News of the German Coastal Engineering Research Council

KFKI aktuell

KRING 2013 in Germany

One of the most well-known Associations concerned with coastal engineering, namely the Dutch "Kring van Zeewerende Ingenieurs" (KRING), will stage its annual meeting on the west coast of Schleswig-Holstein from 22 to 24 September 2013. Traditionally, German coastal engineers are also warmly invited to participate in this meeting.

KRING was founded by Dutch coastal engineers in 1954 in response to the devastating storm surge of 1953. It serves as a platform for exchanging ideas, knowledge and practical experience in the field of coastal engineering and also deals with management issues and engineering problems. KRING is not an Association in the formal sense; it neither has Articles of Association nor members. Continuity is guaranteed by a Dutch Chairman with a secretariat. The present chairman is Adrie Provoost from "Waterschap Scheldestromen".

Since 1954 the three-day KRING meeting has been staged annually in rotation in the Netherlands, Germany, Belgium, Denmark, Poland and the United Kingdom. The programme includes site visits combined with lectures on local and more general topics. The participants are mainly comprised of staff members of public authorities responsible for coastal engineering matters in the above-mentioned states. About one half of the approx. 80 to 100 participants are from the Netherlands.

KRING has already been staged in Germany 12 times. The first meeting was in Lower Saxony in 1962 following the so-called Hamburg flood disaster while the last was in Hamburg in 2005. The German KRING meetings are usually organised by the KFKI (since its founding in 1972) in cooperation with the coastal protection authority of the federal state in question. The number of German participants at the KRING meetings held in Germany in the past ranged between 25 and 50 persons, otherwise between 10 and 30 persons up to 2006. Unfortunately, the number of German participants has diminished in recent years. This has mainly been due to ever-decreasing funds and an increasing work load. In times of climate change, decreasing public financial resources and increasingly complex planning processes (EU directives), however, it would appear that the cross-border exchange of ideas and experiences is more important than ever before.

For this reason, every attempt should be made to reverse this trend this year at the 13th (!) annual meeting in Germany. This year's meeting on the west coast of Schleswig-Holstein will commence on Sunday evening on 22 September in Husum with a welcoming address and opening lectures. Bus and ship excursions to the wadden sea hallig islands as well as to interesting engineering structures and institutions are planned in the morning on Monday and Tuesday. The excursion days will be rounded off by scientific presentations. The official programme will end at lunchtime on Tuesday. There will, of course, also be plenty of time on this occasion for scientific discussions and informal conversations, e.g. at the traditional event dinner on Monday evening. Invitations to the meeting as well as a detailed programme and registration information will be widely distributed in April. In case you have not received an invitation by mid-May, you can either contact the KFKI secretariat or visit the KFKI website.

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AufMod (03KIS082-03KIS088)

Development of integrated model systems for analysing long-term morphodynamics in the German Bight

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As part of the North Sea, the German Bight is one of the world's most intensively used marginal seas in economic terms. The large-scale sediment dynamics and associated bed shaping processes in the German Bight influence a variety of utilisation requirements ranging from maritime shipping to the erection of structures and the realisation of coastal protection measures. It is thus highly important to improve our knowledge of the complex processes responsible for the variability of the sea bed. In order to estimate the effects of hydraulic engineering measures or the consequences of sea level rise, prognostic models based on sound data sets derived from field measurements are required. A first step in this direction has been taken by way of the KFKI-funded project "Development of integrated model systems for analysing long-term morphodynamics in the German Bight (AufMod)". Through interdisciplinary cooperation between modellers and geoscientists, it has been possible to integrate the present state of knowledge in different scientific disciplines into the research work and also improve our understanding of the system.

The main objectives of AufMod are:

1. The development of a plausibilised and as highly consistent sea bed parameter data set as possible (topography, sedimentology) in order to create a functional bed model
2. Development and deployment of numerical models and determination of the applicability and accuracy of these simulation methods based on the hindcasting of past time periods.
3. To gain a better understanding of sediment dynamic processes in representative subsystems of the German Bight by implementing high-resolution hydro-acoustic measuring techniques.

The topographic data base compiled in the bed model includes data from surveys carried out by the German Federal Maritime and Hydrographic Agency and the Waterways and Shipping Authorities. For the near-shore zone, consistent integrated depth distributions with corresponding degrees of fuzziness were generated in yearly time slices from spatial and temporal interpolations over the period 1982 - 2012. Based on the wide-area bathymetric time series obtained in this way, it is possible using the functional bed model to derive additional morphological parameters, such as e.g. the morphological space (see Figure 1), and compare these with the results of the numerical simulation models. Implementation of the numerical methods permits a process-orientated interpretation of morphological changes, e.g. in terms of tide vs. wind and changes due to wave action.

In order to describe sedimentology, grain distribution data were gathered for the entire North Sea. These were then evaluated in the functional bed model throughout the German Bight with regard to standard sedimentological parameters such as median values (see Figure 2) and sorting. Idealised model investigations of sediment sorting and hydrodynamic loading can assist in interpreting observed sediment distribution patterns.

In addition, a highly-resolved description of sedimentology was realised in the bed model on account of the work carried out in the areas of key interest. This includes sediment surface mapping, the analysis of bed profiles, and seismic investigations for determining the thicknesses of the sediment layers available for sediment dynamics.

