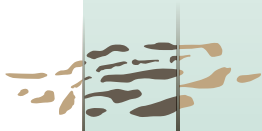




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# Towards an Integrated Knowledge Agenda for the Wadden Sea Region



waddenacademie

# **Towards an Integrated Knowledge Agenda for the Wadden Sea Region**

April 2021

## Colophon

### Author

Wadden Academy

### Photography/illustrations

Meindert Schroor (cover and pages 22, 26, and 30)

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Christiaan Sgrooten from Bosatlas van de Wadden (page 19)

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BW H ontwerpers

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### Contact

Klaas Deen

Secretary

T +31 (0)58 233 9031

E [klaas.deen@waddenacademie.nl](mailto:klaas.deen@waddenacademie.nl)

[www.waddenacademie.nl](http://www.waddenacademie.nl)

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# CONTENTS

<b>1</b>	<b>Introduction, and structure of this report</b>	<b>5</b>
<b>2</b>	<b>International, trilateral, national, and regional frameworks</b>	<b>7</b>
<b>3</b>	<b>Priority research themes</b>	<b>10</b>



# 1. INTRODUCTION, AND STRUCTURE OF THIS REPORT

## Introduction

The world is complex and therefore so is the Wadden Sea region, which is known primarily as a nature conservation area – the Wadden Sea itself has been a UNESCO World Heritage Site since 2009 – but which is also inhabited by people. Like nature and the landscape, mankind is facing major, complex challenges, of which climate change is the most significant, but with issues such as digitalisation and globalisation also playing a role. This complexity raises numerous questions, to which both administrators and residents need answers if they are to make the right decisions. This requires knowledge, and science is there to provide it. The Wadden Academy was established – at the same time as the Wadden Fund (2008) – to promote, support, and guide scientific research for the Wadden Sea region so as to utilise the available funds, sources, and talents as efficiently as possible. The Wadden Academy is thus the pre-eminent “knowledge manager” in the Wadden Sea region. With this report, it indicates – in the light of the most recent scientific insights – where the tasks, prospects, problems, and main questions lie on which science should focus with regard to Wadden Sea research in the near future. In doing so, we have explicitly taken the various ongoing programmes of the main players in the region as our reference point, but without calling our independence and impartiality into question. With this report, we wish to propose an Integrated Knowledge Agenda for the Wadden Sea Region.

The need for an Integrated Knowledge Agenda is becoming increasingly pressing. The most recent arguments for such an agenda can be found in the *Agenda for the Wadden Sea Region in 2050*, in which public authorities, fishery and nature conservation organisations, NGO’s, and the cooperating ports have jointly outlined a course for the region to pursue. The draft Agenda was submitted to the Dutch House of Representatives on 9 July 2020.

As part of the Implementation Programme

accompanying the Agenda, the state of our knowledge must be explored and a shared knowledge agenda for policy, management, and use must be drawn up. That shared agenda must distinguish between scientific questions, questions in support of policy, and research questions regarding day-to-day management and implementation. The organisations working on policy and management will be actively involved. The basis for this will be the *Trilateral Research Agenda* that the Netherlands, Germany, and Denmark included in the 2018 Declaration by the Trilateral Governmental Conference in Leeuwarden.

As already noted, the Wadden Academy wishes with this report to contribute to an Integrated Knowledge Agenda for the Wadden Sea Region. In the light of the major challenges facing the region in the coming decades, the existing knowledge agendas, and an exploration of the state of our scientific knowledge, the report presents six major, integrated research themes, investment in which, the Wadden Academy believes, should be prioritised so as to arrive at a sustainable body of knowledge. This report is an English translation of the Dutch original (December 2020).

## Long-term research questions

There is good reason why the *Agenda for the Wadden Sea Region in 2050* refers to knowledge as being fundamental. That Agenda already includes a number of specific practical research questions for the short term. However, a sustainable body of knowledge for the longer term also requires the bigger underlying questions to be formulated. This report attempts to identify those bigger questions on the basis of an exploration of the state of our knowledge, whereby it is important to bring together both short-term and long-term research questions in the form of a follow-up programme. With this report as the basis, the Wadden Academy wishes to contribute to the shared knowledge agenda for policy, management, and use envisaged

in the Implementation Programme accompanying the 2050 Agenda by actively involving the organisations working on policy and management.

The basis for all the work in and around the Wadden Sea is to be found in two important tasks. First, the three Wadden Sea countries have an international obligation to sustainably preserve the unique natural values of the Wadden Sea World Heritage Site, and where necessary to restore them. At the same time, there are millions of people living and working in the immediate vicinity of the Wadden Sea whose work and income also require long-term protection. These two important tasks – simultaneously preserving unique natural values while also maintaining work and income for people – operate against a background of autonomous changes in the area, such as the changing climate.

The larger issues to be investigated that arise from these two important tasks can be divided up into six major research themes:

- 1. Climate and the Wadden Sea**
- 2. Climate and ecology**
- 3. Lessons from the past**
- 4. Coast and identity**
- 5. Law for the Wadden Sea region**
- 6. Socio-economic development**

## **Structure of this report**

This report is structured as follows:

- Section 2 outlines the international, trilateral, national, and regional frameworks regarding the knowledge infrastructure for the Wadden Sea region.
- Section 3 sets out the six research themes that should be prioritised. Separate boxes address specific issues that illustrate how different research themes are of an interdisciplinary or multidisciplinary nature and relate to one another.

## 2. INTERNATIONAL, TRILATERAL, NATIONAL, AND REGIONAL FRAMEWORKS

### International framework

The **Sustainable Development Goals** (SDGs) are 17 goals for making the world a better place by 2030. They were agreed on in 2015 by the member countries of the United Nations (UN), including the Netherlands. The SDGs were defined on the basis of input from organisations and individuals worldwide. The then chair of the Dutch UNESCO committee, Greetje van den Bergh, already argued in 2015 for making these goals part of a shared vision and a common Wadden Sea policy. She pointed out that the sustainability goals cover responsible food production, sustainable energy, conservation and restoration of global ecosystems, and biodiversity in the context of climate change.

The United Nations has proclaimed the coming decade (2021-2030) to be the “**Decade of Marine Science for Sustainable Development**”. Marine sciences combine a variety of disciplines (physical, geological, and chemical oceanography and marine biology) that study the marine environment. The UN wishes to support efforts to reverse the decline in the health of the sea and to ensure the conditions for its sustainable development.

The coming decade (2021-2030) has also been proclaimed to be the “**Decade of Ecosystem Restoration**”. With regard to the sea, the United Nations is calling for pressure on marine ecosystems to be reduced so that they can recover, both naturally and through the re-seeding or transplantation of key species. The UN is also calling for greater knowledge on how to make both ecosystems and communities more resilient in the face of global changes.

In Europe, an extra boost has been given to these international ambitions by, among other things, the **EU’s Biodiversity Strategy for 2030**. By 2030, 30% of both the terrestrial and marine areas must be given protected status and areas must be connected and managed more effectively. In addition to proper protection of existing natural assets, this strategy emphasises the great importance of nature

restoration. To that end, an EU nature restoration plan is being drawn up for both land and sea.

### Trilateral framework

In *Kennis voor een duurzame toekomst van de Wadden* [Knowledge for a Sustainable Future for the Wadden Area] (2009) the Wadden Academy noted that there is indeed a great deal of knowledge about the Wadden Sea region at the level of the various scientific disciplines, but that that knowledge is also highly “fragmented and compartmentalised”. For a better understanding of the Wadden Sea region as a coherent and open system, an interdisciplinary approach is needed. An important step in combating fragmentation was the *Trilateral Research Agenda* drawn up by the three Wadden Sea countries, namely the Netherlands, Germany, and Denmark. This was adopted on 18 May 2018 in the *Leeuwarden Declaration* by the Council of Ministers of the 13th Trilateral Governmental Conference on Protection of the Wadden Sea.

In the *Trilateral Research Agenda*, scientists from the three countries emphasise the Wadden Sea’s status as a World Heritage Site. The aim of the research agenda is “To achieve, as far as possible, a natural and sustainable ecosystem in which natural processes proceed in an undisturbed way” (*Guiding Principle, Joint Declaration*, 2010, TRA, p. 6). The *Trilateral Research Agenda* emphasises that safeguarding the outstanding universal values of the Wadden Sea region requires proper scientific understanding of the underlying ecological and socioeconomic processes. According to this international research agenda, there are three major challenges for the future:

#### a. The Wadden Sea region as a living lab for people and nature

Preserving the value of the Wadden Sea region for future generations requires bridging the traditional divide between nature and culture: preserving natural values must be placed within a socio-economic context and, conversely, social, cultural, and economic initiatives in the Wadden Sea region

must take explicit account of their impact on natural systems.

