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**WORKSHOP ON MEASURING WAVES IN THE
NORTH SEA ESTUARIES AND WADDEN SEA
MEETING REPORT**

RIJKSWATERSTAAT RIKZ

13 December 2006

 **ARCADIS**

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Participants

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Christian Maushake	Bundesanstalt für Wasserbau (BAW)	Annette Zijderveld	Rijkswaterstaat RIKZ
Denise Knoch	Bundesanstalt für Wasserbau (BAW)	Martijn Andernach	Rijkswaterstaat RIKZ
Heinz Günther	Forschungszentrum Geesthacht (GKKS)	Erik Marsman	Rijkswaterstaat RIKZ
Reiner Onker	Forschungszentrum Geesthacht (GKSS)	Rinus Schroevers	Rijkswaterstaat RIKZ
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Stefaan Gysens	Ministerie van de Vlaamse Gemeenschap	Marcel Zijlema	Delft University of Technology
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Mogens Dam	Kystdirektoratet - Danish Coastal Authority (DCA)	Johan Dekker	WL Delft Hydraulics
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United Kingdom		Iris de Jongh	ARCADIS
Travis Mason	Channel Coastal Observatory	Martine Leewis	ARCADIS
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Herman Peters	Rijkswaterstaat Noordzee		

CHAPTER

1 Introduction

1.1

CONTEXT OF THE WORKSHOP

Most North Sea countries use sophisticated wave models to calculate wave conditions for their design of coastal defences. A few years ago new insights showed that our present wave modelling knowledge for complex shallow water areas might be insufficient. In the Netherlands, reliability of the safety levels of dikes and dunes became subject to debate at locations in the Dutch Wadden Sea. Moreover, the Wadden Sea, being such a complex shallow water area, turned out to be a total blank in terms of available wave data to validate the wave models. Therefore, since 2003 wave measurements are carried out in a tidal inlet and an extended measurement program is proposed for the Dutch Wadden Sea. The expectation is that within these years and in the following years, a storm or a couple of storms will be measured in the Dutch Wadden Sea, valuable enough to calibrate and validate the wave model. Simultaneously, other useful measurement data for the validation of the wave model is looked for in other countries. International data from locations that are very similar to the study area might very well be used for the validation of a wave model.

Data from for instance locations in the German or Danish Wadden Sea can be used for model validation in the Dutch Wadden Sea. This might hold for other locations as well. Exchange of wave measurement information can therefore save money and improve risk assessments at the same time, not only for The Netherlands, but for all countries with similar problems.

Therefore, Rijkswaterstaat RIKZ started an international inventory of wave measurements in shallow areas in the North Sea and a data exchange program. The two-day workshop on 19th and 20th June 2006 in Scheveningen was an important step in that program. The workshop was a direct result of the inventory of wave measurements in shallow areas. Experts from Germany, Denmark, United Kingdom, Belgium and the Netherlands were invited to participate in this workshop. For two days they exchanged measuring methods and wave model results in order to learn from each other and to discover the benefits of sharing data, knowledge on measurement campaigns and experience on wave measuring and wave modelling.

The topics covered in this workshop will be followed up in 2007. However, the focus will be more on the wave model results compared to the measurements. This concerns wave model results of the Dutch Wadden Sea as well as wave model results of other international areas. Attention will also be given to the consequences for measurement strategies, which follow from these model results.

1.2

WORKSHOP PROGRAM

Day 1 - 19th of June:		By:
Welcome and Introduction		Leo Voogt & Rinus Schroevers
Presentation 1: <i>Wave measurements for wave model validation in the Wesser Jade and Elbe estuaries</i>		Denise Knoch & Christian Maushake
Presentation 2: <i>Wave climate in the Wadden Sea</i>		Mogens Dam & Søren Bjerre Knudsen
Work session 1		Martine Leewis & Rinus Schroevers
Presentation 3: <i>An integrated study of wave propagation in Oostende Harbour</i>		Stefaan Gysens
Closure of day 1		Rinus Schroevers
Day 2 - 20th of June:		By:
Presentation 4: <i>Petten - Measuring waves in the surfzone</i>		Annette Kieftenburg
Presentation 5: <i>Observations of Waves on Measuring Piles in the Wadden Sea</i>		Reiner Onken
Presentation 6: <i>Wave Modelling at GKSS</i>		Heinz Günther
Presentation 7: <i>Wave measurements in the Dutch Wadden Sea</i>		Herman Peters
Work session 2		Martine Leewis & Rinus Schroevers
Presentation 8: <i>Measuring waves in the North Sea estuaries and Wadden Sea (for wave model calibration) Why, where and how?</i>		Ralf Kaiser
Closure of day 2		Annette Zijdeveld & Rinus Schroevers

CHAPTER

2 Presentations day 1

2.1 WELCOME AND INTRODUCTION

Rinus Schroevers of Rijkswaterstaat RIKZ welcomed all the participants at this 2-day international workshop in Scheveningen on the subject of measuring waves. Leo Voogt, the Director Coast and Wadden Department of Rijkswaterstaat RIKZ, also welcomed everybody and was very pleased that so many people came from overseas. His hope and expectation is that the workshop will eventually lead to solving the measurement problems all participants are facing now.

The following pages present an introduction to the presentations and a brief summary of the questions and discussions. The presentations are sent on CD along with this workshop report.

2.2 OPENING PRESENTATION - BY LEO VOOGT, RIJKSWATERSTAAT RIKZ (RWS RIKZ), THE NETHERLANDS

Available wave data in the Netherlands

Digitally available wave data under stormy conditions. 1960 - present

Long records are available only offshore from the main measuring poles

In the Waddensea we don't have data at all!

Ministry of Transport, Public Works and Water Management

The opening presentation of Leo Voogt explains that Rijkswaterstaat has a problem with defining the Hydraulic Boundary Conditions for the dikes in the Dutch Wadden Sea. Rijkswaterstaat needs to know the wave height and wave length/period at the dikes for (extreme) storm conditions. The wave model SWAN can calculate these wave conditions. It is

possible that the SWAN model is not fully reliable for defining the Hydraulic Boundary Conditions in the Dutch Wadden Sea. However, Rijkswaterstaat doesn't have enough field data in the Dutch Wadden Sea to validate the wave model. Long nearshore wave records are not available and in some areas there is no field data at all. Therefore Rijkswaterstaat is interested in wave measurements nearshore, especially in areas comparable to the Dutch Waddensea. Rijkswaterstaat RIKZ is interested in the exchange of wave data in shallow areas. The measurement data of Rijkswaterstaat is available (see handouts for how to obtain that data). His workshop goals were:

- Get to know your nearest neighbours
- Exchange knowledge on field data: how, what, where and how to measure in shallow water for wave model validation.
- Exchange of modelling experience

Hopefully this workshop will result in better wave models and safer dikes along the North Sea region.

