Nederlands Centrum voor Kustonderzoek

Book of Abstracts

NCK - days
March 17th and 18th, 2011
NIOZ Royal Netherlands Institute for Sea Research

Co-sponsored by

Nederlandse Organisatie voor Wetenschappelijk Onderzoek

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1. Preface

Dear NCK colleagues and guests,

It is a great pleasure for us to welcome all of you on the island of Texel for the NCK-days of 2011 ! We trust you will find the landscape of Texel a most inspiring place to discuss issues of coastal research with colleagues, listen to talks, and watch the posters. After all, Texel boasts a great variety of forms of landscape, from the Pleistocene hills (modestly called “Hoge Berg” – High Mountain) to the man-made polders, which fill around half of the island. In fact, the island as a unity is itself a man-made construct, for originally (if that word has any geological sense) there were two islands, which were connected by a dike in the early 17th century. This dike runs along the Slufter, one of the areas to be visited during the excursion on Saturday 19 March.

The location of this meeting is the Royal Netherlands Institute for Sea Research, a venerable institution that can be traced back to the late 19th century, when it started as a zoological station in Den Helder. Naturally, the Wadden Sea has been the original focus of its research activities, being around the corner. At first, the emphasis was on biological aspects, but gradually, in the second half of the 20th century, other disciplines were included as well: chemistry, geology, physics. Nowadays, the institute encompasses all disciplines of oceanographic research, and their cross-connections. Meanwhile, the institute also broadened its geographical scope, from the Wadden Sea to the North Sea, and from the North Sea out on the world’s oceans.

This is not to say that coastal research was by any means a finished job. The talks and posters presented during these days will testify to the ongoing journey of discovery that coastal research really is. As part of that journey, we hope you will enjoy the NCK-days of 2011 !

Prof. dr. Herman Ridderinkhof, deputy director NIOZ
Dr. Meinard Tiessen
Dr. Theo Gerkema

Texel, March 2011

2. The Netherlands Centre for Coastal Research (NCK)

2.1 Historical context

Coastal research in The Netherlands has a long history. For many centuries, experience gained from the country's successes and failures in the struggle against the sea has been the major source of innovation. A more formal and systematic approach has developed over the last hundred years:

- 1920: An important step in the development of formalized knowledge was taken in the 1920s by the Nobel-prize laureate Hendrik Lorentz, who designed a computational scheme for assessing the tidal effects of the closure of the Zuyderzee. At the same time, with the founding of Delft Hydraulics, physical scale models became the favourite instrument for designing coastal engineering works. They remained so for a long time.
- 1953: The storm surge disaster of 1953 provided a strong incentive for coastal research in support of the Delta Project, which entailed a drastic shortening of the Dutch coastline. The Delta Project profoundly affected the morphodynamics of the Rhine-Meuse-Scheldt delta; large parts of the system were transformed into what one might call a life-size hydraulic laboratory.
- 1965: In the 1960s, a monitoring programme (JARKUS) was established to assess the evolution of the nearshore zone along the entire Dutch coast on a yearly basis. The resulting data base revealed not only short-term fluctuations of the shoreline, but also large-scale structural trends. The JARKUS data set represents a key source of coastal information, particularly in combination with historical observations of Dutch coastline evolution that date back to 1840-1850. With no equivalent data set available worldwide, the unique JARKUS data base has inspired a wealth of coastal research programmes throughout the years.
- 1985: The growing need for integrated coastal management led by the end of the 1980s to the development of a national coastal defence policy of 'Dynamic Preservation' (1990). This involved sustainable maintenance of the coast through 'soft' interventions (often nourishment of the beach and shoreface with sand taken from offshore) allowing for natural fluctuations. The basic principles were derived from a major research project for the systematic study of persistent trends in the evolution of the coastal system. This Coastal Genesis project – carried out by a multidisciplinary team of coastal engineers, physical and historical geographers and geologists – laid the ground for NCK.
- 1992: The successful multidisciplinary collaboration initiated during the Coastal Genesis project was institutionalized by means of the formal founding of the Netherlands Centre for Coastal Research (NCK).

The NCK was initiated by the coastal research groups of Delft University of Technology, Utrecht University, WL | Delft Hydraulics and Rijkswaterstaat RIKZ. Early 1996, the University of Twente and the Geological Survey of The Netherlands (now the Netherlands Institute of Applied Geoscience TNO: TNO-NITG) joined NCK, followed by the Netherlands Institute for Sea Research (NIOZ, 1999), the Netherlands Institute for Ecology – Centre for Estuarine and Marine Ecology (NIOO-CEME, 2001), UNESCO-IHE Institute for Water Education (2004) and Wageningen IMARES (2008).

2.2 NCK Objectives

The NCK was established with the objectives of:

- increasing the quality of the coastal research in the Netherlands by enhancing cooperation between the various research streams and guaranteeing the continuity of coastal research in the Netherlands by exchange of expertise, methods and theories between the participating institutes;
- maintaining fundamental coastal research in The Netherlands at a sufficient high level and enhancing the exchange of knowledge to the applied research community;
- reinforcement of coastal research and education capacities at Dutch universities;

strengthening the position of Dutch coastal research in a United Europe and beyond.

2.3 Organization

NCK is a cooperative effort between private, governmental and independent research institutes and universities and carries out a research programme that is compatible with the needs mentioned above. Within this framework, the Centre offers the opportunity to conduct innovative research as a member of a team.

A programme committee establishes the framework for the research to be carried out by NCK. Based on this framework, researchers prepare proposals, which NCK submits for funding to national and international agencies.

Since 1998, following the evaluation of the previous report, a part time programme secretary has been appointed. His tasks are amongst others:

- drafting and keeping up to date of the research programme in cooperation with the Programming Committee;
- stimulating joint NCK research projects;
- increasing the visibility of NCK, both inside the NCK partner organisations and external (national and international).

The NCK Programming Committee and the Programme Secretary are supervised by the NCK Directory Board. During the period 1998-2003, ir. Ad van Os fulfilled the role of NCK Programme Secretary. As of January 1st, 2004, he was succeeded by dr.ir. Stefan Aarninkhof. As of June 1st 2006 he in turn was succeeded by dr.ir. Mark van Koningsveld. Since April 1st, 2008 dr. Bert van der Valk fullfils the role of Programma Secretary. Secretarial support is provided by Mrs. Jolien Mans.

Several times a year, the Centre organises workshops and/or seminars that are aimed at promoting cooperation and mutual exchange of information. NCK is open to researchers from abroad. Exchanges of young researchers are encouraged and possibilities for sabbaticals are pursued.

Through the participating institutes, researchers have access to several facilities. The universities offer computing facilities. Field data can be accessed from data banks at Rijkswaterstaat and Deltares. The researchers of NCK may use numerical model systems developed at Deltares and Rijkswaterstaat. Deltares and Delft University of Technology offer various hydraulic laboratory facilities. Advanced equipment for field measurements is available at Utrecht University and at Rijkswaterstaat. Rijkswaterstaat and the Netherlands Institute for Sea Research can provide research vessel support. Through access to these facilities the necessary opportunities to advance the frontiers of knowledge of coastal processes are provided.

NCK- Supervisory Board

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Dr.ir. M.J. Baptist	IMARES (WU)	Den Burg, Texel

2.4 The NCK Partners

The NCK links the strongest expertise of its partners, forming a true centre of excellence in coastal research in The Netherlands. The eight partners are briefly introduced in this section. All individuals participating to the NCK activities as of early 2005 are listed in Appendix B, including their contact details.

Delft University of Technology, Faculty of Civil Engineering and Geosciences

The Faculty of Civil Engineering and Geosciences is recognised as one of the best in Europe. The Department of Hydraulic and Geotechnical Engineering encompasses the Sections Fluid Mechanics and Hydraulic Engineering. Both have gained over the years an internationally established reputation, in fluid dynamics in general, in coastal dynamics, in the fields of coastal sediment transport, morphology, wind waves, coastal currents and the mathematical, numerical modelling of these processes.

Netherlands Ministry of Transport, Public Works and Watermanagement, Directorate General Rijkswaterstaat

As the executive body of the Ministry of Transport, Public Works and Water Management, Rijkswaterstaat manages and develops our country's infrastructure networks. These are the major road and waterway networks and our main water system, which comprises a connected system of large rivers, canals, lakes, coastal waters and the sea. Our fundamental mission is to ensure that we keep our feet dry, that we have sufficient clean water, that traffic flows smoothly on the road and on the water and that useful information is provided. We take a public-oriented approach to the users of our infrastructure networks, resulting in a safe, reliable and efficient national network of roads, waterways and large bodies of water. Our Centre for Water Management monitors the condition and the use of our main water system. Based on this, our aim is to ensure efficient, effective and user-friendly water management, now and in the future. To deliver this aim, we supply knowledge and expertise for Rijkswaterstaat's water projects, while our advisors and project managers are actively involved in national and regional projects. Providing a bridging function between policy, management, execution, oversight and knowledge in the area of water, we play a pivotal role in national water management. Formed from previous divisions of the Directorate-General for Public Works and Water Management, our organisation has a staff of over 500 people working in three divisions comprising a total of 22 departments.

The Division Water Network is concerned with the construction, management, maintenance and development of the main water system. The Division Water and Use focuses its activities on making optimum use of the water system, including water quality monitoring, knowledge development and innovation. The Division Business Operations inspects and oversees business operations and manages purchasing and HR.

Deltares

Deltares is the result of a merger of WL|Delft Hydraulics, GeoDelft, a parts of TNO Built Environment and the research parts of Rijkswaterstaat RIKZ, RIZA and DWW. Deltares, which started its activities on 01-01-2008, is an independent non-profit organisation for consultancy, research and development in the field of hydrodynamics, hydrology and water resources management. It has some 80 years of world-wide experience in physical scale modelling, mathematical modelling, field work and transfer of knowledge and know-how in these areas. The relevant experience of Deltares as far as NCK is concerned lies in research, development and application of models concerning hydrodynamics, sediment transport and morphodynamics in the coastal zone. A close link between research and practical advisory work warrants a strong interaction with potential end users. Offshore and coastal activities concentrate on seabed and coastal infrastructure and resources, seabed mapping and surveying, geo-hazard and environmental assessment, marine and coastal research and marine and coastal information systems.Deltares has a unique set of experimental facilities to its disposal, recognised by the EU as "Large Installations". Another important class of facilities is formed by the wide range of numerical modelling software for coastal dynamics, at various levels of sophistication.

University of Utrecht, Institute for Marine and Atmospheric Research Utrecht IMAU

Institute for Marine and Atmospheric research Utrecht (IMAU) is composed of the Meteorology and Physical Oceanography Department of the Faculty of Physics and Astronomy and the Coastal Research Section of the Physical Geography Department of the Faculty of Geosciences. The Institute's main objective is to offer an optimal, stimulating and internationally oriented environment for top quality fundamental research in Meteorology, Physical Oceanography and Physical Geography, by integrating theoretical studies and extensive field studies. IMAU focusses on the morphodynamics of beaches and surf zones, shoreface and shelf and the dynamics of river deltas (especially in the tropics) and estuarine systems.

University of Twente, Civil Engineering & Management

Since 1992, the University of Twente is providing the education and research programme Civil Engineering (previously called Civil Engineering & Management), which aims at embedding (geo) physical and technical knowledge related to infrastructural systems into its societal and environmental context. The combination of engineering and societal faculties makes this university particularly well equipped to run this programme. Early 2002, the two sections Water Resources Management and Modelling of Integrated Civil Engineering Systems formed the new section Water Engineering and Management (WEM). The research of WEM focuses on i) physics of large, natural, surface water systems, such as rivers, estuaries and seas and ii) analysis of the management of such systems. Within the first research line WEM aims to improve understanding of the physical processes and to model their behaviour appropriately, which means as simple as possible but accurate enough for the water management problems that are considered. Dealing with uncertainty plays an important role here. An integrated approach is central to the water management analysis, in which not only (bio) physical aspects of water systems are considered, but also the variety of functions these systems have for the users, the way in which decisions on their usage are taken, and how these are turned into practical applications. Various national and international research projects related to coastal zone management, sediment transport processes, offshore morphology and eco-morphodynamics have been awarded to this section.

Royal Netherlands Institute for Sea Research NIOZ

The Netherlands Institute for Sea Research (NIOZ) aspires to perform top level curiosity-driven and society-inspired research of marine systems that integrates the natural sciences of relevance to oceanology. NIOZ supports high-quality marine research and education at universities by initiating and facilitating multidisciplinary and sea-going research embedded in national and international programmes

Netherlands Institute for Ecology, Centre for Estuarine and Marine Ecology NIOO-CEME

The Netherlands Institute of Ecology (NIOO-KNAW) focusses on basic and strategic research into individual organisms, populations, ecological communities and ecosystems. The NIOO-KNAW employs more than 250 people at three research centres and its headquarters. The Centre for Estuarine and Marine Ecology (NIOO-CEME) in Yerseke concentrates on ecosystems in brackish and salt water. It conducts research in estuaries and coastal waters in Europe, Africa, Asia, and the Polar Regions. It also participates in several deep-sea projects. The centre originally started as the Delta Institute for Hydrobiological Research in 1957. CEME consists of three departments: Ecosystem Studies, Marine Microbiology and Spatial Ecology.

UNESCO-IHE Institute for Water Education

UNESCO-IHE is a UNESCO Category 1 institute for water education and research. Based in Delft, it comprises a total of 140 staff members, 70 of whom are responsible for the education, training, research and capacity building programmes both in Delft and abroad. It is hosting a student population of approximately 300 MSc students and some 60 PhD candidates. Although in existence for more than 50 years, it was officially established as a UNESCO institute on 5 November 2001 during UNESCO's 31st General Conference. UNESCO-IHE is offering a host of postgraduate courses and tailor-made training programmes in the fields of water science and engineering, environmental resources management, water management and institutions and municipal water supply and urban infrastructure. UNESCO-IHE, together with the International Hydrological Programme, is the main UNESCO vehicle for applied research, institutional capacity building and human resources development in the water sector world-wide

Wageningen IMARES

Wageningen IMARES(Institute for Marine Resources and Ecosystem Studies) is the Netherlands research institute established to provide the scientific support that is essential to developing policies and innovation in respect of the marine environment, fishery activities, aquaculture and the maritime sector.

Wageningen IMARES is:

- an independent, objective and authoritative institute whose aim is to find the right equilibrium between marine ecology, seafood production and maritime economy.
- a key, proactive player in national and international marine research networks (including ICES and EFARO).

We carry out research for both national authorities and specific research programmes (50%), international RTD programmes (30%) and contract research for private, public and NGO partners (20%). Our key focal research areas cover ecology, environmental conservation and protection, fisheries, aquaculture, ecosystem based marine economy, coastal zone management and marine governance.

Wageningen IMARES has some two hundred people active in field surveys, experimental studies, from laboratory to mesocosm scale, modelling and assessment, scientific advice and consultancy. Our work is supported by unique in-house facilities that include specialist marine analysis labs, experimental halls, outdoor mesocoms, specific field-sampling devices, databases and models. The Wageningen MARES quality system is ISO 9001 certified while special chemical analysis and ecotoxicological studies are performed according to RVA, ISO 17025 accreditation and GLP standards.

We collaborate with fellow research specialists where necessary and where such collaboration generates clear added value. Our research is regularly published in international peer reviewed publications. As part of the Wageningen UR, Wageningen IMARES has close ties with Wageningen University and the Van Hall Larenstein professional University. Both universities cater for Bachelor, professional Master and academic Master education programmes. The institute runs a PhD programme together with Wageningen University

3. PROGRAMME NCK-DAYS, NIOZ TEXEL, 2011

Wednesday 16 March	
20:00-22:30	**Icebreaker at NIOZ**, Texel

Thursday 17 March	
9:00	registration and coffee
9:45	**opening**
Session 1	**Sediment transport modelling**
10:00-10:40	*Keynote:* **Thijs van Kessel:** Abundance or scarcity: stirring up sediments and discussion
10:40-11:00	**Bram van Prooijen:** Squeezing the Wadden Sea into one dimension
11:00-11:20	**Kerstin Siemes:** Seafloor classification by acoustic remote sensing
11:20-11:40	**Meinard Tiessen:** How the pre-existence of crescentic bed-forms can influence their subsequent development
11:40-12:00	1-minute poster presentations
12:00-13:00	**lunch**
Session 2	**Sandy coasts**
13:00-13:40	*Keynote:* **Edwin Elias:** Morphodynamic development and sediment budget of the Dutch Wadden Sea over the last century
13:40-14:00	**Peter Brandenburg:** Scale dependency of dune erosion models
14:00-14:20	**Kees den Heijer:** Comparison of dune erosion models
14:20:14:40	**Kees Willem Pruis:** Modelling decadal barrier island evolution
14:40-15:00	**Bas Hoonhout:** Development of an advanced dune safety assessment model
15:00-16:00	**coffee break + posters**
Session 3	**Biogeomorphology**
16:00-16:40	*Keynote:* **Tjeerd Bouma:** Biogeomorphology: progress and changes
16:40-17:00	**Jasper Donker:** Dissipation of wave energy over an intertidal mussel bed
17:00-17:20	Marije Smit: Wave attenuation over intertidal flat adjacent to a salt marsh
17:20-17:40	**Rob Uittenbogaard:** Hydrodynamics and mechanics of flexible vegetation subjected to surface waves
17:40-18:40	social event
18:40-20:30	**dinner**
20:30-21:00	presentation of NIOZ
21:00-22:30	**drinks**

Friday 18 March 2011	
Session 4	**Building with Nature**
9:00-9:40	*keynote:* **Martin Baptist:** Building with Nature firmly established
9:40-10:00	**Renske de Winter:** The effect of climate change on extreme waves on the North Sea
10:00-10:20	**Maarten de Jong:** Habitat factors for infaunal macrozoobenthos in a part of the Dutch coastal area
10:20-10:40	**Francesco Cozzoli:** Modelling biota-mud interactions in estuaries: the Westerschelde-Oosterschelde case
10:40-11:00	1-minute poster presentations
11:00-11:20	**coffee**
Session 5	**Estuaries and tidal inlets**
11:20-12:00	*Keynote:* **Henk Schuttelaars:** Morphodynamic equilibria in short tidal embayments
12:00-12:20	**Sjoerd Groeskamp:** Observations of estuarine circulation and solitary internal waves in a highly energetic tidal channel
12:20-12:40	**Mick van der Wegen:** The impact of sea level rise on the morphodynamic development in an elongated tidal basin
12:40-13:00	**Cilia Swinkels:** Application of navigation radar images to analyze spatial current fields in the Amelander tidal inlet
13:00-14:00	**lunch and posters**
Session 6	**Coastal zone management**
14:00-14:40	*Keynote:* **Kathelijne Wijnberg:** Coastal management and long-term foredune behaviour: on the role of humans as geomorphic agents
14:40-15:00	**Miriam Belblidia:** Flood mitigation in New Orleans & The Netherlands: Building with (and against) Nature
15:00-15:20	**Katie Jagt:** Working with water in the California Delta
15:20-15:45	awards and closure

Saturday 19 March	
10:00-16:30	excursion to Slufter and Schorren

4. Abstracts

4.1 Abstracts for presentation

ABUNDANCE OR SCARCITY: STIRRING UP SEDIMENTS AND DISCUSSION

Thijs van Kessel [1)]

[1)] Deltares

Description of research

Sediment transport is steered by hydrodynamics for and important part. However, it is not the only factor. Also, sediment supply may be a determining factor, notably for fine sediments. Although not overlooked, this aspect does not always get the full attention it deserves.

