

Abstract Volume



The 14th International Scientific
Wadden Sea Symposium

TØNDER - DENMARK

ISWSS14

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On climate change and future Wadden Sea ecosystem studies

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The research questions of the Trilateral Research Agenda on Ecology focus on the direct and indirect effects of global climate change. Wadden Sea scientists, therefore, need serious consideration of climate change studies to specify future research questions. It is apparent that the climate, the 30 years averaged weather, is changing. It expresses in the Arctic Sea Ice Extent or the Great Barrier Reef bleaching. However, there is a great uncertainty in future predictions of climate change and even a fierce debate over the causes. I give a brief overview of climate change literature and will point to some of the discussions in the field of climate studies. What to believe of climate change studies is one thing, but what to study on climate change effects is another. I will elaborate on some of the predictions and what this may mean for research on the Wadden Sea ecosystem. A main question is where we should emphasise our research efforts. Climate change effects could be overriding everything or just be another variable in the cumulative effect-equation, which also includes exploitation, habitat alteration, habitat destruction, habitat extinction, eutrophication, pollution and species introductions. Last but not least, our management responses to climate change can potentially become the dominant variable in determining the state of the Wadden Sea ecosystem.

The TRA Geosciences Group: Background and Main Points

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Based on decisions formulated in the in declarations from the Trilateral Ministers meetings 2010 and 2014 the preparations of an upcoming similar meeting in 2018 has resulted in the establishment of five working groups under the following headings: Geosciences, Ecology, Economy & Society, Cultural Heritage and Climate & Water. All groups have formulated a report. These reports formed the background for the formulation of a combined draft version for a trilateral research agenda, which has been circulated prior to SWSS14. Subsequently a finished proposal is to be formulated and presented to the ministers at the Minister Conference scheduled to be held in early 2018. An earlier draft of the Geosciences Report was presented for discussions at a workshop held at Hanse-Wissenschaftskolleg in Delmenhorst May 9, 2016. This workshop was attended by 22 scientists with participation from all three Wadden Sea countries, and formed the basis for the final report concerning Geosciences. The primary recommendations made in this report can be summarized in 5 points: 1) The need for a combined sedimentary/morphological model of the development of the Wadden Sea in Holocene. 2) The need for a modern database containing all relevant geo-parameters including frequent mapping of the combined Wadden Sea. 3) The need for a better understanding of the origin, pathways and deposition of mud in the Wadden Sea. 4) The need for a better understanding for the sediment/geomorphological response of the Wadden Sea to rising Sea level scenarios. Of special interest here is the reaction of the ebb tidal deltas. 5) The need for a better understanding of reactions in the subsurface in relation to e.g. the post glacial rebound and reactions related to the utilization of oil and gas.

Sensitivity of birds to environmental change in the Wadden Sea: Key questions to address in future

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The Wadden Sea is of paramount importance as a breeding area and as a stopover site for a number of coastal waterbird populations in the East Atlantic Flyway. Based on coordinated long-term field recordings of numbers and distribution of breeding and migratory waterbirds in the international Wadden Sea, collected within TMAP, we have identified some major changes in trends and large scale distribution of a number of species, some of which also affect overall numbers in the East-Atlantic Flyway. We highlight some of the most pronounced changes. Overall, it can be expected that certain species of waterbirds will come under pressure from both small scale and large scale changes in the Wadden Sea.

Currently, the processes behind the emerging patterns of change in the distribution of migratory waterbirds are not well understood, and we see a need for identifying the underlying key factors that play a role within the Wadden Sea itself, or elsewhere in the flyway. The food source and its availability is likely to be one of the key factors determining waterbird distribution in the international Wadden Sea. It is, therefore, of relevance to reach a better understanding of how factors such as climate change affect the invertebrate communities and the spatio-temporal variation in productivity of invertebrates. To reach a better background for forecasting future changes in numbers and distribution of waterbirds relying on the Wadden Sea as a refueling area during migration, we see a need for applying comparative analyses and modelling, and for initiating focused monitoring at selected sites. Successful outputs will require collaboration with Wadden Sea researchers from other fields, integration of analyses of existing data and coordination of focus for future research both in terms of choice of key questions and selection of study areas.

The continued commercial and recreational demand for space and resources in the Wadden Sea is creating challenges for local breeding bird populations and direct and indirect effects on populations of migratory birds. Breeding birds in the Wadden Sea rely on availability of sites where they can breed safely against human disturbance and predators, and some of the species also need high quality feeding sites near to their nesting area in order to successfully raise chicks to fledging.

Unfortunately, it is far from trivial to develop wise strategies that can be applied when incorporating the requirements of breeding birds and migratory birds in spatial planning. For example, (a) for some species it is necessary to consider a larger geographical scale than for others, (b) some species are more sensitive to a change in the environment than others, (c) some areas are of extraordinary high importance whereas others are of less importance, (d) some species need access to alternative sites as a buffer to rare events and unpredictable changes in the distribution of predators and food resources etc.

Despite the conduction of valuable research projects in local areas of the Wadden Sea we are in need of collation of research results and experiences for proper guidance of planners and site managers. Furthermore, finding answers to some remaining questions is critical for well-informed spatial planning in the Wadden Sea.

Sense of Place in the Wadden Sea Area: The relevance of place-based heritage epistemologies for sustainable development

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Inhabitants of the coastal region in the Wadden Sea have been living with and struggling against the sea for centuries. This relationship has been portrayed in the long-lived motto “God created the sea, the Frisians the coast” exhibiting a sense of place with the coastal landscape and the sea. Structured by historical features, intangible traditions, social relations, emotional attachments and local knowledge(s) about landscape, flora and fauna, the relevance of these relationships in terms of cultural landscapes and values have politically been proclaimed in the Sylt Declaration 2010 on the importance of cultural heritage of the Wadden Sea. However, this acknowledgement is still widely lacking in policies practices striving for a sustainable development of the region. Different kinds of place-based epistemologies – to be understood as differently structured forms of regionally and locally grounded knowledge(s) – are often conflicting with growth-oriented planning cultures, institutionalised rationalities in nature protection or outmoded ideas of coastal protection in times of an impending climate change. Surprisingly though, emerging participatory procedures still aim at facilitating top-down knowledge transfer between science and society while missing to integrate the existing perspectives of the people living in the area. This more or less hierarchical view has proven to be problematic for an integrative and sustainable development as it relies on a knowledge deficit model and neglects the contextualised and practical character of local sense of place and values relevant for cultural heritage. Even though first attempts to understand and implement local knowledge underlying the framing and assessment of cultural heritage are underway, scholars from the humanities and the social sciences have to date been relatively silent about the conceptual processes informing the social generation of local heritage knowledge(s) in the Wadden Sea region. The paper takes this aspect as a starting point and North Frisia as an example to analyse place-based heritage epistemologies that endow the North Frisian land- and coastscape with tangible and intangible values. Data was gathered through semi-structured and walking interviews with a variety of coastal dwellers in the Wadden Sea and analysed according to requirements outlined in grounded theory. The aim of the paper is threefold: to empirically uncover place-based heritage epistemologies and values, to determine how these epistemologies might provide opportunities for an integrated and sustainable management in the context of transformative science, and to show how the outcomes of our study could be used to develop awareness among policy makers for implementing place-based approaches for cultural heritage in the Wadden Sea development strategy.