In detail Leo Voogt would like to achieve the following with this workshop:

- He wants to know if the participants experience the same wave modelling problems as Rijkswaterstaat (hindcasting). What could be the solution(s)?
- Rijkswaterstaat has started a measurement strategy in the Wadden Sea. He is interested to know what the participants think about this strategy. New measurements are costly, is there alternative?
- Rijkswaterstaat wants to complete their data-inventory. In his view a common database would be ideal.

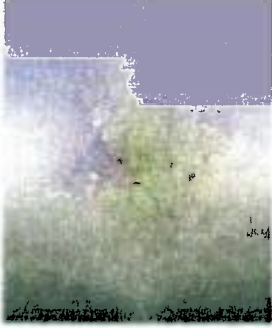
The initial reaction from the group is that sharing data is not enough. We would need to exchange everything. Apparently the UK shares the same problems, also in deeper waters (semi-offshore).

This presentation is available on the CD with this meeting report (Day 1, Leo Voogt).

2.3

PRESENTATION 1: WAVE MEASUREMENTS FOR WAVE MODEL VALIDATION IN THE WESSER JADE AND ELBE ESTUARIES - BY CHRISTIAN MAUSHAKE AND DENISE KNOCH, BUNDES ANSTALT FÜR WASSERBAU (BAW), GERMANY

**The Federal Waterway Engineering and Research Institut
– Coastal Department Hamburg (Germany)**




Wave measurements for wave model validation in the Jade-Weser estuary

part 1 Christian Maushake

- background (why are we doing what we're doing)
- measuring network
- measuring technique (ADCP waves array)
- processing

part 2 Denise Knoch

- wave model UnK
- model area and grid
- results and comparison with measurements



Federal Waterways Engineering and Research Institute (BAW) Karlsruhe • Hamburg • IJmuiden
BAW / DH / 2006-12 K2 Folie-Nr 1 Denise Knoch Christian Maushake

Presentation:

The subject of this presentation was twofold. Firstly, the wave measurements are presented that are carried out in the Wesser-Jade and Elbe estuaries. Secondly, the results of the wave model UnK were presented and the comparison of these results with the wave measurements. The data of BAW is available free of charge if a formal permission is provided and on the condition that the data is only used for research purposes.

The presentation concludes:

Modelling wave transformation from the open sea into the estuary

- Valuable field data is necessary
- Energy dissipation was reproduced well in the simulation

ADCP waves array is a robust and effective method

- But processing is not very transparent
- Moorings in tidal areas are critical

This presentation is available on the CD with this meeting report (Day 1, Christian Maushake & Denise Knoch).

Discussion:

The audience wanted to know if the BAW measures currents with ADCP as well. BAW explained that they do (at the same locations as they measure the waves), which is an advantage of this system.

The results in the presentation show a disturbance (of a ship wave) in only one of the lines in the spectrum. The participants were interested to know what was the cause of that. It is not probable that this is caused directed by a ship. Rinus Schroevers suggested it may have something to do with stratifications. To his knowledge the disturbance is caused by internal

waves. It is possible to verify this by checking a pulse in the data. These do start off by ship waves. He also explained that these are not tide dependent in the Netherlands.

From the discussion it appeared that there are two (Danish and Dutch) participants that use same processing equipment/instrumentation.

There was a question from the audience whether water levels are taken into account in the model. BAW explains that that is the case and a modelled wind field is also taken into account in the model.

The audience was also interested in why the ADCP's were located at the points presented. At what locations in the river are they, in the middle of a channel or nearshore? BAW explained there are various factors to select the measurement locations. For example Fedderwarder Priel might have been chosen because of political interests. One station is in the main channel and another in a side-arm of a channel. Also an important factor is where it was allowed to place a station.

The main thing BAW would like to achieve with this workshop is learning more on measuring waves nearshore.

2.4

PRESENTATION 2: WAVE CLIMATE IN THE WADDEN SEA - MOGENS DAM AND SØREN BJERRE KNUDSEN, KYSTDIRECTORATET, DANISH COASTAL AUTHORITY (DCA), DENMARK



Presentation:

The DCA presentations explained which measurements are carried out in the Danish Wadden Sea. At what locations the measurements are carried out, explanation of the instruments that are used (such as WAMOS, S4 and ADCP) and some measurement results at storm surges.

This presentation is available on the CD with this meeting report (Day 1, Mogens Dam & Søren Bjerre Knudsen).

Discussion:

One of the participants wanted to know if S4-measurements gave any new information. The answer was that an analysis still needs to be done on the wave periods. Dspec in this context is the pressure.

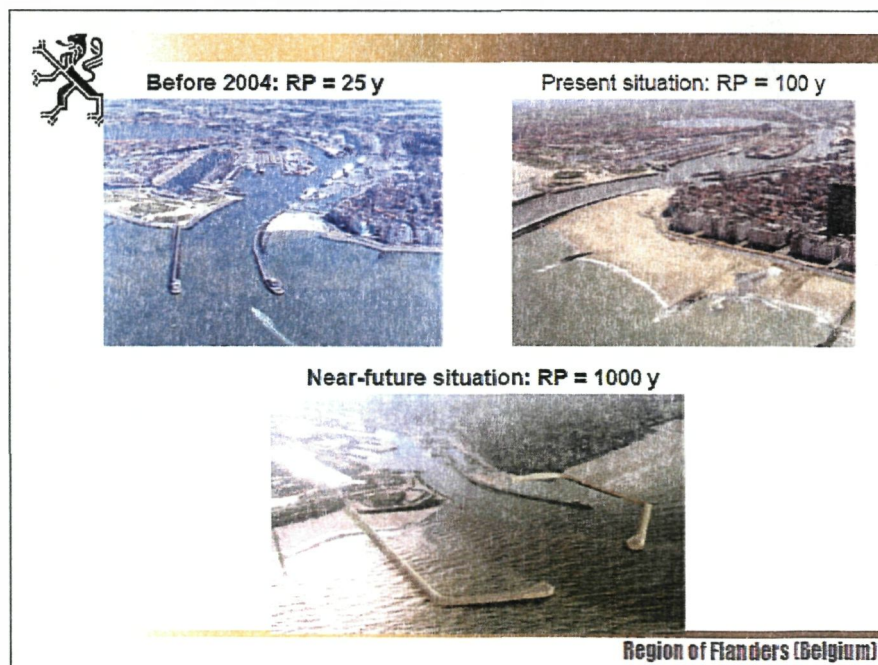
The participants wanted to know who has experience with WAMOS in the Wadden Sea. WAMOS is basically a wave instrument. Current influences waves, but currents are not affecting waves when perpendicular. Waves from the west are a problem for WAMOS. However, DCA has similar problems with other wind directions. WAMOS is one of the instruments with overviews in space. With all other instruments you only see one point. In the future, these two things need to be combined. WAMOS is also a processing system. Verona is used as well. The pulse length is short. The 1999 storm had a wind speed of 30-35 m/s. The measurement periods of WAMOS are after this event and not during.