**b. Coping with climate change and sea level rise.**

Global warming – with the associated changes in weather patterns, heatwaves, longer periods of drought, with more torrential downpours and rising sea levels – will probably continue over the coming decades. Simultaneously, subsiding land is likely to further increase the rate of relative sea level rise. How will we deal with this slow but pervasive process, which will have strong long-term repercussions, not only for nature but also for social, economic, and cultural structures and processes?

**c. The Wadden Sea region as a sustainable coastal region.**

For the future of the Wadden Sea region, preserving the Outstanding Universal Value of the World Heritage Site and, at the same time, offering residents attractive social and economic opportunities poses an enormous challenge.

According to the *Trilateral Research Agenda*, addressing these three challenges necessitates researchers cooperating more effectively along four thematic lines:

1. **Climate, water, sediments, and subsurface;**
2. **Ecology, biodiversity, and spatial processes;**
3. **Cultural heritage, identity, and historical embedding;**
4. **Economy, society, and sustainable development.**

The *Trilateral Research Agenda* is the trilateral framework for determining the major research themes for the Netherlands.

## National framework

The *Agenda for the Wadden Sea Region 2050 (Agenda voor het Waddengebied 2050)*; ratified on 4 February 2021) also stresses the importance of knowledge as a crucial element in the cycle from policy to management of the region. It also argues for drawing up a jointly supported Dutch knowledge agenda, based on the *Trilateral Research Agenda*, in which eight thematic tasks and strategies are distinguished:

1. **World-class nature;**
2. **Landscape and cultural heritage;**
3. **Sustainable accessibility;**
4. **Climate change;**
5. **Energy transition;**
6. **A liveable Wadden Sea region;**
7. **A sustainable Wadden Sea economy;**
8. **Other themes.**

## Regional framework

In 2016, the Provincial Councils of the provinces of Noord-Holland, Fryslân, (Friesland) and Groningen adopted the *Wadden Sea Investment Framework [Investeringskader Wadden]*, with which the three provinces commit to implementing a cohesive, wide-ranging programme, including deployment of the Wadden Fund. This framework focuses on facilitating initiatives aimed at strengthening the ecology or making the economy more sustainable. There must be joint involvement by both the provinces and the large network of parties and individuals in the Wadden Sea region. The Wadden Sea Investment Framework specifies six main themes, namely:



1. **The Wadden Sea;**
2. **Port development and nature improvement;**
3. **Strengthening and marketing the World Heritage site;**
4. **A robust coast and Afsluitdijk;**
5. **The Ems-Dollard region in balance;**
6. **Islands under their own power.**

3. **Lessons from the past:**  
The genesis of the western Wadden Sea; as exemplary of the relationship in the Wadden Sea area between human activity and the environment in the past.
4. **Coast and identity:**  
Pride in the Wadden Sea region and knowledge of its cultural past as the bases for sustainable protection;
5. **Law for the Wadden Sea region:**  
The role of law in preserving and strengthening the core values and sustainable climate-proof use of the Wadden Sea region;
6. **Socio-economic developments:**  
Sustainable socio-economic development of the Wadden Sea region that suits its people and the region.

### Three levels

The *Trilateral Research Agenda*, the *Agenda for the Wadden Sea Region in 2050*, and the *Wadden Sea Investment Framework* form the international, national, and regional framework within which the future knowledge infrastructure for the Wadden Sea region must be developed. Other programmes such as the *Delta Programme for the Wadden Sea Region* and the *Programme towards a Rich Wadden Sea* must also be taken into account.

### Wadden Academy: six closely linked themes for future research

With the international, national, and regional frameworks as the starting point, the Wadden Academy proposes six major overarching research themes that should be given priority.

1. **Climate and the Wadden Sea:**  
The influence of climate change on the hydrodynamic and morphological conditions and the related development of nature and relevant ecosystem services and user functions in the Wadden Sea region;
2. **Climate and ecology:**  
The effects of climate change on the ecological functioning of the Wadden Sea World Heritage Site;

Section 3 explains these themes in greater detail, including the fundamental scientific questions, questions in support of policy, and research questions regarding management and implementation. The emphasis may of course differ from one theme to another.

It is important to bear in mind that there are also many cross-connections and overlaps between the six proposed research themes; these will also lead to multidisciplinary knowledge generation. Theme 5 research on “Law for the Wadden Sea region”, for example, addresses the issue of how the changes in the morphology and ecology of the Wadden Sea region relate, in the short and long term, to the applicable legal frameworks. Theme 6, investigation of “socio-economic developments” in the Wadden Sea region, also requires a linkup with insights into ecological developments in the region.



## **3. Priority research themes**

The influence of climate change  
on the hydrodynamic and  
morphological conditions and  
related development of nature and  
relevant ecosystem services and  
user functions in the Wadden Sea  
region



# 3.1 CLIMATE AND THE WADDEN SEA

## What is the influence of climate change on the hydrodynamic and morphological conditions and related development of nature and relevant ecosystem services and user functions in the Wadden Sea region?

### Introduction

This research focuses on the following questions: What are the major changes in the water movement and morphology of the Wadden Sea region under the influence of climate change? What opportunities and threats does this present for the Wadden Sea region? The research aims to clarify how the changing climate affects natural ecosystems and usage in the region.

### Climate change is already apparent

Weather and especially weather extremes are already revealing changes in the climate, and this will become even clearer over the years ahead.

Worldwide, a great deal of attention is already being paid, for example, to the accelerated rise in sea level. However, interpretation of this as regards local processes such as tidal and wave action, let alone the impact on the Wadden Sea region, is still insufficient. That is partly because the relationship between water movements and morphology in the Wadden Sea region is a complex one driven by many feedback mechanisms. Changes in current and wave conditions affect morphology, which in turn affects water movement. When, for example, increasing wave erosion causes tidal flats to disappear in the intertidal zone, larger open water masses are created. This leads to a further increase in wave energy, which in turn increases erosion. The morphological development of the Wadden Sea region is therefore an essential link to understand the relation between currents and waves in the North Sea and the safety of the mainland coast.

At least as important is interpretation of the change in physical conditions in terms of the functioning of ecosystems in the Wadden Sea region. The quality and quantity of the natural environment will change, with the most extreme change perhaps being loss of the intertidal zone due to the drowning of tidal flats, mudflats, and salt marshes.

In order to properly investigate the long-term effects of climate change, the various physical and ecological components of the Wadden Sea system need to be considered in combination. Whereas current research often focuses on components of the system (such as tidal inlets or salt marshes), more attention must be paid to the interactions and cumulative effects of natural developments and human action. In that context, it is also important to investigate how the nature and scope of human activity is changing. Pressure on the Wadden Sea system will increase due to a growing need for ecosystem services (for example supplying food and energy from the sea) and due to a potential increase in tourism after the COVID19 pandemic.

### Link-up with relevant research agendas

#### **Trilateral Research Agenda:**

- Theme 1: Climate, water, sediments, and subsurface;
- Theme 2: Ecology, biodiversity, and spatial processes;
- Theme 3: Economy, society, and sustainable development.

#### **National:**

##### *Agenda for the Wadden Sea Region 2050:*

- Theme 1 World-class nature;
- Theme 2: Landscape and cultural heritage;
- Theme 3: Sustainable accessibility;
- Theme 6: A liveable Wadden Sea region.

##### *Dutch National Research Agenda (NWA);*

##### *National Delta Programme;*

##### *Sea Level Rise Knowledge Programme.*

## **Regional:**

*Delta Programme for the Wadden Sea region;*

*Wadden Sea Investment Framework:*

Theme 1: Wadden Sea

*Programme Towards a Rich Wadden Sea:*

Pillar 1: Nature improvement for a resilient ecosystem;

Pillar 2: Transitions towards sustainable (economic) co-use.

## **Important research questions**

### **1. Relationships between areas**

What relationships are there between the morphological development of the islands, the tidal inlets, and the tidal basins with channels, tidal flats, mud flats, and salt marshes? On what time scale is this relevant? To what extent is human influence (such as coastal nourishments and the dredging of shipping channels) important in this regard, and what can we learn from the history of the genesis of the western Wadden Sea and the effects of recent interventions in the coastal system (for example the effects of the Afsluitdijk causeway dam)? Are there coastal areas elsewhere in the world that can serve as examples?