This presentation deals with sediment supply and its consequences for sediment concentration, fluxes and budgets. Straightforward assumptions on sediment sources and sinks may result in non-trivial effects on net sediment transport. This is illustrated with some practical examples from sediment modelling.

A bed module is a nice tool to keep track of all sediments in your systems. But how should it look like? Is it only relevant for mud modellers and can sand modellers get away with it? And what about initial bed conditions, can we prescribe these or should our modelling go back to the Big Bang?

Figure 1: Typical example of sand transport (left) and mud transport (right).

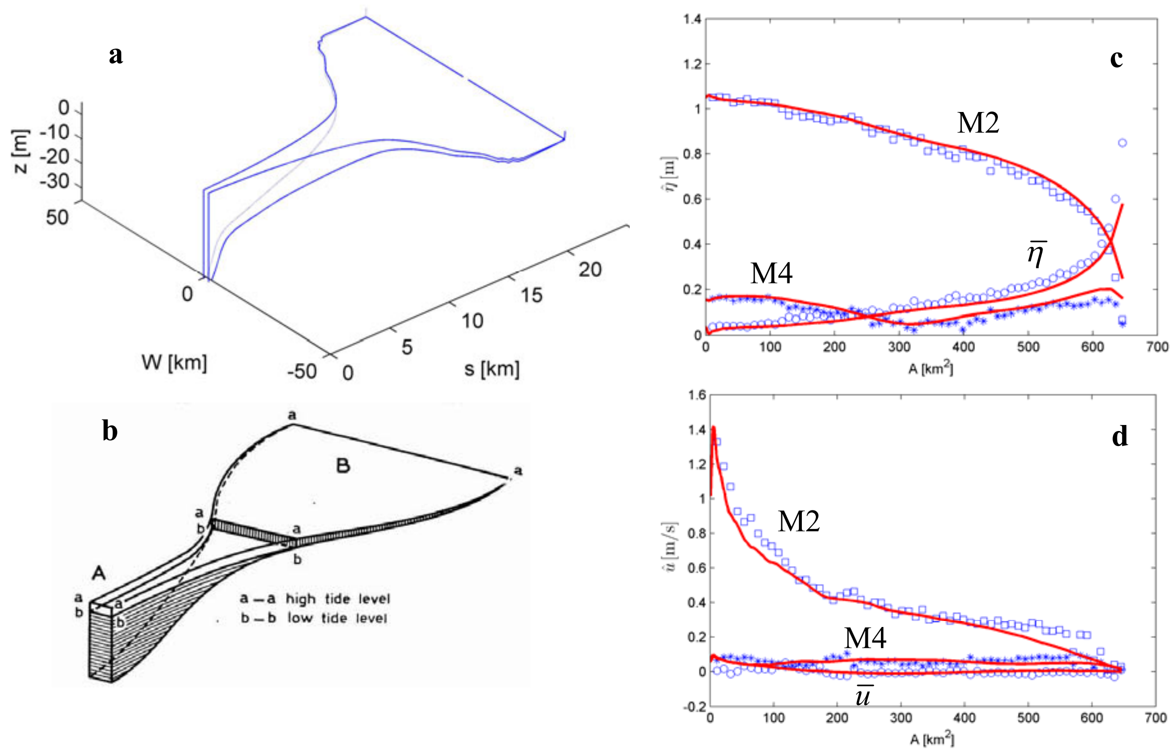
Squeezing the Wadden Sea into One Dimension

Bram van Prooijen[1] and Zheng Bing Wang [1,2]

[1] TU Delft, [2] Deltares

The simulation of (fine) sediment transport and morphology in the Wadden Sea is an ambitious challenge. This is partly caused by the lack of available data and understanding of physical and biological processes, and partly by the wide range of spatial and temporal scales. Detailed numerical models and a wide range of sensitivity studies are principally needed. As such required models are not feasible yet, models with simplified geometries have their value in the prediction of the response of the basins to anthropogenic interventions and climate change.

In this study, we propose a 1D model for a single tidal basin, making use of the dendritic channel pattern. Where previous 1D models use a constant width, we use a width diverging from the mouth into the basin. This divergence is based on implementation of results of a 2D simulation in the continuity equation, making use of the hypsometric curve. Figure a shows a birds-eye-view of the resulting geometry for the Vlie Basin. Note the similarity with the sketch made in Van Straaten&Kuenen (1957), see Figure b.



After setting the geometry, the waterlevels and velocities were solved with a 1D finite volume method. A comparison is made with the results of a 2D simulation. Figure c shows the mean waterlevel and the waterlevel amplitudes for M2 and M4 as function of the storage area. Markers represent aggregated 2D simulations and the solid lines the 1D simulations. Figure d shows these values for the velocity. Remarkably good agreement is found, verifying the underlying (crude) assumptions.

Now the hydrodynamics is simulated, sediment transport and morphology can be modelled. Preliminary results show a reasonable representation of the bed development over the last 70 years. The 1D approach, with newly proposed geometry, opens possibilities for quick assessments of sediment transport (including effects of biota) and morphology on basin scale.

Seafloor classification by Acoustic Remote Sensing

Mirjam Snellen, Kerstin Siemes, Dimitrios Eleftherakis, AliReza Amiri-Simkooei, Dick Simons

Acoustic Remote Sensing Group, Faculty of Aerospace Engineering, Delft University of Technology
Kluyverweg 1, 2629 HS, Delft

Description of research

For many applications it is of high importance to have up-to-date information regarding the sea- or river floor composition is. Applications include marine geology, marine biology, off-shore construction projects, as well as coastal zone, estuary and river management. When using samples of the sediment for obtaining the required information, these samples are analyzed in a laboratory, which is a time-consuming and costly process. An appealing approach, therefore, consists of using acoustic remote sensing techniques for classifying the sediments, employing measurement equipment such as single-beam echosounders (SBES) and multi-beam echosounders (MBES), which are already in common use for depth measurements. Whereas single-beam echosounders acquire a single measurement per ping, multi-beam echosounders can take up to 500 measurements per ping along a wide swath perpendicular to the direction of navigation.

Within the Acoustic Remote Sensing Group a package of acoustic classification techniques has been developed for both the SBES and the MBES. These techniques can be divided into two groups, the phenomenological (or empirical) and the model-based (or physical) approaches. In the phenomenological approaches, features such as energies, time spreads, or skewnesses are determined for the received echo signals. These features are known to be indicative for the sediment type. Independent measurements, such as sediment samples or cores, can be used to link the acoustic sediment classes, obtained from signal features, to real sediment properties or sediment type. In contrast, the model-based approaches make use of physical models and determine the seafloor type by maximizing the match between modeled and measured signals or signal features, where seafloor type, or parameters indicative for seafloor type, are input into the model. The advantage of this approach is that, in principle, no independent measurements are needed and the application of a model-based approach directly provides the sediment parameters. However, more precise knowledge about the system characteristics is required.

All acoustic remote sensing classification techniques, i.e., phenomenological and model-based, have been applied to both SBES and MBES data. The results of applying the acoustic classification techniques to various sites with different sediment composition will be presented.

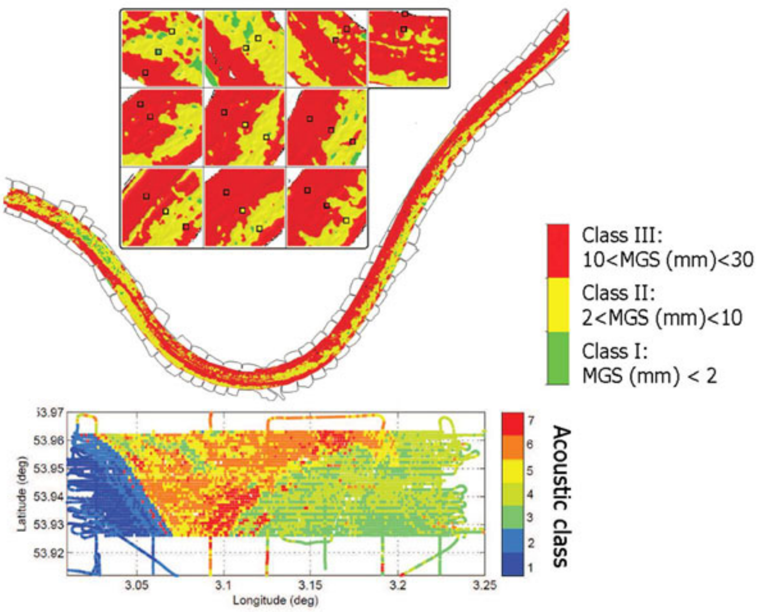


Figure 1: Examples of acoustic sediment classification results.

HOW THE PRE-EXISTENCE OF CRESCENTIC BED-FORMS CAN INFLUENCE THEIR SUBSEQUENT DEVELOPMENT

Meinard Tiessen[1,3], Nicholas Dodd[1], Roland Garnier[2]

[1)] Department of Civil Engineering, University of Nottingham, Nottingham, United Kingdom
[2)] Environmental Hydraulics Institute "IH Cantabria", Universidad de Cantabria, Santander, Spain
[3)] Currently working at: NIOZ Royal Netherlands Institute for Sea Research, Texel, The Netherlands

Over the past two decades, great progress has been made both in the monitoring and modeling of the development of nearshore bed-forms, such as crescentic bed patterns [eg. Falques et al., 2008]. However, comparisons of field measurements and observations with modelling results have to-date been unsuccessful in fully capturing the temporal evolution of these bed patterns. [eg. Tiessen et al., 2010]. One of the reasons for this is that many modeling attempts describe the development of crescentic bed patterns starting from an alongshore constant bed, whereas in reality bed patterns already exist during most of the time.

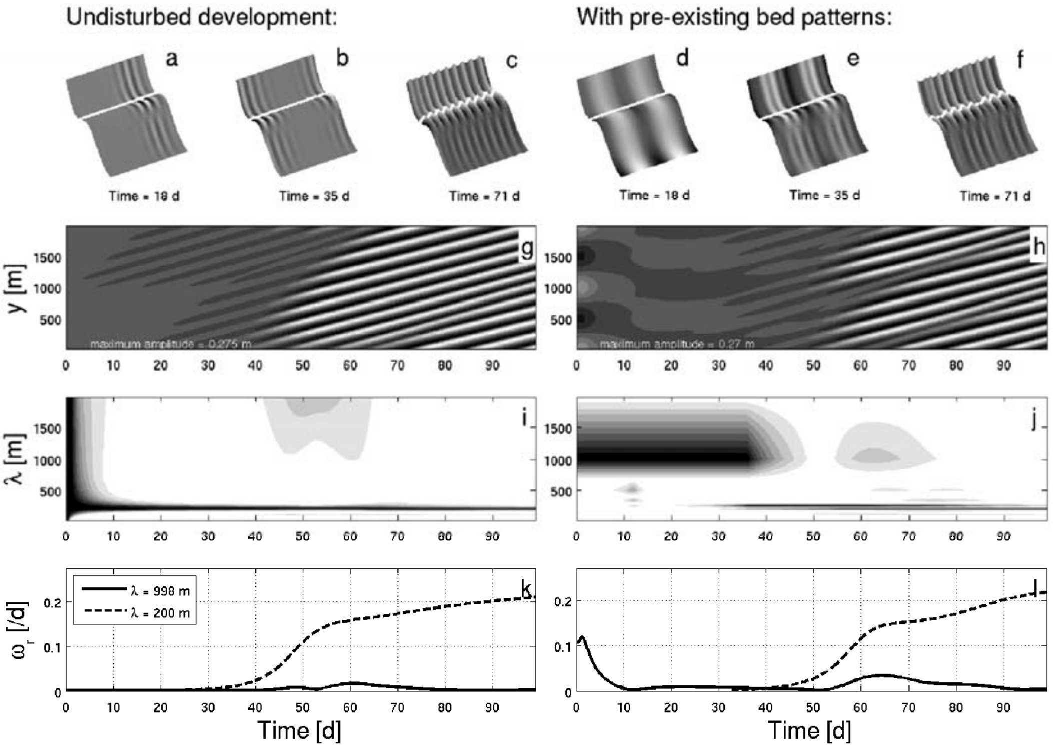


Figure 1 – The development of crescentic bed patterns from an alongshore constant beach profile (a, b, c, g, i, k) and when bed patterns already exist (d, e, f, h, j, l). (a - f) show the bed profile at different moments in time (with the disappearing pre-existing bed-form (length = 1000 m) visible in (d, e). (g, h) show the temporal evolution of one alongshore transect (white areas are crests, whereas black represents troughs). (i, j) show the dominant length scale in time. (k, l) show the development of the amplitude of the finally dominant and pre-existing length scale.

The aim of this research is to investigate to what extent pre-existing bed-forms interact with the evolution of crescentic bed-forms. To this end, various pre-existing crescentic bed-forms are introduced to a non-linear stability model (Morfo55 [Garnier et al., 2008]) and the evolution of the nearshore seabed under constant wave forcing is investigated. Results (see figure 1) show that pre-existing bed-forms cause significant changes to the evolution of the nearshore seabed. However, these effects can be closely linked to the undisturbed evolution of bed-forms, i.e. when bed patterns develop from an alongshore constant beach profile.

Falques, *A., Dodd, N., Garnier, R., Ribas, F., MacHardy, L., Sancho, F., Larroude,P., and Calvete, D. (2008). Rhythmic surf zone bars and morphodynamic self- organization. Coastal Eng., 55(7-8):622–641.*
Garnier, *R., Calvete, D., Falques, A., and Dodd, N. (2008). Modelling the formation and long-term behaviour of rip-channel systems from the deformation of a longshore bar. J. Geophys. Res., 113(C07053).*
Tiessen, *M. C. H., van Leeuwen, S. M., Calvete, D., and Dodd, N. (2010). A field test of a linear stability model for crescentic bars. Coastal Eng., 57: 41–51.*

Morphodynamic development and sediment budget of the Dutch Wadden Sea

over the last century

Edwin Elias 1) Zheng Bin Wang 2) Ad van der Spek 2), John de Ronde 2)

1) US Geological Survey, 2) Deltares

Description of research

Despite rising sea-levels the Wadden Sea, the world's largest coastal wetland and a UNESCO World Heritage Site, has sustained a wide variety of barrier islands, channels, sand and mud flats, gullies and salt marshes over the last 7000 years. Historically, sediments were delivered by the adjunct retreating barriers and coastlines. Frequent bathymetric measurements of the Dutch Wadden Sea have resulted in a unique dataset that allows the analysis of its morphodynamic evolution under rising sea-level and human constraint. The large continuous sedimentation in the tidal basins (over 600 Mm^3) and similar inlet and channel-shoal characteristics seems to indicate that the Wadden Sea is resilient to anthropogenic influence, and can import sediment exceeding the present rates of sea-level rise given sufficient sediment supply. A major constraint however is sediment availability. Over the last century multiple large and small scale interventions have basically fixed the basin and barrier dimensions prohibiting retreat, and at present much of the basin infilling is supplied by the ebb-tidal deltas that are limited in size and rapidly reducing. Without future human intervention it is unlikely that the adjacent barriers and coastlines can supply sufficient sediment to regain and keep the Wadden Sea in dynamic equilibrium to relative sea-level rise. Beach nourishments and optional ebb delta nourishments might be used to sustain sufficient sediment availability, allowing the natural processes to respond to future sea-level rise.

SCALE DEPENDENCY OF DUNE EROSION MODELS

PERFORMANCE ASSESSMENT OF THE DUROS AND XBEACH MODEL FOR VARIOUS EXPERIMENT SCALES

Peter Brandenburg[1], Jaap van Thiel de Vries[2], Kathelijne Wijnberg[1], Jan Ribberink[1]
[1)] University of Twente, [2)] Deltares

Dune erosion models are used in the safety assessment of the coastal dunes that serve as flood protection for the Dutch coast. Presently, the safety assessment is based on the relatively simple cross-shore dune erosion model DUROS (Van Gent et al., 2008). The empirical DUROS-model is designed for alongshore uniform coastlines. Since the DUROS-model is not qualified to assess storm impact in complex cases, a more generic model that includes the long-shore dimension, such as Xbeach (Roelvink et al., 2009), can be a helpful instrument. The XBeach-model contains a physical description of the most important processes that are of relevance to dune erosion in both cross-shore and long-shore direction. Since the normative storm conditions that are used in the safety assessment have never been observed, both models are based on laboratory experiments. As DUROS and XBeach are based on the same lab experiments but predict different storm impact on real scale (XBeach estimates about 70% less dune erosion), the lab-to-prototype conversion in the two models is apparently different (see Figure 1).
The above problem led to two research questions: *What causes the difference in storm impact predicted by DUROS and XBeach for reference conditions? And what consequences do these differences in storm impact have on the prediction for prototype scale?* To answer these questions the results of an existing series of lab experiments on various scales (M1263) and a field case were re-analysed and studied with the models. The selected lab experiments were chosen because the current DUROS-model was constructed with the results of these experiments.

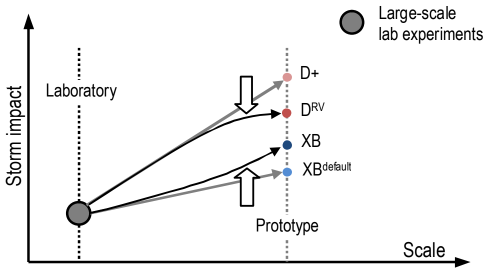


Figure 1: *Storm impact on various scales: DUROS and XBeach predict similar storm impact on lab scale (gray) but deviate for prototype application (coloured).*

Figure 2: *Dune erosion in a large-scale experiment (Deltaflume).*

Both the DUROS and XBeach-model were very well capable of reproducing the large-scale experiments. However for small-scale experiments, both models showed a lack of performance: erosion volumes were underestimated by DUROS but slightly overestimated by XBeach. Therefore, at prototype scale they were expected to resp. overestimate and underestimate dune erosion. A strong scale dependency of run-up zone characteristics was identified as one of the reasons for this. After integrating a run-up zone in DUROS, the model showed excellent performance for all lab scales. The erosion prediction for the prototype reference case was reduced by 60m^3/m using the revised model (D^{RV}) as compared to the current DUROS version D+. In case of XBeach, six numerical parameters were indentified that needed scale-dependent values in order to reproduce erosion processes on different scales: Three parameters concerned the dune face erosion algorithm, and three parameters concerned limiters in the sediment transport computation. The changes altogether led to a substantial prediction improvement of XBeach for small-scale experiments. The erosion prediction for the prototype reference case with the revised model increased to 150m^3/m (default=80m^3/m).
The modifications implemented in the two models to account for scale dependent effects in the dune erosion experiments, led to a decrease in the difference between the DUROS and the XBeach erosion predictions at prototype scale. Hence, models with more consistent performance at different scales, i.e. less *scale dependency*, are expected to be better able to predict dune erosion at prototype scale.

