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Viewpoint

Water in a Heated World

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■ THE INCREASE IN THE INTENSITY OF EXTREME EVENTS AFFECTING WATER AVAILABILITY AND QUALITY: TIME FOR ACTION

The impacts of climate change, population growth, and overexploitation of water resources are becoming increasingly evident worldwide in the loss of ecosystem services, changes to precipitation patterns, prolonged droughts with record heat waves, glacier mass loss, degraded water quality with increasing water-related health risks, declining groundwater recharge rates, and altered runoff regimes in surface waters.[1] The German Advisory Council on Global Change (WBGU) in its new flagship report entitled "Water in a heated world" comes to the conclusion that the frequency, magnitude, and duration of extreme events are increasing with impacts more frequently beyond the spectrum of human experience, escalating into "regional water emergencies".[2] These threats are by no means limited to certain water-stressed regions but can be observed more widely representing a pattern with a planetary dimension, resulting in increasing loss of life and limb, increasing long-term adverse effects on human health (e.g., heat stress and psychological impairment), affecting large ecosystems and their biodiversity, and resulting in major economic losses. For these new and drastically accelerated changes, the WBGU speaks of these changes as threatening situations in which the limits of controllability are exceeded, social structures and ecosystems are substantially destabilized, and the scope for action no longer exists.

Drastic changes in water availability will threaten the existence of entire ecosystems and at least compromise ecosystem services. The need for irrigation in agriculture and forestry will increase. Prolonged droughts in the summer months can increase pressure on local groundwater resources with increasing drinking water consumption and increasing irrigation requirements for urban greenery. Persistent low water discharges of streams and rivers with significant inputs of municipal wastewater result in additional pressures on the affected ecosystems but also pose growing challenges for energy production (cooling water), navigation, and recreation. Earlier warming in a year is also accompanied by an earlier onset of the growing season with corresponding water requirements of the ecosystems and greater evaporation. Under these conditions, soil moisture also changes earlier, which can adversely affect not only the availability of water for vegetation but also the infiltration capacity of the soil for natural groundwater recharge. Similarly, the demand for cooling water for industry and commerce and the energy sector will also increase. The public water supply will also have to make adjustments due to higher peak water consumption during heat waves and prolonged dry periods, for which the existing distribution networks are frequently not designed.

Extreme events such as prolonged droughts, large-scale flooding, and extreme flash floods cannot be avoided, nor can their effects be completely controlled. To avoid large-scale and disruptive changes in water availability due to climate change and excessive use of water resources, pollution, and degradation of natural systems, the WBGU recommends the maintenance of a proper distance to the limits of controllability. Traditional mitigation strategies and methods, however, are insufficient to cope with these challenges. The natural water cycle has been substantially altered by anthropogenic activities and is increasingly getting out of hand. Forecasting the variability of natural systems based on empirical observations within a defined time period (i.e., stationarity) as the basis for design and operation of water infrastructure systems is becoming less certain. Nonstationarity is the new normal, which requires revised strategies of water management and constant recalibration of their local adaptability. If transformative measures no longer help, it is also advised that regions at risk prepare a plan B at an early stage. Where necessary, an orderly and timely retreat (e.g., no resettlement in flooding areas, abandoning established agricultural practices, retreat from affected coastlines, etc.) may be the last resort. Social negotiation processes must focus on which risks are considered intolerable and which individual adaptation paths should be taken or are even feasible locally.

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To largely maintain adaptability to these changes, there is no alternative to limiting climate change at 1.5 °C global warming and even reversing it in the long term.[1] To keep a safe distance from the limits of controllability due to the effects of climate change and to avoid regional water emergencies on a planetary scale, all countries are required to step up to these challenges by not only better forecasting extreme events and minimizing the associated risks as much as possible but also integrating water management into national climate policy, such as nationally determined contributions (NDCs) and national adaptation plans (NAPs).[3] Given the transboundary nature of water and climate challenges, these efforts need to be leveraged by regional and international cooperation.

Water is not only the messenger delivering the bad news of climate change but also an enabler of climate mitigation! This is evident by the fact that the water agenda has now been firmly embedded in UN Climate Change Conferences (COPs) with several major accomplishments and agreements in the recent past, including the establishment of the UN Secretary-General's Special Envoy on Water and the most lately Declaration on Water for Climate Action at the COP29 to enable the implementation of these actions.[4] This declaration resolves to (1) promote water dialogues and partnerships among countries, (2) strengthen the generation of scientific evidence on the causes and impacts of climate change on water resources and water-related ecosystems, and (3) enhance water-related climate policy actions. However, questions about how these requirements can be met and translated into specific action remain.

