

# Joint LOICZ – Institute for Coastal Research Conference

## Linkages between German Coastal Research and LOICZ

Working groups  
Background documents

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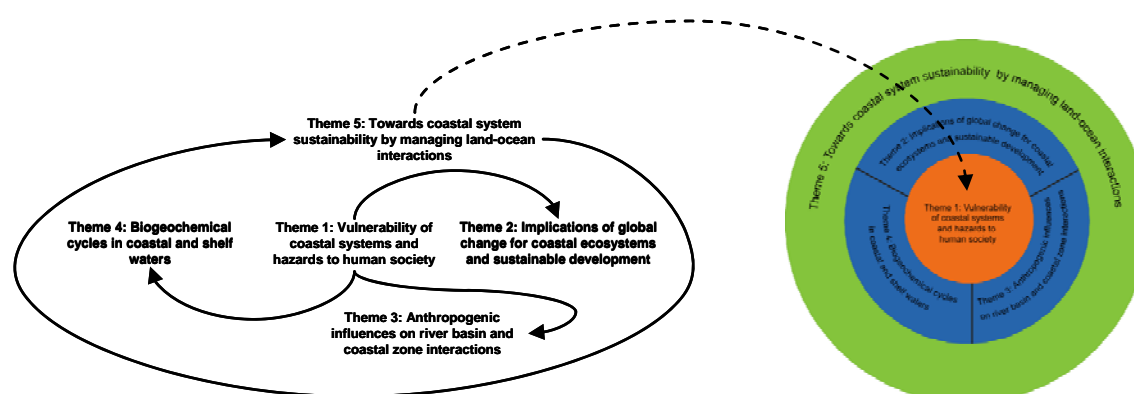
## Introduction

The Land-Ocean Interactions in the Coastal Zone (LOICZ) project is a core project of IGBP, with a task to integrate land, ocean and atmospheric sciences, and a core project of IHDP, with a task of integrating human dimensions science of coastal zones, relating to global environmental change (GEC). To achieve this suite of tasks LOICZ seeks to promote, facilitate and engage with two aspects of GEC science:

1. Fundamental research that addresses key issues of coastal change and use in the context of future scenarios of human activity and environmental state change, and
2. Applied research that synthesises and up-scales scientific measurements both for dissemination within the scientific community and outreach of research outcomes into 'science – policy – public' fora.

The LOICZ project is organised around five scientific themes (Fig.1) that assembles research activities from diverse sources in innovative ways to develop improved understanding that integrates coupled biogeochemical, physical and human dimensions of coastal change. All themes have three common challenges:

- i. Up-scaling of regional science results for global science and policy/ management agencies and, similarly, down scaling to make available global science results to regional stakeholders and managers;
- ii. understanding the interaction between impacts of local or regional versus global drivers and pressures; and
- iii. combining natural and social sciences and stakeholders to understand and contribute to solutions for sustainable use of the river basin-coast-shelf continuum.



**Figure 1.** Diagram illustrating the LOICZ cycle of science where Theme 1 develops the science agenda and challenges that informs the coastal issue science needs and gaps to be addressed by the traditional biogeochemical sciences of LOICZ of Themes 2,3 and 4. Theme 5 captures the science outputs and explores how they address and contribute solutions to the issues identified in Theme 1. A new level of comprehension and knowledge modifies understanding of Theme 1 and begins a further iteration of the LOICZ cycle of science interest.

## The 5 research themes of LOICZ

**Theme 1:** *Vulnerability of coastal systems and hazards to human society* sets the stage for the subsequent themes that address the wider coastal domain. It addresses the hazards to humans from coupled human and ecological system change, carrying capacities and vulnerability issues including the risk of degrading sustainability of coastal goods and services delivery under different scenarios of change. Key issues include:

- The effect of non-linearities and uncertainties on vulnerability of coastal societies and ecosystems to global change hazards in the coastal zone.
- Community's stakes in the coastal zone including resources, goods and services.
- Exogenous and internal factors of human and coastal vulnerability.

**Theme 2: *Implications of global change for coastal ecosystems and sustainable development*** focuses on conflicting spatial, temporal, and organisational issues of coastal change, land and sea use, how these exert pressures on coastal systems and influence natural resources availability and natural systems sustainability. Key issues include:

- Nature and location of different boundaries of coastal environmental and social systems, and their tapestry of interactions.
- Assessment of systems sensitivity and robustness that show critical thresholds for changes to the biogeochemical and/or hydrological cycle that lead to permanent state changes.
- Quantifying human impacts on coastal units through natural science and ecological economic indicators, including valuation methods.
- Identifying options to design and manage system robustness through a scenario approach that considers critical thresholds and loads as well as sustainability.
- Evaluating the effects of changing inputs on ecosystem health, goods and services of the coastal zone including the link between biological functioning, geochemistry and human drivers.