The audience was interested in how to deploy moorings in shallow waters. DCA explained that it is not easy, but it is done with a nylon rope. In the discussion it became apparent that there are three other institutes with the same problem. (The minimum depth is 4 to 5 meters, but in very low tidal area.)

Is there acceptance in waiting for years until a large storm will appear? DCA explains that it is, because the measurements are very low costs.

2.5

PRESENTATION 3: AN INTEGRATED STUDY OF WAVE PROPAGATION IN OOSTENDE HARBOUR - STEFAAN GYSENS, MINISTERIE VAN DE VLAAMSE GEMEENSCHAP, FLEMISH COASTAL AUTHORITY (FCA), BELGIUM



Presentation:

The FCA project has two aims: The design of Coastal Defences in the Oostende Harbour with a return period of once in the 1000 years and the improvement of the Oostende Harbour Entrance. To study the wave propagation in the Oostende Harbour, three approaches were used:

- 1) Set-up of Field Measurement
- 2) Numerical Modelling
- 3) Physical Modelling

After this a comparative study was undertaken.

This presentation is available on the CD with this meeting report (Day 1, Stefaan Gysens).

Discussion:

FCA wanted to know if the other participants have experience with wave reflection in docks. FCA modelled a smaller harbour, and had problems with the numerical modelling. Apparently Gent has solved this problem. Participants can contact Stefaan Gysens for information on numerical modelling, and he will refer them to someone in Gent. The experts from Delft would expect it is easy to model, because there would be 100% reflection. FCA explained however, that it is not a regular dock, so it is a lot more complicated to model it. There are also side currents measured within the harbour and there is actually some kind of vortex in the harbour, which is interesting.

FCA were interested in differences with the approach in the Netherlands. Rijkswaterstaat RIKZ apparently had the same problems with the cable. The problem was solved by a NIVO-box, which has been running for 2 years now with no problems. Installation of the box is very sensitive, so RIKZ placed the equipment themselves. RIKZ measures air pressure as an alternative. The cables are a lot cheaper as well.

The participants want to know whether the pressure sensors have problems with waves. Apparently the membrane and sensors are well protected. This protection takes away the currents as well. How about velocity inside the harbour? Stefaan Gysens will check this when he is back in Belgium. FCA uses half an hour steps in the calculations. Half an hour is the limit concurred Herman Peters of Rijkswaterstaat Noordzee. A sample frequency of 4 Hz or more is used, but FCA reduces to match other instruments (at least 2 Hz).

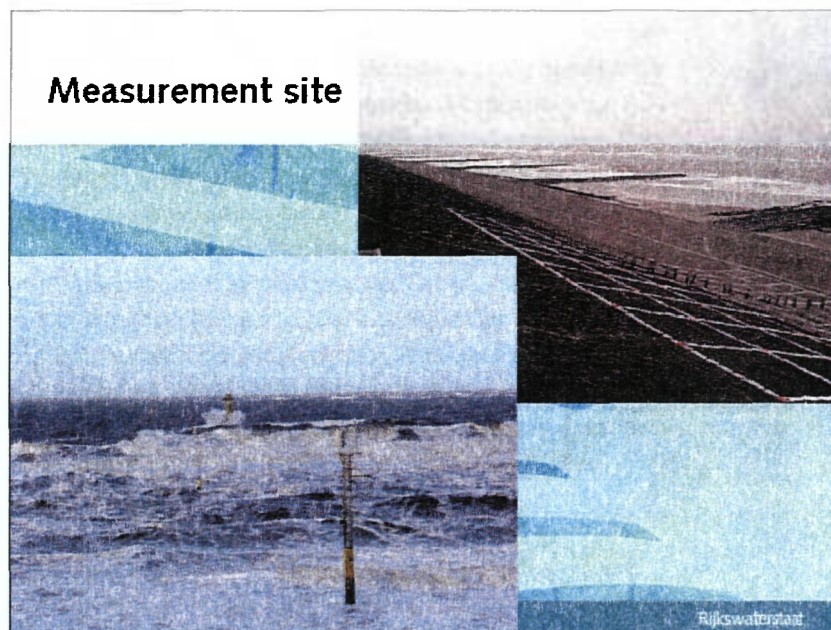
CHAPTER

3

Presentations day 2

3.1

PRESENTATION 4: PETTEN - MEASURING WAVES IN THE SURFZONE, ANNETTE KIEFTENBURG, RIJKSWATERSTAAT RIKZ (RWS RIKZ), THE NETHERLANDS

**Presentation:**

This presentation is about the measurement site at the sea dike of Petten, which is situated at the Westcoast of the Netherlands. The wave run-up at the dike is measured and the wave propagation from deep water to shallow water. The main goals of the measurement site at Petten are:

- Validation of the Hydraulic Boundary Conditions (HBC) of the sea defence
 - Verification of the formula for failure mechanisms of wave run-up and overtopping
- RWS RIKZ also presents the plans for the Petten site in 2006 and further. For example, a wave-overtopping device will be built in 2006, and RIKZ explains what the focus will be concerning the measurements and datamanagement.

The main question RWS RIKS has is: how to measure wave parameters with sufficient quality in the surfzone with breaking waves?

This presentation is available on the CD with this meeting report (Day 2, Annette Kieftenburg).

Discussion:

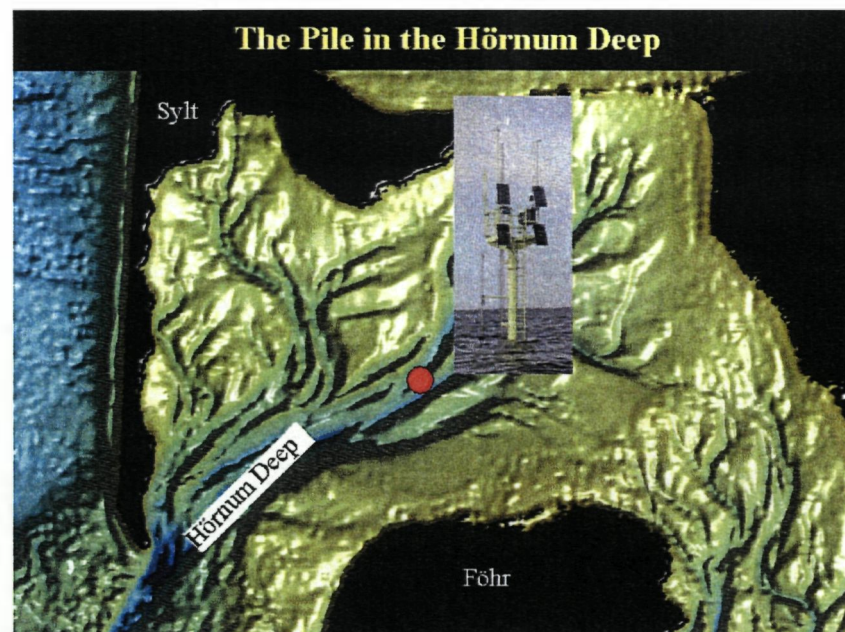
The audience wanted to know how much data is generally used for this type of measuring. RWS RIKZ uses observation data during a period of about 20 minutes.

