital flows (UNCTAD, 2021). For this reason, the UN's Financing for Sustainable Development Report 2021 calls for measures to be taken so that capital flows can be channelled into low-income countries where they are particularly needed, but where this is not yet done due to an insufficiently developed capital market (UN, 2021a). International cooperation is needed here to strengthen the local capital markets of low-income countries, for example by improving the legal environment or making corporate reporting more transparent (UN, 2022a).

Development banks can play a significant role in financing the SDGs or the transition to a climate-neutral economy by investing more in the expansion of suitable projects and tying their future investments to the existence of a Net Zero strategy (Volz et al., 2022b).

7.6.4 Recommendations for action

In the highly dynamic field of corporate responsibility, companies should act in such a way that they take responsibility for more than the direct impacts on the health and human rights of their employees and the immediate environment. Rather, there should be a further increase in the indirect assumption of responsibility that exists in relation to globalized supply chains and product responsibility.

Strengthen the linkage between sustainability standards and indicators and the SDG catalogue in corporate reporting

Multilateral sustainability goals repeatedly refer to the importance of involving the private sector. To enable companies to better communicate their individual efforts in this regard to the outside world and to report on their willingness, the WBGU recommends defining specific requirements for companies in addition to the existing indicators at the interface between environment and health. Ongoing processes, such as those relating to the European Sustainability Reporting Standards (ESRS), can be used for this purpose and taken into account. Reporting requirements should be developed in such a way that not only direct impacts of corporate activities on the environment and health are addressed but also indirect impacts.

Gear public capital investment more towards sustainability criteria

This orientation should explicitly involve not only underweighting investments that do not meet the criteria but also completely withdrawing from them. Reporting on public capital investments should be made more transparent (SFB, 2021: 53). Sustainability issues should also be addressed directly in a dialogue with companies in the sense of shareholder engagement.

Make more ESG disclosures compulsory

More of the existing international (i.e. outside of the EU) disclosures of sustainability information in the 'environmental', 'social' and 'governance' fields (ESG for short) on the social and ecological impacts of corporate activity should be made compulsory instead of the currently widespread voluntary implementation. The focus should be on the consideration of double materiality, especially in the G7 countries (Erdmann et al., 2022). Like financial reporting, non-financial reporting outside the EU should also be subject to scrutiny (SFB, 2021).

Measures to make commitments more legally binding

The protection of human rights and the environment (as well as combating corruption, i.a.) should be legally

7 Global urgency governance

enshrined as integrated protected goods; European and national legislation should be adopted convergently with international standards; and ecological, social and health standards should be interlinked. There is also a need to ensure implementation and enforcement for all groups of actors through legal remedies.

7.6.5 Research recommendations

Study the possible inclusion of non-financial values in financial reporting and management accounting

Traditional financial accounting and sustainability reporting have been largely separate until now (Sajjad, 2019). Integrated reporting was a first step in linking the two parts more closely. However, non-financial risks increasingly affect the financial position of companies and are thus becoming directly relevant to decision-making from a financial perspective. More research is therefore needed on the degree to which companies currently factor non-financial risks, for example caused by climate change, into their financial accounting and whether provisions are made for them.

Combine corporate indicators for environment and health

At present, the fields of environment and health are predominantly considered and analysed independently of each other. In order to complement the reporting of companies in a targeted manner, it is necessary to develop suitable indicators that link both areas, environment and health, without losing too much information. See also the demands made by Chenet, 2019.

Analyse the disaggregated reporting of the environment and health determinants

Environmental indicators are often reported by companies in a highly aggregated manner and summarized in ratings. Disaggregated reporting of the environment and health determinants is key, especially for the linkage to health effects. In the field of water pollution, for example, reporting at the level of individual substances is necessary in order to identify health effects. It is then possible to empirically identify the effect of such risks on the capital market.

Develop a system of early reporting on internal impact chains of the environment and health

Corporate reporting very frequently refers to external environmental factors such as emissions. Internal environmental factors and their influence on employees' health have been scientifically studied less often to date. This is mainly due to the fact that most of the data are

only available internally. Usually they do not become available until they are registered in the public health system. Research is also needed into a system of early reporting on internal impact chains of the environment and health within companies, using appropriate indicators.

Study the limits of insurability

Global environmental change is a major challenge for insurance companies in particular (SFB, 2021). Although initial results on the subsequent effects of these changes on the insurance sector already exist, they are mostly limited to physical environmental risks and not yet to the effects on health. The WBGU recommends that more research be conducted on how significant the health impacts of global environmental change are on the limits of insurability.

Develop material obligation for companies beyond formal due-diligence obligations

At present, corporate environmental and human-rights protection is predominantly based on formal due-diligence requirements. Because of social, health-related and environmental transformational needs, it is necessary, especially in the field of global supply chains and corporate responsibility, to better understand how a proportionate material obligation of companies beyond formal due-diligence obligations might also be designed. To what extent can globally ramified supply chains prevent possible implementation? Where do reporting boundaries exist? When are actors no longer willing to offer information voluntarily? Where are the limits to actual or legal reasonability?

Analyse and evaluate supply-chain due-diligence laws

Supply-chain due-diligence laws operate between civil and public law and transfer international obligations to protect environmental and human rights to nation states. This could mean opportunities for an effective integration of the aforementioned duties, but it also could raise tensions between the different logics of the individual areas and levels of the law; this should be the subject of jurisprudential research.

Research liability regimes and due-diligence obligations in supply-chain legislation

Value and supply chains are structured very differently around the world, so that different liability regimes and due-diligence obligations may be appropriate for different sectors and different types of value chains. Research is needed on how supply-chain legislation can adequately address these different organizational structures. Supply-chain-related due-diligence obligations also create uncertainties for companies. How can

businesses in socio-ecological transformation processes be supported in such a way that these uncertainties lead to a proactive shaping of transformation processes?

Identify uncertainties for companies with regard to due-diligence obligations in the supply chain

Uncertainties for companies with regard to due diligence in the supply chain can have far-reaching consequences for locational and investment decisions. How can due-diligence obligations be prevented from causing the withdrawal of capital from countries that rely on investment for further development, but where compliance with due-diligence obligations is difficult for companies to verify?

Identify further instruments and approaches for increased development financing

With regard to Global Public Investment, it is important to identify which criteria can be used to determine the performance of individual countries, how the decision-making processes can be structured, and which problems should be prioritized using the concept of Global Public Investment. In order to improve the use of social impact bonds, there is a need for an analysis of the success or failure of past social impact bonds and of the best possible design, for example in the health sector.



Education and science are key to the vision of ‘healthy living on a healthy planet’ and have enormous transformative potential. A high level of societal education based on scientific findings is the foundation for a joint ability to act and communicate when dealing with global challenges. The WBGU recommends systematically promoting education and science worldwide in the spirit of the guiding principle of ‘healthy living on a healthy planet’, dismantling differences between national science systems, and promoting transregional partnerships on the basis of mutual cooperation.

The transformations towards sustainability that can make nature and humans worldwide healthy in the long term will be knowledge- and technology-intensive and must be undertaken with great urgency. The COVID-19 pandemic again underlined a fundamental problem: societies with high educational standards and well-equipped science and innovation systems were much quicker at developing and producing vaccine, thus helping to tackle the crisis. At the same time, in view of the different ways in which the health crisis was handled, it is necessary to reflect intensively on the role and importance of science-based policy-making, of ‘fake news’ and ‘alternative facts’ as opposed to scientifically sound policy-making and crisis management (Jamieson, 2021).

In order to deal with future crises at the interfaces between environmental and climate change on the one hand and human, animal and plant health on the other, the full potential of knowledge and education systems will have to be mobilized and their structural design and performance oriented accordingly. The aim of this mobilization is to increase appreciation of natural life-support systems and planetary health, and to fundamentally change values, interests and lifestyles all over the world. The guiding principle of ‘healthy living on a healthy planet’ challenges educational and science policy worldwide.

While addressing the dynamics between environmental changes and the health of nature and humans is of key importance in the education systems, in science systems it is necessary to integrate these dynamics into

research, counselling and teaching. The aim is to provide a high level of societal education based on scientific findings worldwide in order to lay the foundations for joint communication and action skills when dealing with global challenges. A purely instrumental understanding of science, which reduces it to producing solutions for already known problems, is not enough in this context due to rapidly advancing environmental and climate change and the health risks of the future, which can hardly be foreseen today.

Moreover, for the further design of education and advisory systems, the guiding principle of ‘healthy living on a healthy planet’ means making lifelong learning possible globally and for all social groups. The aim is to empower people to acquire knowledge about the guiding principle of ‘healthy living on a healthy planet’, and to develop skills that enable transformative action towards a healthy life in harmony with nature.

In order to achieve this aspiration for education in the sense of the ‘healthy living on a healthy planet’ principle it is possible to build on the concept of Education for Sustainable Development with a greater integration of the health dimension. Accordingly, this chapter also examines the potential and challenges of Education for Sustainable Development. In this context, Education for Sustainable Development is not a thematic extension of previous educational content. Rather, it must lead to a critical review of existing knowledge and the generation of new knowledge, oriented towards the ethical model of

sustainable development, which must explicitly include the health aspect. Indispensable parts of the concept of Education for Sustainable Development include reflecting on values, developing new perspectives and ways of thinking, and a new learning culture that relates knowledge and action more closely to each other in order to motivate people. It goes without saying that education based on the ‘healthy living on a healthy planet’ principle, in particular, needs an integrated understanding of man and nature, systemic thinking and the inclusion of the relationships between different societal fields of action, as well as the different forms of knowledge through participation and cooperation. The opportunities offered by new technologies, the promotion of digital skills and the responsible use of data must also be taken into account within the value horizon of sustainable development – both to improve conditions in the sense of ‘healthy living on a healthy planet’ and to further develop the field of health itself along these lines.

As regards the further development of science systems, the WBGU considers it problematic that the predominantly national organization of science systems is accompanied by substantial differences in their respective performance, and that the action logic behind their ways of dealing with challenges at the interfaces of environment and health is determined by competition rather than cooperation. Also problematic is the fact that disciplinary specialization in the production of scientific knowledge is still very pronounced and that there is too little inter- and transdisciplinary funding. This also involves a hitherto unbalanced relationship between basic and applied research. Finally, the WBGU points out the need to expand the scientific landscape and the science-funding landscape in order to meet the planetary challenges and their implications for human health. Specifically, the WBGU proposes the establishment of a German Alliance for Planetary Health Science, in order, in the German context, to bring together research, teaching and advisory services on interactions between the environment and health in a structured way, and lead them towards an international science-policy exchange. For the task of dealing with global environmental and health challenges, the guiding principle of ‘healthy living on a healthy planet’ thus suggests that we lift our gaze beyond the thematic (environment versus health), disciplinary and national frame of reference, and accept the need to shape international science policy and science-funding policy in the spirit of the ‘healthy living on a healthy planet’ principle.

The following section first looks at the field of education according to the ‘healthy living on a healthy planet’ vision. This is followed by an analysis of the global science-funding landscape and the German specifics in the field of science in terms of the ‘healthy living on a healthy planet’ principle.

8.1

Education according to the guiding principle of ‘healthy living on a healthy planet’

Education is essential to enable individuals and societies to develop the potential for transformation. With this in mind, Education for Sustainable Development has been promoted for several decades.

Education for Sustainable Development requires an integrative perspective on problems and societal action that interrelates ecological, social, economic and cultural aspects and fields of action, and sees their interdependence and interactions in pursuit of the objective of sustainable development and its underlying values. Health must therefore always be included as an essential area for social participation – both for individuals and for society (Stoltenberg, 2009). However, the potential of the educational approach for the connection between a healthy life and a healthy planet is not being fully exploited; this applies even to current material from the United Nations Organization for Education, Science and Culture (UNESCO, 2017). Here, the guiding principle of ‘healthy living on a healthy planet’ (Chapter 3) deserves greater consideration, and Education for Sustainable Development can be further developed into education in the sense of the ‘healthy living on a healthy planet’ principle by integrating a holistic health perspective – as seen, for example, in the Planetary Health concept (Section 3.3).

The transformative potential of Education for Sustainable Development is limited by the fact that it interprets the educational concept as environmental education, as an additional ‘field of education’ alongside others, or as a thematic enrichment (Sterling, 2021; Wals, 2021). The 2030 Agenda provided some fresh impetus. It includes the goal of ensuring inclusive, equitable and high-quality education and creating lifelong learning opportunities for all (SDG 4; UN, 2015a). The aim is, by 2030, to “ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture’s contribution to sustainable development” (SDG 4.7; UN, 2015a).

The international discourse widely agrees on the main elements of the concept of Education for Sustainable Development: knowledge of key future issues and knowledge of nature as the basis of life; systemic thinking (in order to be able to penetrate the complex future issues and their mutual relations); reflection on values, on the ethical guiding principle of sustainable development – i.e. the indissoluble connection between

human dignity and the preservation of the natural life-support systems – and on the potential of cultural diversity for world society. At the same time, a new learning culture is called for to interrelate knowledge and action more closely, and to motivate people by involving them in shaping their own lives together with others. This also means learning through participation in serious tasks; innovative, creative thinking and thinking in alternatives; dealing with openness and uncertainty while being aware of risks; and the skills needed to ‘re-model the future’ (de Haan, 2008; Stoltenberg and Burandt, 2014).

The whole-institution approach, which is based on the concept of Education for Sustainable Development, has a lot of potential. Following experience with further training, the concept is now practised in many day-care centres, occasionally also in schools and institutions of higher education, and increasingly in cultural institutions and companies. It is a reaction to the request to design not only educational processes and the participatory culture of living and working together but also the learning environment according to the principles of Education for Sustainable Development, thus enabling informal learning and, at the same time, contributing to sustainable development. This affects the consideration of sustainability criteria with regard to nutrition, constructional features, the use of energy and water as well as the materials used in everyday life.

Because it involves such a diversity of relevant aspects in all sectors, the comprehensive inclusion of the health issue in the entire educational landscape is key to laying the foundations for a successful transformation towards sustainability, for a healthy environment and for healthy people, to constructing a corresponding framework of values, and to opening up opportunities for shaping individual and societal action. This is linked to the opportunity to gain a new perspective on the necessity of a comprehensive, future-proof design of the relationship between humans and nature via the question of one’s own health, which is something people can relate to.

The following section provides an insight into the status quo of the education landscape with regard to Education for Sustainable Development from early childhood and school to extracurricular, vocational, higher and adult education (Section 8.1.1). Subsequently, the role of health professionals as multipliers for education in the sense of the guiding principle of ‘healthy living on a healthy planet’ is described in detail with existing concepts and initiatives (Section 8.1.2). The section then presents a vision of comprehensive planetary health literacy as a common goal of Education for Sustainable Development and education in the sense of the guiding principle of ‘healthy living on a healthy planet’

(Section 8.1.3). On this basis, the section contains the main recommendations on measures and strategies that are necessary for education in the sense of the ‘healthy living on a healthy planet’ principle (Section 8.1.4).

8.1.1

Education for sustainable development through lifelong learning: the status quo

In principle, lifelong learning means all learning in every phase of life – from childhood to old age – and comprises *formal education* in educational settings such as schools, universities or adult education centres, *non-formal education*, e.g. in extracurricular contexts, and *informal education* via social media, play and work.

Already in early childhood, fundamental values and skills are laid down and formed that influence the way we deal with our fellow human beings, the environment, the natural world and ourselves (including our own health). Educational institutions such as day-care centres and kindergartens therefore play an essential role in laying the foundation for Education for Sustainable Development at an early age, thus enabling people to think responsibly and act sustainably early on. The years at school, in vocational training and, where applicable, at university are further formative phases of life in which creative skills for participation in sustainable development can be acquired. Adult education and learning into old age also play an essential role with regard to developing lifestyles or transformative practices in societal institutions. The WBGU regards Education for Sustainable Development as an essential strategy for societal transformation, also for the goal of focusing on the inseparability of human health and nature and its connection with other sustainability goals.

Since the adoption of Agenda 21 (1992), UNESCO has been driving forward the process of developing and mainstreaming the concept of Education for Sustainable Development (Michelsen and Wells, 2017; UNESCO 2020c, 2021). In the wake of the education goal set out in the 2030 Agenda (SDG 4, especially SDG 4.7), a large number of national and international projects and plans have been established that contribute to achieving this goal. The indicator of SDG 4.7 is seen as the “extent to which (i) global citizenship education and (ii) Education for Sustainable Development are mainstreamed in (a) national education policies; (b) curricula; (c) teacher education; and (d) student assessment” (Destatis, 2023). Since 2020, UNESCO’s programme ‘Education for Sustainable Development: Towards achieving the SDGs’ has carried forward UNESCO’s World Programme of Action on Education for Sustainable Development (UNESCO, 2019, 2020c). At the same time, SDG 4 made it clear

that access to education must be ensured worldwide as an indispensable basis for sustainable development (UN, 2015a).

In 2018, approx. 260 million children and young people worldwide were denied access to education (UIS, 2019). This corresponds to about a sixth of the global population in the corresponding age groups (UIS, 2019). Without access to education, the guiding principle of ‘healthy living on a healthy planet’ can only be communicated and implemented to a limited extent – although the impact of non-formal and informal education should not be underestimated.

Although the following section provides insight into the status quo of the German education system with regard to the topic of health, it does not claim to be a complete inventory. However, in order to find starting points for a strategy for education according to the guiding principle of ‘healthy living on a healthy planet’, it is worthwhile on the one hand to take a look at previous approaches where health is indeed established in the formal education system, and, on the other hand, at innovative programmatic and practical approaches for an understanding of education that sees a connection between individual human health and the societal and natural conditions for it.

In early-childhood education and in schools, there have been many programmes for a ‘healthy kindergarten’ or a ‘healthy school’ in recent years. In these programmes, as in the worksheets and teaching materials offered by the DIPF (Leibniz Institute for Research and Information in Education) via the German Education Server, enhanced health quality is sought merely as a prerequisite for the improvement of education and educational tasks. Even when formats are found, e.g. the regular ‘Week of Health and Sustainability’ in Bavaria, no correlations are made between health and sustainability (Bayerisches Staatsministerium für Unterricht und Kultus, 2023). Although some educational plans of the *Länder* for day-care centres make introductory references to Education for Sustainable Development, educational fields such as ‘Nature and the Environment’ and ‘Health, Physical Activity and Nutrition’ are usually covered separately.

In conceptual work (Stoltenberg, 2014) and in the educational practice of day-care centres and primary schools, however, there are convincing examples of teaching the insight that healthy people depend on a healthy planet. There it is no longer the ‘healthy breakfast’ but the ‘sustainable breakfast’ that is practised, or healthy soil is recognized as a prerequisite for our health (Stoltenberg and Thielebein-Pohl, 2011). Links to health are made especially with reference to the need to conserve biodiversity. A significant role in this change in practice has been played by initiatives offering further

training for educators, as well as advice and an exchange of experience with experts outside the educational institution, e.g. KITA21 (DayCare21) in northern Germany, Ökokids (ecokids) or Mobilspiel (mobile play) in Bavaria. Since 2014, an association called ‘Acker e.V.’ (‘Field’), which has spread from Germany to Switzerland and Austria, has been offering educational programmes and, above all, opportunities to experience sustainability. There are now over 250 ‘AckerKitas’ and 600 ‘Acker-Schulen’, where children and adults can find out how health, nutrition and food cultivation are connected (Acker e.V., 2023).

‘Global classrooms’, which make exchanges possible between young people in different living environments around the world, promote an awareness of and a sensitivity for one’s own responsibility for healthy living conditions – also taking a global perspective into account.

It is still only a minority of institutions of higher education that are committed to the guiding principle of sustainable development and design their teaching, research, business operations and living environment according to the principles of Education for Sustainable Development. It is possible to enable students to see human health and a healthy planet in context by offering interdisciplinary and transdisciplinary seminars, by allowing space for self-organized and collaborative learning, through student initiatives and by taking a whole-institution approach to shaping life at institutions of higher education. This includes both a sustainable canteen and health-promoting options at the university workplace.

In the non-school sector, many educational centres are committed to enabling people to experience how to deal responsibly with people and nature. One important partner in Germany runs the Voluntary Ecological Year (FÖJ), which offers education and experience related to the guiding principle of ‘healthy living on a healthy planet’, and can thus have an impact both on young people and on the companies and organizations involved.

In addition, vocational education and training can play an essential role (Box 8.1-1).

In the context of Education for Sustainable Development, municipalities, too, play a key role in influencing people and specific areas of their lives, e.g. nutrition (Section 4.1), physical activity and mobility (Section 4.2), housing (Section 4.3) and healthcare (Chapter 6). When integrating Education for Sustainable Development into all municipal fields of action, the guiding principle of ‘healthy living on a healthy planet’ should also be addressed in educational matters. For example, integrated programmes on land use in municipalities can be developed jointly in participatory processes.

Box 8.1-1**Vocational education and training as a lever for the guiding principle of ‘healthy living on a healthy planet’**

In addition to education for children and adolescents, vocational education and training, when, as with general higher education, it is oriented towards the guiding principle of ‘healthy living on a healthy planet’, is an important lever for initiating change processes both in businesses and in the social environment of the learners. It offers a chance to gain knowledge and experience in both initial and further training, enabling people to recognize and use options for action that can be incorporated into operational processes. In the context of Germany’s dual training system, there are two starting points for this: on the one hand, the curricula of vocational schools, which are the responsibility of the Länder, and, on the other hand, the content of in-company training, which can teach practices that are needed in the context of transformations to sustainable societies. Germany’s Federal Institute for Vocational Education and Training (BIBB), an agency of the Federal Ministry of Education and Research (BMBF), has an important role to play here. One of its three main tasks is to moderate the training regulations for skilled occupations with the social partners, chambers of industry and commerce, etc. It can thus exert an advisory influence on the content of in-company training. As part of its second main task, the BIBB supports projects on issues relating to digitalization, permeability within the education sectors and between academic and vocational education and training, as well as on the task of sustainable development. Support is given not to projects that regard initiatives for more sustainability as an add-on, but to those that integrate the task into the operational processes themselves. Sustainability

should not be an additional burden for enterprises; rather, the processes themselves should be transformed in the sense of sustainable development. This approach can be supported by BIBB’s third task: advising policy-makers and society.

All three of BIBB’s tasks offer a chance for the guiding principle of ‘healthy living on a healthy planet’ to become better integrated, with the aim of making both in-company trainers and the trainees themselves change agents. In this context, the focus of in-company training in the sense of an overall institutional approach is initially on the sustainable design and management of the workplace, avoiding contamination and other forms of environmental pollution that affect the health of people and nature (noise, exposure to particulate matter, soil quality at industrial sites), the increasing transformation to a circular economy and the development of a materials-management system with a corresponding orientation of procurement. The health-promoting design of working hours and recreational spaces is necessary both inside and outside the workplace.

In order to actually be able to use the leverage effect of vocational education and training in a timely manner for the guiding principle of ‘healthy living on a healthy planet’, the challenges existing in this area must also be addressed. For example, analyses of national monitoring of Education for Sustainable Development in vocational education and training show that the key federal laws on vocational education and training do not yet contain any references to sustainability or sustainable development, that up to now there has been little focus on designing learning venues with sustainability in mind, and that trainers and vocational-school teachers have so far been insufficiently trained to give vocational training for sustainable development (Holst, 2022). In order to address the latter point in particular, in January 2023, the BMBF published a guideline on funding projects within the framework of a programme called ‘Sustainability at Work – Future-Oriented Training (NIB)’.

Furthermore, the agriculture-nutrition-education field of action can contribute to a careful and health-promoting use of natural resources (also in agriculture and forestry; Box 8.1-2) and their regeneration for sustainable availability for generations to come.

In Germany, the National Platform on Education for Sustainable Development in 2017 adopted the National Action Plan for the Implementation of the UNESCO Global Action Programme on Education for Sustainable Development (2015–2019) (Nationale Plattform Bildung für nachhaltige Entwicklung, 2017). In the course of this, strategies and measures were developed, implemented and evaluated to strengthen and establish Education for Sustainable Development in the areas of early-childhood education, schools, extracurricular education, vocational training, higher education and municipalities.

‘National Monitoring on Education for Sustainable Development’ shows the extent to which Education for Sustainable Development has become established in curricula, training regulations, teacher training, laws, political resolutions and other important documents of the German education system, which trends can be

identified in the various areas of education and what action still needs to be taken. Although there has been a positive trend in the field of early education in recent years in embedding Education for Sustainable Development as a cross-cutting educational concept in the education plans of the federal states, the concept has still not been sufficiently implemented in the training of early-childhood educators (Singer-Brodowski and Holst, 2022). In the school sector, the depth and breadth of the integration of Education for Sustainable Development in curricula varies greatly between subjects and Länder, and here too there is a qualification gap in teacher training (Brock and Holst, 2022). The monitoring of Education for Sustainable Development in the field of vocational education and training in Germany comes to similar results (Holst, 2022). In higher education, Education for Sustainable Development and sustainability have become increasingly integrated into target and performance agreements and laid down in laws as a task of higher-education institutions (Holst and Singer-Brodowski, 2022). While there are only isolated references to sustainability in the documents of the German Rectors’ Conference

Box 8.1-2**Agricultural consultants as agents of Planetary Health competence**

Agricultural advisory services (also known as agricultural extension) can play a decisive role in communicating the guiding principle of ‘healthy living on a healthy planet’ in agriculture and at the community level. Agricultural extension agents can point to new ways of using agricultural and natural resources, raise farmers’ awareness of health issues and promote the exchange of information among them (Sanginga et al., 2009: 245; Hossain et al., 2009); they therefore have the potential to multiply knowledge on the environment-health nexus in agriculture. Similarly, in the community context, agricultural advisers can contribute to making Education for Sustainable Development possible for everyone (SDG 4.7).

Status quo

There are many forms of agricultural extension systems, which differ in terms of funding, organization, the exact target group of the system and the overall context (Davis et al., 2020; Leta et al., 2020: 389). A general trend is the pluralization (especially e.g. in India, many countries in Latin America, Kenya, Uganda, Zambia), decentralization (e.g. in Tanzania, Bangladesh) and privatization (e.g. in Germany) of agricultural extension systems, especially as regards the provision of extension services (Davis et al., 2020: 2; Wijaya and Offermans, 2019: 4; Hornidge et al., 2016; Ingram et al., 2022). Due to this increasing diversity of actors (e.g. nation states, private-sector actors, NGOs, farmers’ associations, international organizations, governmental development agencies), very different interests are pursued in agricultural extension, be it yield increase, food security or more sustainable agriculture (Davis et al., 2020: 2). Agricultural extension sometimes addresses aspects such as climate and environmental change and sustainable agriculture (Santuah et al., 2022; Gérard, 2020), as well as health issues – on the one hand human health (e.g. the physical and mental health of farmers; Hammersley et al., 2022), and, on the other, the health of animal and plant species (e.g. pest control; Barrett et al., 2022) and ecosystems (e.g. soil health; Kumar and Rani, 2018). However, these forms of engagement with health and environmental issues usually take place separately from each other. In most cases up to now, agricultural extension has neither shown these cross-links nor identified the multiple benefits of certain agricultural practices both for human health and for the protection of species and ecosystems.

Practical examples

Some examples show how extension systems can be used as educational formats to promote Planetary Health competence in agriculture and communities. For example, many digital advisory solutions address the efficiency and effectiveness of seeds and fertilisers and diagnosing diseases in plants, animals and humans. The PlantwisePlus application helps smallholder farmers to reduce harvest losses by demonstrating climate-adapted practices and technologies, and explaining the risks of pesticides to the environment and human health. Information on pest distribution is also provided to help contain infestations and thus ensure healthy nutrition (PlantwisePlus, 2023; Barrett et al., 2022). The ‘Cotton made in Africa’ project is an example of a private advisory service provider that combines production, environmental and nutritional aspects. In training courses, African smallholders learn sustainable

cotton cultivation methods “that help them to increase the quality and yields of their cotton, improve their living and working conditions and protect their health and the environment” (CmiA, 2023).

Rural development-advisory systems cover an even broader range of topics and thus offer linkages for education on the environment-health nexus. For example, agricultural extension programmes in the United States – primarily education services for adolescents and adults – address healthy eating, environmental quality, nature conservation, community development, agriculture and food safety (Narine et al., 2020), as well as health disparities caused by social determinants (Andress and Fitch, 2016). In addition, numerous associations, organizations and regionally active organic farmers in Germany offer children, young people and adults educational programmes on the connection between environmental and health issues. For instance, a non-profit association called ‘Ökomarkt Verbraucher- und Agrarberatung e.V.’ (Ecomarket Consumer and Agricultural Consulting), founded in 1986, advises “consumers on a [...] health-conscious and environmentally sound diet with organic products” and offers seminars, workshops and excursions for various target groups (Autarkia, 2023). These educational programmes open up a window of opportunity for training new farmers and communities on the cross-links between environmental change and health.

Furthermore, the example of agricultural extension agents who have been able to raise awareness of mental-health risks among farmers in Australia and Ireland after having mental-health training themselves (Hossain et al., 2009; Hammersley et al., 2022) demonstrates the potential for extending services to other areas. Similarly, rural development advisers such as ‘Dorfhelfer:innen’ (Village Helpers) in Germany – local contact persons for families on issues such as nutrition, animal husbandry and farm management (AELF-IP, 2023) – with the necessary training could also act as multipliers for planetary health literacy.

