

# Coastal protection: Delfzijl vs Emden

The challenges and- opportunities regarding coastal defense in the cities Delfzijl (NL) and Emden (G)



Figure 1: Marconi project Delfzijl-Eemshaven

Bachelor thesis

Student: Jasper van Rozen

Student number: s2787636

University of Groningen

Education: Spatial Planning & Design

Supervisor: Prof. J. Kuper

Date: 16-12-2018



university of  
 groningen

faculty of spatial sciences

## Colophon

### Bachelor thesis / Spatial Planning & Design

<b>Title</b>	Coastal protection: Delfzijl vs Emden
<b>Subtitle</b>	The challenges and opportunities regarding coastal defense in the cities Delfzijl (NL) and Emden (G)
<b>Place</b>	Groningen
<b>Date</b>	11 February 2019
<b>Author</b>	Jasper van Rozen (s2787636)
<b>Contact</b>	Jan hissink jansenstraat 3a 9713 HS Groningen <a href="mailto:Jaspervrozen@gmail.com">Jaspervrozen@gmail.com</a>
<b>University</b>	University of Groningen Faculty of Spatial Sciences Landleven 1 9747 AD Groningen
<b>Supervisor</b>	Prof. B.J. Kuper, MSc
<b>Version</b>	Final version
<b>Illustration front page</b>	(Gemeente Delfzijl, 2016)

## Abstract

Due to the continuous rise of the sea-level (Church et al., 2013), cities near coastal zones keep fighting against water. The development of primary flood defenses is necessary to protect the land from water. For those cities, the structure of their coastal management and sustainable/innovative solutions are important in the future. The institutional context regarding water management gives a country the opportunity to set up rules and desires for their priorities, therefore the approach of countries towards coastal defense can differ. In the north of the Netherlands and Germany, at the border, are two areas that have to deal with the same water. The cities Delfzijl and Emden border the Ems-estuary, but both cities are located in different countries. The differences in the institutional contexts of the Netherlands and Germany can result in differences in organization or legislation, especially because the National water policy of those countries is translated into regional measures for every Province (NL) and Federal State (G). This research aims to explore if these two cities, whom both border the Ems-estuary, have a different approach regarding coastal protection. The differences in the strategy towards coastal protection between these cities could lead to a more efficient strategy for Delfzijl or Emden, or both. The central question is the following:

*To what degree are the challenges and opportunities regarding coastal defense in the cities Delfzijl (NL) and Emden (G) dealt with in similar ways?*

This research contains qualitative data research methods using six semi-structured interviews and one questionnaire. Secondary data is gathered by literature review. In both countries, the central government is responsible for the national water policy, and the Provinces (NL) and Federal States (G) translate the national water policy into regional measures. The challenges for both regions are equal. In the future, both cities will experience problems with available materials to build the dike. Concerning the financial situation, the Dutch preserve significantly more money for coastal defense than the German. The significantly higher budget reserved for coastal management in Delfzijl has as a consequence that the integration of spatial development into water safety has more benefits for the spatial planning of the city Delfzijl. Another vital aspect to succeed the targets of coastal protection is the degree of communication between the involved stakeholders. There is more communication between the involved stakeholders in the region around Delfzijl than between the involved stakeholders in the region around Emden.

Keywords: Sea-level rise, water/coastal management, coastal defense, challenges, opportunities, stakeholders.

Theme: Water management

Words: 7000

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## 1. Introduction

Chapter 1 of this thesis discusses the background and relevance of this research (1.1). Paragraph 1.2 presents the aim of this research. The research question and sub-questions are formulated based on the objective of this research (1.3). The last section (1.4) shows the structure of this thesis.

### 1.1 Background

For many deltas in the world, that are situated along oceans or seas, water forms a threat. Due to climate changes, the sea level is rising rapidly, and there are no concrete numbers that tell us how fast the sea level is growing, only indications. The IPCC reported a "likely" range of 0.45 to 0.82 meter for sea-level projections for the late 21st century and 0.52 to 0.98 meter by 2100 (Church et al., 2013). In order to protect the cities against floods, primary defenses are built to keep the water out of the cities, but the continuous rise of the water level asks for new innovative sustainable strategies (Neuvel and van den Brink, 2009).

