Quick Scan Monitoring Delta Programme Wadden Sea Area

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Summary

In the framework of the Quick Scan Monitoring an inventory is made of the knowledge demand in order to answer policy questions underlying the issues of safety, nature and socioeconomic developments in the Delta Programme Wadden sea Area. A first analysis is made of which historic, current and future monitoring programmes meet the research plans described in other Quick Scans.

Many of the requested parameters are being measured in various monitoring programmes. However, by far not all of these parameters are measured sufficiently frequent, in sufficient resolution and at the right locations. Relevant socioeconomic and governance knowledge is still poorly available. The Wadden Sea Long Term Ecological Research (WaLTER) is an important instrument for harmonisation of monitoring programmes, data management, international tuning and development of a basic system of ecological and socioeconomic monitoring. Three research projects study the socioeconomic and policy questions in the Wadden Sea Area.
As a result of this Quick Scan five (parallel) monitoring tasks are proposed. Some of these task could be split up in different phases of execution:

- Organisation: Overview and analysis of monitoring demand, Establishing climate monitoring network and Harmonisation and Data management (phased)
- Trend analyses of historic ecological and socioeconomic data series
- Hydrodynamic and Geomorphological monitoring in tidal basins and model development (phased)
- Quick Reaction Force (phased): Organisation and protocol development, Equipment purchase, installing and calibration, and Post storm surveying (Registration of erosion immediately after storm events en recovery time (semi natural resilience in response to beach nourishment)
- Monitoring socioeconomics, governance and progress

Samenvatting

In het kader van de Quickscan Monitoring is een overzicht gemaakt van de kennisbehoefte die bestaat om antwoord te kunnen geven op de beleidsvragen die ten grondslag liggen aan de dimensies van veiligheid, natuur en sociaaleconomische ontwikkeling in het Delta Programma Waddengebied. Er is eveneens een globale analyse gemaakt van welke historische, huidige en toekomstige monitoringsprogramma's voldoen aan de plannen die in de andere Quickscans staan beschreven.

Veel van de gevraagde parameters worden gemeten in diverse monitoringprogramma's. Lang niet alle parameters worden echter voldoende frequent, in voldoende dichtheid of op de juiste locaties bemonsterd. Op het gebied van sociaaleconomische en governance vraagstukken ontbreekt ook nog veel kennis. Het Wadden Sea Long Term Ecological Research (WaLTER) is een belangrijk instrument ten behoeve van harmonisatie van monitoringprogramma's, data management, internationale afstemming en het ontwikkelen van een basis programma voor ecologische en sociaaleconomische monitoring. Er loopt verder een drietal projecten dat onderzoek doet aan sociaaleconomische en beleidsvraagstukken in en rond het Waddengebied.
Naar aanleiding van deze Quickscan worden de volgende vijf monitoringstaken voorgesteld die grotendeels parallel kunnen worden uitgevoerd. Een aantal taken kunnen gefaseerd worden uitgevoerd:

- Organisatie: Overzicht en analyse van monitoringbehoefte, Opzetten klimaat monitoring netwerk en harmonisatie en Data Management (gefaseerd)
- Trend Analyse van historische ecologische en sociaaleconomische datasets

- Hydrodynamische en geomorfologische monitoring in kombergingsgebieden en model ontwikkeling (gefaseerd)
- Quick Reaction Force (gefaseerd): Organisatie en protocolontwikkeling, apparatuuraanschaf en -kalibratie en registratie van erosie onmiddellijk na stormperiodes en hersteltijd (semi-natuurlijke flexibiliteit onder invloed van zandsuppletie)
- Monitoring van sociaaleconomische en governance ontwikkelingen en projectvoortgang

1 Introduction

1.1 National Delta Programme

The National Delta Programme is a cooperative national programme of the Dutch Government, provinces, municipalities, water boards and NGOs. It builds on the advice of the Second Delta Committee of 2008 'Samen werken met water' (Working together with water, ed.) for more attention to flood safety and fresh water security on the long term. The Dutch Delta Act (2010) forms the legal basis for the Delta Programme. Using coherent measures, this programme aims to accomplish sustainable water safety and fresh water supply for the coming decades, in view of climate change, socioeconomic developments and changing public opinions. The programme includes three generic sub programmes (Water safety, Fresh water supply and New construction and restructuring) and six area specific sub programmes (Coast, Wadden Sea Area, South-western Delta, Rijnmond–Drecht cities (Rotterdam and environs), Rivers, and Lake IJssel).

1.2 Delta Programme Wadden Sea Area

1.2.1 Problem definition

The Delta Programme Wadden Sea Area directs the Wadden Sea, the Wadden Sea islands, the Eems-Dollard estuary and the coastal zones of the provinces of North Holland, Friesland and Groningen that border the Wadden Sea and the Eems-Dollard estuary. Climate change may lead to increased sea level rise and a change to more extremes in the tidal amplitude, the atmospheric precipitation pattern and in the occurrence and timing of storm events and the angle of wave attack relative to the coastline. As a consequence it is likely that the North Sea side of the Wadden Sea island will experience other and increased coastal erosion and the intertidal mudflats and salt marshes in the Wadden Sea Area, the natural coastal defence of the mainland, could drown. If and how these changes occur and at which pace is still unclear.
This sub programme aims:

- To develop an integrated routine which should secure the safety of the islands' and main land's coasts. The objective is to integrate water safety with other functions of the Wadden Sea Area, which are: nature, recreation and tourism, and sustainable economic activities.
- To monitor the effects of climate change on ecosystems and developments in the Wadden Sea Area.