**Theme 3: *Anthropogenic influences on river basin and coastal zone interactions*** addresses river catchment-based drivers/pressures that influence and change the coastal domain. The whole water cascade (source to sea) is considered as a single system. Transport processes across the ocean boundary and anthropogenic influences through activities in the Exclusive Economic Zone (EEZ) are included in particular through links with theme 2 and 4. Key issues include:

- Disentangling the cause-effect relationships of those impacts and human activities which are strictly coast or river basin-oriented (regional) from those derived from much wider external pressures on the river-coast system.
- Modelling coupled human/natural systems in river basins using the Driver-Pressure-State-Impact-Response (DPSIR) approach and assessment framework to identify links between major anthropogenic and natural pressures in river catchments affecting coastal ecosystems.
- Scenarios of coastal change to elaborate future state changes and impacts on systems from pressures such as different land use and climate change patterns, response (management) options.
- An evaluation of societal and institutional dimensions and changes in order to establish basin-coastline linkages.

**Theme 4: *Biogeochemical cycles of coastal and shelf waters*** focuses on budgeting methodologies to describe the cycling of carbon, nutrients and sediments in coastal and shelf waters and their exchange with the ocean. This recognises that coastal waters are the locality for vital benthic processes influencing shelf ecosystems and global chemical cycles, and that processes here are changing. Key issues include:

- Quantifying transport of materials within and across the continental shelf, transformation of materials within the water column and sediments, storage of materials in the coastal zone and air-sea exchange.
- Assessing regional differences and why some shelf waters are more resilient or resistant to change than others.
- Defining the landward boundary condition for nutrient fluxes through better integration of river basin information, sediment dynamics, and organic loading and inputs.

- Developing regional budgets and flux estimates for shelf and coastal waters in order to understand and predict the impacts of global and basin scale changes in ocean climate and biogeochemical cycles.

**Theme 5: *Towards coastal system sustainability by managing land-ocean interactions*** provides an overarching integration cutting across the four other themes. It is expected to serve as a platform addressing the development of the coastal zone and management of its resources, thus the people using them, in the context of strong and weak sustainability options. Key issues include:

- Considering how temporal and spatial scales, including institutional dimensions, affect scientific and management perspectives of coastal change.
- Classifying and comparing different settings of drivers/pressures in coastal system state interactions and existing responses by applying typology approaches.
- Linking natural, economic and human dimension sciences into ‘futures’ scenarios.
- Management response options and participation derived from ‘futures’ scenarios that integrate policy/management /investment communities into their assessment and development.

### ***LOICZ niche and scientific priorities***

The broad scientific frame given by the LOICZ Science Plan (SPIS) articulates the breadth and diversity of issues and problems that exist in the coastal zone for which society looks to science to provide solutions. To help facilitate the implementation of LOICZ, and make it a meaningful innovative contribution to global change and human dimensions science, the project has focused on three key topics to which all of the themes outlined in the Science Plan are pertinent. Each topic forms a cohesive science question that can run within and between the themes and have been identified to provide the near to mid-term scientific frame in which LOICZ aims to be value adding to individual research projects as well as to broader scale initiatives and organisations.

LOICZ will engage in these topic areas through the following operational mechanisms:

- i. Clustering existing or proposed scientific research activities on local, national regional and global scale primarily through the network of affiliated projects (affiliation to the LOICZ portfolio will largely be done along the five themes as listed in the SPIS).
- ii. Designing and implementing targeted or open scientific workshops and congresses to work on a specific question or a subset of those along the LOICZ scientific priorities.
- iii. Designing and promoting targeted LOICZ research activities.
- iv. Encouraging and promoting as well as co sponsoring, scientific synthesis.
- v. Dissemination, and communication, capacity building and training.

### **The topics**

#### ***Topic 1: What are the implications of ecological and economic change for patterns of land and sea use?***

This topic encapsulates much of the content of Themes 1, 2 and 5 of the LOICZ science plan. The ecosystem approach (underlying ‘ecosystem based management’) regards humans to be an integral part of current natural systems. There are large numbers of deterministic and stochastic models that examine various facets of the natural environment, and similarly large numbers of models dealing with human social systems. However, there have been very few attempts to couple them together into a single socio-ecological system that consider the system to consist of an assemblage of interdependent life forms – including humans – and

their non-living habitats and resource base, the integrity of which is highly dependent upon human decisions.