### **2. Influence of the climate**

What is the influence of sea level rise and climate change on the Wadden Sea region in terms of water levels (including extreme levels), tidal and wave action, the supply and distribution of fresh and salt water, the change in water and air temperature, and the related transport of sand and silt? What morphological developments can be expected on that basis, and to what extent will these in turn influence water movement through positive or negative feedback in the Wadden Sea system?

### **3. Influence on nature**

What do the hydrodynamic and morphological changes mean for the natural habitats in the

region and the associated natural values? To what extent will these changes affect the various ecosystems and, their functioning, and thus determine the availability of ecosystem services?

### **4. Influence on flood protection and infrastructure**

How will the changes in the Wadden Sea region affect flood protection and the incorporation of new measures (landward/seaward) and the vulnerability of infrastructure and areas outside the dykes (ports, ferry jetties, water and energy supplies), and what will be their effects on regional water management (fresh water resources, drainage and salinisation)?

### **5. Prospects for action**

What interventions and adaptations are possible in the Wadden Sea region so as to offset negative developments and where possible convert them into new opportunities?

## **Possible approaches to tackling the research questions**

This research combines data collection in actual practice with the development of models. It uses existing and new data in the fields of historical geography, hydrodynamics, morphology, geology/sedimentology, and ecology. The new field observations can be collected *in situ*, but also by remote sensing, for example by satellites. The data will be used to further unravel the interaction between hydrodynamics and morphology so as to improve existing morphodynamic models for the Wadden Sea region. One important aspect is that greater attention will be paid to the effect of wave action and the influence of sediment fractions. The research will also explore further the relationships between abiotic processes and conditions and the development of natural habitats, thus enabling us

to understand the interactions with ecology better. The latter will also need to be effectuated primarily in cooperation with the theme of Ecology.

The current behavioural model on which all predictions regarding the morphological effects of sea level rise in the Wadden Sea are based is now more than twenty years old, and it is in serious need of improvement. Knowledge of the system – although still inadequate in some respects – has improved significantly, and new developments in information technology also open up new perspectives. The knowledge generated from this new research is intended to be applied to the development of new models (conceptual/behavioural models in combination with numerical models, i.e. hybrid modelling). These models will thus act as a knowledge integrator and can be used for scenario studies to predict the future morphological development of the area under the influence of changes in climate and sea level. The results of these models must then act as an important source of information and inspiration for policy-makers, so that they can actively apply the new knowledge that has been generated.

### Relationship to other research themes

Questions 1, 2, and 3: Climate change and influence on ecology (habitat development)

Question 2: Genesis of the western Wadden Sea;

Questions 1, 3, and 4: Sustainable Economic Wadden Sea Region and legal framework.

### Example 1 of the relationship between the themes


#### **Dredging from Holwerd to Ameland**

*Integrating climate adaptation, sustainable accessibility, a liveable Wadden Sea region, and nature restoration*

A long history of land reclamation works and embankments, including construction of the Afsluitdijk and the closing off of the former Lauwerszee, have radically changed tidal dynamics in the Wadden Sea. One of the effects is that shipping channels become silted up increasingly quickly, for example that between the ferry port of Holwerd and the island of Ameland. Millions of euros are spent annually on dredging harbours and channels, with all the effects this has for the ecology. If the sea level in the Wadden Sea follows the upward global trend, this problem could well be exacerbated by erosion of the tidal flats and filling in of the channels. That is at least a possibility, but in practice our current knowledge of the system is insufficient to be able to make well-founded statements about it. The question is therefore whether this strategy of keeping the islands and ports accessible by dredging can be maintained in the long run. Is it perhaps possible to follow the dynamic natural course of the channels even better than we do at present? Or would using shallower-draught ferries make some of the dredging work unnecessary?

Dredging less will disturb the Wadden Sea ecosystem less. On the other hand, the use of fewer or different ferries has major potential consequences for the accessibility of ports and the quality of life and tourism on the islands. In this context, climate adaptation, nature restoration, and more sustainable management go hand in hand with questions of cultural heritage and the economy.



A close-up photograph of succulent plants, likely a species of sea purslane, growing in a dark, sandy or silty substrate. The plants have thick, green, segmented stems with small, rounded buds at the tips. Some stems show a yellowish or orange tint, possibly due to environmental stress or nutrient levels. The background is blurred, showing more of the same plants.

Short-term effects of  
climate change on the  
ecological functioning of  
the Wadden Sea World  
Heritage Site

## 3.2 CLIMATE AND ECOLOGY

### What are the effects of climate change on the ecological functioning of the Wadden Sea World Heritage Site?

#### Introduction

There are various international conventions designed to protect the natural values of the Wadden Sea region, including UNESCO World Heritage, RAMSAR, OSPAR, Natura 2000, and the EU's Water Framework Directive. These conventions concern not only the protection of species and habitats but also the ecological functions that the Wadden Sea region performs at an international scale. For example, the Wadden Sea is a “nursery” for young fish and a “refuelling station” for migratory birds. In short, the Wadden Sea countries have an international obligation to protect this area not only from a regional but also from an international viewpoint.

At the same time, the demand for “ecosystem services” from the Wadden Sea (such as supplying food and energy) is increasing and more and more people are spending their summer holidays in their own country. The Wadden islands and the Wadden Sea itself are as popular as ever. These demands lead to a variety of changes in the landscape, such as the construction of mussel seed capture installations and holiday home resorts, and also result in changes due to the different use of land and water, such as subsidence caused by the extraction of gas and salt. These changes in use lead to specific issues requiring further investigation, for example, the direct consequences of these interventions for protection and development of the natural values of the Wadden Sea region.

The pressure is further increased by the impacts of climate change. The frequency and timing of extremes of weather such as ice winters, heatwaves, storm surges, and downpours affect natural values as well as co-use by humans. The habitats of species, including shellfish, fish and migratory birds, will change. As a result, mobile species will move northwards and/or into deeper waters. Life forms dependent on tidal flats will experience additional stress factors. Seasonal dynamics will change and with them relationships between species, such as

those between predators and their prey. Individuals of various species of fish and birds will become smaller. This also raises specific issues that require investigation: What are the effects of different aspects of climate change on interactions within the food web, including the carrying capacity to sustain local densities of fish and birds?

#### Link-up with relevant research agendas

##### **Trilateral Research Agenda:**

- Theme 1: Climate, water, sediments, and subsurface;
- Theme 2: Ecology, biodiversity, and spatial processes.

##### **National:**

*Agenda for the Wadden Sea Region 2050:*

- Theme 1: World-class nature;
  - Theme 4: Climate change;
- Dutch National Research Agenda (NWA);  
Programme-based Approach to Large Water Bodies (PAGW) – the Wadden Sea and the Ems-Dollard.*

##### **Regional:**

*Wadden Sea Investment Framework:*

- Theme 1: Wadden Sea;
- Theme 4: A robust coast and Afsluitdijk;
- Theme 5: The Ems-Dollard region in balance;

*Programme Towards a Rich Wadden Sea:*

- Pillar 1: Nature improvement for a resilient ecosystem.

#### Important research questions

##### **1. Species, habitats, and interactions**

What effects will climate change have on species (for example their composition, demography, and behaviour) and their habitats (quantity and quality) in the coming decades? What shifts can we



expect in interactions between species (for example also as a result of changes in seasonal dynamics and individuals becoming smaller) and between species and their habitats (for example the role of biobuilders and biobreakers on sedimentation)?

## 2. **Ecosystem functioning**

What effects will climate change have in the coming decades on the ecological functions of the Wadden Sea, including the carrying capacity set by primary production, the “nursery” for young fish, and the “refuelling station” for migratory birds? How are shifts in species, habitats, and ecological functioning related? Is it necessary to opt for the one (species conservation) or for the other (natural dynamics) management strategy?

## 3. **Natural values and userspace**

In the light of climate change, to what extent is it possible to preserve and develop species, habitats, and/or ecological functions, while also responding to society’s increasing demand for userspace? What demands does that make on management and policy in the Wadden Sea region, in the Netherlands, trilaterally, and internationally? Is it possible and effective to make the Wadden Sea more resistant to climate change by reducing other pressure factors?

## 4. **Effectivity of local measures**

How can local measures contribute to preserving and strengthening species, habitats, and/or ecological functions during a time of major changes? To what extent do these measures reinforce or weaken one another both locally (for example creation of salt marshes as opposed to preservation of tidal flats) and on a larger spatial scale (for example creation of a breeding island whereby birds are relocated but their population does not change)?

## 5. **Building with nature**

What is the potential role of “naturebased solutions” (NBSs) in management? Which NBS management measures are appropriate and which are not as a potential solution for making the Wadden Sea resistant to climate change (in an economically efficient manner)?