1.2.2 Safety

The basic rule for protection against flooding and storm surges is a guaranteed safety level for embanked land. Other rules in the Delta Programme are a fixed so called Basic Coastline and a Coastal Foundation that follows sea level rise. Research and monitoring should prove a long term strategy in order to meet these preconditions.

1.2.3 Nature

For the Wadden Sea Area sustainable nature is specifically mentioned in the Delta Program as an important additional criterion. Therefore preferred are measures taken to meet the safety norm that positively affect the natural dynamic and characteristic biotic and abiotic processes and conditions which make the Wadden Sea Area (a UNESCO World Heritage and Natura 2000 site) unique in the world. In accordance with the Dutch National Water Plan, confinement of natural dynamics and physical processes should be limited and the water quality should allow optimal development of flora and fauna. Water

safety and natural development could reinforce each other using a concept of building with nature in contrast to fighting nature.

1.2.4 Socioeconomic development

The joint ambition for the Wadden Sea Area is to ensure sustainable water safety while creating opportunities for a robust and resilient natural system which allows sustainable human use. A safe Wadden Sea environment anchored in natural processes forms an attractive area for people to live, work and recreate. This multifunctional use concept for the Wadden Sea Area allows engineering of a cost effective coastal defence infrastructure providing ecosystem functions and services and sustainable socioeconomic benefit. It requires a coherent and integrated approach involving stakeholders from government, the business sector, local communities, NGOs and research and knowledge institutes. The priority sequence, however, is safety first and then nature and other functions (e.g. recreation, tourism, agriculture, fisheries, industry, energy and shipping).

1.2.5 Quick scans

In order to develop a widely supported management plan for a sustainable multifunctional Wadden Sea future, multidisciplinary research and integrated analysis is necessary. This requires a coherent view on effective management strategies based on scientific knowledge and public support. An analysis of research subjects relevant to the Wadden Sea Area sub programme revealed nine major areas of scientific and managerial attention. An interactive quick scan approach is followed to reveal how the nine areas are related to each other in time, place and knowledge demand, which knowledge is already available or still lacking, when and where these knowledge gaps should be filled-in and how the necessary research should be scheduled in time and place as to support future policy decisions. The quick scans should reveal a list of qualities and functions that need to be protected or improved and examined in relation to flood defence, natural quality and ecosystem services, public perception and economic development. The nine areas of attention are:

1. Impact of new safety norms
2. Reduction of wave impact by salt marshes and mud flats
3. Climate sustainability of unembanked alluvial land in the Wadden Sea area
4. Storm surge flood level Ems-Dollard
5. Integrated coast and island management
6. Safety issues related to sediment budget and climate change
7. Monitoring
8. Innovative sea walls of Wadden Sea islands and main land
9. Governance

The quick scan Monitoring, to which this report pertains, examines the available knowledge, current national and international monitoring programmes (parameters measured and planning in time and place) and the monitoring demand drawing on the quick scan results of all areas of attention and fore sightings of relevant Wadden Sea institutions (e.g. the Wadden Academy).

2 Monitoring

2.1 Policy questions

The Wadden Sea Area plays an important role in the protection of the northern Netherlands against flooding from the sea. Climate change may have a significant impact on the area's morphodynamics, hydrodynamics and ecosystem functions and on feedback mechanisms between these processes. A change in the system may lead to a reduction in the protective capacity of the Wadden Sea Area against flooding, e.g. a decline in dune, intertidal and salt marsh area, and is therefore directly related to policy measures concerning water safety and nature management. A change in the system could also have consequences for the natural and socioeconomic values of the area.
For appropriate policy development it is important to know:

- **If and which system changes are likely to occur and at what pace (**5.1; 5.2; 5.3**),**
- **If these changes negatively affect safety or natural and socioeconomic values (**5.2; 5.4**),**
- **If these changes are disagreeable from a public opinion's point of view (**5.1; 5.2**), and**
- **If moments in time can be signposted at which adaptive measures should be taken or beyond which changes are irreversible and other less appealing or expensive measures are required to meet at least the flood defence safety norm (**5.2; 5.4**).**

2.2 Objectives

The objectives of a Monitoring programme as one of the nine areas of attention in the Delta Programme Wadden Sea Area are:

- To create coherence between and optimisation of different monitoring activities and data information management (national and international)
- To integrate the long term measurements suggested in the other eight quick scans.
- To interpret data in order to answer the policy questions raised above and to contribute to the objectives of the Wadden Sea Area sub-programme as a whole.

2.3 Relation to the Delta Programme

The Monitoring Task relates to the Delta Programme sub programmes: Water safety, New construction and restructuring, Coast, Wadden Sea Area and South-western Delta.