Wadden Sea Quality Status Report 2017: Salt Marshes – status and trends

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The salt marshes of the Wadden Sea currently cover an area of 400 km², and comprise barrier-connected salt marshes (40%), foreland-type salt marshes (55%) and hallig salt marshes (5%). Most of the foreland salt marshes developed from salt-marsh works. Since about 2000 (encompassing three consecutive surveys), the total area of salt marsh in the Wadden Sea increased by expansion of island (barrier-connected) salt marshes, and by some natural (unaided) growth of mainland (foreland) salt marsh in Schleswig-Holstein. The size of hallig salt marshes remained constant.

Despite the recent extension of salt marshes, the extent of pioneer and low-marsh vegetation types remained relatively constant, whereas vegetation of late-succession stages increased, especially **Elytrigia atherica** vegetation. The latter has become the most dominant vegetation type in the high-marsh zone.

In order to transform the artificial foreland salt marshes towards a more natural state, maintenance of the artificial drainage system has been abandoned in the major part of these marshes. Most salt marshes are managed for nature conservation. In line with diverging conservation objectives, however, vegetation management differs from minimum intervention (to secure the undisturbed course of natural processes) to moderate livestock grazing (to increase structural vegetation diversity and local biodiversity).

In order to evaluate the status of Wadden Sea salt marshes in relation to current of sea-level rise, available data on marsh-elevation changes were collected, and will be evaluated.

In order to reach a favourable conservation status for salt marshes, five targets for salt marshes have been agreed upon and framed in the trilateral Wadden Sea Plan. These targets will be evaluated, and recommendations for monitoring, research and management will be presented.

Geosystem Research in the Wadden Sea: Where do we stand, where should we go?

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There appears to be general agreement that climate change is the overarching theme along which future research in the region should orient itself because it affects every aspect of the Wadden Sea. This theme has been aptly summarized in 2016 by the Climate & Water Working Group in the form of the following question: What kind of scientifically based information, evidence, projections, experiences, methods & techniques and system understanding is needed to secure and enhance the Outstanding Universal Value (OUV) of the trans-boundary UNESCO World Heritage Site (The Wadden Sea) and its integrity in the light of climate change and in need for sustainable development in the 21st Century and beyond?

With this overarching theme in mind, the present contribution concentrates on a selected number of key issues, all of which are rather complex when analysed in detail. Although quite a substantial knowledge base is available in most cases, the data from different regions are often incompatible with each other, making comparisons difficult if not impossible. In addition, the misapplication of data sometimes confounds their correct interpretation.

Selected key issues

1) Spatial grain-size distributions of surficial sediments

Although much data is available, several different and mutually incompatible analytical methods have been used to generate the data. In addition, different classification schemes have been used in data presentation.

Therefore, existing grain-size data need somehow to be normalized, e.g. by developing algorithms for the conversion of one into another; this can be achieved by comparative analyses.

Concerning the future, decisions are needed about which classification scheme and which analytical method(s) are to be applied across the Wadden Sea. It would appear that both geometric (sieve, laser-based analyses) and hydraulic data (settling tube analyses) are required, the former for ecological purposes such as animal-sediment relationships where the physical grain size is important, the latter for sediment transport modeling where the hydraulic nature of the sediment is important.

2) Sediment budgets

This is a very wide and complex subject. It should, amongst others, include the quantification of Holocene sediment reservoirs (volumes) of the Wadden Sea (i.e. the sediment stored above the Pleistocene/Holocene boundary) as well as their overall grain size composition. This issue is fraught with numerous methodological problems, e.g. a lack of reliable criteria to link seismic reflection profiles (vertical changes in impedance) with down-core sediment composition; changes in grain size are clearly not the only factor involved.

Some important questions include:

- a) Which parts of the Wadden Sea still benefit from the import of sediment from external sources to compensate sea-level rise (aggradational/progradational systems)?
- b) Which parts of the Wadden Sea, if any, are cut off from external sediment supply, having instead to rely on their own reservoir to compensate sea-level rise (transgressive systems)?
- c) How much sediment, and of what grain size, must the individual tidal basins import annually (on average) to compensate the current rate of sea-level rise?
- d) Are there tidal basins which don't import sufficient sediment to compensate sea-level rise and, if yes, what is the reason?
- e) What are the main sediment sources, transport modes, transport routes and ultimate sinks?

3) Barrier islands and tidal ebb-deltas

What is the role of barrier islands and, in particular, the ebb-deltas in wave energy dissipation and dispersion?

How do ebb-deltas respond to changes in tidal currents and wave climate?

What maximum rates of sea-level rise can the ebb-deltas (and barrier islands) of the Wadden Sea survive before being overstepped?

4) Freshwater seepage along sub-bottom aquifers

Freshwater seepage has locally been shown to occur (e.g. Wurster Watt, Germany).

What is the local impact on the ecology and is it relevant on the Wadden Sea scale?

Are there possible interactions between the deeper biosphere (aquifer) and the surface/near-surface biosphere?

Little is known about this!

5) Mass physical sediment properties

The trends in mass physical properties of sediments of different grain-size composition can be used as excellent proxies for a variety of ecologically important parameters. A problem here is the frequent confusion between content (mass per unit mass) and concentration (mass per unit volume). Such confusion has resulted in serious errors and misrepresentations which, unfortunately, have found their way into models, manuals, and environmental guidelines and directives.

Recommendation

In order to harmonize, standardize, and normalize future Wadden Sea research relevant to the World Heritage objectives, the most effective solution would be to appoint a number of small research groups (e.g. a biologist, a sedimentologist, a lab assistant and a field assistant) in each region, who are attached to established local research institutions, have their own budgets and standardized laboratory equipment. The head of each group should be given the authority to co-ordinate the Wadden Sea research in their region, while being obliged to coordinate their own research with the groups of the other regions. This is the only way to guarantee uninterrupted continuity of such research. This should, however, not exclude or stifle research by other scientists who may follow their own specific research aims and which may ultimately also benefit the Wadden Sea World Heritage knowledge base.

Plastics in the Wadden Sea marine environment

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The results from various studies and programs reveal the continuous and widespread occurrence of plastic litter in the Wadden Sea and adjacent offshore waters. Plastic litter from diverse sources occurs on dunes and beaches, in and on inter- to subtidal sediments and in marine organisms, including protected seabirds and mammals. Most of the investigations on marine litter in the Wadden Sea are one-off events. They do not provide information on temporal trends but demonstrate that litter densities in the Wadden Sea are not lower than in other coastal regions. The OSPAR Beach Litter Monitoring and Monitoring on Litter in Fulmars' Stomachs provide an evaluation of the temporal development of litter abundance in the southern North Sea. Both programs show that densities of plastic litter have not declined in recent years, indicating that huge amounts of litter are still entering the marine environment either directly within the Wadden Sea or from adjacent waters. Plastic litter is not restricted to specific habitats but occurs in all compartments of the marine environment with a constant exchange between them. Accordingly, monitoring litter densities in both coastal and offshore habitats is essential for a sound evaluation of plastic pollution of the Wadden Sea. Recent campaigns, such as Fishing for Litter and the assessment of benthic marine litter densities within bottom trawling surveys, can become important elements in a comprehensive monitoring strategy on marine litter pollution.