Large-scale sediment transport was calculated (see Figure 3) on the basis of the measured bathymetry

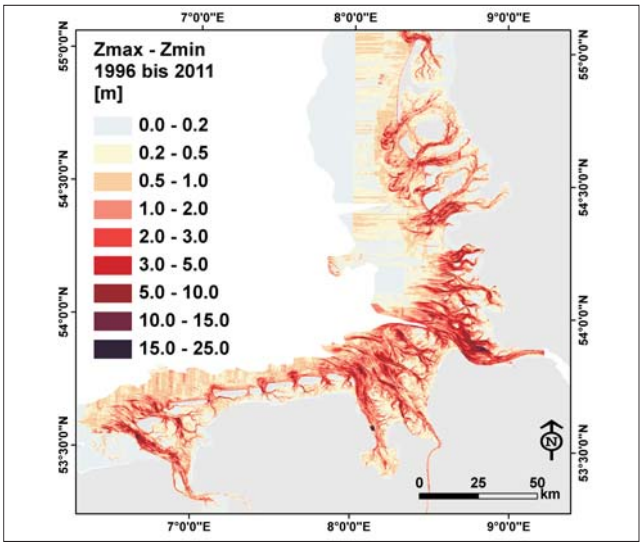

Figure 1:
Morphological space (Zmax-Zmin) over the coastal strip of the German Bight up to the 20 m isobath for the period 1996-2011

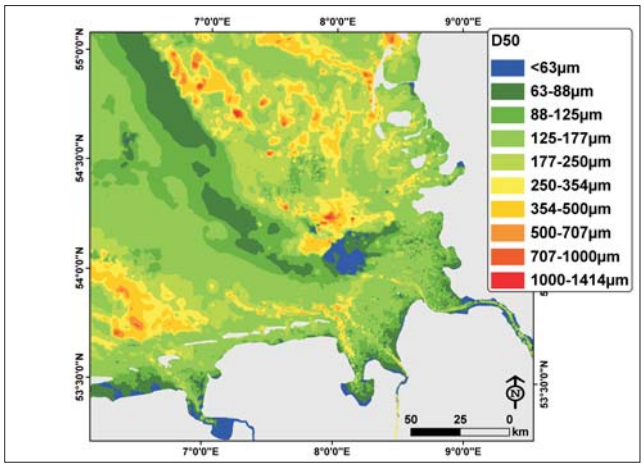

Figure 2:
Interpolation of the median value over the full extent of the German Bight, grouped in 1/2 Phi intervals

and sedimentology and balanced in the German Bight. The results show redistributions in the German Bight, especially a net deposition in the nearshore zone. In long-term simulations (100 years), possible changes in this behaviour were investigated for a sea level rise of 80 cm. No significant differences were detected, however.

At present, a more extensive validation of the results of these large-scale models can only be achieved qualitatively or by reverting to integral parameters such as redistribution volumes. In contrast, a direct comparison is possible in the case of small-scale simulations in the areas of key interest. By this means, it was possible to interpret the model results and the findings from the geological analyses in an integrative manner and also improve our understanding of the governing processes.

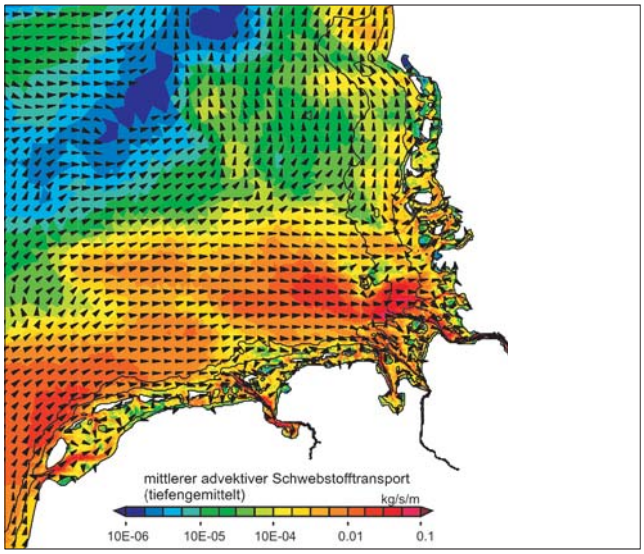

Figure 3:
Representation of large-scale sediment transport based on the example of the average advective suspended material transport given by the TRIM-SediMorph model (averaging period: 14.01.2006 – 30.01.2006)

ZukunftHallig A (03KIS093)

[Future scenario for the halligs, subproject A] Project presentation and analysis of the hydrological and hydrodynamic boundary conditions in the proximity of the halligs