3 Inventory

3.1 Available knowledge

In the past, many monitoring activities have been initiated to generate knowledge about the Netherlands' coastal (eco)systems for scientific, economic and policy purposes. Some of the generated time series have a long history and until today serve important (international) statutory monitoring obligations. Meteorological and climate registrations of the Royal Netherlands Meteorological Institute (KNMI) date back hundreds of years. Tide and water levels, coastal mapping and water temperature have been recorded for over 100 years. The ministry of Infrastructure and the Environment (directorate general RWS) provides relevant data via the data portal "IRIS" (a.k.a. "DONAR"). Other mostly ecological and scientific monitoring programmes have a shorter history of maximum 45 years. The international monitoring agenda has a history of 10 to 15 years (Smit et al., 2010). With respect to the Wadden sea area, the Trilateral Monitoring and Assessment Program (TMAP) provides an important platform for exchange of knowledge and data. Historic and still running monitoring programmes which serve an important function for the Wadden Sea Area Delta Programme and from which important information may be drawn are listed in section 3.1.1 below.

3.1.1 Relevant historic data, current monitoring programmes (national and international) and agreements or frameworks through which data are collected

- KNMI (Royal Netherlands Meteorological Institute)
- Rijkswaterstaat (Different departments under the ministry of Infrastructure and Environment; RWS)
- Monitoring Waterstaatkundige Toestand des Lands (Monitoring Water-Infrastructural State of the Country; MWTL)
- KaderRichtlijn Water (Framework Directive Water; KRW)
- Marine Strategy Framework Directive (Europese Kaderrichtlijn Marien)
- Bird and Habitat Directive (Vogel- en Habitatrichtlijn)
- Netwerk Ecologische Monitoring (Network Ecological Monitoring; NEM)
- Wettelijke Onderzoekstaken (Statutory Research Tasks; WOT-projecten)
  - ✓ Demersal Fish survey
  - ✓ Mussel bed survey,
  - ✓ Cockle survey
  - ✓ Development of undisturbed flood basin (Rottum area)
- Mosselwad
- Waddensleutels (Wadden Sea Keys)
- Programme 'Naar een Rijke Waddenzee' (Towards a Rich Wadden Sea)
- SIBES (bethic organisms and sediment composition)
- Wadden Meta Ecosystem (METAWAD)
- Sterkte en Belastingen van Waterkeringen (Strength and Loading of Water Defences; SBW) (Storm season September – April)
- Simulating Waves Nearshore (SWAN)
- TESO ferry
- Monitoring by Nederlandse Aardolie Maatschappij (Dutch Petroleum Company; NAM)
- Trilateral Monitoring and Assessment Program (TMAP)
- Joint Monitoring and Assessment Program (JAMP) – OSPAR
- Herring larvae and Mackerel egg surveys and MARKSAM project (Market Sampling of Dutch Landings of Commercial Species: IMARES) of IMARES (ex RIVO)
- Economic monitoring of LEI, the 'Productschap Vis' and IMARES

- Recordings Sea Fishes The Netherlands ('Recordlijst Zeevissen Nederland' of the Dutch Committee Records Sea Fishes)
- Dutch Central Planning Office (Centraal Planbureau; CPB)
- Dutch Planning Office for the Environment (Planbureau voor de Leefomgeving; PBL)

3.2 Future / planned monitoring programmes: WaLTER

Apart from ongoing monitoring programs, the Dutch WaLTER project has been accepted for funding by the Dutch Wadden Sea Fund and has recently started its work. WaLTER is the acronym for Wadden Sea Long Term Ecological Research. The overall aim of WaLTER is to provide a basic contribution to the sustainable future of the Wadden Sea region by increasing the effectiveness of the use of knowledge, necessary for planning processes, policy and project development, and adaptive management. With the implementation of WaLTER, the Wadden Sea Area enters the International Network of Long-term Research Areas (ILTER). The aim will be achieved by:

- Establishing a web-based, low-threshold, user-friendly central knowledge platform, for making available existing and new knowledge.
- Achieve consensus about a basic system of monitoring, i.e. basic system variables (ecologic and socio-economic) that must be monitored to be able to understand the functioning and development of the Wadden Sea system.
- Tuning running and future monitoring programmes, measuring networks and data portals.

The first phase of WaLTER (2011-2012) is the inventory phase. In this phase, the knowledge requirements of all potential users will be inventoried and the necessary monitoring parameters determined. In addition an inventory and evaluation of conceptual ecological and economic models will be carried out, resulting in an overview of necessary monitoring requirements. In phase two (2013-2014), the data portal will be developed and the results from phase one analysed, focusing on a comparison of data needs and data availability. The analysis will reveal overlaps and redundancies in current monitoring practices and make recommendations for improving effectiveness.
Finally a monitoring programme for ecological and socioeconomic parameters will be developed, based upon the outcome of the analyses regarding customer needs and effectiveness. The Common Wadden Sea Secretariat (CWSS) participates as partner in the project and will be responsible for the input of trilateral information and experience in the fields of monitoring and assessment. Other WaLTER partners are NIOZ, University of Groningen, University of Nijmegen, IMARES and SOVON.