References

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COMPARISON OF DUNE EROSION MODELS

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Description of research

Dunes protect the largest part of the coastal areas in The Netherlands against the sea. Proper assessment of dune safety against flooding is essential, since these areas are densely populated and contain high economical value. The current dune safety assessment method, based on the DUROS+ model (Vellinga, 1986; Van Gent et al., 2008), is not applicable for a part of the coast, among others due to the occurrence of hard structures, strongly curved coastlines, very mild sloped cross-shore profiles or shoals in front of the coast. The D++ model (Deltares, 2010) has been recently developed to be able to cope with mild sloped cross-shore profiles and shoals in front of the coast. The process-based XBeach model (Roelvink et al., 2009) is more advanced, and is supposed to be able to deal with the mentioned complex situations. When applying different models for the safety assessment, consistency between the models is crucial. This study intercompares the dune retreat distances calculated by DUROS+, D++ and XBeach. To that end, 12 cross-shore profiles along the Dutch coast have been selected where the three models are conceptually applicable (Figure 1). In general it is concluded that the three models have a similar response. DUROS+ and D++ are consistent when choosing the offshore boundary at relatively deep water. For extreme conditions, DUROS+ and D++ result in a larger retreat distance compared to XBeach (Figure 2). When introducing an additional erosion contribution for uncertainty and storm duration effects to D++, as is prescribed in the Dutch dune safety assessment guidelines, it is exemplified that D++ overestimates the retreat distance with respect to XBeach.

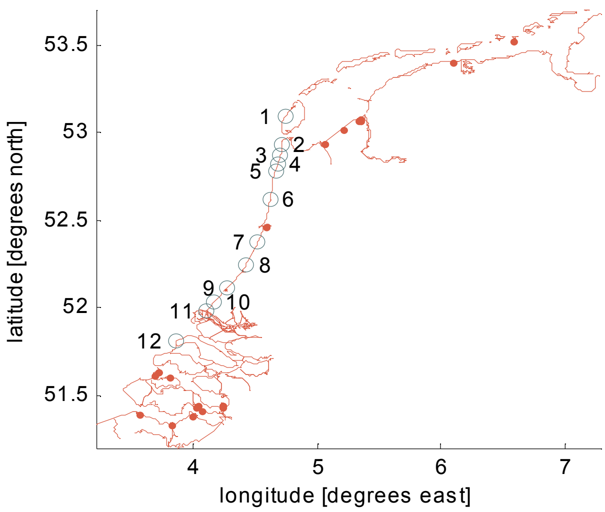

Figure 1 Used transects on map of The Netherlands

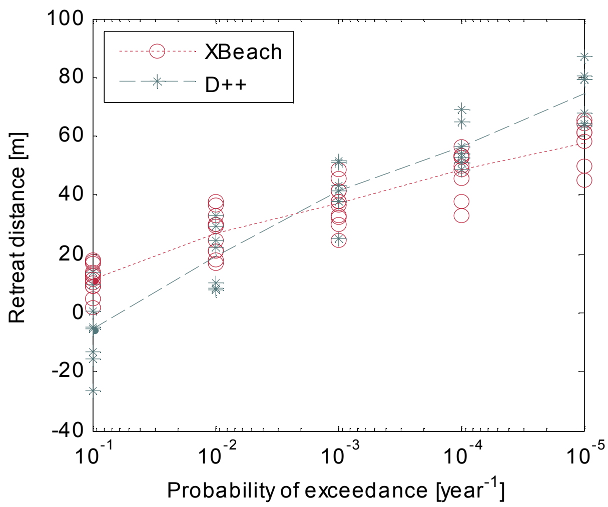

Figure 2 Comparison between XBeach and D++ as function of the probability of exceedance

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MODELLING DECADAL BARRIER ISLAND EVOLUTION

Kees Willem Pruis [1] Jaap van Thiel de Vries [2] Robert McCall [2] Ap van Dongeren [2] Nathaniel Plant [3]
[1] TU Delft
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[3] USGS

Description of research

The barrier islands in the Gulf of Mexico are regularly exposed to hurricanes, one of the main functions of the islands is to protect the mainland. Due to climate change the frequency and intensity of hurricanes is expected to change, which may affect the long term evolution of the islands. In this study these long term (decadal) morphological changes are investigated.

Objective and approach

The objective of this thesis is to find out how the long term (decadal) evolution is affected by the intensity of hurricanes and by various recovery factors.

In order to investigate the long term behavior of barrier islands a model train of a coupled storm impact model and a recovery model was created. The erosion events were modeled by making use of the depth averaged 2DH model XBeach (Roelvink et al., 2009). The recovery phase in between hurricanes is modeled with a newly developed recovery model. A schematization of the model train is shown in Figure 1.

The model train was calibrated with 8 years (2002 – 2010) of data from the Chandeleur islands, Louisiana, USA. Figure 2 is included to give an idea of the evolution of the Chandeleur islands. This illustrates the evolution of the island from 1855 to 1996.

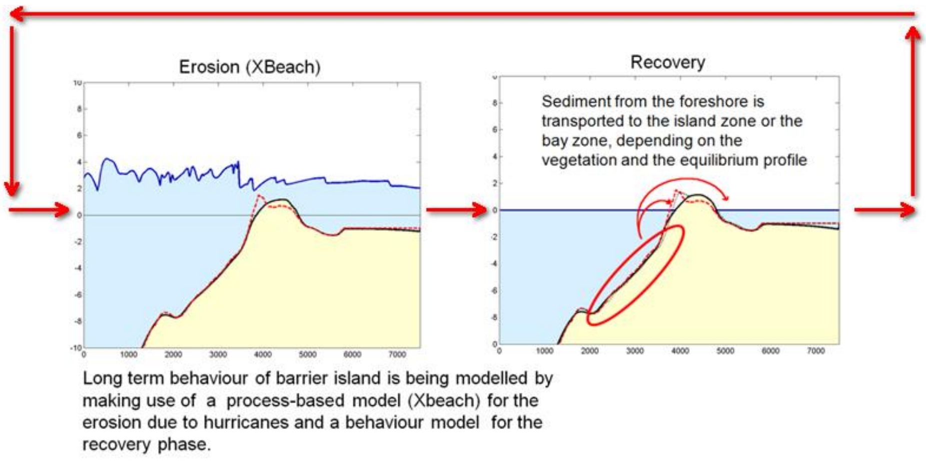

Figure 1: Model train schematization

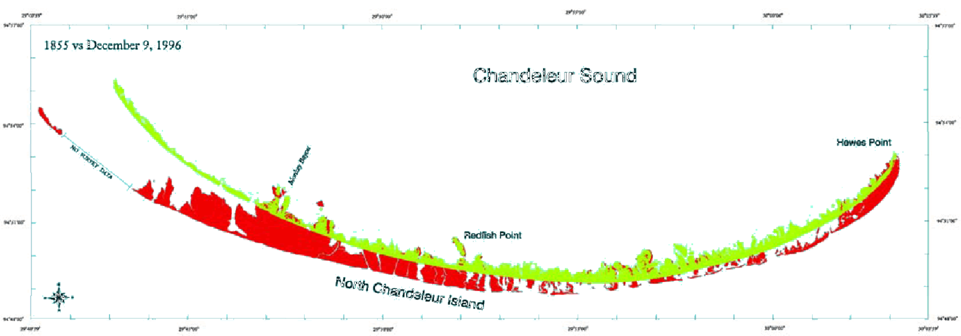

Figure 2: Evolution of the Chandeleur islands

DEVELOPMENT OF AN ADVANCED DUNE SAFETY ASSESSMENT MODEL

Bas Hoonhout[1], Ap van Dongeren[1], Jaap van Thiel de Vries[1,2], Robert McCall[1],
Dano Roelvink[1,3], Pieter van Geer[1], Marien Boers[1]

[1] Deltares, [2] TU Delft, [3] Unesco-IHE

Description of research

The safety of the Dutch sea defenses, which consists of dikes and dunes, is assessed every six years. Most of the coastline consists of dunes for which the safety is presently assessed using DUROS, essentially an empirical formula based on laboratory data. DUROS is applied under the assumption of a long-straight sandy coast and bathymetric profile, a uniform grain size diameter, a fixed storm duration and hydrograph and no non-erodible elements.

While large parts of our coast more or less satisfy these assumptions, there are notable exceptions where dune revetments, sea dikes, boulevards, variations in the dune topography, strongly curved coasts and strong bathymetric features such as channels exist. There, a simple tool does not suffice anymore and a 2D process-based model should be used for the assessment of complex features along the coast.

Such a model, the open-source model called XBeach (Roelvink et al., 2009; xbeach.org), is under development in the SBW-program (Strength and Loads of Sea Defenses). Before that, the model has been developed for the assessment of hurricane damage to the Gulf Coast (USA), and has been applied on 9 European coasts for an EU-project. The current development thrust is to make the model suitable for application in the Dutch situation.

We will show recent developments in model formulations, notably the inclusion of "hard" elements, applications on the Petten and Egmond coasts, and the development of an automated "testbed" in which data of a large number of lab- and field experiments are collected and against which the model is run on a daily basis. In this way, it is possible to track the model performance, identify undesired model results and demonstrate potential use of the model.

The figure shows still images of an XBeach simulation of a hypothetical dune erosion and inundation event near the Dutch coastal town Egmond aan Zee. The figure shows the 2D inundation of a dune valley which threatens the coastal town indirectly. Evacuation maps are generated instantly.

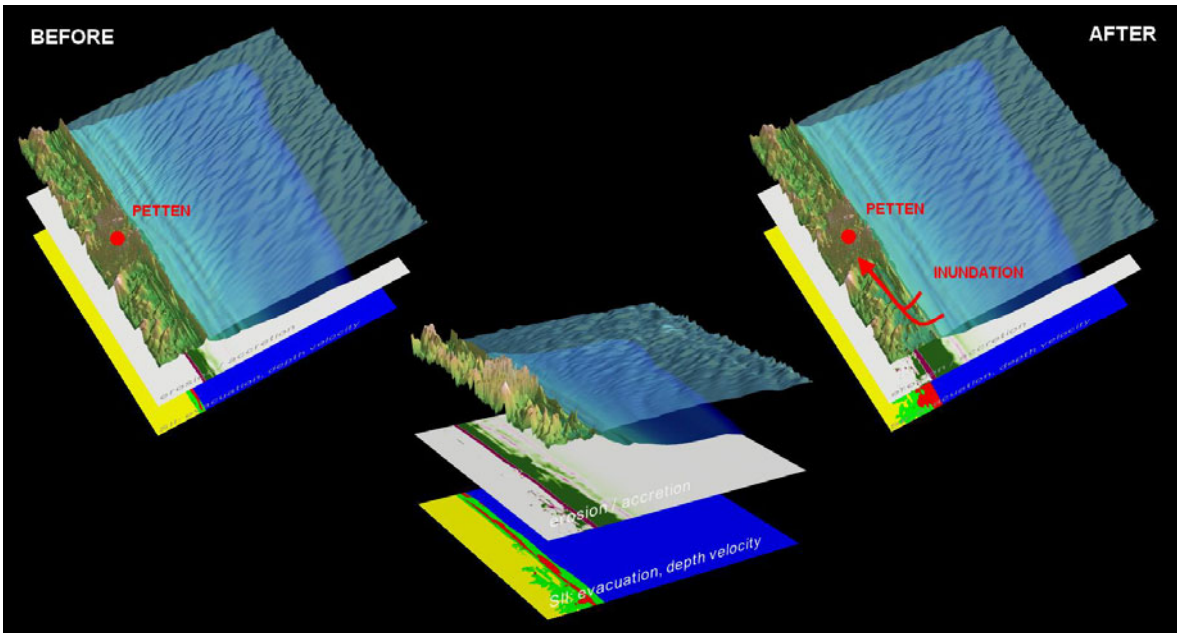

Figure 1: XBeach simulation of inundation of Egmond aan Zee

Bio-geomorphology: progress & challenges

T.J. Bouma, S. Temmerman, J. vd Koppel, M.M. van Katwijk, T. Ysebaert,

M. De Vries, P.M.J. Herman

NIOO-CEME

Abstract

The estuarine and marine environment is strongly affected by the hydrodynamic forces from currents and waves, which often form both a resource and a stress to the organisms inhabiting these areas. Organisms that inhabit these areas interact with these physical forces, thereby modifying their abiotic environment. This is referred to as ecosystem engineering, which may result in improved growing conditions for the organisms. By their activities, ecosystem engineers can have major influence on sediment dynamics in the coastal ecosystems. As a consequence, landscape formation in estuarine and marine is in many areas a bio-geomorphologic process.

In the recent decade, there has been made major progress in the field of bio-geomorphology in estuarine and marine ecosystems. For example, it has been shown for several organisms that bio-physical interactions can lead to self-organised landscapes. In our presentation we aim to i) exemplify for a limited number of model ecosystems the progress in our current understanding of bio-geomorphology, ii) discuss how this knowledge may be useful for application and iii) identify some of the challenges that lay ahead

Dissipation of wave energy over an intertidal mussel bed

Jasper Donker [1], Maarten van der Vegt [1] and Piet Hoekstra [1]

[1] Department of Physical Geography, Utrecht University

In the context of the Mosselwad project, which studies the stability of mussel beds in the Wadden Sea, we seek to predict mussel bed stability with respect hydrodynamic forcing. In order to make accurate predictions, field experiments are needed to establish representative estimates for model parameters. Our first field experiment was a six week campaign focused to measuring wave and current induced bed shear stresses acting on an intertidal mussel bed. The studied mussel bed, located in the Wadden Sea close to De Cocksdorp, Texel, is relatively young. Mussels cover the underlying substrate as a net with a thickness of 10-30 cm with increasing density toward the Wadden Sea. Wave heights, orbital velocities and currents were measured at several positions on the intertidal flat on which the mussel bed is located. In addition, measurements were performed on the local morphology. From these measurements the wave energy dissipation rate is determined, which is subsequently used to estimate the wave friction factor, bed shear stress and roughness length. Observations show that the dominant waves are propagating from East to West; this suggests that they are locally generated. Dissipation of wave energy is caused by bed friction, not by wave breaking. A large increase in wave energy dissipation is observed on the mussel bed compared with the uncovered parts of the intertidal flat. Values for the wave friction factor are 5 times as large as on the tidal flat. The large increase in measured bed shear stress is attributed to the large roughness which increases the amount of turbulence generated near the bed. Furthermore, a large decrease in wave energy is observed at the Wadden Sea side of the bed. This large decease in wave energy is caused by normal forces acting on the edge of the bed.

Figure 1: Areal photograph of a mussel bed in the Wadden Sea.

WAVE ATTENUATION OVER INTERTIDAL FLAT ADJACENT TO A SALT MARSH

Marije W.J.Smit [1], Peter M.J. Herman [1] and Tjeerd J. Bouma [1]

[1] NIOO CEME

Introduction

A salt marsh system generally consists of a vegetated marsh, some sort of a cliff edge and an intertidal flat extending into a deeper channel. To understand the role of salt marshes in coastal defense, most attention is paid to the wave dissipative effects of the marsh vegetation itself, or of the evolution of waves over the cliff edge of the marsh. Along the Western Scheldt, generally the marsh vegetation does not endure large wave impacts. We presume that the area offshore of the cliff edge plays a major role in attenuating waves prior to arriving at the marsh itself. In the current research we investigate the wave attenuation from deep water to the cliff edge using both wave models and measurements. The location of maximum bed shear stress and turbulence varies over the cross shore profile due to different water levels, different steepness and different wave heights. These variations over the tidal cycle should be taken into account in order to understand the attenuating affect of both the adjacent flat and the salt marsh itself and thus correctly estimate the effect on the coastal defense. This knowledge will give insight in the importance of the steepness and width of the flat and may thus have implications for planned changes in this cross-shore bathymetry of estuaries like widening of channels.

Figure 1: Zuidgors with 6-7Bft Southwestern storm -onshore- with installed equipment on February 4-6 2011. Waves break offshore (the white band, indicated with the →) from cliff edge (point of the camera) due to steep bathymetry instead of nearshore.

Method

Measurements are taken at Zuidgors, on the Northern side of the Western Scheldt during the Southwestern storm on 4 to 6 February 2011, with a local tidal range of around ± 2 m. The equipment was installed at depths from -1.5 m to + 2.5 m, 8 pressure transducers were used, 4 EMF's and 4 OBS's.
The wave computations were performed with SWAN to compute the locations of maximum wave impact over the tidal cycle for various wave conditions approaching the profile as measured at Zuidgors.

Results

We plan to present results from both the computations and measurements indicating the locations on the cross-shore profile where most bed shear stress occurs and where large wave attenuating affects occur. The first indicating where the profile may endure changes and the second indicating that there will be large effects on the attenuating properties of the cross-shore profile if this profile would be changed.

Hydrodynamics and mechanics of flexible vegetation subjected to surface waves

Uittenbogaard, R.E. & J.T. Dijkstra

Deltares

Abstract

The restoration of vegetation on the muddy bed of the 2m deep Lake Loosdrecht should induce a turnover (Scheffer, 2004) to better ecology as well as water quality. Since (Gons, 1986) it is assumed that surface waves erode the weak muddy bed that increases light extinction such that vegetation cannot survive. The latter is substantiated by more recent quantitative analysis (Uittenbogaard *et al.,* 2008). A solution to establish the required turnover is reducing surface-wave activity by reducing the fetch lengths of this lake. This reduction in fetch length, however, hampers sailing activities. The question is whether the reduction in fetch length can be removed after the desired turnover to a bed strengthened by vegetation is well established. This paper presents a tool for answering the latter overall question. The tool (Figure 1) combines previous research on wave-current-turbulence interaction (Uittenbogaard, 2000), on flow-turbulence-vegetation interaction (Uittenbogaard, 2003) and on the bending of flexible vegetation in steady currents (Dijkstra & Uittenbogaard, 2010).

Some underlying questions are whether the near-bed velocity and erosion is reduced directly by the vegetation or indirectly through wave damping by vegetation and whether the stem and root system can survive the stresses induced by the waves. These subjects are addressed in the 2011 NCK presentation.