The monitoring of plastics in Fulmars' stomachs and the examinations of carcasses of Harbour Porpoise, Harbour Seals and Eider Ducks revealed that plastic litter does not simply occur in the marine environment but actually interacts in a potentially harmful way with the marine biota. It is yet unknown whether marine litter has demographically relevant implications for marine species. For evaluating this, the effects of marine litter must not be considered in combination with the effects of other environmental stressors such as ocean warming and acidification, eutrophication and the exploitation of natural stocks.

Plastics degrade in the marine environment and breaks down into small fragments. Recent studies revealed a

substantial contamination of Wadden Sea beaches and sediments with smallest synthetic particles. However, a scientifically sound and standardized monitoring of microplastics in the Wadden Sea is as yet lacking. Several Wadden Sea Plan targets are compromised by the continuous pollution of the North Sea with plastics. A proper management of the marine litter problem will require appropriate reduction measures and extended and optimized monitoring programs in order to evaluate future developments.

Towards improved collection, quality assurance and use of authoritative environmental data in Denmark

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The Danish experience proves that a collective approach from the municipal, regional and national governmental level towards collecting and sharing authoritative environmental data creates value in a very cost efficient way. It has, e.g., been estimated that if a national authoritative database did not exist the municipalities and the national government would have to employ more than 300 additional employees to do the same level of work. This compares to an IT cost of less than 1 million Euro per year.

A key to achieving this has been the creation of the Danish Natural Environmental Portal which is a jointly owned by the national government, the regional government and the municipalities. Within the governing structure of the Danish Natural Environmental Portal a shared definition of authoritative environmental data has been agreed. So that data can be used in the decision making process regardless of which governmental body has collected it. Furthermore, governing bodies with the knowledge and authority to make the decisions needed to facilitate a unified approach to collecting and sharing of environmental data has been established. This does not just include the establishment of the necessary IT infrastructure, but also defining, who is the owner of the different data sets as well as finding common grounds on terminology, data quality declarations and the development of Inspire compatible logical and physical data models.

In recent years the Danish Natural Environmental Portal has seen an increased use of its services. In 2016, a total of 0,5 million data records was created or updated, more than 100 systems integrated with the databases and more than 5 million visits from more than 100.000 unique users. The above resulted in more than 25 billion data storage transactions.

The IT infrastructure of the Danish Natural Environmental Portal is hosted in the cloud. The portal is regarded as a front runner in the public sector in Denmark. Not just for hosting of IT but also in terms of developing new solutions in the cloud. Relying on cloud based components provides a range of new opportunities for combining different data sources, advanced analytics and sharing of data. The technical developments combined with an increased cooperating with consulting engineering companies, the emergence of IoT as well as crowd sourcing for data collection has the potential to radically change the way the environment is monitored.

QSR - Initial address and overall results

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Common Wadden Sea Secretariat (CWSS)

The Trilateral Monitoring and Assessment Programme (TMAP) is one of mainstays of the Trilateral Wadden Sea Cooperation and a cornerstone of the protection of the Outstanding Universal Value (OUV) of the Wadden Sea. This was acknowledged by UNESCO in the World Heritage nomination process. TMAP covers the marine and coastal area of the Wadden Sea, including the barrier islands, and is conducted jointly by Denmark, Germany and the Netherlands. The aim of this comprehensive programme is to determine the ecological status of the Wadden Sea. Changes in status and their possible causes are identified, as well as issues of concern, the effectiveness of implemented measures and existing gaps in knowledge. Since 1993, four Quality Status Reports (QSR) reflecting the results of these exemplary monitoring efforts have been issued at regular intervals, providing valuable information and recommendations for science, research, policy-making and management. The QSR 2017, which is about to be finalized, will be the first update to be primarily accessible online. The new QSR web portal will reach out to an even broader audience than its predecessors by meeting modern international standards. The QSR Editorial Board and the Common Wadden Sea Secretariat (CWSS) coordinated contributions by more than 120 scientists from

the Wadden Sea region. 29 individual Thematic Reports cover topics in the areas of “Geomorphology and Climate”, “Habitats and Communities”, “Species”, “Human activities” and “Pollution”. A corresponding Synthesis Report will summarize major findings and contributions in a printed brochure format, addressing policy makers and the wider public in order to increase the dissemination of the QSR.

National Marine Ecosystem Monitoring Program in Korea

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The National Marine Ecosystem Monitoring Program in Korea is performed by KOEM every 2 year with support of the ministry of oceans and fisheries. This monitoring program consists of a fundamental survey (tidal flat, inshore, rocky shore, and offshore) and a hot spot survey (tidal flat, estuary/upwelling, and rocky shore) depending on various marine characteristics in Korea.

At each survey, biotic (plankton, benthos, nekton, and seabird) and abiotic parameters (environment and socio-economy) are investigated. As the survey is carried out by the joint various investigation team, it is followed the united survey protocol to have a standardized sampling and analysis method. The survey results are open to the public through the official website (www.ecosea.go.kr).

Marine Data Infrastructure Germany

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In the North Sea and the Baltic Sea, data from sea surveying, environmental monitoring, spatial planning and others are mainly collected for the execution of technical tasks, which until now were only accessible on different platforms under the respective aspects of use. The Marine Data Infrastructure Germany (MDI-DE) lays the foundations for a shared use of distributed heterogeneous data stocks in the German coastal zone. It fulfills the requirements of the European spatial data infrastructure INSPIRE and is integrated as a specialist portal in the German geodata infrastructure (GDI-DE).

The development of the MDI-DE was sponsored by the Federal Ministry of Education and Research (BMBF) in the years 2010-2013. A total of 11 federal and state authorities involved in coastal engineering, coastal water protection, marine environmental protection and marine protection took part. The aim of the project was to make the data and information from the above-mentioned areas of responsibility accessible via a common Internet portal www.mdi-de.org.

As a result of the MDI-DE, the various specialist marine data distributed in the German coastal zone are used via a network for marine data with Internet services according to the definitions of the Open Geospatial Consortium (OGC). In the MDI-DE portal, they are documented in a catalog service (CS-W) with standardized metadata according to ISO19115. Specialized data are displayed and made accessible by standardized web services (WMS, WFS). Prototypes of Web Processing Services (WPS) have been implemented, for example, for assessment procedures under the European Maritime Strategy Framework Directive (MSFD).

The standardized Internet services for display, download and research enable the sharing of these data, both on the MDI-DE portal as well as in other target systems such as the federal state information and communication platform WasserBLICK. They can also be used in local GIS applications. By adhering to the technical standards mentioned, data and data products can be reused several times without additional effort on the part of the providers. In particular, the MDI-DE supports the authorities in the coastal zone in fulfilling their reporting obligations for EU framework directives and INSPIRE.