4 Monitoring requests

An analysis of the quick scan results revealed a wide variety of knowledge questions and considerable overlap in monitoring data demand in the Quick Scans. These demands can be grouped in five main categories, which are elaborated below. The codes of the 'Existing monitoring programmes' are explained in section 3.1.1 and Appendix A, B. The tables below can be filled in after all Quick Scan reports are final and specific research projects and long-term measurements are described and specified in more detail. Then, integration of monitoring programmes is possible.

4.1 Meteorology

Parameter		Frequency	Resolution	Location(s)	Existing monitoring programme	Support for DP-W
Wind	Speed	Real time		Pm	KNMI H10, TMAP, SBW	Sufficient
	Direction	Real time		Pm	H10, SBW	Sufficient
Temperature		Real time		Pm	H10, MWTL, TMAP, SBW	Sufficient
Storm frequency		Real time		Pm		Sufficient
Air pressure		Real time		Pm	H10	Sufficient
Depression routes		Real time		Pm		Insufficient
Sand (eolian)	Composition			Islands and marshes		Insufficient
	Import			Islands and marshes		Insufficient
	Export			Islands and marshes		Insufficient
	Transport			Islands and marshes		Insufficient

4.2 Water

Parameter		Frequency	Resolution	Location(s)	Existing monitoring programme	Support for DP-W
Tide	Amplitude	Real time		Tidal basin	H4, MWTL, TMAP, KRW	Insufficient
	Propagation	Real time		Tidal basin		Insufficient
Current	Strength	Real time		Tidal basin	H6 (noordzee), KRW, SBW, TESO	Insufficient
	Direction	Real time		Tidal basin	H6 (noordzee), KRW, SBW, TESO	Insufficient
Wave	Height	Real time		Tidal basin	H7 (Noordzee), MWTL, TMAP, SBW	Insufficient
	Evolution	Real time		Tidal basin	MWTL, TMAP	Insufficient
	Propagation	Real time		Tidal basin	TMAP	Insufficient
	Attenuation	Real time		Tidal basin	TMAP	Insufficient
	Energy redistribution	Real time		Tidal basin	TMAP	Insufficient
	Period	Real time		Tidal basin	H7 (noordzee) MWTL, TMAP, SBW	Insufficient
	Direction	Real time		Tidal basin	H7 (noordzee) MWTL, SBW	Insufficient
Salinity				Representative locations	H3, TESO	Sufficient
Temperature		Real time		Pm	H8, 9, MWTL, TMAP, TESO	Sufficient
Depth				Tidal basin	MWTL, KRW, SBW, NAM, TESO	Need analyses
Turbulence				Specification needed		Insufficient
Fresh water input				Inlets	H5, MWTL, KRW	Sufficient
Turbidity				Representative tidal basin	MWTL, TESO	Insufficient

4.3 Sediment

Parameter		Frequency	Resolution	Location(s)	Existing monitoring programme	Support for DP-W
Intertidal flat	Height			Tidal basin	TMAP, NAM	Need analyses
	Dynamics			Tidal basin	TMAP, NAM	Need analyses
Sediment / mud	Composition			Tidal basin	H2, TMAP, KRW, NAM	Need analyses
	Import			Specification needed	TESO	Insufficient
	Export			Specification needed	TESO	Insufficient
	Transport / route			Specification needed		Insufficient
	Bottom roughness / sheer stress			Tidal basin		Insufficient
	Sedimentation			Tidal basin		Insufficient
	Stability			Tidal basin		Insufficient
	Nourishment			Islands		Insufficient
Fluid mud fields	Occurrence			Ad-hoc		Insufficient
	Softening					Insufficient
	Properties			Ad-hoc		Insufficient
	Dynamics			Ad-hoc		Insufficient
	Turbulence			Ad-hoc		Insufficient
Salt marsh	Growth	1 x y-1		Pm	P7, 8, 9, 10, 11, TMAP, KRW, WOT	Sufficient
	Erosion	1 x y-1 + storm events		Pm	P7, 8, 9, 10, 11, TMAP, KRW, WOT	Sufficient
	Level	1 x y-1		Pm		
Channels / Gullies	Dynamics			Tidal basin	TESO	Insufficient
	Bathymetry			Tidal basin	H1, KRW, SBW	Insufficient

4.4 Ecology

Parameter		Frequency	Resolution	Location(s)	Existing monitoring programme	Support for DP-W
Eco-engineers				Tidal basin	M6, P6, METAWAD	Sufficient*
Biodiversity				Tidal basin	M6, P8, 9, 10, 11, NAM	Sufficient*
Species (relevant flora and fauna)	Density			Tidal basin	M6, P6, 8, 9, 10, 11	Sufficient*
	Distribution			Tidal basin	P6, 8, 9, 10, 11	Sufficient*