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Background and introduction

Covering an area of approx. 9000 km², the wadden sea of the North Sea is one of the largest wetlands in the world and provides a habitat for about 10,000 animal and plant species (UNESCO). Owing to their special importance, the national parks and biosphere reserves of the Schleswig-Holstein and Lower Saxony wadden sea were designated as UNESCO world heritage sites in 2009. Ten German halligs are situated in the middle of the Schleswig-Holstein wadden sea. This worldwide unique hallig environment evolved to some extent from the remains of former coastal marshes. The major part, however, resulted to a large extent from more recent mud depositions (QUEDENS, 1992). The term "hallig" means more or less "flat" or "low" and characterises the slight difference in height between the halligs and mean tide level. As a result of this situation, combined with the fact that apart from just a few summer dykes, there are no other dykes on the halligs, inundation of the halligs presently occurs up to 50 times a year. Whereas the deposition of suspended sediment on the halligs during flood events contributes towards the formation of new land on the one hand, severe storm surges in particular over the past centuries have repeatedly resulted in erosion along the unprotected hallig coastlines and hence to a loss of land. If one considers the morphological development of the halligs in recent centuries, it becomes evident that land loss predominates in the interplay between sedimentation and coastal erosion. Between the 13th

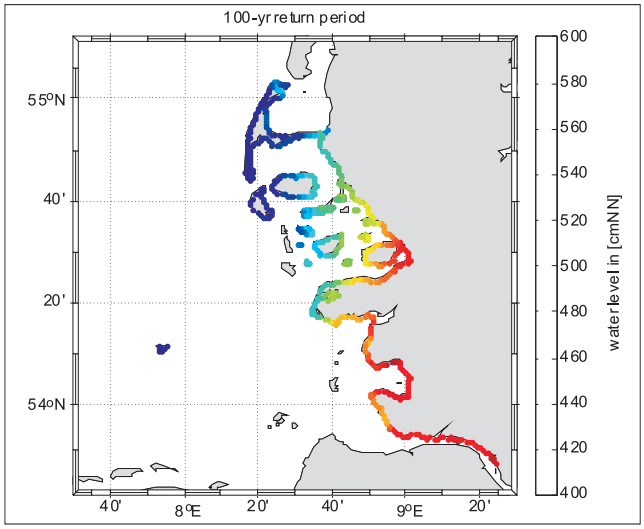

Figure 1:
Water levels with a probability of occurrence of PE = 0.01 (return period of 100 years) along the coast of Schleswig-Holstein.

and 20th century, the halligs have reduced in size by about 50 %. Some of them have in fact disappeared altogether (QUEDENS, 1992).

The research project "ZukunftHallig" [Future scenario for the halligs]

In order to counteract this development, an interdisciplinary team has now been established within the framework of the research project "ZukunftHallig" ["Future scenario for the halligs"] funded by the German Federal Ministry of Education and Research (BMBF). This project, which is aimed at developing sustainable coastal protection and management strategies for the halligs, involves the participation of the Institute of Hydraulic Engineering and Water Resources Management (IWW) and the Institute of Sociology (IfS) of the RWTH in Aachen, the Geoscience Centre of the University of Göttingen (GZG), the Schleswig-Holstein State Agency for Coastal Protection, National Parks and Marine Conservation (LKN-SH) and the Research Centre for Water Management and the Environment (fwu) of the University of Siegen. This project is particularly concerned with hydrodynamic loading under present-day and future climatic conditions as well as the morphological and sedimentological changes on and in the surroundings of the halligs. By quantifying the presently existing protection standard, it will be possible to carry out risk-oriented vulnerability analyses as a basis for developing sustainable coastal protection strategies matched to climatic changes. An exploration of the acceptance of these strategies among the hallig dwellers will be then be undertaken in the final stage of the project.

Subproject "ZukunftHallig A" [Future scenario for the halligs, subproject A]

A rise in mean sea level (MSL) as well as changes in the height and frequency of extreme storm surges represent one of the major risks resulting from a warming climate. A deeper understanding of these processes is of utmost importance in order to meet up to future demands. About 200 million people worldwide presently live in low-lying areas and are exposed to the potential risk of flooding. Owing to population growth and ever-increasing settlements in coastal regions, this number is expected to increase further in the future and is estimated to rise to about 800 million by the year 2080 (NICHOLLS, 2004). In order to effectively protect coastal regions, various techniques have been developed in recent decades for estimating the heights and frequencies of extreme water levels. In some cases, however, the methods implemented both nationally and internationally vary considerably. Owing to the application of different statistical methods, this has resulted in different predictions of the height and frequency of extreme storm surge events. Even applying the same models, it is found that the results can differ considerably. Generally speaking, these differences arise from a subjective choice of model setup. For this reason, a comparison of extreme events and hence a determination of the required degree of protection along the German North Sea coast is hardly possible.

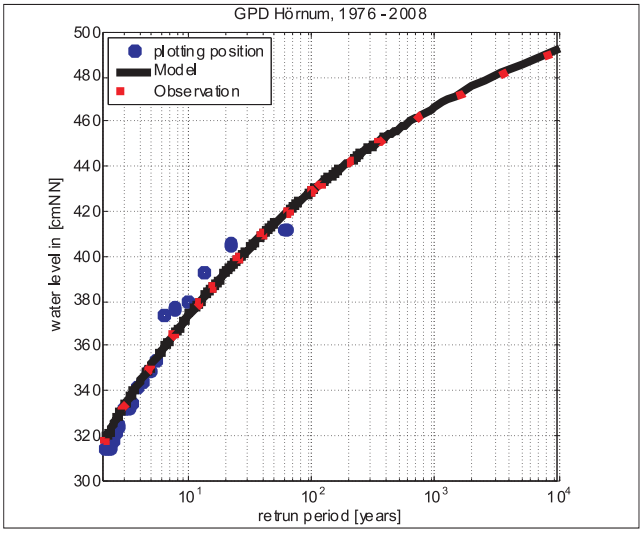

Figure 2:
Comparison of the return periods for model results and observed data at the Hörnum tide gauge.