This also includes services such as a coastal thesaurus, which includes the vocabulary of natural and environmental protection, as well as the vocabulary of coastal engineering. Together with a coastal gazetteer service for the geographic names in the German coastal waters, these services form the basis for locating data and their contextual description through metadata.

The MDI-DE is an open network in which any number of local nodes can be integrated via standardized metadata and services. In this way, data sets from the coastal authorities together with data from the research are uniformly researchable and usable. MDI-DE is intended to be the platform for the general public, business, politics, admini-

stration and marine science to access information in the future. Since 2014, it has been permanently anchored under the umbrella of a cooperation agreement for the development of an environmental information system in Germany with an annual budget for the technical consolidation and content-related further development of the search and information system.

Tourism, Nature Conservation and UNESCO World Heritage Stewardship in the Danish Wadden Sea

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The designation effect of protected areas (PAs) such as national parks has been extensively researched, but less has been written about how complex values held by those involved in nature conservation and tourism may affect UNESCO World Heritage environments. This paper addresses the significant need to understand the underpinning values and opportunities seen by those involved in tourism, nature conservation and World Heritage stewardship.

The role of values is central to World Heritage sites, which are unique PAs because they are based on the concept of Outstanding Universal Value (OUV) (UNESCO, 1972). Whilst many values are often local or national, the concept of universal values, by definition, should be relevant to everyone, including visitors from around the world. The relevance of understanding OUV is critical for World Heritage sites in the day-to-day **realpolitik** of governance, where local and national stakeholders are in control, with only occasional, but potentially powerful inputs from UNESCO in Paris representing the universal values (Liburd & Becken, 2017). The International Union for Conservation of Nature [IUCN] and UNESCO enjoy a longstanding trajectory that includes co-drafting of the 1972 World Heritage Convention text and the IUCN is explicitly recognised within the Convention as the technical Advisory Body on nature to the World Heritage Committee (IUCN, 2016a). Thus, attaching values of nature to the IUCN categories aligns well with the philosophy that underpins conservation and the OUV of World Heritage sites (Liburd & Becken, 2017).

Natural World Heritage sites are globally recognized as the world's most important PAs (IUCN, 2016b). There are currently 203 natural World Heritage sites in the world of which the Wadden Sea National Park in Denmark, the focus of this research, is a recently nominated site. In 2014, the Danish part of the Wadden Sea followed the Dutch-German 2009 inscription on the UNESCO World Heritage List. The Wadden Sea spans 500 km and the coastline of three countries - Germany, Netherlands and Denmark. The Wadden Sea is the largest unbroken system of intertidal sand and mud flats in the world, described as "a seascape of immeasurable importance" (Marencic & Domnick, 2014: 4). The Wadden Sea was inscribed for its globally important geology, ecology and biodiversity. The three countries have been committed to jointly conserve and protect the Wadden Sea as an ecological entity since 1978. The aim of nature conservation in the Wadden Sea is: "to achieve, as far as possible, a natural and sustainable ecosystem in which natural processes proceed in an undisturbed way" (Marencic & Frederiksen, 2014: 4).

In addition to 30-40 million day visitors more than 10 million tourists visit the World Heritage Wadden Sea destination per year. They generate about 50 million overnight stays, with an estimated yearly turnover of 5 billion Euros (Marencic & Domnick, 2014: 6). The tourism industry in the Wadden Sea inherently depends on a healthy natural environment, and is also likely to benefit from the World Heritage brand. Still, the positive impact of conservation designation on tourist visitation is contested in the literature (e.g., Buckley, 2004; Hall, 2006; Selman, 2009; Shone, Espiner & Stewart, 2016).

The principal motivation for this research is to understand the underpinning values and identify opportunities seen by those involved in tourism, conservation and World Heritage stewardship. The concept of stewardship differs from stakeholder and agency theories, both of which find their justification in self-preservation, economic motives and a pragmatist, rational approach to management (Donaldson & Davis, 1991; Freeman, Wicks, & Pamar, 2004; Bernstein, Buse, & Bilimoira, 2016). In other words, stakeholder and agency theories have a strong individualistic focus, which can jeopardize larger environmental and societal good. Stewardship theory does not reject individual motivations, but suggests that those involved gain benefit by putting the interests of others above their own and pursuing actions that generate their own intrinsic rewards (Neubaum, 2013). Neubaum (2013) defines stewardship as "caring and loyal devotion to an organization, institution, or social group" (p. 2).

The distinction between stewardship and governance as the act of governing is relevant. Governance denotes a “conceptual and representational role of the state in the coordination of socio-economic systems” (Hall, 2011 p. 439). The concept of governance is void of meaning without the centrality of the state, even if issues of network relationships and public-private partnerships are involved (Rhodes, 1997). Informal governance is exercised by stewards who care, display loyal devotion and identify with the conservation of PAs beyond own and state interests. The concept of stewardship thus puts emphasis on the people involved in conservation efforts, their values and dynamic interrelations.

Methodology

A qualitative approach was adopted to allow for underpinning values to emerge and reduce the risk of being prescriptive. The relativist ontology underpinning the work assumes that reality is socially constructed, even if particular elements of this reality (e.g. the environmental quality of the Wadden Sea) are measurable by objective approaches. A total of 12 in-depth interviews with key tourism operators, public sector managers and other stakeholders from the Danish Wadden Sea National Park and UNESCO World Heritage Site were collected in 2016. The duration of interviews ranged from between 30 and 120 minutes, all interviews were transcribed verbatim. Interviews were then coded for emergent themes using content analysis, a commonly employed tool that is useful for uncovering knowledge and new insights from the participants’ perspective (Jennings, 2010: 211-213).

In addition, a tourism co-design approach has been applied to engage tourism practitioners, researchers, post-graduate tourism students, the public sectors at municipal, regional and national levels in innovation processes.

Tourism co-design is a co-generative and co-learning development endeavour that leverages the communicative interaction between people (Heape, 2007; Mattelmäki & Visser, 2011; Sanders & Stappers, 2008) and enable people to change their practices. Interviews and co-design materials were complemented by longitudinal participant observation and action research by the first mentioned author, who also serves as appointed Chair of the Wadden Sea National Park Board in Denmark (from January 2015). Action research generally relates to research that is connected to a change process, for example by the researcher working closely with stakeholders who are guided by the research findings to adjust decision making (Munch, 2014).

It is not in the scope of this paper to detail the methods and interventions applied. Suffice it to say that we have carried out other action research and tourism co-design projects. Funded by **Innovation Fund Denmark**, an example is the project entitled [InnoCoast](#) (2016-2019). By visiting and bringing locals who live in the Wadden Sea National Park together in a series of workshops we identified, principally from their narratives about life in the area, a range of innovation opportunities.

Findings

The analysis seeks to uncover how stewardship values and narratives can be used to identify new opportunities for nature conservation and sustainable tourism development in the Danish Wadden Sea. Examples arising from the interviews and workshops include service and experience innovation, branding of local produce, new partnerships and collaboration, climate change mitigation, and opportunities for enhancement of quality of life for senior visitors and residents alike. To illustrate the latter, and despite the fact that tourism has historically been used for health purposes, especially in natural environments (Bramwell, 2011; Bramwell & Lane, 2011), the current state of scientific knowledge on health outcomes and how to encourage active or responsible ageing is deficient. Whilst there is some evidence that leisure and tourism can provide health benefits, there is little knowledge of how sustainable tourism development can be used as a tool to facilitate healthier ageing. Moreover, there is little integration of knowledge or skills between visitors and those engaged in conservation practices. This is in spite of potentially shared values of nature conservation by those residing in, and visitors to the Wadden Sea, who may readily engage in stewardship and innovation in and beyond the Danish National Park and the trilateral UNESCO World Heritage Wadden Sea.