After some catastrophic floods in the 20th century in the Netherlands, the awareness for coastal protection grew. Between 1950-1960, the Netherlands was hit by various floods where many people got killed or wounded, which led to a big reaction in the planning of coastal zones (Bouma et al., 2005). Also Germany started to improve their existing strategy of coastal protection as a reaction to the storm surge of 1953 in the Netherlands (Ahlhorn, 2018). Nowadays, the responsibility lies with the Federal States, but all coastal states have special legislation for water management incorporated coastal protection into this framework, except for Lower Saxony with its State Law of Dikes (Deutscher Bundestag, 2007b).

In the Netherlands and Germany, the central government makes the national water policy (German Environmental Agency, 2018; Rijksoverheid, 2018). The Flood Directives of these countries are supposed to complement the European Floods Directive, but the considerations of a European Directive are however not legally binding (Jong and van den Brink, 2017). The Provinces (NL) and Federal States (G) are responsible for translating the national policies into regional measures (German Environmental Agency, 2018; Rijksoverheid, 2018), which give the Provinces and Federal States the freedom to adjust the national policies into slightly different policies that are more relevant for an area with certain specific characteristics. Due to the opportunity of translating the national water policy into regional measures, the strategy of coastal protection between Provinces or between Federal States in the same country can differ. Especially the approach regarding coastal defense between a Province of the Netherlands and a Federal State in Germany, because the national water policy of those countries already differ and the National water policy is translated into regional measures. The essence of this research is to see how two cities, which are relatively close to each other, one in the Netherlands and one in Germany, differ in operating against the challenges and opportunities regarding coastal defense. At the border of these countries, two cities fight against the same water in the Ems-estuary.

The Ems-estuary is located in the north of the Netherlands and Germany. The interesting thing is that the Ems-estuary is essential for both the Netherlands and Germany. These countries are situated next to each other, and both countries have areas that border the Ems-estuary. The biggest city in the Netherlands that borders the Ems-estuary is Delfzijl, for Germany this is Emden.



Figure 2: map with the location of Delfzijl and Emden (Michelin, 2019)

The relevance of this research is to investigate how both cities protect their coastline against water. Both regions have an own approach for coastal management, which prevents the water from transcending the dikes. No data compares the strategy for coastal protection of these two cities, while Delfzijl and Emden fight against the same water from the Ems-estuary. This research contains the differences and similarities that both cities have regarding their coastal defense. By comparing these cities who have to deal with the same water, both cities could learn from each other, and an efficient approach for coastal protection can occur that optimize the strategies for both cities.

## 1.2 Research goal

This research aims to see how the cities Delfzijl and Emden tackle the problems with water. These two cities are relatively close to each other and are situated next to the same river, the Eems, and bay, the Dollard, but how do these cities deal with the challenges of coastal defense? Because both cities are in different countries, Delfzijl in the Netherlands and Emden in Germany, regulations are different and therefore the actions of the governments against flooding can be different.

## 1.3 Research questions

The main question is as follows:

*"To what degree are the challenges and opportunities regarding coastal defense in the cities Delfzijl (NL) and Emden (G) dealt with in similar ways?"*

The answers to the following three sub-questions will form the core of a structured response to the main question. The sub-questions are:

1. *What are the biggest challenges regarding coastal defense for both Delfzijl and Emden?*
2. *What impact does coastline defense have on the spatial planning of the cities Delfzijl and Emden?*
3. *How is the communication between the involved stakeholders regarding coastal defense?*

## 1.4 Reading guide

Chapter 2 elaborates on the theoretical framework and describes the various concepts underlying this research. Besides the concepts and theories, a conceptual model is displayed. Section 3 describes the methodology of the study. This section highlights the type of data and research methods and provides further information about the research process. Also, it mentions the ethical considerations within this research. In chapter 4 the results are worked out. The sub-questions are each highlighted in a separate section. Chapter 5 concludes this research. Chapter 6 recommends future research. The last chapter reflects on the process of this research.

## 2. Theoretical Framework

This chapter discusses different topics and concepts which are used in the research as a framework.