In order to reduce the influence of subjective decisions, the direct methods usually adopted in Germany for determining design water levels and water levels with a particular return period were tested regarding their applicability as well as their robustness in the subproject "ZukunftHallig A". This involved varying the respective parameters within realistic range limits (or according to literature research) in order to investigate their influence. The aim of this work was to develop a method that results in comparable design values suitable as input for risk analyses. A comparison of the most widely used direct methods for a statistical determination of extreme values of water levels showed that the POT (Peak Over Threshold) method yields far more stable results than the Block Maxima Method. The analyses showed that the Block Maxima Method responds far more sensitively to possible sources of subjective influence, thereby resulting in considerably larger discrepancies between the possible results compared with the POT method. Moreover, the results show that it is possible using the POT method to obtain almost the same results from short time series compared to those given by the Block Maxima Method using very long time series. More detailed information may be found in Arns et al. (presently under preparation).

The probabilities and time histories of extreme water levels are required as input for the risk-oriented vulnerability analyses. As the available data in the proximity of the halligs is scarce, a 40-year water level hindcast was generated at the "fwu" using the software MIKE21. Based on the previously defined procedure for the statistical determination of extreme water levels, univariate statistical data were generated and visualised along the entire North Sea coast of Schleswig-Holstein. For demonstrative purposes, water levels with a probability of occurrence of PE = 0.01 (return period of 100 years) are shown in Figure 1. A comparison of the statistical data by means of the GPD (General Pareto Distribution) is presented in Figure 2. The results show that the differences between the data generated by the model and the observed data are negligible.

Literature

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ZukunftHallig B (03KIS094)

[Future scenario for the halligs, subproject B] Risk-oriented vulnerability analyses and the development of sustainable coastal protection concepts for the halligs

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Summary

In order to preserve the unique cultural heritage and natural environment of the North Frisian halligs under changed hydrological boundary conditions and guarantee sustainable development for future generations, an examination and adaptation of existing coastal protection measures and coastal protection strategies is necessary. Against this background, a basis for structural dimensioning as well as tools for evaluating newly-developed coastal protection concepts are currently being created with the aid numerical simulations and risk analyses within the framework of KFKI/BMBF project "ZukunftHallig" at the Institute of Hydraulic Engineering and Water Resources Management at RWTH Aachen University.

Present-day and future wave conditions are being modelled in the southern part of the North Frisian wadden sea with the aid of numerical simulations. Figure 1 shows sample results of modelling carried out by Deltares using the software Delft3D. The tidal model of the North Sea (cf. Figure 1A) hereby provides the boundary conditions for the available wadden

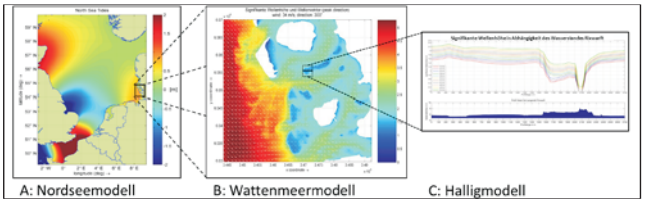

Figure 1:
Wave model of the study area

sea model (cf. Figure 1B) with a mesh spacing of 200 m x 200 m. This model in turn provides the boundary conditions for the high-resolution wave model for the halligs, by means of which it is possible to perform sensitivity analyses regarding the hydrodynamic effectiveness of different coastal protection measures (cf. Figure 1C).

In further studies, the halligs will be subdivided into the three sub-domains hallig foreshore/shoreface, hallig flats and artificial settlement mound, and investigated separately. This will also include the consideration and analysis of combinations of coastal protection measures for the different hallig domains.

The investigations in the hallig shoreface region will include physical model tests in the tilting flume at the Institute of Hydraulic Engineering and Water Resources Management. These tests are aimed at developing a method for dimensioning the super-elevated hallig revetments ("hallig hedgehogs"), whose design and construction up to now have been based on values gained from experience.

With regard to the hallig flats, a measurement campaign is planned for the 2012/2013 storm surge season. The purpose of this is to investigate to what extent an opening of the tidal sluice gates at elevated water levels might increase sedimentation rates over the central hallig regions. On the basis of a high-resolution numerical model study in the proximity of a tidal sluice gate facility, it was specified in Schleswig-Holstein (LKN-SH) that the measurement campaign can be undertaken in stages for an elevated mean high tide water level of up to one metre. This will involve in situ measurements of hydraulic parameters as well as sedimentation. These investigations are intended as a basis for the development of a new coastal protection strategy for the North Frisian halligs, by which sedimentation rates may be increased by purposive flooding of the halligs at elevated water levels.