There was a discussion on how to measure wave parameters with sufficient quality in the surf zone with breaking waves. RIKZ wanted to know who has experience with measurements in the surfzone. Apparently the Danish (DCA) have some experience. In Britain it would be the University that has done some. Also the University in New York (Stone Brooke) has experience. They photograph the surf zone and make analyses from that. Delft University of Technology uses that photography method as well.

Heinz Günther commented that there is no stationarity, therefore it is advised to go back to time series for these situations. Using spectra you lose critical information. Also because of linearity it makes sense to use time series. Furthermore, it is noted that Petten is not one-dimensional because of the groins in the water.

RIKZ wants to know if there is any experience with overtopping in combination with waves. It appears Belgium does some in combination with the University of Gent (Prof. De Luc). RIKZ commented that the Petten data is available for the other participants. Now the data is standalone, but it will be stored to make the processed data available for a large number of parameters. Participants can contact RWS RIKZ for the data.

It is noted that you need time series in order to make proper use of the data. WAVES2004 is a processing model. The time series are transformed to spectrums. It handles all kinds of sensors as well. Processing is done by RWS standards, which are well documented. It is ASCII format and it runs on a normal PC. For sharing information it would be interesting to uniform processing.

3.2**PRESENTATION 5: OBSERVATIONS OF WAVES ON MEASURING PILES IN THE WADDEN SEA - REINER ONKEN, GKSS RESEARCH CENTRE, GERMANY****Presentation:**

Since about ten years, the Institute for Coastal Research at the GKSS Research Centre (Geesthacht, Germany) is operating stationary measuring piles in the German Wadden Sea

for long-term acquisition of various oceanographic and meteorological parameters. In the standard mode, all parameters are provided as 10-minutes means, but in case of significant wave activity, the instruments on the piles may switch to a 2-Hertz sampling mode applied to parameters relevant for the analysis of waves and related processes.

This presentation is available on the CD with this meeting report (Day 2, Reiner Onker).

Discussion:

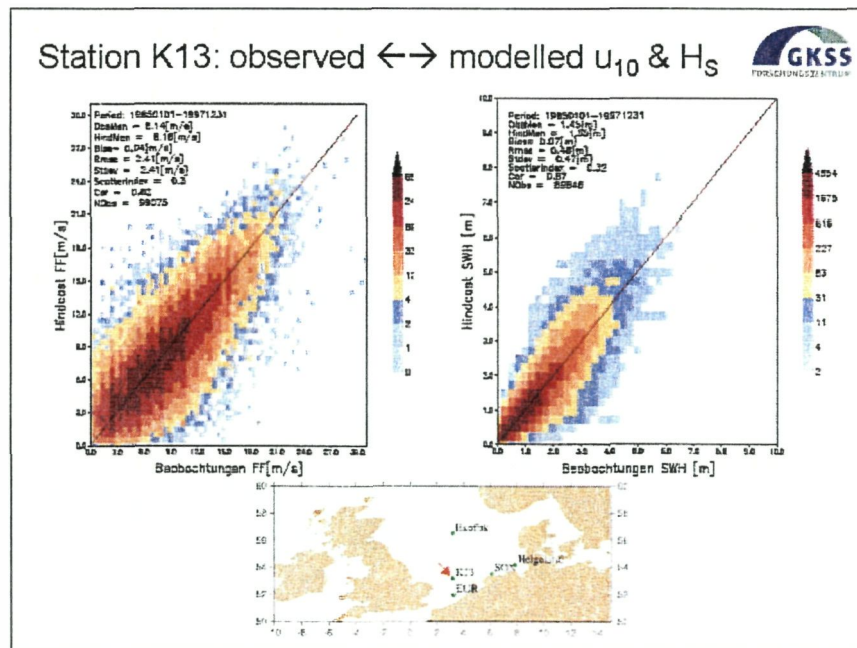
The participants are interested to know if this type of measuring piles are a useful method and if they could be superior to wave buoys. Heinz Günther explains that they tried wires but they broke often and had problems with high salinity. The gauges used by GKSS are very robust.

Maintenance is a function of water temperature. June and July maintenance is needed about every 4 days, with lower temperatures about every 10 days. The main reason for the frequent maintenance is the use of optical sensors. If you only measure waves, less maintenance may be needed.

The piles have many purposes, for example suspended matter (turbidity) and conductivity in protected area. Another item is ecological modelling. However, there are still problems with morphodynamics.

3.3

PRESENTATION 6: WAVE MODELLING AT GKSS - HEINZ GÜNTHER, GKSS RESEARCH CENTRE GEESTHACHT, GERMANY



Presentation:

This presentation is about wave modelling carried out by GKSS. Results from the wave model are presented in comparison with measurements. Further, some examples of 2D spectra and WAMOS results are shown.

The main conclusions of this presentation were:

- We need measurements to validate the models

- 2D-spectral data are very important
- Combine time series and spatial data in inhomogeneous areas
- Use simultaneous measurements of waves and other parameters, e.g. depth, currents, winds, etc
- Use coupled Models

This presentation is available on the CD with this meeting report (Day 2, Heinz Günther).