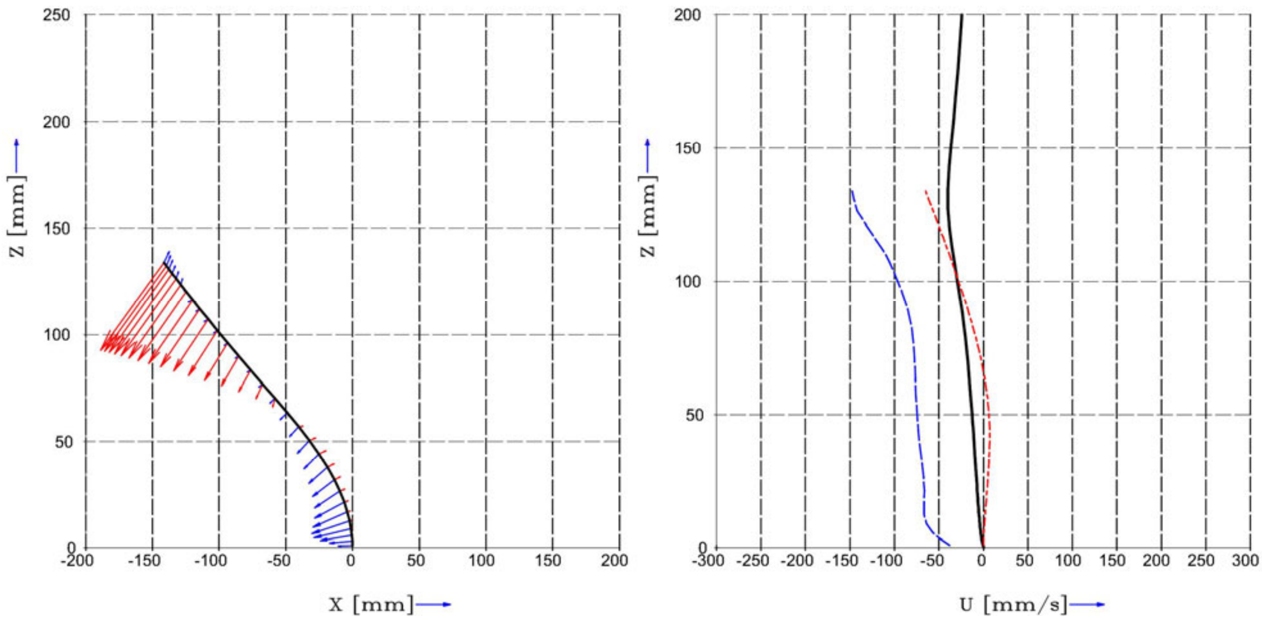

Figure 1. Left panel: the shape (black), forces (red) and relative flow velocity on flexible vegetation subjected to 3 sec. wave period with 0.15m wave height in 2.2m water depth. Right panel: the velocity (red) of the flexible vegetation, the water (blue) and the mean current (black).

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BUILDING WITH NATURE FIRMLY ESTABLISHED

M.J. Baptist[1)]

[1)] EcoShape / IMARES / NCK

Description of research

The Building with Nature programme started running in 2008. Early 2011 the programme is in full swing. A number of practical case studies are investigated in The Netherlands and abroad, such as Zandmotor, seascaping of the sand borrow area of MV2, oyster reef stabilization of intertidal areas, sand import in the eastern Scheldt, adaptation of the Frisian IJsselmeer coast, halting the degradation of Markermeer, and innovative coastal defense in Singapore. Monthly working sessions (‘ateliers’) in the EcoShape headquarters in Dordrecht have been carried out on a multitude of subjects. The Open Earth data system is filling rapidly and more and more Open Earth apps are developed to visualize and analyse data. In total 19 PhD students work on their theses within the programme, and many researchers of the various consortium partners are involved. Last, but not least, the EcoDynamic Design Guideline is getting shape.

Our integrated, ecosystem based approach in which we pro-actively tackle infrastructural challenges linking engineering with ecology and governance is getting national and international attention. We have yet to successful finish the programme with tools and knowledge that will spread around the world, but we can already conclude that Building with Nature is firmly established.

THE EFFECT OF CLIMATE CHANGE ON EXTREME WAVES ON THE NORTH SEA

Renske de Winter[1,2], Gerben Ruessink[1], Andreas Sterl[2], Hans de Vries[2] and Nanne Weber[1,2]

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[2] Royal Netherlands Meteorological Institute (KNMI)

Climate change is likely to affect the main hydrodynamic boundary conditions of many coasts. We are interested in the damaging coastal impact that changes in storm surge levels and storm wave characteristics may have, relative to the slow steady effect of sea level rise. Our study area is the southern North Sea. Severe coastal erosion mainly takes place under extreme wave and storm surge conditions. Below we discus the preliminary results of the study on the effect of climate change on extreme wave conditions.

As climate input the ESSENCE Ensemble is used. This is a 17 member climate run, based on the ECHAM5/MPI-OM climate model. The greenhouse gas concentrations follow the IPCC SRES A1b scenario. Using an ensemble run with 17 members makes it possible to determine events with an extreme return period. The wind fields and sea level pressure results of the ESSENCE ensemble are used as forcing for the North Sea wave model NEDWAM. NEDWAM is an operational model used at the Royal Netherlands Meteorological Institute (KNMI).

The characteristics of the total wave climate for the period 1961-1990 look similar to the wave characteristics for the period with enhanced greenhouse gases, 2071-2100.
For the period 1961-1990 and the period 2071-2100 the 1% highest wave heights are selected from the total dataset of 17 members. The exceedance frequencies for extreme wave heights for these two periods are similar. Although the change in wave height is small, some changes in the wave direction can be seen. In Figure 1 wave roses are shown for the 1% highest waves. For the period 2071-2100 waves come less frequently from the North-West and more often from West. Though the North-Western waves remain dominant. This corresponds with the change in extreme wind directions in the ESSENCE Ensemble.

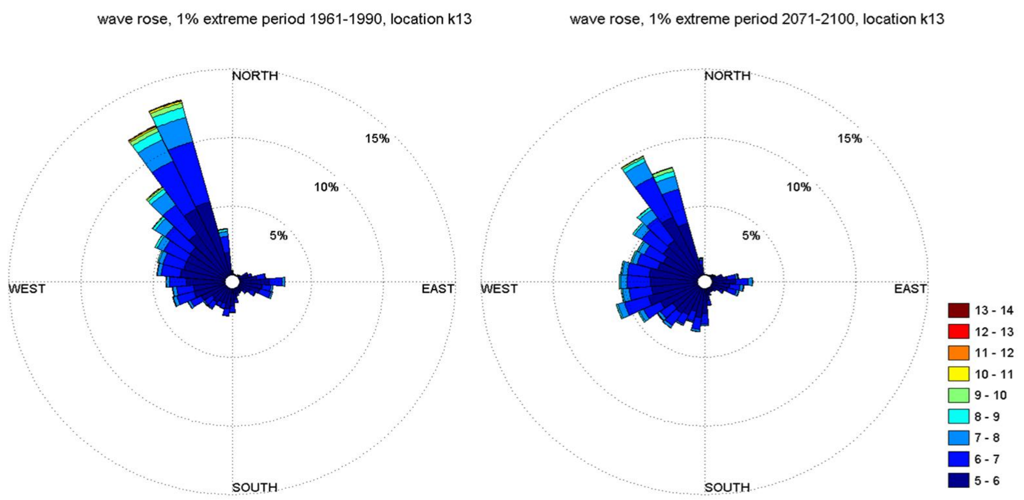

Figure 1: Wave rose for wave heights that are exceeded 1% of the time in the NEDWAM-ESSENCE data-set. Left, period 1961-1990, right 2071-2100, location platform K13.

Conclusions

- The minor changes in the wind climate do not lead to changes in the wave climate
- Extreme wave heights probably do not change as a result of climate change
- For extreme wave heights there is a small shift to more waves from the West, although the North Western direction remains dominant

Habitat factors for infaunal macrozoobenthos in a part of the Dutch coastal area.

Maarten de Jong 1[1)]
[1)] IMARES

Description of research

We investigated macro- and mesoscale habitat factors for infaunal macrozoobenthic assemblages in a part of the Netherlands Continental Shelf (NCS). Data is collected during the environmental impact assessment (EIA) of harbour authority Rotterdam (HbR) investigating ecological effects due to the construction of the Second Maasvlakte. Three hundred boxcore samples were collected during spring 2008 in the Dutch coastal zone from Vlissingen to Putten. Data on factors as water depth, salinity, conductivity, temperature, grain size distribution were collected. We used Generalised Linear Models (GLM), Generalised Additive Modelling (GAM) and regression trees to derive explanatory factors which structure macrozoobenthos in the North Sea.

We conclude that species richness and abundance is significantly affected by median grain size, organic carbon content and depth in our GAMs. 32.6-34.1% of the deviance is explained by these explanatory variables. We found a higher number of explanatory variables with regression tree analyses. For response variable macrozoobenthic clusters we found that explanatory variables depth, sorting (D_{90}/D_{10}), mud content, median grain size, and organic carbon content played a structuring role. For response variable species richness; mud content, organic carbon content, sorting, depth and median grain size were important. Response variable biomass is structured by mud content, organic carbon content and sorting.

Cluster analyses revealed a distribution pattern as shown in figure 1.

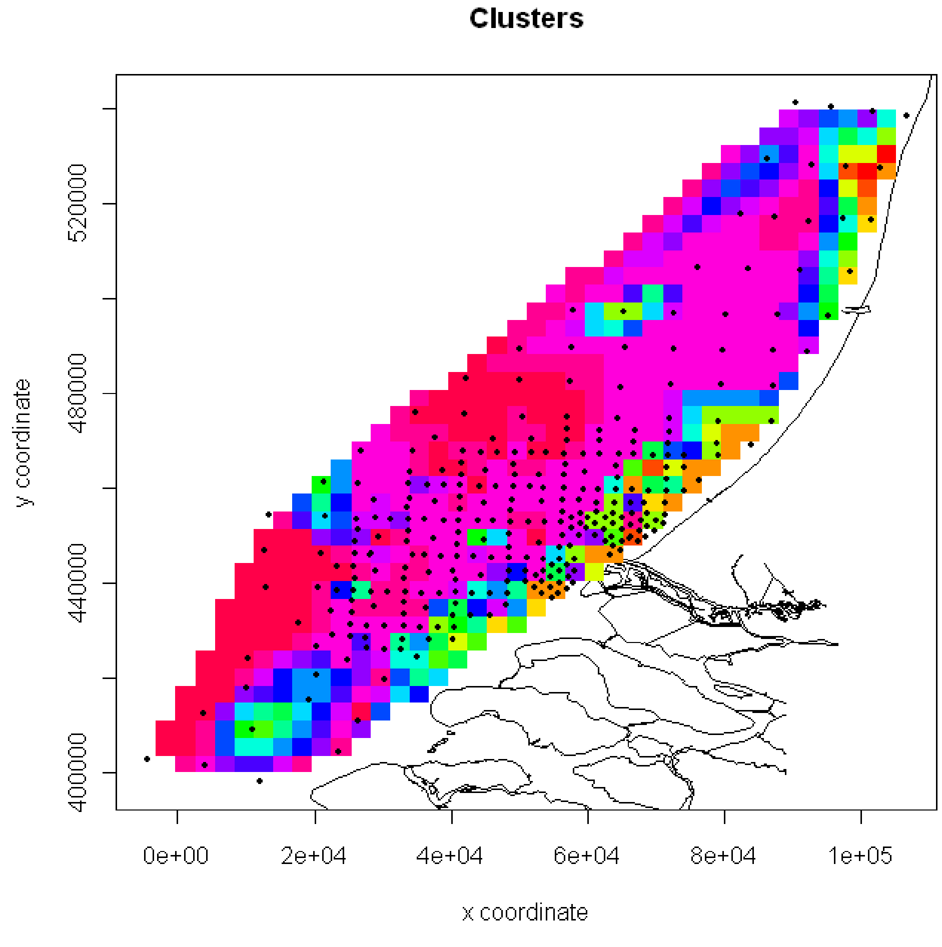

Figure 1: distribution patterns of infaunal macrozoobenthos clusters in the NCS (2008). The biological data were classified into distinct clusters by hierarchical agglomerative clustering using the Bray-Curtis dissimilarity index and average linkage (Legendre & Legendre 1998)

**MODELLING BIOTA-MUD INTERACTIONS IN ESTUARIES:
THE WESTERSCHELDE-OOSTERSCHELDE CASE**

Francesco Cozzoli 1) , Tjeerd J. Bouma1), Tom Ysebaert, 1,2) Peter M.J. Herman 1)

1) Netherlands institute of ecology (NIOO-KNAW) Center for marine and estuarine ecology (CEME)
2) Wageningen IMARES, Institute for Marine Resources and Ecosystem Studies

Although sediment dynamics is mainly driven by hydrodynamic forcing, biotic engineering of the sediments can significantly affect the outcome of physical interactions. The development of long-term, large-scale morphodynamic models must therefore be associated with semi-empirical information about the spatial distribution of benthic species and with process-based models of the biotic influence on sediment behavior. The ecological literature describes many examples of the influence of benthic biota (microphytobenthos, benthic animals) on the geomechanical properties of intertidal sediments. The reverse process, namely how mud content of sediments influences the composition of the biological community, is also well known from a descriptive point of view, but generalizations are rare or absent. Especially, accurate predictions of the distribution of benthic communities across different basins has proven to be extremely difficult. We try to resolve this question by applying a new analyses for the Western and Eastern Schelde, which differ in many aspects

The Schelde estuary, a macrotidal, turbid, nutrient-rich, coastal plain estuary situated near the border between The Netherlands and Belgium, is composed principally by two aligned 160 km long water bodies called Westerschelde and Oosterschelde. Despite the common morphogenesis and geoclimatic features, the two branches differ substantially from each other due to human interferences over recent centuries. While the Westerschelde still has open connection to the sea, the Oosterschelde was partly closed off by a storm surge barrier (Delta Works). This has abruptly reduced the in and outgoing tidal volume by approximately 30%, triggering a pronounced trend towards the erosion of the intertidal areas. Nowadays, the loss of relevant habitats and the increased pressure on the inner dams put new threats for the Oosterschelde management. Accurate predictions about the morphological evolution of the basin are needed to plan a safe and sustainable development of human coastal populations.

The influence of mud content on benthic communities is investigated through the (statistical) analysis of a large macrobenthic dataset that is available for the Westerschelde and Oosterschelde. B-spline quantile regression was used to account for realized species abundances distributions typically showed heterogeneity in variance and non-linearity along the sediment texture gradient.

The benthic communities in both systems show similarities and have many species in common, but distribution, abundance and dominance often differ. In the Westerschelde biomass is concentrated mostly in the muddy sites while in the Oosterschelde it's widespread along the sediment texture gradient. The analysis shows also a well-defined turnover of species predominance between the two basins. In the Oosterschelde, species showing preference for sandy sediment are relatively abundant. Mud-fitted ones are conversely dominant in the Westerschelde.

Availably of mud content alone is not sufficient to explain the observed patterns. Differences in species distribution could be interpreted through *a priori* knowledge about the local features of the basins. In the Westerschelde sandy bottom are consistently associated with really dynamic conditions and high abiotic disturbance. In the Oosterschelde, due to mud depletion and altered hydrodynamics, sand could yet be found at much lower current velocities. In such conditions the sand fitted species are no more limited by hydrodynamic stress and they replace the mud fitted ones, pushing the system towards a different equilibrium state.

This framework will be further extended converting the observed patterns in specific abundances in modeled effects on sediment dynamics (i.e. if the changes in Oosterschelde's species compositions have the effect to "buffer" or further "emphasize" the existing erosive trend). The final aim is to include the biotic influences into existing morphodynamic models, increasing accuracy in "biologic" and "fluvial engineering" future scenarios predictions. This project is part of the innovative program Building with Nature (www.ecoshape.nl).

Morphodynamic equilibria in short tidal embayments

Henk Schuttelaars[1)] and Miriam ter Brake[1,2)]

[1)] DIAM, TU Delft [2)] BMT ARGOSS

Tide-dominated inlet systems, such as those located in the Wadden Sea, display complex morphological behaviour. The objective of this study is to gain further insight into the physical mechanisms responsible for the observed migration of channels and their branching in these embayments. For this purpose a two-dimensional nonlinear idealized model has been developed.

The geometry, representing the tidal inlet, is assumed to be rectangular with fixed side-walls and an erodible bed. The water motion is described by the depth-averaged shallow water equations, neglecting coriolis effects. The transport of suspended sediment is modeled by a depth-integrated advection-diffusion equation and is restricted to diffusive processes only. The bed changes due to convergences and divergences of the suspended sediment flux.

The initial formation of channels is investigated by performing a two-dimensional linear stability analysis of an equilibrium bed profile that has no variations in the lateral direction. When the friction parameter exceeds a critical value, small bottom perturbations become unstable and start to grow. The unstable bottom perturbations resemble the initial formation of bed forms in the shallower areas. This result is similar to that obtained using the numerical modelling system Delft3D for the initial formation of a channel shoal system.

Using the information from the linear stability analysis, nontrivial morphodynamic equilibria are obtained using the idealized model. Close to the critical value of the friction parameter, bed forms with small finite amplitude are found. They are located close to the landward side of the inlet (see figure 1, left panel). These bed forms are in morphodynamic equilibrium. By slowly increasing the bottom friction parameter non-trivial morphodynamic equilibrium profiles are obtained with bedforms that have larger amplitudes (see figure 1, middle panel) and can show cyclic behaviour. Furthermore, the channels increase in number, form a fractal like pattern and are not restricted anymore to the landward side of the embayment (see figure 1, right panel). The physical processes involved in initiating these channel and shoal systems will be discussed and the physical mechanisms will be explained.

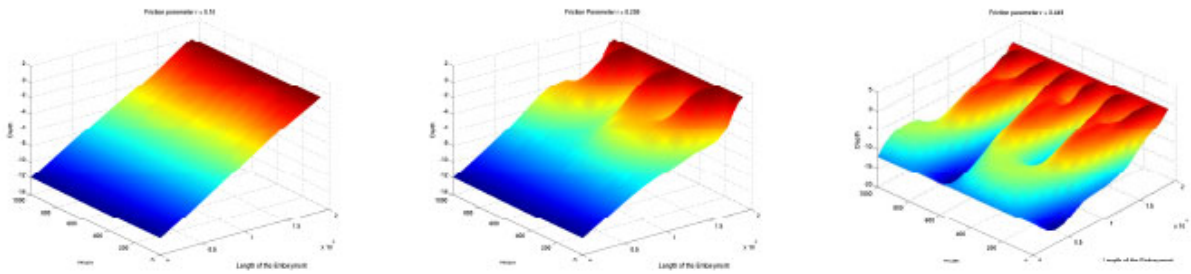

figure 1: Equilibrium bed profiles for different values of the bed friction parameter

Observations of Estuarine Circulation and Solitary Internal Waves in a highly energetic tidal channel

Sjoerd Groeskamp1[1], Janine Nauw1[1] and Leo Maas 1[1]

[1] NIOZ Royal Netherlands Institute for Sea Research

Description of research

Despite vigorous tidal and wind mixing, observations in an estuarine tidal inlet in the Wadden Sea show that during part of the tidal cycle vertical stratification and internal waves may still develop. Acoustic Doppler Current Profiler (ADCP) and Conductivity, Temperature, Depth (CTD) observations, collected over the past 6 years at 13h Anchor Stations (ASs), reveal that this occurs especially during slack tide, when there is little wind and large fresh water discharge from nearby Lake IJssel. Measurements with a moored ADCP show that in the same tidal phase strong, cross-channel circulation develops, which may suddenly reverse circulation sense due to passing density fronts. In the vertically-stratified phase that follows after the front passage, propagating mode-one Solitary Internal Waves are observed. These seem to be resonantly generated during decelerating tidal ebb currents when the (shear) flow passes a transcritical regime (Froude number equal to one). A combination of photographs (including one from the International Space Station), bathymetric data and ASs data lead to the discovery of yet another source of Internal Waves in this area. They seem to be produced during slackening tide by propagating lee waves that develop over a deep trench. We suggest that both the cross-channel circulation as well as the (Solitary) Internal Waves may locally be of importance for the (re)distribution and transport of sediments and nutrients and may influence tidally-averaged transports.

