# INTRODUCTION

The coastal region can be considered as the land that influences the ocean and the ocean that influences the land. It is in this broad sense that we have interpreted the term ‘coastal zone’. Before the Land-Ocean Interaction Study (LOIS), the coastal zone had been largely overlooked as a focus for a major research programme. Previously, and for sound practical reasons, the coast has tended to be a boundary between different kinds of research, rather than a focus. Thus the Natural Environment Research Council's (NERC's) LOIS became the first of a number of national (e.g. LOIRA - Land-Ocean Interactions in the Russian Arctic) and international (e.g. ELOISE - European Land-Ocean Interaction Studies) programmes that aimed to understand processes through, in and across the coastal region.

LOIS has been the largest Thematic Programme ever undertaken by the NERC. It has involved much of the UK's coastal science community in NERC institutes and universities in a co-ordinated programme over 6 years (1992-1998) (**Fact Box 1**).

Historically, LOIS is the sequel to the North Sea Project (1987-1992) and its original aim was to quantify inputs from estuaries and to understand better the boundary conditions along the landward edge of the coastal water models, in particular the North Sea Model. It was a small and logical step, therefore, to extend this objective to include gaining an improved understanding of the processes along a deep ocean boundary. Hence the **LOIS study areas** came to comprise the UK East Coast between Berwick-on-Tweed and Great Yarmouth, and the shelf edge to the west of the Hebrides. The principal focus of effort in the East Coast study area has been the Humber estuary and the catchments of the rivers that flow into it, in particular the rivers Ouse and Trent. Off the Humber estuary, the estuarine plume has been a focus of effort, while the Holderness coast has been the subject of major experiments to study coastal erosion, sediment inputs to coastal waters and their subsequent transport. Similarly, inside the estuary at Skeffling, experiments in the intertidal zone have quantified some of those factors that determine the erosion and deposition of sediments on the seashore.

Having briefly set the scene, you are now free either to stay here and delve more deeply into the LOIS Programme through words and images, or to access the data assembled by the SES programme.

# LOIS ORGANISATION

Some information on the organisation of LOIS is necessary in order to appreciate the results, although it is not the purpose of this CD-ROM to set out in detail the structure of the programme. LOIS has been organised primarily around geographically focused components, for example rivers and estuaries, with work carried out by multi-disciplinary teams. However, some work such as the study of Holocene geology and atmospheric chemistry has been conducted within the conventional scientific disciplines. These components, and those who led them, are listed in **Fact Box 2**, by which component committee memberships and component objectives may be accessed. Since a principal objective of LOIS has been to consider the coastal environment in a more geographically integrated and cross-disciplinary manner than before, we have chosen themes (**Fact Box 3**) for the Overview CD-ROM that cut across the organisational structure of LOIS.

# LOIS OBJECTIVES

Underlying the overall objectives of LOIS (**Fact Box 4**) is an approach that needs further explanation. LOIS is a programme that has been directed at measuring, understanding and simulating processes, from the cycling and fate of agricultural nutrients to the transport and deposition of sediments. It has not been our aim to describe the state of the coastal system so much as the rates of the processes within it and through it (**Fact Box 4 Objective 1**). Since we recognise that many of the materials passing through the coastal zone originate on land, a necessary prerequisite for flux estimation and modelling has been the creation of databases of determinands measured using the same analytical techniques across the whole programme. We have thus endeavoured to harmonise, so far as possible, the rivers data, the results from the Humber Flux Curtain, and the cruise data from *Challenger* with the information from **CASI imagery,** the shelf edge and atmospheric studies.

It was recognised that to estimate fluxes and budgets for the passage of materials into, within and out of the coastal zone, it was important to incorporate fluxes that occur during intermittent events; the high winds and heavy rainfall, which cause rivers to run in spate, and storms and high tides which occur at sea. These infrequent events which happen over less than 5% of the time may cause 90% and more of the flux of materials. Hence, capturing data for such events for **rivers** and **coastal waters** was vital to the estimation of overall fluxes and budgets.