Discussion:

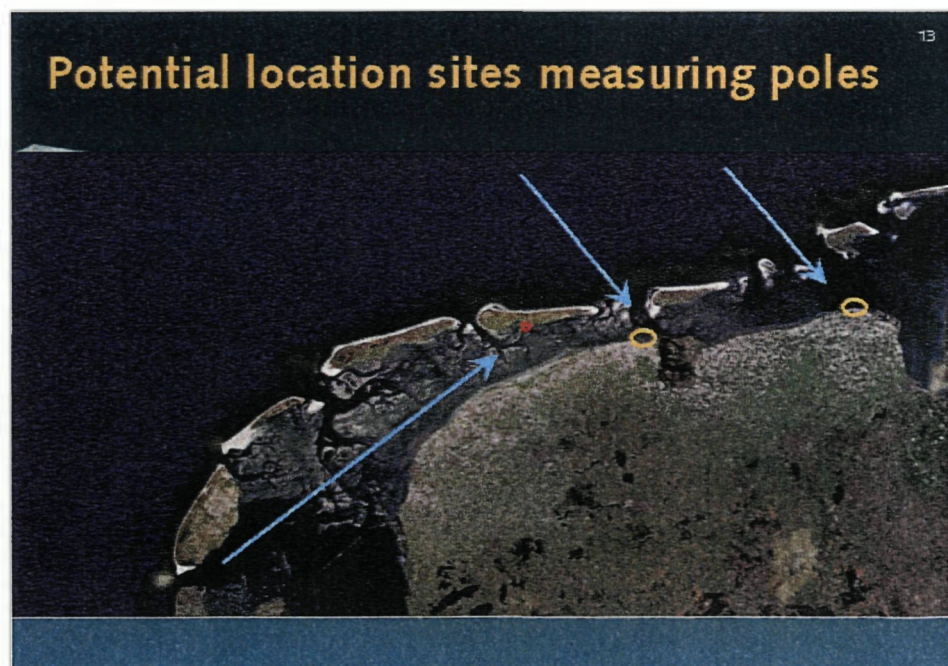
GKSS Research Centre has 45 years of measuring data collected. Could the participants use this data for nearshore models (boundary values)? WAM model doesn't work nearshore, because it over-predicts.

Heinz Günther is interested to find out whether the participants can develop a strategy to exchange data sets. According to Heinz, an operational data exchange strategy is set up in his country, but this is not set up for international use. However, Heinz is interested in long-term measurements being available on the internet (with some explanation on how the data was processed). Interpretation of one single point is always difficult; therefore we need long-term measurements. A few questions arise with this:

- Can we combine our experience to improve the models for extreme shallow waters?
- Can we define an experiment and/or a model inter-comparison to identify and improve the gaps in wave modelling?
- Is there an explanation for the declining line in the climate change? It is driven by atmosphere, so the data was actually measured in this particular area. The same decline was seen earlier, so it is probably a natural variation.

3.4

PRESENTATION 7: WAVE MEASUREMENTS IN THE DUTCH WADDEN SEA - HERMAN PETERS, RIJKSWATERSTAAT RIKZ (RWS RIKZ), THE NETHERLANDS



Ministry of Transport, Public Works and Water Management

Presentation:

In his presentation, Herman Peters of RWS focused on the purpose of wave measurements in the Dutch Wadden Sea. They cope with problems to determine reliable Hydraulic Boundary Conditions (HBC) for the validation of sea defences. He presented the present measurements in the tidal inlet of Ameland and the planned measurements program for the Wadden Sea. These measurements will be used for the validation/calibration of a wave model and to verify the extreme wave conditions near the sea defences. An interesting item in the measurement program is the planned installation of two (or three) wave-measuring poles, scheduled for 2007.

The participants were asked what the optimal combination of in-situ sensors for wave measurements is (for example wave staff, radar, pressure sensors, etc)? Also questions were asked on how to improve the spatial coverage (to put our point measurements in a broader spatial perspective).

This presentation is available on the CD with this meeting report (Day 2, Herman Peters).

Discussion:

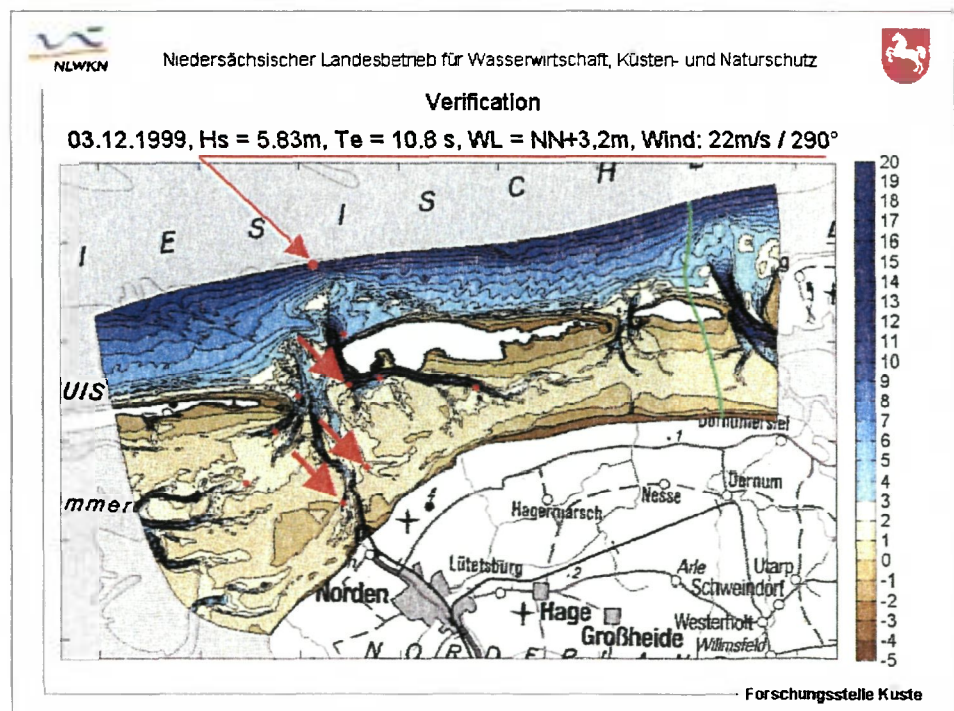
The buoys are generally in another position as the poles, since they have different purposes. The purpose of the poles is not only to validate the model, but also to independently measure the extreme wave conditions on the coast. The buoys have the purpose to validate the model.

Heinz Günther notes that you can try to measure an extreme storm, but in the end you may need to extrapolate to an extreme situation.

During a southwest wind there can be a situation of a very low water in the Wadden Sea. During low tide, the fetch will be interrupted, but at higher water a long fetch may occur.

3.5

PRESENTATION 8: MEASURING WAVES IN THE NORTH SEA ESTUARIES AND WADDEN SEA (FOR WAVE MODEL CALIBRATION) WHY, WHERE AND HOW? - RALF KAISER, NLWKN FORSCHUNGSSTELLE KÜSTE, GERMANY



Presentation:

Forschungstelle Küste is responsible for the sea defences of the coastal zone and islands of the German province of Niedersachsen. They determine the Hydraulic Boundary Conditions with a wave model in order to validate their dikes. In the presentation, Ralf Kaiser gave an explanation of the daily business of measuring in the German Wadden Sea. They have to deal with collision, stolen electronics and damage of the instruments by ice. Ralf also presented the verification of the SWAN wave model by comparison with measurement data and the effect of lateral boundary conditions on the model results. Forschungsstelle Küste had two questions for the participants:

- Where and how to measure?
- What is the cause of the difference between measurements and model?

