

Joint LOICZ – Institute for Coastal Research Conference

Linkages between German Coastal Research and LOICZ

Abstracts
Participants list

14 June 2006
GKSS Geesthacht



Programme

9:00 - 9:20	Opening	J. Krohn, F. Colijn, J. Pacyna
9:20 - 10:40	Presentations	H. Kremer A. Moll, Ifm Hamburg Review of three-dimensional ecological modeling of the North Sea shelf system G. Liebezeit, Terramare Wilhelmshaven & K. Wirtz, GKSS Geesthacht Research Group „BioGeoChemistry of Tidal Flats“ Inorganic Nutrients – Inputs, Outputs and Budgets H.-J. Brumsack, ICBM Oldenburg Research Group “BioGeoChemistry of Tidal Flats”: Some thoughts about the coastal “bioreactor” P. Overduin, AWI Potsdam Arctic Coastal Dynamics F. Colijn, GKSS Geesthacht Automated Measuring System for Monitoring of Coastal Waters: Synthesis of results of the EU funded FerryBox project R. Doerffer, GKSS Geesthacht Application of Envisatdata for coastal areas F. Buchholz, AWI Helgoland Long-Term Ecological Research at the North Sea islands of Helgoland and Sylt R. Asmus, AWI List Coastal Perspective from polar to tropical regions
10:40 – 11:00	Coffee break	
11:00 - 12:30	Presentations	H. Kremer G. Schernewski, IOW Warnemünde Implications of climate, economic and social changes for the Oder/Odra estuary H. Sterr, Uni Kiel Sea-level Rise and Coasts at Risk R. Weisse, GKSS Geesthacht Wind waves & storm surges: Recent and potential future changes B. von Bodungen, IOW Warnemünde Coastal – Ocean system approach within the Baltic Sea Research Institute Warnemünde

Presentations

H. Kremer

K. Emeis, Uni Hamburg
The nitrogen cycle in the Elbe River-North Sea System:
Present and Past

M. Glaser, ZMT Bremen
A transdisciplinary approach to sustainable coastal management
in North Brazil

A. Kannen, FTZ Büsum
Sea use change in the German North Sea: Assessment and
implications for planning and management

D. Bray, GKSS Geesthacht
Coastal M&Ms: Putting Coastal Research into ICZM

12:30 - 13:50 Lunch break

13:50 – 14:30 Introduction Topics M. Le Tissier, H. Kremer

14:30 – 14:45 Coffee break

14:45 – 16:50 Parallel working groups

A. Gilbert
Topic 1: What are the implications of ecological and
economic change for patterns of land and sea use?

D. Swaney
Topic 2: What are the effects of changes to the flow of
freshwater and materials to estuaries and shelf seas?

S. Olsen
Topic 3: How can comparative analysis inform the
Improvement of the governance of human activities in
changing coastal ecosystems?

16:50 - 17:00 Break

17:00 - 18:00 Plenary J. Pacyna

18:00 - 19:30 Reception

Abstracts

Review of three-dimensional ecological model validation related to the North Sea shelf system

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The aim of this review is to provide an overview about the status of validation of eleven models of the greater North Sea area (COHERENS, CSM-NZB, DCM-NZB, DYMONNS, ECOHAM, ELISE, ERSEM, FYFY, GHER, NORWECOM, POLCOMS-ERSEM), of which half of them have a three-dimensional space resolution and some new models that are in preparation. The review shows that important findings by model simulations have either confirmed existing knowledge derived from field work or have given new insight into the mechanisms of the functioning of the North Sea system. The validation exercises reported show that several of the models were able to reproduce observations of the state variables correctly in the order of magnitude. The evaluation of the validity of the model simulations were performed according to the different spatial and temporal scales sorted by: regional distribution, annual cycles and long-term development at stations.

Research Group „BioGeoChemistry of Tidal Flats“: Inorganic Nutrients – Inputs, Outputs and Budgets

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Inorganic nutrients such as ammonia, nitrate, phosphate and silicate are key compounds in the formation and degradation of organic matter in aquatic systems. Thus, a detailed knowledge of their sources and sinks as well as their biologically controlled reaction kinetics is desirable. In tidal flat systems of the Wadden Sea, southern North Sea, a number of sources can be identified including land input both via tide gates and atmosphere and sediments via advective and diffusive transport. Sinks encompass the coastal North Sea and the atmosphere via e.g. denitrification.