Challenges

Implementing holistic counselling in rural areas according to the guiding principle of ‘healthy living on a healthy planet’ is a universal challenge. Depending on the context, there are varying degrees of difficulty in implementing agricultural advisory services on the health of humans and nature. For example, agents should have a wide range of knowledge, e.g. on health issues, environmental protection and climate-change mitigation, in order to make full use of their potential as mediators of comprehensive health competence for people and nature. However, agents are often not trained in such challenges as environmental sustainability or human health risks (Santuah et al., 2022; Davis et al., 2020). On the one hand, this is due to the inadequate training opportunities for agricultural extension in low- and middle-income countries (WBGU, 2020: 165). Another reason is the separation of this knowledge into individual professional fields. In India and Germany, for example, advisers on agriculture and nutrition are trained separately (Davis et al., 2020: 82 f.). In addition to technical expertise on health issues, counselling at the interface between the environment and health also requires strong social and communication skills, which many consultants see as a key challenge (Hornidge et al., 2016: 174; Hossain et al., 2009; Davis et al., 2020: 329; Hammersley et al., 2022). Also important for implementation is the recognition of local creativity, innovation and requirements (Sanginga et al., 2009: 299), although these sometimes conflict with the diversity of interests of different agricultural extension actors.

Recommendations for action and research

For a holistic advisory service for farmers and municipalities that takes into account planetary guard rails in relation to the environment and climate as well as to human health, the WBGU recommends bringing the predominantly separate treatment of health and environmental aspects together in counselling practice. To this end, agricultural extension agents should be trained to teach comprehensive health literacy for people and nature, and receive training e.g. on healthy nutrition, climate protection and climate-change mitigation, as well as on communication skills. Advising on human and nature’s health should not only include the necessary transfer of knowledge to farmers and communities on the connection between human health, other species and ecosystems, building on farmers’ local knowledge and capacity for innovation. Consultants should also provide decision-making support for rural actors, identifying options for action that are health-promoting and environmentally sound, including areas like seeds, fertilisers, crops and farming methods. At the same time, the rural advisory and training programmes mentioned above should be used as a

window of opportunity to train new farmers and communities on the cross-links between environmental change and health. Depending on the context, educational opportunities on health literacy relating to the interrelationships between humans and nature should be established in existing structures of agricultural extension. In Central and South America, for example, an already well-developed training system for providers of agricultural extension could be used as a starting point (Davis et al., 2020: xix). However, this can only work if countries take on the role of coordinating the different advisory actors (Davis et al., 2020: 12) and provide incentives for Planetary Health education in line with the 2030 Agenda’s mandate for action (Ingram et al., 2022: 21).

In addition, there is a need to conceptualize models for evaluating agricultural extension that examine not only its innovation (Davis et al., 2020: 330) but also its contribution to farmers’ health literacy on the interrelationships between humans and nature.

Source: Mandler, 2022

and the Länder Rectors’ Conferences, Länder student representatives formulate very ambitious positions on sustainability and Education for Sustainable Development (Holst and Singer-Brodowski, 2022). However, Education for Sustainable Development is still not fully integrated into the curricula in the module manuals of many subjects or in study and examination regulations, and there are also few offers of advanced and further training in higher-education didactics on Education for Sustainable Development (Holst, 2022). To sum up, it can be seen that Education for Sustainable Development has not yet been sufficiently embedded and implemented in all educational sectors in Germany.

The implementation of a whole-institution approach to education under the guiding principle of sustainability (Kohl et al., 2022), which can also be used for the principle of ‘healthy living on a healthy planet’, is seen as a strategically successful approach in this context (Section 4.1–4.3).

8.1.2**Health professionals as multipliers: concepts and initiatives**

Health professionals such as doctors, nurses, midwives, health and nutrition scientists and physiotherapists are key actors who can function as multipliers to reach a broad population group inside and outside the medical health system (Section 6.4.2.2). However, the training received by health professionals is currently mainly focused on curing diseases and does not sufficiently address aspects such as global environmental changes and their impact on health, or the multiple benefits that

can be generated by health-promoting and sustainable behaviour. Similarly, the concept of Education for Sustainable Development has been unable to establish itself in education and training in the medical sector. However, a separate educational concept has been developed here, namely Education for Planetary Health. This still relatively new concept has developed very dynamically in the education and training of health professionals in recent years and holds great potential for education in the sense of the guiding principle of ‘healthy living on a healthy planet’. Key concepts and educational initiatives in this area are described in the following.

With the publication of twelve overarching principles for teaching Planetary Health, Stone et al. (2018) have laid an initial foundation for Planetary Health education (with a focus on human health; Box 8.1-3) at the international level. These principles are meant to apply to Planetary Health teaching at “all levels, across all scales, and in all regions of the world” (Stone et al., 2018: 192). The WBGU also considers the principles to be transferable to ecosystem health and the health of species, and advocates strengthening these principles in the sense of comprehensive education in line with the guiding principle of ‘healthy living on a healthy planet’.

With its Consensus Statement on ‘Planetary health and education for sustainable healthcare’ published in 2021, the Association for Medical Education in Europe (AMEE) has created another framework that can serve as a basis for developing teaching concepts on Planetary Health for the target group of health professionals (Shaw et al., 2021). The Planetary Health Education Framework of the Planetary Health Alliance (Guzmán et al., 2021; Box 8.1-4) serves as a further basis.

Box 8.1-3**Twelve cross-cutting principles for teaching Planetary Health**

1. *A Planetary Health lens*: the ability to better understand linkages, cause-effect relationships and feedback loops between environmental change and human health with the help of a Planetary Health lens.
2. *Urgency and scale*: understanding the complexity of interactions between the geographical scale, temporal scale, socioeconomic factors, and political and cultural context that shape specific challenges to and potential solutions for sustainable human health outcomes.
3. *Policy*: an understanding of the policy applications of Planetary Health research and a knowledge of opportunities for action at the individual and community level for the meaningful and context-specific implementation of research in policy and society.
4. *Organizing and movement building*: understanding the role played by civil-society self-organization and the mobilization of societal groups in the political process, both locally and globally (bottom-up approach).
5. *Communication*: knowing the importance of communication in translating research findings into practice and understanding the variety of the communication methods available, including an appreciation of the importance of listening as a part of effective communication.
6. *Systems thinking and transdisciplinary collaborations*: incorporating holistic thinking and working across disciplines to develop approaches to complex challenges.
7. *Inequality and inequity*: understanding the differences between equality and equity and a knowledge of concepts like marginalization, vulnerability and resilience.
8. *Bias*: critical reflection on the political, social and economic dynamics that influence the presentation and perception of environmental change and its health impacts, and the ability to identify potential biases and stakeholder influences.
9. *Governance*: being able to understand the importance of leadership and governance structures at regional, inter-regional and global levels and to recognize how challenges to Planetary Health can be created or aggravated by the failure of governing bodies.
10. *Unintended consequences*: recognizing systemic uncertainties and unexpected positive and negative consequences of global environmental change; understanding predictive limitations of impact assessments, and the shift in mindsets that this requires to allow for increased adaptive capacity and resilience.
11. *Global citizenship and cultural identity*: perceiving and reflecting on one's own cultural identity and being part of local and global communities; based on this, the opportunity to positively influence values and practices within these communities.
12. *Historical and current global values*: knowledge of historical developments of Planetary Health (including the perspective of marginalized groups) and placing them into the current global context.

Source: WBGU, based on Stone et al., 2018

In Germany, a guide called 'Climate.Environment. Health: A Guide for Planetary Health Curricula' has been jointly written by Health For Future and the German Climate Change and Health Alliance (KLUG) (Gepp et al., 2022). It offers orientation for the establishment of teaching programmes on Planetary Health in medical and health-science departments in Germany. A curriculum for Sustainable Healthcare and Training has also been developed in the UK (Tun and Martin, 2022). Efforts already initiated to integrate Planetary Health education, for example into the curricular training of medical doctors in Germany under the revision of the National Competence-Based Catalogue of Learning Goals for Medicine (NKLM 2.0), are essential and necessary developments which must, however, be extended to other health professionals as soon as possible. In addition to traditional health professionals such as dentists, nurses, midwives, physiotherapists and nutritionists, actors who play a key role in education systems (e.g. educators in early-childhood education, teachers in school education or vocational training; Section 8.1.1) should also be addressed.

One best-practice example from the health sector in German-speaking countries is the German Alliance on Climate Change and Health (KLUG), a network of individuals, organizations and associations from the health

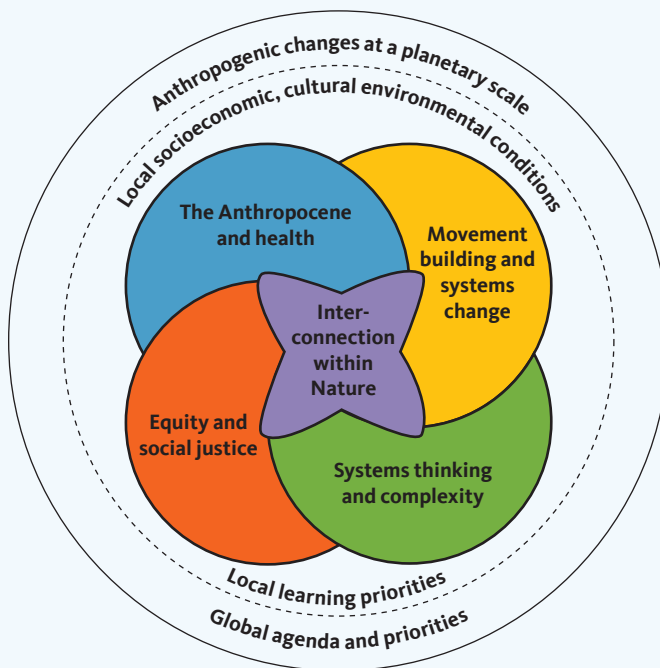
sector which was founded in 2017 with the aim of publicizing the consequences of climate change for health. In the process, the health professions are to become actors in the necessary transformation of society as a whole. In 2022, KLUG's educational work in the context of the Planetary Health Academy (Gepp et al., 2023) was one of 29 initiatives to receive the award for Education for Sustainable Development from the Federal Ministry of Education and Research and the German UNESCO Commission (BMBF, 2022a). The information materials and recommendations on climate change and health compiled by the Federal Centre for Health Education (BZgA, no date) are also a positive example of information and education for the adult sector – although the focus is exclusively on the consequences of climate change and does not include biodiversity loss or pollution. More such formats and networks that go beyond the health sector could make Planetary Health education accessible to more target groups at the national and international level.

The educational concepts and initiatives from the health sector presented here are selected examples in which the link between environmental and human health in the sense of education in line with the guiding principle of 'healthy living on a healthy planet' has already been launched, become established or has

Box 8.1-4**The 'Planetary Health Education Framework' – a starting point for further educational concepts aimed at implementing the guiding principle of 'healthy living on a healthy planet'**

In 2021, the Planetary Health Alliance consortium published the Planetary Health Education Framework (Guzmán and Potter, 2021), which is intended as a basis for creating educational concepts and learning materials, and aims for application in higher education. The Framework contains five foundational domains (Fig. 8.1-1). The focus is on 'interconnection within Nature', which is closely interwoven with 'the anthropocene and health', 'systems thinking and complexity', 'equity and social justice' and 'movement building and systems change'. The five areas are:

1. *Interconnection within Nature*: The focus is on fostering compassion for and interconnection with planet Earth. This approach takes into account cognitive, affective and behavioural components in the development of transformative educational strategies. In addition, an essential role is played by the combination and integration of learning pathways, e.g. from traditional and modern practice, as well as the recognition of diverse knowledge and traditions.
2. *The Anthropocene and health*: This area looks at understanding the links between the Anthropocene and human health, taking into account their multiple influencing factors and determinants, and is based on a social and ecological approach to health promotion and disease prevention and control.
3. *Systems thinking and complexity*: A systems-based understanding that incorporates and recognizes characteristics of complex adaptive systems is essential for Planetary Health education learners.
4. *Equity and social justice*: Based on the rights of humans and the rights of Nature, systemic disparities are to be prevented by implementing equity and justice. Education processes must acknowledge structural inequalities, and future Planetary Health practitioners should be able to design health-promoting and sustainable living environments.
5. *Movement building and systems change*: Inclusive relationships, thoughtful strategy, effective communication and transformational partnerships are designed to enable movement building and systems change in the context of a major transformation.

**Figure 8.1-1**

The five domains of the Planetary Health Education Framework.
Source: WBGU, based on Guzmán and Potter, 2021

succeeded. However, these concepts and initiatives within the group of health professionals are predominantly focused on medical doctors, and should urgently be extended to other health professions. Section 8.1.4.2 contains the WBGU's application-related

recommendations for action for the nationwide implementation of the above-mentioned education concepts in the health sector.

8.1.3

Vision: through education in the sense of the ‘healthy living on a healthy planet’ guiding principle to comprehensive planetary health literacy

In the WBGU’s vision, education based on the ‘healthy living on a healthy planet’ principle is accessible from birth onwards to people of all ages in all regions of this world, and aims to strengthen the comprehensive health literacy of individuals and societies – building on an appreciation of planet Earth’s natural life-support systems and an integrative understanding of humankind and nature. The concept of planetary health literacy (Jochem et al., 2023) corresponds most closely to the WBGU’s guiding principle. Comprehensive planetary health literacy can be understood as the ability to find, understand, assess and apply information relevant to the guiding principle of ‘healthy living on a healthy planet’. It aims to encourage environmentally friendly, sustainable and health-promoting action (Fig. 8.1-2; Jochem et al., 2023). Comprehensive planetary health literacy combines existing concepts of health, sustainability, environmental and ecological literacy with skills relating to transformative action. Individuals and societies with comprehensive planetary health literacy make health-promoting and environment-friendly choices, and shape their everyday lives accordingly, e.g. by practising (or being able to practise) healthy and sustainable lifestyles through plant-based nutrition (Section 4.1) and active mobility (Section 4.2), and accordingly help to create health-promoting, sustainable conditions. As a result, individuals and societies with such comprehensive health literacy behave responsibly and are also prepared to take responsibility themselves (for the health and well-being of present and future generations in an intact natural environment). They further develop their skills by also incorporating cultural, indigenous and local knowledge (Box 8.1-5). In this way, they specifically promote the mobilization of civil society and societal change towards improving the health of people on a healthy planet.

In education systems, moreover, this vision is reflected in a whole-institution approach aimed at both reducing the ecological footprint of educational institutions and increasing the social handprint within (and from) educational institutions. An education strategy oriented towards strengthening comprehensive planetary health literacy through education in the sense of ‘healthy living on a healthy planet’ can thus also lead to the successful achievement of the ‘healthy living on a healthy planet’ vision – for biodiversity and ecosystems and for humans, provided that global warming is limited, if possible, to below 1.5°C in a targeted and timely manner.

8.1.4

Recommendations for action and research: educational strategy in the sense of the guiding principle of ‘healthy living on a healthy planet’

It is apparent that Education for Sustainable Development that pursues the guiding principle of ‘healthy living on a healthy planet’ is still poorly or insufficiently integrated into the various educational sectors in Germany. It is therefore necessary to further establish this educational approach quantitatively and qualitatively, and to strengthen a holistic and comprehensive health perspective in order to use the resulting potential for a nationwide educational strategy in the sense of the guiding principle of ‘healthy living on a healthy planet’.

The WBGU regards the following two aspects as essential for a reorientation of education under the guiding principle of ‘healthy living on a healthy planet’, and participation and transdisciplinarity are essential components:

1. Promote and facilitate knowledge, perspectives and skills for environmental and human health throughout life.
2. In the sense of an overall institutional approach, provide opportunities for sustainable action in the educational institutions, and take on the role of pioneers of change through cooperation in the community.

In this context, the educational mission broadly encompasses an understanding and appreciation of important core elements of a healthy and sustainably designed environment. A core element is the conservation and restoration of healthy ecosystems and their biodiversity, ultimately also as a prerequisite for stabilizing human natural life-support systems and their sustainable use. Another core element is designing the human-made environment in a way that is oriented towards principles of promoting people’s health. A third core element comprises the careful and health-promoting use of natural resources and their regeneration to ensure their sustainable availability for generations to come.

In a national and international education strategy, the following measures can help to close education and training gaps regarding the linkage between health and the state of our environment, and to achieve the rapid pace of transformation made necessary by the delays of the last few decades. This education strategy according to the guiding principle of ‘healthy living on a healthy planet’ should feed into and give fresh impetus to the existing process of embedding Education for Sustainable Development into all areas of education. To this end, the WBGU recommends highlighting health as an integral and explicit field of action in the concept of Education

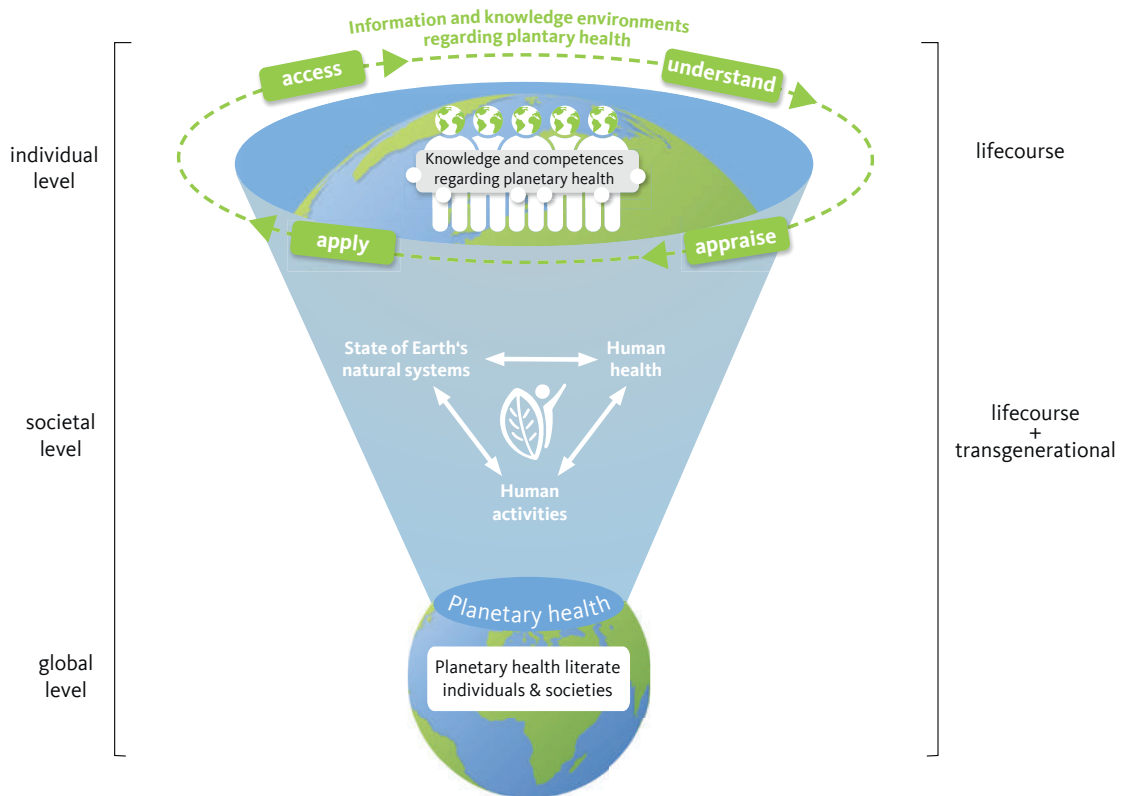


Figure 8.1-2

Planetary health literacy – a model. While the focus at the individual level is on knowledge and skills relating to Planetary Health, individuals and societies that act responsibly can make a positive contribution to the development of healthy people on a healthy planet for present and future generations. Corresponding education and science systems that enable and promote the development of planetary health literacy are essential.

Source: Jochem et al., 2023

for Sustainable Development, and using education as a strategy for encouraging healthy and sustainable behaviour in healthy and sustainable conditions. In this way, the WBGU also supports the plan formulated in the Federal Government’s Future Research and Innovation Strategy to structurally integrate Education for Sustainable Development into all areas of education in order to raise society’s awareness of sustainability, as well as its knowledge and creative competence to promote sustainable development (BMBF, 2022b).

8.1.4.1 Recommendations for action for a nationwide education strategy in the sense of the guiding principle of 'healthy living on a healthy planet'

The timely establishment of nationwide strategies covering everything from early-childhood and school education to further training in lifelong learning via Education for Sustainable Development serves to mutually strengthen the health of species, ecosystems and humans. Overarching planetary health literacy, combined with a knowledge of and a full appreciation for natural life-support systems and ecosystemic and planetary

functional relationships, should be included as a goal in existing and future education curricula across all ages and target groups.

The WBGU recommends:

1. *Integrate the guiding principle of 'healthy living on a healthy planet' into education across the board:* The guiding principle of 'healthy living on a healthy planet' with its corresponding educational concepts should be an overarching guiding principle at all educational institutions. Day-care and kindergarten children, pupils and students should be able to practise and reflect on sustainability strategies in their educational institutions, and be ambassadors for the transformation approach in their social and private environments.
2. *Develop interdisciplinary curricula:* Interdisciplinary curricula that encourage basic societal skills in dealing with the natural life-support systems should be developed for all levels of school education. The orientation for this comes from the conservation of natural functional relationships (i.e. the conservation of the health of humans, other species, ecosystems and the planet).

Box 8.1-5**Local knowledge:
traditional medicine in Indonesia**

Besides formal education and science systems (Knorr Cetina, 1999, 2007), local and indigenous knowledge systems play a key role in ensuring healthy living on a healthy planet. These are historically grown, societally embedded systems of observing, interpreting, producing and handing down a sense of meaning. They play a key role in society in the informal production and transfer of knowledge, but are usually hardly formalized (e.g. by means of certification and institutionalization processes; Antweiler, 1998; Nygren, 1999; Smith, 2011). Examples range from family- or neighbourhood-based knowledge systems and advisory structures for dealing with issues such as household duties, managing vegetable and fruit gardens, and organizing cultural festivities to dealing with sexuality, or even to artistic and dance-based forms of expression (Sillitoe, 1998; Hornidge and Antweiler, 2012; Hornidge et al., 2016). Especially in societies where survival systems are heavily dependent on nature, and where formal primary health care is limited (particularly in rural regions of many low- and middle-income countries), local knowledge systems play a key role in the everyday lives of many people for manoeuvring the interfaces between environmental change and human and animal health challenges. Indonesia's traditional medicine, called 'Jamu', is presented below as an example of such a local knowledge system at the interface between environment and health.

Jamu is a form of traditional medicine that uses herbal medicinal drinks made from the roots, flowers, fruits, seeds, bark, stems and leaves of local plants (Ratnawati, 2020) to prevent and acutely combat diseases in many parts of Indonesia. These juices and powders have been used as remedies for several hundred years and the knowledge has been handed down from generation to generation (Yaman et al., 2014). The raw materials are usually easy to obtain and are also mixed by the people themselves or offered as an industrially produced finished product according to mostly orally handed down recipes, which can vary from region to region.

Although general healthcare in Indonesia has improved overall, the uneven distribution of medical staff in rural and urban areas remains a challenge. The division into Puskesmas (community health centres with medical care), Puskesmas Pembantu (smaller clinics with far fewer staff) and Polindes (service points at the village level) does not fully cover the everyday care particularly of marginalized parts of the population (Gunawan and Aunguroch, 2015). Jamu medicinal drinks, which traditionally are extremely widespread, continue to enjoy extensive popularity against this background. Jamu is not only cheaper but also much easier to obtain logistically, especially in rural regions of Indonesia's archipelago of over 17,000 islands. This explains the increasing demand during COVID-19 in view of a lack of access to COVID-19 vaccines and the desire of many Indonesians to strengthen their immune system with Jamu (Hartono et al., 2021). Despite the initial decline in popular support following the advent of science-based medicine and the campaigns to disseminate it in Indonesia at the time, the sales value of Jamu products in Indonesia's domestic market two years ago was Rp 20,000 trillion and their export value Rp 16,000 trillion (€1.2 billion and €1 billion respectively; Ministry of Industry, 2020 as cited in Nurmajesty et al., 2022).

Recognizing the economic factor, the Indonesian government is planning to market Jamu globally and establish it as

an export product, as announced by the Indonesian Minister of Trade in 2021 in his keynote speech 'Modern Jamu for Asia, Africa, Middle East and Europe Market'. Following this idea, the number of places offering 'herbal tourism' is also increasing. One example is the Jamu Gendong Tourism Village Visitor Centre, where interested people can learn about the manufacturing process.

Local knowledge systems, systems of knowledge production and transfer, are usually organized along gender-specific, age-specific and ethnic or religious lines (Nygren, 1999; Hornidge et al., 2016). A gender-specific organization applies in the case of Indonesia's Jamu healers. Jamu medicine is traditionally passed on from mothers to their daughters and is – with a few exceptions – organized by women. Especially in rural regions, Jamu medicine is an additional, mostly informal, source of income for women (Torri, 2012). Within local communities, being a Jamu practitioner is a respected profession with a long tradition firmly rooted in local identity: Jamu is part of Indonesia's cultural heritage, officially recognized by the Ministry of Education and Culture (Kementerian Pendidikan dan Kebudayaan (Ministry of Education and Culture), 2018).

In the past, the mixtures were sold exclusively by women traders – Jamu Gendong herbalists – with bamboo baskets on their backs, on foot or by bicycle on the streets or on the doorstep. Today they are also offered in cafés as health-promoting 'shots'. As a result, younger generations no longer regard them merely as an old-fashioned custom but as part of their lifestyle (Nurmajesty et al., 2022). This in turn increases the general popularity and interest in Jamu, also on social media (Mantappu, 2021). In addition, its ritual character links up with a literal 'back to the roots' momentum. The desire for a life in harmony with nature is also expressed in scepticism towards chemical agents and their side effects – in a similar way to organic or slow-food movements in high-income countries. Furthermore, most of the Jamu Gendong have known their customers personally since birth. This also enables intensive counselling on a personal and communicative level, which clearly goes beyond a purely symptom-related treatment and instead promotes social interaction within the community.

However, Jamu drinks are not used in hospitals or health centres in Indonesia. On the one hand, this is because there is no standardized quality assurance or sufficient scientific evidence on their effectiveness based on clinical studies. On the other hand, some research studies attest to potentially hazardous effects on health and, in some cases, a critical degree of purity (Limiyati and Juniar, 1998; Lim and Pranata, 2020). Moreover, difference between soil types and the plants' cultivation methods influence the pharmacological effect of the end product. For these reasons, the Indonesian government is pursuing a strategy to establish quality standards for Jamu medicine, the Road Map Pengembangan Jamu 2011–2025 (Road Map of Herbal Medicine Development; Kementerian Kesehatan (Ministry of Health), no date). In addition, the Jamu Scientific Programme was introduced in 2010 (at the Center for Research and Development of Medicinal Plants and Traditional Medicines – B2P2TOOT) in order to be able to integrate the medicines into the national health system by means of robust research results. An encyclopaedia, the 'Jamupedia', of the various contents and raw materials is accessible in Indonesian and Dutch. Nevertheless, traditional medicine receives only minimal financial support from the government and is only partially integrated into the national health insurance programme (Rahayu et al., 2022). Jamu medicine, like many local knowledge systems, is thus characterized by a low degree of formalization and institutionalization (Sumarni et al., 2019).

There are no formal quality standards, certification processes or institutions that implement these standards, initiate training courses for Jamu healing practitioners and prepare them for a formal labour market. Instead, Jamu medicine is widely practised according to informally negotiated standards (without any formal, science-based quality assurance). Against the background that, according to the World Health Organization (WHO, 2019d), an estimated 80% of the world's population

relies on traditional forms of medicine, the lack of scientifically based quality control in particular is a challenge that needs to be addressed in line with the guiding principle of 'healthy living on a healthy planet'. The Global Centre for Traditional Medicine in India, for example, aims to scientifically explore the potential of traditional medicine (WHO, 2022a). Source: Dippel, 2023b

3. *Make further education and training of (teaching) staff possible:* The accelerated implementation of an education strategy under the guiding principle of 'healthy living on a healthy planet' requires the mandatory and target-oriented training and further education of (teaching) staff in early-childhood education, at all school levels and in vocational, higher and adult education. This includes the development and organizational integration of training courses for Education for Sustainable Development, including the perspective of comprehensive planetary health (conservation and restoration of the health of ecosystems and the planet), oriented towards the transformation needs of society with a view to meeting climate, biodiversity and medical-health targets. In the field of early-childhood education, further training must be integrated as compulsory elements of employment contracts and financed accordingly. School curricula should include spaces for addressing this approach. Target agreements with higher education institutions can be used to require all courses of study to address the guiding principle of sustainability, paying particular attention to the perspective of Planetary Health.
4. *Promote interdisciplinarity and bring together different forms of knowledge:* Especially interdisciplinary and socio-politically highly topical learning areas such as Education for Sustainable Development and Planetary Health lend themselves to modularly organized project weeks. The short-term development of basic and advanced training for teachers and learners on topics relating to comprehensive planetary health should be implemented promptly, initially in the professional fields entrusted with the rapid and large-scale societal transformation now required, from natural sciences and engineering to economics, social sciences and political science.
5. *Promote the use and further development of training concepts and educational courses:* Already designated further-training concepts on Education for Sustainable Development should be used in the sense of the guiding principle of 'healthy living on a healthy planet'. To this end, a funding programme should be developed that enables municipal and civil-society providers of such educational services to further develop their courses in the short term.
6. *Make materials available to disseminate the guiding principle of 'healthy living on a healthy planet':* The population should be given the opportunity to find out about the guiding principle of 'healthy living on a healthy planet' on a broad scale. To this end, recognized adult education providers, professional training events and civil-society initiatives should be promptly provided with materials that promote the integration of the guiding principle into their respective work.
7. *Strengthen the whole-institution approach under the guiding principle of 'healthy living on a healthy planet':* Educational establishments, companies, organizations and institutions are called upon to adopt a whole-institution approach incorporating the guiding principle of 'healthy living on a healthy planet', so that they also have an impact on the community. Education should also include action on sustainable catering, infrastructure, professional practice, human and natural health, and participatory governance. In this context, municipalities have a key role to play as partners in these processes (NP BNE, 2021).
8. *Promote the European Education Area, expand trans-regional cooperation on education:* Germany should implement the above-mentioned measures of the education strategy. At the same time, the guiding principle of education in line with 'healthy living on a healthy planet' should be made the subject of international discourse in the standardization processes of the European Union (EU) for harmonizing national education systems, as well as in multilateral forums such as those of UNESCO; efforts should be made to take up the principle in other nationally organized education systems.