*Guaranteed for the coming 2 years only

4.5 Governance

Parameter		Frequency	Resolution	Location(s)	Existing monitoring programme	Support for DP-W
Development	Economic			Wadden Sea Area	M1, TMAP, KRW, CPB	Need analyses
	Demographic			Wadden Sea Area	CPB	Need analyses
Management and Maintenance	Salt marsh			Pm	M2, P7	Sufficient
	Coast			Pm		Need analyses
	Island			Pm		Need analyses
	Levee			Pm	M2, TMAP	Need analyses
Public perception	Urgency			Wadden Sea Area		Insufficient
	Safety			Wadden Sea Area		Insufficient
	Directions for remedies			Wadden Sea Area		Insufficient
Process**	Progress	Yearly	As agreed with Ministry			

** Process applies to monitoring the progress of the Delta Programme Wadden Sea Area

4.6 Monitoring gaps

Many parameters that are relevant for the Delta Programme Wadden Sea Area have been and are being monitored in different national and international initiatives. For the ecological developments (including erosion and growth of salt marshes) in the area these programmes reveal sufficient data. However, guarantees for continued ecological monitoring as of 2013/14 are lacking. For many meteorology (QS 1, 4), hydraulic conditions (QS 1, 2, 4), eolian and hydrolic sediment budget and composition (QS 1, 2, 4, 5, 6, 8) and governance parameters (QS 9), however, the monitoring frequency and/or density and/or the (number of) locations is insufficient or lacking in order to meet the objectives of the Delta Programme, especially with respect to the development of reliable and Wadden Sea Area generic models. The current models, for instance, showed unreliable predictions for storm surge high tides in the Eems-Dollard estuary. The current resolution of data feeding the models, especially concerning tides, currents and waves, does not allow the required level of accuracy that is necessary to take decisions on cost effective coastal defence alternatives.

For some parameters the usability needs to be analysed before deciding on requirements for additional monitoring (QS 2, 6, 9). These concern primarily governance parameters (QS 9), under which also societal / anthropologic and economic parameters. WaLTER will develop a monitoring programme for ecological and socioeconomic parameters based upon the outcome of the analyses regarding customer needs and effectiveness. The way in which safety, economy and nature is appraised by different communities and the impact of (new) technological interventions on these communities depend to an important extent on culture, tradition, religion, political preferences, etc., especially when these interventions concern innovative designs and alternative (unorthodox) solutions (viz. below-ground CO2 storage; Hedwige polder). These societal conditions are not uniform and subjected to a certain level of change over time. This could result in the adoption of different, local, solutions not only depending on

climate change and predictions for local or temporal geomorphological, hydrodynamic and/or ecological conditions, but also on the prevailing societal environment.

4.7 Advice for integration, additional monitoring and modelling

Based on the discussion above, the following is recommended:

4.7.1 Data management

An important first step towards integrated knowledge based management and future policy decisions in the framework of the Delta Programme is to combine the wealth of information generated from projects in the Wadden Sea Area. The added value to which this would lead is very important in understanding the functioning of the system as a whole.

4.7.2 Remote Sensing

Remote Sensing is a relatively cheap and labour extensive method to obtain measurements from large areas (altitude, sediment composition, channel and gully morphology, geological and biogenic structures, zonation and vegetation characteristics). Remote Sensing techniques may be used to translate ground information from point measurements to a wider geographical area.

4.7.3 Hydrodynamics

- Install 'Hydrodynamics Measuring Poles' (SBW programme) in each tidal basin and one additional up the Eems-Dollard estuary for continuous high frequency measurement of wave height, wave period and wave direction, wind speed and wind direction, air temperature, water current speed and direction, spatial distribution of currents and waves, and suspended sediment.
- In one representative tidal basin detailed spatial and temporal registration of the parameters mentioned above may be recorded and related to detailed sediment composition and ecologic parameters as to support model development.

4.7.4 Bathymetry

Based on the long term bathymetric measurements (in Dutch: lodingskaart) a trend analysis of bathymetry changes in relation to sea level rise and beach nourishment should be carried out.

4.7.5 Storm erosion

Protocol development for consistent measurements of changes after each major storm event (cliff formation salt marshes and dunes, beach level), e.g. with 4x4 mounted laser scanner and aerial surveys (coast gard airplane equipped with LIDAR).

4.7.6 Ferries

The ferries between main land and islands are excellent monitoring platforms for bathymetry (channel depth and sand wave propagation), current speed and direction, suspended sediment, salinity and temperature, as has been shown for the TESO ferry communicating between Den Helder and Texel. Other ferries could also be equipped with similar monitoring gauges.

4.7.7 Socioeconomics

The human communities in the Wadden Sea Area form an indissoluble component of the system. Monitoring of the social and economic systems and the biotic and abiotic systems should therefore be equally addressed.

4.7.8 Model development

Models are powerful and indispensible tools to signpost moments of future adverse (eco)system shifts under continued current management conditions with respect to safety, ecology and socioeconomic development. They are therefore also indispensible to signpost moments of timely policy decisions to mitigate these adverse system shifts. The models need to be instrumental to predict the consequences of different policy alternatives, calculate the costs (and long term benefits) involved and the expected social and economic responses. Quality, quantity and relevance of the data feeding the models determine the accuracy of their predictions.