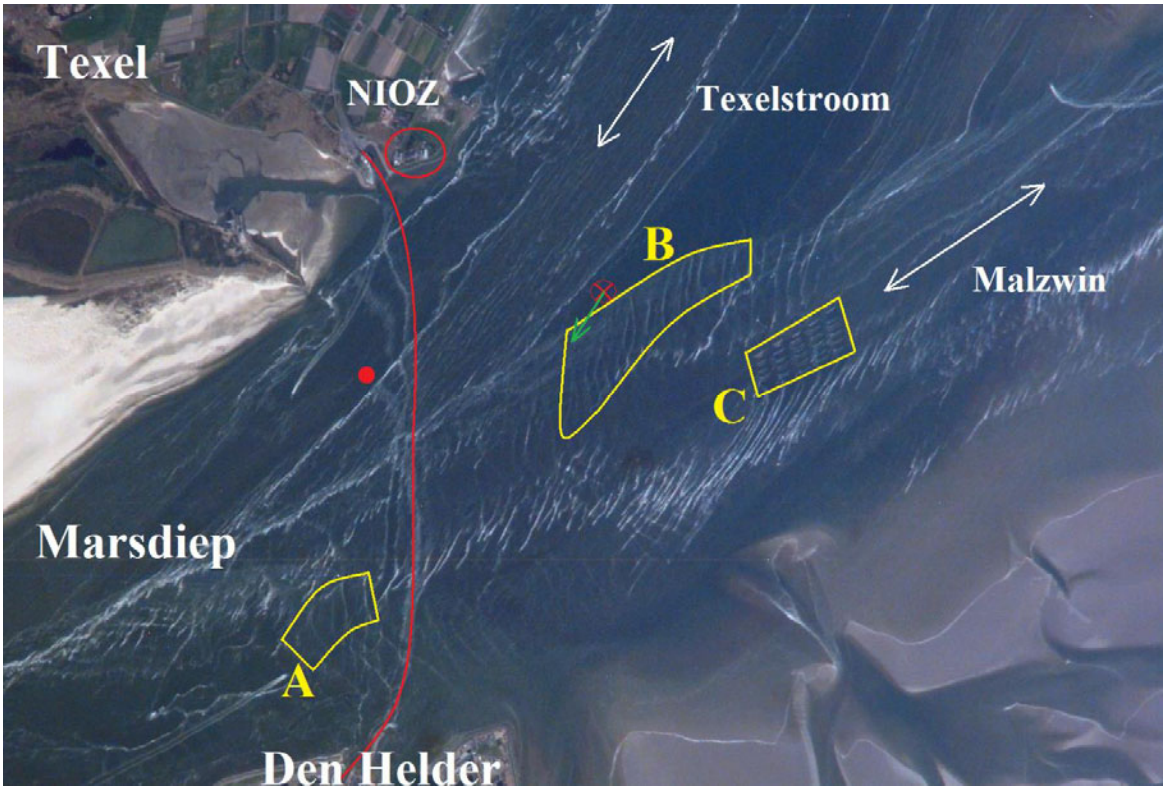

Figure 1: A photograph of the Marsdiep taken by an astronaut onboard ISS, on 1 May 2007 during late ebb. The red circle indicates the location of the NIOZ, The red cross marks the location of the deployment and the filled red dot marks the location of Anchor Stations taken by RV Navicula. The green arrow shows the propagation direction of the first soliton of ebb slack 22. The white arrows denote the direction of the two main currents. The red line is the approximate ferry track. Areas A and B, marked with yellow, indicate the locations (near the Ferry and near the deployment), where the surface expressions of SIWs might be seen. The area C, also marked yellow, is an artificial structure to breed mussels (musselseed installation).

THE IMPACT OF SEA LEVEL RISE ON THE MORPHODYNAMIC DEVELOPMENT IN AN ELONGATED TIDAL BASIN

Mick van der Wegen [1)]
[1)] UNESCO-IHE

Introduction

The impact of SLR on the morphology in estuaries has been studied only to a limited extent. Many former studies focused on a qualitative description of potential impacts on estuarine systems and implications for management. In geology, sedimentary data analysis focuses on hindcasting long-term trends with emphasis on Holocene developments. Last decade process-based modelling techniques improved and achieved realistic reproduction of morphological patterns and morphodynamic behaviour over timescales of centuries to millennia. The aim of the current research is to investigate the impact of sea level rise (SLR) on the morphodynamic behaviour in a schematized and elongated tidal basin by means of a 2D process-based modelling approach.

Model results

Model results represent basin development from different tidal forcing and different age of the basin. Imposing a rate of sea level rise gradually up to 67 cm/century, leads to significantly different morphodynamic evolution, albeit, adaptation timescales remain low and gradual. As sea level rises

- the basin 'drowns' and the amount of intertidal area decays considerably. The decay is smaller (both in relative and absolute terms) for larger tidal amplitudes;
- sediment export (seaward tide residual transport) decreases and, finally, shifts to sediment import (landward tide residual transport). This effect is most pronounced mid-basin and for relatively shallow basins;
- basin import does not keep up with SLR;
- channel-shoal pattern migration shifts from seaward to landward direction;
- basin shoal volume shows a large decay (18-135%, (with the largest difference for young basins and small tidal amplitudes). This is probably the most important parameter causing tidal assymetry (the development of an M_4 overtide) and a shift from export to import.

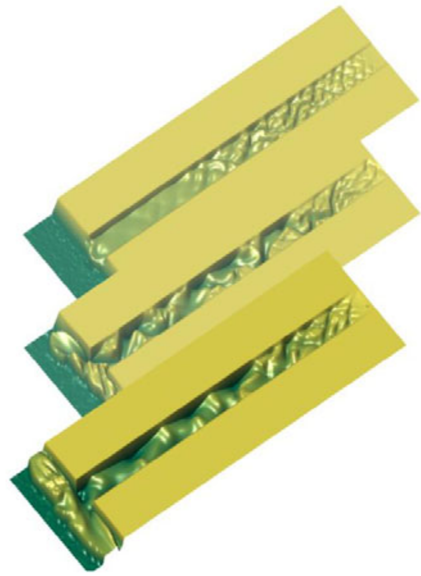

Figure 1 Morphodynamic development after 25, 400 and 3200 years (after Van der Wegen et al., 2008)

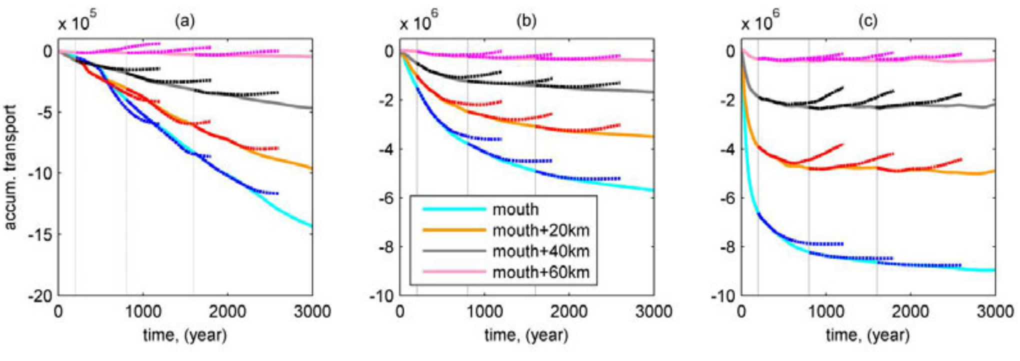

Figure 2: Accumulated sediment transport (a) for 0.85m forcing; (b) for 1.75m forcing; (c) for 3.5m forcing. Darker colours and dotted lines indicate the impact of SLR scenarios on the 200, 800 and 1600 year bathymetries respectively.

APPLICATION OF NAVIGATION RADAR IMAGES TO ANALYZE SPATIAL CURRENT FIELDS IN THE AMELANDER TIDAL INLET

Cilia Swinkels [1)] Jan Kleijweg [2)] Jos van Heesen [2)] Caroline Gautier [1)]

[1)] Deltares [2)] Tech5 B.V.

For the 6-yearly safety assessment of our flood defense structures, extreme water levels and wave conditions along the Dutch coast have to be determined. So far, the safety assessments have not been completely satisfactory, as the prediction of extreme conditions still involves many uncertainties. The Strength and Loading of Flood Defenses Programme (SBW) involves the research needed to fill in the knowledge gaps and to help improve the safety assessments. One of the research topics within SBW is the penetration of North Sea waves into the tidal inlet systems of the Wadden Sea.

For accurate modelling of the wave propagation through the complex tidal inlets, it is important to correctly include the water level and current conditions in the mouth of the inlet. To gain insight in such environmental conditions, Rijkswaterstaat conducted an extensive field campaign in the Amelander tidal inlet. In contrast to the large data set collected for water levels and waves in this campaign, current data were collected at a few locations and for a very limited period only. These scattered current measurements do not provide great insight in the complex current patterns that exist in the tidal inlet.

Since the beginning of 2010, however, analysis software is deployed on the navigation radar at the lighthouse of Ameland. The software (SeaDarQ) processes the radar data and derives spatial information on waves, water depths and currents from the radar images. This novel remote-sensed data provides the unique opportunity to assess the temporal and spatial propagation pattern of waves and currents over the whole tidal inlet. The spatial coverage of the radar data stands in sheer contrast to the point information obtained from conventional in-situ measurements.

In the present study, a comparison was made between the current fields derived from the radar images and numerical model results (Delft3D) for a hindcasted storm event in January 2010. After tuning of the model, the correlation between the model results and the radar data was found to be extraordinary good. Even for complex flow phenomena, such as eddies, tidal flow reversal and flow divergence over the ebb tidal delta, the agreement was high. Crucial in achieving this agreement proved to be incorporation of spatially-varying roughness characteristics in the model. The ultimate correspondence between data and model has increased our confidence in the performance of both the SeaDarQ system and Delft3D to describe the flow patterns in the tidal inlet accurately.

This exploratory study shows that radar data forms a very valuable data source, which will certainly be utilized in future studies. The spatial detail that the radar data provides will allow us to calibrate our numerical model not only for water levels but in future also for currents. This will improve the prediction of extreme current and wave conditions in the Wadden Sea and thus aid the safety assessments of our flood defense structures.

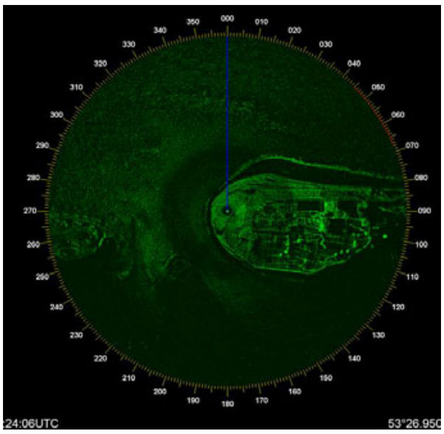

Figure 1: unprocessed radar image

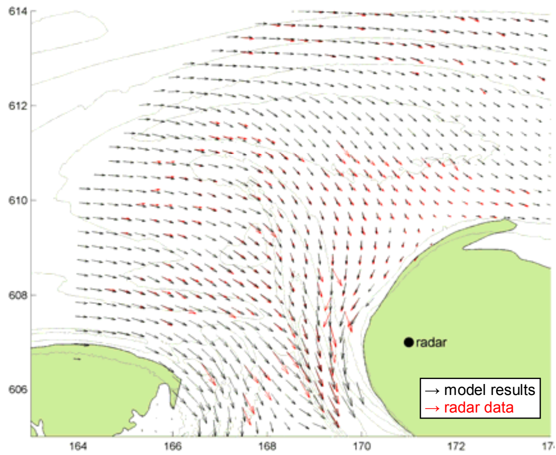

Figure 2: comparison model and radar data at maximum flood flow

COASTAL MANAGEMENT AND LONG-TERM FOREDUNE BEHAVIOUR: ON THE ROLE OF HUMANS AS GEOMORPHIC AGENTS

Kathelijne Wijnberg

University of Twente, Dept. of Water Engineering and Management

Coastal dunes that are located in densely populated areas provide various services to society, such as protection against flooding and area for recreation and nature conservation. As a result, humans will interfere with the natural dynamics of coastal dunes when these negatively affect these functions. For example, local storm erosion of the foredune will reduce the safety level of dunes as flooding defense, or the resulting steep dune front can be perceived as a public safety issue (collapse). Usually, the applied management interventions aim at restoring the pre-storm situation. As such they should result in an increased recovery rate from an erosional event as compared to post-storm recovery rates occurring without human intervention.

The above raises the question whether the usually localized and intermittent human interventions will actually interfere with the long term evolution of the foredune area (i.e. over many tens of years). This is especially of importance for the flooding defense functionality, as we can expect natural drivers of coastal behavior, such as storm climatology and mean sea level stand, to change over the next century.

By discussing results from analyses of morphologic behaviour of managed foredunes along the Dutch coast (Bochev-van der Burgh et al., 2011), it will be argued that there appears to be hierarchy in the level of impact of human interventions related to the scale at which sediment redistribution is affected, although the state of the system at the moment of intervention may also play a role. Finally, considerations concerning the long-term effect of localized and intermittent human interventions so far excluded the feedback to human use of the area. The way the coastal system responds to interventions may affect the way humans use the area, hence may trigger different types of interventions or increase the frequency of intervention, which also may interfere potentially with the long-term evolution.

Figure 1: Examples of coastal management interventions influencing foredune development: sand fences (upper left-hand panel), regular beach nourishment (lower panel), and a 'Sand Engine' mega nourishment (upper right-hand panel, artist impression from http://www.kustvisiezuidholland.nl/zandmotor)

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Bochev-van der Burgh, L.M., Wijnberg K,M., and Hulscher, S.J.M.H., (2011). Foredune management and foredune morphodynamics: A case study of the Netherlands' coast. Accepted for publication in *Journal of Coastal Conservation*

Flood mitigation in New Orleans & the Netherlands: Building with (and against) Nature

Miriam S. Belblidia

City Hazard Mitigation Office, New Orleans
Guest researcher at TU Delft through Fulbright Water Management fellowship

Description of Research

New Orleans and the Netherlands have much to gain from sharing flood mitigation expertise, as the viability of both places depends on interventions in natural deltas to minimize flood risk. Technical approaches to large-scale mitigation have included levees (dikes), floodwalls, and other constraints on the natural system. While these measures have been largely successful at reducing seasonal flooding, they have also come with unintended consequences: increased subsidence rates, urban development in at-risk areas, and a reduction of residents' risk perceptions. In New Orleans, the engineering failures following Hurricane Katrina illustrated the devastating effects of a breakdown in such large-scale flood mitigation measures.

New Orleans' post-Katrina recovery necessitates consideration of historical mitigation approaches and the unintended consequences of interventions in the natural system. Historically, residents in the dynamic Mississippi Delta reduced their flood risk through raised home construction. Reliance on technical, large-scale mitigation became the norm in the 20th century; however, following Hurricane Katrina, there has been a resurgence in home elevations to deal with residual risk at the City level. This presentation will explore flood mitigation approaches in New Orleans and the Netherlands, with a focus on the role of building with respect to the natural system and the lessons of unintended consequences in flood control.

Figure 1: An example of historical flood mitigation approaches in
New Orleans, in which houses were designed to be resistant to flooding.

Working With Water in the California Delta

Katie Jagt [1)]

[1)] US Fulbright Fellow, TU Delft, Deltares

Description of research
The California Delta, at the confluence of the Sacramento and San Joaquin Rivers, is an inland river delta and the largest estuary on the west coast of the United States. It is comparable in size to the Netherlands in terms of area of land below sea level, kilometers of levees, and number of dike rings. The California Delta water provides drinking water to 25 million people, irrigation to some of the most productive farmland in the United States, as well as a home to 20 endangered species and the large urban centers of Sacramento and Stockton. When the delta was first settled in the mid 19th century, the prevailing attitude regarding draining the inland sea, land reclamation, and flood control was subjugation of nature. Less than a century later, after several large and costly failures, the approach necessarily changed. Since that time, adaptations have been made to allow parts of the California Delta to function as they would under natural conditions and this has resulted in improvements to safety and ecosystem function. Today, efforts are underway to develop comprehensive water management plans that give equal weight to the anthropocentric and environmental needs in the delta and estuary. This presentation will review some of the strategies California has historically used and is currently proposing to work with the functions of the natural water systems for the benefit of both humans and the environment.

Figure 1: The Yolo Bypass near Sacramento, California can function as a floodway for high river flows, land for agriculture, and as habitat for several endangered species.

4.2 Abstracts for posters

Storms of the 18th century at the Dutch Coast

Fedor Baart[1,2], Marcel Bakker[3], Ap van Dongeren[2], (C.) Kees den Heijer[1,2], Sytze van Heteren[3], Mark van Koningsveld[1,4], Marije Smit[5], Arend Pool[6]

[1] TU Delft [2]Deltares [3]TNO [4]Van Oord [5]NIOO-KNAW [6]Provincie Zuid-Holland

Coastal and river flooding are the main natural hazards in the Netherlands. To reduce flooding risks, primary sea- and river-defense systems (i.e. dunes and dykes) must have minimum elevations as defined in periodic assessments based on monitoring and modelling data. The safety standard defined for the Dutch coast is based on an exceedance probability of a 1/10,000 per year storm surge. The use of this extreme scenario is a direct reflection of the fact that the economic centre of the Netherlands is situated below sea level, in the area most vulnerable to flooding. Working with extremely low exceedance probabilities results in statistical challenges, as extreme storm surge events are likely not represented in the much shorter tide-gauge records. To quantify such extreme storm surges, the distribution of observed surges is extrapolated by applying extreme value statistics. Using this technique an estimate can be given of properties of the 1/10,000 per year storm surge. On the basis of the last 117 years of measurements Brink (2004) estimated the confidence interval of the surge at Hoek van Holland to have a range of 3.6 meters (2.9 - 6.5 meter).
To be able to reduce the size of the confidence interval it is not enough to have observations or estimates of high historical surges. Crucial is not only the time period but also the return frequency of such storm surges; is it the biggest in a century or is it the 2nd biggest in a decade?
Considering the above, our goal is to improve the confidence interval by estimating the surge height and morphological effect of the biggest storms of the 18th century, i.e. prior to the instrumental record, but in times with abundant, contemporaneous historical data. To constrain 18th-century storm parameters, historic maps, paintings, topographic reconstructions, analyses of sedimentary deposits and written documents are used. The distribution with the new found storm surges will be derived from these 18th-century records by the Bayesian method for updating extreme value distributions by historic observations (van Gelder 1996).