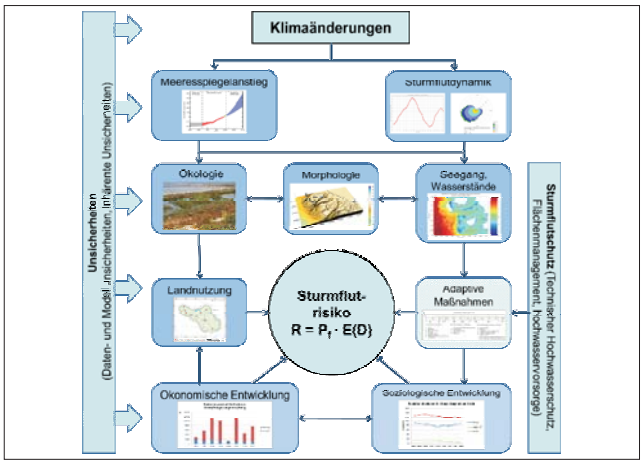

Figure 2:
Elements of the underlying storm surge risk in each particular case

With regard to the artificial hallig settlement mounds, it is planned to carry out investigations to quantify the present protection standard based on determinations of possible wave overtopping water volumes for different storm surge events. The results of these investigations at the IWW will provide the input data for the proposed risk analyses, which will enable a prioritisation of adaptation measures to be performed as required in the event of an increased need for action. The underlying storm surge risk in each particular case is thereby composed of the elements shown in Figure 2, and computed using the software PROMAIDES (Protection Measure against Inundation Decision Support) developed at the Institute of Hydraulic Engineering and Water Resources Management at RWTH Aachen University.

PROMAIDES, a decision support system for the risk-based assessment of existing flood protection measures, additionally includes methods for carrying out reliability analyses, hydrodynamic analyses and a consequence analysis, the results of which are combined to yield a flood risk prognosis (Bachmann, 2012).

Literature

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ZukunftHallig D (03KIS096)

[Future scenario for the halligs, subproject D] Recent marshland development and storm surge activity on the North Frisian halligs

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Mesotidal coastal marshes are highly dynamic landscapes in which flood-induced sediment accumulation processes are capable of compensating sea level rise to a certain degree. The governing parame-

ters for positive feedback are flood frequency and height, the sediment concentration in the floodwater as well as transport mechanisms that effectively convey suspension-rich water to the inland marshes (D'ALPAOS et al. 2007, KIRWAN et al. 2010). The marshlands of the North Frisian halligs are strongly characterised by anthropogenic interventions. Summer dykes (Hallig Hooge and Langeneß) minimise yearly flooding events and tidal sluice gates isolate inland tidal creeks and ditches from tidal action. The major aim of subproject D is to examine the extent to which the above-mentioned adaptation processes in the hallig marshes still take place under the rising mean tide high water level (MTHW) in this region, and also to possibly provide information as to how sedimentation processes may be optimised by modifying coastal protection strategies to match future hydrological framework conditions.

A first working step includes the visualisation and evaluation of high-resolution digital terrain models of the three halligs selected for investigation, namely Hallig Hooge, Langeneß and Nordstrandischmoor. The present tidal-surge dependent sediment accumulation as well as its spatial variability will be recorded during the half-year winter periods from October to March (2010/11, 2011/12, 2012/13). Two types of sediment traps arranged in a 400 x 400 m mesh are implemented. The dating of near-surface sediment deposits by means of the 137Cs and 210Pb method yields important information regarding the development of the marshes over about the past 120 years. Hydrological data will also be taken into consideration when interpreting the sedimentological findings. Tide gauge data collected by the Schleswig-Holstein State Agency for Coastal Protection, National Parks and Marine Conservation ("ZukunftHallig C") provide important information regarding the frequency of flooding over many years as well as the annual variability in the number of flood events. In addition, unequivocal and easily reproducible threshold values for the onset of inundation and complete inundation were determined for the three halligs considered.

The topography of the marshes exhibits characteristic relief elements, which may be traced back to highly variable spatial sediment accumulation processes. Floodwater sediment preferably accumulates on the landward side of the revetment structures, which means that levels close to the shore are significantly higher than in centrally-located areas. Also striking and at the same time typical of coastal marshes in

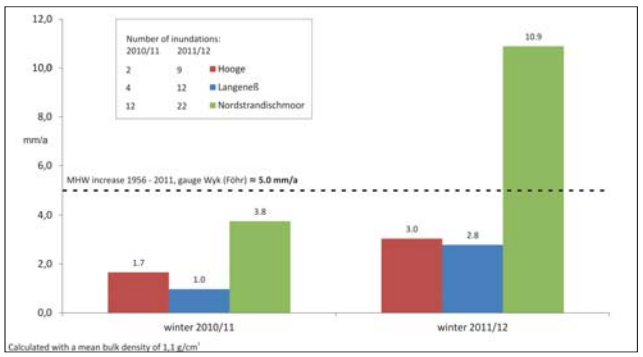

Figure 1:
Flooding frequency and marshland growth on the halligs Hooge, Langeneß and Nordstrandischmoor during the half-year winter periods of 2010/11 and 2011/12. The rise in MTHW is computed on the basis of a 19-year moving average of the mean annual high water level recorded by the Wyk tide gauge on the island of Föhr over the period 1956-2011.

their natural state are embankment structures with a height of several decimetres along meandering inland tidal creeks. The spatial distribution of the sediment accumulation recorded so far also shows that only a small amount of inorganic solid material is transported to the central regions of the large halligs. Nevertheless, it was possible to confirm the persistent formation of embankments along the inland tidal creeks on Langeneß.