Despite the availability of long-term data sets these are beset with a number of shortcomings: Sources and sinks are not adequately taken into account, e.g. atmospheric inputs are largely neglected. Sampling time scales usually do not take short-term, e.g. tidal variability, into account. Thus, attempts to establish nutrient budgets in these highly dynamic systems miss significant parts of the processes involved.

In order to overcome these deficiencies the research group „BioGeoChemistry of Tidal Flats“ has established various sampling approaches in the backbarrier tidal area of Spiekeroog Island, East Frisian Wadden Sea. Results will be presented and future research foci discussed.

Research Group "BioGeoChemistry of Tidal Flats": Some thoughts about the coastal "bioreactor"

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Backbarrier tidal flats are very dynamic systems, whose mode of operation and impact on coastal nutrient and trace element budgets may only be understood by an integrated multidisciplinary approach. One of the major requirements is the availability of long time-series of physical, chemical, and biological parameters at key locations. Within the framework of the Research Group "BioGeoChemistry of Tidal Flats", which was established in 2001 by the German Research Foundation, a permanent autonomous time-series station was set up in the tidal inlet between Langeoog and Spiekeroog islands in the Southern North Sea. The station is equipped with a suite of sensors allowing on-line monitoring of physical, chemical, and biological parameters. Parallel to this whole year round data acquisition chemical and microbiological parameters besides the aggregation state of water column particles are investigated during several one-week cruises. Furthermore pore water chemistry is monitored in sand flats on a monthly basis through permanent pore water lances, which allow sampling of uncontaminated waters from down to five meters depth. These lances are equipped with temperature and pressure sensors for estimating advective flow. The plankton bloom-associated particle formation, microbe-induced aggregation, and mechanical/biological incorporation into porous sand flats serves as a pulsed trigger for catabolic processes. This seasonally changing microbial activity in the coastal bioreactor is reflected in chemical water column properties.

Arctic Coastal Dynamics

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Global and regional climate change significantly affects physical processes, biodiversity and socio-economic development in the Arctic coastal regions. In response, Arctic coastal changes feedback in to the global system via the material flux generated by the eroding coasts and the release of greenhouse gases from degrading coastal permafrost. Instigated in 1999 by the International Permafrost Association (IPA), Arctic Coastal Dynamics (ACD) is a LOICZ-IGBP and an IASC project. Now in its second round of support by IASC, ACD is co-chaired by Paul Overduin and Nicole Couture at the Alfred-Wegener-Institute, Potsdam, Germany and McGill University, Montreal, Canada, respectively. An international steering committee provides leadership and continuity, and working groups serve to focus efforts on permafrost in onshore/offshore transition, human dimensions of change, environmental forcing and development and refinement of geographic information.

Over its six-year history, the project has brought together a international community of researchers focussed on coastal processes and environmental forcing along permafrost-affected coastlines. The Arctic coastline has been segmented and classified based on geomorphological criteria. This classification has resulted in a GIS database used to estimate total sediment and carbon fluxes into the Arctic Ocean. The second phase of ACD begins with a workshop in the fall of 2006. This year's workshop will result in monitoring templates for coastal observatories being established as part of the International Polar Year's (2007-2009) Arctic Circumpolar Coastal Observatories Network, using an interdisciplinary approach to observing change. This effort is aligned with the recent Second International Conference on Arctic Research Planning, which resulted in a Science Plan for the next 10 years of Arctic coastal research.

Automated Measuring System for Monitoring of Coastal Waters: Synthesis of results of the EU funded FerryBox project

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Within the EU funded project FerryBox during a three year period 9 Ferries in European waters were used to make on-line observations of standard oceanographic parameters (water temperature, salinity, turbidity, chlorophyll-a fluorescence). On selected ferries additional observations were made with an ADCP, with nutrient sensors, pH, or oxygen sensors. A few trials were made with a flowcytometer and with a FRRF. Results of the measurements will be presented. Apart from the in situ observations data were combined with remote sensed data from the ENVISAT satellite, to obtain information about the scale of observed phenomena such as the extension of algal blooms. Several efforts were undertaken to use the operational data as input to ecosystem oriented models as well as for water transport models.

The strength of the system is that detailed environmental information for coastal and offshore waters became available without the need of expensive ship time of research vessels. Therefore the FerryBox system has been proven to be an cost-effective alternative for regular monitoring of water quality in coastal areas. However, also scientific applications were made to study the extension of eutrophication phenomena, upwelling, and long distance effects of river inflows. By using the ADCP estimates of sediment transports in a tidal inlet could be made. Examples of the different applications will be presented. FerryBox has been adopted as a pilot project for GOOS.