Atmospheric chemistry has been an integral part of the LOIS programme with the principal objective of determining fluxes between the atmosphere and the sea (**Fact Box 4 Objective 1**). The chemistry of atmospheric reactions during day and night has been studied in intensive field experiments using the **Weybourne Atmospheric Laboratory** and a downwind sampling point on a **research vessel offshore** to establish rates of chemical reactions and degradation in the marine boundary layer.

While it was intended to characterise those geochemical processes that govern morphodynamic processes and ecosystem behaviour (**Fact Box 4 Objective 2**), an underlying aim has been to determine the extent to which biological processes are important in driving the geochemistry, for example, the extent to which the benthic invertebrate fauna may contribute to sedimentation rates (biodeposition), or to sediment turnover (bioturbation) and sediment cohesiveness. Such data are important for simulating the exchange of sediments with the seabed and seashore. The focus of this work has been in the Littoral Investigation of Sediment Properties project (LISP); a field and experimental study within LOIS.

Sedimentation related to saltmarshes has been the focus of the **Biological Influences On interTidal Areas** project (BIOTA), which has determined

deposition and erosion related to different saltmarsh plant communities, not only because they are a long-term sink for sediments, but because accurate sedimentation rates are necessary to judge the efficacy of soft sea defences to the threat of rising sea level.

While most of the LOIS programme has been directed to contemporary processes, a geological perspective (**Fact Box 4 Objective 3**) is essential to understand the evolution of coastal morphology and how it is likely to change in response to climatic pressures, particularly those related to trends in the global climate and sea level rise. To reliably predict risks of flooding in the UK, sea level change must be integrated with changes in land level. Risks of flooding may be enhanced or reduced regionally depending on isostatic changes in land level. The **Land-Ocean Evolution Perspective Study** (LOEPS) has carried out a major campaign to take new onshore, littoral and offshore boreholes of Holocene sediments. This, allied to new luminescence dating techniques (**Fact Box 5 Product 5**), is helping to improve the interpretation of cores and our understanding of the development of the UK East Coast over the last 10,000 years.

Numerical model development features in each of the components of LOIS and exemplary output of individual models will be given on one of the other CDs. However, the overall objective has been to develop models that can be coupled, so as to simulate the flux of materials from the catchment into the river, from the river into the estuary and so on (**Fact Box 4 Objective 4** and **Fact Box 5 Product 3**), and how those materials are transformed along the way.

Linking the modelling products of LOIS in this way is inevitably the final stage in the programme. Due to delays at the start of the programme and limiting resources, completion of work necessary to meet Objective 4 (**Fact Box 4 Objective 4** and **Fact Box 5 Product 3**) will be carried out during an extension to LOIS of 2 years running from 1998 - 2000. Coupled model output will be released on a Modelling CD-ROM (**Fact Box 6**) at the conclusion of this extension. It is therefore possible to demonstrate only some aspects of the modelling on the Overview CD-ROM. It is important to appreciate that the intention from the outset has been that such pre-operational models should be used to explore 50-100 year scenarios.

# LOIS THEMES

A principal objective of LOIS has been to understand how materials move into, out of and within the coastal zone. A related aim has been to foster an holistic approach that brings together and links the separate river, estuary, coastal water, deep sea and atmospheric models. Therefore, in selecting the data to include on the Overview CD-ROM, we have adopted themes that cut across the traditional scientific and geographical structure of the LOIS programme and reflect our progress in integrating our knowledge of coastal processes. These themes are:

**Nutrients**

**Sediments**

**Micro-organic contaminants**

**Trace metals**

**Air-sea interface**

**Integration over time**

**Intertidal (saltmarshes)**

**Chlorophyll and phytoplankton**

**Physico-chemical determinands**

**Model output**

# LOIS PRODUCTS

As the great majority of materials, particularly the sediments, are transported from the catchment and within the coastal region (**Fact Box 4 Objective 1**) by relatively rare events, for example, when rivers are in spate or there are high winds and storms in coastal waters, emphasis has been given to designing robust sensors and instrument platforms (**Fact Box 5 Product 5**). They are capable of monitoring continuously in order to quantify the fluxes during such events, for which there have been few data. Some of these instruments were developed within a NERC Thematic Programme called SIDAL - Sensor and Instrument Development for Autosub and LOIS which ran from 1992 to 1996.