This presentation is available on the CD with this meeting report (Day 2, Ralf Kaiser).

Discussion:

The audience is interested in the cause of the difference between measurements and model. Buoys are the backbones of the measurements. How accurate are measurements in situations with current? Ralf Kaiser comments that from their location they can actually look at some of their buoys, which is an advantage.

The tidal signal is much stronger, that may be part of the problem with the model (Dopler shifting and model dissipation). Dissipation in de SWAN model works better for stronger waves. This may need improvement. Using spectra may be the best way to look at it more closely. It is also possible to change some of the Default parameters (information Annette Kieftenburg). It is suggested to start a small work group to look into this.

The measurement may be slightly disturbed in the smaller gullies, but there is no problem in larger ones. Belgium has some problems with wave measurements in currents as well. It is suggested that the problem with buoys application in currents can be solved. This can be done by means of the buoy diameter and mooring design. It might be a good idea to perform data assimilation. There are differences between the model and the measurement at several points. This method would work for homogenous area, but when this is not the case, it is very difficult.

CHAPTER

4

Work sessions

In addition to the presentations and discussions two active work sessions were organised to achieve a better understanding of each others methods and problems. The results of these work sessions are in annex 1 of this report.

4.1

WORK SESSION 1 - POSTERS

The groups were asked to make a poster on which problems others are facing and why they are measuring. Each group fills in a poster with the strategy, practical methodology, strengths/opportunities and weaknesses/ threads. Delft Hydraulics serves as an expert panel. The groups spend an hour on these posters, questioning each other on the pro and cons of the strategies.

The following nine groups made a poster:

- Group 1 - Ministerie van de Vlaamse Gemeenschap (Flemish Coastal Authority, Belgium)
- Group 2 - GKSS Forschungszentrum Geesthacht (GKSS Research Centre, Germany)
- Group 3 - Channel Coastal Observatory (UK)
- Group 4 - Kystdirektoratet (Danish Coastal Authority, Denmark)
- Group 5 - Amt für Landliche Raume Husum (Germany)
- Group 6 - NWLKN Forschungsstelle Küste (Germany)
- Group 7 - Bundes Anstalt für Wasserbau (Germany)
- Group 8 - Rijkswaterstaat 1 (The Netherlands)
- Group 9 - Rijkswaterstaat 2 (The Netherlands)

The poster results are in annex 1 of this meeting report.

4.2

WORK SESSION 2 - THE WADDEN SEA CASE

Rijkswaterstaat is going to place 2 (or 3) poles in the Dutch Wadden Sea.



However, they have 2 important questions for which they would like advice and suggestions:

- What is the optimal combination of in-situ sensors for wave measurements (wave staff, radar, pressure sensors, etc.)?
- How can we improve the spatial coverage (to put our point measurements in a broader spatial perspective?)

The Wadden Sea Case is discussed in 3 mixed groups for about 20 minutes. The three groups present their solutions.

Results of group 1

Pro	Con
Strengths	Weaknesses
Opportunities	Threats
WAMOS well suitable for spatial information Additional measurement devices (frames) in stormy season Measure wind profile	check ice problems (flexible poles?) combine poles with buoys in tidal inlet

To improve the spatial information group 1 suggests firstly to use WAMOS to cover at least part of the area and, secondly to add off-line measuring equipment. They also suggest measuring at different heights for wind and not just at a height of 10 m. It is still necessary to

solve problem with ice, because there can be storms in combination with ice in the Wadden Sea. They advise using a combination of poles with buoy information in order to get the whole sequence.

Results of group 2

Pro	Con
Strengths	Weaknesses
Opportunities	Threats
improve spatial coverage by radar (HF versus navigational) use also optical instruments at normal conditions and during storm (airplane/helicopter) and SAR satellite (that is being developed extra buoys in outer delta.	- optical instruments only for normal conditions

Group 2 suggests improving the spatial coverage by using radar, using SAR satellite or taking photographs during storm (plane). They also suggest placing extra buoys in the tidal inlet.

Results of Group 3

Pro	Con
Strengths	Weaknesses
<ul style="list-style-type: none"> - Pole at southwest side of the island of Ameland is perfect for leeside computations W/NW winds - Directional info w/ADCP or EMS 	<ul style="list-style-type: none"> - Not one inlet completely measured <p>Post-it: small poles ice pole destructed ship risk</p>
Opportunities	Threats
<p>Move one mainland pole to island of Ameland (verification) or both [RK] or move buoys Use (more) cheaper (S4) gauges, also for reason of morphological stability & ice and ships Measure meteo, temperature (also for maintenance), conductivity harbor radar for synoptic view WAMOS on inlet throat</p>	<p>Morphological (in)stability Problem placing poles (installing) Radar may not work during storms</p>

Group 3 suggests moving the poles to where Rijkswaterstaat has buoys (close to the dike). If a choice needs to be made between WAMOS and another pole, the group would choose an extra pole near the dike. The problem with ice was discussed and the group suggests using flexible poles. However, flexible poles can be a disadvantage when they are placed too late. Segments in the shipping channel can be a shipping problem. Take care of morphological instabilities. The location of the poles can be very near the dike or further, but the group hasn't chosen an exact location yet. A downward-faced radar may not work during storms. This needs to be checked. One pole is also useful for other purposes (seaside computation of W/NW winds).

CHAPTER

5

Evaluation and
closure

Rinus Schroevers summarizes and notes that everybody wants to know about waves in shallow water (< 5 m), but dare not measure too close to the shore.

There are different issues that measurements can benefit. However, the approach is often the same. He wonders, are we doing the right thing, or are we doing what we know?

Furthermore, everybody uses more or less the same equipment and still most people in the room haven't shared experiences. He also noticed that data processing and validation hasn't really been discussed much today. He wonders why. There are many differences in doing this. Rijkswaterstaat has developed a standard method that others are welcome to look at. Also Rijkswaterstaat would like to collect data from other participants. Finally, he invites other participants to organize similar events/workshops in the near future.

Annette Zijderveld closes the 2-day workshop. She hopes this workshop provided everybody with better knowledge on where we all stand with the measurements and modelling.

Rijkswaterstaat hopes to increase data exchange. Therefore, we need to keep talking.

Rijkswaterstaat will follow this 2-day workshop up with visits to the participants, in order to further discuss data exchange.

She suggests the need for smaller groups working on different specific problems.

During the sessions it was suggested to make data available via the Internet. She also asks what data is needed exactly and in what form it should be made available. Rijkswaterstaat will set up this exchange of data. The group responds with the remark that they are not all interested in measurement data, but are more interested in the model results. On the other hand, exchanging data helps to know what others are doing. Setting up data exchange will take a lot of effort.

Annette Zijderveld asks the participants for any follow up ideas. Is there interest in model validation?