Application of Envisat-Data for coastal areas

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Since March 2002 the environmental satellite ENVISAT, which is operated by the European Space Agency ESA, is observing the earth. With a size of 10 meters, a weight of 8 tons and 10 scientific instruments it is one of the most ambitious earth observation missions ever. Four of its instruments are used for oceanographic and partly coastal research: the Advanced Synthetic Aperture Radar ASAR, the Advanced Across Track Scanning Radiometer AATSR, the Radar Altimeter RA-2 and the Medium Resolution Imaging Spectrometer MERIS.

In this talk I will present background information about MERIS, which is beside ASAR the most interesting instruments for coastal applications and the procedures used to evaluate its data. With a spatial resolution of 300 m, a revisit period of 2-3 days and 15 spectral bands in the visible and near infrared spectral range it provides information mainly about the distribution of phytoplankton, suspended matter and coloured dissolved organic matter. But also information about land vegetation can be derived. Furthermore, inherent optical variables as scattering and absorption and the light attenuation can be determined. However, the retrieval of these variables and the atmospheric correction is a difficult task particularly for coastal waters and not always successful. Thus the flags describing possible uncertainties have to be carefully taken into account. Brief information about access to the data and the software to use the data will complete the presentation.

Long-Term Ecological Research at the North Sea islands of Helgoland and Sylt

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The Biologische Anstalt Helgoland was founded in 1892 on Helgoland and extended in 1924 to include a “littoral station” on the island of Sylt. Ever since, researchers have used the proximity to the sea to observe on a regular basis changes in the marine environment. At present several time series are conducted ranging from hydrography to macrobenthos. Recently, a few series have been added. At present, an increasing interest in marine biodiversity and its long-term change can be observed. The long research tradition at our stations offers a great opportunity for documenting changes in the marine environment. In this presentation, an overview of long-term research activities at the Alfred-Wegener-Institute including the stations at Helgoland and Sylt will be given and recent highlights of our investigations will be presented.

Coastal perspective from polar to tropical regions

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Coastal ecosystems of all geographical zones are very susceptible to Global Change. The mainly biological (physiological as well as ecological) coastal research at the AWI focuses on the North Sea and Wadden Sea in addition to the competence of the AWI in polar research. The AWI also conducts a number of comparative studies in different temperate and even in tropical areas. The coastal research of the AWI addresses the effects on pelagic and benthic ecosystems of: climate change, by pollution and eutrophication, invasive species, changes and destruction of habitats, and the causes and effects of harmful algae blooms. The approach lies in a combination of laboratory- and field experiments with long term observations. Beside a general introduction to the coastal research at the AWI, some examples from the main AWI coastal research activities will be given, especially concerning the sensitivity of coupled benthic-pelagic processes in North Sea and Wadden Sea with some perspectives to polar and tropical regions.

Implications of climate, economic and social changes for the Oder/Odra estuary

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The Odra (German: Oder) estuary is located on the southern Baltic Sea and consists of the shallow Szczecin (Oder-) Lagoon and the Pomeranian Bay. The entire estuary is dominated by the discharge of the River Odra (Oder) into the lagoon. With its length of 854 km and basin area of 120,000 km², the Odra is one of the most important rivers in the Baltic region. Between 1980 and 1999, the annual average Odra discharge was 17 km³ (530 m³ s⁻¹) and contributes at least 94 % to the lagoon's water budget. The Odra river carries high loads of nitrogen and phosphorus and causes severe and ongoing eutrophication of the coastal waters.

Climate and changes in land use have strong and multiple effects on water quality in the estuary system. We can distinguish external and internal effects. Climate change effects in the river basin and result in altered water discharge and nutrient loads in the Oder river. For example, the strong reduction in nutrient loads and nutrient concentrations in the lagoon, observed in the early 1990s, was largely an effect of warm and dry years. But the estuary is directly effected by climate, as well. An example is the internal eutrophication process: A thermal stratification in the water column and oxygen depletion above the sediment can

develop during warm and calm summer periods. Model-based estimates indicate an anoxic P-release from sediments of up to 10 $\mu\text{mol P m}^{-3}\text{d}^{-1}$ or up to 400-600 t P for the entire Lagoon during a few weeks.

However, even more important are the changes in riverine nutrient loads due to social and economic changes in the river basins.