## **Possible approaches to tackling the research questions**

**Scientific basis** – Based on the climate scenarios specific to the Wadden Sea, the expected changes in species, habitats, and ecological functioning will be outlined for the trilateral Wadden Sea, and also for the areas elsewhere in the world that are directly connected to it (for example via ocean currents, and migratory birds and fish). Particular attention has to be paid to nearby geographical tidal flat systems where the current climate conditions are comparable to those that will develop in the trilateral Wadden Sea region over the next few decades. Special consideration should be given to the projected interactions at different scales in time (tide, season, life cycle) and space (tidal flat, tidal basin, habitat).

## **Comparison with other tidal flat systems** –

The aim is to apply scientific knowledge of species, habitats, and ecological functioning in areas of tidal flats so as to produce specific guidelines for developing (or restricting) regional and local management measures, forming part of an international approach. An international conference of “tidal flats countries” (including marine World Heritage sites) all over the world could compare the scenarios, problems, solutions, and dilemmas of different tidal areas. These proposals could then be tested with the aid of experiments in the field (on a local scale) and modelling (extrapolation to the regional and international scale).

**Monitoring** – Finally, a trilateral platform should be developed in cooperation with the Dutch Monitoring System for the Wadden Sea [*Basismonitoring Wadden*] and the *Trilateral Monitoring and Assessment Programme* (TMAP). This will include making existing and new information on climate, species, habitats, ecological functions, and human activities available in the form of interactive maps. It will allow developments to be monitored and the effectiveness of any measures to be evaluated.

### Relationship to other research themes

There is a clear connection to the theme of “Climate and the Wadden Sea”. Even before the effects of sea level rise become apparent, the changing climate will already have direct effects as warmer and, in particular, more extreme weather conditions. Those effects of weather and climate on nature may perhaps also have consequences for international protection obligations and will therefore need to be weighed up within the theme of “Law for the Wadden Sea”. The effects of climate change for nature in the Wadden Sea region will also have repercussions as regards the identity of the region’s inhabitants, while the combination of nature conservation and co-use (such as tourism) by humans in a changing world is linked to the theme of “Socio-economic development”.

### Example 2 of the relationship between the themes

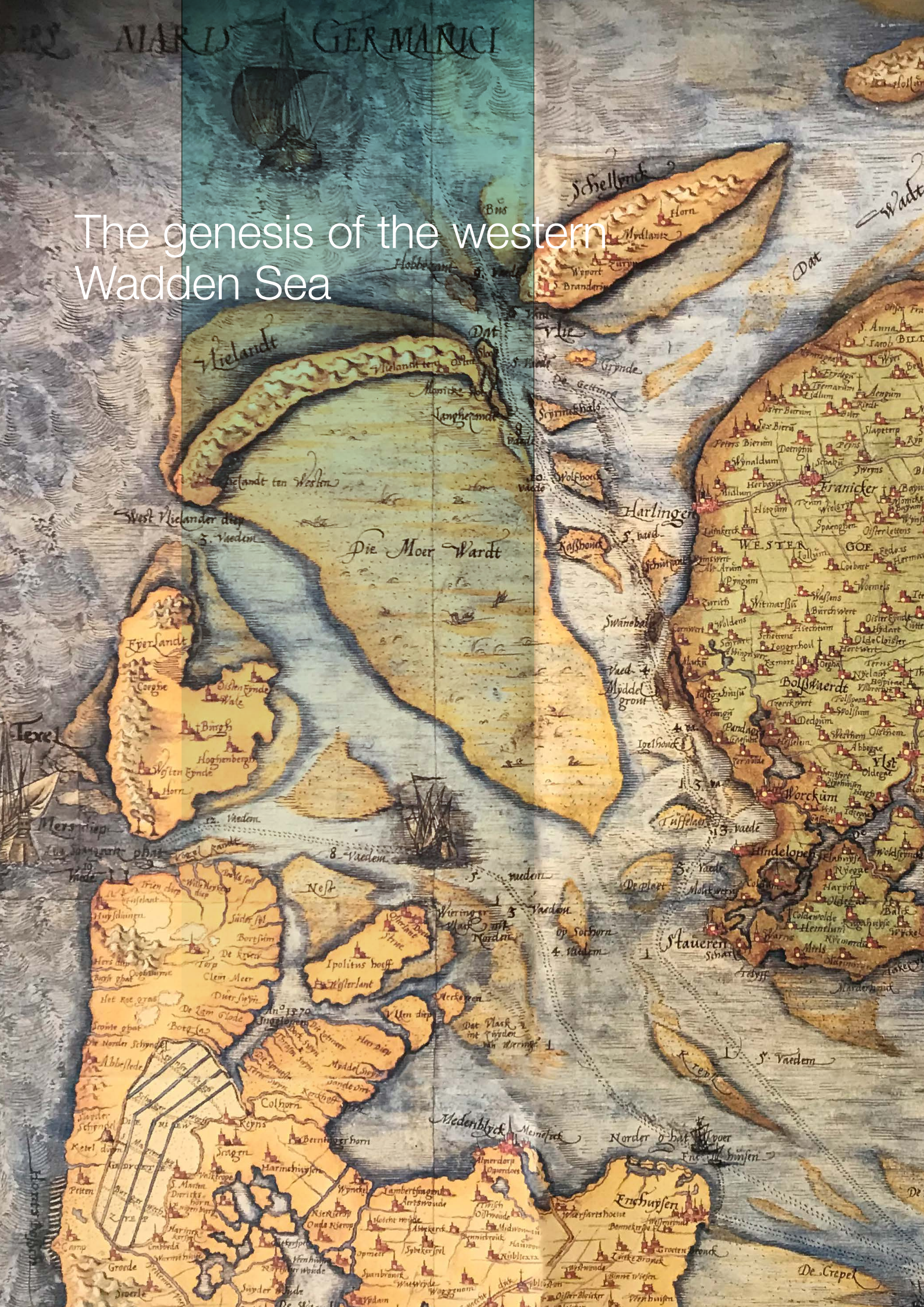
#### **Restoration of gradients along the Fish Migration River**

*Integrating ecology, climate adaptation, and economy*

The historic struggle against water has had both winners and losers, with the indisputable winner being the safety of the inhabitants of the Low Countries. But in a number of places ecology has been a loser, for example where the Afsluitdijk and many other barriers have cut off the natural gradient between tidal marine and stagnant freshwater ecosystems. At the Afsluitdijk, the “Fish Migration River” currently under construction will, however, result in a (relatively small-scale) restoration of this gradient and allow migratory fish to once again migrate from the Wadden Sea to the IJsselmeer and back again through a permanent opening in the Afsluitdijk. The Fish Migration River might not only be beneficial for standing stocks of migratory fish and estuarine food webs, but also for tourism and (possibly) the fishing industry.



# The genesis of the western Wadden Sea





## 3.3 LESSONS FROM THE PAST

### What does the genesis of the western Wadden Sea tell us about the future of the entire Wadden Sea region?

#### Introduction

Accelerated climate change and sea level rise may seem to pose new risks. But understanding the adaptability and resilience of our ancestors may well teach us important lessons for the future. If the combination of climate change and usage affected the Wadden Sea region in the past, then it was in the late Middle Ages, in an area roughly coinciding with the present-day western Wadden Sea between the island of Texel and the port of Harlingen on the Frisian mainland. Similar developments probably also took place elsewhere in the Wadden Sea region, in particular in Schleswig-Holstein, in the North Frisian Wadden Sea region with the Halligen islands and the surrounding area. According to the Dutch narrative, it was above all the Dutch themselves who wrested their country from the sea. Increasing evidence is nevertheless emerging that this hydrological triumph was preceded by a period of significant land loss – in part caused by human action – through excavation of peat and drainage work. This loss of land was compounded by the fact that it coincided with a period of higher temperatures, increased precipitation, and more frequent storms.

#### Link-up with relevant research agendas

##### **Trilateral Research Agenda:**

- Theme 1: Climate, water, sediments, and subsurface;
- Theme 3: Cultural heritage, identity, and historical embedding;

##### **National:**

*Agenda for the Wadden Sea Region 2050:*

- Theme 2: Landscape and cultural heritage.

##### **Regional:**

*Wadden Sea Investment Framework:*

- Theme 1: Wadden Sea;
- Theme 4: A robust coast and Afsluitdijk.

*Programme Towards a Rich Wadden Sea:*

- Pillar 1: Nature improvement for a resilient ecosystem.

#### The research questions

##### **1. Reconstruction of the geological and climate history**

What does the sediment and freshwater balance look like when there are higher temperatures, rising sea levels, more extreme storm surges, and stronger wave action? What currently available data can be matched to past developments so as to give an indication of what we may be in for?