8.1.4.2

Recommendations for action focusing on health professionals as multipliers for the vision of 'healthy living on a healthy planet'

Health professionals have a key role to play in transporting the guiding principle of 'healthy living on a healthy planet' into society. This task makes specific demands on the education system concerned, but some training concepts and initiatives are already in place (Section 8.1.2). To empower health professionals in their role as multipliers of the guiding principle of 'healthy living on a healthy planet', the WBGU recommends the following:

1. *Expand all forms of training and further training for health workers to include Planetary Health education:* Planetary Health education should be integrated into all forms of training for health professionals in all fields and all disciplines with the explicit aim of strengthening health professionals' skills in comprehensive planetary health and of training transformative action skills. Relevant target groups are all health professionals, e.g. doctors, dentists, pharmacists, public health experts, nurses and carers, midwives, nutritionists and physiotherapists. Approaches such as 'climate clinics' and climate-sensitive health counselling (Section 6.4.2.2) should pursue the goal of contributing to comprehensive planetary health literacy for patients, and thereby improving patient education.
2. *Acknowledge and promote the relevance of individual occupational groups in communicating the guiding principle of 'healthy living on a healthy planet':* Relevant teaching content from the educational concepts of Education for Sustainable Development and Education for Planetary Health should be integrated into the curricula of corresponding study programmes. The differences between the various professional groups mentioned above should be taken into account in training and further-training programmes for communicating the guiding principle of 'healthy living on a healthy planet'. Further training for health professionals, e.g. on how to run a 'climate clinic' (Section 6.4.2.2), should be made more widely available. There could also be a focus on the public health service, which can provide the population with comprehensive health education. Midwives can serve as a further focus group; since they closely accompany families in a sensitive phase of life, they can encourage comprehensive planetary health literacy among parents. Nutritionists and diabetes counsellors can also have a positive influence on the dietary habits of their patients by passing on comprehensive knowledge, e.g. on the advantages of a predominantly plant-based diet (Section 4.1). The same applies to physiotherapists, who can promote the health of their patients by imparting knowledge

and teaching skills relating to active mobility (Section 4.2). Nurses, too, should be trained to communicate aspects of comprehensive health literacy in their often very close – and sometimes long – contact with patients.

8.1.4.3

Research recommendations

In addition to the above-mentioned recommendations for action, the WBGU makes the following research recommendations:

1. *Promote inter- and transdisciplinary research projects:* In view of the rapidly growing urgency of combined crises, inter- and transdisciplinary research projects can develop educational and implementation options on how accelerated action can succeed in the field of comprehensive health protection. For this purpose, relevant disciplines and actors should be brought together to develop time-optimized strategies for interaction between different fields of action. In this way, market mechanisms, combined with regulatory measures and legal frameworks, can speed up implementation. Accompanying research should be established or strengthened that examines the implementation and effectiveness of education in the sense of the guiding principle of 'healthy living on a healthy planet'.
2. *Promote further research programmes for teacher education:* Follow up the expiring programme called 'Quality Offensive in Teacher Training' from the Federal Ministry of Education and Research (BMBF) and the *Länder* with a new funding phase for projects on the topic of Education for Sustainable Development that explicitly addresses health in a broadly understood sense according to the principle of 'healthy living on a healthy planet'.
3. *Embed sustainability aspects into health research:* Future studies and research projects in the health sector should be expanded to include sustainability aspects. For example, future studies and research projects addressing topics such as nutrition or promoting physical activity primarily from a health perspective should explicitly integrate aspects offering multiple environmental benefits and sustainable development.
4. *Research comprehensive planetary-health literacy:* planetary health literacy among health professionals and other multipliers should be surveyed, increased by means of targeted measures, and the effectiveness of such measures evaluated. This includes, for example, surveying the status quo of comprehensive planetary health literacy among health professionals, implementing interventions to increase planetary health literacy, and examining the effectiveness of such interventions (with possible outcomes such as

the level of planetary health literacy, quality of life, well-being, health, dietary and physical activity behaviours, etc.).

8.2 Science and science funding

Science, as it has developed since the Enlightenment in 18th-century Europe and successively gained a foothold in societies on all continents, has always acted as a key engine of societal progress and change. In this context, it has been the originator of technological, institutional and social innovations, enabled the fundamental, systematic exploration of contexts, acted as a historical memory and ethical reflection surface of societies, and offered spaces for scientifically based and informed discourse. In addition to research and teaching, the tasks of science include providing political policy advice, promoting young scientists and exchanging information with the general public. In its interaction with global challenges, science also takes on the key role of facilitating transnational cooperation through science diplomacy efforts, when, at the state level, this is made difficult or impossible by political considerations, such as geopolitical tensions.

Accordingly, science is also seen as playing a key role in overcoming the great crises of the 21st century, in the sustainability transformations and in the guiding principle of 'healthy living on a healthy planet' formulated here. The action programme for sustainable development known as 'Agenda 21', which was adopted at the Earth Summit in Rio in 1992, already formulated this expectation. The 2030 Agenda and its 17 Sustainable Development Goals (SDGs), jointly adopted by the international community at the level of the United Nations in 2015, and the Paris Agreement adopted in the same year, formulate comparable expectations for science and science policy.

However, science systems differ substantially worldwide in terms of their financial and personnel resources, their disciplinary, inter- or transdisciplinary organization, their application orientation and the importance attached to basic research, also in terms of the research infrastructures (e.g. laboratories, research ships, etc.), their internationality and transnational cooperation behaviour. What all science systems have in common is, firstly, their largely national organization and funding and, secondly, their historically evolved structures, which will continue to shape international cooperation, language use, disciplinary cultures and scientific topics (with corresponding effects on the shaping of public discourse) into the future. In terms of agenda setting and disciplinary composition, the recent COVID-19 pandemic revealed significant gaps in the way environmental-change-related health

risks are dealt with in science and innovation systems worldwide.

For example, SDG 9 of the 2030 Agenda refers to the need to contribute to committed action for a transformation towards sustainability that ensures the long-term health of people and nature by promoting the increasing integration of a science for shaping society's future on a global scale. This encompasses research, advisory services, education and the promotion of young scientists in cooperation between the natural and social sciences and the humanities, acknowledging the full breadth of societies worldwide. The underfunding of science in the health sector has repeatedly been an issue since the 1990s (Randolph and Bloom, 1990). Due to the rapid increase in health risks that arise as a result of the direct interaction between humans and nature, science-policy discussions on researching the environment-health nexus are also urgently needed (Kickbusch et al., 2022; Taylor et al., 2022).

This section deals with the science-funding landscape and the organization and practice of science, in particular with the suitability of its structure for addressing growing environmental and climate-change-related health risks, and with better equipping science systems worldwide for researching and managing health risks caused by environmental change and human behaviour. The first part of the section highlights the status quo and reveals persistent misalignments, for example in the field of research funding. It shows that there is a fundamental discrepancy between scientific knowledge production on environmental and health risks and the actual distribution of these risks. The combination of insufficient funding and historically evolved path dependencies relating to material and immaterial science infrastructures has led, among other things, to a situation in which precisely those countries that are most seriously affected by environmental and health risks have little research capacity and, globally speaking, little voice. The resulting lack of context-specific research, e.g. at the interfaces of environmental change and human health, in turn affects political and societal decision-making processes and thus represents a significant limitation of science's transformative potential.

The second part of the section discusses measures aimed at overcoming this conflict situation. Possible courses of action at the national and multilateral level are identified which are primarily directed at actors in research policy, but can also serve as a stimulus for reform for the actors within the science systems themselves.

8.2.1 Financial structure: globally, European Union and Germany

In most countries worldwide, as well as in the global average, public and private investment in science does not meet the challenges of the necessary transformation processes towards sustainability (Fig. 8.2-1). In 2020, for example, gross domestic expenditure on R&D (GERD) worldwide amounted to an average of 2.63 % of GDP (UIS, 2022b). This includes public and private investment in research and development and the funding areas of basic research, applied research and experimental development projects in publicly and privately organized science, tertiary education and civil-society organizations.

Moreover, this 2.63 % is distributed very unevenly around the world. There are significant differences between countries of different income groups. For example, R&D spending in 2020 averaged 2.74 % of GDP in high-income countries, 1.30 % in middle-income countries and 0.2–0.5 % in low-income countries (UIS, 2022c; Fig. 8.2-2). It should also be borne in mind here that the mobilization of private funds – in addition to the public funding of science – is much more successful in high- and middle-income countries (UNESCO, 2015: 64). With the exception of China, even the countries of the

BRICS group (Brazil, Russia, India, China, South Africa) and numerous major regional powers such as Indonesia and Nigeria invest comparatively little in their science (Table 8.2-1).

It is also striking that little progression is recognizable. Globally, the trend is positive: total public and private spending on research and development increased from 1.69 % in 2015 to 1.93 % in 2020 (UIS, 2022a). However, the progression stems from middle- and high-income countries. Low-income countries continue to invest relatively little in R&D, and countries in the lowest income bracket even saw a steady decline in R&D spending over this period (Fig. 8.2-2). Apart from the fact that in low-income countries less is invested in research and development in relation to GDP, the absolute amounts invested are, of course, also much smaller than in high-income countries, where the GDP is significantly larger. In per-capita terms, low-income countries employ 26 times fewer scientists than high-income countries (UIS, 2022a); they also have less research infrastructure, such as laboratories or access to scientific literature (UNESCO, 2021).

It should also be noted that a number of countries have fallen short of their self-set targets. For example, the EU had set itself the goal of investing a total of 3 % of GDP in research and development as early as 2010 (Albu, 2011). Yet even by 2020 only five countries had reached

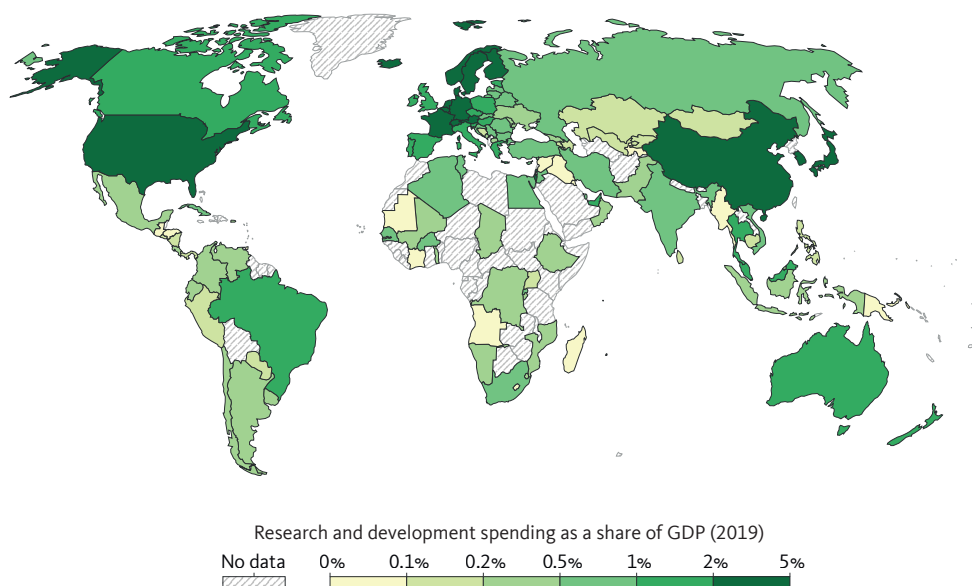
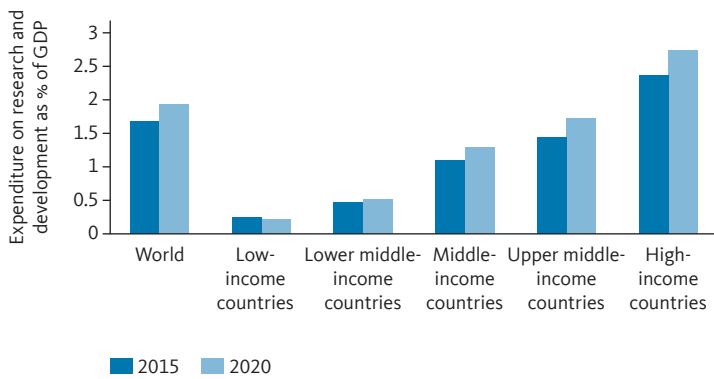


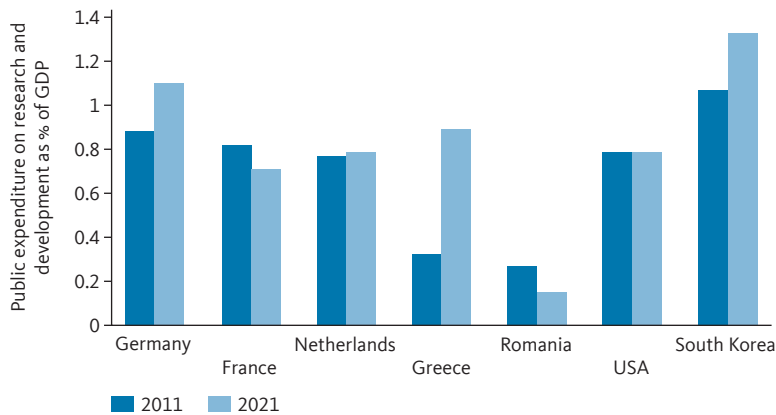
Figure 8.2-1

Gross domestic expenditure on research and development as a percentage of gross domestic product (GDP), 2019 or latest year available.

Source: Our World in Data, 2022, based on data from the UNESCO Institute for Statistics (UIS)


Figure 8.2-2

Research and development expenditure as a proportion of GDP.
Source: WBGU, based on UIS, 2022a


Figure 8.2-3

Development of public expenditure on research and development in relation to gross domestic product.
Source: WBGU, based on Eurostat, 2022

this target – including Germany with 3.1% (Eurostat, 2021). The situation is similar in the African Union: to date, not one of the countries has reached the 1% target set for 2010. South Africa and Kenya come closest with 0.8% (UNECA, 2022). This is problematic inasmuch as public investment in research and development is a fundamental lever in the way states can foster innovation in the areas that are critical to their sustainability transformations. Science provides an important basis for the promotion of national innovation systems, which in turn play a fundamental role in mobilizing private funds for sustainability transformations. In line with the vision of ‘healthy living on a healthy planet’, the aim is on the one hand to strengthen the development of science systems at the interfaces of environmental change and human health, on the other to reduce the discrepancies between nationally organized knowledge and innovation systems with a view to transregional cooperation for a healthy future.

Looking at research and development spending from exclusively public sources, i.e. expenditure that is the direct result of government decisions, public spending on research and development in 2021 in the EU, for example, was equivalent to only 0.75% of GDP. The highest level of investment was in Germany, the lowest in Romania (Eurostat, 2022). Nor was such public investment

substantially higher in other high-income countries such as the United States and South Korea (Figure 8.2-3). Between 2011 and 2021, only a few high-income countries recorded a significant increase in public spending on R&D: Germany (from 0.88% to 1.10% of GDP), South Korea (1.07–1.33%) and Greece (0.32–0.89%). As a percentage of GDP, the corresponding expenditure remained constant in the United States, and in the EU it only rose from 0.72% to 0.75%, partly due to the fact that investment fell in some EU countries (Eurostat, 2022). There is a lack of comparable data from low- and middle-income countries. However, looking at the data on total public and private expenditure on R&D in low- and middle-income countries, it is plausible to conclude that public expenditure on R&D in all these countries is still much lower than in high-income countries.

This huge disparity in funding reproduces interdependencies between science systems, which has a negative impact on how well the knowledge to be gained is suited to local conditions. Because national investment in research and development is so low, science in many middle- and low-income countries is extremely dependent on international funding. Most of this comes from actors in high-income countries, such as the European Commission, national science-funding agencies and/or representatives of foreign cultural policy and

Table 8.2-1

Expenditure on research and development (R&D) in selected countries.

Source: UIS, 2022c

Country	Gross domestic expenditure on R&D (GERD), GERD as a percentage of GDP	Year from which the data originate
Israel	5.44	2020
South Korea	4.81	2020
Sweden	3.53	2020
USA	3.45	2020
Japan	3.26	2020
Germany	3.14	2020
China	2.4	2020
UK	1.71	2019
Brazil	1.21	2019
Russia	1.10	2020
India	0.68	2018
South Africa	0.62	2019
Indonesia	0.28	2020
Uzbekistan	0.14	2020
Nigeria	0.13	2007

foundations. This mixture is often criticized for several reasons. First, because agendas are set by the donor and low- and middle-income countries have little leverage to co-determine a research agenda according to their own priorities. Second, because funding for cooperation between high-income countries and low- and middle-income countries often largely benefits institutions in high-income countries, resulting in correspondingly little institutional capacity-building in low- and middle-income countries. Studies also show that cooperation relationships in transregional projects are often characterized by inequality. Scientific institutions from the donor countries often take on a more dominant role in defining the scientific agenda. Decision-making power over the use of human and financial resources usually lies primarily with representatives of institutions from high-income countries. This is also reflected in publications. First authorships on regional research are mostly held disproportionately by researchers from institutions in the funding countries (Besson, 2022; Boshoff, 2009; Erundu et al., 2021; Kok et al., 2012; Okeke, 2021; Hornidge et al., 2023; Partelow et al., 2020).

In addition to the disparity between countries of different income groups, research in the social sciences is still markedly underfunded. This imbalance can be illustrated by the example of research on climate change. Between 1990 and 2018, climate research in the natural and technical sciences accounted for 770% more funding than research in the social sciences and humanities, and only 5.21% of total climate research funding during this period was allocated to social science research on climate-change mitigation (Overland and Sovacool, 2020). This is partly due to the different costs of experimental research, which are often particularly high in the natural and technical sciences. Nevertheless, this fact reinforces the imbalance that while our understanding of the causes and effects of climate change has increased significantly and numerous technological mitigation solutions have already been identified (and should continue to be identified), implementation of the urgently needed transformation of society as a whole remains poor.

Looking at the thematic portfolio of the German funding landscape, there is a variety of funding lines on the environment or health, but relatively little on the environment-health nexus and the future risks it holds.

Although this interface has recently increasingly been at the centre of calls for proposals (Box 8.2-1), in view of the diversity and breadth of the portfolio of topics and problems involved, systematic scientific coverage is still far from sufficient. There is a lack of funding programmes and funding initiatives that specifically focus on the interface between health and the environment, e.g. in the context of nutrition, mobility and housing. Similarly, there are few funding programmes that address natural, health, social and cultural sciences in equal measure. However, the draft of the Future Strategy for Research and Innovation (BMBF, 2022b) from October 2022 indicates that this weakness has been recognized and that Germany's Federal Government is keen to push ahead with research on the environment-health nexus. One sign that greater attention will be paid in future to the cross-relationships between human health, animal health and ecosystems is the planned further development of the National Research Platform on Zoonoses, which has existed since 2009 (with the participation of the BMBF, the Federal Ministry of Food and Agriculture (BMEL), the Federal Ministry of Health (BMG) and, since 2016, the Federal Ministry of Defence (BMVg)), into a research platform for One Health (with additional participation of the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) and the Federal Ministry for Economic Cooperation and Development (BMZ)). It is important here to make sure that the platform is further developed in the spirit of the 'healthy living on a healthy planet' vision.

8.2.2

Scientific practice: disciplines and types of science

The funding differences between the science systems, most of which are nationally organized (with the exception of the EU), are also reflected in the organization of the systems. Especially the better funded and better equipped science systems of countries in the Organization for Economic Co-operation and Development (OECD) are still largely organized along disciplinary lines (UNESCO, 2021; WR, 2020; Barry et al., 2008). This is the result of decades of subject differentiation and professionalization processes that immensely accelerated the progress of knowledge in the 19th century. The professional specialization of labour, knowledge production and transfer played a significant role in the history of the development of the science system as an innovator and driver of progress (Gravert, 2022). At the same time, today's disciplinary organization poses huge challenges to the advancement of knowledge for dealing with highly complex socio-ecological and global crises. There is a demand for disciplinary expert knowledge to ensure systemic multiperspectivity in interdisciplinary exchange. Science for dealing with the major global challenges at the interfaces of environmental change and human health is called upon to fill the field of tension between disciplinarity, interdisciplinarity and transdisciplinarity, as well as knowledge production in cooperation with practitioners and end users. This means simultaneously developing interdisciplinary systems knowledge in addition to largely disciplinary basic research and – through

Box 8.2-1

Current examples of ministerial research funding for the environment-health nexus in Germany

Intervention studies for healthy and sustainable living conditions and lifestyles (BMBF)

This funding measure specifically addresses the questions posed by the WBGU in its discussion paper on Planetary Health (WBGU, 2022): how can our societies be shaped in such a way that health-promoting and sustainable living conditions become possible for everyone? What are the specific challenges for vulnerable groups? The BMBF emphasizes that the aim of the funding measure is to “generate evidence for effective measures for a fundamental societal transformation towards health-promoting, ecologically sustainable and socially just living conditions and lifestyles. The measures are intended to help prevent damage to health caused by societal and environmental factors and to create fair living environments for sufficient physical exercise and health-promoting nutrition” (BMBF, 2022d).

Ecological sustainability in outpatient healthcare (BMG)

This funding announcement aims to support facilities in the outpatient health and care system (such as doctors' practices, pharmacies and outpatient-care facilities) by developing approaches to improving their resource efficiency and sustainability. Relevant areas of resource use include buildings, energy supply, transport, hygiene, food supply and waste (BMG, 2022).

Research into the links between biodiversity and human health (BMBF)

Interdisciplinary research projects addressing one or more of the following topics are to be funded in the context of these measures: integrity of aquatic or terrestrial ecosystems, zoonotic health threats, agrobiodiversity, non-communicable diseases, urban and landscape development, mental illness and resilience. The explicit aim is to promote cooperation between disciplines that have had little contact with each other to date, and to involve societal stakeholders (BMBF, 2022c).

Source: Matthies-Wiesler, 2022

transdisciplinary research projects with practitioners – developing context-specific solutions, as well as technical and institutional innovations in line with the guiding principle of ‘healthy living on a healthy planet’.

In Germany, the importance of inter- and transdisciplinary cooperation in the field of sustainability research has increased noticeably over the last ten years. In particular, the ‘Research for Sustainability’ (FONA) funding programme and the BMBF’s ‘Socio-Ecological Research’ funding priority illustrate this development.

However, the promotion of excellence within individual disciplines continues to predominate both in the German science system and in research on sustainability. This becomes evident from the fact that although there is an increasing amount of exchange between engineering and the natural sciences, links with the social sciences only take place in selected areas (Deutsche UNESCO-Kommission and Möller, 2012: 5). Examples from scientific fields relevant to the interaction between humans and the environment from a health perspective include research on agriculture and fisheries. Here, the economic system uniting the scientific disciplines calls for an orientation towards applications as well as inter- or transdisciplinarity, thus enabling inter- and transdisciplinary exchange (Mollinga, 2008, 2010; Callo-Concha et al., 2017; Hornidge et al., 2011; Franke et al., 2021). In research areas relating to One Health and Planetary Health, Fig. 8.2-5 shows that although scientists are working on similar topics, the focus in One Health has so far been primarily on animal health, infectious diseases and related topics, e.g. COVID-19, antimicrobial resistance and zoonoses. In addition to COVID-19, research in the field of Planetary Health focuses on environmental issues and climate change, as well as on the social determinants of health. Particularly because of the increasingly broad focus of One Health research, the two areas are showing more and more overlaps and offer potential for inter- and transdisciplinary, integrating cooperation. This potential has not yet been exploited, however (de Castañeda et al., 2023: e1111). Especially for the development of practical solutions and technological and institutional innovations for dealing with environmental health dynamics, it would be a good idea to specifically promote these forms of knowledge cooperation.

Although enormous progress has been made in many other areas of socio-ecological change processes, the necessary inter- and transdisciplinary exchange is also hampered by the disciplinary fragmentation between university and non-university research in the German context. For example, interdisciplinarity and transdisciplinarity in Germany’s marine and climate sciences are characterized by the concentration of large-scale natural-science research at Helmholtz institutes, a few Leibniz institutes and universities, and much more sparsely

positioned social-science research at universities and a few Leibniz institutes (Markus et al., 2018; Hornidge and Schlüter, 2020). Interdisciplinary interaction is limited by differences in structural size and, as a result, different degrees of thematic differentiation and specialization on the part of the social sciences. Inter-institutional cooperation even in joint externally funded projects is further complicated by integration into different institutional contexts, each with its own logic and priorities – non-university research institutes focusing on research versus universities whose daily routine is characterized by the semester cycle and teaching activities. Experience shows that the application of political consulting work and the need to coordinate its timing with the political cycle – both necessary in the political context – are only possible to a limited extent. Mission-oriented marine research conducted under the unifying umbrella of the German Alliance for Marine Research (DAM) aims to fill this void in applied inter- and transdisciplinary marine research. The WBGU proposes a similar format for cooperation between environmental and health research. In the field of German health research, it has become clear – at the latest since the COVID-19 pandemic – that this research is not sufficiently networked either within itself or with other disciplines. The German Science Council (2021: 12) states that there are “hardly any established, networked health-research structures that are directly operational in the event of a crisis to coordinate research activities at the national level and to ensure an exchange of the daily new findings and data. This insufficient networking not only became evident within health research, but also affects cooperation between health research and other disciplines.”

A more open disciplinary structure of science as a whole and thus the development of interdisciplinary and transdisciplinary formats of knowledge production, development and dissemination also involves a greater differentiation between the priorities of basic and applied research. One tangible example here is the translation of basic medical research into product and vaccine development in dealing with the COVID-19 pandemic (WR, 2021: 51). Alongside successful vaccine development, the vaccine scepticism observed in societies around the world is a reminder of the significance of communicating scientific knowledge and innovation to society, which is important for translating scientific knowledge and innovation into implementation and use. This underlines the importance of inter- and transdisciplinary approaches in prevention research regarding health risks at the interface of environment and health.

There is also an increasing number of approaches aiming to counteract science’s CO₂ footprint and its contribution to health challenges, and to make sustainability research itself more sustainable. These include

the German Committee for Sustainability Research in Future Earth (DKN), which contributes to reflections on sustainability research within the framework of the ‘Sustainability 2030 Science Platform’ and supports the environment-friendly design of research activities (DKN, no date), as well as the ‘Sustainability Guide’ (LeNa), a BMBF-funded initiative launched by the non-university research communities Leibniz, Helmholtz and Fraunhofer (Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V. et al., no date). Moreover, there are initiatives aiming to make science itself more sustainable, lower in CO₂ emissions and healthier for people and the environment. These include the ‘Contribution to more sustainability in research funding’ by the German Research Foundation (DFG), which offsets CO₂ emissions caused by business trips (DFG, 2020) and departmental research (e.g. Climate Neutral BMZ 2030).

8.2.3 Output: knowledge products and basis for action

The global financial structure of science funding (Section 8.2.1) is also reflected in the distribution of research output. For example, in 2019, 90.6% of global scientific publications (excluding publications from the arts, humanities and social sciences) came from the Group of

Twenty (G20) countries (UNESCO, 2021: 32). As one result, the scientific evidence on the relationship between climate change and human health comes predominantly from high-income countries and China (Berrang-Ford et al., 2021). Even research that takes place in low- and middle-income countries, e.g. tropical marine sustainability research and research on infectious diseases such as Ebola, is dominated by high-income countries (Mbaye et al., 2019; Partelow et al., 2020). An analysis of One Health and Planetary Health research conducted since December 2019, which increased sharply especially in 2020 and 2021 (Fig. 8.2-5), shows that it comes mainly from European and North American scientific institutions. These institutions published 76% of One Health publications (mainly on infectious diseases and related topics, e.g. COVID-19, antimicrobial resistance and zoonoses) and 92% of Planetary Health publications (mainly on COVID-19 and climate change; Fig. 8.2-5). At the same time, countries with a large proportion of newly emerging infectious diseases (i.e. countries in East and West Africa, Brazil, China, India) account for more publications on One Health than on Planetary Health (de Castañeda et al., 2023: e109; Fig. 8.2-5). The same pattern of a bigger share of publications coming from high-income countries can also be observed in numerous other areas of scientific work (UNESCO, 2021; Fig. 8.2-4; Tab. 8.2-2).