Conclusion

Findings are still nascent and have not been applied to the wider industry or policy context, as they should be subjected to further, multi-disciplinary research. Preliminary conclusions point towards a more holistic approach to World Heritage nature conservation, innovation, and sustainable tourism development, which may emerge through recognition of the values held by stewards who devotedly care, beyond individualistic or commercial gain, while not excluding the latter.

Welcome to Anthropocene

Markager, Stiig

Department of Bioscience, Aarhus University, Denmark

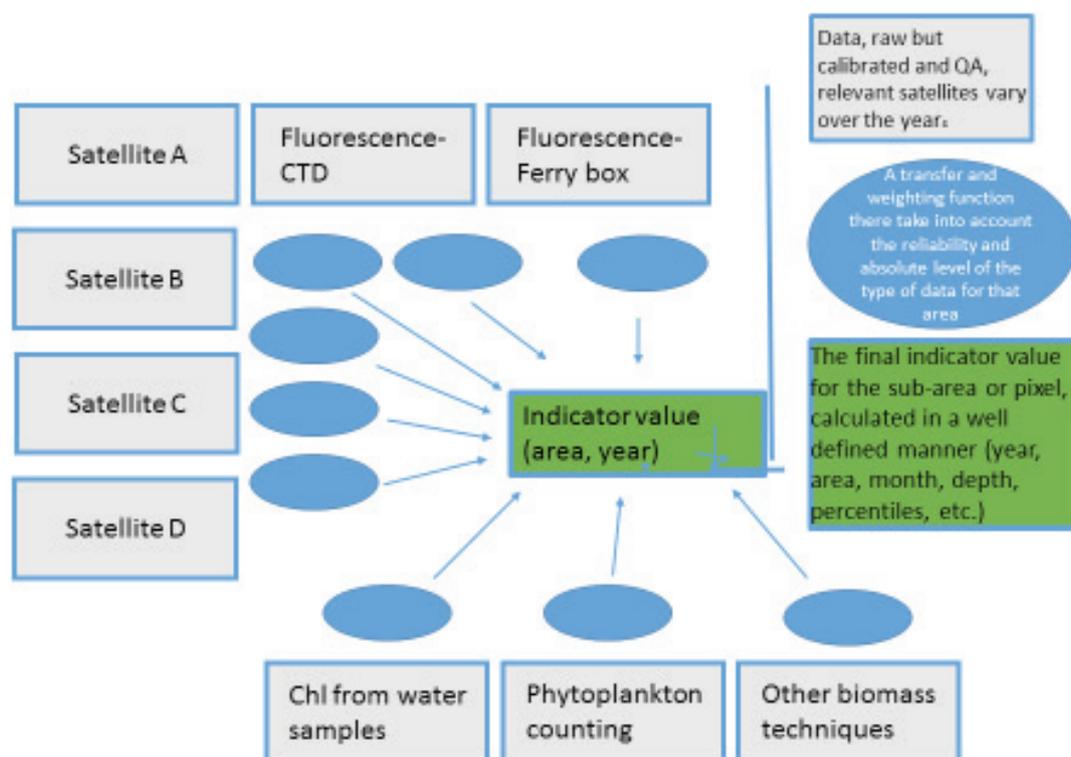
Ground control to pilot: 'We are handing over the full control over this spaceship to you.

Unfortunately, it seems like your radar is down and your windscreen is full of scratches'

A communication like this seems a little scary, but in many ways reflects the situation we are facing. Humankind is now dominating many of the major biogeochemical cycles, e.g. for carbon, nitrogen and phosphorus. The consequence is that we need a clear view ahead, i.e. we need to know the consequences of decisions for the biogeochemical cycles, and thereby implications for the environment, biodiversity, social life and economy. This is a huge task, and we, here in this room, will probably only see very beginning before we retire. However, we can see our current efforts within environmental monitoring and data handling as a beginning.

This talk will try to point out some directions and visions for future marine environmental monitoring and suggest a concept for data handling across nations. The concept build upon experiences from the Danish marine monitoring program and ideas for the EU-funded project Joint Monitoring Programme of the Eutrophication of the North Sea with SATellite data "JMP EUNOSAT" there started three month ago.

The project is about the use of satellites in monitoring of chlorophyll in the North Sea and combining different types of data there measure phytoplankton abundance. The concept is outlined below for chlorophyll but might be of general interest within marine monitoring.



Ecology in the TRA: History and urgency of the research questions

Philippart, Katja

Waddenacademie, The Netherlands

Although many historical regional drivers of ecological change (i.e., fishing, hunting, pollution, eutrophication, embankments) in the Wadden Sea have been mostly phased out or declined since its trilateral management became effective, the rate of ecosystem change in this coastal area has not slowed down. At present, however, many ecological changes and patterns within the trilateral Wadden Sea are still unexplained, including the decline in juvenile

fish and migratory birds, and unequal distributions of seagrass, mussel beds, foraging and breeding birds. Climate change is hypothesized being a main driver of accelerating alterations in biotic and abiotic patterns of the Wadden Sea, with its impacts possibly enhanced (or reduced) by other human activities. Considering the unprecedented rates of change and the high uncertainties in impacts (including cumulative effects, tipping points and feed-backs), target-orientated ecological research is required, which enables flexible, adaptive and timely management and protection measures for a rapidly changing environment.

Research questions to address the underlying causes of ecological changes and patterns within the trilateral Wadden Sea include the direct and indirect effects of climate change on the occurrence and dynamics of species and communities, the occurrence of habitats and primary production areas, the exchange processes between Wadden Sea systems and other environments, and the responses of ecosystem functions to (cumulative) global changes. A more integral approach to ecological studies in the Wadden Sea Region should be adopted to explicitly take into account relevant interactions with adjacent biomes.