##### **2. Colonisation of the peatlands inland from the North Sea coasts**

Large-scale colonisation of the peatlands adjacent to the salt marshes would seem to have begun between Texel/Wieringen (at the time an island) and the Frisian mainland. From there it probably spread to the “Green Heart of Holland”, Westergo (part of Friesland), the rest of Friesland, Groningen, and further east (Hollerland near Bremen, the Elbe marshes, the delta of the Vistula). This kind of research can provide us with a knowledge (currently almost non-existent) of the occupation of the islands, salt marshes, and peatlands by man in combination with the ecological and socio-geographical effects.

##### **3. Fens in Carolingian and Ottonian times?**

Just how reliable are the historical sources and chronicles – partly considered apocryphal – regarding the presence of extensive fens in Carolingian and Ottonian times (ca. 750 to ca. 1050) in the Wadden Sea area as well as in comparable areas elsewhere (for example the Fens around the Wash bay)?

##### **4. The toponymy of the Wadden Sea region**

In addition to soil science, geology, archaeology, and history, toponymy, especially regarding the names of the



channels and tidal flats in the Wadden Sea, can help us understand the previous functions and qualities of those places.

### **Possible approaches to tackling the research questions**

This multidisciplinary project requires the knowledge of geologists, soil scientists, geomorphologists, archaeologists, historical geographers, historians, and linguists. The following institutions will be invited to cooperate: the University of Groningen Centre for Landscape Studies (historical geography, archaeology), the University of Utrecht (physical geography and history), VU University Amsterdam (history of water management), TNO-Deltares (geology), the Cultural Heritage Agency of the Netherlands in Amersfoort (terrestrial and maritime archaeology), and the Meertens Institute (onomastics, toponymy).

### **Relationship to other research themes**

There is a close relationship and partial overlap with the project on *Hydrodynamic and Morphological Conditions and Usage* in the Wadden Sea Region. There is also a certain amount of overlap with the *Coast and Identity* project. Moreover, the project has a very clear international component and as such fits in well with the *Trilateral Research Agenda*.

### **Example 3 of the relationship between the themes**

#### **Salty opportunities**

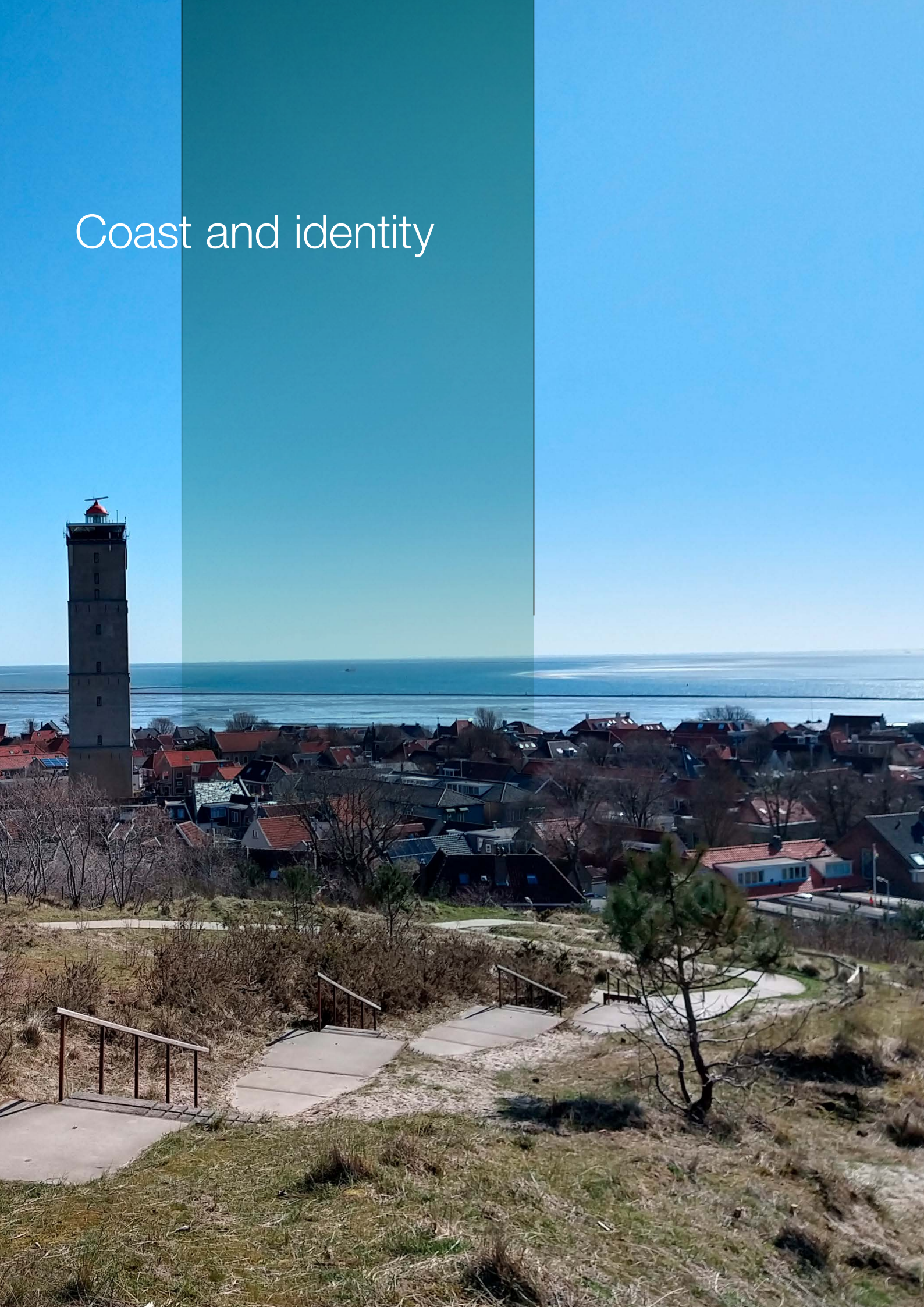
*Integrating climate adaptation, quality of life, history, and identity*

For generations, those living along the coast of Wadden Sea have battled against salt water. With impending sea level rise and the already tangible increase in periods of extreme summer drought, that struggle is entering a new phase. With decreasing “counterpressure” from fresh water on the landward side, salt from the sea is slowly but surely advancing inland. For the moment, this salinisation can still be held in check by “flushing” the land with fresh water, but that strategy is becoming increasingly untenable due to a lack of summer precipitation.

Farmers in the coastal zones of the Wadden Sea are therefore faced with a challenge: after centuries of struggling against salt water, does saline agriculture perhaps represent a solution – an economically stable livelihood?

Saline agriculture demands more than an adjustment as regards water management and the choice of crops and plant varieties. It also requires a different way of thinking on the part of residents along the coast – a break with a long history and with established agricultural practice. Financial aspects also play a role, such as developing a sales market and a marketing policy for the saline products that are produced.

# Coast and identity





## 3.4 COAST AND IDENTITY

### How can the perspective of inhabitants of the Wadden Sea region be included in the issues to be investigated?

#### Introduction

The Wadden Sea and the Wadden islands are a product of ebb and flow, of fresh and salt, but also of humankind and nature. Protection and sustainable development of the special qualities of the Wadden Sea region are also only possible if people are aware of the interplay between the cultural and ecological significance of the region. With a view to the long-term future, research into the “Wadden identity” can contribute to a better link-up of the two main aims of the Wadden Fund, namely strengthening ecology and the economy. Recognition of that Wadden identity can also provide a substantive basis for development of the area as a sustainable coastal region.

A coherent narrative of the identity of the Wadden Sea region begins with research into its eventful social, economic, and cultural history. Successfully confronting the challenges of globalisation and climate change in the region also begins with feeling pride in a living environment with a highly diverse ecology. That pride often seems to be lacking at present. The region can hardly be called a cultural unit, mainly because it is highly fragmented both geographically – it is elongated with an irregular, interrupted coastline – and as regards political administration. However, its insular character – with the Frisian or Wadden Islands on the one hand as well as peninsulas separated by estuaries on the mainland, on the other – does not exclude common socio-cultural identities.

What is the story of the (trilateral) Wadden Sea region from the perspective of its inhabitants? The focus of cultural-historical research is hardly ever on the region as a whole but on its components: countries, provinces, regions, and municipalities. Whereas ecological research is taken care of by institutes such as NIOZ, Deltares or IMARES, there are no research institutes or agencies that concern themselves with cultural “Wadden research”. Nevertheless, the demand

for authentic regional products from a healthy living environment could, for example, provide new opportunities for future economic and social development.