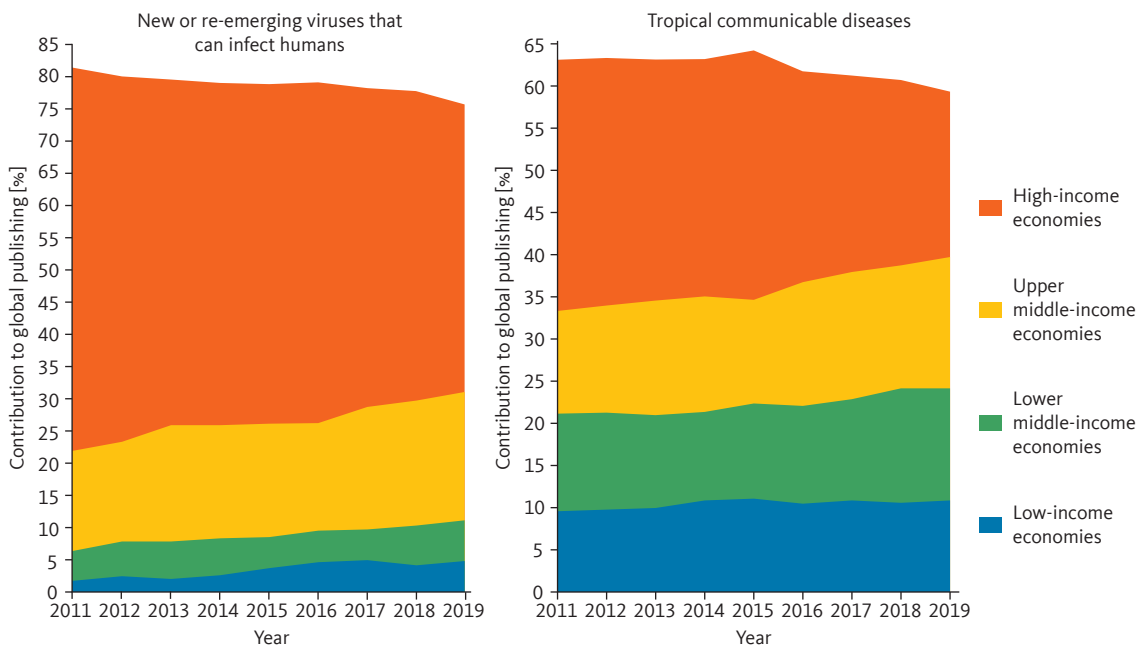


Figure 8.2-4 Contributions of different income groups to the volume of publications on new or emerging viruses that can infect humans and on tropical infectious diseases. Source: UNESCO, 2021

8 Education and science

In addition to specialist publications, patents can also be used to measure the output and performance of scientific activity. Patents as a result of research and development activity reflect to some extent the innovative capacity and institutional frameworks that allow firms to reduce uncertainty about returns from innovation through patenting (Czarnitzki and Toole, 2011). In 2019,

the G20 countries also accounted for 96.4% of patent applications at the five largest patent offices worldwide (UNESCO, 2021: 32). Better R&D performance in low-income countries, as reflected inter alia by patents, could help attract investment and contribute to improvements in prosperity by developing local value chains.

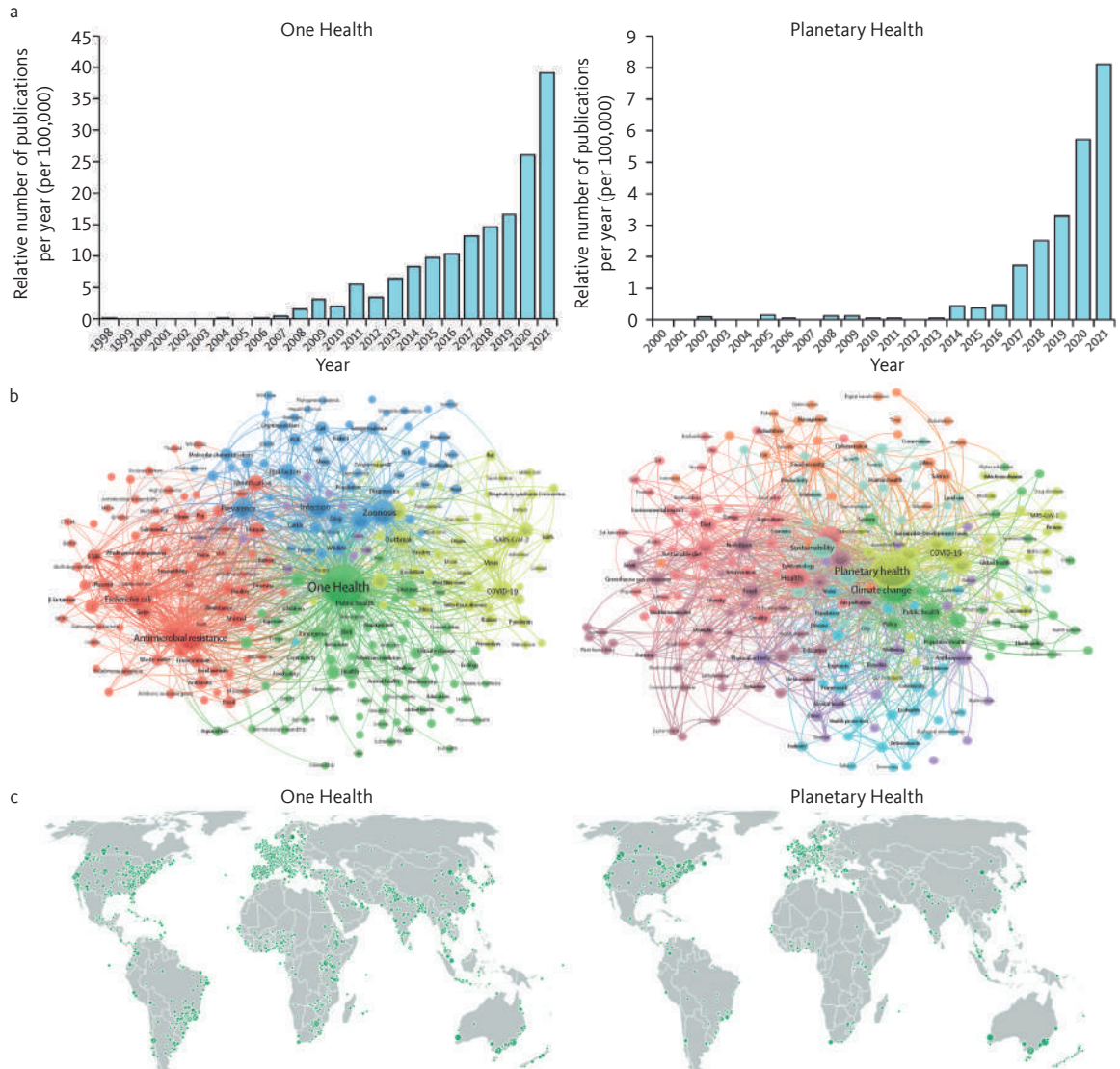


Figure 8.2-5

One Health and Planetary Health research trends, topics and global distribution. (a) One Health and Planetary Health publications relative to the total number of publications indexed in the Web of Science per year (per 100,000). (b) Keyword co-occurrence network graph of One Health and Planetary Health research topics (created with Vosviewer, version 1.6.17). The size of the nodes represents the number of publications in which a keyword occurs. The closer the nodes to each other, the stronger the link between the keywords. The keywords are grouped in clusters depending on their interrelation, and these clusters are represented with different colours. (c) Geographical distribution of institutions active in One Health (left panel) and Planetary Health (right panel) research in 2020 and 2021 by urban areas (created with Netscity). The counting method is the normalized number of publications (agglomeration): for One Health the maximum value is 47.14 and the minimum value is 0.04; for Planetary Health the maximum value is 22.78 and the minimum value is 0.04.

Source: de Castañeda et al., 2023: e110, own translation

Table 8.2-2

Contributors to global health inequalities research (1966–2015).
Source: WBGU, based on Cash-Gibson et al., 2018

Income group	Frontrunner	Contribution of frontrunner to total publication volume on health inequalities
High-income countries	USA	44.8 %
Upper middle-income countries	Brazil	2.2 %
Lower middle-income countries	India	1.2 %
Low-income countries	Tanzania	0.2 %

Depending on financial resources and the disciplinary and thematic positioning of the science systems, the discrepancies in scientific knowledge production described above significantly limit global societal decision-making and transformation processes. First, the lack of context-specific research on particular regions and problems stands in the way of developing effective solutions. This is also reflected in the patent developments described above. In the field of climate and environmental research, it can be seen that this is largely located in high-income countries and China, but that the consequences of these change processes particularly affect middle- and low-income countries in the tropics. Transformative research on approaches to mitigating and dealing with the concrete impacts of these change processes is urgently needed in the local contexts, designed by local scientists and involving their transdisciplinary networks with practitioners and decision-makers to ensure change (Berrang-Ford et al., 2021; Pasgaard et al., 2015; Karlsson et al., 2007). The same applies in the field of Global Health. While the main burden of disease worldwide is found mainly in low- and middle-income countries, few medical research facilities exist there (Chu et al., 2014). Furthermore, in the field of Global Health the fact that less than 10% of health research funding is spent on 90% of health problems was denounced as early as the 1990s – this is expressed by the term ‘10/90 gap’ (Global Forum for Health Research, 2000). At that time, this gap referred mainly to the lack of research on the sort of health problems that affect low- and middle-income countries. In the meantime, there is overall criticism that health research is not being conducted in a needs-oriented manner, and that certain populations, diseases and topics – such as antibiotic resistance and child-friendly medicines – are being disproportionately neglected (Viergever, 2013). Context-specific research and locally adapted solutions are needed to meet the special challenges that arise, for example, in the course of advancing urbanization in Latin America, Africa and Asia (Section 4.3) (Nagendra et al., 2018). However, as

the advances in scientific knowledge on environmental and health risks are shaped by the perspective of high-income countries, they can only be used to a limited extent as an evidence base for transformation measures in low- and middle-income countries (Bansard and van der Hel, 2022). Global knowledge production is in a geographical and socio-economic imbalance. Much of the research is located in well-resourced science systems in high-income countries (de Castañeda et al., 2023), while low-income countries serve as research regions; yet research agendas continue to be largely designed from outside and thus do not fit locally for shaping transformation processes. This in turn fosters a problem of legitimacy that can be well exemplified by institutions such as the Intergovernmental Panel on Climate Change (IPCC) and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), which occupy a key position at the interface between science and policy-making. Despite growing efforts to diversify teams of authors and to consider a wide range of publications when producing status reports, the current situation still inevitably reflects the imbalanced capacity and publication situation that continues to characterize science (Corbera et al., 2016; Bjurström and Polk, 2011; Ho-Lem et al., 2011; Timpote et al., 2018; Montana and Borie, 2016; Diaz-Reviriego et al., 2019). This increasingly leads to disputes when summaries for policymakers are to be adopted for political decision-makers. In the IPCC context, for example, African countries criticize the lack of differentiated statements on the continent and on issues that are particularly important to them, such as certain types of drought. Countries like India fundamentally question the assumptions that are made, for example, in Shared Socioeconomic Pathways (SSPs) (Bansard et al., 2021). Such dissatisfaction erodes confidence in the content of the progress reports as a common basis for action.

8.2.4

Vision: partnership-based science that unleashes transformative potential to address environmental and health risks

The vision of ‘healthy living on a healthy planet’ needs science to help shape society’s future on a global scale – equally in high-, middle- and low-income countries – in an interaction between research, consulting and the promotion of young scientists at the interfaces between health science and the natural and social sciences. The transformative potential of science can only unfold globally if empirically based, context-specific answers to the respective challenges are developed worldwide, and networks for reflection and implementation are established. The consequences of science and innovation systems that perform very differently globally could be observed during the COVID-19 pandemic: while vaccine development and production were possible in efficient national science systems, transregional distribution posed a huge challenge because of local demand. Some vaccine-producing countries, such as the United States and India, even imposed temporary export bans. Discussions on ‘global vaccine injustice’ or ‘vaccine apartheid’ did considerable damage to existing structures of global governance and prepared the ground for an intensification of geopolitical tensions.

Major upheavals like those we are currently experiencing in global society when dealing with the major crises of our time – climate, biodiversity, debt, health and war – and in the search for sustainable futures are negotiated at the societal level. This requires the targeted promotion of public discussion processes with a strong scientific foundation. Research is needed in partnerships between scientists from countries of different income groups and regime types. It requires continuous, iterative processes of idea and technology development as well as successive changes in institutional rules and cultural everyday practices. To achieve this, underfunded science systems and science fields at the interfaces of environment and health must be strengthened worldwide, and alliances of environmental-health actors from science, politics and practice must be cultivated and further developed. The aim is to ensure a common ability to speak and act in global society in the sense of the guiding principle of ‘healthy living on a healthy planet’ – through transregional cooperation between science, science policy and science funding.

Guided by this vision, the development of a cross-departmental, national research platform for One Health in Germany is promising. This should now be further developed in the sense of the ‘healthy living on a healthy planet’ vision and underpinned by the various ministries

with the corresponding science funding. The WBGU is also in favour of setting up a science alliance based on the example of the German Alliance for Marine Research in the sense of the guiding principle of ‘healthy living on a healthy planet’, through which targeted mission-driven and transformative research at the environment-health interfaces is promoted in cooperation between universities and non-university institutions, and in international dialogue with other science systems.

Similarly, at the international level, transregional support programmes focusing on the environment-health nexus should be further expanded and a joint funding landscape institutionalized; this should also include private-sector actors. Initial transregional support networks exist in this field in the form of the Belmont Forum and Future Earth. These need to be further expanded and funded, especially in the area of transformative environment and health research.

8.2.5

Recommendations for action

Expand the landscape of science funding internationally in the sense of the guiding principle of ‘healthy living on a healthy planet’ and promote transregional science

1. *Research funding at the multilateral level:* Allocating research funds at the multilateral level would ensure that all states on principle can participate in agenda-setting through research funding. In addition, this could raise awareness of the value and necessity of expanding hitherto underfunded science systems, promoting fair cooperation in the processes of knowledge production, and developing these processes in an appropriately interdisciplinary, basic-research- and application-oriented manner for the challenges of environmental-change-related health risks. Finally, an awareness could also be created of the fact that public investment in research and development is a fundamental lever with which states can promote innovation in the areas relevant to their sustainability transformation, and also mobilize private funds to this end. Various options are conceivable as an institutional framework for such multilateral research funding, in particular: (1) a newly established committee for transregional science funding along the interfaces of environmental change and human health under the ideational leadership of the Secretary-General of the United Nations (UN); (2) a section of this committee at UNESCO, which is already the authoritative UN institution for education and science; and (3) a marked strengthening of research funding by individual multilateral organizations such as the WHO.

2. *Regional science policies*: Jointly negotiated science-policy priorities between countries and regions should be consciously strengthened and further developed. On the one hand, the EU's mission-oriented science policy with a focus on the major global challenges and its 'agile funding formats' is relevant here. On the other hand, transregional funding formats should be further developed through institutions such as the Belmont Forum, or in joint funding lines involving the DFG and the research-funding organizations of other countries. Joint funding programmes with science funders from the African continent are a particular gap that needs to be filled. The African continent is not only Europe's direct neighbour but also particularly affected by ecological and climatic-change processes. The health systems are comparatively weak and subject to the pressure of a high population. Investment in alliances based on trust within the framework of bilateral state cooperation between Germany or Europe and Africa is necessary as autocratic regimes become stronger, but is currently only possible to a limited extent. Cooperation at the level of science and funding policy, which simultaneously promotes joint dialogue on the future and its design, is therefore highly recommended. One vehicle through which capacity building could be pursued in the long term is the promotion of joint research training groups with African partner countries. These could take the form of a structured graduate programme based on a cotutelle (binational doctorate) model, in which a joint cohort of doctoral students from the respective German and African partner universities researches similar issues.
3. *Research and innovation network relating to the guiding principle of 'healthy living on a healthy planet'*: In the medium term, a globally interconnected and regionally embedded research and innovation network should be established to strengthen research capacity in low- and middle-income countries, with core funding from public and private donors. This could be modelled on the Consultative Group for International Agricultural Research (CGIAR) and designed as a strategic partnership involving government institutions, development banks, multilateral organizations and private-sector actors, depending on the possibilities. Such a network would serve to mobilize and pool resources for health research at the interface between humans and the environment. The network would work in a solution- and public-welfare-oriented way. Transdisciplinarity should be the focus here. The individual research centres would initially take on a lighthouse function in their national and regional science landscapes, but serve the development of local capacity in the long term.

Among other things, the open provision of research data and results would contribute to this. A central point in the governance of this partnership should be the role of the host countries and regions in the programmatic orientation of the individual research centres. Although such a network would be largely donor-funded, the research agenda should reflect local needs. The respective orientation of each of the network's individual regional centres should be coordinated and overlaps with existing institutions avoided. Agenda-setting should therefore be inter- and transdisciplinary and locally co-determined to bring about long-term capacity-building in the region and promote the development of local value chains.

Improve the positioning of science and innovation systems for fighting future environmental and health crises

1. *'Healthy living on a healthy planet' as the main topic*: The national and international scientific landscape should focus on the interdependence of the environment, climate, ecosystems and human health in order to systematically advance their research in an inter- and transdisciplinary manner with a view to possible future crises. The thematic agenda-setting is currently still characterized by a strong focus on environmental challenges or health risks. Research into the mutual dynamics between them should be intensified. The WBGU welcomes the draft of the Future Strategy for Research and Innovation, which aims to promote an understanding of the links between the environment and human health (BMBF, 2022b: 28) and also refers to key issues such as pandemic preparedness, antimicrobial resistance, health inequalities, poverty-associated diseases and prevention. Furthermore, the WBGU welcomes the interdepartmental research platform for One Health, as set out in the agreement on research into human, animal and environmental health (One Health) between the BMBF, BMG, BMEL, BMUV, BMVg and BMZ. This must now be further developed in the spirit of the 'healthy living on a healthy planet' vision, and supported by the various ministries with the appropriate scientific funding. Orientation for the further development of funding and research programmes is provided by the concrete recommendations for research formulated by the WBGU in Chapters 4, 5, 6, 7 and 8 of this report. In addition, the EU-funded Health Environment Research Agenda for Europe (HERA) project provided an overview of key research gaps in the environment-health nexus (Huss et al., 2022).

2. *Science alliance in the spirit of the guiding principle of 'healthy living on a healthy planet'. Promote interdisciplinarity:* The organizational structure of science in disciplines should be specifically supplemented at the interfaces between environment and health by interdisciplinary formats of knowledge production and promotion of young scientists. Both interdisciplinary cooperation between the health sciences (medicine) on the one hand and the natural/environmental sciences on the other, should be expanded, as should cooperative knowledge production with the social sciences and economics. Systemic analyses and the development of action approaches relating to the interplay between the environment and human health will be increasingly required in the future. The structural prerequisites at universities and non-university institutions already need to be laid down today in preparation for this. Specifically, the WBGU advocates the establishment of a science alliance in the sense of the guiding principle of 'healthy living on a healthy planet', through which targeted mission-oriented research at the environment-health interface is promoted in cooperation between universities and non-university institutions. The German Alliance for Marine Research can be used as an example for the structural setup of the Alliance. In addition to the planned networking of human and veterinary medicine with the environmental sciences, the WBGU emphasizes the need to include the social sciences and humanities. In the field of medical research, the constellations of interdisciplinary cooperation to be targeted range from basic biomedical research and patient-oriented clinical research to the public health service. One example is the COVID-19 Task Force of the European Clinical Research Infrastructures Network (ECRIN), which provided timely research literature and a metadata repository during the pandemic (WR, 2021: 50). There should also be better networking between "public health research, care and prevention research, and the health sciences, which include nursing, midwifery and therapy sciences" (WR, 2021: 15). The Science Council suggests: "Intensive networking of medical expertise with medicine-relevant expertise offers an opportunity to improve translational processes beyond individual medical diagnostics and therapy for the entire breadth of health care" (WR, 2021: 15). Furthermore, cooperation between health and prevention research with other disciplines must be further expanded.
3. *Scenario research and foresight studies:* There is also a need to promote historical research on the environment-health nexus as well as interdisciplinary scenario research. Especially scenario research that empirically brings together expertise on natural science, health science and social science with change processes that have a reference to the past, and examines them in a model-based way looking to the future (in the sense of longer-term foresight studies) remains an urgent gap that needs to be filled. Furthermore, the scientific results of models of global change processes are only reliable and politically usable if they are based on empirical data collections from different world regions, ecosystems, societal organizational forms and cultural areas. Science on environmental change and human health is currently geographically biased with a focus on the OECD context and a few other countries; the WBGU strongly recommends decisively countering this bias. The interplay between the environment and human health needs to be studied globally. Only in this way can the dynamics be assessed in a sufficiently differentiated manner, and possible future health risks and the danger of epidemics and pandemics be met at an early stage.
4. *Expand data infrastructures at the environment-health nexus:* The accelerating dynamics of environmental change (including climate change and biodiversity loss) and the risks being faced by human health call for preventive research that studies future risks. However, since the future cannot be researched empirically, but only theoretically, using models, historical depth (i.e. long-term data series with the highest possible data density and quality) is all the more important in order to make modelling as realistic as possible. It is therefore of immediate importance to successively develop and expand the existing data infrastructures at the environment-health nexus. Governments, the private sector and civil society should work together in this context to jointly build and sustain capabilities for collecting health and environmental data. Since most emerging infectious diseases originate at the human-animal-environment interface, it is particularly important to link the genome sequence data of pathogens with other data such as clinical, epidemiological and biological metadata, to strengthen environmental-data collection as a tool for pandemic preparedness (Bright et al., 2022: 3–5) and to incorporate public health institutions and veterinary, food and agricultural authorities into data-collection systems (Ricciardi and Lomazzi, 2022: 5). A significant example of linking environmental and health data at the national level is the National Cohort (NAKO), an interdisciplinary study supported by 27 research institutions in Germany (Box 6.5-1). To further promote the interlinking of environmental and health data, national and subnational systems of data collection should

be strengthened in all countries and data standards established (Sections 6.6.1.3, 6.6.2.4). The association 'National Research Data Infrastructure (NFDI) e. V.', which brings together actors from science and research in Germany and aims to establish and expand comprehensive national research data management (NFDI, no date), represents an important step in this direction. In particular, networking data from health and environmental research should be supported in this context. Furthermore, when dealing with these data, it is important to expand the knowledge of public health personnel as regards the evaluation of health data. On the other hand, a global architecture for data documentation and analysis should be created, e.g. to ensure rapid and comprehensive information sharing and analysis in public-health emergencies. This should be done in collaboration with existing platforms for sharing health data, such as the Global Initiative on Sharing All Influenza Data (GISAID), where most genome-sequence data of the SARS-CoV-2 virus has been collected worldwide (Bright et al., 2022: 4 f.). Moreover, agreements on information-exchange systems should be concluded and the coherence of several agreements ensured in such a way that all countries benefit from participation in the arrangements on the exchange, documentation and analysis of data. This means, among other things, ensuring equal access to genome-sequence data, as well as measures that can be developed on the basis of these data such as vaccines, diagnostics and therapeutics.

5. *Build transdisciplinary and implementation-relevant network structures:* For the future management of health risks related to climate and environmental change at the policy level, as well as within the private sector and civil society, the WBGU further recommends the targeted development of transdisciplinary and implementation-relevant network structures on transdisciplinary and transformative science between the health, environmental and social sciences and economics. In this context, it is important that the network structures are internationally open and embedded. Structurally, this can be ensured by expanding existing science-policy interfaces and network structures in the field of sustainability research and policy (e.g. Think7, Think20, Sustainable Development Solutions Network (SDSN) Germany, SDSN Europe) or via exchange rounds with the private sector supported by the German government (e.g. the BMZ's Vaccine Production Roundtable). In the context of the Group of Seven (G7) negotiations, the WBGU recommends introducing a Planetary Health Task Force at the level of WHO to meet the challenges of systemically bringing together expertise

on environmental change and health. This would make a targeted coordination of network structures possible at the interface between environment and health at the WHO level (Section 7.2). However, important factors for achieving a targeted strengthening of Germany's and Europe's innovation system at the environment-health interface include systemic support and a continuous exchange with private-sector actors, as well as feedback from this exchange to German science policy and the funding landscape. Structures to promote this exchange should be further developed.

6. *Strengthen climate-stabilizing transformation processes in science itself:* Science itself contributes to environmental change and health challenges and is called upon to evolve in a climate-stabilizing and health-promoting way. Appropriate approaches can be found as part of the BMBF-funded initiative called the 'Sustainability Guidelines (LeNa)' of the non-university research communities Leibniz, Helmholtz and Fraunhofer, in the DFG's 'Contribution to More Sustainability in Research Funding', and in departmental research (e.g. Climate Neutral BMZ 2030). These and other initiatives to make science itself more sustainable, less CO₂-intensive and more health-promoting for people and the environment should be structurally promoted and given the financial and personnel resources to meet the challenge.

8.2.6

Science in the spirit of the guiding principle of 'healthy living on a healthy planet'

Our planetary guard rails have largely been reached or even breached. Multiple and highly dynamic crises are the result. For science, this means it must become the engine of circular, climate-stabilizing and health-promoting prosperity. Both the handling of environmental and health crises and the active shaping of transformation processes for planetary health and sustainability, in the sense of the guiding principle of 'healthy living on a healthy planet', require scientifically based approaches to solutions and technological and institutional innovations on an appropriate scale in view of the great diversity of application contexts worldwide. As part of transformative knowledge production, it is also important to shape the transnational dialogue processes and structures that are necessary to develop a societal impact across social groups and continents.

Overview of recommendations

This chapter contains an overview of the recommendations for action and research developed in this report. The complete recommendations, together with further aspects, details and examples, can be found in chapters 4–8.

Shaping areas of life: what we eat, how we move, where we live



Ways to a healthy diet – for everyone

The basis for a sustainable, resource-efficient, ecologically sustainable and health-promoting diet that meets the needs of the growing world population – especially in view of the increasingly dangerous effects of climate change worldwide – can be offered by a change in people’s diets to one that is largely plant-based; this requires reducing meat consumption by approx. 80% and further restricting animal-based products, while e.g. using near-natural grasslands extensively. By fundamentally restructuring the way we produce and eat, we can achieve the goal of improved and healthier diets that are accessible to everyone, while simultaneously reducing the impact on the environment. Coordinated research on production and consumption can point the way to transforming human and livestock diets for the benefit of humanity, species and ecosystems, and thus

also make a significant contribution to making them future-proof (Section 4.1).

Recommendations for action

Make healthy, nutrient-rich and diverse foods more attractive and better appreciated

- › *Make healthy nutrition more attractive and better appreciated:* The benefits and diversity of sustainable nutrition (based on the Planetary Health Diet) and the related, necessary appreciation of health-promoting and sustainable food should be communicated more clearly. To this end, the WBGU recommends positive communication and education on nutrition within the framework of educational measures and awareness campaigns, but also in advertising and the way in which political measures are communicated and implemented.
- › *Promote dietary change:* Taking into account specific local, regional and national characteristics, the shift towards a predominantly plant-based diet should be promoted – following the guidelines of the Planetary Health Diet – in a way that makes healthy, diverse food in sufficient quantities available to everyone.

Adapt guidelines and recommendations for healthy and sustainable nutrition

- › *Adapt nutrition guidelines:* National (e.g. from the German Nutrition Society) and international nutrition and breastfeeding guidelines for all age and population groups should be adapted to the Planetary Health Diet guidelines for a healthy and sustainable diet.

Lifelong education on health-promoting and sustainable nutrition in theory and practice

- › *Communicate theoretical knowledge and promote practical action on healthy and sustainable nutrition:* Extensive educational measures should, on the one hand, communicate knowledge about healthy and sustainable nutrition. On the other hand, they should enable the development of action-oriented planetary health literacy that makes sustainable choices in food selection and preparation possible, and that is accompanied by corresponding transformative action in practice. Alongside extensive education for all age groups, a focus on the education, training and further education of multipliers is also recommended.
- › *Make communal and away-from-home catering healthy and sustainable:* Food supply and processing, as well as the food environments in communal or away-from-home catering in general – in the large kitchens of public institutions, kindergartens, schools, universities, clinics and companies – should be adjusted in the sense of a whole-institution approach to a health- and biodiversity-promoting and climate-friendly diet.

Awareness initiatives as a contribution to health-promoting behaviour

- › *Use and concretize existing structures and projects for fostering the food transition:* The German Federal Government should concretize its plans to support a food transition. For example, a campaign aimed at more sustainable nutrition and physical exercise in the first 1,000 days of a person's life, accompanied by the implementation of corresponding measures, could tie in with existing structures such as the 'Healthy Start Network' or 'IN FORM'.
- › *Use awareness campaigns for fostering the food transition:* National and international target-group-oriented educational campaigns should draw the population's attention to the attractiveness and necessity of a new diet standard for healthy, sustainable nutrition, inform them about the harmful effects of current dietary patterns on health and the environment, and emphasize a mindful and appreciative approach to food, thereby also counteracting food waste.
- › *Label food uniformly with regard to their health and environmental effects:* Consumer-friendly, integrated and (for companies) compulsory labelling of food showing its nutritional value and impact on health and the environment should help people when buying food. This also means reducing the current large number of different labels in order to improve clarity and make their presentation more standardized.

- › *Reduce advertising for unhealthy and unsustainable food products:* The placement of advertisements for unhealthy and unsustainable food should be curbed in public-service media. In Germany, for example, a uniform federal regulation could not only further restrict advertising for foods with a high sugar, fat or salt content that targets children, but also communicate aspects of ecological sustainability in foods.