Sea-level Rise and Coasts at Risk

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The disasters caused in 2004 by the tsunami in Southeast Asia (over 200.000 deaths) and by hurricanes in the Gulf of Mexico region last summer (>175 billion € damage) have shown the high vulnerability of coastal regions, their societies, economies and ecosystems. Climate change and sea level rise will exacerbate coastal risks dramatically in upcoming years and decades. In particular, flooding of lowlands, erosion of soft-rock coastlines and saltwater intrusion into ground water and soils will be massive impacts to be dealt within the context of coastal risk management. These hazards necessitate new & innovative methodologies for the analysis, modeling and management of present and future risk.

The coastal geography group at Kiel University has looked at coastal vulnerability in Germany (North Sea and Baltic Sea) and Latin America (Brazil, Argentina) at various levels of scale and detail. Its work is aimed at developing a quantitative and model-based multi-hazard risk assessment tool in order to

- identify possible hotspots of risk in basically vulnerable coastal regions,
- quantify potential damage versus economic benefits of response options, and
- improve the feasibility of decision-making processes in risk mitigation in the presence of considerable uncertainty.

This approach requires the combination of existing (sectoral) tools and models into a composite vulnerability assessment, which encompasses geologic, ecologic, economic and social risk parameters. Therefore, a close cooperation with coastal geoscientists, economists and social scientists is crucial. Such cooperation is envisioned within the framework of the proposed *FUTURE OCEAN “cluster of excellence”* at Kiel. Based on this we hope to develop a comprehensive instrument for assists risk mitigation and management as well as for long-term coastal-zone planning. Such an instrument, e.g. an integrative Decision-Support-System, has recently been demanded by major (re-) insurance companies and political bodies (UN Early Warning Conference, Bonn, March 2006).

Wind waves & storm surges: Recent and potential future changes

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Storms represent a major environmental threat. They are associated with abundant rainfall and excessive wind force. Wind storms cause different types of damages on land and on sea; on land, houses and other constructions may be damaged; also trees may break in larger numbers in forests. At sea, wind pushes water masses towards the coasts, where the water levels may become dangerously high, overwhelm coastal defense and inundate low-lying coastal areas; also the surface of the sea is affected - wind waves are created, which eventually transform into swell. Obviously, ocean waves represent a major threat for shipping, off-shore activities and coastal defense.

We review activities at the Institute for Coastal Research to assess past and potential future changes of the wind, wave and storm surge climate. The analysis is based on a consistent series of high-resolution multi-decadal hindcasts and climate change scenarios for the

atmosphere, ocean waves and storm surges. In addition, observed and reconstructed storm indices are considered. It is first shown that the met-ocean hindcasts reasonably describe the observed conditions, in particular the statistics of extreme events. It is further demonstrated that the storm activity as well as related changes in ocean wave and storm surge statistics have undergone considerable variations in the recent past but exhibit no clear trend. From the climate change scenario runs climate change signals for wind, waves and storm surges are determined and assessed against the long-term variability estimated from the hindcasts. In addition, uncertainties caused by the application of different models as well as different climate change scenarios are quantified. For storm surges, rather similar climate change patterns that exceed the variability estimated from the hindcasts were identified among all models and scenarios. For the sea state, the uncertainties caused by the application of different models are of the same order of magnitude as the signals themselves. Although the method has been applied here to assess regional climate change projections for the North Sea it may be applied in a similar way to other regions as well. Some examples for further application of this data set (coastDat) are provided.

Coastal – Ocean system approach within the Baltic Sea Research Institute Warnemünde

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Overarching goal from 2002 to 2012:

Develop predictive capacity for the reaction of the Baltic Sea to changes in both the natural and the human system

- with the respective tools for meeting the specificities needed for the Baltic Sea but to be also applied to other coastal seas
- encompassing spatial scales from bights to basins and temporal scales from decades, centuries to millenia (Litorina-Period)

An interdisciplinary research programme (2002 to 2012) serves to formulate activities and projects both from institutional and third party funding:

comprising investigations on :

- external forcing by climate change/variability
- external forcing by changes in land-use and by increasing seaward extension of use of marine space
- internal ecosystem responses, rates and regulations
- strategies for data collection, data management and models.

The major components of the system approach are:

- the identification of spatial and temporal scales of changes in distribution patterns of physical, chemical, sedimentological and biological properties and processes in the pelagial and benthic – by means of long-term data collections, time series measurements and proxy – development
- analysis of the relations between external forcing and internal response – during field campaigns, in laboratories and simulation experiments in mesocosms
- the description of causal coherences on the respective spatial and temporal scales through models.