4.7.9 Trend analysis

Trend analysis based on existing long-term monitoring data sets will provide additional knowledge on monitoring needs in terms of parameters and sampling frequency, resolution and locations.

5 Proposed Monitoring Plan (recommendations by the authors of the Quick Scan Monitoring)

The proposed monitoring plan consists of five packages which could run to a certain extent parallel to each other:

- Organisation: Overview and analysis of monitoring demand, Establishing climate monitoring network and Harmonisation, and Data Management
- Trend Analyses of historic data series
- Hydrodynamic Monitoring in tidal basins and model development
- Quick Reaction Force
- Socioeconomics, Governance and Progress

5.1 Organisation

Harmonization and synchronisation of data collection leads to more monitoring efficiency, a sharper identification of monitoring needs and a sustainable Wadden Sea Area knowledge base.

5.1.1 Phase 1: Overview and analysis of monitoring demand

The primary mission of the Monitoring task of the Wadden Sea Area Delta Programme is to take the lead in reconciliation and harmonisation of policy relevant data demand and should provide an overview of the monitoring programmes that fit the objectives of the Delta Programme. The overview (as next step after this quick scan) serve as the basis for a first analysis of (additional) monitoring demand.

5.1.2 Phase 2: Establishing climate monitoring network and Harmonisation

This phase includes first of all the establishment of a monitoring network (or link climate change monitoring to existing networks). Secondly, monitoring schemes of current and future monitoring activities of existing programmes, national and international, needs to be analysed. Where possible negotiation of mutual beneficial sampling schemes should take place as to match the demands both of the monitoring programmes concerned and of the Delta Programme. Contact persons for Germany and Denmark are Franciscus Colijn and Morten Pejrup. For international comparison of tidal basins Folkert de Jong (CWSS) is contact person. Data sharing and harmonization will contribute to mutual beneficial sampling efficiency and, hence, cost reduction for all parties involved. This may require inter-calibration of sampling techniques and analysis methods depending on available laboratory facilities and capacity. Clever planning and incorporation of new monitoring activities addressing the knowledge gaps is also a Monitoring task and should lead to added value for all parties involved.

5.1.3 Phase 3: Data Management

Just as important is data management. The Monitoring task will take responsibility for negotiation and extraction of data from existing databases, filling of databases with new knowledge and for managing the availability of data. Shared, efficient and cost effective data gathering comes with additional requirements for the availability of data, which should readily meet the purposes and objectives of the different monitoring programmes involved, whether that be science, management or policy.

It is proposed to generate an e-platform giving access to existing data and future monitoring programmes and providing science based knowledge for policy decision making, management options and other stakeholder uses. Easy access to integrated Wadden Sea knowledge that is readily available

for end users is taken care of in the cooperative Wadden Sea Long-Term Ecosystem Research (WaLTER) project plan and involves:

- Setting up a central Wadden Sea Area data portal
- Setting up a Basic Monitoring Programme based on mutual consent (parameters relevant for ecological and socioeconomic development)
- Harmonise current and future monitoring programmes, networks and data portals

This approach, which may be adapted to fit the objectives of the Delta Programme and to serve a wider use beyond the Wadden Sea Area, will result in:

- Possibilities for adaptive management as to respond to the dynamics in the coastal zones at the level of entire systems
- A basic monitoring plan including the most relevant variables that are necessary to understand and follow developments in the functioning of the systems
- Secured financing and standards for data collection, storage and management
- International embedding of current and future monitoring programmes, measuring networks and data portals
- Cost reduction

Relation with: All Quick Scans of the Delta Programme Wadden Sea Area, Delta Programme Coast, Delta Programme Southwest Delta
Cost: PM
Time frame: On-going
Products: Database, Integration, Basic monitoring programme, Data portal

5.2 Trend analyses of historic ecological and socioeconomic data series

Trend analyses of historic data sets provide valuable information on the behaviour of important components of the Wadden Sea Area in the past in response to changes that are expected to continue in the future and which have an effect on water safety, natural qualities and system resources and services. Trend analyses will also reveal shortcomings in data sets and monitoring gaps that should subsequently be addressed in the monitoring activities supporting the Delta Programme objectives. Relevant in respect to the Delta Programme are:

- Fauna
  Developments in biodiversity, biomass and species composition in relation to sediment composition, sediment stability, hydrodynamics, shoal area and elevation. This includes eco-engineering and positive and negative feedbacks between fauna and geomorphology.
- Salt Marshes
  Area, elevation, cliff erosion and pioneer zone development in relation to sea level rise, storm events and salt marsh management.
- Dune Development
  Area and elevation in relation to sea level rise, storm events and management (including beach nourishment)
- Socioeconomic and Policy Development
  Trends in policy developments are being investigated in three NWO-ZKO projects by five PhD students and three postdocs

The natural qualities of the Wadden Sea Area receive specific institutional and legal protection. At the same time, the area is intensively used for a variety of socioeconomic activities. Climate change further increases the pressure on the system. Sustainable management of the area, preserving its natural values while taking advantage of its ecosystem services and resources and adapting to climate change, is

therefore not straightforward. Investments in the sustainability of development projects in the area are relatively large. A variety of organisations collect data on the natural and socioeconomic systems of the Wadden Sea Area as to monitor the long term effects of -often- specific projects or interventions. Other collections serve scientific research.