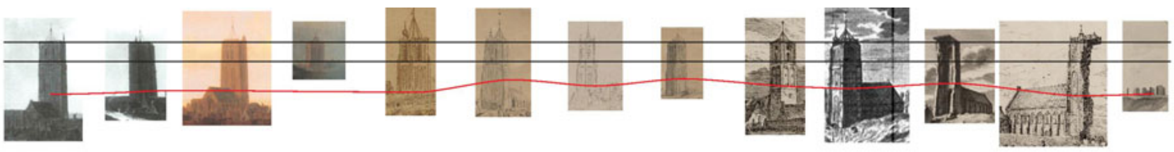

Figure 1: Estimating within and between painter reliability of the paintings of Egmond aan Zee between 1600 and 1800

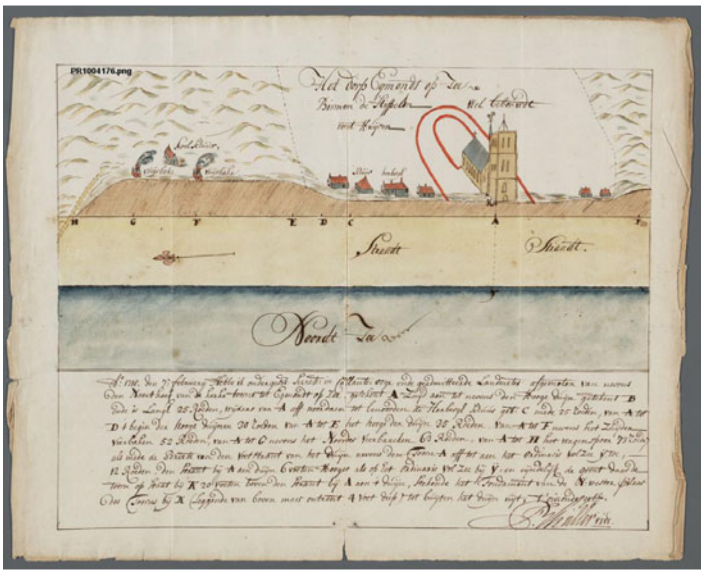

Figure 2: Field measurements after the 1717 christmas flood at Egmond aan Zee

Key processes in the restoration of mussel beds

Hélène de Paoli, Johan van de Koppel

NIOO-CEME, Waddensleutels project

Description of research:

In the western Wadden Sea, stable mussel beds have declined since 1989 and have now almost all disappeared from this area. This decline has a big influence on the entire ecosystem, as mussel beds are ecosystem engineers, providing refuge for many species, and filtering the water. To improve the prospects for restoration of mussel beds, we will try to understand the mechanisms determining to the establishment and persistence of a artificial mussel bed.

An important characteristic of establishing intertidal mussel beds is the presence of both small-scale patterns (clumps or strings separated with bare sediment) and large-scale patterns (hummocks), which are often observed in young mussel beds in the Wadden sea. These patterns are known to improve the resistance to strong current and waves.

The four main axes of our study are: the importance of patterns (1), of substrate (2), of species cooperation (3) and of stress conditions (4) on the persistence and resistance of artificial mussel beds. To carry out this study, we will perform large-scale experiments (creation of artificial mussel beds in the Wadden Sea) and small-scale experiments, focusing on specific processes that determining mussel persistence. This study will hopefully provide crucial information about how to overcome the processes that limit mussel bed restoration in the Wadden Sea.

Figure 1: Large-Scale patterns in a natural mussel bed (Bangor, UK). Source: Johan van de Koppel, 2005

COUPLED SANDBAR PATTERNS: BREAKER LINES AND DEPTH VARIATIONS

Timothy Price and Gerben Ruessink

Department of Physical Geography, Faculty of Geosciences, IMAU, Utrecht University

Nearshore sandbars, located in 2-10m water depth, can contain remarkably periodic alongshore undulations in both cross-shore position and depth. These so-called crescentic sandbars can be seen as a sequence of shallow horns (shoals) and deep bays (cross-shore troughs) alternating seaward and landward of a line parallel to the coast (see Figure 1a). In a double sandbar system, the alongshore spacing of morphological features in the inner sandbar (including rip channels) may be identical to those in the outer sandbar. This coupling is similar to the commonly observed correspondence between crescentic sandbars and shoreline perturbations, resulting in an alongshore alternation in beach width and, consequently, in locations of dune erosion. Using a 9-year data set of daily time-exposure images from the Gold Coast (Australia), we aim to characterise the patterns and typical development of coupled sandbar morphology.

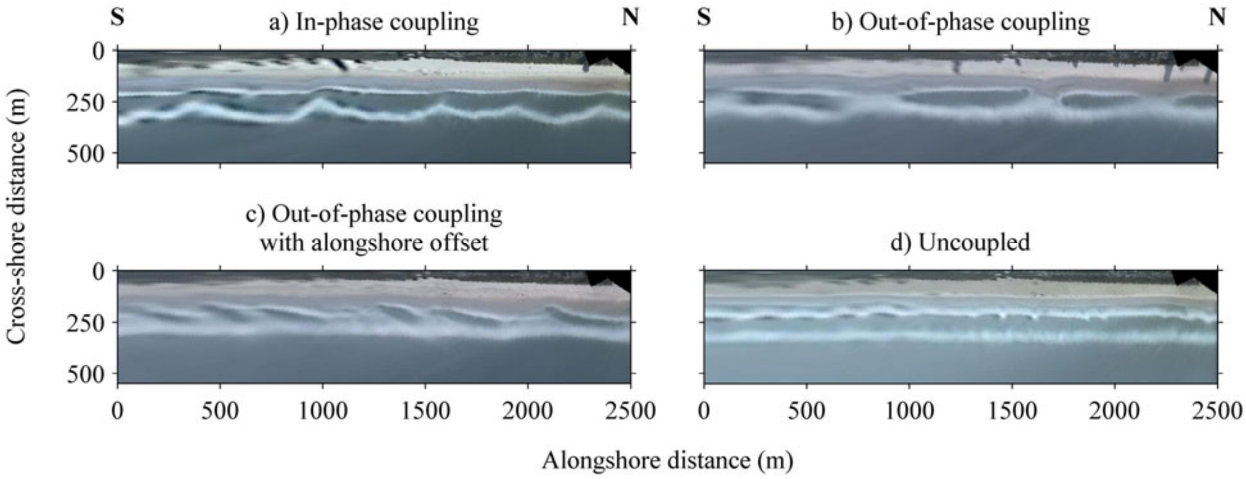

Figure 1: Examples of planview time-exposure images showing coupled sandbar morphology. The patterns of the breaker lines provide an indication of the sandbar shape and depth.

We applied cross-correlation on the optical breaker lines (barlines) of both the inner and outer bars, for detecting coupled inner and outer barlines. The barlines coupled at least 40% of the observations, of which 85% coupled in-phase (where the outer bar horn faces a landward perturbation of the inner barline; Figure 1a), and 15 % out-of-phase, during which the outer bar was dominantly attached to the inner bar (Figure 1b). We found that the large mean angle of wave incidence at our study determines the type of coupling, and leads to an alongshore offset between the coupled barline features (Figure 1c), or even straightening of the barline (Figure 1d). Furthermore, we applied a data-assimilation method (named “Beach Wizard”; van Dongeren *et al.*, 2008) to estimate the alongshore variations in depth of the outer bar, which form an important factor leading to coupled sandbar patterns (Castelle *et al.*, 2010).

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MapTable within 'Building with Nature' - interactive design and decision support

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Introduction MapTable

A MapTable is an interactive tool that can visualise geographic changes in, for example, a river bed or an estuary. The tool is based on simple but robust models which allow for a quick evaluation of different design alternatives. Moreover is it a useful communication tool for involving stakeholders.

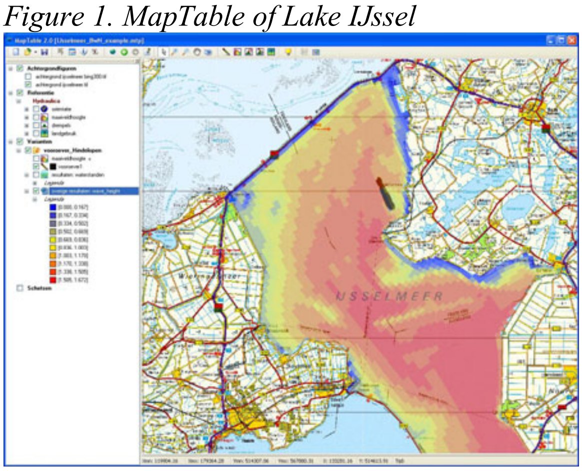
The MapTable's interface is a horizontal touch-screen onto which one can alternate the bathymetry and topography of a project area. All information that is drawn on the screen is stored in an underlying spatial database and effects can be calculated immediately. In this way, different stakeholders may together, collected around the MapTable, evaluate preferred options. All stakeholders see the effects of their design directly. This improves the dialogue.

The MapTable has proven its use in several Room for the River projects. For these projects, the hydrodynamic model WAQUA was plugged into the MapTable. This allowed visualisation of the effects of a measure on the water levels within a few minutes.

MapTable within Building with Nature

For Building with Nature the aim is to develop an extended version of the existing MapTable: a number of plug-ins allows prediction of the effects of a measure on a number of design parameters in different layers. For the case Lake IJssel spectral wave model SWAN and wave overtopping tool PC-overslag were plugged into the MapTable. Other design parameters that may be incorporated are for example morphology, ecology (PCLake), recreation, costs and benefits. Open standards like OpenEarth will be used to enhance the applicability of MapTable and to ease the coupling with plug-ins. MapTable will grow to a more flexible design tool.

Figure 1. MapTable of Lake IJssel



The extended MapTable is comparable with opportunity mapping, extended with an interactive element. It is therefore especially useful in spatial projects with multiple objectives: it assists in screening (geographical) options, ranking criteria and getting all parties involved in dialogue with each other at an early stage. By working together they will understand each other's dilemmas more easily and the search for solutions can be more focussed.

Within Building with Nature some possible applications of MapTable will be examined. MapTable will be applied in the Coast of Holland case and in the Singapore case. This involves further technical development (software) of the MapTable as well as experience in stakeholder involvement. MapTable is based on simple or simplified models. This is both an advantage (quick, interactive) and a drawback (less accurate). The results of a MapTable may therefore also be used as a basis for more advanced modelling.

Measurements of SPM 'hot spots' at the North Holland Coast

Carola van der Hout [1)], Theo Gerkema, [1)], Janine Nauw [1)] and Herman Ridderinkhof [1)]

[1)] NIOZ

The Dutch coastal zone forms a transport path of suspended particulate matter (SPM) from the Strait of Dover towards the Wadden Sea and the Norwegian Trench. The presence and volume of SPM has effects on the existence and growth of biota, because it reduces light penetration in the water column, but also contains nutrients and organic material. Engineering projects along the coast, such as the extension of the Rotterdam harbour and the Sand Engine, may have effects on the transport of SPM and thus on the survival of biota in the Southern North Sea and the Wadden Sea. However, at present the natural processes driving this transport have not even been accurately quantified. Budget studies estimate the northward transported volume of SPM to be in the order of 20 Mton per year. However, these studies do not include the nearby (0.5-5 km) and relatively shallow coastal zone. It is an area difficult to access both from sea with research vessels and from land, as the depth varies between 2 m and 15 m.

Multiple measurements of the suspended matter concentration distribution done with the 1 m draught R.V. Navicula on the coast of North Holland have revealed the presence of unexpected high concentrations near the bottom, so-called 'hot spots' (figure 1). The measurements have been done in 2003 (pilot program) and spring and autumn 2010 (Building with Nature) with the ship-mounted instruments ADCP (acoustic Doppler current profiler), CTD (conductivity, temperature and depth) and OBS (optical backscatter). Besides, water samples have been taken 1 m above the bottom and 1 m below the surface for concentration and grain size determination. The results show hot spots near the bottom of high SPM concentrations up to 200 mg/l, while average surface concentrations are 5-15 mg/l. These hot spots manifests itself around a water depth of 12 m and shows a high temporal variability over the tidal period and with varying atmospheric conditions.

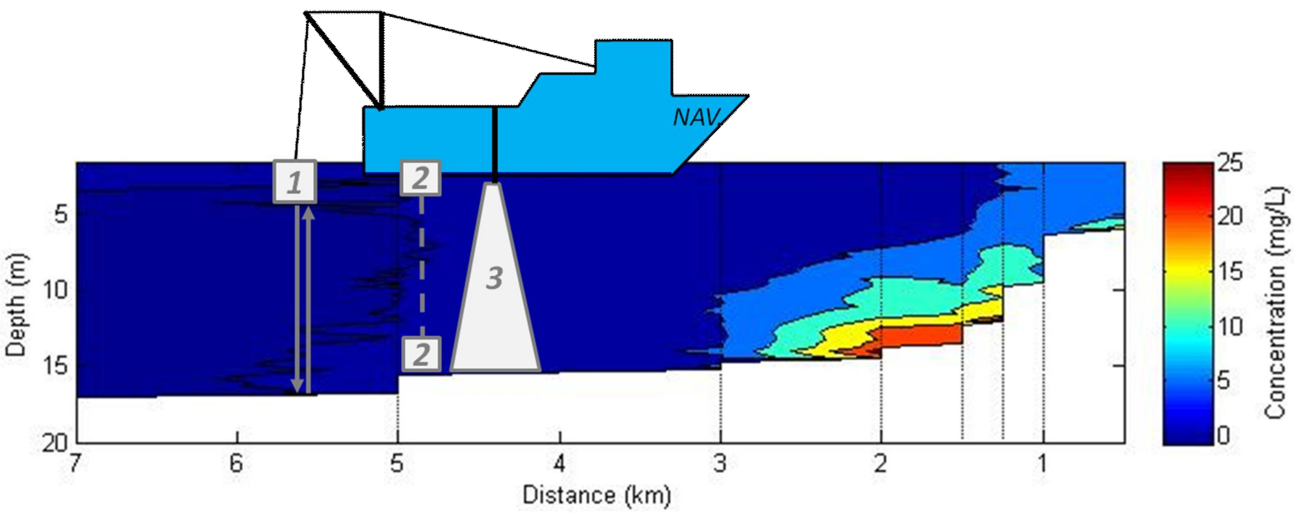


Figure 1: Nearshore cross-section of SPM concentration distribution with ship-mounted instruments ADCP (no.3), CTD + OBS (no.1) and water samples (no's.2).

INTEGRATED DESIGN OF COASTAL PROTECTION WORKS IN THE TOWN OF WENDUINE-BELGIUM

Toon Verwaest 1[)], Wael Hassan 1[)], Tomohiro Suzuki 1[)], Tim Spiesschaert 1[)] , William Veale 1[)] , Niels Balens 1[)], Koen Trouw 2[)] and Tina Mertens 2[)]

[1)] Flanders Hydraulics Research, [2)] Agency for Maritime and Coastal Services

Description of research

Wenduine is one of the weakest links on the Belgian coast for which the masterplan to strengthen sea defences along the whole Belgian coast recommends combining both beach nourishment and improvement of the dike-boulevard resistance against overtopping waves. This Wenduine case is a pilot area in the framework of the European project SUSCOD (Sustainable Coastal Development in Practise, http://www.noord-holland.nl/web/Projecten/Suscod/). It is a good location to test good practices for integrating a technical engineering design with concerns regarding touristic-recreative benefits when one increases the attractiveness of a coastal town. In other words, an integrated design is the ultimate goal.

Different alternative engineering solutions were studied to offer the prescribed safety level using numerical models (DUROSTA for beach erosion, SWAN1D for wave and empirical overtopping formulas). The design concept was selected based on the different design criteria and the requirements of the local stakeholders. The design concept consists of a combination of a beach nourishment and a parapet wave wall on top of the promenade (Figure 1). Further detailed studies of this design concept will be performed in combination with an architectural study and a technical study. These technical studies will focus on improving the simulation of waves overtopping of the dike using experiments on a physical scale model. Mutual interaction between the engineering approach and the architectural vision to improve the quality of the promenade area will result in an optimal, integrated design. To improve communication on technical aspects the engineers work on better visualizing their simulation results, both from numerical models and from physical scale models.

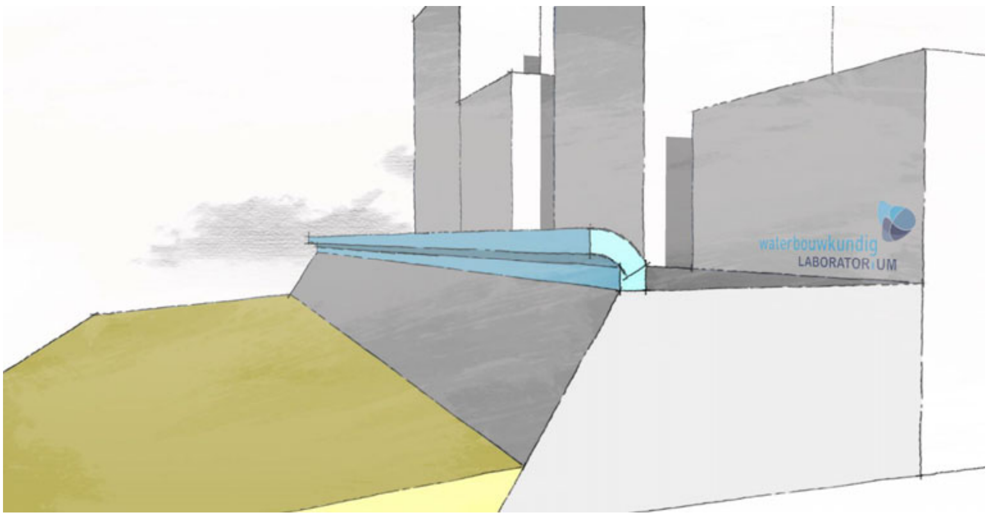


Figure 1: the design concept for the coastal town of Wenduine: beach nourishment + parapet wave wall

STRUCTURE OF THE TURBULENCE DISSIPATION IN THE SURF ZONE

Florent Grasso [1] and Gerben Ruessink [1]

[1] Institute for Marine and Atmospheric Research,
Dept. Physical Geography, Faculty of Geosciences, Utrecht University

High-energy wave conditions induce major morphological changes of sandy beaches; however, the lack of knowledge on physical processes acting in the inner surf zone limits our ability to predict accurately such storm-induced changes. It may be explained by not considering effects of wave-breaking induced turbulence on sand suspension. We use field data collected at Truc Vert beach (France) during a 18-day period in the shallow-water surf zone under high-energy wave conditions to estimate the turbulence dissipation rates at three elevations between the sea bed and the wave trough level. The vertical structure of the dissipation rate and its correlation with breaking-wave intensity (wave height to depth ratio) are investigated. The large dissipation rates up to 10^{-2} m^2 s^{-3} highlight the high-energy wave conditions of this study. The vertical structure of the turbulence dissipation rate of our data demonstrates surface-generated turbulence as a dominant source of turbulence. Nonetheless, turbulence generated in the bottom boundary layer is not negligible, especially for weakly-breaking wave conditions. As main trend, the dissipation rate increases with breaking-wave intensity; however, a saturation of the dissipation rate is observed for highly-breaking waves, which may be due to less vortex injection as waves modify from breakers into bores. Our results suggest that wave-breaking induced turbulence has to be considered in numerical models to predict accurately sediment transport in the surf zone.