The average growth rates recorded so far (winter 2010/11 and 2011/12) for the two largest halligs, Langeneß and Hooge, are minimal and lag behind the present rise in MTHW recorded at the Wyk tide gauge on the island of Föhr (Figure 1). Initial data on sediment dating support these findings. Only the hallig Nordstrandischmoor was able to boast a threefold increase in sediment accumulation compared to the previous year in the winter of 2011/12, thereby profiting from the numerous inundation events. Another striking feature is the high variability of inundation events: (1) in different years and (2) on different halligs. The first of these may be explained by highly variable weather conditions. Despite years with an over-average number of inundation events (2011/12), years without flooding are also not uncommon (e.g. 2005/2006). In contrast, the different frequencies of inundation events among the various halligs are directly linked to hydraulic engineering measures. Hooge and Langeneß have a summer dyke with an average height of 1.54 m (Hooge) and 0.98 m (Langeneß) above MTWH, which drastically reduces the number of inundation events. Nordstrandischmoor, on the other hand, is only protected on three sides by a rough revetment strip ("hallig hedgehog") with an average height of 0.70 m

above MTHW. The coastal marshes of the halligs thus rank among "transport-limited landscapes" (KIRWAN et al. 2010) in which the poor transportation of suspension-rich water prevents an adaptation to changed hydrological framework conditions.

Literature

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Flüssigschlick (03KIS065)

Fluid-Mud - Extension of a morphodynamic-numerical simulation model for simulating the dynamics of fluid mud along the German North Sea coast and its adjoining estuaries and tidal rivers

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Owing to the rapid development in the dimensions of vessels operated in international maritime shipping and the continuous increase in ship draughts over the past decades, a guarantee of sufficient water depths in the navigation channels serving ports along the German North Sea coast has become a major locational factor. This can only be ensured in the long term by sustained deepening and subsequent maintenance of approach channels. Of the approximately 45 Mio. m³ of material dredged in Germany in recent years by hydraulic dredging, about 90% is comprised of material extracted from estuaries and tidal rivers. Particularly in the freshwater-saltwater mixing zone, i.e. the brackish water zone, a special organic sediment, namely silty mud, is permanently generated. This forms flocs in the water body with a very low settling velocity which varies considerably depending on local sediment concentration and local flow conditions (Dyer, 1989). This fine sediment is especially deposited in zones where the flow is weak or where flow reversal occurs at the turn of the tide. This results in a near-bed highly concentrated mud layer with characteristic mechanical properties regarding the flowability of fluid mud.

Within the framework of the research project FLMUD 03KIS065, carried out in cooperation with ISMAR-CNR in Venice, the flow model SHYFEM (Umgiesser, 1995, 1997 and 2004) available in Venice was extended in order to model the dynamics of fluid mud. Also in cooperation with Joseph Zhang from the Virginia Institute of Marine Science (VIMS), the SELFE model was additionally included in order to investigate the possibility of simulating the dynamics of fluid mud within the framework of FLMUD. This was achieved on the one hand by implementing a rheological model which represents the non-Newtonian properties of fluid mud by means of different viscosity models and also takes into consideration its structural behaviour and thixotropic properties. Account was also taken of feedback between the high density caused by fluid mud and the flow model as well as the effect of high concentration gradients on turbulent exchange in the turbulence model. The implemented extensions were investigated in a series of synthetic test cases of increasing complexity. The effect of waves on mud dynamics was additionally accounted for in SHYFEM and SELFE by coupling these with the wave model WWMII (Roland et al., 2009).

In the view of the authors, the chosen models (SHYFEM and SELFE) represent state-of-the-art research and serve the needs of a wide circle of users of three-dimensional numerical flow models employing unstructured computational grids. SHYFEM is thus applied for investigating numerous lagoons worldwide and is also implemented as an operational model for the Mediterranean (Ferrarin et al. 2012) and the Adriatic Sea. SELFE is also deployed worldwide by different institutions for modelling estuaries, coastal regions and inland waterways. Although the SELFE model closely resembles the SHYFEM model in terms of the applied numerical methods, it nevertheless has the advantage that a parallel version already exists. Both models have a wide variety of extensions at their disposal, such as e.g. the above-mentioned wave model WWMII, extensions for simulating water quality and the sediment transport of non-cohesive material as well as the inclusion of precipitation runoff models. Both SHYFEM and SELFE may be described as an integrated model environment for hydraulic and ecological investigations in the fields of inland

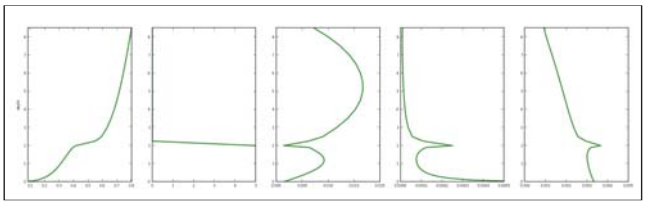

Figure 1:
Lutoclines with characteristic stratification. From left to right: velocity profile, mud concentration, turbulent viscosity, production of turbulent kinetic energy (TKE) k and the corresponding dissipation of TKE ε.

waterways and coastal engineering research. Both models can easily be driven using the databases of various weather centres (ECWMF, NOAA, DWD) and simulate 3-D salinity and temperature transport on the basis of a three-dimensional flow field obtained from the solution of the Reynold's averaged Navier-Stokes equations (RANS). The turbulence model GOTM (General Ocean Turbulence Model; Umlauf und Burchard, 2002) is implemented in both model systems.