### 2.1 Institutional context

Institutional contexts define the expected rationality or logic as specific to different areas of human action and interaction (Aasen and Vatn, 2018). An institutional context influences what is considered the right way to act to a social dilemma (March and Olsen, 1989), with individual rationality and social rationality as main targets (Vatn, 2015). Behind the processes of coastal protection, an institutional framework is made which discloses the responsibilities of different stakeholders regarding coastal defense, and the laws that these stakeholders have to take into account during their duties. The Netherlands and Germany have their own central government which gives them the opportunity to set up an institutional context that meets the interests of the country. According to Crawford and Ostrom (2005), institutions are described as extensively understood rules, norms or strategies that create incentives for behavior in monotonous situations. Through the possible variety of interests of the Netherlands and Germany regarding coastal defense, the content of their institutional context could differ. Once the original institutional context is established, 'path dependency' is the base of the institutional development, which means that the patterns of political mobilization, the institutional rules, actors' interests, and the way of conceiving of the political world will often engender self-reinforcing dynamics (Pierson, 2000). According to Pierson (2000), path dependency have the following key claims: specific patterns of timing and sequence; beginning with similar conditions; relatively small events may have a significant impact; introduced courses of action are difficult to reduce; institutional development is often punctuated by critical junctures. Shortly, these key claims have influences on the development of an institutional context which can lead to a more or less significant difference in the institutional context regarding coastal protection between the Netherlands and Germany. The priorities of these countries are important as potentially factors for both institutions and the appearing policy outcomes (Van den Hurk et al., 2014). The strategy for coastal defense of these countries, as a consequence of the differences in the institutional context, can vary from solely focusing on water safety to the integration of spatial development into water safety. Paragraph 2.4 continues about the consequences of the possible differences in the institutional context on a more local level.

Sea level rise is one of the consequences caused by climate change. If cities do not protect their coastline during the next decades, water will conclusively transcend the dikes which could lead to effects that are extensive and potentially devastating (IPCC, 2013). As a result of the potentially devastating effects, sea level rise is stated as a social dilemma. Therefore, coastal protection, which is a subject of water management, requires an institutional context. The next paragraphs highlight the institutional context of the Netherlands and Germany regarding water- and coastal management.

### 2.2 Water Act in the Netherlands and Germany

Water management is the control and movement of water resources to minimize damage to life and property and to maximize efficiency, beneficial use (Natural Resources Conservation Service, 2018). In the 20th century, the Dutch had undergone a few severe disasters due to flooding. Back in 1953 a catastrophic flood nearly killed 2000 people (Bouma et al., 2005). This flood is known for being one of the significant flooding events. Not only at the coast of the Netherlands problems with water occurred, in the years 1993 and 1995 the water levels in major rivers rose to extreme levels. In the year 1995, the water rise was so high that this led to an evacuation of approximately 200.000 people in various areas near the rivers (Driessen and De Gier, 1998). These floods led to a growing demand

of a new institutional context of water management, which caused a shift in water management policy. Not only the organization of institutional setting and political arrangements changed, but it encompassed changes in the technical way in which water was controlled and managed as well. The fundamental changes of this new approach were; instead of reaction, anticipation; searching for more space beside techniques; not shifting responsibilities (Ministerie van Transport en Water Management, 2000). In 2009, the Netherlands implemented a new official government water policy plan called "The National Water Plan", with 'sustainable water management' as key principle. The idea is to go with the flow of natural processes where possible, to offer resistance where necessary and to seize opportunities to foster prosperity and well-being (Ministry of Infrastructure and the Environment, 2009). The Water Act from 2009 is the legal framework behind the National Water Plan. In the Netherlands, a few organizations regulate water management. The primary goals of these organizations are flood prevention, providing enough ground- and surface water and maintaining good water quality. The two central water organizations in the Netherlands are Rijkswaterstaat and the waterboards, but the Rijksoverheid, the provinces, and the municipalities have a role in managing the water as well (Rijksoverheid, 2018). Appendix 1 shows an overview of the tasks of these stakeholders (Rijksoverheid, 2018).

In Germany, the most important federal law for water management is the Federal Water Act from 1957 (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, 2018). The primary goals of this water protection policy are; maintaining or restoring good ecological and chemical water quality; ensuring a supply of drinking and process water; securing for the long term all other water uses that serve the public interest. The targets and management provisions of the Water Framework Directive, which is a principal legal provision of the EU water resource management, are a central element of the Federal Water Act (German Environmental Agency, 2018). All states in Germany complement the national provisions and serve to implement them. The Federal States in Germany can vary the use of the right to differ from the Federal Water Act. Therefore each Federal State has a slightly different use of rights than other Federal States. The municipality can adjust provisions within their area of sovereignty (German Environmental Agency, 2018).

### 2.3 Organization of coastal management in the Netherlands and Germany

In the Netherlands, the Flood Defenses Act indicates the safety standards for every dike ring area (Ministry of Infrastructure and the Environment, 2009). In Germany, flood protection used to be a matter for the Federal States, but after the catastrophic floods of the rivers Elbe and Danube in June 2013 this changed. During the Conference of Environmental Ministers on 2 September 2013, the Federation and the Federal States set up a flood protection program under the coordination of the Federation. This change meant that problems had to be addressed by individual states acting in solidarity (German Environmental Agency, 2018).