Contribution of state actors to healthy, equitable and resilient food environments

- › *Reflect environmental and health costs in food prices:* Taxes and other levies should be used to price-in and make visible the societal follow-up costs of food – e.g. from environmental pollution and greenhouse-gas emissions in production – as well as the health consequences of their consumption. This makes sustainable products proportionately cheaper and more attractive. One example of such a steering tax is the sugar tax. Food should only be subsidized if its consumption is associated with positive effects on health and sustainability.

Promote ecological production methods and local markets

- › *Certify farms:* Compulsory certification of farm sustainability should be successively introduced. Food-processing and trading firms should be able to use obligatory reporting and certifications of farms to reveal the societal costs of food and to support consumer decisions.
- › *Strengthen supply-chain laws and transparency rules:* Supply-chain legislation and transparency rules across all stages of food production, taking into account key regional issues, offer an important starting point for improved transparency.
- › *Price and regulate externalities and adjust subsidies in agriculture:* The food system in its current form causes high costs that have to be borne by society. A consistent system that prices-in externalities in agriculture via steering taxes and makes them visible to consumers, regulates them where necessary and links subsidies primarily to public goods can contribute to the sustainable use of land and healthy, sustainable nutrition.
- › *Make fisheries sustainable:* This involves in particular the implementation of the WTO's 2022 decision on the targeted reduction of subsidies for industrial fisheries. Low-income countries, on the other hand, should be given more support in building their own 'blue economies'. Furthermore, local fish-processing industries and transregional marketing should be specifically developed to strengthen local value chains.

Make agricultural production environment-friendly and resilient

- *Strengthen sustainable spatial and landscape planning and land use to conserve biodiversity and ecosystem services:* The need for integrated landscape planning has further increased against the background of the new Kunming-Montreal Global Biodiversity Framework. This applies especially to African countries with large populations and a high need for food security, that simultaneously play a significant role in biodiversity conservation (e.g. Ethiopia, Nigeria and Somalia). Sustainable spatial and landscape planning can mean maintaining and expanding near-natural mosaic landscapes or land-sharing approaches, coupling crop and livestock production, and using more diversified, multifunctional agricultural production systems. This involves, in particular, maintaining or restoring healthy and degraded soils by means of appropriate management and measures, for example through greater crop diversity and crop rotation or the use of alternative fertilisers.
- *Promote the (further) development and implementation of scientific and technical innovations and digitalization in agriculture:* Existing technical innovations for sustainability (e.g. digitalization) that are adapted to the respective agricultural systems should be further developed and implemented. Governments, companies and investors should therefore increase their expenditure on research, development and innovation.
- *Promote knowledge transfer, education and (further) training on sustainable production practices:* The aim here is to promote active participation and understanding, knowledge transfer and mutual learning, as well as the joint generation of knowledge by all actors involved, for example by creating networks and providing training courses.
- *Reduce food losses and inefficiencies in agricultural production:* Reducing food losses directly after production and along processing and supply chains would reduce greenhouse-gas emissions and the need to increase productivity in agriculture, and would also contribute to food security in particular.

Make fisheries and aquaculture environment-friendly and resilient

- *Promote sustainable fishing methods:* The promotion of sustainable fishing methods includes adapting ecosystem-friendly methods, introducing and enforcing bans on, and more effective monitoring of, e.g. destructive fishing methods and the management of bycatch.
- *Reduce the environmental impact of aquaculture and adapt systems to climate change:* Promoting and implementing environment-friendly practices and technical innovations can both reduce environmental

impacts and increase the resilience of aquaculture systems to climate change.

- *Promote flexible and sustainable fisheries management:* Management strategies and conservation measures should be flexibly planned and implemented in view of climate change. Institutionally strengthen and develop regional fisheries-management capacity in the face of scientific uncertainties about the impacts of climate change.
- *Strengthen small-scale and coastal fisheries, especially in low- and middle-income countries:* Examples include a ban on all fishing activities outside the Exclusive Economic Zone (EEZ) and a more equitable distribution of fishing rights.
- *Promote technology and knowledge transfer:* Intensify the generation of generally accessible data, e.g. through science and monitoring, the transfer of technologies, build-up of digital infrastructure, promoting knowledge transfer and exchange, and the joint production of knowledge by all actors involved.
- *Minimize food losses in fisheries and aquaculture:* For example, by means of technological improvements along the value chain, more efficient infrastructure for logistics and processing, and the reduction of bycatch and excessive use of wild catch as feed in aquaculture.

Take market and power concentration into account

- *Make the role of agricultural and food corporations more transparent:* The role of agricultural and food corporations in nutrition systems should be made more transparent, as should their influence, e.g. on multilateral agenda-setting regarding food systems. Meetings like the UN Food System Summit should discuss the considerable influence of corporations (also on the conferences themselves) and look for structural solutions for better balance. The WHO's first drafts on this are still perceived as insufficient. More international cooperation in the form of a "Framework Convention on Food Systems" can bring together the various groups of actors.

Research recommendations

- *Intensify research on the health and environmental effects of sustainable nutrition:* The linkage between a transition to a healthy, sustainable diet and improved human health should be better researched. This research should look at countries with different incomes and be conducted by various countries. Ongoing large cohort studies, such as the German National Cohort (GNC) or the COPLANT study, can also be used for this purpose. In addition, the effects of foodstuffs, especially food innovations, on health and the environment should be researched at the

same time. A distinction must be made between different plant-based diets, since not all have the same positive effect on health and the environment. Future research should build on existing studies and integrate education and skills on nutrition or physical activity, as well as aspects of environmental sustainability.

- *Intensify transdisciplinary research on the effectiveness of measures aimed at changing dietary habits:* The effectiveness of measures for health-promoting and sustainable nutrition in canteen catering on health and quality of life should be subject to transdisciplinary study. Canteen catering for children, adolescents and adults should be examined with a particular focus on factors that promote or impede the adaptation of consumption patterns. When measures are successfully implemented and effective, the accompanying communication should also be evaluated. The reasons for short-term changes in dietary habits, e.g. during the COVID-19 pandemic, should be understood in order to prevent negative impacts during future crises, and to harness positive impacts for socio-ecological transformation. Moreover, the WBGU recommends transdisciplinary research on institutional innovations across national, regional and international governance levels that make a food transition possible in different regions of the world.
- *Study food labelling and its effects on consumer decision-making:* Recent research results from the UK and Ireland show that (processed) foods which, according to nutritional labelling, have a relatively favourable nutritional value, are usually also more environment-friendly in their production. Such calculations have not yet been carried out in Germany, nor in most other countries. Apart from the combination of nutritional value and environmental impact, the complex interplay with affordability and accessibility of healthy and environment-friendly foodstuffs should also be explored, especially with regard to the purchasing decisions, health and well-being of population groups.
- *Research on the concentration of power and its impact on the availability of healthy food:* There is a need for research into effective measures to promote resilient structures in food production and upstream sectors, such as agrochemicals or seed production, in different regions of the world. Research should examine the potential synergy effects or economic advantages of market concentration on the one hand, and, on the other, its negative effects, such as a possibly lower prevalence of healthy diets.
- *Research reform options for tax and subsidy systems:* Current production methods generate negative externalities for humans and the environment which are not reflected in product prices. In some cases, these

are further exacerbated by subsidies. There is therefore a need for more research into options for internalizing negative societal and environmental costs both at the European and at the multilateral level. To this end, the respective ecological, economic and social implications of different measures to internalize external costs should be compared (e.g. taxation, regulation). Similarly, possibilities for reforming subsidy systems must be studied so that subsidies for unsustainable production can be identified and eliminated as quickly as possible. Furthermore, agricultural subsidies should always be oriented towards ecological standards, and suitable assessment and transformation mechanisms should be developed for this purpose.

- *Research the up-scaling of sustainable production practices in agriculture:* Up to now, new approaches have mainly been applied in smallholder structures or communities. In view of the ambitious climate and biodiversity goals, it is necessary to determine the suitability of different business structures for demand-oriented and sustainable production methods in agriculture and forestry as well as in aquaculture and fisheries, and to promote any necessary restructuring.
- *Increase resilience research in agriculture and fisheries:* Increasing ecological, social and economic resilience in food production involves a sustainable increase in productivity and a simultaneous adaptation to climate change, as well as securing the income and food basis of the population in both key sectors. Whether and how resilience can be operationalized and aligned at all levels remains a fundamental research question. Resilience research should be stepped up, supported by local knowledge and early, proactive clarification and assessment of knowledge gaps in both sectors.

..... Activity-friendly environment, environment-friendly activity

Changing people's physical activity patterns offers enormous potential for health and the environment. Physical activity is currently being eliminated from all areas of life. On average worldwide, about half of kindergarten children, over three-quarters of adolescents and a quarter of adults do not reach the WHO's recommendation for physical activity and spend many hours a day sitting; the figures are sometimes significantly higher in high-income countries and for girls and women. Yet physical inactivity and sedentary behaviour (especially sitting) are major risk factors for many non-communicable diseases, and the means used to avoid physical activity often harm the environment and people. Car traffic in particular consumes a lot of energy, resources and space, and causes air pollution, climate damage and noise. It restricts freedom

of movement, safety, social interactions and participation in people's living environment and for all those who walk, cycle or rely on public transport. The recommendations for action on environment-friendly physical activity are therefore divided into three interlinked areas: the reintegration of environment-friendly physical activity into all areas of life with cross-sectional strategies; linked to this, a genuine mobility turnaround in which active mobility replaces car journeys; and, finally, children's need for exercise and autonomy as a benchmark for healthy living environments. The research recommendations include sedentary behaviour, governance structures and effective interventions for the environmentally conscious promotion of physical activity, health aspects in systemic mobility research, political-economic research on the transformation of car-centred societies, and strategies and local means of transport for LMICs (Section 4.2).

Recommendations for action

Reintegrate physical activity into all areas of everyday life and link it to climate-change mitigation and environmental protection

Promoting physical activity, protecting the environment and climate-change mitigation mutually support each other and should be communicated and approached as a joint project with directly experienced, positive impressions of a healthy, mobile life in a healthy environment. This requires external conditions in which healthy, environment-friendly behaviour is most attractive. Thus, different actors need to work closely together to develop overarching strategies and implement locally adapted solutions.

- *Integrate a 24-hour approach and environmental perspective into recommendations on physical activity:* National and international recommendations on physical activity and sedentary behaviour should be supplemented with information on physical exercise options and strategies in different areas of life and on environmental impacts, and should explicitly refer to the multiple benefits of active mobility for the environment and health.
- *Strengthen cross-cutting strategies to promote physical activity:* Large-scale, systemic approaches for more environment-friendly physical activity require national cross-cutting strategies, for which eight core elements can be summarized under the acronym 'E-MOTION^{kids}': focus on activity-friendly conditions and surroundings (Environment); analysis of physical activity behaviour and evaluation of measures founded on a broad data base (Monitoring and evaluation); capacity building in the population and among professionals (cCompetence); quantified targets for more physical activity and the expected contributions

of different areas of life and responsible government departments, separately also for children, and monitoring these targets (Targets); financial incentives for physical activity, subsidy reforms, financing of environmentally conscious programmes on physical activity and sedentary behaviour (Incentives and financing); national coordination structures for cross-sectoral and cross-ministerial programmes and the scaling up of successful approaches, as well as sufficient decision-making powers and resources for cities and municipalities (Organizational structures); cooperation between health, transport, spatial-planning, sports, education and family policies at all levels, as well as scientific and civil-society actors, e.g. through compulsory coordination and the linking of physical-activity promotion and government-department strategies (Networks, cross-sector partnerships and policies); children as an important focus of design (kids).

From transport policy to mobility policy: systemic strategies for a real mobility turnaround

Combinations of many measures are necessary, especially in the mobility sector, e.g. on infrastructure, spatial planning, public services, as well as regulation and the pricing of vehicle characteristics and use. Mobility should become not only low-emission and efficient in terms of energy, resources and land, but above all involve much more activity. All those who walk, cycle or use public transport should be able to participate fully in society. Consistently set framework conditions for private cars also make the complementary use of shared transport (especially with public transport as its 'backbone') much more attractive.

- *Develop long-term strategies for more active mobility:* National and urban mobility strategies should be further developed, focusing on physical activity and road safety, emissions (greenhouse gases, air pollution, noise) and efficiency (energy, resources, land), each with quantified targets. Implementation requires combinations of measures that promote physical activity, limit car use and encourage accompanying communication; the sequencing of these measures should take into account societal and political-economic barriers and encourage the development of new habits and social norms. Funding for urban mobility should be linked to the preparation of sustainable urban mobility plans. New road-building plans, instruments of transport and also tax policy should be reviewed and strategically realigned.
- *Make the influence of interest groups fully transparent, engage more with sustainability actors:* For current and possible future mobility systems and business models, there should be a discussion on

- who benefits, who bears the internal and external costs and the health and environmental risks, and how broadly-based inclusion opportunities can be secured. Political influence by all interest groups should be made fully transparent to the public. Special access to politics or disproportionate participation in committees (e.g. of the car, fuel and road-building industries), personnel overlaps and donations must be disclosed and prevented. Examples of measures include lobby and secondary-income registers, without exceptions, for all political levels and senior positions in government departments, local authorities and the judiciary. Mobility providers, civil-society and public environmental and health actors, urban planners and academia should be politically involved in a balanced way.
- ▶ *Promote active mobility: infrastructure, compact settlement areas and traffic regulation:* In order to promote active mobility, it is essential to have extensive infrastructure networks that are seamlessly safe for unaccompanied children, women, older people and people with physical disabilities, and that are located in attractive public spaces. Spatial planning should be oriented towards compact, mixed-use settlement areas to keep distances short. Traffic rules and management should be geared towards the safety and efficiency of active mobility.
 - ▶ *Expand (local) public-transport services nationwide, integrate pooling and sharing services especially in non-urban areas:* Public passenger transport on short and long routes should be further improved. Especially outside urban areas, complements such as call-buses and shared, primarily smaller vehicles should be integrated in a way that is convenient for users. A nationwide network of highly available public transport services and flexible add-ons should be treated as part of public service provision.
 - ▶ *Increasingly redesignate public space, price its use and reduce access for cars:* Parallel to the expansion of alternatives to the car, public parking areas should be greatly reduced and charged for; all road use by cars should be priced according to time, distance and location. Car traffic in residential areas should be reduced to a child-safe minimum and, in the medium term, limited to a few ring roads and cul-de-sacs in inner cities (as in Groningen, for example). Freed-up spaces can be used for footpaths and cycle paths, green public spaces and public housing.
 - ▶ *Increasingly regulate and price car use according to efficiency potential and societal costs; create incentives for small vehicles:* Fuel prices should reflect environmental and climate externalities; subsidies should be reduced and taxes on vehicle purchase and ownership should be staggered according to weight, energy consumption, and emissions of pollutants and greenhouse gases. Efficiency improvements, e.g. as a result of digital services or better propulsion technologies, should be linked to proportionally more stringent targets, e.g. on energy and land consumption, in order to prevent a rebound. Lightweight micro-vehicles, which are more efficient and less dangerous to other road users, should be promoted by less stringent registration and use regulations, subsidies and public procurement.
 - ▶ *Offset the effects of public investment and regulation on private housing costs and land prices for the socially vulnerable, skim off land rents:* Upgrading urban neighbourhoods and infrastructures with public funds, traffic regulation and more compact settlements can lead to increases in property and land values ('land rents') and changes in housing prices. These changes should be planned for, e.g. land rents skimmed off via taxes and the revenue used for public housing policy or direct payments to low-income households.
 - ▶ *Develop user-group-specific promotion and communication measures:* Measures should be bundled for specific user groups (e.g. for students and trainees, commuters, families) and communicated as a package, reinforced by information campaigns and large public events such as car-free days. Suggestions and incentives for new forms of mobility behaviour can be particularly effective at typical turning points in a person's life, such as changing jobs, starting a family, moving house or retiring.
 - ▶ *Make it obligatory for car advertising to include references to negative environmental and health effects as well as to active mobility:* Since cars are harmful to health and to the environment, advertising them should be more regulated. The ban on tobacco advertising or the obligation to advertise walking or cycling on car advertisements, which has been in force in France since March 2022, can serve as examples of this.
 - ▶ *Support LMICs in the development and implementation of mobility strategies:* Integrated mobility and urban planning and their implementation should be supported at the national and municipal level in low- and middle-income countries (LMICs). In addition to the infrastructure and general conditions for cycling and walking, this also applies to improvements to shared mobility options typical of the locality as well as to micro-mobility, e.g. e-bikes and micro-vehicles from the countries' own production. Programmes for active, inclusive mobility should be better funded, both in city networks (e.g. ICLEI, Global Covenant of Mayors, C40.org) and in civil-society networks (e.g. Habitat International Coalition).

Use children's and young people's need for movement and autonomy as a design perspective in all areas of life

The needs of children and young people should be used as a substitute indicator and design focus ('proxy') and as a political narrative for naturally green, environment- and climate-friendly, activity-promoting and safe public (exercising) spaces and infrastructures for everyone.

- ▶ *Child-friendly spatial and transport planning for activity- and environment-friendly living environments, participation and social inclusion:* The radius in which children and young people can move independently and safely should be widened, and access to spaces for movement and play should be improved. To achieve this, cities and infrastructures must be extensively redesigned and adapted to young people's natural urge to move. National coordination centres for the environmentally aware promotion of physical activity could accompany and promote such activities. In Germany, for example, the local authority associations can also play a role.
- ▶ *Local, national and UNESCO programmes for the environments of day-care, school and training facilities:* In an integrated, whole-institution approach to education, not only the content but also the educational institutions and their environment as a whole should be realigned to ensure consistency and direct local experience in everyday life. This requires overarching promotion programmes at the local and national level, for example for curricula development, school construction, educator and teacher training; these could be supported by UNESCO, for example.
- ▶ *Boost global programmes for child-friendly cities:* Global programmes for child-friendly urban planning and the implementation of such plans, e.g. in the context of sustainable mobility strategies, should be quickly supported and expanded. Examples include the Child Friendly Cities Initiative, the Urban95 initiative and the Streets for Kids programme.

Research recommendations

Patterns and determinants of physical activity, sedentary behaviour and mobility

- ▶ *Patterns of physical activity in low-income countries, among older people, and shifts caused by climate change:* While current patterns, trends and determinants of physical activity are becoming increasingly better understood in high- and middle-income countries, there is still a need for research in low-income countries. High-quality studies on certain groups, e.g. older people, are still lacking in most countries. Little research has been done on possible shifts in activity and mobility behaviour in response to environmental changes, for example as a result of climate change.

- ▶ *Basic research on sedentary behaviour worldwide:* Data and research on sedentary behaviour as a risk factor in its own right, its causes and consequences are still very limited internationally and should be improved. Standardized or comparable measurement methods, e.g. using portable devices, as well as context-specific documentation are important here.
- ▶ *Determinants of mobility behaviour in low- and middle-income countries:* Here, there is still a lack of comprehensive data and studies on the determinants of short- and long-term mobility behaviour (choice of means of transport, purchases, choice of place of residence), also outside urban areas, which include individual and socio-cultural as well as external framework conditions. The effectiveness of measures aimed at reducing sedentary transport behaviour should be evaluated more intensively.

Political processes and integrated structures of physical-activity promotion; assessments of interventions

- ▶ *Comparative research on the governance and structures of environmentally aware promotion of physical activity:* To ensure the effectiveness of cross-cutting strategies for promoting physical activity, the governance and structures of physical activity promotion and integration with environmental concerns should be compared in different countries and municipalities, e.g. on institutional ways to better integrate health effects into urban and spatial planning.
- ▶ *Evaluations of specific interventions to promote physical activity, especially in the school context:* More methodologically meticulous evaluations are also needed on individual measures whose methods and results can be transferred to other contexts, e.g. for measures on sedentary behaviour and physical activity among schoolchildren. Additional research capacity for this purpose should be developed in low- and middle-income countries.
- ▶ *Survey methods on physical activity and mobility behaviour:* Methods, international standards and databases on physical activity and mobility behaviour should be further developed in order to be able to use data from mobile terminal devices better, more efficiently and safely and, for example, to record everyday activity and non-motorized traffic better and comparably.

Systemic mobility research on health effects and new services, as well as research on political-economic interlockings

- › *Pay more attention to health aspects in systemic mobility research:* In systemic, transdisciplinary mobility research, as pursued, for example, under the BMBF's 'Sustainable Urban Mobility' research agenda, greater attention should be paid to the health aspects of active mobility and corresponding strategies that use synergies, e.g. in the analysis of measures, technologies and transformation paths. There should also be more research on the interactions between active mobility and physical activity or sedentary behaviour as a whole.
- › *Effects of new mobility services on interacting short- and long-distance mobility:* There should be more research on the effects of new electric or automated means of transport and digital mobility options and platforms on short-term mobility decisions, transport chains, vehicle purchases and long-term mobility behaviour. Interactions between mobility behaviour over short and long distances and corresponding 'long-distance effects' of new options and policy measures in urban and rural areas, e.g. through changes in vehicle ownership, should also be better researched.
- › *Effects of bicycle-parking facilities and car-parking design on mobility behaviour and health:* The impact on health and quality of life of urban parking areas or of urban planning options such as clustered parking within walking distance of residential areas is still under-researched. Similarly, there are research gaps on the effects of secure bicycle parking.
- › *New narratives for a more active, sustainable mobility system and transformation research in the field of political economics:* There should be a greater focus on social-science research looking at new narratives and visions of sustainable, more active mobility and possible implementation paths – complementing, for example, technology-focused climate-change-mitigation scenarios – as well as political-economic analyses on transformation strategies for car-centred transport systems and societies.

Local mobility concepts and means of transport, vehicle and transport technology

- › *Mobility concepts and strategies, local means of transport in LMICs:* Low- and middle-income countries (LMICs) should be supported in researching and developing alternative mobility concepts and strategies. These should include alternative means of transport that are adapted to local needs, clean, robust, easy to repair, and developed and produced using local resources.

- › *Health aspects of traffic-guidance systems and in-vehicle safety systems:* Technical innovation potential is offered by traffic-guidance systems which, in addition to efficiency and environmental aspects, also take into account effects on health and the promotion of active mobility, as well as in-vehicle safety systems with intervention options, e.g. to comply with speed limits.

Housing in health-promoting and sustainable residential areas

Alongside land use and energy systems (including transport), in 2011 the WBGU identified urbanization as an area of transformation. Further areas of transformation include the oceans and digitalization. Healthy living is closely linked to these areas of transformation: urban energy use and transport policies significantly determine the extent to which people are exposed to air or noise pollution, for example. The way in which cities are built shapes the opportunities for physical activity and recreation in one's living environment. More green and blue spaces in cities not only reduce soil sealing, they also lessen the health-damaging heat-island effect and enhance residential quality of life. The need to build new residential areas for around 2.5 billion people by the middle of the century offers a window of opportunity for advancing sustainable and healthy construction with climate-friendly building materials on a large scale in a short period of time – and for avoiding unsustainable path dependencies. The US\$90 billion expected to be invested in housing and urban development by 2030 is an opportunity to integrate health issues, as well as climate-change adaptation and mitigation, directly into urban infrastructure and planning, social policies (including education and health infrastructure) and urban environmental management. If this opportunity is missed, such urban growth will not only perpetuate unsustainable, unhealthy housing patterns; it is also likely to cause a further significant acceleration of global warming (Section 4.3).

Recommendations for action

Planning and governance

- › *Develop visions of a desirable future for one's own living environment:* In addition to municipalities, city governments and regional administrations, the participation of civil-society actors is also needed to jointly initiate a process of reflexive and experimental learning with the aim of developing visions of a desirable future for a city's living environment. This makes it all the more important that political decision-makers are willing to engage in a reflexive

and experimental process of 'learning by doing' in real-world laboratories.

- *Overcoming institutional and disciplinary boundaries in planning processes:* If the implementation of these goals for liveable cities is to succeed, it will be necessary to overcome the institutional and disciplinary boundaries that still exist in planning processes. Urban-planning processes require not only inter-agency cooperation but also the active participation of urban society and the involvement of informal structures. Initiatives, ideas and innovations 'from below' should also be given the opportunity to develop, and space for experimentation in planning processes provided in the sense of 'real-world laboratories', so that urban planning can also act as a facilitator for transformative change.
- *Establish locally adapted indicators and targets for environment- and health-oriented urban planning:* There is a need for regionally and locally adapted indicators, making it possible to measure progress in the implementation of environment- and health-oriented urban planning. Data is not always readily available. Where it is, different cities often use slightly different data and collection methods, making comparisons difficult. Uniform data standards, comprehensive data collection and comparable methods for monitoring and benchmarking should therefore be developed, based on regionally and locally adapted indicators and targets.
- *Reserve an appreciable proportion of the urban space for common-good-oriented uses:* A key condition for the success of transformative planning processes is how urban land use is designed. This makes it necessary to diversify urban ownership models, secure land for municipalities and the public sector, take local conditions into consideration when designing land use, link informal and formal aspects of land use, and take precautions against corruption in the allocation and use of land. An appreciable proportion of the urban space should be reserved for common-good-oriented uses.
- *Be more consistent in sanctioning inner-city noise pollution caused by motorized traffic:* Motorized road traffic is the number-one source of noise in cities. As a rule, noise pollution can be reduced by avoiding motorized transport wherever possible: e.g. by walking or cycling (which is also healthy), sharing transport instead of using it individually (thus cutting CO₂ emissions), using quieter vehicles, adapting road surfaces, building noise barriers and soundproofing buildings.
- *Take into account the multiple burdens of disadvantaged neighbourhoods and population groups:* Disadvantaged neighbourhoods and population groups are often simultaneously affected by housing insecurity, multiple environmental stressors and poor health resources. These multiple burdens should be

evaluated according to population group and given special consideration in all urban planning processes.

- *Ensure safe, affordable and health-promoting housing for all population groups:* When urban neighbourhoods are upgraded by redevelopment or conversion, resulting in higher property and rental prices, the traditional residential population of an urban neighbourhood is often displaced (gentrification). Along with all measures to improve housing conditions and design neighbourhoods in a health-promoting way it should therefore be ensured that these population groups are adequately protected from displacement, and that the social mix is maintained.
- *Establish a new position of Urban Chief Health Officer:* The need to create a coherently health-oriented settlement and urban-development structure requires an assertive institution at the administrative level. Analogous to the functions of a Chief Digital Officer or Chief Sustainability Officer, cities should therefore establish a position of Chief Health Officer to ensure that the health dimension is taken into account in all urban and neighbourhood development issues. Existing structures of public health services can be used here.

Infrastructure and construction

- *Expand, connect and enhance urban green and blue spaces:* Green and blue spaces have a substantially positive impact on human health and well-being; they regulate environmental stressors such as heat, air pollution and noise, and provide important other ecosystem services. Existing green and blue spaces should therefore be extended, qualitatively upgraded and interconnected wherever possible. Already sealed areas should be increasingly unsealed, and degraded and polluted green and blue spaces restored.
- *Promote the protection of biodiversity in urban green and blue spaces – nationally and internationally:* If designed accordingly, green and blue spaces can act as protective spaces for conserving biodiversity. To this end, the German federal government's 'Urban Nature' master plan should be consistently implemented, given a financial boost and further developed in terms of content. At the same time, the 'Urban Nature' funding priority of the Federal Programme on Biological Diversity should be expanded and internationalized.
- *Upgrade public urban areas with no green or blue spaces to recreational and exercise spaces – and green them:* A health-promoting redesigning of public urban spaces would, among other things, help to ensure that people are not exposed to avoidable health hazards during their everyday activities within their residential environment and beyond. Conceivable measures

in this context include creating more generous areas for pedestrian traffic and relaxation in public places, for greening squares, street spaces and building façades, and providing sufficient seating and a basic sanitary infrastructure.

- ▶ *Promote timber construction as a sustainable alternative in building construction; erect public buildings using timber-based methods:* The land needed for sourcing timber, e.g. from plantations, can have a detrimental effect on natural, biodiversity-rich forests; the globally sustainable potential therefore needs to be precisely estimated here. In order to actively promote timber construction as a sustainable building method, environmental costs should be priced into conventional construction and building regulations adapted. Provided that wood from sustainable forestry is used, increased timber construction of public buildings should be promoted.
- ▶ *Reduce greenhouse-gas emissions from concrete construction:* The current dominance of concrete construction in the creation of new housing and the infrastructure needed for it will probably continue in the coming decades, even if the use of wood and other sustainable building materials increases. It is therefore necessary to significantly reduce greenhouse-gas emissions by improving energy and resource efficiency in each phase of conventional cement and concrete production and use. This should be done at the material level by using supplementary cementitious materials or modern, recycled types of concrete.
- ▶ *Promote the reusability and recyclability of building materials:* In order to implement a circular economy in the building-materials sector, more work should be undertaken on databases for materials and components that cover building materials, state the degree of reusability and recyclability, including suitable, standardized methods for life-cycle analysis. These databases should be created for both old and new buildings and made available to municipalities, construction companies and private individuals. An assessment of the reusability of building materials is therefore also needed for the demolition of old buildings.
- ▶ *Promote sustainable and more efficient water management by recycling water:* More efficient water use can reduce the risk of water scarcity and increase both economic and environmental resilience. Water re-use is a promising option here, as drinking-water quality is not required for many applications. Therefore, various approaches to water reuse should be promoted, both small-scale (e.g. grey-water recycling for toilet flushing and washing machines) and larger-scale (e.g. irrigation of green spaces with treated wastewater).
- ▶ *Develop and apply precautionary strategies for protecting water resources at the municipal and regional level:*

Against the backdrop of advancing climate change, precautionary water-resource strategies should be developed at the municipal and regional level, especially in cities that will be increasingly affected by droughts in the future. These strategies should preferably be developed in the area of the respective hydrological watershed. A core element of such strategies is a comprehensive risk assessment based on current hydrological data and models that consider different climate-change scenarios.