The major challenge in the development of the FLMUD module was embedment in the existing numerical environment of the various models concerned. A stable integration technique was finally realised by taking into consideration the additional rheological viscosities on the new time level. The high density gradients resulting from the presence of fluid mud and their influence on momentum transport as well as turbulence also had to be integrated semi-implicitly in order to finally arrive at an efficient and robust integration technique. The major feature of FLMUD within the framework of the continuous approach is that the fluid mud phase may be modelled in the same computational grid, thereby permitting a representation of the different hydraulic regimes ranging from stable stratification to fully-mixed conditions. Figure 1 shows the results of numerical experiments using the FLMUD module. The experiments were performed in a 60 km long and 10 m deep channel with a width of 800 m. Fluid mud with a concentration of 5g/l was introduced. The floc diameter in this case was 6µm. As evident in Figure 1, a lutocline develops with characteristic stratification. A governing factor in this case is that the fluid mud layer is also in motion and that a turbulent regime develops below the lutocline which finally leads to complete mixing over the water depth. Similar results have been reported by Winterwerp (2002). Models that are unable to describe a turbulent regime in the fluid mud layer are not capable of simulating this behaviour.

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Project RAdOst

Regional adaptation strategies for the German Baltic Sea coast
Focal topic: coastal protection

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Overview

The aim of the RADOST project is to develop adaptation strategies for the German Baltic Sea region in dialogue between science, industry, administrative bodies and the public. In equal measures, this involves minimising the damage to industry, society and nature as a result of climate change and at the same time, taking optimal advantage of the development opportunities associated with climate change. A further goal is to permanently strengthen protagonist networks and communication structures within and beyond the region.

The structure of the RADOST project may be subdivided into the following superordinate working areas (modules)

- Creation of networks and regional dialogue
- Research in natural and engineering science
- Socio-economic research
- National, European and international integration
- Communication and dissemination of the results

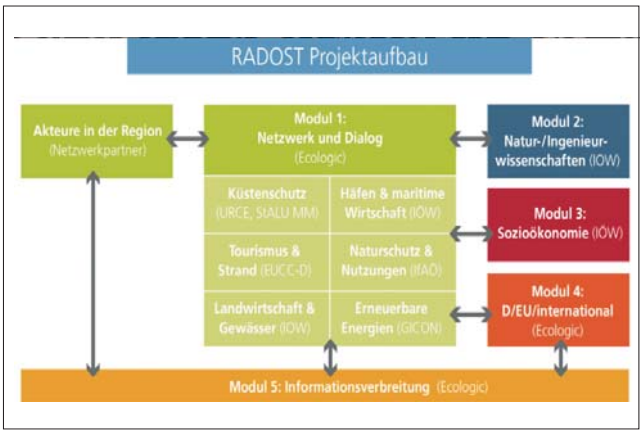

Figure 1:
Structure of the RADOST project

The creation of networks and dialogue are oriented to six focal topics which essentially comprise the economic sectors and fields of activity affected by climate change in the region. The results from the modules "natural and engineering science research" and "socio-economic research" will be processed under consideration of the need for action indicated by the focal topics and complemented by application-oriented research carried out within the framework of the individual focal topics. Implementation projects involving on-the-spot practice partners will assist in developing solution methods in mathematical models.

A cross-networking of the focal topics takes place in both overarching dialogue forums, which bring together experts and protagonists within and outside the region, as well as locally in selected focal areas.

RADOST is one of seven projects within the framework of the action plan "Future-oriented regional adaptation to climate change" (KLIMZUG) funded by the German Federal Ministry of Education and Research (BMBF). KLIMZUG assists model regions in Germany in the development of innovative climate adaptation strategies. A central objective of the measure is to create lasting and robust protagonist networks.

Focal topic "Coastal Protection"

The focal topic "Coastal Protection" aims at developing sustainable and long-term coastal protection strategies along the German Baltic Sea coast. This also takes into account a conflict of interests among other sectors such as tourism and nature conservation. Sensitivity analyses identify priority stretches of the coastline and coastal protection measures. Gradual changes in water levels, waves and currents are recorded by monitoring.

Over about 70 % of their length, the Baltic sea coastal stretches of Mecklenburg - Western Pomerania and Schleswig-Holstein are permanently subject to sediment erosion and hence to coastal recession. Protection of the coast, i.e. protection of the hinterland against flooding as well as stabilisation of the shoreline, already demands considerable annual financial investments at the present time. Against the background of the forecasted climate change with rising water levels, it is anticipated that the expenditure for coastal protection will increase further in

Figure 2:
RADOST focal regions

order to maintain the present level of safety in the protected regions.

With rising water levels and changing hydrodynamic loading of the coastline, a further question arises concerning the medium-term and long-term applicability and effectiveness of conventional coastal protection structures and concepts.