LOIS made a commitment at the outset to the use of airborne remote sensing and CASI - the **Compact Airborne Spectrographic Imager**, as they offered the opportunity to capture large amounts of data for key determinands for dynamic coastal systems synoptically (sediments, chlorophyll, plant communities). While the data over water relate to the surface layers alone, the unsuspected degree of spatial variability in rivers and estuaries has provided new insights for those developing models.

Using the NERC aircraft, CASI has been flown extensively during LOIS, covering large areas in the study area to test and validate algorithms with sea and ground truth data from ships and moored instruments. Flightlines were routinely flown over the Humber catchment and estuary, the Holderness coast, the Tweed estuary and saltmarsh BIOTA sites. Due to delays in developing the Integrated Data System for CASI, most LOIS CASI data will become available to the community during the Integrated Modelling phase of LOIS to meet Objective 4.

While LOIS was of necessity a site specific study, aiming to provide the landward boundary conditions for the North Sea model, the intention has been that the scientific understanding, the technologies, models and information systems would be generic and portable to other sites and circumstances. Its bold aims and scope, formulated 8-10 years ago, had a vision that has been emulated by other programmes and has lent much to coastal programmes around the world through IGBP LOICZ, ELOISE, LOIRA and others. From the outset and throughout the programme, we have shared freely our thinking and plans. By way of this CD-ROM, and others in the LOIS family of CDs, we share our data, the new insights we have won and other products of our research.

# THE LOIS CD-ROM FAMILY

The Overview was the first CD-ROM of a series and provides examples of what LOIS has achieved over 6 years, 1992-98. Subsequent CDs are dedicated to single components of LOIS and will be released at intervals throughout 1999 (**Fact Box 6**), although the last, which will provide examples of coupled model output and 50 -100 year scenarios (**Fact Box 4 Objective 4**), will not be released until Summer 2000.

The purpose of the LOIS CDs is to make data gathered for LOIS available to future scientists and ensure the long-term security of this unique dataset by disseminating it as widely as possible. However, the Overview CD-ROM has a different structure and broader purpose than the Component CDs. It contains an introduction to the LOIS programme, examples of data, particularly for those determinands that trace the movement of material through the coastal zone, and a Viewer with which to examine the data in context.

An important aim of the Overview CD-ROM is to show that it is now technically and logistically possible to bring together, within a single database, all the data acquired by a large multidisciplinary study such as LOIS and hence facilitate the study of problems that cross all the traditional scientific boundaries. However, the assembly of data in this way, although a considerable achievement in its own right, is not the whole answer. For the data to be useful, the datasets emanating from the different Components must be harmonised. Units, terminologies and, most importantly, methods have to be matched. To achieve this across hundreds of variables of many different disciplines has been a challenge. The surface of the problem has barely been scratched and the CD-ROM reveals as much about what remains to be done as what has been achieved.

Although the assembly of data is the main and major task of the DATA Component, the development of advanced data management software is also part of its mission. During LOIS, DATA has worked on prototypes for a new 4D database, generic data load software, attribute dictionary editors and the user interface for the database. The Overview CD-ROM Viewer is the end product of this work and is the first prototype for the new system. The word ‘Viewer’ has been used intentionally. At this stage its objective is purely to allow users to browse and look at data. Later, resources permitting, it is the intention that a whole range of querying and analytical facilities be added. However, it is hoped that it demonstrates, how, in a completely generic way, the spatial and temporal variation of almost any attribute describing any object can be recorded and retrieved. Again, the CD-ROM will probably demonstrate how much there is yet to learn about the construction of multidisciplinary database systems.

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