#### Link-up with relevant research agendas

##### **Trilateral Research Agenda:**

Theme 3: Cultural heritage, identity, and historical embedding;

##### **National:**

*Agenda for the Wadden Sea Region 2050:*

Theme 2: Landscape and cultural heritage;

Theme 6: A liveable Wadden Sea region.

##### **Regional:**

*Wadden Sea Investment Framework:*

Theme 3: Strengthening and marketing the World Heritage site;

Theme 6: Islands under their own power.

*Programme Towards a Rich Wadden Sea:*

Pillar 2: Transitions towards sustainable (economic) co-use.

#### The research questions

##### **1. Wadden identity**

Is there already a Wadden identity, or how can it be developed? In this narrative, regional traditions and sports play an important role.

##### **2. The Wadden Sea region in a globalising world**

How do inhabitants of the Wadden Sea region relate to globalisation? We have had a global economy since the 1950s, but there are also trends towards more local, region-specific production and self-sufficiency in a number of areas.

### 3. **Fresh and salt**

Human activities in the Wadden Sea region are centred to a large extent on fresh water and salt water. What was that relationship like in the past, what is it like now, and what will it be like in the future when the climate will probably alter how fresh and salt relate?

### 4. **Will the islands be independent or dependent?**

Although the owners of the region's seagoing and whaling vessels were mainly based on the mainland, the Wadden or Frisian islands until recently enjoyed a high degree of self-sufficiency. Food, drinking water, and energy have led to their becoming highly dependent on the mainland. Instead of providing natural resources, nature itself seems to have become a restricting factor. What do relative overpopulation and tourism mean for such issues as sustainability, climate change, and the self-reliance of the islands? (This links up with themes 2 and 4.)

### 5. **Clay versus sand, mainland versus islands**

Large parts of the – trilateral! – Wadden Sea region have always been culturally and historically equated with Frisian identity. In the Netherlands nowadays, that identity is often narrowed down to merely the Frisian language, but traditionally it was far broader, being linked to both marine and inland waters and to an agricultural-maritime society. The rich area of clay along the mainland coast of the Wadden Sea has traditionally been home to a wealthy maritime-agricultural society. The sand of the islands was virtually synonymous with poverty. But for a century now, that picture has been reversed. The sandy islands flourish because of tourism, while the clayey mainland is shrinking, becoming depopulated, and stagnating economically. How can the culture of the Dutch mainland along the Wadden Sea coast

be broadened and reconnected with its rich past in agriculture and maritime and inland shipping? How can suitable jobs be created that are nature-oriented on the islands and culture-oriented on the mainland?

### 6. **Shrinking versus fixing up**

Seemingly contrary processes are taking place in the Wadden Sea region. The islands are doing very well economically, but the mainland considerably less so, although shrinkage there has been countered in the past few years. It does seem, however, that the islands are increasingly becoming the exclusive domain of the well-off, whereas, despite the positive developments, part of the mainland still suffers from a negative image. Can this trend be turned around?

## **Possible approaches to tackling the research questions**

This multidisciplinary project calls on the knowledge of (historical) geographers, historians, archaeologists, economists and other researchers, particularly social scientists, not only in the Netherlands but also in the other two Wadden Sea countries. Some of the questions will also feature in the section on economics. Some of the research is already underway, for example on the supposed gentrification of the islands. A great deal of research is also “filed away” in cultural history publications, which will be made accessible in the first instance via the International Wadden Library as far as older research is concerned.

An initial trilateral symposium already took place at the end of 2016, during which a survey was drawn up of cultural-historical research in the three Wadden Sea countries and contacts were forged with national and international researchers and research institutions.

A landscape biography of the Wadden Sea region was also published in cooperation with the Cultural Heritage Agency of the Netherlands (RCE) and the State Forest Service as an initial impetus and framework for cultural-historical research. Biographies of the islands of Ameland and Schiermonnikoog are now being developed on that basis.

### Relationship to other research themes

There is a relationship to the project on the *Sustainable Economic Wadden Sea Region*. Because the emphasis is on the role of man in the Wadden Sea region, there is also a relationship to the *European Legal Framework* project, and to a certain extent also to both the projects on *hydrodynamics* and *ecological conditions and usage*.

### Example 4 of the relationship between the themes


#### **Come to the coast!**

*Integrating identity, history, quality of life, and sustainable economic development*

Whereas the sandy soils on the islands were traditionally poor – in every conceivable sense of the word – and the clay soils were rich, that picture has largely been reversed from the economic perspective. The islands have become rich through tourism, while the clayey soil areas along the coast have become depopulated and relatively impoverished. Both sides are feeling the drawbacks of these developments. The pressure of mass tourism on the islands is often as pronounced as the emptiness in the villages of North Friesland and Groningen.

Can new tourism in the coastal strip perhaps take the pressure off the islands? There is certainly the potential for it to do so. At least 25 million people live within half a day's drive, and they regularly want to go on holiday. The challenge in developing this new tourism is to strike a balance with the natural values and quality of life of the area. TV reports about the "Dutch Venice" village of Giethoorn (province of Overijssel) – with its unending procession of small boats, packed together on the little canals, almost in the residents' backyards – will not arouse much enthusiasm among the remaining inhabitants of North Friesland and Groningen. On the other hand, new tourism can ensure that the local neighbourhood supermarket will continue to exist and villagers will not need to drive into town for every bit of shopping.



A landscape of sand dunes with a lighthouse in the distance under a cloudy sky. The foreground is dominated by a dune covered in dry, brownish grass and some green shrubs. In the middle ground, a wide, flat expanse of sand leads to another dune. On top of this dune, a small white lighthouse is visible. The background shows more dunes and a dark, overcast sky with heavy clouds. A vertical teal bar is overlaid on the left side of the image, containing the text.

The role of law in preserving  
and strengthening the core  
values and sustainable  
climate-proof use of the  
Wadden Sea region



## 3.5 LAW FOR THE WADDEN SEA REGION

### What does the law have to say about preserving and strengthening the core values and sustainable use of the Wadden Sea region? And how should climate change be dealt with within the applicable legal frameworks?

#### Introduction

The Wadden Sea region is one of the most ecologically, scenically, and culturally valuable areas in Europe. In legal terms, those values have achieved extensive recognition. For example, the Wadden Sea region is protected as an international wetland (Ramsar Convention), as a World Heritage site (UN World Heritage Convention), as a Particularly Sensitive Sea Area (PSSA, International Maritime Organisation), as an OSPAR Protected Marine Area (Convention for the Protection of the Marine Environment of the North-East Atlantic, the OSPAR Convention), and as an EU Natura 2000 area (designated as such under both the Birds Directive and the Habitats Directive).

Because the German and Danish Wadden Sea regions also have various protected statuses, the trilateral Wadden Sea region is an example of a cross-border area enjoying solid legal protection. The importance of the Wadden Sea region is further emphasised by its importance for the protection of migratory species (Bonn Convention, and the special conventions on seals and migratory birds drawn up under it). Parts of the Wadden Sea region have also been designated as Belvédère areas for implementation of the European Landscape Convention (Florence Convention) and the European Convention for the Protection of the Archaeological Heritage (Malta Convention). In addition to all this, international and EU requirements on environmental quality must be complied with in the Wadden Sea region, including those of the EU Water Framework Directive and the Marine Strategy Framework Directive. However, the Wadden Sea recently also lost a protected label: the Dutch Wadden Sea had long enjoyed UNESCO Man and Biosphere status, but this (non-judicial) status was recently withdrawn by the Dutch Ministry of Agriculture, Nature Management and Food Quality.

The requirements arising from these conventions and directives for the Wadden Sea region are enshrined in a complex system of Dutch regulations and policy documents. In the course of the coming decades, the challenge will be to achieve all the various conservation objectives in a coherent manner, while people's ambitions and the climate and environment undergo change. This challenge constitutes the basis for this theme, which aims to clarify – in a time of change – the role of international, European, and national law in preserving and restoring the core values of the Wadden Sea region, while leaving scope for sustainable use.

#### Link-up with relevant research agendas

##### **Trilateral Research Agenda:**

- Theme 2: Ecology, biodiversity, and spatial processes;
- Theme 4: Economy, society, and sustainable development.

##### **National:**

###### *Agenda for the Wadden Sea Region 2050:*

- Theme 1: World-class nature;
- Theme 2: Landscape and cultural heritage;
- Theme 4: Climate change;
- Theme 5: Energy transition
- Theme 7: A sustainable Wadden Sea economy; Various other themes.

##### **Regional:**

###### *Wadden Sea Investment Framework:*

- Involved in all themes.