Relation with: Governance, Legal issues (incl. Natura 2000), Coastal Zone Management, Quick Scans 1, 2, 3, 5, 9, Delta Programme Coast, Delta Programme Southwest Delta
Cost: PM
Time frame: On-going
Products: Reports, Scientific publications (Non-linear behaviour; Multiple stable states)

5.3 Hydrodynamic and Geomorphological Monitoring

Hydrodynamic processes (horizontal and vertical tidal movements, waves (storms) and sea level rise) have created and maintain the Wadden Sea and determine to the largest extent what will happen with the Wadden Sea on the long term. As long as sufficient sediment is available these processes will guarantee the persistence of the Wadden Sea. Sediment shortage, either caused by reduced availability, inadequate transport mechanisms or increased demand due to increased sea level rise, signposts the tipping point beyond which the Wadden Sea will drown. If, how and when this happens is not clear. It is therefore important to measure and model sediment budgets in relation to hydrodynamics.
Changes in geomorphological development can be determined by the on-going 5 yearly bathymetric surveys and development of shoals and gullies based on satellite images and aerial photographs.

5.3.1 Phase 1: Large scale high frequency monitoring programme

It is proposed to deploy hydrodynamic measuring poles in each tidal basin in the Wadden Sea, or at least in those basins that represent the different characteristics of the Wadden Sea tidal basins:

- Marsdiep: Tidal basin with a large sublitoral area
- Eierlandse Gat: Tidal basin without coastal squeeze ('open wantij')
- Borndiep: Characteristic tidal basin between two islands in the Dutch Wadden Sea; 80% intertidal; inner and outer deltas; levees with 'kwelderwerken'; coastal squeeze; dredging in the eastern part, no dredging in the western part: possibilities to increase understanding of mud dynamics and to design pilot experiments and dredging experiments.
- Lauwers: Tidal basin comparable to Borndiep, but a more complex system made up of several smaller tidal basins, less disturbance (nature protected area).
- Up the Ems-Dollard Estuary

These measuring poles record year round at high frequency all important tidal, wave and current parameters, wind, temperature, suspended sediment. In the Borndiep tidal basin these high frequency measurements should be supplemented with intensive monitoring of sediment composition, fauna, gully, channel and shoal development.

5.3.2 Phase 2: Model development Borndiep

An integrated model will be developed for Borndiep tidal basin. The model will be applied to the other tidal basins in which only measuring poles are deployed as to predict the developments in these areas.

5.3.3 Phase 3: Model validation and calibration.

Based on the outcome of Phase 2, the model will be validated and calibrated based on the predictions as compared to the high frequency measurements from the measuring poles and boundary conditions in Marsdiep, Eierlandse Gat and Lauwers.

5.3.4 Phase 4: Applying and validation

After validation and calibration of the model for the tidal basins mentioned above, the model will be validated and applied to the other basins for with only boundary conditions are available.

Relation with:	Quick scans 1, 4, 5, 6, Governance, Delta Programme Coast, Delta Programme Southwest Delta, other national and international programmes
Cost:	PM
Time frame:	approximately 10 y
Products:	Yearly reports, Models, Atlases, Knowledge development of sandy shores, Scientific publications

5.4 Quick Reaction Force

The Delta Program is directed at providing safety for a 1 in 4,000 to a 1 in 10,000 years storm event. Because these events are rare, it is essential to measure and model the effects of more frequently occurring storms to gain insight in -and extrapolate- these effects to predict the effects of the extreme events. Pre- and post-storm measurements are required to provide data input responding to the knowledge questions of other quick scans in order to ascertain that relevant safety and natural criteria are met for saltmarsh area, elevation of tidal flats, dunes, basic coastline, etc.

5.4.1 Phase 1: Organisation and protocol development, Equipment purchase, installing and calibration

A protocol needs to be developed for in order to respond quickly to storm events (organisation, logistics). Equipment to measure storm erosion needs to be purchases and installed (4x4's, side scan laser, LIDAR). Base-line data on coastline, dunes and salt marshes need to be available before each storm event, re-establishment needs to be monitored between storm events and calibration before the next storm event is necessary to reset the base-line data.

5.4.2 Phase 2: Post storm surveying

In addition to measurements described above it is essential to do measurements during, and surveys as soon as possible after, each storm event as to determine the maximum net sediment transport capacity at extreme circumstances (hydraulic boundary conditions, wave characteristics, current speeds, sediment transports, dune erosion, cliff erosion along salt marshes, change in channel and gully patterns and change in sediment characteristics of tidal flats). Measurements soon after a storm event should comprise new dune and tidal marsh formation in the following season as to determine the (semi) natural resilience of dune and tidal marsh systems to storm events. This Quick Reaction Force will determine the pace at which dunes and salt marshes recover from storms and if the nourishment measures taken as to compensate for dune and beach erosion (and ultimately the erosion of tidal flats) are sufficient to meet the objectives of the Delta Programme.