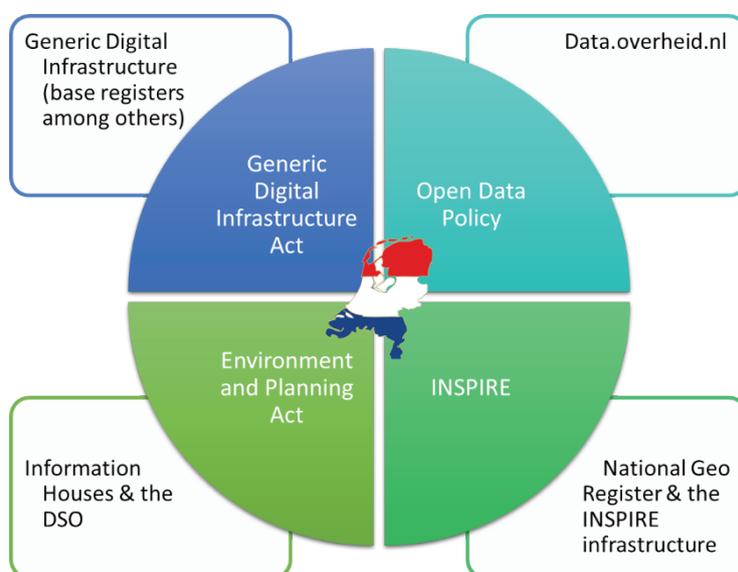
Existing and new scientific data, information and insights on ecological changes and patterns should be structurally linked to coastal spatial planning (CSP), bringing together multiple users of coastal areas to make informed and coordinated decisions about how to use coastal resources sustainably. A future framework for CSP in the Wadden Sea Region needs to include not only the Wadden Sea but also the North Sea coastal zones, river catchment areas, estuaries, rural marshes on the mainland and on the islands. New ways of monitoring will have to be considered in order to meet the increasing demands for long-term data series.

Dutch contribution to the data-session of the ISWSS14

Pijpker, Udo

Geonovum, The Netherlands

In the session we will be introduced to the Dutch data strategies that are in place now or will come into place in the near future.



First of all we have a long history with basic data and registers, much the same as the Danes have, moreover the development lines of the Dutch and the Danes basic data strategies have been quite parallel for some time due to the exchange of knowledge and experiences. All this effort is now culminating in the coming Generic Digital Infrastructure Act in which the basic data registers and some other digital government services come together in one law. The Ministry of the Interior is co-ordinating that effort.

Within the same Ministry the furthering of Open Data in Dutch government is co-ordinated. The Reuse of government data Act which is established in 2015, serves, among other initiatives, as the basis for creating the data. data.overheid.nl repository of open data in the Netherlands.

As we shift to the Ministry of Infrastructure and the Environment we see two major data strategies and a underlying policy to publish everything as open data. First of the two is the INSPIRE initiative as part of the Dutch implementation of the EU INSPIRE directive with the subsequent standardization and harmonization. The National Geo

Register, which is the INSPIRE hub for the Netherlands, and the created infrastructure are being deployed for the obligatory INSPIRE reporting but also for the e-reporting obligations of the involved Dutch government agencies. The second strategy that has come into play in the last 2-3 years, is the new Environment & Planning Act which, at first will replace 15 existing laws, including the Water Act, the Crisis & Recovery Act and the Spatial Planning Act. The provisions of eight other laws will also be transferred to the new Environment & Planning Act. The expectation is that the Act will take effect in 2019. Under this Act there are two relevant digital efforts, which are the Information Houses and the Digital System for Environment & Planning Act, in short (and Dutch) DSO. The first effort will see realise Information Houses for Water, Nature, and many more (12 Houses are foreseen) in which all relevant data of that field are collected and accessible with modern standards and strict quality assurance schemes. All these strategies will help, I am sure, firstly the Research Agenda and the Platform with up-to-date and high quality data which will be exchangeable with our German and Danish colleagues and secondly the foreseen basic monitoring efforts in the Netherlands.

Contribution to the trilateral scientific agenda Subgroup 4 Cultural Heritage: History and main points

*Ratter, Beate M.W.**

Helmholtz Zentrum Geesthacht, Institute of Coastal Research

The cultural landscape of the Wadden Sea Region (WSR) is the product of human/nature-interaction over the past 2,500 years. From a cultural perspective the WSR has always been a laboratory of water management where coping with a challenging environment was paramount. Human activities like land reclamation, peat digging, salt extraction, diking, dredging, port construction etc have profoundly affected the topography of the area, resulting in a cultural landscape with a fragmented geography of islands and mainland peninsulas without major urban centres. Together with a potentially hazardous environmental background of storms and floods, this has strongly influenced the economic development of the area as well as the mentality and perceptions of coastal dwellers. Histories can explain to a large extent how regional identities evolve over time, are constructed and can be maintained. In order to develop suitable, sustainable and accepted development strategies in the WSR, there should not only be explored the cultural heritage in a comprehensive trilateral perspective but also the awareness of how cultural and political heritage really is and always has been. The development of the WSR depends on its people and the supportive action which is based on their sense of place and understanding of common tasks. A common research agenda can help to strive into that direction.

The paper will present main points of the presented Report on Cultural Heritage in the WSR, existing major achievements to date and persistent knowledge gaps. For the research agenda, the following questions will be addressed and directed towards main questions relevant for policy:

1. Which traces and artifacts of the Wadden Sea Region heritage can be identified?
2. How can we learn from the past adaptability and resilience of the littoral society in the WSR?
3. What are the historical roots of governance and societal cohesion in the WSR?
4. What might constitute a cross-national regional identity in the WSR?
5. Are there any remnants of historic regionality and networks?
6. Is there a gender bias in the Wadden Sea Region?

**for the lead of the working group: Mette Guldborg, DK; Beate Ratter Chair, DE; Meindert Schroor, NL*

From a user's perspective: How do we get the best available scientific knowledge to fulfil our common responsibility to secure outstanding universal value and integrity of the Wadden Sea World Heritage?

Scheiffarth¹, Gregor and Margrita Sobottka¹

¹Wadden Sea National Park Authority of Lower Saxony

The Lower Saxon Wadden Sea National Park, founded in 1986, is part of the UNESCO-World Heritage Site "The Wadden Sea" and covers 345.000 ha. The National Park Authority shares the common responsibility to secure its outstanding universal value and integrity.

Good governance of a protected area should build on the best available knowledge to ensure that conservation goals are met and further developed. Science is a fundamentally important element to the understanding of the Wadden Sea as complex system consisting of the natural ecosystem, landscape and its socio-economically shaped, surrounding region. Science-based advice is vital to answer questions concerning status assessment, planning and management for protection, preservation and sustainable use on site level.

Communication between research and nature conservation institutions should be a continuous process and ideally lead to reliable information which can be applied in conservation. We regard the participation model (e.g. Hetland 2014) as a good basis for communication between research and conservation.

The aim of the presentation is to give a user's perspective from the implementation level and highlight, how both sides, research community and conservation institutions may mutually benefit from closer collaboration. We will elaborate on communication models and illustrate the process with an example which relates research and management to the Wadden Sea World Heritage conservation goals. Finally, we will encourage the research community to engage in networking and planning for a trilateral Wadden Sea World Heritage Partnership Centre as a basis for institutionalising and stabilizing this process.

LANCEWAD and beyond: Towards a new frame for the Wadden Sea Region

Schroor, Meindert

Dutch Wadden Academy/ Bureau Varenus, The Netherlands

In the past 50 years the Wadden Sea proper has been framed successfully as a primarily natural area, resulting in its registration on UNESCO's World Heritage List in 2009. As a result, a lot of scientific research is guided by physical and ecological principles. In my lecture I will elaborate on the necessity for a comparable cultural historical framing of the Wadden Sea Region (scilicet the marshes and the Frisian islands), both as a guidance for politicians and tourists, as well as a framework for scientific research, in the context of the Trilateral Research Agenda. Apart from a treatise on cultural similarities in the Wadden Sea Region, the potential of cultural history regarding some upcoming challenges (i.e. climate change) will be discussed.