Against the background of changing climatic conditions, a major objective is to develop sustainable and long-term strategies for coastal protection along the German Baltic Sea coast, under consideration of the present situation regarding storm surges and coastal protection, and, on the basis of sensitivity analyses, to undertake an early prioritisation of individual coastline segments or coastal protection measures as well as an assessment of action periods and leeways.

Especially due to long planning periods, it is also necessary at the present time to analyse the safety situation regarding existing coastal protection structures under changed hydrodynamic loading.

Issues linked to the project both internally and externally especially relate to questions concerning the use of beaches by tourists as well as questions concerning nature conservation.

An important key aspect of the work concerns the focal regions (see Figure 2), where current questions relating to coastal protection will be addressed and analysed against the background of a change in climatic conditions.

The project RADOST will run from July 2009 until June 2014.

Sources

Text from: ***www.radost-klimzug.de***

KLIWAS

Climate change on and in the North Sea – results of high-resolution climate models

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Within the framework of the departmental research programme KLIWAS of the German Federal Ministry of Transport, Building and Urban Development (BMVBS), the German Federal Maritime and Hydrographic Agency (BSH) and the DWD's Marine Weather Office (SWA) are engaged in the evaluation of climate scenarios for the North Sea and Baltic Sea region. The aim of KLIWAS is to investigate the effects of climate change in the North and Baltic Sea region as well as along their coasts. Among other things, this concerns maritime shipping in the North and Baltic Sea.

In cooperation with the Max Planck Institute in Hamburg (MPI-HH), the Swedish Meteorological and Hydrological Institute (SMHI) and the University of Hamburg (IfM-HH), this will broadly involve the performance of high-resolution coupled model computations for the A1B scenario, which will be validated and evaluated jointly with the modelling groups. In contrast to the coarse-resolution coupled climate models which were applied e.g. as a basis for preparing the 4th IPCC Report, the models implemented in the present study have spatial resolutions suitably matched in scale to both shelf seas, ranging from 3-10 km in the ocean and 25-37 km in the atmosphere.

For the first time, different highly-resolved climate projections will be carried out in this project using three different coupled oceanic-atmospheric models for the North and Baltic Sea. This offers the opportunity to determine a portion of the spectrum of possible climatic changes. This will be supplemented by an

evaluation of the regional atmospheric climate model data determined in the ENSEMBLES project for the North and Baltic Sea regions.

The change in temperature and salinity distribution in the North and Baltic Sea as well as sea level rise will be investigated on the basis of the initial simulations already carried out using the coupled model MPIOM-REMO. According to the simulations, the warming of the North Sea is forecasted to be about 2° C by the end of the 21st century. A significantly larger temperature rise of 3.5 °C is forecasted for the Baltic Sea. These simulations indicate a pronounced change in the horizontal temperature distribution in the North Sea due to the exchange of water with the North Atlantic. In the inflow regions on the shelf edge to the north and in the vicinity of the English Channel, lower warming rates are forecasted than in the central part of the North Sea.

Marked differences in salinities are also forecasted as a result of climatic developments. Lower salinities are expected in the North and Baltic Sea owing to increased precipitation and a rise in continental runoff. The changes in salinity in the North Sea are moderate on the whole, reducing by about 0.2 psu. In contrast to this, very large salinity changes of 2 psu and more are forecasted for the Baltic Sea. This significant reduction in salinity in the Baltic Sea is reflected in a near-surface salinity reduction in the North Sea due to spreading of the Baltic outflow, thus resulting in salinity reductions in the region of the Belt Sea and along the Norwegian coast.

The steric rise in sea level in 100 years time is forecasted to be about 25-30 cm in the North Sea and 30-35 cm in Baltic Sea. The fact the spatial patterns of sea level in both marine areas are expected to remain almost unaltered during this period means that changes in circulation are likely to be small.

Only slight changes in circulation patterns are forecasted in the North Sea. A notable feature, however, is a weakening of circulation over large areas of the southern North Sea. In keeping with this, the time series of the inflow of Atlantic water via the English Channel reveal a significant reduction in inflow, whereas no marked trends are evident regarding inflow via the Skagerrak and over the northern shelf edge. Moreover, changes in the wind regime over the southern North Sea could have an effect on the reduced flow fields. The initial analyses would suggest that this is more likely due to a change in wind direction rather than a reduction in wind speed.

The future development of storms is a governing factor regarding the safety of maritime shipping as well as endangerment of the coastlines. A possible future change in wind speeds over the North Sea is hence of major importance. In order to investigate near-ground winds fields over the North Sea, the results of a global climate model as well as the results obtained from several regional climate models within the framework of the ENSEMBLES project were analysed over the period 1950 – 2100. The simulation of wind fields using the regional models is considered to be realistic. A comparison of the average wind fields computed by the models over the period 1970-2000 using ERA-40 data revealed differences in winds speeds lower than the estimated inaccuracies of satellite measurements.

An investigation of the anticipated temporal changes in wind fields up to the end of the 21st century was carried out in selected areas based on wind speed frequency distributions. The resulting annual distributions exhibit high variability from year to year. Linear trends in wind speed for the period 1950-2000 between the models and in different wind categories (percentiles of the frequency distributions) do not exhibit uniform plus or minus tendencies. The robustness and significance of these trends in relation to wind direction is hence a matter of discussion for the selected investigation areas.

Imprint

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