Relation with: Quick Scans 1, 2, 3, 5, 6, 8, Governance
Cost: PM
Time frame: On-going
Products: Post-storm reports, Insight in sediment dynamics, scientific publications

5.5 Socioeconomics, Governance and Progress

5.5.1 Monitoring programme for socioeconomic parameters

WaLTER will develop a monitoring programme for socioeconomic parameters (besides ecological parameters) based upon the outcome of the analyses regarding customer needs and effectiveness.

Relation with: Governance
Cost: PM
Time frame: 5 years
Products: Socioeconomic monitoring plan

5.5.2 Progress monitoring

Besides, progress of the Delta Programme Wadden Sea Area project needs to be followed and reported to the beneficiary. This monitoring exercise should:

- Register active and passive reach out of the Delta Programme Wadden Sea Area to stakeholders and stakeholder participation
- Register media attention for Delta Programme Wadden Sea Area, especially in regional newspapers and periodicals, television and radio
- Measure (development of) people's trust in local and national administrations through panels and surveys

Relation with: Governance
Cost: PM
Time frame: On-going
Products: Yearly progress reports

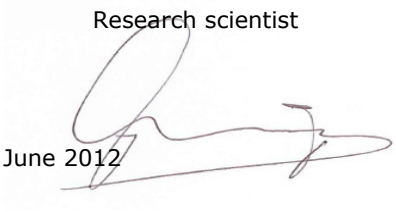
Quality Assurance

IMARES utilises an ISO 9001:2008 certified quality management system (certificate number: 57846-2009-AQ-NLD-RvA). This certificate is valid until 15 December 2012. The organisation has been certified since 27 February 2001. The certification was issued by DNV Certification B.V. Furthermore, the chemical laboratory of the Environmental Division has NEN-AND-ISO/IEC 17025:2005 accreditation for test laboratories with number L097. This accreditation is valid until 27 March 2013 and was first issued on 27 March 1997. Accreditation was granted by the Council for Accreditation.

Justification

Report	C074/12
Project Number:	430.82010.76

The scientific quality of this report has been peer reviewed by a colleague scientist and the head of the department of IMARES.

Approved:	C.J. Smit, MSc. Research scientist
Signature:	
Date:	June 2012

Approved:	F.C. Groenendijk, MSc. Head of Department
Signature:	
Date:	June 2012

Appendix A. Table 1: Monitoring codes (see 4.1 – 4.5) and corresponding programme, monitored parameters and monitoring organisation

Code	Title / Programme	Parameters	Organisation
H1	Elevation (shoal, land), bathymetry and coast line	Elevation / Height	RWS
H2	Bottom physical characteristics	Erosion and sedimentation processes	RWS and others
H3	Water column physical characteristics: salinity	Salinity	RWS
H4	Water column physical characteristics: tide	Tidal characteristics	RWS
H6	Water column physical characteristics: current	Current	RWS
H7	Water column physical characteristics: waves	Waves	RWS
H8	Temperature fresh and salt waters	Water temperature	RWS
H9	Satellite based water temperature	Water temperature	KNMI / NOAA
H10	Climate and climate change	Temperature, precipitation, wind direction, wind speed	KNMI
P6	Distribution and densities of seagrass in the Wadden Sea and southwest Delta	Distribution, areal extent, trends	RWS, RU Nijmegen
P7	Wadden Sea salt marsh elevation and areal	Areal extent, water levels, vertical growth (accretion), management, biodiversity, trends	RWS, IMARES
P8	Salt marsh elevation and vegetation development Friesland and Groningen coasts	Areal extent, biodiversity, management, trends	RWS, IMARES
P9	Salt marsh elevation and vegetation development gas concession Ameland	Subsidence, areal, biodiversity, management, trends	IMARES, NAM, Alterra
P10	Salt marsh areal and vegetation zoning Friesland and Groningen	Subsidence, areal extent, biodiversity, management, trends	RWS, IMARES
P11	Salt marsh elevation and accretion Wadden Sea islands Friesland, Dollard and Polder Breebaart	Subsidence, areal extent, biodiversity, management, trends	RWS, IMARES
M1	Human co-use and its effect on ecosystems	Numbers (tourists and sightseers, ships, airplanes, aviation), distribution and quantities (dredging, gas extraction), numbers and behaviour (birds, seals)	RWS
M2	Coastal defence: policy and measures	Areal extent, levee and dune heights, salt marsh elevation	RWS
M6	Reference area Rottum	Species biodiversity, distribution, trends	IMARES

Appendix B. Table 2: Organisations (re Table 1)

IMARES	Institute of Marine Resources and Ecosystem Studies, Wageningen University and Research Centre
RWS (a.k.a. WD)	Agency of the Ministry of Infrastructure and Environment
Alterra	Alterra Wageningen University and Research Centre
RU Nijmegen	Radboud University Nijmegen, The Netherlands
KNMI	Royal Netherlands Meteorological Institute
NOAA	National Oceanic and Atmospheric Administration
NAM	Dutch Petroleum Company