A number of conceptual models have been employed to describe coupled socio-ecological systems, but such an interrelated and interdependent system poses a major challenge to the modeller who is always forced into making some assumptions in order to understand the system. This leads to models with a large range of complexity, from the huge mechanistic models used by many natural scientists to the probabilistic formulations employed to describe human decision making (e.g. game theory) or “market mechanisms”. It is the difference between the approaches taken by humans observing nature and humans observing humans that make it difficult to model socio-ecological systems.

Work within this topic will focus on:

*Conceptual modelling* - LOICZ will explore how models can incorporate dynamic interpretations of data and source empirical data to populate models.

*Quantitative models* - Mechanistic or stochastic models operate at various different scales and levels of complexity and this topic will explore how scale affects system properties requirements for data as well as mixed methodology approaches to accommodate the entire scale of systems.

*Scenario-building and decision support models* - One of the most exciting challenges for system models is to gain insights on the likely future state of the marine environment through their application in various economic and social scenarios.

The objective of the topic is to gain insights on the likely future state of the marine environment in various economic and social scenarios.

### ***Topic 2: What are the effects of changes to the flow of freshwater and materials to estuaries and shelf seas?***

This topic encapsulates much of the content of themes 3 and 4 of the LOICZ science plan,

1. Examining the changes in loads associated with human activities in coastal watersheds as well as other human-induced effects, and
2. examining the response of coastal and shelf ecosystems to these changes.

To the extent that we can extend or develop LOICZ approaches to apply to coastal governance, activities under this topic will also address theme 5 of the LOICZ science plan.

Runoff, groundwater flows, nutrient and sediment loads are all affected by human activity and especially human induced changes in climate and land use. These may be addressed using a variety of relatively simple analytical tools, including nutrient accounting approaches and large-scale hydrologically based models. Several activities are proposed to extend existing approaches either geographically or methodologically, to permit estimation of nutrient loads, their uncertainty and variation.

The response of coastal and shelf systems has been addressed in LOICZ I by estimating the metabolism of coastal and shelf ecosystems using the LOICZ budget methodology. This methodology will be refined and extended under LOICZ II, and specifically in an attempt to address issues of coastal sustainability and governance. The use of additional modelling approaches will be evaluated to determine whether such approaches are more appropriate to address particular coastal management questions.

### ***Topic 3: How can comparative analysis inform the improvement of the governance of human activities in changing coastal ecosystems?***

This question integrates across the five themes of the LOICZ Science Program. It addresses the primary goal of LOICZ II: “to provide knowledge, understanding and prediction to allow coastal communities to assess, anticipate and respond to the interaction of global change and local pressures in determining coastal change”. A coastal community is defined to include

policy makers, managers and stakeholders. The term “coastal ecosystems” embraces large marine ecosystems (LMEs), coasts and their associated watersheds.

The approach will be to select sites for an analysis of success factors in bridging between ecosystem science and governance. The analysis will focus upon successes and failures in instigating the changes in human behaviour (institutions, markets and civil society) that mark the implementation of a coastal ecosystem management initiative. In all cases the analysis will examine coastal governance within the context of the next larger system – a watershed, a Large Marine Ecosystem or geographic region. The analysis will address three central questions:

1. How are overviews of ecosystem condition being developed and trends being communicated?
2. How can coastal ecosystem governance initiatives affect the behaviour of societies more effectively?
3. What are the resulting outcomes and how can we improve upon them?

### **Workshop Terms of reference**

The aims of the day are to explore the ways of integration and collaboration between the community of German Coastal Researchers and the global LOICZ project and the morning has provided opportunity to hear a sample of the range of science that is currently, or recently, being undertaken. The afternoon provides an opportunity to explore in more depth how this science can contribute to the LOICZ project, and, importantly, how the LOICZ project can provide support and “added value” to coastal GEC science in Germany. Therefore the workshops should aim to address and report back on the following:

1. To what extent does coastal GEC research in Germany align with the structure and goals of LOICZ science?
2. To what extent are the themes and topics of LOICZ relevant to science-public-policy dialogue in Germany?
3. What are the bottlenecks and barriers to furthering research interests that are of mutual benefit to both the German science community and LOICZ and how could we work together to address these?