- ▶ *Improve energy supply and health in an integrated way:* Energy strategies should be linked to strategies for resilient health systems and supplemented by a component geared towards health systems. In particular, there should be greater emphasis on development-cooperation programmes for improved access to ‘clean’ energy and electricity. First, the focus in low-income countries should be on disseminating clean and efficient cooking devices. A second focus should be a reliable power supply, especially for all health facilities.

Research recommendations

Planning and governance

- ▶ *Research on integrating health into overarching urban agendas:* Research is needed to enable health professionals to better integrate health into economic, social and other development plans and policy-making processes. Furthermore, the relationship between political, environmental, economic and social factors in the urban environment and health outcomes should be explored. Research is also needed on the impact of geographical inequalities within cities on vulnerable groups and their access to health services.
- ▶ *Investigate methods for implementing the 15-minute city in the context of urban regeneration:* The 15-minute city is gaining more and more acceptance and appeal in urban design. Further research should therefore show how this approach can be implemented on a broad scale, especially in the context of urban-regeneration measures, and which planning and incentive models are conducive to it. Special attention should be paid to the enforceability of planning measures vis-à-vis a housing sector that is dominated by the private sector.
- ▶ *Improve knowledge about the health risks of vulnerable groups:* There is a need for research into urban inequalities, their role in exacerbating health risks at neighbourhood level, and how eliminating them can improve health equity. There is also a need to collect, assess and, where appropriate, develop local and global indicators for monitoring and evaluating urban health interventions targeting specific population groups (e.g. age-appropriate cities).

- › *Intensify research on climate change and urban health:* The interrelations between climate change and urban health are under-researched. They include, in particular, effective responses to climate change, the impacts of climate change on vulnerable population groups, effective measures, and the interactions between climate change and other health threats.
- › *Examine interactions between different stressors of urban life and identify potential ways to reduce stress:* There is a great need for research on interactions between different stressors, the conditions under which they increase the morbidity and mortality of mental and physical illnesses, and on vulnerable population groups. Moreover, research should be conducted into how cities can be designed to be as stress-free and health-promoting as possible.
- › *Explore experience with innovative urban legislation:* The example of the Brazilian urban-planning reform, which has received a lot of attention especially in low- and middle-income countries, should be examined regarding the extent to which the concerns of marginalized and poorer population groups could be taken into account in urban development. The experience of other countries with similar laws and tools based on this should also be examined. South-South research cooperation could also be initiated for this purpose.
- › *Strengthen the link between research results and their implementation:* Research results on urban health should be more strongly linked to implementation or measures taken. This involves sharing knowledge, creating and disseminating databases, applying systems thinking and predictive methods, using comparative urban-health research and monitoring the impact of policies and measures. Finally, research is also needed on existing health-assessment tools (e.g. Health Impact Assessment, Urban HEART).
- › *Study the health effects of urban nature:* The clear benefits of urban nature, such as strengthening mental and physical health or improving the microclimate, are offset by potentially negative effects such as pandemic risks or conflicts between humans and wildlife. Research on avoiding such risks and conflicts, but also on the role of urban-planning concepts such as ‘animal-aided design’, should be better funded and expanded.
- › *Promote the development of sustainable and circular building materials:* Modern materials research and new materials with suitable physical and chemical properties can make a major contribution to improving resource efficiency and environmental protection in construction, and to health protection. The research and development of suitable materials and concepts for durable construction methods should be promoted.
- › *Initiate comparative studies on climate-friendly construction methods and natural building materials:* In addition to building with wood, other ways of reducing the use of climate-damaging building materials include the use of modern and recycled materials, straw bales, mudbrick and stone. Unlike timber construction, however, they are less often perceived as viable alternatives. Comparative studies on the greenhouse-gas emissions of different construction methods or on the locally adapted use of various natural building materials can provide clarity here. Materials ageing should also be taken into account in life-cycle analyses.
- › *Examine the conflict of objectives between the use of natural building materials and the protection of biodiversity:* A transition to the intensive use of wood as a building material could lead to an increase in forest plantations, mainly at the expense of unprotected natural forests and other natural vegetation. Further studies are needed on the possibility of conflicting goals between biodiversity conservation and an increased use of timber and other natural building materials, particularly on the respective globally sustainable potential, available and required land, and future uncertainties due to climate change.
- › *Investigate the potential impacts of light pollution:* There are already indications of the possible impacts of light pollution on health and the environment, but not yet sufficient data to prove a causal linkage to health risks. There is a need for research above all on ‘light pollution’ in outdoor areas and on the question of whether or when influences on the body’s own rhythms can endanger health. Especially through laboratory experiments, light pollution is also suspected of changing the behaviour and composition of species in flora and fauna. The extent to which outside ecosystems could also be altered by light pollution is unclear and requires extensive research.

Infrastructure and construction

- › *Investigate the health effects of urban green and blue spaces:* Research should be conducted on how green and blue spaces should be designed to meet specific requirements for ecosystem services, health benefits and social and cultural needs. In addition, there is a particular need for transdisciplinary and practice-oriented studies on the health-promoting and resilient design of green and blue spaces.
- › *Improve the data basis on green and blue spaces and set up urban observatories:* The data basis on green and blue spaces should be improved, existing data merged, and data-management methods standardized. Furthermore, a global network of ‘urban observatories’ needs to be established.

Managing planetary risks: climate change, biodiversity loss, pollution



Climate change and the loss of biodiversity are detrimental to the health of species, ecosystems and humans. The impacts affect the sustainable functioning of ecosystems, human societies and planet Earth. Healthy living on a healthy planet will therefore only be possible in the long term if both climate change and biodiversity loss are halted (Section 5.1).

Recommendations for action

An integrated approach to climate-change mitigation and biodiversity conservation

Overarching recommendations for both climate-change mitigation and biodiversity conservation

- › **Abolish harmful subsidies; correct balance sheets:** Harmful subsidies that drive climate change or biodiversity loss should be redirected or abolished. Public- and private-sector reporting, taxes, levies and tariffs should take the hitherto externalized environmental and health costs into account.
- › **Reconcile infrastructure investments with climate-change mitigation and biodiversity conservation; avoid path dependencies:** For the global energy transformation, undesirable path dependencies and lock-in effects should be avoided, e.g. in infrastructure investments, which can shape emissions development for decades. Phasing out the use of fossil fuels and expanding renewable energies must go hand in hand to avoid supply bottlenecks that could lead to a return to fossil fuels. Lock-in effects caused by new investments in the exploration and extraction of fossil fuels must be avoided. In addition, biodiversity conservation should be taken into account in each case.
- › **Advance the global energy transition:** The shortage of fossil fuels resulting from the Russian war of aggression on Ukraine should be actively used to accelerate a successful transformation of energy systems; emissions should be reduced to a path compatible with a 1.5°C global warming limit. A concerted mix of market-based and regulatory measures can coordinate

the transformation of interdependent sectors, help avoid energy shortages, mobilize market forces and contribute to achieving climate, biodiversity and related health targets.

- › **Conserve ecosystems by expanding protected areas and by restoration:** To conserve ecosystems, protected-area systems should urgently be expanded to cover 30% of land and ocean areas – in line with the Kunming-Montreal Global Biodiversity Framework. This can also help to reduce land-use changes and deforestation. In addition to implementing the protected-area target, the goal of restoring degraded ecosystems is also particularly important, both for the restoration of biodiversity and for adapting to climate change.
- › **Ensure the sustainable management of ecosystems that are in use:** Ecosystems should be managed in a way that takes into account both biodiversity conservation and climate-change mitigation. The reduction of animal-based diets can open up new scope here and make multiple benefits possible. Public funds should only be used if sustainability criteria are taken into account.
- › **Adaptation and dealing with loss and damage:** High-income countries must finally live up to their responsibility for climate change and biodiversity loss by promoting adaptation and compensation measures, especially in low-income countries – also to avoid negative health impacts there.
- › **Sustainably safeguard the health of species and ecosystems:** Unpolluted conditions should urgently be created in settlement areas and ecosystems, also by applying nature-conservation law. Spatial planning should designate areas where species can develop healthy populations, where ecosystems can function resiliently, and people can find recreation, sometimes in places directly adjacent to such designated areas or in areas shared by species and people. Food production and forestry should also be linked to the goal of sustainable biodiversity. Protection and design rules, as well as criteria for health, should be further developed. There should be a constant exchange among actors in health systems for ecosystems and species, as well as in human health systems.

Focus on fossil fuels: stop exploration and extraction

- › **Avoid undesirable path dependencies (lock-in effects) caused by fossil infrastructures:** Countries should limit the development of fossil infrastructures along the entire value chain from the exploration and extraction of fossil fuels to their processing and use in order to avoid path dependencies that counteract the climate goals.

- › *End funding and other government support for exploration and extraction:* Countries should phase out their support for fossil-fuel production, end subsidies not only for fossil fuels themselves but also for their extraction and, instead, prioritize financing climate-resilient development pathways with renewable energies.
- › *Create transparency on exploration and extraction projects:* Countries should regularly disclose their plans, or the concessions they have granted, for the extraction and exploration of fossil resources, including the corresponding subsidies, and report on them under the UNFCCC. It would also be conceivable for the IPCC to report on extraction pathways or for the Global Stocktake to include measures to control extraction.
- › *Launch multilateral negotiations on phasing out the extraction of fossil fuels:* Ending the exploration and extraction of fossil fuels should be made an issue at the international level. Multilateral negotiations should be sought to agree on an immediate halt to the exploration of new oil and gas fields and on timetables to end fossil-fuel extraction. The aim should be to bring the extraction of fossil fuels into line with exit paths from the use of fossil resources for energy and, if possible, also for material uses – paths that are in line with the still-permissible CO₂ budgets.
- › *Support poorer countries in their transition away from fossil fuels:* To achieve a just transition away from fossil fuels, wealthier resource-rich countries might forego the further extraction of their fossil deposits in favour of poorer resource-rich countries, thus giving poorer countries more time to make the transition. In addition, targeted financial and technological support should be provided to help poorer countries build modern and climate-friendly energy-supply systems. Economically weaker countries with few resources should also be supported in order to prevent from the outset the emergence of energy-supply structures based on fossil technologies. Promising approaches in this regard include the ‘Just Transition Energy Partnerships’.

Focus on zoonotic pandemics: promote prevention

- › *Strengthen efforts to set up protected-area systems:* Implementation of the CBD’s Kunming-Montreal Global Biodiversity Framework is key not only for biodiversity conservation, but also for combating zoonotic pandemics. In particular, the target of placing 30% of terrestrial, marine and limnic areas under protection by 2030 – or taking other area-based nature-conservation measures and integrating them into protected-area systems – should be pursued now with great momentum, as protected areas can help to reduce land-use changes and deforestation and to keep human and wildlife habitats more separate.

Strategies for the restoration of degraded ecosystems should be added.

- › *Regulate trade in wildlife and wildlife products:* Wildlife hunting in low-income countries and trading in the products is a factor in the emergence of zoonoses and should therefore be more strictly regulated. Due to possible side effects on other SDGs, and out of respect for indigenous peoples’ ways of life, regulation should be based on a holistic view of ecological and socio-economic contexts.
- › *Begin with consumption patterns and supply chain:* More attention should be paid to supply chains that aim for less destructive infrastructure projects (e.g. road construction, mining), no further destruction of primary forests, sustainable timber management as a tool for expanding natural and near-natural forest areas, and a reduction in the fragmentation of major natural areas (especially in biodiversity hotspots).
- › *Establish measures for zoonosis prevention and management:* More use should be made of nature-conservation measures to prevent zoonotic spillovers. First, it should be examined whether – in close cooperation with the CBD and the GEF – this focus can be added to the Financial Intermediary Fund for Pandemic Prevention, Preparedness and Response, which was newly established by the World Bank in 2022, or whether additional funding instruments should be set up within the framework of the CBD. Second, the capacity of regional networks and authorities for zoonoses prevention should be strengthened. The Washington Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) plays an essential role in monitoring and regulating the trade in wildlife. To improve implementation, the financial, organizational and personnel capacity of regional networks and national authorities should be expanded. Third, the CBD should become the main forum for pandemic prevention in the context of biodiversity and nature conservation, and be given corresponding financial, capacity-building and regulatory backing. Preventive strategies should also be taken into account in the Pandemic Treaty that is yet to be negotiated. Close cooperation with CBD and CITES would make sense here. Fourth, there is a need to create a pandemic early-warning system in which information ranging from sporadic zoonotic events to large-scale epidemics can be accessed quickly and transparently. Global databases on virus genomes and serology should be developed and networked with the early-warning system. Finally, the World Biodiversity Council should consider updating the workshop report on Biodiversity and Pandemics and, if necessary, developing it into a special report together with the IPCC, also in order to encourage relevant research activities.

Focus on habitat loss and new limits to habitability

- › *Develop regulated forms of human migration, especially for regions that will be uninhabitable in the future:* Regulated forms of human migration should be developed for regions where the limits of adaptation to climatic and environmental change will be reached in the foreseeable future. This includes strengthening and expanding regional migration regimes in Africa, Asia, Latin America and in European neighbour countries – regimes that promote regulated cross-border movement, make migration conducive to development, guarantee freedom in migration decisions and protect migrants from violence and abuse.
- › *Loss and damage – pay people’s ‘moving costs’:* Climate change is already causing damage and loss worldwide. Against this background, Germany’s Federal Government should commit to the Global Compact on Refugees. This means using the bilateral and multilateral instruments of humanitarian aid and development cooperation in the spirit of the ‘humanitarian development peace nexus’ increasingly to support sustainable prospects of integration and adaptation at the place of resettlement.
- › *Facilitate the migration of species with interconnected protected areas and ecosystems:* Protected areas and their connectivity through migration corridors should be planned and implemented accordingly, taking into account the species-specific requirements of the respective environmental conditions. In line with the integrated-landscape approach, the interconnectivity of protected areas – both with each other and with the surrounding land area – should be improved in order to conserve and enhance biodiversity and ecosystem services, strengthen resilience to climate change and ensure goods and services in the long term.

Pollution

Pollution with persistent, bioaccumulative and mobile toxic substances should be recognized as a challenge that politically has the same priority as climate change and biodiversity loss; it must be reversed and avoided in the future. There are many individual agreements on preventing and controlling the pollution of the environment with hazardous substances, especially harmful and persistent chemicals. However, up to now these have neither been effective nor have they had a preventive effect, as their approach has been to ban individual substances only after they are known to be harmful and have been regularly released into the environment. Internationally, there is no framework agreement comparable to climate and biodiversity governance or any pooling of global expertise (Section 5.2).

- › *Establish zero pollution and the circular economy as guiding principles internationally:* Hazardous chemicals that cannot yet be substituted must be kept in technical applications or cycles – or else must not be released into the environment during use. The guiding principles of zero pollution and the circular economy can be boosted by a global framework convention to combat pollution from hazardous substances. Further current opportunities for strengthening these principles include, for example, the negotiations on the successor instrument to the Strategic Approach to International Chemicals Management (SAICM), the negotiations on the UN Treaty on Plastic Pollution, and legislative initiatives by the EU in the context of the Green Deal. The guiding principles should also play a prominent and permanent role in the implementation of the 2030 Agenda and in the post-2030 Agenda.
- › *Implement prevention and precaution as guiding principles for action:* The internationally recognized precautionary principle is already enshrined in the REACH regulation and the Stockholm Convention, but should apply generally to all chemicals and substances that are hazardous to health. Preventive and precautionary chemicals governance requires, in particular, legally binding thresholds geared to protecting vulnerable groups and sensitive ecosystems, legally binding minimization requirements with regard to the use of harmful but indispensable substances, and the standardization of the manufacture and marketing of substances and products (‘safe and sustainable by design’).
- › *Equip new chemicals governance with an international registration regime:* A key component of a global framework convention to combat pollution from hazardous compounds should be an international registration and authorization regime for substances of very high concern, which should include a preventive ban under which the supervisory authority reserves the right to grant exemptions for essential uses; criteria for essential uses as well as aftercare and withdrawal obligations are yet to be defined. Manufacturers must develop processes to render substances harmless. The obligation to present facts and the burden of proof with regard to a substance’s environmental and health compatibility, should lie with the applicant. Approval procedures could be accelerated by setting deadlines.
- › *Set up an intergovernmental science-policy platform on pollution:* For the scientific monitoring of the corresponding transformation processes, an intergovernmental science-policy platform modelled on the IPCC and IPBES should be set up – among other things – to review the state of the art on pollution and thereby form a knowledge base for various actors. The science-policy panel on chemicals, waste and pollution

adopted by the UN Environment Assembly should address, i.a., life-cycle analyses of substances and criteria for essential uses.

- *Expand pharmaceutical regulation to include consideration of environmental aspects:* In the case of pharmaceuticals and other substances for which full recycling is difficult to achieve, authorization should only be granted after a positive risk-benefit assessment that also takes environmental aspects into account. Pharmaceuticals that still pose a high environmental risk should be subject to prescription. Doctors should be specifically informed of the environmental risks of such pharmaceuticals, and environmental aspects should also be included in post-authorization monitoring. Exemptions for medicines from chemical and supply-chain regulations should be abolished where possible.

Research recommendations

An integrated approach to climate-change mitigation and biodiversity conservation

Overarching recommendations for both climate-change mitigation and biodiversity conservation

- *Research the foundations for ecosystem health:* Aside from recognizing the spatial needs of species and ecosystems and strengthening natural plant and animal communities, there are few generalizable and quantifiable criteria for restoring and maintaining ecosystem health and resilience. Research is required on the causes and therapeutic options when ecosystems have suffered disruptions of functionality, species diversity and species populations, as well as on their spatial requirements. There should also be research on how ecosystem health can be measured and implemented, e.g. by involving nature-conservation authorities and further developing their fields of action. Authorities that can contribute significantly to ecosystem health should promptly incorporate new knowledge from animal, plant and microbial physiology, pathophysiology and ecology into therapeutic measures.

Focus on fossil energy sources: stop exploration and extraction

- *Equity in the phase-out of exploration and extraction:* Further research should be conducted on how to handle the phase-out of exploration and extraction in an equitable manner, also using different principles of equity, and on which instruments can support such a phase-out at the national and international level.
- *Design of agreements on phasing out exploration and extraction:* Research should be conducted on how agreements on phasing out exploration and extraction can be designed in such a way that they reliably

safeguard phase-out decisions in the longer term – even if fossil-fuel prices rise in the meantime.

- *Economic-policy instruments:* Possible economic-policy instruments should be developed and examined which might enable resource-rich countries to initiate and accelerate the necessary diversification of their economic structures. Deep structural breaks should be avoided, and room should be created for new economic developments.

Focus on zoonotic pandemics: promote prevention

- *Step up research on the conservation and restoration of biodiversity and ecosystems:* It should be clarified in greater detail how anthropogenic factors influence the emergence of zoonoses, and whether ecosystem restoration can reduce the frequency of zoonotic host animals.
- *Improve research into and monitoring of wildlife trading:* Research and monitoring should be strengthened to improve knowledge and data on the causes, connections and containment of wildlife trading.
- *Strengthen microbial research on the emergence risks of zoonoses:* Longitudinal studies on virus dynamics in reservoir and spillover host populations could contribute significantly to containing the zoonotic risk. Monitoring and the detection of viruses and their transmission pathways between wildlife species should be linked to studies on climate-induced range shifts of species.
- *Strengthen economic research on the cost-benefit ratio in the prevention of zoonoses:* Targeted economic research should be promoted on the cost-benefit ratio in the prevention of zoonoses by conserving and restoring biodiversity and ecosystems, and by sustainable land use.

In all research efforts, particular attention should be paid to an appreciation of indigenous knowledge and the incorporation or consideration of this knowledge in other knowledge systems of research and education.

Focus on habitat loss and new limits to habitability

- *Rethink ecosystem management for the translocation of species and species communities:* In order to maintain and strengthen ecosystem services and biodiversity, it is necessary to develop new management approaches that take into account not only regional human activities but also the impacts of climate change on species and ecosystems. Regional scientific studies on the possibilities of the migration of species or species communities (e.g. via natural corridors), as well as on managed relocation, are necessary to answer the scientific, ethical and legal questions and concerns that might arise in this context. These studies should be carried out in direct cooperation with the competent

authorities and stakeholders. There should also be more research investment in the production of global datasets on the status of ecosystems, threatened species and protected areas, as well as on the “status of interconnections between protected-area systems, on their integration into the landscape, and on the coverage of critical ecosystem services and other effective area-based conservation measures”.

- › *Improve understanding of the adaptation limits of species and species communities:* In order to assess whether species can colonize a region, it is necessary to understand the adaptation limits or tipping points of both the species involved and their communities, taking into account the respective site- and system-specific food chains and, if applicable, symbioses (e.g. in the case of warm-water corals). This includes knowledge of the environmental conditions and their variability, or the occurrence of limiting environmental conditions, particularly with regard to the selection of new sites for the translocation of species and species communities.
- › *Prepare for the limits of habitability:* Climate migration should also be internationally recognized in the future as one strategy among others. Interdisciplinary research on climate-induced migration should be promoted in order to develop a better understanding as well as long-term and flexible protection options. The key element is to ensure a safe and orderly movement of people within and between countries, and to guarantee the freedom of those affected when making migration decisions. By preparing in good time for the approaching limit of habitability in a region, a gradual deterioration of life-support systems and the associated negative psychological, health and socio-cultural effects should be prevented as early as possible.
- › *Improve understanding of migration processes:* More research should be conducted on the criteria according to which preparations should be made for a timely and orderly withdrawal of individuals or groups, under what conditions this should take place, and which framework conditions would need to be created. In addition, our understanding of the expected extent of migration, the decision to migrate and the health or psychological effects of migration should be improved. An integrated, place-specific habitability assessment is needed, with increased exchange within and between the respective research fields. Models need to be validated by local research on the ground for improved data. Integrative, interdisciplinary research approaches and more nuanced definitions of habitability can promote a broader, more location-specific range of policy recommendations or measures.

Pollution

- › *Establish internationally standardized criteria for life-cycle analyses of chemicals:* Internationally standardized criteria must be established for life-cycle analyses, and more research is needed here. A particularly suitable body for this purpose is the science-policy panel on chemicals, waste and pollution, which the UN Environment Assembly has decided to establish.
- › *Collect impact and long-term data on hazardous substances:* Collecting impact data and long-term studies lays an essential foundation for assessing the environmental risk of hazardous substances (e.g. PFAS and pharmaceuticals).
- › *Develop solutions for the conflict of interests between intellectual property rights and the accessibility of private data:* The required accessibility of the necessary data could be hampered by legally protected trade and business secrets as well as by intellectual property rights. There is a need for research on the extent to which these subjective rights can limit the transparency and accessibility of data.
- › *Strengthen public research on chemicals governance:* National and international research on chemicals governance is largely dominated by the chemical industry. It would be desirable to increase publicly funded research in this area to avoid any possible influence on research results by individual economic interests.
- › *Uncover drivers of and barriers to PFAS regulation:* There is a deficit of research on drivers of and barriers to PFAS regulation at the international level.
- › *Develop cross-regulatory instruments:* Overarching instruments need to be developed that interlink sectors instrumentally – e.g. in the form of a PFAS regulation under water law, in relation to air pollution or via the REACH Regulation – both in the EU and globally. Exactly what this might look like is open and should be researched.
- › *Compare chemicals law internationally:* Comparative legal and policy research on chemicals law (especially on the REACH approach) is needed to facilitate mutual learning effects and understand the effects of European legal changes on other countries.
- › *Characterize PFAS toxicologically:* A comprehensive toxicological characterization of PFAS that have been less well studied up to now (e.g. short-chain PFAS and substitutes) should be carried out; this can be used as a basis for suitable assessment values.
- › *Develop substitution possibilities:* Research should be conducted on the development of sustainable substances and materials to replace substances that are hazardous to health; there should also be research on the efficient, emissions-free recycling of infrastructure that is hazardous to health and the environment and needs to be replaced.

- *Research conditions for the use of secondary materials:* To enable the implementation of after-care obligations, conditions for the use of secondary materials containing harmful substances should be researched. In addition, processes should be developed to remove already released substances from natural cycles (e.g. using advanced water-treatment processes).
- *Research consumer behaviour with regard to chemicals and pharmaceuticals:* In addition, research should be conducted on the promotion of behavioural changes in the use of chemicals and pharmaceuticals by consumers of different age groups.

Harnessing the transformative potential of health systems



By strengthening environmentally sensitive prevention and health promotion, environmental resilience and ecological sustainability in a targeted way, health systems can fulfil their core tasks also in times of global environmental change, as well as additionally initiate transformations in other fields of action and sectors. In particular, health systems can make a decisive contribution to promoting healthy and sustainable lifestyles and to multisectoral structural prevention. This requires health systems to fully take into account healthy ecosystems as an important prerequisite and resource for health, and environmental changes as major determinants of disease. In order to overcome the existing barriers and harness the transformative potential of health systems, a number of measures should be taken in different fields of action. The corresponding recommendations for action should be implemented on the basis of scientific evidence, which should urgently be expanded in some areas (Chapter 6).

Recommendations for action

Acknowledge the importance of environmental changes and healthy ecosystems

- *Understand environmental changes as a risk and healthy ecosystems as a resource for health:* The growing scientific evidence should be implemented systematically and comprehensively in health systems. Transdisciplinary health concepts such as One Health and Planetary Health can be applied here. Holistic approaches to patient care, such as integrative medicine, can be used in implementation in health services.
- *Consider environmental changes in medical guidelines:* Existing recommendations should be taken into account in this context. This can provide health professionals with specific standards of action with regard to environmentally sensitive prevention and health promotion, resilience and sustainability.

Promote healthy and sustainable lifestyles and living conditions

- *Boost environmentally sensitive prevention and health promotion:* The two approaches should be transformed into a holistic strategy that takes into account healthy ecosystems as an important prerequisite and resource for health, as well as environmental changes as major determinants of disease.
- *Enable health professionals to promote planetary health literacy:* In counselling sessions, all health professionals should address the disadvantages of behaviour that is harmful to health and the environment, as well as the opportunities and multiple benefits of healthy and sustainable lifestyles. In addition, information about environmental health risks and corresponding behavioural recommendations should be provided. This requires sufficient human resources and appropriate education, training and further training.
- *Targeted modification of the primary health care approach:* When improving primary health care (PHC), the focus should be on environmentally sensitive prevention and health promotion. Corresponding measures should be implemented especially in low-threshold community-care structures (e.g. health kiosks, community health nurses), as well as in the form of outreach services.
- *Adapt, expand and interlink existing health-promotion and disease-prevention services:* The services should be complemented by promoting healthy and sustainable lifestyles and communicating ways of designing sustainable and health-promoting living environments. In addition to health-insurance funds, other actors should be entrusted with the implementation of the services.

- › *Modify remuneration systems:* Remuneration systems should encourage, not inhibit, health promotion, disease prevention, sustainability and resilience. Furthermore, they should not lead to disproportionate staff retrenchments and inappropriate care including over- and underuse. Conceivable elements are fee-for-service remuneration for environmentally sensitive counselling sessions and additional budgets for preventive supplementary services. Moreover, ongoing performance-based bonuses based on the fulfilment of sustainability criteria are conceivable as a supplement to regular remuneration.

Strengthen public health departments and use their potential

- › *Equip public health departments better and expand their remit:* The financial, material and personnel resources of public health departments should be greatly improved, and specific targets and tasks defined that address global environmental change and environmentally sensitive prevention and health promotion. In Germany, the ‘guiding principles for a modern public health service’ could be supplemented accordingly and established as a compulsory working basis. Public health departments themselves should also be made resilient.
- › *Public health departments contribute to structural prevention:* Public health departments should be established as an interface with politics and the administration and networked with all relevant actors and institutions. Public health departments can encourage and guide cooperation across sectors and government departments to further health-promoting and sustainable living environments, whereby a participatory approach should be used (e.g. Place Standard Tool). In particular, transnational collaborations at the city or municipal level should also be promoted.
- › *Conduct regular exposure, vulnerability and adaptation assessments:* Public health departments should conduct targeted and informative analyses in the above areas that involve health risks from different environmental changes. To this end, cross-system, international and transnational cooperation between all relevant scientific disciplines and institutions should be sought, promoted and financed. The new German Federal Institute of Public Health could play a key role at the national level here.
- › *Establish integrated environment- and health-information systems:* These could be part of nationally and internationally networked sentinel and monitoring systems and link up with existing projects (e.g. the EU health information system). Within the systems, health and environmental data and stressors should be continuously recorded and merged in a spatially and temporally differentiated way, and subjected to a multi-dimensional analysis. The transmission of environmental and health data could be simplified by automated systems, which would make a comprehensive digitization of the collected data necessary. In the future, artificial intelligence could be used in analyses of risk factors and epidemiological developments.
- › *Implement targeted early-warning and information systems:* Both health professionals and people at risk should be specifically and automatically informed about health risks; early-warning and information systems should be resilient to shock events and consistently take into account both personal information requirements and individual vulnerability factors. Digitizing relevant patient data and making them available to public health services would help here; of course, data-protection rules and self-determination rights must be respected.
- › *Continuously evaluate the ecological footprint of health systems:* Public health departments should continuously monitor the environmental footprint of their respective national health systems and identify any need for action to reduce resource use and emissions. In addition, public health departments can contribute to scaling up successful interventions to strengthen sustainability by providing appropriate tools and institutional support for existing initiatives.