Research is implemented through 3 foci:

- Transport and Transformation Processes in the Sea
- Marine Communities and Matter Cycles
- Changing Marine Ecosystems-External Influence and Internal Change

and through 2 cross-cutting activities:

- Modelling
- Marine Instrumentation.

According to the *mission statement of the Wissenschaftsgemeinschaft Leibniz* our research is also directed towards providing a sound scientific background for societal efforts with regard to appropriate assessments of the environmental state of the Baltic Sea, protection of the environment, mitigation measures and management of the resources.

Respective transfer is concentrated in the cross-cutting activity:

Coastal Seas and Society.

The nitrogen cycle in the Elbe River-North Sea System: Present and Past

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Reducing the eutrophication of estuaries and the coastal North and Baltic Seas is a major goal of national and international environmental policy. The North Sea that has a watershed populated by 164 million inhabitants who caused a tripling of nutrient loads since the 1950's. Reacting to rising nutrient discharges and expected environmental deterioration, countries bordering the North Sea in 1985 agreed to reduce nutrient discharges by 50% of discharges to re-establish a status approaching that of the pristine North Sea, assumed as 1960's. A major scientific challenge is to define that pristine status, and to determine background nutrient concentrations before the advent of both serious eutrophication and scientific measurements.

Our prime objective in an ongoing project is to determine the modern contribution of riverine and atmospheric sources to the reactive nitrogen pool the North Sea, and to reconstruct the history of that input for the time since 1850 AD. To do this we

- 1) Trace the signature of isotopically distinct riverine dissolved inorganic nitrogen (DIN) input in the Elbe-German Bight-North Sea system by analysing the stable isotope ratios of nitrogen in surface sediments, and of reactive nitrogen in North Sea water of variable salinity, in river water and in precipitation.
- 2) Analyse the isotope ratios in dated (210-Pb) sediment cores of the Elbe River estuary and suitable accumulation areas in the German Bight (e.g., Süderelbe, Helgoländer Loch).
- 3) Reconcile mass-balances from a numerical 3D ecosystem model (augmented with an isotope module) with isotopic balances for the present day and the past, assuming published river reactive nitrogen discharge under pristine conditions. Spatial gradients and absolute ¹⁵N levels modelled for a pristine German Bight must match levels found in cores and old sediment samples sample archives.

A transdisciplinary approach to sustainable coastal management in North Brazil

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The presentation summarizes the development over time of the interdisciplinary Brazilian-German research programme Mangrove Dynamics and Management (MADAM) which operated on the coast of the North Brazilian state of Pará from 1996 until late 2005. It is shown how the research proceeded in three consecutive phases (I Human-nature interactions in mangrove areas; II Major issues in mangrove management; III Research and public policies in mangrove management) and how an explicit focus on social-ecological linkages between mangroves and people evolved over time. Some critical social-ecological linkages and dynamics associated with the key resources and keystone species of the mangrove ecosystem are briefly presented and major sustainability implications of prevalent dynamics are identified. The final part presents an analysis of the coastal co-management experiment RESEX in Brazilian mangrove areas and shows how transdisciplinary tools and approaches are being used to steer social-ecological development into desirable directions.

Sea use change in the German North Sea: Assessment and implications for planning and management

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Using the German North Sea coast and large scale development plans for offshore wind farms as examples for changing use patterns, the presentation will describe the assessment approach used in the BMBF funded project “Zukunft Kueste – Coastal Futures”. This approach examines a range of different scenarios or pathways for future development of the German North Sea region in order to frame potentially associated changes in marine use patterns and their implications for the ecological, economic and social subsystems of the coast.