###### *Programme Towards a Rich Wadden Sea:*

- Pillar 1: Nature improvement for a resilient ecosystem;
- Pillar 2: Transitions towards sustainable (economic) co-use.

## Important research questions

### 1. **A changing Wadden Sea region within the legal frameworks**

The morphology and ecology of the Wadden Sea region will change as a result, *inter alia*, of climate change. How do those changes correlate with the applicable legal frameworks? For example: in the light of the changes in the Wadden Sea region, what management efforts are required so as to fulfil the active protection obligations pursuant to conventions and EU directives?

### 2. **The ecosystem approach to management**

Is ecosystem-based nature management with scope for changes in biodiversity compatible with the applicable conventions and EU directives? How should new natural values be dealt with?

### 3. **Potential natural values**

Can a more pronounced focus on the development of “potential natural values” ensure that nature targets are met sooner and that the international, European, and national ambitions regarding nature restoration are fulfilled in the Wadden Sea region? Or do legislation and regulations in fact stand in the way of such restoration approaches? Do efforts for achieving the nature conservation targets lead to *more* or to *less* conflict with socio-economic interests?

### 4. **The Wadden Sea region within a chain**

What efforts are needed outside the Wadden Sea region so as to comply with the legal obligations and ambitions for the region, such as reducing nitrogen levels in the air and rivers or efforts to create international “flyways” for migratory birds and “swimways” for fish?

### 5. **Economic co-use, “synergy opportunities”, and the Dutch Environment and Planning Act**

What do the changes in the Wadden Sea region mean for the future of economic use of the region, based on the international and European legal frameworks? Is it to be expected that certain existing forms of economic co-use will cease to be permissible within the legal frameworks, given the changes in the region? What opportunities are there for more explicitly linking up public tasks – such as flood protection, the energy transition, and economic co-use such as fishing and tourism – with the tasks of restoring biodiversity, developing a resilient ecosystem, and protecting openness, peace and quiet, and darkness? For example, what role could “nature-based solutions” (NBSs) play and in what specific form? Can the new range of instruments in the Dutch Environment and Planning Act actively promote the obligations and ambitions regarding biodiversity restoration, development of a resilient ecosystem, and protection of openness, peace and quiet, and darkness?

## Possible approaches to tackling the research questions

The above questions leave room for both relatively large-scale and small-scale research projects. Due to the close connection with the expected changes in the Wadden Sea region, direct cooperation with experts from other disciplines should be a feature of all these projects. The legal component of the studies will consist mainly of desk research, focusing on sources of international, European and national law, policy documents, and case law. Generally speaking, however, it is advisable to combine desk research with empirical research so as to ensure an effective link with the Wadden Sea region.

## Relationship to other research themes

The projects on the short-term and long-term effects of climate change on the ecology and morphology of the Wadden Sea region are intended to identify those changes in the region as accurately as possible through sound research. This legal theme ties in directly with these aims by investigating how those changes relate to the applicable legal frameworks as regards protection of the ecological, landscape, and cultural values of the Wadden Sea region. Given that the future of economic co-use is also considered on the basis of those legal frameworks, there are also direct relationships with the other themes.

## Example 5 of the relationship between the themes

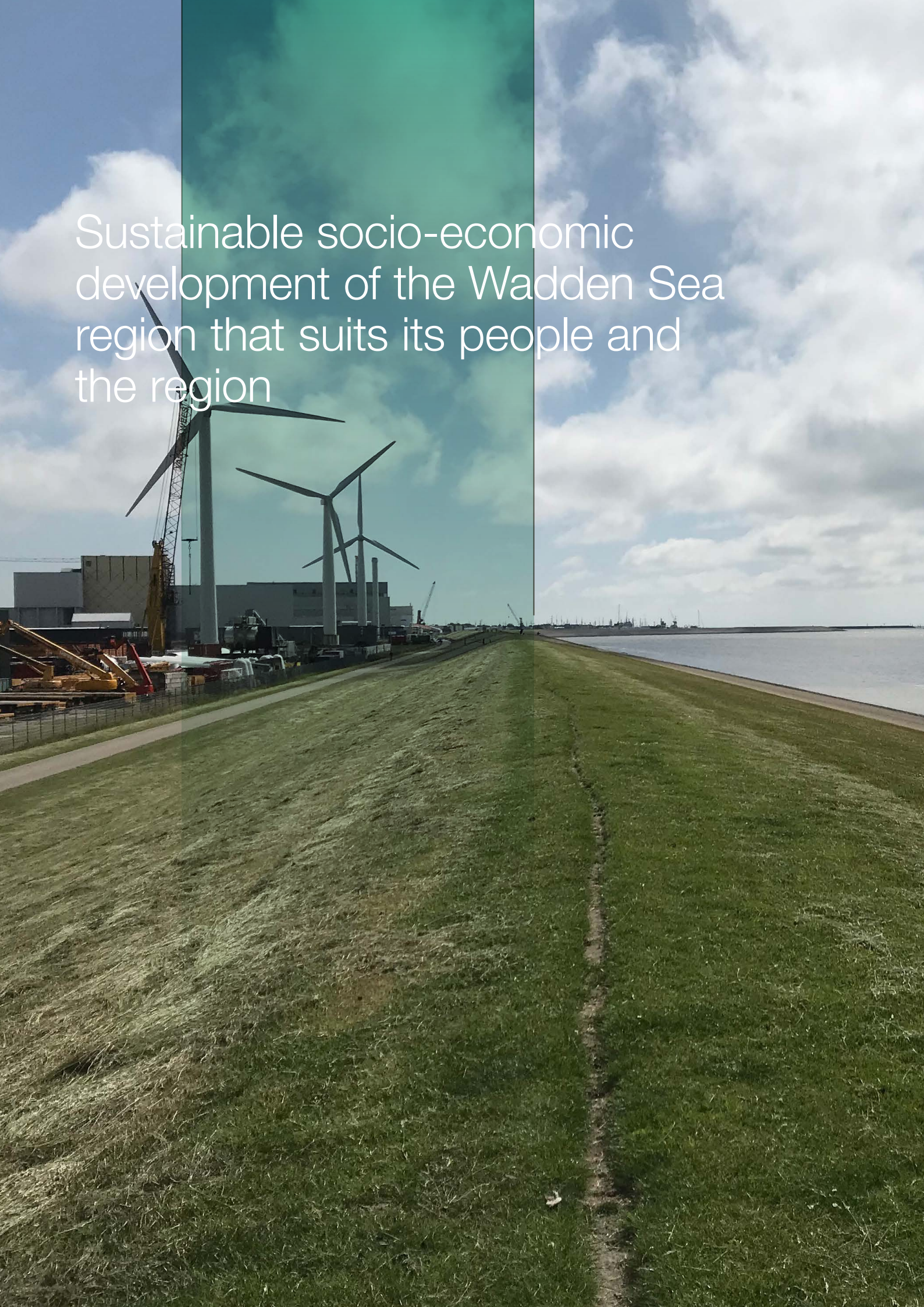
### **Ecosystem under pressure**

*Integrating climate adaptation, nature restoration, and law*

Rising temperatures and sea levels will lead to changes in the Wadden Sea region. They are also expected to have adverse effects on the habitats of species that are dependent on tidal flats. The Dutch government must not simply take those effects on biodiversity for granted. The Natura 2000 regime and the relevant conventions oblige the government to put in place active measures to protect certain specific species and habitat types and enable them to recover. An important question is what those measures should entail and how this obligation relates to the basic principle of allowing the Wadden Sea to function as an ecosystem as freely as possible. The question also arises as to what these developments mean for the permissibility of other (human) pressure factors, such as fishing and tourism. This requires integrating knowledge from a range of different fields: climate change, ecology, socio-economic developments, and international, European, and national law.



Sustainable socio-economic development of the Wadden Sea region that suits its people and the region





## 3.6 SOCIO-ECONOMIC DEVELOPMENT

### How can sustainable socio-economic development of the Wadden Sea region take account of the people who live and work there?

#### Introduction

Viewed from the socio-economic perspective, the Wadden Sea region is highly diverse. Not only does it belong to three different countries, but there are also major regional differences between the islands and the mainland. The region lies within commuting distance of a number of urban centres in between natural coastlines, agro-industrial landscapes, and large ports along dredged shipping lanes. Apart from within this web of spatial factors, the Wadden Sea region also operates within a web of tourism, agriculture, and the maritime sector as well as of employment, education, and population development.