Implement targeted adaptation and resilience strategies

- › *Integrate and implement environmental resilience in health systems:* Complementary to existing strategies and recommendations for strengthening resilience in health systems, the WBGU proposes a more comprehensive guiding principle of ‘environmental resilience’ that takes into account all health-relevant anthropogenic environmental changes. In Germany, a national competence centre should be set up; together with the EU, a global programme to promote environmentally resilient and sustainable health systems could be established, especially in cooperation with other supranational institutions.
- › *Develop country-, discipline- and target-group-specific adaptation and resilience strategies:* The strategies should be developed in a participatory process, involve transdisciplinary and transsectoral cooperation, and comprehensively take into account the risks of different environmental changes and country-specific framework conditions. They should be based on an anticipatory approach in order to be prepared for future dynamic developments of environmental changes and shocks. Specific measures should be sustainable, build on existing structures and address all relevant components of health systems.

- › *Strengthen adaptation and resilience in health systems in LMICs:* The task of improving basic health services should be pursued in low- and middle-income countries (LMICs) as a key measure to reduce vulnerabilities. Health services provided by private actors can be managed in the public interest by means of regulatory mechanisms based on regulatory law and fiscal-policy instruments, paying particular attention to strengthening sustainability and resilience. High-income countries should offer financial and technical support to build environmentally resilient and sustainable health systems and efficient public health departments. Available international funds could also be used for financing.

Improve sustainability in health systems

- › *Reduce and avoid inappropriate care including overuse and underuse:* Existing recommendations for action and research to reduce overuse should be implemented; in addition, ecological benefits and their health effects should also be considered. Economic savings should be invested in health-promoting, preventive and transformative measures.
- › *Reduce resource use and emissions in health systems:* The existing recommendations on reducing resource use and emissions should be combined to generate synergies. When reducing emissions, it should be noted in particular that the aim should be to reduce not only greenhouse-gas emission but also other environmentally harmful emissions. The medical products and technologies used should be as sustainable as possible; among other things, there is also a need for short-term action in the areas of pharmaceuticals and medical waste. Healthy and sustainable catering should be introduced across the board in health facilities. Binding emissions-reduction targets in health systems could be enshrined in law at the national and supranational level.
- › *Make use of opportunities for influence beyond health systems:* Health institutions should consistently communicate their environmental sustainability. When procuring resources, medical products and technologies, attention should be paid to environmental sustainability along the entire supply chains. Financial resources in health systems, especially from health insurance funds and companies and professional pension funds for physicians, should only be invested in line with appropriate sustainability criteria.

Research recommendations

Interactions between environmental changes, ecosystems, human health and health systems

- › *Impact of environmental changes on medical disciplines:* There is a need for comprehensive medical studies that systematically investigate the precise effects of environmental changes on the respective diseases, diagnostic measures and therapies, specific to medical disciplines and across disciplines. Moreover, the ecological sustainability of all diagnostic and therapeutic measures and treatment plans should be systematically examined. Specific health benefits resulting from healthy ecosystems should also be systematically investigated.
- › *Measures for integrated environmental and health protection:* Intersectoral solutions for environmental health risks should be developed that include health systems and address the health of humans, other species and ecosystems at the same time. All research on interactions between environmental changes, ecosystems and human health should be transdisciplinary in the sense of health concepts such as One Health and Planetary Health.

Prerequisites for transformations in health systems

- › *Evaluation of health systems and development of targeted financing structures and remuneration systems:* Systematic evaluations of health outcomes, sustainability and resilience are helpful for identifying characteristics of health systems that lead to a high health status of the population, and to a high level of resilience, while having a low ecological footprint. Evaluation tools should cover all components of health systems. In this context, remuneration systems and financial incentive structures should also be examined for any disincentives, and ways to eliminate them should be researched.
- › *Legal, political and societal preconditions for transformations in health systems:* Research should be conducted on the necessary preconditions for transformations in health systems. It should be clarified how they contribute (and could contribute) to transformations towards more sustainability, also beyond health systems; it should also be examined whether a fundamentally new understanding of health is required and how such an understanding would have to look like.

Effectiveness and multiple benefits of environmentally sensitive prevention and health promotion

- › *Effectiveness of health-promotion and disease-prevention measures:* In particular, complex measures and programmes should be studied, and appropriate research methods, indicators and parameters should be developed and validated for this purpose. They should assess health-related, social, ecological and economic effects, especially those resulting from the promotion of healthy lifestyles, living conditions and the successful strengthening of adaptation and resilience.
- › *Multiple benefits of health-promotion and disease-prevention measures:* There should be research into the potential of health promotion and disease prevention for reducing the burden of disease, saving resources and cutting emissions. Furthermore, health-promotion and disease-prevention measures should be identified that can achieve particularly large multiple benefits for strengthening adaptation and resilience.

Measures, instruments and data for strengthening sustainability and environmental resilience

- › *Instruments and data for implementing environmental resilience:* Analyses, monitoring and warning systems require validated methodological foundations and a comprehensive data basis that meets the corresponding requirements. Research that enables personal environmental monitoring and personalized early-warning systems should also be funded. Practice-oriented and transdisciplinary early-warning, monitoring and surveillance systems should be developed, including new dynamic approaches that make comprehensive use of the available digital possibilities.
- › *Effective measures to strengthen adaptation and resilience in LMICs:* Research should be conducted on the best measures for quickly and effectively protecting particularly vulnerable population groups from health risks caused by environmental changes. The potential multiple benefits for improving primary care and the general health of the population should be quantified and measures identified that maximize benefits in this regard, while being as ecologically sustainable as possible and capable of being implemented in a resource-saving way.
- › *Improve sustainability in health systems:* Tools for systematic analyses of sustainability in health systems should be developed; research should be conducted on detailed potential for saving resources and emissions by reducing overuse. Scientific criteria should be developed for implementing emissions-reduction targets for pharmaceutical and medical-technology companies. In addition, research should be conducted on emission sources that are specific to

health systems (pharmaceuticals, medical products and technologies) in order to quantify their environmental effects, evaluate reduction potential and develop more sustainable alternatives.

Global urgency governance



There is an urgent need for global environmental and health governance that portrays a healthy life in a healthy environment not as a utopia but as a realizable vision. Such a form of governance must be based on inclusive values that respect human dignity and an international rules-based order. It must keep room for manoeuvre open in the medium to long term, and, at the same time, be in a position to face interdependent global crises decisively and vigorously. There are no blueprints for such a form of urgency governance. It must be adjusted to local, regional and national circumstances and conditions and be adaptive, i.e. capable of learning. The 2030 Agenda, adopted by the international community in 2015, serves as a framework for orientation and as a mandate for action. However, we repeatedly lose sight of medium- and long-term sustainability goals as a result of global crises and short-term ad-hoc reactions. Immediate reactions take the place of medium- and long-term policies. Implementation of the global mandate for action is inhibited by path dependencies, such as institutionally separate environmental and health-protection policies, as well as fragmented political, administrative and legal systems (Chapter 7).

Recommendations for action

Urgency governance as a mandate for Germany's Federal Government

- › *Assume leadership for urgency governance:* The WBGU recommends that the German Federal Government should now show leadership in the form of urgency governance and, first, actively introduce the 2030 Agenda as an international mandate for action, second, anchor the guiding principle of the 'human right to a

healthy environment' in conventions and constitutions, and third, promote a form of cooperation across transformation fields with the necessary weight in all upcoming international, European and national processes and decisions ('cooperative assumption of responsibility').

- *SDG Summit and Summit of the Future: initiate 2030 Agenda as a mandate for action and as a post-2030 process:* A clear signal should be sent stressing the importance of the 2030 Agenda as a political guiding principle for strong multilateralism; initial points of emphasis for a post-2030 agenda should be laid out at the SDG Summit in September 2023 and the Summit of the Future in 2024. As these points are developed further, the linkages between the individual SDGs and, in particular, with environment, climate and health should be emphasized even more and brought into focus.

Guiding principle and instrument for implementation: the human right to a healthy environment

- *Include the human right to a healthy environment in national constitutions and human rights catalogues:* A human right to a healthy environment should be included in national constitutions and regional human rights catalogues, especially in Germany's Basic Law and the European Charter of Fundamental Rights. The judicial or extrajudicial enforcement of this individual right should be guaranteed. The precise content of what the right entails should also be enshrined either in the text version or in guidelines on interpretation.
- *Strengthen the cooperative assumption of responsibility:* In addition to this, the WBGU recommends increasing the focus on individual countries' capacity to act. On the one hand, there are considerable differences in capacity between countries in the different income groups, which are obscured by a binary division into 'industrialized and developing countries', e.g. in many multilateral processes. For example, there are marked income differences between low-income countries (US\$1,085 or less gross per-capita income) and upper middle-income countries (US\$4,256–13,205, according to the World Bank's classification for 2023). On the other hand, a country's capacity for action should not be viewed exclusively from a financial perspective. Transfers that help other states combat problems can also take other forms. One important example is knowledge-based leadership.
- *Openness for cooperation at eye level:* The actions of high-income countries have an impact on other countries, e.g. through consumption, production, trade and global environmental problems. There is therefore a need for high-income countries to co-create joint solutions on an equal footing and to adjust the structures of international cooperation accordingly.
- *Develop country-specific 'meta-indicators' for environment and health:* Country-specific 'meta-indicators' for environment and health should be developed to track 2030 Agenda implementation; there should also be environmental and health audits.
- *Set strategic priorities for the 2030 Agenda that are oriented towards synergies:* To ensure an effective, country-specific implementation of the 2030 Agenda's complex system of goals, strategic priorities should be set that are oriented towards synergies. This can enable resources to be channelled more efficiently and across government departments; it can also focus political attention, increase commitment, and facilitate societal communication and participation.
- *Support low-income countries in implementing the 2030 Agenda:* Low-income countries should be given support in their national implementation of the 2030 Agenda, especially with capacity- and structure-building for strategy-development and implementation processes. This would also boost their ability to play a key role in shaping a post-2030 agenda.
- *Promote inter-institutional cooperation at UN level:* In order to promote healthy, resilient and sustainable food systems, it would be a good idea to first set up an exchange between FAO, WHO, OIE, UNFCCC, UNCCD, CBD, the International Fund for Agricultural Development and the Committee on Food Security. Second, cooperation should be promoted between the Quadripartite and the CBD and CITES on the issue of zoonoses. Third, on the issue of plastics, it would be useful to increase cooperation between UNEP, WHO, UNFCCC, CBD, the chemicals conventions and the Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization. And fourth, UN-Habitat could cooperate with the WHO, UNFCCC and CBD to shape global urbanization dynamics.
- *Establish coordination mechanisms between government departments:* In order to strengthen the cooperative assumption of responsibility within governments, positive coordination mechanisms between government departments should be established, evaluated and further developed.
- *Establish a new framework for economic activities:* Economic leadership by different actors should promote implementation of the 'healthy living on a healthy planet' vision. The task of nation states in this context is to use their steering power for the environment and health via taxes, regulatory policy and subsidies, or as international funding bodies. Internationally, for example, there should be a coordinated minimum tax on fossil fuels, and subsidies that are harmful for the environment and health should be abolished.

- › *Human-resources policy: further training for decision-makers:* In all public administrations, whether local, national, European or in international organizations, a human-resources policy should be established that enables staff and decision-makers to work and make decisions systemically. As in further-training measures on topics such as corruption prevention, which are already standard at the national and UN level, civil servants and members of parliament should be provided with basic knowledge on the environment-health nexus. France is already setting a good example here.

The WHO as a forum for international cooperation for healthy people on a healthy planet

- › *Integrate structural prevention for healthy human and non-human life:* The WHO's programmatic work should integrate structural prevention for both healthy human and non-human life.
- › *Use negotiations on pandemic prevention to integrate overarching issues:* The international negotiations on pandemic prevention, preparedness and response in the context of the IHR reform and the new pandemic treaty should be used to noticeably integrate overarching needs; these include boosting the One Health approach, the transformation towards efficient and sustainable health systems, strengthening health promotion, principles of solidarity and the cooperative assumption of responsibility. Pandemic prevention by means of nature conservation and the regulation of wildlife trading should be negotiated under the conventions on biodiversity conservation.

G7, G20 and multi-stakeholder alliances for environment and health

- › *Advocate for more attention to the health and environment nexus in G7 and G20 negotiations:* In negotiations within the G7 and G20 framework, Germany's Federal Government should work to further strengthen the WHO as a coordinating body for global health cooperation, and to counteract any fragmentation of the global health architecture. To this end, an Inter-Agency Global Health Standing Committee should be established under Germany's G7 presidency, analogous to the Think7 recommendations, to coordinate global health organizations and alliances, their mandates and funding. Furthermore, Germany should strengthen the transregional dialogue and cooperation between health systems and international climate, biodiversity and environmental policy in the G7 and G20, advocate for education and training in health systems worldwide, and pursue the vision of healthy living on a healthy planet with a view to the environmental-change-related health risks. In the

context of the G7 negotiations, a Planetary Health Task Force at the WHO level should be introduced to meet the challenges of systemically bringing together expertise on environmental change and health. At the same time, the opportunity should be taken to systematically embed the One Health and Planetary Health debates into health-system development worldwide during Japan's G7 presidency, which is focused on Universal Health Coverage. In addition, the establishment of a phased plan for internationally agreed funding for science and innovation systems at the environment-health interface should be prepared and advanced.

European Union: moving towards an environment and health union

- › *Maintain the level of ambition, expand solidarity:* Despite the economic challenges posed by high energy prices and high inflation, the EU should not reduce its current level of climate and environmental ambition, or give in to pressure from Member States. Germany should work decisively to advance the implementation of the Green Deal, while ensuring strong solidarity among Member States.
- › *Set up and expand common, EU-wide transparency mechanisms, evaluation systems and monitoring systems:* The surveillance and reporting systems on health-risk factors and health envisaged under the European Health Union should be implemented and extended to include non-communicable diseases and their risk factors. This should include developing a more consistent common framework to assess the state of health systems in Member States.
- › *Expand partnerships and integrate them strategically:* The EU should seek and strengthen environmental and health-policy partnerships based on reciprocal cooperation and the clear assumption of responsibility by both sides for common objectives. Such partnerships should be embedded in an overarching foreign-policy strategy with the 2030 Agenda as a clear frame of reference. Weaker partners should be supported in solidarity, especially in the current crisis situation, so that short-term crisis management does not come at the expense of health and sustainability goals.

International funding: overcome barriers

- › *Reduce the debt burden of low-income countries:* Many middle- and low-income countries suffer from a crushing debt burden that severely limits their ability to act. Due to the considerable financing gap for the necessary implementation of multilateral sustainability goals, there should be more discussion on restructuring these debts.

- › *Increase the use of debt swaps as an instrument of development cooperation:* The WBGU recommends making greater use of debt swaps as an instrument, and advocating the international standardization of debt-swap processes. Debt swaps can reduce the high debt burden of low-income countries while promoting the achievement of multilateral sustainability goals. Programme-specific debt swaps (e.g. debt-for-climate swaps) can ensure that the released funds are used for the intended purpose. To ensure widespread use, the processes should take place on a global level, and excessive fragmentation should be avoided.
- › *Create a Finance Facility against Climate Change:* Following the example of the International Finance Facility for Immunization, a programme for front-loading investments with the participation of private investors should also be set up for climate finance.

Increase corporate responsibility

- › *Strengthen the linkage between sustainability standards and indicators and the SDG catalogue in corporate reporting:* Multilateral sustainability goals repeatedly refer to the importance of involving the private sector. To enable companies to better communicate their individual efforts in this regard to the outside world and to report on their willingness, the WBGU recommends defining specific requirements for companies in addition to the existing indicators at the interface between environment and health. Ongoing processes, such as those relating to the European Sustainability Reporting Standards (ESRS), can be used for this purpose and taken into account. Reporting requirements should be developed in such a way that not only direct impacts of corporate activities on the environment and health are addressed but also indirect impacts.
- › *Gear public capital investment more towards sustainability criteria:* This orientation should explicitly involve not only underweighting but also completely withdrawing from investments that do not meet the criteria. Reporting on public capital investments should be made more transparent. Sustainability issues should also be addressed directly in a dialogue with companies in the sense of shareholder engagement.
- › *Make more ESG disclosures compulsory:* More of the existing international (i.e. outside the EU) disclosures of sustainability information in the 'environmental', 'social' and 'governance' fields (ESG for short) on the social and ecological impacts of corporate activity should be made compulsory and replace widespread voluntary implementation. The focus should be on the consideration of dual materiality, especially in the G7 countries. Like financial reporting, non-financial reporting outside the EU should also be subject to scrutiny.

Research recommendations

Urgency governance as a mandate for Germany's Federal Government

- › *Accompany the development and implementation of urgency governance scientifically:* The WBGU recommends accompanying the development and implementation of urgency governance scientifically, in the sense of real-time monitoring.
- › *Scientifically evaluate national implementation of the 2030 Agenda:* The national implementation processes for the 2030 Agenda and the governance structures used for this purpose should be intensively accompanied by scientific research.

Guiding principle and instrument for implementation: the human right to a healthy environment

- › *Explore specific rights-based approaches:* There should be further research into rights-based approaches, such as a human right to a healthy environment or the recognition of nature's own rights. Furthermore, research is needed on how a right to healthy and sustainable living conditions can be defined in terms of content, granted by the state and enforced in court.
- › *Develop forms of cooperative assumption of responsibility:* Ideally, research projects with internationally diverse staffing should study how the cooperative assumption of responsibility can be possible in the current conflict-ridden international politics, where very different interests exist.
- › *Evaluate the increase in complexity of political processes:* The establishment of cross-cutting mechanisms confronts political processes and the individuals designing them with a further increase in complexity in their work processes, which makes corresponding evaluations necessary.

Further development of the WHO as a forum for international cooperation in the spirit of 'healthy living on a healthy planet'

- › *Governance implications of One Health and Planetary Health:* Pandemic cooperation is a key area where the comprehensive implementation of a One Health approach is recommended. It might be a good idea to use this example to further explore governance implications of One Health and Planetary Health, such as how different sectors and levels of work can cooperate better to implement One Health or Planetary Health concepts so as to deliver sustainable pandemic prevention.
- › *Analyse compliance mechanisms for international treaties:* Incentive-based compliance mechanisms for international treaties that can contribute to the

implementation of the IHR and the pandemic treaty but also other international treaties should be further studied.

European Union: research the need for an expansion of responsibilities

- › *Examine areas of EU responsibility and sanctioning mechanisms in the health context:* In the light of experience from the COVID-19 pandemic, there should be research on whether an expansion of explicit EU responsibilities in the health sector beyond the decisions on the implementation of the European Union would have substantial additional benefits. Possible sanctioning mechanisms that could encourage Member States to show more solidarity in the event of a crisis should also be considered.

Analyse international financing barriers more broadly

- › *Evaluate and standardize debt swaps:* A scientific evaluation of existing debt-swap programmes, especially the Global Fund's Debt2Health programme, can help identify best practices. In particular, standardized processes should be identified that avoid a fragmentation of programmes and reduce transaction costs.
- › *Explore options for private participation in debt swaps:* Debt swaps currently take place largely at the inter-governmental level, but there are also substantial debt claims on LMICs in the hands of private investors. In order to encourage them to participate in debt swaps, suitable measures and incentives should be researched and identified so that these investors also use their claims on debtor countries for debt swaps.

Corporate responsibility

- › *Study the possible inclusion of non-financial values in financial reporting and management accounting:* Traditional financial accounting and sustainability reporting have been largely separate until now. Integrated reporting was a first step towards linking the two aspects more closely. However, non-financial risks increasingly affect the financial position of companies and thus become directly relevant to decision-making from a financial perspective. More research is therefore needed on the degree to which companies currently factor non-financial risks, for example as a result of climate change, into their financial accounting and whether provisions are made for them.
- › *Combine corporate indicators for environment and health:* At present, the fields of environment and health are predominantly considered and analysed independently of each other. In order to supplement the reporting of companies in a targeted manner, it is necessary to develop suitable indicators that link

both areas, environment and health, without losing too much information.

- › *Analyse disaggregated reporting of environmental and health determinants:* Environmental indicators are often reported by companies in a highly aggregated manner and summarized in ratings. Disaggregated reporting of environment and health determinants is key, especially for the linkage to health effects. In the field of water pollution, for example, reporting at the level of individual substances is necessary in order to identify health effects. It is then also possible to empirically identify the effect of such risks on the capital market.
- › *Develop a system of early reporting on internal impact chains of environment and health:* Corporate reporting very frequently refers to external environmental factors such as emissions. Internal environmental factors and their influence on employees' health have been scientifically studied less often to date. This is mainly due to the fact that most of the data are only available internally. Usually they do not become available until they are registered in the public health system. Research is also needed into a system of early reporting on internal impact chains of environment and health within companies, using appropriate indicators.
- › *Study the limits of insurability:* Global environmental change is a major challenge for insurance companies in particular. Although initial results on the subsequent effects of these changes on the insurance sector already exist, they are mostly limited to physical environmental risks and not yet to health effects. The WBGU recommends that more research be conducted on how significant the health impacts of global environmental change are on the limits of insurability.
- › *Develop a material obligation for companies beyond formal due-diligence obligations:* At present, corporate environmental and human-rights protection is predominantly based on formal due-diligence requirements. Because of social, health-related and environmental transformational needs, it is necessary, especially in the field of global supply chains and corporate responsibility, to better understand how a proportionate material obligation of companies beyond formal due-diligence obligations might also be designed. To what extent can globally ramified supply chains prevent possible implementation? Where do reporting boundaries exist? When are actors no longer willing to offer information voluntarily? Where are the limits to actual or legal reasonability?
- › *Analyse and evaluate supply-chain due-diligence laws:* Supply-chain due-diligence laws operate between civil and public law and transfer international obligations to protect the environment and human rights to nation states. This could mean opportunities for an

effective integration of the aforementioned duties, but also raise tensions between the different logics of the individual areas and levels of law; this should be the subject of jurisprudential research.

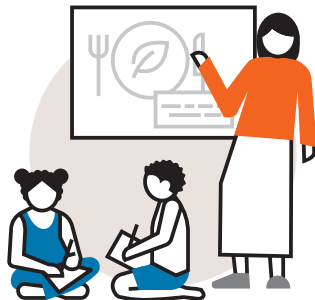
- *Research liability regimes and due-diligence obligations in supply-chain legislation:* Value and supply chains are structured very differently around the world, so that different liability regimes and due-diligence obligations may be appropriate for different sectors and different types of value chains. Research is needed on how supply-chain legislation can adequately address these different organizational structures. How can businesses in socio-ecological transformation processes be supported in such a way that these uncertainties lead to a proactive shaping of transformation processes?
- *Identify uncertainties for companies with regard to due-diligence obligations in the supply chain:* Uncertainties for companies with regard to due diligence in the supply chain can have far-reaching consequences for location and investment decisions. How can due-diligence obligations be prevented from causing the withdrawal of capital from countries that rely on investment for further development, but where compliance with due-diligence obligations is difficult for companies to verify?

2. In the sense of a whole-institution approach, provide opportunities for sustainable action in the educational institutions, and for taking on the role of pioneers of change through cooperation in the community.

In this context, the educational mandate broadly encompasses an understanding and appreciation of important core elements of a healthy and sustainably designed environment. One core element is the conservation and restoration of healthy ecosystems and their typical biodiversity, also as a prerequisite for stabilizing the natural life-support systems for humankind, and for their sustainable use. Another core element is designing the human-made environment in a way that is oriented towards principles of human-health promotion. A third core element comprises the careful and health-promoting use of natural resources and their regeneration to ensure their sustainable availability for generations to come.

This education strategy according to the guiding principle of 'healthy living on a healthy planet' should feed into and give fresh impetus to the existing process of embedding Education for Sustainable Development into all areas of education. To this end, health should be highlighted as an integral and explicit field of action in the concept of Education for Sustainable Development, and education used as a strategy for encouraging healthy and sustainable behaviour in healthy and sustainable conditions (Section 8.1).

Education and science



Education according to the guiding principle of 'healthy living on a healthy planet'

For a reorientation of education under the guiding principle of 'healthy living on a healthy planet', the following two aspects are essential – and participation and transdisciplinarity are important components of both:

1. Promote and facilitate knowledge, perspectives and skills for environmental and human health through-out life.

Recommendations for action

A nationwide education strategy in the sense of the guiding principle of 'healthy living on a healthy planet'

The timely establishment of nationwide strategies from early childhood and school education to further training courses for lifelong learning through Education for Sustainable Development serves to mutually strengthen the health of species, ecosystems and humans. Overarching planetary health literacy, combined with a knowledge and full appreciation of natural life-support systems and ecosystemic and planetary functional relationships, should be included as a goal in existing and future education curricula across all ages and target groups.

Integrate the guiding principle of 'healthy living on a healthy planet' into education across the board

The guiding principle of 'healthy living on a healthy planet' with corresponding educational concepts should be an overarching guiding principle at all educational institutions. Nursery and kindergarten children, pupils and students should be able to practise and reflect on sustainability strategies in their educational institutions, and be ambassadors for the transformation approach in their social and private environments.

- › *Develop interdisciplinary curricula:* Interdisciplinary curricula that encourage basic societal skills in dealing with the natural life-support systems should be developed for all levels of school education. The orientation for this comes from the conservation of natural functional relationships (i.e. the conservation of the health of humans, other species, ecosystems and the planet).
- › *Make further education and training of (teaching) staff possible:* The accelerated implementation of an education strategy under the guiding principle of ‘healthy living on a healthy planet’ requires the compulsory, target-oriented and properly resourced education and training of (teaching) staff in all educational institutions. This includes courses on Education for Sustainable Development including the planetary health perspective, oriented towards the transformation needs of society and the goals of climate, biodiversity and medical health.
- › *Promote interdisciplinarity and bring together different forms of knowledge:* Especially interdisciplinary and socio-politically highly topical learning areas such as Education for Sustainable Development and Planetary Health lend themselves to modularly organized project weeks. Basic and further training for teachers and learners should be set up promptly, initially in the professional fields that are responsible for the current transformation.
- › *Promote the use and further development of training concepts and educational courses:* Already designated further-training concepts on Education for Sustainable Development should be applied in the sense of the guiding principle of ‘healthy living on a healthy planet’. To this end, a funding programme should be developed that enables municipal and civil-society providers of such educational services to further develop their courses in the short term.
- › *Make materials available for disseminating the guiding principle of ‘healthy living on a healthy planet’:* The population on a broad scale should be given the opportunity explore the guiding principle of ‘healthy living on a healthy planet’. To this end, recognized adult-education providers, professional training events and civil-society initiatives should be promptly provided with materials that promote the integration of the guiding principle into their respective work.
- › *Strengthen the whole-institution approach under the guiding principle of ‘healthy living on a healthy planet’:* Educational establishments, companies, organizations and institutions are called upon to adopt a whole-institution approach explicitly incorporating the guiding principle of ‘healthy living on a healthy planet’, so that they also have an impact on the community. Education should also include action on sustainable

catering, infrastructure, professional practice, health for humans and for nature, and participatory governance. In this context, municipalities have a key role to play as partners in these processes.

- › *Promote the European Education Area, expand trans-regional cooperation on education:* Germany should implement the above-mentioned measures of the education strategy. At the same time, the guiding principle of education for ‘healthy living on a healthy planet’ should be made the subject of international discourse in the standardization processes of the EU for harmonizing national education systems, as well as in multilateral forums such as those of UNESCO; efforts should be made to adopt the principle in other nationally organized education systems.

Health professionals as multipliers for the vision of ‘healthy living on a healthy planet’

- › *Expand all forms of training and further training for health workers to include Planetary Health education:* Planetary Health education should be integrated into all forms of training for health professionals in all fields and all disciplines with the explicit aim of strengthening health professionals’ comprehensive competence in Planetary Health, and of training transformative action skills. The relevant target groups include all health professionals.
- › *Acknowledge and promote the relevance of individual occupational groups in communicating the guiding principle of ‘healthy living on a healthy planet’:* Relevant teaching content from the educational concepts of Education for Sustainable Development and Education for Planetary Health should be integrated into the curricula of corresponding study programmes. More training opportunities for health professionals should be made available. The public health service, too, can provide the population with comprehensive health education. Midwives can encourage broad-based Planetary Health literacy among parents since they closely accompany families in a sensitive phase of life. Nutritionists and diabetes counsellors can exert a positive influence on eating habits. Physiotherapists can provide knowledge and skills for active mobility. Nurses should also be trained and further educated in this regard.

Research recommendations

- › *Promote inter- and transdisciplinary research projects:* In view of the rapidly growing urgency of combined crises, inter- and transdisciplinary research projects can develop educational and implementation options on how accelerated action can succeed in the field of comprehensive health protection. For this purpose, relevant disciplines and actors should be brought together

to develop time-optimized strategies for cooperation between different fields of action. In this way, market mechanisms, combined with regulatory measures and legal frameworks, can speed up implementation. Accompanying research should be established or strengthened that examines the implementation and effectiveness of education in the sense of the guiding principle of 'healthy living on a healthy planet'.

- *Promote further research programmes for teacher education:* Follow up the BMBF's expiring programme called 'Quality Offensive in Teacher Training' with a new funding phase for projects on the topic of Education for Sustainable Development that explicitly addresses health in a broadly understood sense according to the principle of 'healthy living on a healthy planet'.
- *Embed sustainability aspects into health research:* Future studies and research projects in the health sector should be expanded to include sustainability aspects. For example, future studies and research projects addressing topics such as nutrition or promoting physical activity primarily from a health perspective should explicitly integrate aspects offering multiple benefits for the environment and sustainable development.
- *Research comprehensive Planetary Health literacy:* Planetary Health literacy among health professionals and other multipliers should be surveyed, increased by targeted measures, and the effectiveness of such measures evaluated. This includes, for example, surveying the status quo of comprehensive Planetary Health literacy among health workers, implementing measures to increase Planetary Health literacy, and studying the effectiveness of such interventions.