Figure 1: Instrumented rig deployed at the neap low-tide water level at Truc Vert beach (left photograph) during high-energy breaking wave conditions (right photograph). The instruments measured the flow velocities at three elevations above the sea bed, providing an estimation of the turbulence dissipation rates in the water column.

MODELLING OFFSHORE SAND WAVES; A VALIDATION WITH DATA

Fenneke Sterlini[1)] and Suzanne J.M.H. Hulscher[1)]

[1)] University of Twente

Description of research

Offshore sand waves form a bed pattern that occurs in shallow seas. They show both spatial and temporal variation in their characteristics such as their height (1-10m), length (100-800m), asymmetry and migration rate (1-10m/y). Due to their size and migration rate sand waves can severely affect human offshore activities such as navigation and pipelines.

The reason for the variation in sand waves is still not fully understood. Due to the different environmental processes that are incorporated in our present sand wave model (SWC), see Sterlini (2009), parts of this variation can be modelled and understood in more detail (Németh et al. 2007, Sterlini et al. 2009). The model we use is an idealized 2DV sand wave code, which is developed specifically to describe sand wave evolution from their initial state until their full grown state. However, an in depth comparison with sand wave data has not been carried out.

In this research the SWC is compared with available sand wave data from the North Sea and the Golden Gate sand waves. It shows that, one of the largest drawbacks of our model is the overprediction of the sand wave heights, especially in shallow water. A possible explanation for this overprediction is the absence of wind and weather influences in combination with suspended sediment transport. Another reason might be that the model currently has no maximum depth for the troughs, while in reality often coarse layers occur that stop the vertical growth of sand waves.

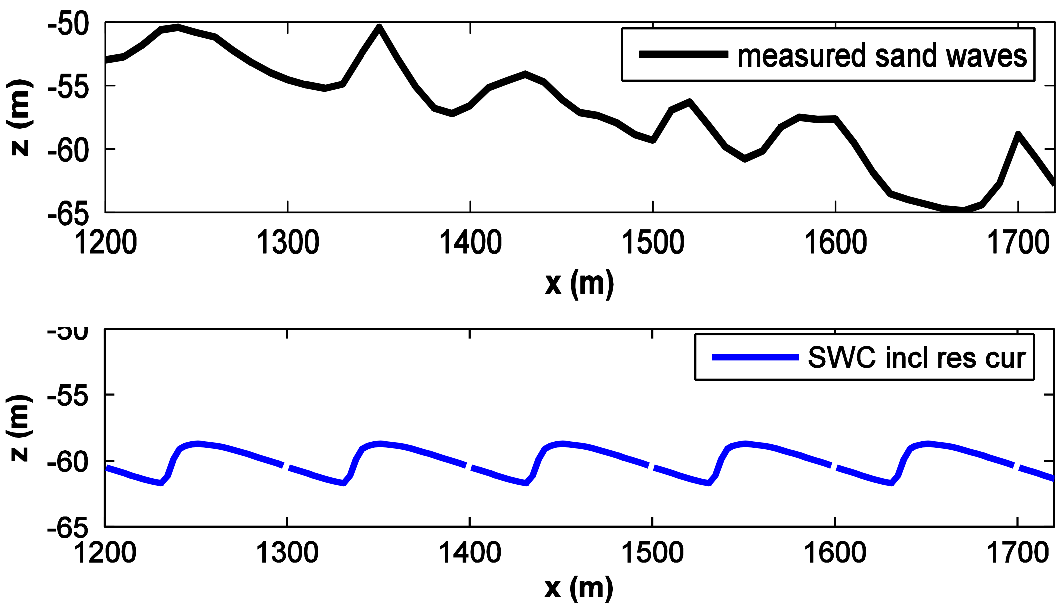


Figure 1: Comparison between sand wave data (top) and SWC results (bottom), for a transect of the Golden Gate sand waves

References:

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TURBULENCE AND SEDIMENT SUSPENSION UNDER BREAKING WAVES

Aline Pieterse[1)] and Gerben Ruessink[1)]

[1)] Department of Physical Geography, Utrecht University, The Netherlands

Nearshore sediment transport is often parameterised in terms of the wave height or orbital velocity to some power. This parameterisation does not seem to be applicable to sediment transport under breaking waves, as it is based on the assumption that sediment is suspended by near-bed processes, while surface-generated turbulence is not taken into account. Under breaking waves, turbulence generated at the surface can penetrate downward through the water column, hit the bed, and thus provide an additional mechanism to suspend sediment.
A nearshore field experiment was conducted at Ameland, on the North Sea Dutch coast in September and October 2010. Ameland beach is a very low-sloping beach (1:80) with an intertidal bar. The goal of the field experiment was to measure hydrodynamic processes, sediment concentration and transport during breaking-wave conditions. The deployed instruments are shown in Figure 1 and were used to measure vertical profiles of the water flow (from turbulence quantities to mean currents), wave characteristics and water depth, seabed configuration (absence/presence ripples), and sediment concentration.

Figure 1: The instruments deployed during the field experiment; 3 Sontek Acoustical Doppler Velocimeters ADVs, 1 pressure sensor, 5 Optical Back-Scatter Sensors and a ripple scanner. Measurements were typically performed at 10 Hz in bursts of 29 minutes. From the 3 vertically stacked ADVs we estimated the cross-shore, alongshore and vertical turbulence fluctuations, u', v' and *w', respectively.*

Our analysis shows that the turbulent kinetic energy k is positively related to the degree of wave breaking, taken here as the ratio of the significant sea-swell wave height to water depth Hs/h (Figure 2). The position relative to the surf zone also seems important for the turbulent kinetic energy. In the outer surf zone mostly low values of turbulent kinetic energy are found, while in the inner surf zone the turbulent kinetic energy shows a wider range with also much larger values at relatively low Hs/h. The relative contribution of u'^2, v'^2 and w'^2 to turbulent kinetic energy was found to have a ratio of 0.45:0.40:0.15 (Figure 3). This suggests that the vertical component is relatively unimportant, while the contribution of the cross-shore and longshore components is almost equal. At the NCK conference we will present our analysis of the characteristics of turbulent kinetic energy and the correlation between surface-generated turbulence and sediment suspension.

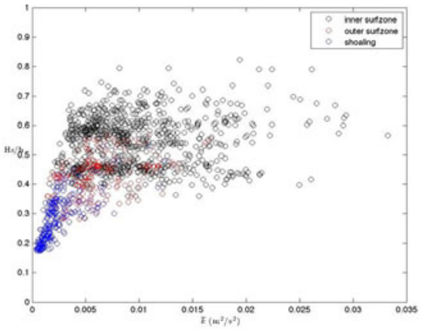

Figure 2: Hs/h against k for inner/outer surf zone and shoaling waves.

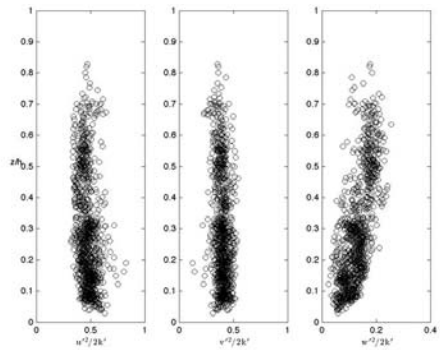

Figure 3: Relative contribution of u'^2, v'^2 and w'^2 to 2k, plotted against normalized instrument height z/h.

INFRAGRAVITY WAVE BEHAVIOUR ON A LOW SLOPING BEACH

Anouk de Bakker[1)] and Gerben Ruessink[1)]

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Introduction
The present study, part of a field campaign on Ameland (NL) from September until November 2010, focuses on the infragravity wave behaviour on a low sloping beach. Although infragravity waves are known to be important to beach and dune erosion, several aspects of the infragravity wave dynamics are not well understood. As an example, existing field and laboratory data indicate that infragravity waves dissipate energy in the very-shallow nearshore (Sheremet *et al.,* 2002; Van Dongeren *et al.*, 2007). Several dissipation mechanisms have been put forward, however there is little field evidence supporting these hypotheses. The present study is aimed at establishing the level of energy dissipation at infragravity frequencies and at pointing to the dominant mechanism for the energy dissipation on a low sloping beach.

Methodology
The data set that has been collected during the campaign comprises observations of pressure, cross-shore and longshore velocities, and sediment concentrations. The instruments were placed in a cross-shore array (see Figure 1). The array was positioned in the intertidal zone, with a total cross-shore distance of around 200 m, with a maximum water depth of around 2.5 m at high tide at the most seaward sensor. Along this transect three small triangular metal frames and one larger triangular metal frame were placed, each equipped with a pressure sensor, optical backscatter sensors, and velocity meter(s). Furthermore, ten OSSI pressure transducers were placed along the transect. The equipment typically operated continuously when submerged with a sampling frequency of 4 Hz. DGPS measurements were performed several times during the campaign.

Figure 1: Instrument array on Ameland.

Results
We found that infragravity wave behaviour depends on frequency. For higher infragravity frequencies (say, 0.02 – 0.05 Hz) the infragravity wave is an onshore progressive wave, while for lower frequencies (< 0.02 Hz) the wave exhibits a cross-shore standing pattern with nodes and antinodes. Thus, higher infragravity frequencies experience much more dissipation than lower infragravity frequencies. Most dissipation appears to take place in water depths less than 0.5 – 1 m, suggesting that infragravity-wave breaking is the dominant source of dissipation. This suggestion is confirmed by estimates of the infragravity-wave breaking parameter proposed by Van Dongeren *et al.* (2007).

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Sheremet, A., R. T. Guza, S. Elgar, and T. H. C. Herbers (2002), Observations of nearshore infragravity waves: 1. Seaward and shoreward propagating components, J. Geophys. Res., 107(C8), 3095.
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Net currents in the wave boundary layer in tunnel and flume

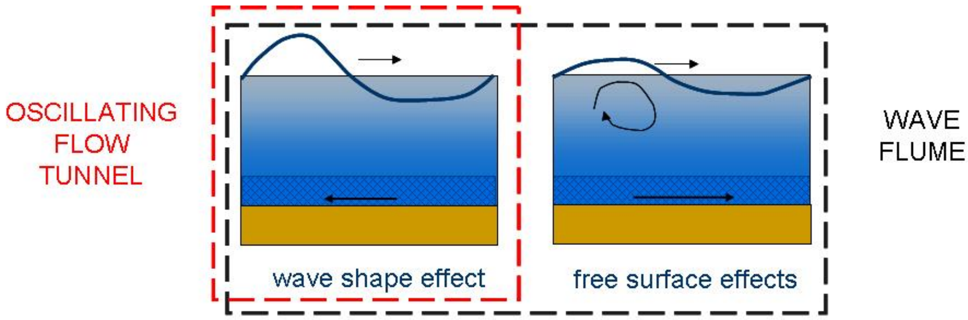
Wouter Kranenburg [1], Jan Ribberink [1] and Rob Uittenbogaard [2]
[1] University of Twente; [2] Deltares;

Introduction

Recently, Schretlen (2008) carried out full-scale wave **flume** experiments on sand transport under waves in the sheet-flow regime. In contrast to results obtained for comparable conditions in oscillating flow **tunnels** (that form the basis for most presently used sediment transport formulae), Schretlen's flume measurements show larger **onshore sediment transport rates**. A potential explanation lies within the net current in the wave boundary layer (streaming) that can differ strongly between flume and tunnel.

Contributions to streaming

The streaming is mainly determined by two competing mechanisms: 1) non-linear wave shapes (e.g. 2nd order Stokes waves) generate different turbulent behaviour during on- and offshore phase of the wave, driving an offshore current. 2) a non-zero period-averaged momentum transport by the vertical velocity in the turbulent boundary layer drives and onshore current. Note that the latter is not present in flow tunnels.



Modeling and systematic investigation

A model (RANS, k-ε-turbulence closure) has been developed to simulate both turbulent boundary layer processes and applied in a systematic investigation of the balance between the two processes. The present results, here shown in terms of normalized wave-averaged velocity U_0 at the outer edge of the wave boundary layer (left) and normalized contributions to the mean bed shear stress, offer sound parameters to include streaming in present engineering models of sand transport under waves. Next, the model will be used to study whether streaming is the full explanation of the larger onshore transport in flumes.

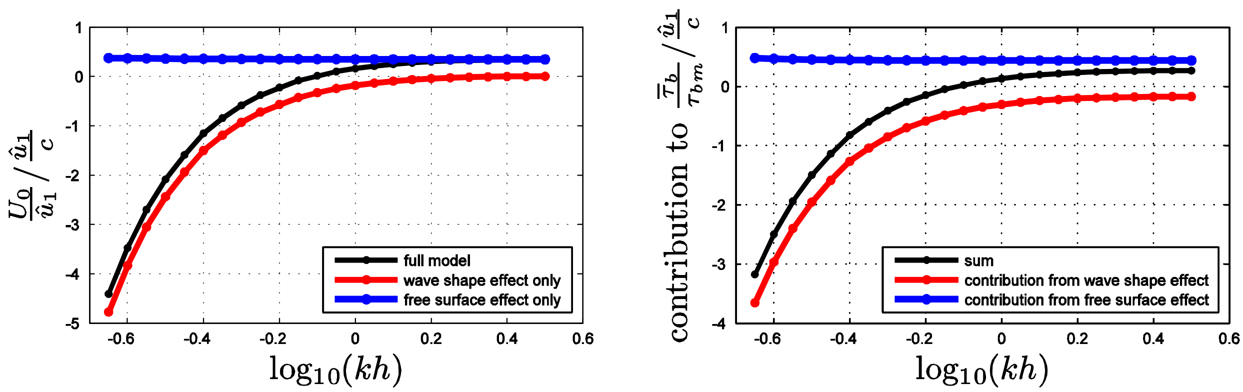


Figure 1: Normalized streaming (net current) at the outer edge of the wave boundary layer (left) and normalized mean shear stress at the bed (right). Black lines: results for 2nd order Stokes waves in a wave flume.

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Schretlen, Jolanthe J.L.M.; Jebbe J. van der Werf; Jan S. Ribberink; Maarten Kleinhans; W. Michel Zuijderwijk; Tom O'Donoghue, New high-resolution measurements of wave boundary layer flow under full-scale surface waves, Proceedings 31st ICCE, Hamburg, Germany, 2008

BALANCE ISLAND

Sander van Rooij 1) Jan Kollen 1) Jana Steenbergen-Kajabová 1)

1) Grontmij

Description of research

Grontmij has researched the possibility of the balancing the salt-fresh water ratio in the area of the Haringvliet (the Netherlands) with a principle of the building with nature. This issue driven by the necessity of the water quality to improvement in the Haringvliet, and promote fish migration onto the Rhine; the so called "slit decision" (decision to maintain a slit in the Haringvliet dam during rising tide).

The brackish water in the area gives opportunity to develop valuable nature and improve the water quality behind the dam. The disadvantage could be the necessity to relocate the fresh water collecting points and an increase risk of salinization of agricultural land. The partial control of the salt water penetration could be an advantage.

Therefore there is a Grontmij idea of the Balance Island. How come?

The natural morphological processes along the coast have lead to the formation of intertidal flats and gullies as part of the former outer delta of the Haringvliet before the closure of the Haringvliet-dam. The idea of the Balance Island is to help nature restore the natural morphology. By construction of a minimum barrier the natural morphological processes will be enhanced.

The natural island that forms can be used for further increase of the natural values, and possibilities for sustainable recreation. Approximately 100 ha of estuarine nature will develop in the area. The island can be a base for production of green energy by wind mills. The most important function of the island is based in its balancing abilities, to control the salt/fresh water ratio in the new formed estuary. The amount of mixing and in- and outflow of salt and fresh water are regulated by the design of the island and the estuary. The resulting brackish water reduces the salt water intrusion into the Haringvliet while allowing a tidal influence in the lake. The estuary itself creates optimal conditions for nature development by providing gradients in salt concentration and wet-dry transitions.

Dissipation of wave energy over an intertidal mussel bed

Jantien Rutten [1], Jasper Donker [1], Maarten van der Vegt [1] and Piet Hoekstra [1]

[1] Department of Physical Geography, Utrecht University

In the context of the Mosselwad program we study the relation between wave forcing and mussel erosion on an intertidal mussel bed. Erosion of mussels inside a mussel bed occurs when the hydrodynamical forces exceed a certain threshold. This threshold is determined by the attachment of mussels to the underlying substrate and to other mussels. A six week field campaign is performed on an intertidal mussel bed, located in the Wadden Sea close to De Cocksdorp, Texel. In this relatively young bed, mussels cover the underlying substrate as a net with a thickness of 10-30 cm. At this site the surface elevation was measured at 10 locations and in addition velocity measurements were performed at locations. From the complete dataset three periods are extracted with a few subsequently high energetic tides. The wave energy flux is estimated from the surface elevation measurements. Subsequently, the wave friction parameter is estimated from the variations in the wave energy flux. Finally, from the data estimates for the wave friction parameter are found of 0.02 and 0.10 for the tidal flat and mussel bed respectively. During one of the selected periods erosion of the mussels from the bed was (visually) observed. This erosion event coincides with the largest measured wave energy flux of 45 W/m at the bed; this is also the only period where the ratio between the water depth and root mean squared wave height exceeds the breaker threshold.