■ MANAGING WATER IN TIMES OF GROWING UNCERTAINTY AND INCREASING RISKS

In lieu of the new quality of risks and growing uncertainties regarding the availability of water resources and water-related impacts of climate change, as well as the large number of sectors affected, water must be treated as a cross-cutting issue. Therefore, both rapid and long-term adaptation and water balancing measures to these changing boundary conditions are urgently required to ensure sustainable management of water resources for future generations and ecosystems providing increased resilience to both. The WBGU proposes very specific principles and actions at the local, regional, and international scale.[2]

■ KEY PRINCIPLES FOR A CLIMATE-RESILIENT AND SOCIALLY BALANCED WATER MANAGEMENT

The WBGU recommends a climate-resilient and socially balanced water management worldwide, in which infrastructure and management approaches adapt to changes in local water budgets and an increasing number of extreme events and which is based on democratically negotiated goals, principles, and rules on tolerable risks and a sustainable scope of adaptation measures. This climate-resilient management is based on seven key principles:

(1) Ensure water as a common good for people and nature. Water must be distributed and stored as a global, life-giving common good according to the needs of all people and nature. Nature-based, technical, and institutional solutions for ensuring a resilient water supply must take into account and balance the multifunctionality for humans and ecosystems.

(2) Increase adaptability in the face of continuous change. Administrations, operators, and users must adapt to a new way of dealing with nonstationarity, high dynamics, resilience, and risk prevention. Systems for the provision and use of water should be kept resilient in the face of previously unknown fluctuations and ongoing changes that cannot be precisely predicted and should be readjusted on the basis of science. To achieve this, structures as well as planning and decision-making processes must be designed to be adaptable and correctable across all stakeholders.

(3) Resilience and risk prevention instead of hazard prevention. Risk prevention and risk minimization must be the basis of planning processes, even where hazard prevention has previously been the main focus, and must be geared toward resilience and preparedness. Planning that is based on a comprehensive risk characterization and on the basis of which risks are managed appropriately in order to deal with increasing aggravations and with uncertainties in the construction or adaptation of water infrastructures is required. Limits to adaptability must be recognized and avoided to maintain controllability.

(4) Managing blue and green water across sectors. Blue and green water must be considered and managed together and across sectors in regional and local solutions. Both have strategic, geopolitical relevance. In addition to river catchment areas, transboundary evaporation and precipitation patterns must also be taken into account. At the regional level, active management of green water can have a stabilizing effect on the natural water balance and biodiversity by (re)establishing a climate-resilient landscape water balance and water-conscious urban development.

(5) Enable science-based discourse on problems and options for action. The WBGU recommends the initiation of a science-based discourse on strategy development and options for action, taking into account the concerns of citizens and stakeholders. Scientists should continuously inform policymakers and take on an advisory role, e.g., by scientifically monitoring the efficacy of mitigation measures. Political and social participation, education, and cooperation should be promoted.

(6) Valuing water and appreciating its value. The value of blue and green water resources for people and nature as well as the scale of water-related risks must be recorded and made transparent for politicians and the public as well as companies and investors. Scarcities and risks should be taken into account in both short-term use and long-term investment decisions; uses should be prioritized, and efficiency improvements should be promoted. In addition, public and private investment decisions should take into account, increasing the risks of damage and loss of value ("stranded assets"), especially in the case of long-term infrastructure.

(7) Accelerate implementation and encourage and promote self-organization. The regulatory framework and all water management instruments must enable accelerated implementation and involve informal, decentralized governance structures where appropriate. In particular, nonstate, self-organized actors need to be involved and strengthened.

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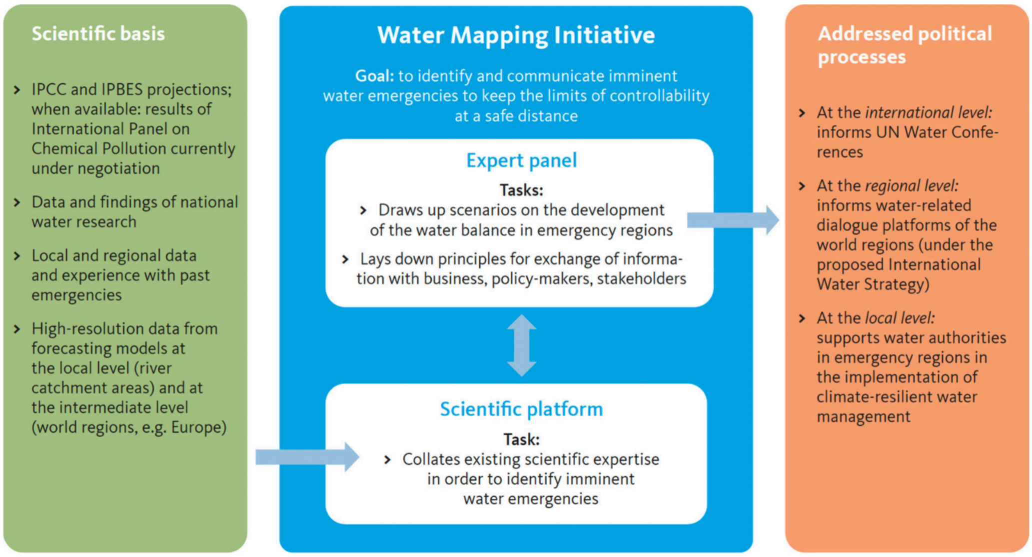

Figure 1. WBGU proposal for an international water mapping initiative as a stepping stone toward a climate-resilient water management.