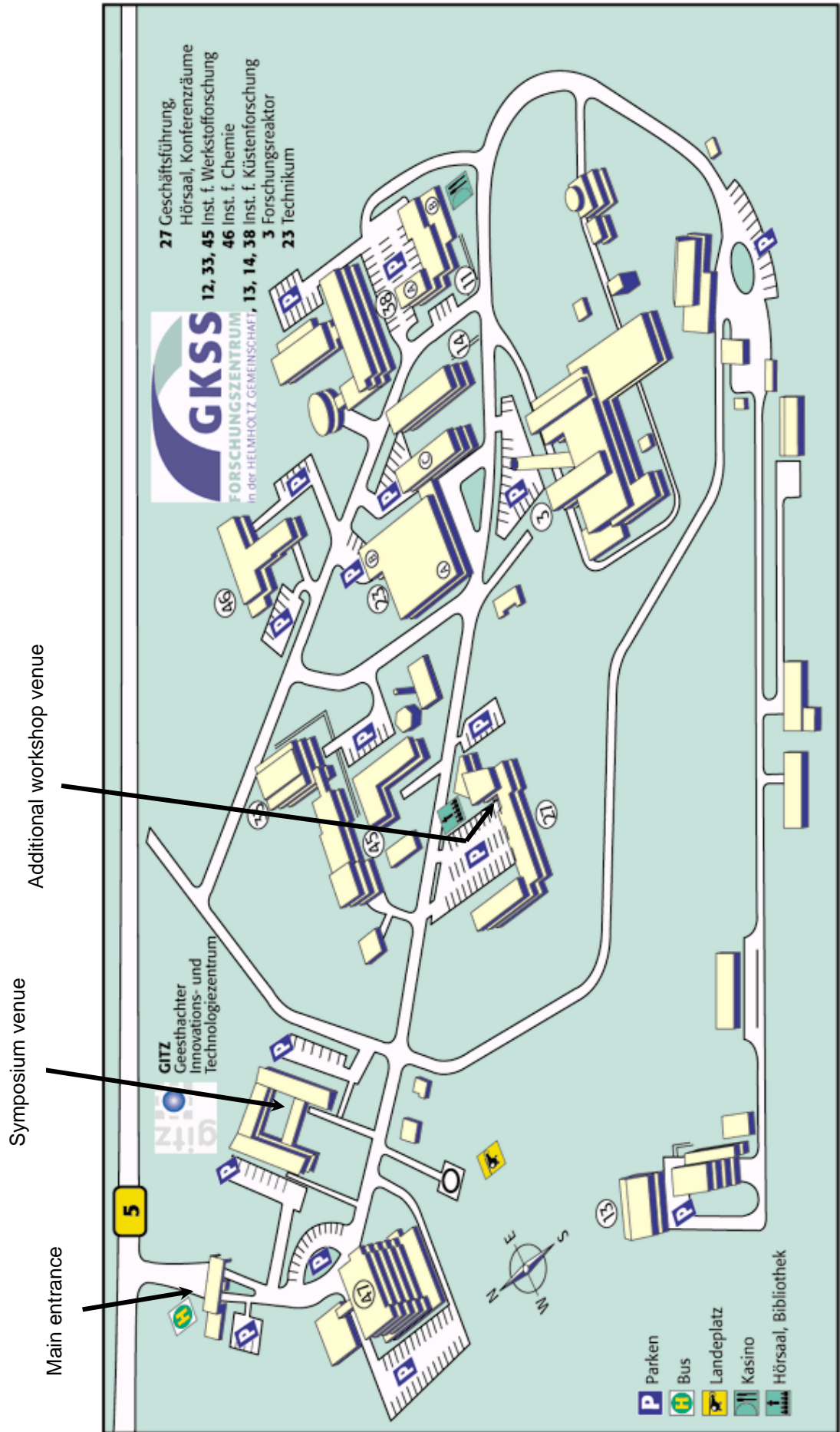
Out of this, a first set of implications for coastal planning and governance, especially concerning interactions between stakeholders at different scales will be derived. These will be discussed in relation to the need for a multiple use concept aiming to achieve an “optimum mix” of several demands in the German North Sea area, which forms one of the guiding principles for marine area spatial planning and the national ICZM strategy in Germany.

Coastal M&Ms: Putting Coastal Research into ICZM

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This talk explores the potential of using dynamic simulation modeling for integrating coastal research, both from the natural sciences and from the social sciences, into coastal management decision support tools. The talk begins with the assumption that it is the role of science to provide aids for management (i.e. decision support systems) and that management itself is beyond the scope of science, as management typically implies a normative component. After a brief description of management, attention will be turned towards the importance of identifying mechanisms that shape the future of coastal regions (hence emphasizing the need for interdisciplinary co-operation). Rather than discussing empirical examples of mechanisms the discussion is of mechanisms as a conceptual tool for understanding coastal change. Subsequently, attention will be turned towards supplying decision makers (management) with useable knowledge in the form of user operable decision support models. This is in the form of a dynamics simulation model of the mechanisms with the ability for the user (management) to input various scenarios which are ultimately of the design of the decision maker. A brief demonstration of a simplified model will be presented.

Venue Map



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