Habitat models for the Wadden Sea - results from the FONA-project STopP - from sediment to top-predators

Schwemmer¹, Philipp; Leonie Enners¹, Sven Adler² and Stefan Garthe¹

¹Research and Technology Centre (FTZ), University of Kiel, Germany

²Swedish University of Agricultural Sciences, Sweden

The research project "STopP - from sediment to top-predators" is one of five projects from the program for sustainable development, funded by the German Federal Ministry of Education and Research (BMBF). One main aim of this interdisciplinary project is to describe the development of different marine habitats and their utilization by birds in the intertidal and subtidal areas of in the coastal zone of the German North Sea. Besides a close cooperation between geologists, modellers and ecologists, this project is coordinated by the National Park Administration

of Schleswig-Holstein to assure that the scientific output can be directly utilized for management purposes. As one part of the project we present a series of models of habitats that are particularly important for birds as top-predators. We investigated how hydrodynamic forces and sediment dynamics were linked to the occurrence of macrozoobenthic habitats and their utilization by birds as top-predators. For example we found that the neobiotic American razor clam can be primarily found in areas with high bed shear stress. In contrast, common cockle and blue mussel beds are only found in areas with low shear stress and medium inundation times. Seabirds were equipped with miniaturized GPS-data loggers to study their habitat choice. Several of the investigated bird species intensively used the intertidal (primarily herring gulls and oystercatchers) and subtidal razor clam fields (primarily common scoters). It was possible to set up a series of prediction maps to forecast the habitat potential of different species in the study area. Until the end of the project in 2019 scenarios will be computed how the habitat potential of different habitat types may change against the background of climate change.

How to assess food webs?

Schücke, Ulrike¹; Heike Büttger², Georg Nehls², Kerstin Stelzer³, Kirsten Binder⁴, Hans-Christian Reimers⁴, Victor de Jonge and Kai Eskildsen¹

¹Landesbetrieb für Küstenschutz, Nationalpark und Meeresschutz Schleswig Holstein, Nationalparkverwaltung, Germany

²Bioconsult SH, Germany

³Brockmann Consult, Germany

⁴Landesamt für Landwirtschaft, Umwelt und ländliche Räume Schleswig Holstein, Germany

⁵Institute of Estuarine and Coastal Studies (IECS), University of Hull, United Kingdom

The Marine Strategy Framework Directive (MSFD) stresses the urgently need of development of indicators that relate to food web functioning and dynamics (Descriptor 4). The Ecological Network Analysis (ENA) is a holistic approach to assess the status of marine habitats and ecosystems by analyzing the food web structure, functioning and system properties. In addition, the ENA is an integrative approach since most existing monitoring data can be used to construct a food web. In the present study, we investigated temporal dynamics of food web models based on long term monitoring data of mussel beds and associated benthic fauna since 1998. While biological data were part of the Trilateral Monitoring and Assessment Program (TMAP), further necessary data were derived from remote-sensing methods. Results of temporal changes in food web structure and functioning over time will be presented. Special emphasis will constitute on different food web indices and attributes (e.g. Detritivory/Herbivory ratio or trophic efficiencies), which are proposed to be potential indices to evaluate the status of food webs.

Trends in Wadden Sea fish: what do we know and what do we need to know?

Tulp, Ingrid and Paddy Walker

In cooperation with colleagues from: Wageningen Marine Research, Programme Towards a Rich Wadden Sea, Van Hall Larenstein University of Applied Sciences, Institute for Hydrobiology and Fisheries Science, Thünen Institute, Royal NIOZ, DTU Aqua, Bioconsult, National Park Administrations of Schleswig-Holstein and Lower Saxony, Marine Science Service

The Wadden Sea stretches across the borders of Denmark, Germany and the Netherlands, from Den Helder in the west to Esbjerg in the north-east. Of the more than hundred fish species occurring in this area, only a handful are there for their whole life cycle. The majority spend only a part of their lives in the Wadden Sea, either as juveniles to feed and grow such as the flatfish species, as adults to spawn or search for food such as the herring, or en route between marine and freshwater habitats, such as the sea trout and eel. These different life cycles mean that the species utilise the Wadden Sea in different ways. Long-term trends in Wadden Sea fish fauna are presented in the Quality Status Report. With a few exceptions, little is known about the causal mechanisms underlying the observed changes in the fish fauna. The trilateral community of scientists proposes to address knowledge gaps using the 'swimway' concept. In the Swimway concept, the role the Wadden Sea plays in the population dynamics of these species will be highlighted by studying the entire life cycle and identifying the bottlenecks in population dynamics. The concept encompasses all fish species which use the entire Wadden Sea area in any stage of their life-cycle. Studies on habitat use, migratory patterns and reproductive strategies of key species will form the basis for the approach. An analysis of the current policy and management measures in the three countries, as well as

the overarching trilateral targets for fish, will provide the legislative and management framework. By combining the insights into the population dynamics of the species with this policy and management framework we aim to create a trilateral coherent management programme for fish species in the Wadden Sea which will address the trilateral policy objectives for fish.

Wadden Sea birds and the flyway approach: zooming out and zooming in for policy and management

van Roomen¹, Marc and Theunis Piersma²

¹Sovon Dutch Centre for Field Ornithology

²Royal NIOZ and University of Groningen

Migrating waterbirds represent the most iconic and shared international value of the Wadden Sea as a World Heritage Site. The Wadden Sea is of huge importance as a breeding, staging and wintering area for large proportions of the populations of migrating species coming from breeding areas as far away as Northeast Canada and West Siberia, 5000 km. Some waterbirds continue their migration to as far as southern Africa, 10,000 km. Just as the conditions in the Wadden Sea will influence these populations even when they move on, so will the conditions at the far-away sites influence what will happen to the birds in the Wadden Sea. This world is strongly interconnected. Only with knowledge of these dependencies we will be able to establish the bottlenecks to the migratory populations and the ways that management can make a difference to alleviate problematic bottlenecks. The fact that many migratory populations using the Wadden Sea are in decline give this a sense of urgency. The Wadden Sea Flyway Initiative, initiated when the Wadden Sea was recognized as a World Heritage site, aims to provide an infrastructure to increase the knowledge about the flyway connections. Given the magnitude of the issues involved, the initiative will focus on the spatially integrated monitoring of the flyway populations, as knowledge on changing numbers and distribution provides the vantage point for a deeper understanding of the demographic and ecological processes explaining these changes. It may also serve as an early warning service. In our talk we will illustrate these ideas with worked empirical examples on the role of the Wadden Sea in the East Atlantic Flyway.