COMPREHENSIVE MANAGEMENT REQUIREMENTS FOR CLIMATE-RESILIENT WATER MANAGEMENT

The WBGU recommends further the establishment of a new approach to water management that aims to acknowledge uncertainties in planning and to minimize them where possible. The WBGU therefore proposes four requirements for the design and management of water resources that should be taken into account when developing, selecting, combining, and implementing measures for a climate-resilient, socially balanced water management.

1. Assess water-related efficacy on different time scales. The efficacy of measures should be assessed first with regard to specific water-related objectives and second with regard to their contribution to the restoration of a climate-resilient landscape water balance and water-conscious urban development. In lieu of exacerbated water-related challenges, different time horizons (i.e., present and 2050 and beyond), uncertainties and impact delays, and adaptation limits must be taken into account when assessing water-related efficacy. For example, large infrastructure measures (such as the construction of new dams or long-distance water conveyance pipelines) that will become effective in only ≥20 years may no longer be fully effective if boundary conditions change.
2. Analyze feasibility in the respective context. The feasibility of measures should be assessed on a context-specific basis, taking into account the availability of water, technologies, financial resources, institutional capacities, their acceptance, and their space and resource requirements, also with regard to their long-term operation and their possible need for adaptation over time. The need for specific knowledge, financial resources, and technical equipment varies considerably between different measures and locations, in terms of both the initial investment required and the longer-term effort required to maintain functionality and, if necessary, adapt to new developments.
3. Greater focus on possible multiple benefits. Measures should be designed to be multifunctional where possible. Possible multiple benefits for climate and biodiversity protection as well as health, social, and economic advantages of measures and the reduction of inequalities should be anticipated, evaluated, and taken into account in the assessment of measures.
4. Avoid unintended consequences. To avoid maladaptation and other unintended water-related, environmental, health, social, and economic consequences, all impacts of measures should be identified, evaluated, and considered using a systemic and transdisciplinary approach wherever possible. This can result in conflicts of objectives and interests that need to be identified and overcome.

MANAGING AND MAINTAINING WATER QUALITY

Due to the close interdependency between water quantity and quality as well as the protection of human and ecosystem health, the protection of water quality is of utmost importance. The WBGU suggests four central building blocks to maintain water quality: (a) consistent implementation of the zero-emissions strategy, including preventive strategies as a precondition for climate-resilient water management, (b) contemporary test procedures and methods for chemical assessment that can better detect persistent and water-soluble pollutants, (c) integrated approaches for the recovery of raw materials from wastewater (e.g., nutrients, biopolymers, inorganic salts, biogas, and heat), and (d) the flexible development and expansion of centralized and decentralized climate-resilient urban water and sanitary infrastructure in middle and low-income countries.

DEVELOPMENT AND IMPLEMENTATION OF A CLIMATE-RESILIENT WATER GOVERNANCE

The WBGU recommends developing an International Water Strategy as a new incentive for water diplomacy, which can strengthen the international water negotiations and serve as a platform for corresponding scientific cooperation that informs policy-making. Governance of blue and green water could, for example, include information, consultation, and approval obligations for projects and extensive land-use changes that have a significant impact on transboundary atmospheric water transport. It should endeavor to better interlink existing water conventions with other international water-related treaties. To

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improve the transfer of scientific findings on water into policy, the WBGU advocates the establishment and internationally shared planning and implementation of a "water mapping initiative" (Figure 1). This initiative should consist of two units: a science platform and an expert panel. The science platform should bring together existing scientific expertise to identify impending regional water emergencies. The expert panel steers the platform and feeds the results of its work into political processes.

To recognize and limit water emergencies at an early stage and develop plans for dealing with them, global data and monitoring capacities need to be merged. This includes the IPCC and IPBES projections, long-term data series, monitoring and observation data from national monitoring organizations, and the results of regional and national research projects. Furthermore, the platform should integrate data and experience gathered in past emergencies, the results of national and supra-regional water research, and local data and experience of emergencies. This should be supplemented by high-resolution spatial and temporal data from observations and forecasting models at the local (river catchment areas), regional, national, international, and global level.

In this respect, coordination and cooperation across policy areas, regions, and governance levels are of central importance. The earlier action is taken, the more options exist to establish a proactive climate-resilient water management.

The article is largely based on the report "Water in a heated world".[2]

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Notes

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