The region's rural areas are struggling with population decline and ageing, particularly due to the selective departure of young people, who are moving to the urban centres for training or study. In agriculture and industry, many jobs – especially those for workers with medium-level qualifications – are disappearing due to automation and robotisation. In recent years, that has also been the case in the services sector.

Against the background of global warming, relative sea level rise, economic and energy transitions, and demographic changes, what kind of policy can steer these economic and social changes in the direction of sustainable development and improve quality of life and overall prosperity?

Work and income are important, but they can also partly be catered for in the urban centres of Alkmaar, Leeuwarden and Groningen, which are further away from the coast. In addition, the availability of facilities – shops, healthcare, education, accessibility, safety, etc. – is crucial for overall prosperity. Work and income in the Wadden Sea region must therefore derive primarily from economic activities that suit the population and the

region, i.e. activities that do not harm the natural values of the World Heritage Site and thus ensure that the landscape remains attractive for residents and tourists.

Industrial and energy-producing activities that take place in or on the edge of the Wadden Sea or in the ports and that could have a negative impact on the ecosystem and the natural values, therefore offer little in the way of opportunities, meaning that in the coastal area the focus will need to be on other types of employment. These include, specifically, tourism, business and personal services, supplying food, and housing. Tourism would seem to offer the best opportunities in terms of potential positive impact, especially for the mainland coast.

The aim of this research theme is to identify what the major changes will be as regards socio-economic, demographic and climate developments, and what the effects of these will be on the quality of life and overall prosperity of the region's inhabitants and visitors, as well as the influence this will have on the natural values of the UNESCO World Heritage site. The research theme must provide insight into the extent to which, and the way in which, usage in the area will be influenced in the future, and what opportunities and threats this will create for the Wadden Sea region.

#### Link-up with relevant research agendas

##### **Trilateral Research Agenda:**

- Theme 2: Ecology, biodiversity, and spatial processes;
- Theme 3: Cultural heritage, identity, and historical embedding;
- Theme 4: Economy, society, and sustainable development.

## **National:**

*Agenda for the Wadden Sea Region 2050:*

- Theme 2: Landscape and cultural heritage;
- Theme 4: Climate change;
- Theme 5: Energy transition;
- Theme 7: A sustainable Wadden Sea economy

## **Regional:**

*Wadden Sea Investment Framework:*

All the themes with the exception of theme 1.

*Programme Towards a Rich Wadden Sea:*

Pillar 2: Transitions towards sustainable (economic) co-use.

## **Important research questions:**

- 1. Jobs for the Wadden Sea region**  
What specific economic activities – including supply chains, business models, and governmental and social structures and institutions – can create targeted “Wadden jobs” that match people’s knowledge and experience? This can include sectors that are directly related to the location and ecosystem of the region – such as tourism, agriculture, fishing, energy, or port activities – but also economic activities that are not tied to a particular location, that have a low impact on the ecosystem, and that are less sensitive to job losses due to computerisation and robotisation.
- 2. Tourism to the mainland coast of the Wadden Sea**  
Tourism can still grow, especially around the mainland coast of the Wadden Sea, which is where the priority must therefore lie. Additional research on the carrying capacity of the islands must enable us to understand where the limits and warning signals for overtourism lie, in combination with the aim of developing tourism on the Dutch coast. The wishes and behaviour of potential visitors must be analysed in relation to the tourism product, accessibility, and facilities.
- 3. Investing in the World Heritage Site**  
Development of models for evaluating investments in nature conservation, coastal protection, and exploitation of natural resources. This involves not only financial evaluation but also evaluation of the ethical potential, well-being, and quality of life for the population, and the impact on the natural values of the Wadden Sea World Heritage Site.
- 4. Government assistance**  
What kind of government structures and institutions are needed to promote and facilitate initiatives by market parties, to tap the economic potential, and to make sustainable use of the available human, natural, and social capital?
- 5. “Cyberwadden”**  
What opportunities are offered by digitalisation? Given that good digital facilities mean that people no longer need to live close to a work location, what opportunities does this offer for greater economic development in the Wadden Sea region?
- 6. Energy transition**  
The Netherlands, Germany and Denmark have agreed, trilaterally, to strive for a CO<sub>2</sub>neutral Wadden Sea region by 2030. The energy transition required to achieve that objective in a vulnerable area like the Wadden Sea represents a major challenge. On the other hand, their remote location and self-sufficiency mindset make the islands ideal locations for demonstrating how the energy transition can work in actual practice. There are many questions underlying the envisaged energy transition. How does the aim of being self-sufficient relate to natural values and the goals regarding an open landscape? What is the role of local energy cooperatives, residents, and businesses in the energy transition, and how can local involvement and support for this process be increased?



How can wind farms be constructed to the north and west of the Wadden islands without their having a negative impact on how people experience the islands, or without damaging the natural environment by laying cables across the Wadden Sea itself?

### 7. Sustainable Development Goals

The Sustainable Development Goals (SDGs) are seventeen goals for making the world a better place by 2030. They were agreed by 193 member countries of the United Nations, including the Netherlands. The Wadden islands also endorse the SDGs. The question is how they can be operationalised on an island scale and how understanding the interrelationships between the seventeen SDGs can promote sustainability in the Wadden Sea region.

### Possible approaches to tackling the research questions

In order to answer these questions, it is necessary for the Basic Monitoring system to become operational. It must be developed into a monitoring system for the entire international Wadden Sea region, with indicators at a detailed spatial level (municipalities) over a longer period of time. The data thus derived will form the basis for combined analyses of socio-economic and demographic trends over time and space. Examples of such analyses include employment development by sector and level of education, technical and social innovation potential, human capital, business dynamics (including self-employment), unemployment, educational level, income, personal assets, home ownership, population development (births, deaths, migration, ageing), well-being, quality of life, life expectancy, and health perception.

The above questions leave room for both large-scale and small-scale research projects. Due to the close connection with the expected changes in the

Wadden Sea region, direct cooperation with experts from other disciplines should be a feature of all these projects.

Given the pursuit of sustainable coastal development, will new economic opportunities be sought for inhabitants of the region? What radically new, creative concepts regarding nature conservation, active ageing, sustainable tourism, local agricultural and fishery products (such as saline agriculture), can respond to climate change and sea level rise?

The ultimate goal is for the Wadden Sea region to become a “living lab” for socio-economic transitions and sustainable investment in its natural capital. The region must become a model for other coastal regions in and beyond Europe that are confronted by climate change, environmental degradation, and economic change.

### Relationship to other research themes

The research questions regarding the theme of *Sustainable Socio-Economic Development* of the Wadden Sea region that suits its people and the environment have numerous links with the other themes of the Wadden Academy. “Wadden jobs” can only be created that involve activities without any adverse effect on the ecological values of the UNESCO World Heritage Site. Climate change will have consequences for the availability and suitability of space for economic activity and the provision of ecosystem services. There are thus clear links with the themes *Climate and the Wadden Sea* and *Climate and Ecology*.

The legal frameworks and the role of government that are necessary for giving shape to *Government Assistance* again tie in well with the research questions within the theme of *Law for the Wadden Sea Region*. The links with these themes apply in a highly specific manner to the research questions in the field of the Energy Transition and to the Tourism sector and the related *Investing in the World*

*Heritage Site*. Tourism and Investing in World Heritage are related to the *Coast and Identity* theme and, more indirectly, to that of *Lessons from the Past*, from which narratives of the history of the region emerge that are of interest to residents and tourists.

## Example 6 of the relationship between the themes

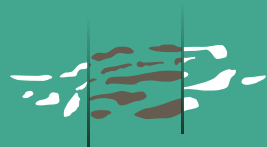
### **New opportunities between double dykes**

*Integrating climate adaptation, flood protection, nature restoration, and quality of life*

The Wadden Sea region protects the north of the Netherlands by forming a buffer between the North Sea and the coast. In time, the sea level will also rise in the Wadden Sea, while simultaneously the land behind the dykes will continue to subside. Could the concept of “rotation polders” [*wisselpolders*] combine this issue of climate change and flood protection with nature restoration and economic development?

In a *wisselpolder*, the tide is allowed to flow in again between two dykes, resulting – millimetre by millimetre – in a new salt marsh being created on former – often subsiding – cultivated land. In the first few years, or perhaps decades, such a *wisselpolder* will be able to provide a home for foraging birds and thus strengthen natural values. In the somewhat longer term, tide action may perhaps form new, fertile soil that can once more be used for agriculture if so desired.

*Wisselpolders* offer opportunities but potentially also tension. After all, the inhabitants of the Wadden Sea coast have for generations been used to keeping out the tides and salt water. It will only be possible to seize the opportunities for nature and agriculture if the inhabitants are closely involved in these projects from the very beginning.



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