- Belgium would like to see more measuring methods, and is less interested in models.
- The UK would be interested in standards for quality control parameters for data. There is a strong need for guidelines.
- The Danish Coastal Authority is interested in results with the SWAN wave model, especially near the dike.
- GKKS thinks it is possible to use the measurements to improve some points in the models, or identify the weak points in the models in terms of physics. The programmers of models need to come together with people that experience differences between models and measurements.

Annette comments that in this workshop Rijkswaterstaat invited modellers and measurers together. Perhaps on the next occasion there should be separate meetings? Perhaps in smaller groups?

The network of international contacts should also be used for smaller details. There could be a good informal network (e-mail, phone) to share experiences.

Annette Zijderveld and Rinus Schroevers thank everybody for coming and emphasize again the Dutch are very interested in exchange of data and experience. They hope for a follow up in The Netherlands or hosted by one of the other participants.

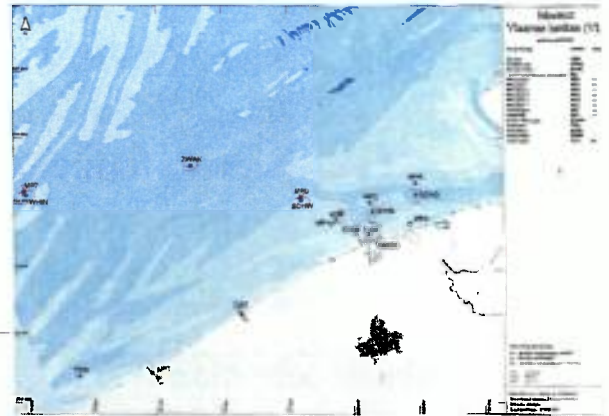
ANNEX **1**

Results of posters; experience and problem analyses



Ministerie van Verkeer en Waterstaat

Group 1 - Ministerie van de Vlaamse Gemeenschap
(Flemish Coastal Authority, Belgium)



Problem definition

- Real time - Ship Traffic Assistance
- Hydraulic Boundary Conditions -> Forecasts -> Ship Traffic Assistance
- Wave Climate -> Statistics
- Design Coastal Defence

Strategy

- Monitoring Network: offshore and nearshore (Ostend Harbour - Ostend ONS)
- Coupling with RWS Monitoring Network
- Forecast Model Hypas < Refra (navigation channels)
- Model calculations - Hydraulic Laboratory

Practical methodology

- Waverider network
- Modelling Wave Climate on the shore by DELFT3D/ SWAN
- Starting with RADAR wavesensor

(Post-it) Bottom topography in DELFT3D/SWAN?

(Post-it) Which waterdepths in SWAN?

(Post-it) What did you do to convince yours of data quality of RADAR?

(Post-it) Experiences with Nortec wavesensor?

Pro (strengths and opportunities)	Con (weaknesses and threats)
Waverider: proven technology	<ul style="list-style-type: none"> - Coupling nearshore? - Sufficient info/knowledge <p>(Post-it) What instruments in shallow water?</p>



Ministerie van Verkeer en Waterstaat

Group 2 - GKSS Forschungszentrum Geesthacht
(GKSS Research Centre, Germany)



Problem definition

Simultaneous measuring: waves, currents, SPN for the development and validation of coupled model systems

- (Post-it) Climate change
- (Post-it) Model development
- (Post-it) Two measurements enough?

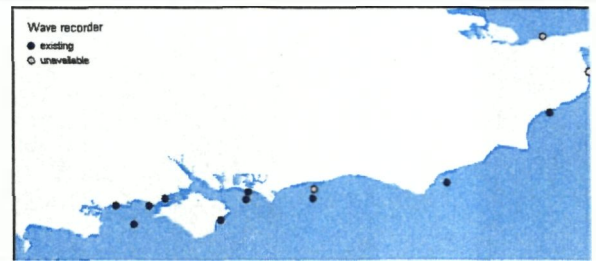
Strategy

Long-term measurements with robust instruments withstanding extreme events

Practical methodology

- Multi-sensor stationary platforms (piles), buoys, ADCPs, RADAR
- High-resolution bottom mapping
- Data assimilation

<p style="text-align: center;">Pro (strengths and opportunities)</p>	<p style="text-align: center;">Con (weaknesses and threats)</p>
<ul style="list-style-type: none"> - Cost effective - Combination of space/time measurements - simultaneous measurements of various parameters 	<ul style="list-style-type: none"> - Problems with fishing and tourism (Post-it) Dialog with fishers. Giving them online data



Problem definition

To produce nearshore wave statistics for use in coastal structures design

Strategy

- UK Met Office model pouts too far offshore to be used for structure design - also to validate transformed UK Mo data
- Model data seems not to be reliable < 10m depth

Practical methodology

- Measuring

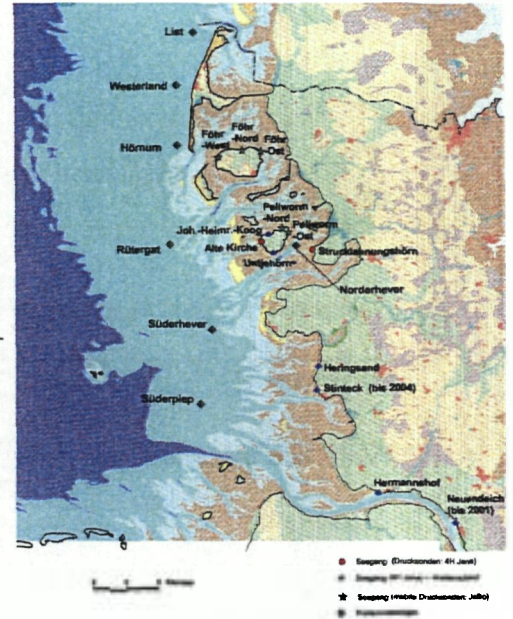
(Post-it) Did you ever compare the waveradar to a waverider? Do you trust the waterlevel?