Seasonal dynamics of the Sylt-Rømø Bight food web

Vega¹, Camille de la; Sabine Horn¹, Ragnhild Asmus¹ and Harald Asmus¹

¹Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung, Germany

The Wadden Sea undergoes large seasonal changes in abundance and biomass of the multiple components in its food web. Four food web models were constructed of the Sylt-Rømø Bight, one for each season, and each flow model consisting of 66 compartments depicting the respective biomass and energy budget of each of compartments, and the flows between them. These food web models were analyzed with ecological network analytical methodologies (ENA) to assess the seasonal development of the resultant system properties reflecting on the functioning and structure of the Sylt-Rømø Bight food web. The whole system indicators derived from ENA were surprisingly constant across seasons given the high degree of uncertainty measured on the compartment biomass. However, clear seasonal trends were observed showing that the Sylt-Rømø Bight tent to have higher capacity to cope with disturbances in spring and summer than in fall and winter. This result can be related to the presence of predators in the warm seasons, which increase the parallel pathways and the redundancy in the system, increasing in turn the ability of the food web to withdraw disturbances.

Research needs form a Climate and Water perspective

*Vellinga, Pie**

Waddenacademy The Netherlands

Research priorities form a Water and Climate perspective “What kind of scientifically based information, evidence, projections, experiences, methods & techniques and system understanding is needed to secure and enhance the Outstanding Universal Value (OUV) of the transboundary UNESCO World Heritage Site (The Wadden Sea) and its integrity in the light of climate change and in need for sustainable development in the 21st century and beyond.”

The (societal) values at stake identified by the group as important in the 21 st century and beyond in the Wadden Sea Region are:

- 1) Unique UNESCO World Heritage Site; including
 - a. Biodiversity
 - b. Habitats & wildlife
 - c. Typical landscape shaped by sea and man, cultural heritage
- 2) Safety from flooding, erosion and salinization; this includes
 - a. Flood protection for (urban) settlements, harbor & infrastructure facilities;
 - b. Securing beaches and shorelines against erosion
 - c. Drainage of low-lying marshland areas
 - d. Prevention of salt water intrusion into aquifers, estuaries and soils
- 3) Tourism, including both threats (e.g. flooding & beach erosion) as well as opportunities (e.g. warmer air and water temperatures, extended season)
- 4) Food, including high quality water, agricultural and sea food products;
- 5) Housing, seaports and infrastructure;
- 6) Climate neutrality in energy, housing, transport, leisure activities, agriculture and landscape management.

With respect to these key societal values we suggest addressing core questions such as:

1. Climate-related impacts in particular the response of the sediment system and the ecosystems of the Waddensea, the North Sea coast and outer delta's and the islands to sea level rise and changing winds and the options of interventions and their effects;
2. The vulnerability of marshland areas and islands, coastline / beach erosion, freshwater deterioration (supply and quality), seawater eutrophication & pollution etc.? What interventions and adaptation strategies are at hand to reduce / minimize risks to human lives, infrastructure, water and soil? How can such interventions be kept in compliance with the World Heritage objectives?
3. Tourism & recreation, food production, housing & seaports as well as renewable energies are essential services from which humans benefit in the WSR. How can these benefits be maintained, or perhaps even improved, in compliance with the goals for World Heritage integrity and for adequate safety for lives and well-being?
4. What information and knowledge is needed to assess the range and degree of system responses to adaptation measures / interventions? How can compatibility between ecosystem, social system, economic system related interventions be achieved?

It is important to enhance public understanding of the issues and options for intervention as such options are likely to require significant amounts of public funding and the options are likely to have an impact on the landscape. It is therefore recommended to include public participation in problem analysis and in the development of options for intervention in this part of the research agenda.

** on behalf of the tri-lateral ad-hoc group Climate and Water: Jacobus Hofstede, Frank Ahlhorn, Per Sørensen Aart Kroon, Jeroen Aerts and Pier Vellinga, with Hessel Speelman as observer from the geology ad-hoc group.*

The environmental history of trilateral cooperation in the Wadden Sea area

*Wöbse, Anna-Katharina**

Institut für Biologiedidaktik, Justus-Liebig-Universität Gießen, Germany

From the birth of a Wadden Sea concept in the late 19th century until today, perceptions of the North Sea coast have changed fundamentally. Within a brief and turbulent phase of recent history, the Wadden Sea became environmentalized and globalized. Based on the results of an interdisciplinary workshop the paper examines how and why this mind shift in society came about. It sheds light on the complex history considering aspects like the expansion of scientific exploration, the rise of environmental movements, public and scientific controversies, the role of pollution and embankments as drivers for protest and the development of environmental diplomacy.

**Presenting results of a workshop together with Jens Enemark, Karsten Reise and Henny van der Windt*

ABSTRACTS FOR POSTERS

Alien species in the Wadden Sea

Büttger¹, H., C. Buschbaum², P. Dolmer³, A. Gittenberger⁴, K. Jensen⁵, S. Kabuta⁶, D. Lackschewitz² and K. Troost⁷

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Although so far there is no evidence that alien species have caused the extinction of native species in the Wadden Sea, and most alien species become inconspicuous residents, some alien species have the potential to alter dominance structures, habitats and trophic regimes. In consequence of the Sylt declaration (2010) and Tønder Declaration (2014) a draft trilateral strategic framework for dealing with alien species in the Wadden Sea was compiled including the need of trilateral monitoring program for alien species which is currently under preparation. At present the trilateral alien species list of the Wadden Sea comprises 90 alien species, disregarded phytoplankton, zooplankton, fish, birds and terrestrial species taxa. Most of these marine alien taxa originate from the Pacific or from the Atlantic. Main vectors are transoceanic shipping and aquaculture; direct introduction is the most important factor for terrestrial plants. The poster presents status and trends of marine, terrestrial and freshwater alien species introduction in the Wadden Sea as well on the Trilateral progress in aliens species assessment, including applied International and European and national policies, the draft Trilateral Strategic Framework for Alien Species (TSFAS), which its objectives and measurements. The given recommendations focus on the implementation of a harmonized alien species monitoring program including macrobenthos, algae, phytoplankton, zooplankton, fish, birds and terrestrial species.

Three scenarios for coastal future in face of climate change, Husum Dockkoog

Fröhlich¹, Jannes und Hans-Ulrich Rösner¹

¹WWF Wadden Sea Office, Germany

WWF Germany initiated a participatory planning process for the development of a coastal marshland („Dockkoog“), situated between the city of Husum and the Wadden Sea. The work was done by a project group consisting of representatives of the city and many other organisations and administrations concerned.

WWF Germany initiated a participatory planning process for the development of a coastal marshland („Dockkoog“), situated between the city of Husum and the Wadden Sea. The work was done by a project group consisting of representatives of the city and many other organisations and administrations concerned.

As a result two rather conventional and one rather unusual planning alternatives were proposed. They would result in fairly different types of landscape and nature, with different effects for tourism, recreation and economic development. All three alternatives would safeguard Husum against storm surges. For the two planning alternatives “Wide Marshland” and “Hotel at the Dike” the main feature would be to strengthen the dike along the present dike line. The main difference between the two would be the absence or presence of large buildings within the Dockkoog. The planning alternative „Husum Hallig“ is proposing a managed realignment of the dike, thus allowing for climate adaptation and better nature enjoyment in the former Dockkoog. A hotel should then be built on a new dwelling mound („Warft“) outside the dike, being accessible any time by a dam.

The results of the project group have been published in autumn 2016 (available at www.wwf.de/watt/dockkoog) and allow now for a discussion on the planning alternatives in Husum.

The project was supported by the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB).