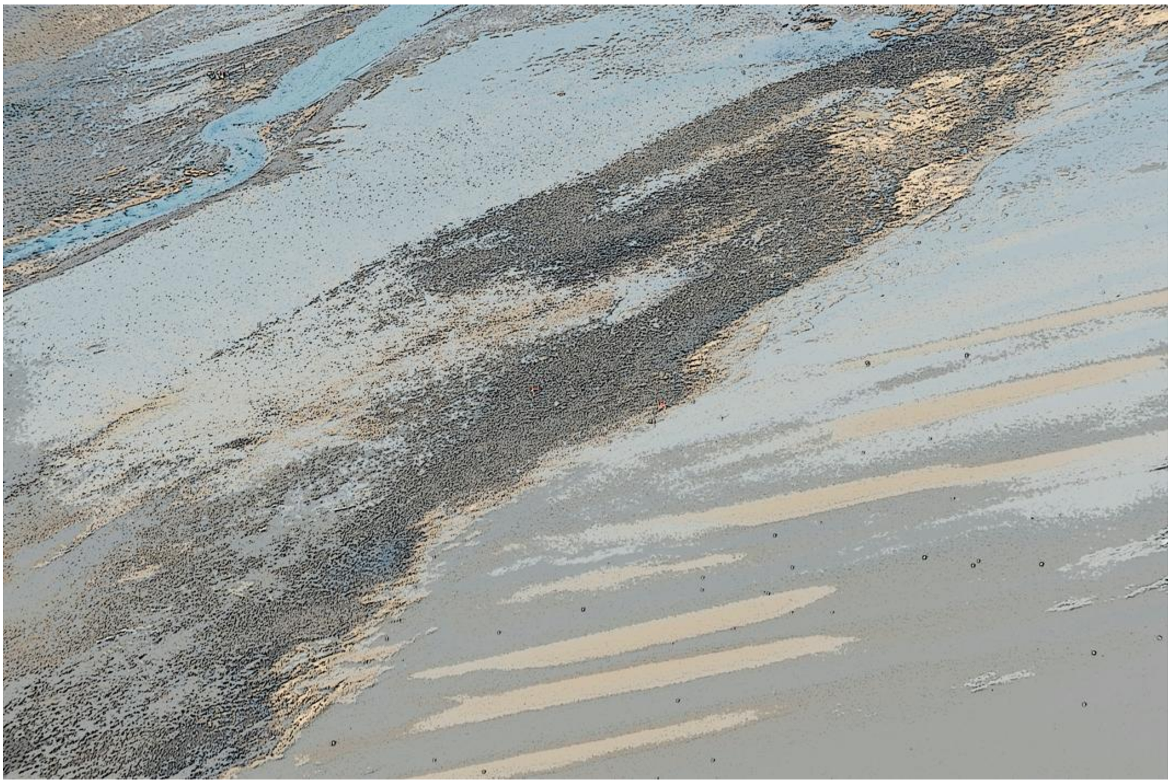


Figure 1: Areal photograph the investigated mussel bed.

A DIGITAL SEABED-SEDIMENT DATABASE FOR NORTHWESTERN EUROPE: FLEXIBLE QUERY POSSIBILITIES FOR MULTIPLE END USERS

Sytze van Heteren[1)], Vera Van Lancker[2)], Manfred Zeiler[3)], Jørgen Leth[4)], Jennifer Valerius[3)] and Patrick Kiden[1)]

1) Geological Survey of the Netherlands, PO Box 80015, NL-3508 TA Utrecht, the Netherlands
2) Royal Belgian Institute of Natural Sciences, Management Unit of the North Sea Mathematical Models, Gulledelle 100, 1200 Brussels, Belgium
3) Federal Maritime and Hydrographic Agency, Bernhard-Nocht-Strasse 78, 20359 Hamburg, Germany
4) Geological Survey of Denmark and Greenland, Ø. Voldgade 10, DK-1350 Copenhagen, Denmark

The lack of uniform surface-sediment data across European seas presents an obstacle for marine researchers and policy makers dealing with cross-border or pan-European issues. To address this problem, European geological surveys collaborate in two projects focused on the dissemination of marine-geological data to end users via two web portals: Geo-Seas (www.geoseas.eu) and EMODNET Geology (via OneGeology Europe: onegeology-europe.brgm.fr/geoportal/viewer.jsp). As part of this collaboration, a seabed-sediment map was made for northwestern Europe and the Baltic countries. This map is used by biologists as part of a European project, but only provides a single parameter from grain-size descriptions and analyses that contain much more information. In a follow-up initiative, full-distribution grain-size curves from Belgium, the Netherlands, Germany and Denmark are being merged. Upon completion, a new module in the Geo-Seas portal will allow end users to create tailor-made grain-size grids from these data, addressing their specific needs. Flexible querying is particularly useful for ecologists, who deal with species and assemblages that depend on specific sediment textures, and for engineers, who need other parameters for sediment-transport calculations than for predictions of suspended-sediment plumes as a result of dredging or aggregate extraction.

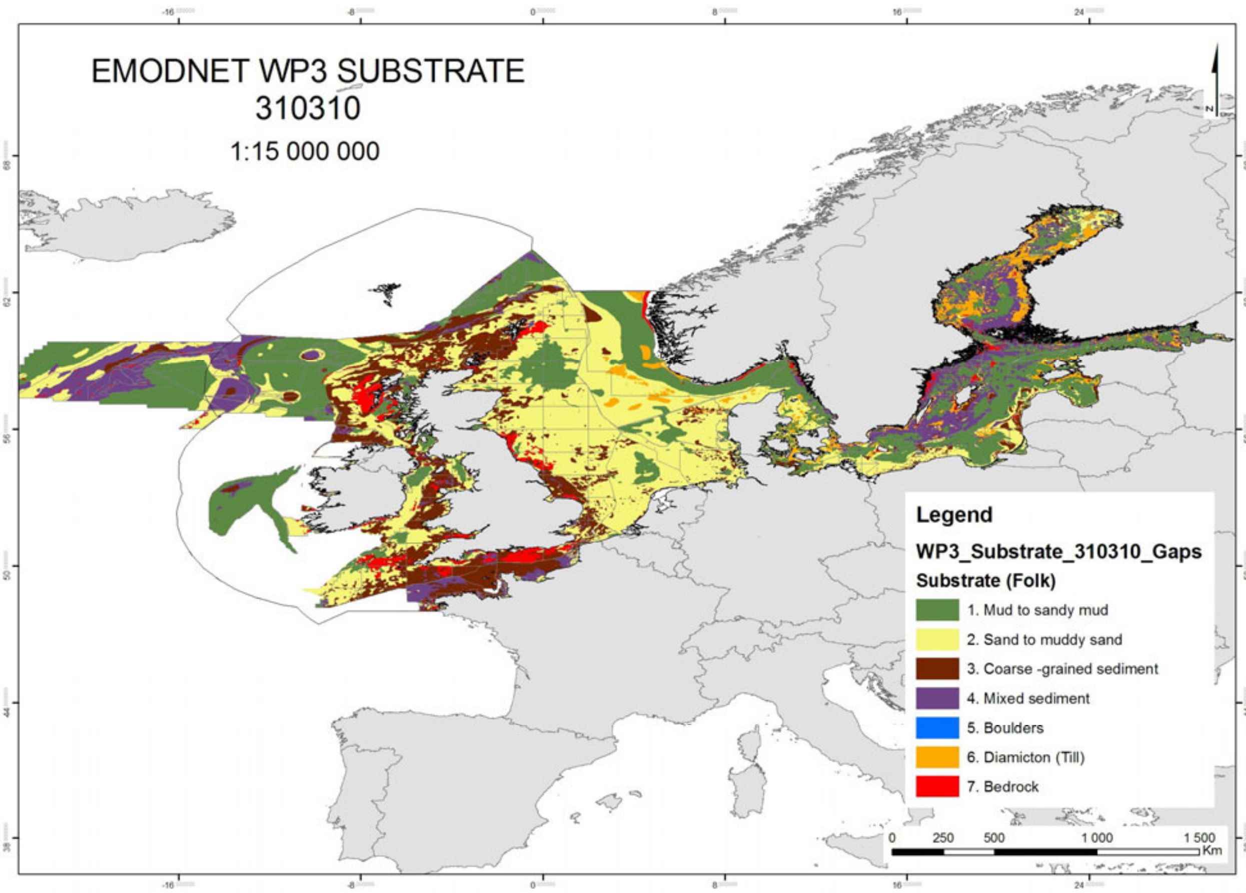


Figure 1: Seabed-sediment map for northwestern Europe and the Baltic countries.

DUNE EROSION AND OVERWASH AT SHALLOW FORESHORES

Pieter van Geer[1], Bas Hoonhout[1], Robert McCall[1], Marien Boers[1], Ap van Dongeren[1],
Jaap van Thiel de Vries[1,2], Dano Roelvink[1,3]

[1] Deltares, [2] TU Delft, [3] Unesco-IHE

Description of research

The safety of the Dutch sea defenses, which consists of dikes and dunes, is assessed every six years. Most of the coastline consists of dunes for which the safety is presently assessed using DUROS, essentially an empirical formula based on laboratory data. These laboratory data are obtained using a single, schematized dune profile that is considered representative for the coast of Holland.

Especially on the Wadden Islands, the coastal profiles are less steep compared to the Holland coastal profiles. Observations during a storm in 2006 raised questions on the validity of the DUROS concept for these shallow profiles. In order to obtain insight in the validity of DUROS for these profiles, physical model experiments are performed in context of the SBW-program (Strength and Loads of Sea Defenses). A dune profile with a wide beach, like can be found on Ameland and Schiermonnikoog was used during these experiments.

In the United States, barrier islands exist with similar profiles. For example, the Chandeleur Islands near New Orleans. These islands suffered from severe storm impacts due to hurricane Katrina in 2005. In order to provide insight in the hydro- and morphodynamics in such event, the erosion experiments are followed with overwash experiments. The data obtained will be used for validation of the dune erosion and overwash model XBeach (Roelvink et al., 2009; xbeach.org), which is currently developed in the SBW-program as well.

We will present the setup of the measurement performed and techniques used, for example, video and stereo photography. The performance of DUROS on the tested profile and it's sensitivity to profile variations will be discussed and several remarkable observations during the erosion and overwash experiments are presented.

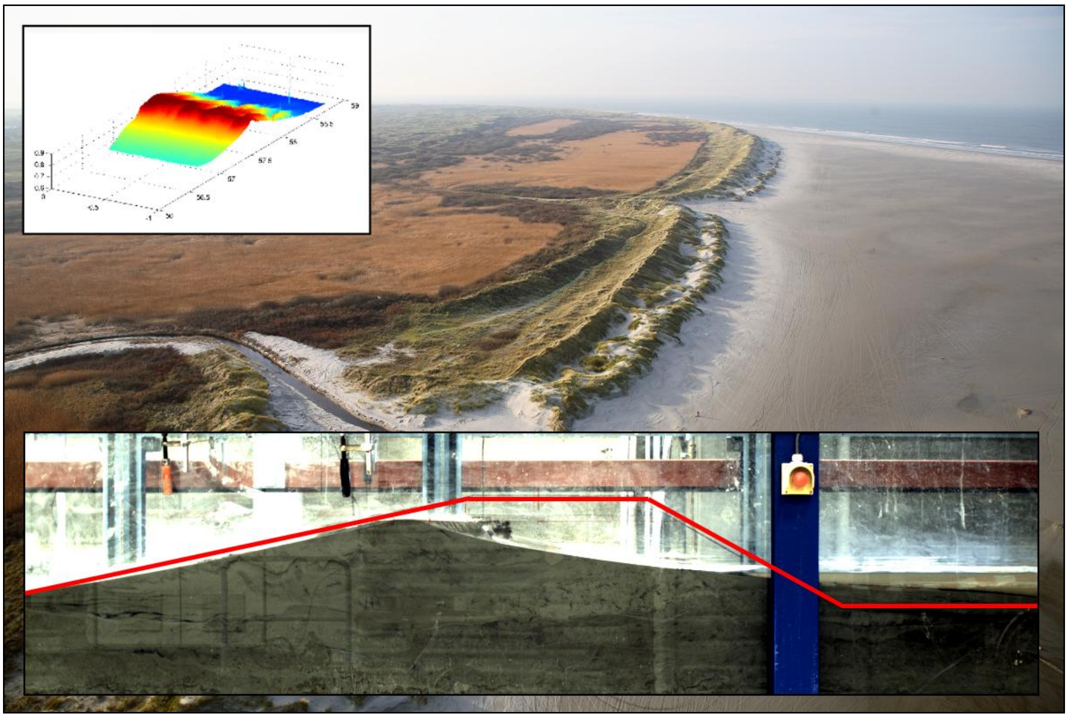


Figure 1: Coastal profile with wide beach at Ameland (background), schematization in Scheldt Flume (lower) and 3D image obtained from stereo photos (upper)

Measuring and revealing the coastal architecture

Marco de Kleine[1], Sytze van Heteren[2], Laura Vonhögen[1]

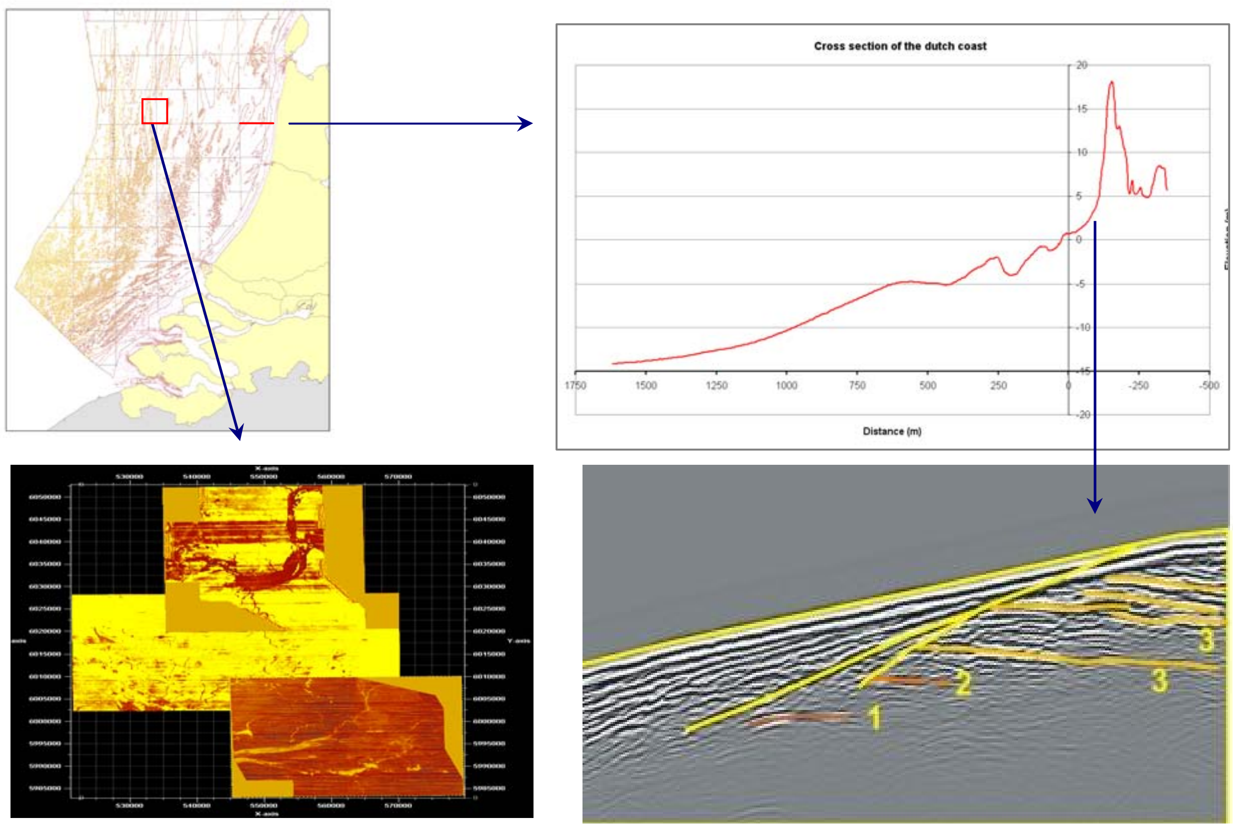
1) Deltares - Subsurface and Groundwater systems 2) TNO - Geological Survey of the Netherlands

Policy makers are increasingly forced to think about the effects of their actions on the longterm development of the coastal system. In order to make such longterm predictions, it is essential to understand the processes that take place on such time span. Geology explores the processes that have taken place in the past, by analyzing the architecture of sediments that are preserved in the subsurface.

Models are often used in addition to geology to make reliable predictions of the development of the coastal system over time. These models are nowadays able to take into account the variations in the characteristics of the subsurface. This is essential, given that the subsurface is often composed of several lithological units, which tend to vary in space and depth. Moreover, models are currently capable off rebuilding the structures found in the subsurface thus providing an opportunity to reconstruct the processes that have taken place in the past.

Due to these developments, the demand for trustworthy and detailed information about the actual subsurface composition is increasing. In order to provide this information, not only point data (1D) are necessary, but also area covering data (2D and 3D). This requires the application of geophysical techniques for mapping the coastal system. These techniques each have their strengths and weaknesses and perform well under specific conditions. By combining or integrating different techniques simultaneously in the so-called “One sweep survey”, the best and desired results can be efficiently obtained.

Still there are some areas in the coastal system in which no geophysical technique or combination of techniques has proven valuable. The challenge in these areas is to create a method which will work. And additional challenge is to translate the data measured to useful input parameters for the models and complete answers for the policy makers.



5. About the organizers

NIOZ Royal Netherlands Institute for Sea Research is the national Oceanographic Institute of the Netherlands and is one of the institutes of Netherlands Organization for Scientific Research (NWO).

Our mission consists of three parts:

- To gain and communicate scientific knowledge on coastal seas and open oceans for a better understanding of the system and a sustainable management of our planet.
- To manage the national facilities for fundamental sea research.
- To support research and education in the Netherlands and in Europe.

The institute was founded in 1876, currently employs 250 people and the annual budget is 25M€. Eleven of our senior scientists also hold professorships at Dutch universities. Our most important products are about 200 scientific publications published annually in the international open peer-reviewed literature. Our main work is of a fundamental origin ('how does the sea work?'), but we also carry out research to answer specific questions from policy-makers and industry when this merges well with our fundamental work.

De Slufter (photograph: Ecomare)

De Schorren (photograph Oscar Bos, Ecomare)

6. NCK Field trip Saturday March 19th, 2011

De Slufter & De Schorren

Saturday, March 19th, 2011

Departure:
In front of NIOZ: 10.15
From "De Pelikaan": 10.30
Arrival:
Back at the ferry: 16.30

Note: Participants are strongly advised to wear tight fitting Wellington boots when visiting the very muddy Schorren.

1: De Slufter

Arrival: 11.00
Departure: 13.00

The Slufter is a wonderful illustration of how multiple failed coastal engineering projects can lead to a beautiful landscape, and a humbling reminder of the force of nature. In the preface to this Book of abstracts we already evoked the "Zanddijk", which successfully connected the main island to Eierland in 1630. The area west of it grew steadily by dune formation and from 1855 onwards several attempts were made to close off the area by dams, but each time the dams broke, and after a final failed attempt in 1925, the idea was abandoned. The result is an area in which seawater can freely enter through a system of creeks. The flooding with salt water stamps the vegetation, such as the characteristic "lamsoor". A wide variety of birds lives in the area.

2: De Schorren

Arrival: 13.45
Departure: 16.00

The Schorren lies at the other side of the island, in the Wadden Sea. It is a saltmarsh, connected to tidal flats ("Vlakte van Kerken"), which only rarely gets completely flooded; most of the time, only part of the area is covered during high waters. It is a paradise for birds and shows a great variety of vegetation. The guided excursion takes place during low waters.

7. Acknowledgements

Organising Committee NCK-Days 2011

NIOZ Royal Netherlands Institute for Sea Research	Prof. dr. Herman Ridderinkhof
	Dr. Meinard Tiessen
	Dr. Theo Gerkema
	Ms. Carmen Blaauboer
Secretary NCK:	Dr. Bert van der Valk
Secretarial support NCK/NCR:	Ms. Jolien Mans
Graphics:	Mr. Hans Roode

Excursion to Slufter and Schorren

Guide: Kees veth, MSc.

Sponsoring

Special thanks goes to the financial support by:

- NWO - Netherlands Organisation for Scientific Research