<p>Pro (strengths and opportunities)</p>	<p>Con (weaknesses and threats)</p>
<p>Real data Real-time Nearshore</p> <p>(Post-it) Lots of data (Post-it) Free data <input type="checkbox"/> get info/models in exchange</p>	<ul style="list-style-type: none"> - Too simple transformation - Spot measurements <p><u>Qns</u></p> <ol style="list-style-type: none"> 1. Methodology for storm definition? 2. How to turn long-term spatial measurements into engineering statistics for design? <p>(Post-it) Small number of users</p>



Ministerie van Verkeer en Waterstaat

Group 5 - Amt für Landliche Raume Husum (Germany)



Problem definition

- Erosion of the beach -> Sylt
- Design of dikes

Strategy

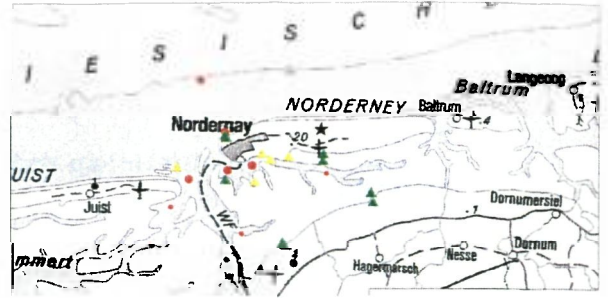
- Knowledge of longshore and cross-shore sediment transport
- Calculation of the design wave with model

Practical methodology

- Wave-measurement, current measurement
- Wave modelling

(Post-it) Trim-2D currents but no storm Boundary Conditions

<p>Pro (strength and opportunities)</p>	<p>Con (weaknesses and threats)</p>
<ul style="list-style-type: none"> - A lot of information - Rave measurement of buoys - Results of nearshore wave measurement and wave run-up 	<ul style="list-style-type: none"> - Data management - No storm event since 2004 (no data from pressure sensors, no wave run-up data) <p>(Post-it) Do you see long waves in directional buoy data?</p> <p>(Post-it) Do you see reflection and/or scattig in directional buoy data?</p> <p>(Post-it) Rijkswaterstaat is building a run-up overtopping device in Petten</p> <p>(Post-it) If you ever measure run-up, Rijkswaterstaat is interested</p>



Problem definition

What are the wave conditions for the design of dykes?

Strategy

- Wave modelling
- Validation of waves models with measurements

Practical methodology

- Bring your institute into your problem area
- Measure waves with instruments suited to problem, area and need for accuracy (-> iterative process)

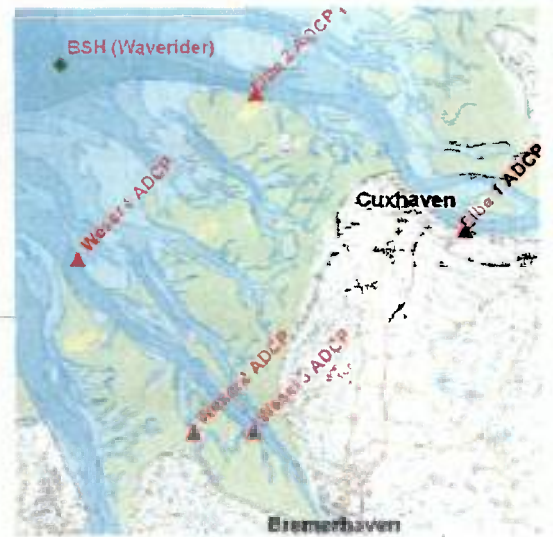
Post-it: What instruments are suitable for the area?
 Post-it: Rijkswaterstaat has 3 reports on what, how, where to measure

Pro (strengths and opportunities)	Con (weaknesses and threats)
<ul style="list-style-type: none"> - Flexible (iterative process.) - Measuring at location with problems in model results 	<ul style="list-style-type: none"> - not always clear if problem is in the model or measuring -> testing of new systems <p>(Post-it): Rijkswaterstaat is very interested in comparison of the 3 types of buoys.</p>



Ministerie van Verkeer en Waterstaat

Group 7 - Bundes Anstalt für Wasserbau (Germany)



Problem definition

- Environmental impact studies due to changes in the design of shipping channels
- BAW: non-biological parameters (physics) - for example: sea state conditions

Strategy

- Comparison of one baseline-case against several future scenarios (design)
- Challenge: model has to be validated.

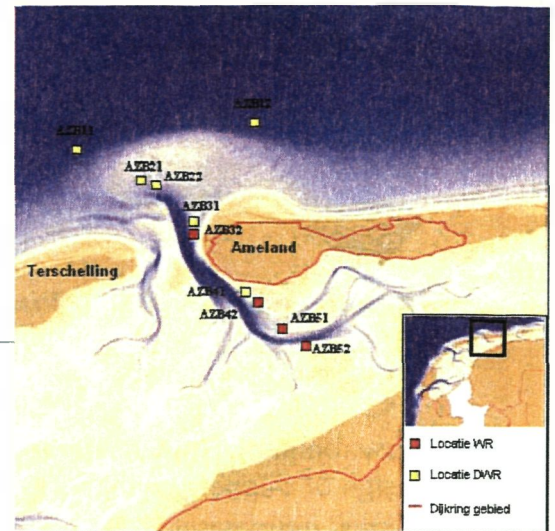
Practical methodology

- Initiating field programmes to validate models. For example: ADCP
- Measuring sea state conditions on specific locations in the estuary (hot spots)

Pro (strengths and opportunities)	Con (weaknesses and threats)
<ul style="list-style-type: none"> - Independent measurements (pressure, surface, velocity) - Current profile at the same location - Easy hardware <p>(Post-it) + Water level (AST) (Post-it) Depth attenuation current infl. (measured) (Post-it) Not really shallow</p>	<ul style="list-style-type: none"> - Bad software - Only point information - Mooring is a lot of involvement <p>(Post-it) Black box (Post-it) AST no vertical beam (Post-it) Only 1 wind point (Post-it) Only 3 points (Post-it) Not really shallow</p>



Group 8 - Rijkswaterstaat 1 (The Netherlands)



Problem definition

Wave propagation from deep to shallow water

Strategy

Measuring in combination with modelling

Practical methodology

- Delivering wave boundary conditions with a few deep water wave buoys
- Measuring wave parameters, current, waterlevel and wind in the transition region from deep to shallow water
- Calibration/validation of the model

<p style="text-align: center;">Pro (strengths and opportunities)</p>	<p style="text-align: center;">Con (weaknesses and threats)</p>
<ul style="list-style-type: none"> - Verification and modification of the model by measurements - Combination of measuring and modelling 	<ul style="list-style-type: none"> - Unreliable measurements in shallow water - Unreliable model in shallow water <p>(Post-it) get info from USA</p>



Ministerie van Verkeer en Waterstaat

Additional Group (9) - Rijkswaterstaat 2 (The Netherlands)



Problem definition

What is wave growth limit above horizontal bottoms (Ijsselmeer)?
Theory and in situ measurements do not give the answer

Strategy

Measurements in a very shallow lake, where high wind speeds occur regularly (typhoons). This lake is Tai Hu, near Shanghai (China)

Practical methodology

- Three measurement stations, measuring wind, water levels and waves (measurements started may 2006)

<p>Pro (strengths and opportunities)</p>	<p>Con (weaknesses and threats)</p>
<p>- Fair chance to have extreme wind speeds and to measure wave growth limit</p>	<p>- Uncertain bottom level? - Algae? - Complex wind field?</p>