Boost context-specific science and science funding

Dealing with environmental and health crises and actively shaping transformation processes for global health and sustainability require science-based and interdisciplinary solutions as well as technological, social and institutional innovations that correspond to the great diversity of application contexts worldwide. As part of transformative knowledge production, it is also important to shape the transnational dialogue processes and structures that are necessary to develop a societal impact across social groups and continents (Section 8.2).

Recommendations for action

Expand the funding landscape internationally and transregionally

- *Also use research funds multilaterally:* Research funds should also be allocated at the multilateral level so that all countries can participate in setting the agenda of research funding; further aims are to expand hitherto underfunded science systems, to promote fair cooperation in the processes of knowledge production, to further develop these in an interdisciplinary way that is oriented to both basic research and applications, and to mobilize private funds. Institutionally, such multilateral research funding would be conceivable via (1) a new committee under the ideational leadership of the UN Secretary-General, (2) UNESCO or (3) a significant strengthening of research funding by individual multilateral organizations such as the WHO.
- *Reinforce regional science policies:* Science-policy priorities that have been jointly negotiated between countries and regions should be deliberately reinforced. Examples include the EU's mission-oriented science policy for major global challenges, transregional funding formats (e.g. Belmont Forum), joint funding lines of the DFG and the science-funding organizations of other countries. In particular, there is a lack of joint funding programmes with science donors from the African continent. With autocratic regimes becoming stronger, cooperation at the level of science and funding policy which simultaneously promotes joint dialogue on the future and its design is highly recommended. One vehicle for long-term capacity building is the promotion of joint research training groups.
- *Research and innovation network relating to the guiding principle of 'healthy living on a healthy planet':* In the medium term, a globally interconnected, regionally integrated research and innovation network should be established to strengthen research capacity and transdisciplinarity in LMICs, and to mobilize and pool research resources in the field of health at the human-environment interface. Such a network should be provided with core funding from public and private donors. This could be modelled on the Consultative Group for International Agricultural Research (CGIAR) and designed as a strategic partnership involving government institutions, development banks, multilateral organizations and private-sector actors, depending on the possibilities.

Improve the positioning of science and innovation systems for dealing with future environmental and health crises

- › *Make ‘healthy living on a healthy planet’ a main topic:* The national and international funding and science landscape should focus on the interdependence of the environment, climate, ecosystems and human health in order to systematically advance relevant research in an inter- and transdisciplinary manner in view of possible future crises. The main topics are currently still characterized by a strong focus on environmental challenges or health risks. Research into the dynamics between them should be intensified.
- › *Establish an interdisciplinary science alliance:* The organizational structure of science in disciplines should be specifically supplemented at the environment-health interfaces by interdisciplinary formats of knowledge production and the promotion of young scientists. For systemic analyses and the development of approaches to action along these interfaces, the structural prerequisites need to be developed at universities and non-university institutions, especially by setting up a science alliance in the sense of the guiding principle of ‘healthy living on a healthy planet’. Based on the example of the German Alliance for Marine Research, mission-oriented research on the environment-health nexus should be promoted in cooperation between universities and non-university institutions as well as the health, natural and social sciences.
- › *Promote interdisciplinary, geographically and culturally broad-based scenario research:* One gap that urgently needs to be filled is scenario research that empirically combines expertise on the health, natural and social sciences and change processes with reference to the past, and examines possible future scenarios on a model basis in the sense of longer-term foresight studies. These scenarios are only reliable and politically usable if they are based on empirical data from different world regions, ecosystems, societal organizational forms and cultural areas. The existing geographically one-sided orientation of research relating to environmental change and human health, especially towards the OECD context, should be resolutely countered.
- › *Expand data infrastructures at the environment-health nexus:* The accelerating dynamics of environmental changes and risks being faced by human health call for preventive research that studies future risks. However, since the future cannot be researched empirically but only theoretically using models, historical depth is all the more important in order to make modelling as realistic as possible. It is therefore of immediate importance to successively develop and expand the existing data infrastructures at the environment-health nexus. This should include strengthening national and sub-national collection systems for data on health and the environment in all countries, establishing data standards, and building a global architecture for data documentation and analysis.
- › *Build transdisciplinary and implementation-relevant network structures:* For the future management of health risks related to environmental and climate change, the WBGU continues to recommend the development of transdisciplinary and implementation-relevant network structures via transdisciplinary, transformative and interdisciplinary science. In this context, it is important that the network structures are internationally open and embedded. Structurally, this can be ensured by expanding existing science-policy interfaces and network structures in the field of sustainability research and policy (e.g. Think7, Think20, SDSN) or via discussion groups with the private sector supported by the German Federal Government (e.g. the BMZ’s Vaccine Production Roundtable).
- › *Strengthen climate-stabilizing transformation processes in science itself:* Science itself contributes to environmental change and health challenges and is called upon to evolve in a climate-stabilizing and health-promoting way. Such approaches can be found as part of the BMBF-funded ‘Sustainability Guidelines (LeNa)’ initiative of the non-university research communities Leibniz, Helmholtz and Fraunhofer, in the DFG’s ‘Contribution to More Sustainability in Research Funding’, and in research focusing on government departments (e.g. Climate Neutral BMZ 2030). These and other initiatives to make science itself more sustainable, less CO₂-intensive and more health-promoting for people and the environment should be structurally promoted and given the financial and personnel resources needed to meet the challenge.

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Glossary

2030 Agenda

The ‘Transforming our World’ declaration adopted by the international community at the United Nations in 2015: the 2030 Agenda for Sustainable Development (Agenda 2030 for short) with its 17 Sustainable Development Goals provides a political orientation framework for global sustainability. The goals of the Agenda are to be achieved by 2030. Ideas are already being floated under the heading ‘post-2030 Agenda’ on future development goals to be agreed for the subsequent period.

Alliance

Compared to a → *club*, a more open, less institutionalized form of issue-specific cooperation between different actors. The criteria for admission to and for leaving an alliance are less static than those of a club and therefore more flexible for new actors to join. Examples of multi-stakeholder alliances (Box 7.3-1) that include not only nation states but also other, mainly private-sector actors, are the Climate and Clean Air Coalition (CCAC) and the Global Alliance for Vaccines and Immunization (Gavi, or the Vaccine Alliance).

Anthropocene

means the ‘age of humankind’ and is partly derived from the concept of geological ages like the Palaeocene or the Holocene. The term was coined in 2000 by Nobel prize winner Paul Crutzen together with Eugene Stoermer and refers to the present geological era in which the impacts of human activities on the environment have reached a global dimension. This leads to – in some cases considerable – changes in → *ecosystems*, even to the extent of their destruction. The most important changes caused by humans include climate change and ozone-layer depletion in the Antarctic (Crutzen and Stoermer, 2000).

Behavioural and structural prevention

If preventive measures (→ *prevention*) aim at people’s individual behaviour (e.g. information campaigns and health education), this is referred to as behavioural prevention. Structural prevention, on the other hand, aims to shape the living conditions and contexts in which people are situated in such a way that risk factors for diseases are minimized and the occurrence of diseases is avoided, mitigated or postponed (e.g. environment-protection measures, occupational health and safety, social standards; Dahlgren and Whitehead, 2007; BMG, 2019).

Biodiversity

or “biological diversity means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic → *ecosystems* and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems” (CBD, 1992: Article 2).

Burden of disease

The burden of disease describes the importance of a disease for the health of a population. It can be calculated using the metric → *disability-adjusted life years* (DALYs). Calculating the burden of disease using a single metric makes it possible to compare the impact of different diseases and the overall burden of disease in different populations. Methodological limitations must be taken into account here (Mazzucco et al., 2021; Gmel and Rehm, 2006). The Global Burden of Disease Study (GBD) regularly calculates the burden of disease of numerous diseases in different populations worldwide (Box 2.2-1).

Change agents

In research into diffusion, innovation and transformation, change agents are actors who are of key importance in initiating and shaping change processes (WBGU, 2011b). Mostly, these are initially individuals and small groups who fulfil various tasks or functions in transformation processes, e.g. the identification of alternatives, their development, investment, optimization, synthesis, dissemination, communication and mediation.

Circular economy

A circular economy is a system of production, distribution and consumption that “maintains the value of products, materials and resources in the economy for as long as possible, and minimises the generation of waste” (EU Commission, 2015). In addition to recovering raw materials or energy from waste – as in early waste-management concepts, e.g. in Germany (UBA, 2020e) – this also includes extending the lifespan of products and their parts, e.g. through corresponding design, repair or alternative use, and reducing the amount of materials and products needed, e.g. through efficient production and shared use (Potting et al., 2017; Kirchherr et al., 2017; European Commission, 2020a). Nature’s contributions to people (→ *Ecosystem services*).

Club

Small, issue- or country-specific group of relevant actors (governmental or non-governmental) that come together on a voluntary basis to pursue common goals. Club membership requires meeting specific criteria and allows access to club assets. Club assets are advantages of the club that make it worthwhile joining. The structure, financing and purpose of the club are by definition not fixed. In economic and financial policy, the Group of Seven (G7) and the Group of Twenty (G20) are particularly worthy of mention.

DALYs

→ *Disability-adjusted life years*

Debt swaps

In a debt swap, a lender – often but not always a state – waives its claim to repayment of a loan that has been granted. In return, the borrowing state agrees to use a predetermined sum to finance a domestic development project (Section 7.5.1).

Defossilization/Decarbonization

The decarbonization of energy systems describes the historically observable trend of transition from high-carbon energy sources (biomass, coal) to less carbon-intensive (oil and gas) and, increasingly, to CO₂-emissions-free energy sources (solar, wind and hydroelectric power). The more modern energy sources often also have higher energy densities, are more universally usable (e.g. electricity), safer, cleaner and more convenient for the end-consumer. Since it is mainly a matter of replacing fossil energy sources or carbon compounds, this is sometimes also referred to as defossilization.

Disability-adjusted life years (DALYs)

The calculation of disability-adjusted life years (DALYs) is a method for determining the → *burden of disease*. It refers to the sum of years of life affected by ill-health or disability (years lived with disability, YLD; their calculation includes, among other things, a weighting factor that takes into account the severity of the disease or disability) and years of life lost due to death (YLL; → *premature mortality*) in a population (Porst et al., 2022; Box 2.2-1).

Disease prevention

→ *Prevention*

Double burden of disease

The double burden of disease refers to the coexistence of → *infectious diseases* and → *non-communicable diseases* in a population. It is particularly relevant in low- and middle-income countries, where there is often both a high burden of disease from infectious diseases and a rising burden of disease from non-communicable diseases (Boutayeb, 2006).

Due diligence

does not entail an obligation to achieve a certain result, but to behave diligently (Beckers, 2021; Bäuml, 2020). It requires exercising the level of care that can be expected. How this ‘expectable’ care is determined depends on the context.

EcoHealth

is an → *integrative and transdisciplinary health concept*. It evolved from the field of ecology and studies the relationship between health, ecosystems, sustainable development and socio-economic stability. The concept aims at the equality and participation of different groups and sectors, often on a regional level and with the involvement of the local population. There is a major focus on biodiversity and ecosystem resilience (Box 3.3-3).

Ecosystem

“A dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit” (CBD, 1992: Article 2).

Ecosystem services

denote the benefits that humans derive from → *ecosystems*. There are 18 ecosystem services, divided into regulatory, material and non-material services (Fig. 2.3-3). A further development of this term is the concept of nature’s contributions to people (NCP), which encompasses “all the contributions, both positive and negative, of living nature (...) to people’s quality of life”, also taking into account the cultural context and the role of indigenous and local knowledge (Díaz et al., 2018).

Epidemic

Epidemic refers to an increase, often sudden, in the number of cases of a disease above what is normally expected in [a specific] population [and] area (CDC, 2012). The term is not applied exclusively to → *infectious diseases*. An epidemic is limited to individual regions, in contrast to a → *pandemic*.

Framework agreement (international law)

A framework agreement is a treaty under international law by which as large a group of states as possible agrees to cooperate on a particular issue; it is most common in international environmental law (Bodansky et al., 2017; Sands et al., 2018: 106). First, general definitions, goals and principles are established in framework conventions; then commitments, such as scientific research, information exchange and cooperation, are agreed, followed by a rough structure for legal and institutional frameworks for future cooperation (Bodansky et al., 2017: 57). Conferences of the Parties provide a forum for the subsequent development of a common legal and policy framework.

GeoHealth

is an → *integrative and transdisciplinary health concept*. It grew out of an initiative from the fields of ecology, earth and space sciences. GeoHealth aims to investigate the drivers of ecological change from the local to the global level in order to mitigate their impact on human health and to enable the human population to make progress in accordance with all ecosystems. It observes the complex interactions of different aspects of the geospheric environment (including water, soils and air) with health and well-being (Box 3.3-3).

Global governance

→ *Governance*

Global Health

refers to health in all countries, with the aim of working together internationally as equals on cross-border determinants of health and health problems that require global solutions. → *Health promotion* and → *disease prevention* are pursued both at the individual and at the population level. The goals of Global Health include social and economic equality and the realization of the human right to health. The approach is interdisciplinary (Box 2.1-2).

Governance

encompasses “structures, processes and actions through which private and public actors interact to address societal goals. This includes formal and informal institutions and the associated norms, rules, laws and procedures for deciding, managing, implementing and monitoring policies and measures at any geographical and political

scale, from global to local” (IPCC, 2022e: 1803). In the context of sustainability, ‘global governance’ means the institutions, actors, control processes and policy instruments that influence international cooperation and obstacles standing in the way of the transformation towards sustainability (Pattberg and Widerberg, 2015).

Green Deal

In December 2019, the European Commission reaffirmed its commitment to addressing climate and environmental challenges with the European Green Deal (European Commission, 2019). This political communication, which includes a roadmap and a timetable of planned policy reforms, was followed by comprehensive policy and legislative packages that fundamentally renew and expand EU environmental law.

Health equity

“Health equity is the absence of unfair, avoidable or remediable differences in health status among population groups defined socially, economically, demographically or geographically” (WHO, 2021q).

Health in All Policies (HiAP)

describes the strategy of embedding health in all policy areas (Köckler and Geene, 2022). The aim is to improve the health of the population and → *health equity* by systematically taking health impacts into account in all policy decisions (WHO 2013c). HiAP aims to ensure that responsibility for → *health promotion* is taken in all policy areas (‘whole-of-government approach’) and that all actors in society are involved in its process (‘whole-of-society approach’; Trojan, 2020). HiAP is described as an opportunity to interlink environmental protection and health promotion more closely (Böhm et al., 2020b; Box 7.1-5).

Health promotion

is defined as “the process enabling people to increase control over, and to improve their health” (WHO, 2021q). It helps strengthen and maintain health and avoid disease. Health promotion was defined in the Ottawa Charter in 1986, and today plays a key role as a guiding health-policy principle of the WHO. The responsibility for health promotion lies with all policy areas (Ottawa Charter, WHO, 1986; → *Health in All Policies*). In contrast to → *disease prevention*, health promotion is based on the concept of → *salutogenesis*.

Health resources

“Resources – in the sense of health resources – are understood as the totality of all health-promoting and health-protecting personal and social, as well as physical and psychological reserves” (→ *Health promotion*; Federal Ministry of Social Affairs, 2023, translated).

Health system

The core tasks of health systems are to protect and improve human health as a basis for both social and economic development and for a life in dignity and prosperity (Declaration of Alma-Ata; WHO, 1978). According to the WHO (2010b), health systems are characterized by six core components: (1) health-service delivery, (2) health workforce, (3) health-information systems, (4) access to essential medicines and technologies, (5) health-systems financing, and (6) leadership and governance. Efficient and stable health systems serve to safeguard the human right to health and are, in addition to healthy living conditions, a prerequisite for → *health equity*.

Healthy Earth

A ‘healthy’ Earth is a metaphor for an Earth with functioning, resilient and efficient ecosystems and a stable climate. Together, these factors form humanity’s natural life-support systems.

Healthy housing

“Healthy housing is shelter that supports a state of complete physical, mental and social well-being. Healthy housing provides a feeling of home, including a sense of belonging, security and privacy. Healthy housing also refers to the physical structure of the dwelling, and the extent to which it enables physical health, including by being structurally sound, by providing shelter from the elements and from excess moisture, and by facilitating comfortable temperatures, adequate sanitation and illumination, sufficient space, safe fuel or connection to electricity, and protection from pollutants, injury hazards, mould and pests” (WHO, 2018e: 2; Box 4.3.2-1).

High-income countries

→ *Low- and middle-income countries*

Infectious diseases

“Infectious diseases are caused by bacteria, viruses, fungi or parasites. Human infection can occur through direct contact (for example, by coughing, touching or sexual intercourse) or indirect contact (for example, by eating contaminated food or [via] vectors such as mosquitoes or ticks)” (BMG, 2023b, translated).

Integrative and transdisciplinary health concepts

The integrative and transdisciplinary health concepts → *One Health*, → *Planetary Health*, → *EcoHealth* and → *GeoHealth* go beyond interdisciplinary health concepts like → *Public Health*, → *International Health* and → *Global Health* and understand human health as being closely intertwined with intact natural life-support systems and the health of other lifeforms and ecosystems. Theoretical concepts, perspectives and approaches from different disciplines and societal actors are integrated to link theoretical science with an action- and target-oriented approach to current problems (Section 3.3.1).

International Health

The field of International Health developed in the course of the 20th century and follows an interdisciplinary and cross-border approach. The focus is on health in low- and middle-income countries, and it looks at infectious diseases, mother and child health and malnutrition, as well as social determinants and the impact of migration on health. International Health is sometimes assigned to the context of classic development cooperation and binational collaborations (Box 2.1-2).

Lifestyle diseases

Lifestyle diseases is a colloquial term used to describe → *non-communicable diseases* whose occurrence is very likely to be related to lifestyles and living conditions that are common in industrialized countries. These include, for example, cardiovascular diseases, obesity and type 2 diabetes mellitus, which are promoted by a lack of exercise and an unhealthy diet, among other factors.

Low- and middle-income countries

The World Bank classifies countries into four income groups, with annual updates based on the previous year’s data (Hamadeh et al., 2022; hereafter data for fiscal year 2023–2024; World Bank, 2023b): low-income countries (gross national income per capita of US\$ 1,135 or less), lower middle-income countries (US\$ 1,136–4,465); upper middle-income countries (US\$ 4,466–13,845), and high-income countries (US\$ 13,846 or higher).

Non-communicable diseases (NCDs)

Heterogeneous group of diseases that are not contagious and mostly occur as chronic conditions. They are the leading cause of death worldwide (WHO, 2020I) and have a range of different causes, with individual behaviour, living conditions and environmental stressors playing an important role. NCDs include cardiovascular diseases, cancers, chronic respiratory diseases, metabolic diseases such as type 2 diabetes mellitus, musculoskeletal diseases and mental illnesses, among others.

One Health

An → *integrative and transdisciplinary health concept* that has influences from veterinary medicine, among other fields, and that, according to current, broader definitions, addresses the health of humans, animals, plants, the environment and ecosystems in the context of anthropogenic environmental changes. In order to deal with health threats, several spatial levels (from local to global) are considered. One Health is described as a practice-oriented approach with a special focus on concrete intersectoral measures to prevent and combat diseases. It explicitly takes animal health into account and emphasizes the importance of maintaining biodiversity (Section 3.3.2.1).

Pandemic

denotes a new, but temporary, major worldwide spread of an → *infectious disease* with a high number of cases and usually also severe courses of disease. In the event of continued human-to-human transmission (e.g. of a novel influenza virus), the World Health Organization may declare a pandemic. The pandemic spread of a severe infectious disease can be a large-scale hazard event that requires the use of crisis- and disaster-management structures (adapted from Kiehl, 2015).

Pathogen sharing

Pathogens are disease-causing agents (e.g. viruses, bacteria, fungi) or chemical substances, such as toxins, which can cause pathological changes in the human organism. The sharing of these pathogens or corresponding (genetic) information between research institutions in different countries is necessary for research into diseases, their prevention and treatment. Pathogen sharing becomes particularly relevant when new or novel pathogens emerge that spread or threaten to spread worldwide.

Planetary guard rails

are quantitatively defined damage thresholds, the transgression of which would entail intolerable consequences today or in the future, so that even great benefits in other areas could not compensate for this damage (WBGU, 2011b: 34), e.g. guard rails for climate change (WBGU, 1995, 1997), soil degradation (WBGU, 2005), ocean acidification (WBGU, 2006), biodiversity loss (WBGU, 2000) and persistent pollutants (WBGU, 2014b).

Planetary Health

is an → *integrative and transdisciplinary health concept*. It is based on a vision “for a planet that nourishes and sustains the diversity of life with which we coexist and on which we depend” (Horton et al., 2014). Planetary Health is regarded as solution-oriented and observes the ecological and societal determinants of health from

a systemic perspective. Equity issues are explicitly taken into account. Planetary Health aims at profound transformations that involve a high diversity of perspectives and actors and are based on a redefinition of the human-nature relationship (Section 3.3.2.2).

Planetary Health Diet

is a nutrition portfolio developed by the EAT-Lancet Commission (Willett et al., 2019) that is consistent with sustaining the natural life-support systems and human health. The Planetary Health Diet (PHD) is flexible in that it provides guidelines for different food groups which together represent optimal nutrition for human health and environmental sustainability. It consists largely of vegetables, fruits, whole grains, legumes, nuts and unsaturated oils, with smaller amounts of animal products and processed foods (Section 4.1).

Premature death

A death that occurs before the deceased person has reached a defined age limit (usually 65, 70 or 75 years; Mazzuco et al., 2021).

Premature mortality

Premature mortality due to a disease can be represented by different metrics, e.g. the number of years of life lost (YLL). One way to calculate these is to multiply the number of deaths at each age by the number of potential life years remaining for that age. To determine the latter, a fixed age limit (e.g. 65, 70 or 75) or specific values for each age or population group can be used. Premature mortality is often standardized to a reference population and usually reported per 100,000 people. It allows the weighting of deaths by age at death and comparisons between different diseases and populations (Mazzuco et al., 2021; Gmel and Rehm, 2006; Gaber and Wildner, 2011; Porst et al., 2022; Wengler et al., 2021).

Prevention

is a strategy for reducing risks and dangers. In environmental and climate policy, it includes taking measures to prevent likely damage whose occurrence is imminent (averting and preventing hazards) – as well as risk prevention, i.e. early action even where there is uncertainty about the time, type and extent of any damage (Box 3.1-1). In health policy, disease prevention refers to “measures to reduce the occurrence of risk factors, prevent the occurrence of disease, to arrest its progress and reduce its consequences once established” (WHO, 2021q). This can be achieved by means of → *behavioural and structural prevention*.

Primary health care

Primary health care (PHC) is seen as a key strategy for achieving → *universal health coverage* (WHO, 2022v). PHC was internationally adopted as a goal in the Declaration of Alma-Ata in 1978 and has since been reinterpreted many times (Section 6.1.2.2). The holistic approach aims at social justice and equal access to health services for all, with a focus on basic medical care, e.g. in GP practices, community health centres or clinics, polyclinics or outpatient departments in hospitals (Hone et al., 2018; Zimmermann, 2021). PHC included for the first time the demand that → *health promotion* must happen within all sectors, which is now referred to as → *Health in All Policies*.

Public Health

is “the science and art of preventing disease, prolonging life and promoting health through organised efforts of society” (Committee of Inquiry into the Future Development of the Public Health Function, 1988). The fundamental objective of Public Health is to make living conditions possible in which people can live healthily. → *Disease prevention* at the population level is a key policy measure and the establishment of social justice in relation to health plays an essential role. The Public-Health approach is interdisciplinary (Box 2.1-2).

Representative Concentration Pathways

Representative Concentration Pathways (RCPs) are scenarios published in the IPCC’s 5th Assessment Report of 2014. They contain exemplary time series of climate-active gases, aerosols and land covers up to 2100, which lead to varying intensities of climate change. The four RCPs – RCP 2.6, RCP 4.5, RCP 6.0 and RCP 8.5 – are named after their radiative forcing values in 2100. Radiative forcing refers to the change in the radiation balance (i.e. downward minus upward radiation energy per area) at the tropopause (boundary layer between the troposphere and the stratosphere) and is a measure of how much the Earth is heating up.

Research

is the systematic search for new knowledge, its documentation and publication (Wikipedia, 2023). Science comprises research, providing policy advice, the promotion of young scientists and teaching.

Resilience

is defined differently in different disciplines and describes a property of biological, ecological, social or technical systems (including individual organisms, groups of organisms and organizations). As a rule, resilience is understood as a measure of the system’s resistance to external influences, i.e. the ability to return to its initial state after disruptions (or at least close to it, without permanent qualitative changes to the system or its state or functions).

Ride hailing

→ *Ride sharing*

Ride pooling

→ *Ride sharing*

Ride sharing

Digital technologies offering improved coordination and control have given new impetus to shared mobility approaches and led to the development of new services. A distinction can be made between services in which vehicles are used jointly but for individual journeys (e.g. scooter, bike, car sharing), and shared or joint transport – either in private car pools (ride sharing, also called car pooling) or commercially using a call bus or shared taxi with flexible times and routes (ride pooling). Taxi rides booked via digital platforms are sometimes referred to as ride hailing (for an overview, see SRU, 2020: 340).

Salutogenesis

denotes a perspective or concept in medicine that concentrates on the factors that protect and promote health – as opposed to pathogenesis, which focuses on the emergence and development of disease. The three key approaches of salutogenesis are the strengthening of resistance resources, of the individual’s sense of coherence and of societal conditions and resources (Section 6.3.2).

Science

→ *Research*

Sedentary behaviour

Sedentary behaviour includes “any waking behaviour characterized by an energy expenditure of ≤ 1.5 metabolic equivalents (METs), while in a sitting, reclining or lying position “ (Tremblay et al., 2017). Working at a desk, driving and watching television are typical examples of sedentary behaviour. In addition to physical inactivity (lack of exercise), long and uninterrupted sitting is considered a risk factor for human health in its own right.

Spillover prevention/Prevention of pathogen spillover

In the context of pandemic governance, this means preventing the spillover of pathogens from animals to humans (and vice versa; Sections 5.1.2.2, 7.2.2.1).

Syndemic

A syndemic denotes the widespread co-occurrence of two or more diseases or disease risks that specifically develop under certain socio-economic (e.g. poverty, lack of education) and ecological (e.g. air pollution, climate change) conditions, interact with each other, potentially reinforce each other, and are partially due to common causes. A syndemic can be widespread worldwide or regionally or socially concentrated.

Transformation(s) towards sustainability

According to the WBGU, a transformation towards sustainability is a comprehensive change towards sustainability involving a restructuring of society and the economy within planetary guard rails in order to avoid irreversible damage to the Earth system and ecosystems and the effects this would have on humanity. The respective scope for action can be shaped in various ways in this context; each society should – depending on the individual country’s specific conditions – develop and follow its own transformation path (WBGU, 2011b: 288; WBGU, 2016b: 540).

Universal health coverage

Universal health coverage (UHC) is an essential objective of global health policies and means that “all people have access to the health services they need, at high quality, when and where they need them, without financial hardship across the life course[...].” (WHO, 2021q). Achieving UHC is one of the sub-targets of the SDGs (SDG 3.8) and includes, among other things, “access to safe, effective, quality and affordable essential medicines and vaccines for all” (UN, 2015; Section 6.1.2.1).

Urban form

denotes the structural-spatial design of cities. It is an essential prerequisite for → *healthy living*.

Zoonoses

are → *infectious diseases* that can be transmitted naturally from animals to humans. They are characterized by an animal reservoir (animals in which the pathogen occurs and reproduces under natural conditions), specific modes of transmission and a defined disease in humans. The pathogens can either be transmitted directly from animals to humans (oral ingestion, inhalation, skin or mucous-membrane contact, animal bite) or indirectly via animal products (especially food) and vectors (mosquitoes, ticks, lice, etc.). Some zoonotic pathogens also have the potential for human-to-human transmission. Zoonoses are of immense importance worldwide (modified according to Alpers et al., 2004).

Healthy living on a healthy planet

“Healthy living on a healthy planet” is a critical and timely synthesis of priority transformations needed in governance, research, planning, and education at all scales, to promote the health and well-being of every individual, today and in the future, while simultaneously healing the damage from and preventing further climate change, biodiversity loss, and pollution. Focusing on health promotion and equity can facilitate rediscovering the intrinsic interconnectedness of all life on earth; and promote effective approaches to increase the resilience and sustainability of people and nature.”

Prof Dr Kristie L. Ebi, Center for Health and the Global Environment (CHanGE)
University of Washington, USA

It is becoming increasingly urgent to promote an integrated view of the close link between the environment and global health. We can no longer afford to think and treat these policy areas, which are central to our future, separately. The WBGU flagship report comes at the right time and offers real added value – on the one hand through a clear analyses of the challenges and on the other hand through concrete proposals for rethinking global health governance. Now it is time to act.

Prof Dr Ilona Kickbusch, Director, Digital Transformations for Health Lab, University of Geneva;
Founder, Global Health Centre, Graduate Institute, Geneva; Chair, World Health Summit



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ISBN 978-3-946830-08-5