The Dutch and German organization for coastal management legislation is quite similar. In the Netherlands, the Rijksoverheid (central government) is responsible for the national policy and in Germany, the Federation (central government) (German Environmental Agency, 2018; Rijksoverheid, 2018). The Provinces in the Netherlands translate the national policies into regional measures, and in Germany, the Federal States incorporate the national policies into their legislation, except for Lower Saxony, with its State Law of Dikes (Ahlhorn, 2018). In the Netherlands, Rijkswaterstaat and the waterboards are the primary stakeholders for maintaining the dikes, whereas, in Germany, the dike boards are responsible (Rijksoverheid, 2018; Ahlhorn, 2018). Appendix 2 shows an overview of the tasks of the stakeholders regarding the Dutch and German water- and coastal management.

## 2.4 Stakeholders regarding coastal management in the municipalities Delfzijl and Emden

Paragraph 2.1 explained how differences in the institutional context of the Netherlands and Germany regarding coastal defense arise. This paragraph shows which factors influence the policy outcomes of coastal protection on a more local level. For this research, the cities Delfzijl and Emden have been compared to each other. These cities are so called *action areas*. The guidelines of coastal management are stated in the Water Act of a country, but each region within these countries have its own specific characteristics, therefore, the national water policy is translated into regional measures. Action areas are affected by three types of exogenous factors: physical/ material conditions, attributes of the community and rules-in-use (van den Hurk, 2013). Figure 5 shows what these rules-in-use are and what these rules mean. These three factors explain the appearance, physical conditions, and organization of an action area. The action area consists out of action situations and participants which means that the measures of a city depends on the communication between all involved stakeholders and the current situation of a city. Therefore, an action area directly affects interaction patters and creates indirect causes for policy outcomes. Figure 4 shows the explanation in the form of a conceptual framework.

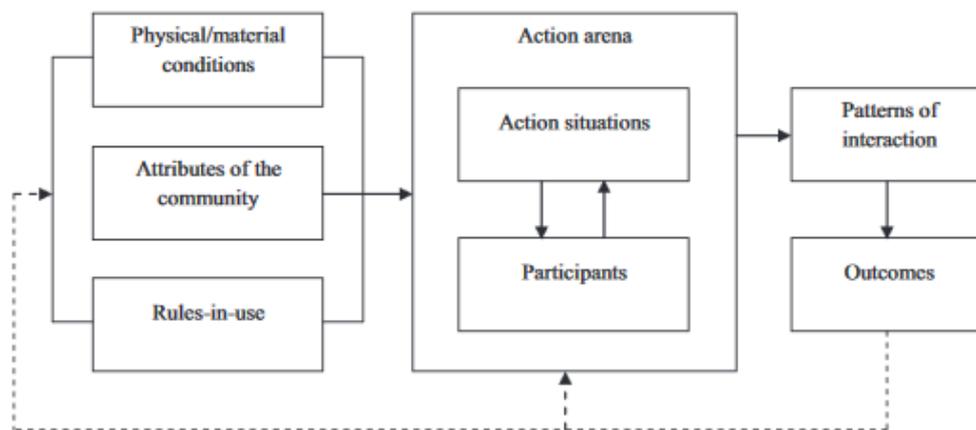


Figure 4: Conceptual framework (after Ostrom's IAD framework, 2005)

Rules-in-use	Related action arena component	Definition
Position rules	Positions	Who holds which position?
Boundary rules	Participants	Who participates—and who not?
Choice rules	Actions	What is allowed, what is obliged, and what is prohibited?
Aggregation rules	Control	Who decides? Who permits?
Scope rules	Outcomes	What are the intended outcomes?
Information rules	Information	Which information is available or necessary?
Payoff rules	Costs and benefits	Which actions will yield rewards and which actions will yield sanctions?

Figure 5: Relations between rules-in-use and action area components (Polski and Ostrom, 1999)

Knowing how the differences in an institutional context on a more local level occur, it is possible to see if these differences show variations in the organization of Delfzijl and Emden. Delfzijl is a city in the Netherlands situated in the north-east of the province Groningen, while Emden is a city in Germany located in the north-east of the state Lower Saxony. Both cities are coastal cities, and these cities border the Ems-estuary. On average, the coast of these cities is between -1.00 to 1.00 meters relative to sea level (Topographic-map, 2018; Actueel Hoogtebestand Nederland, 2018).

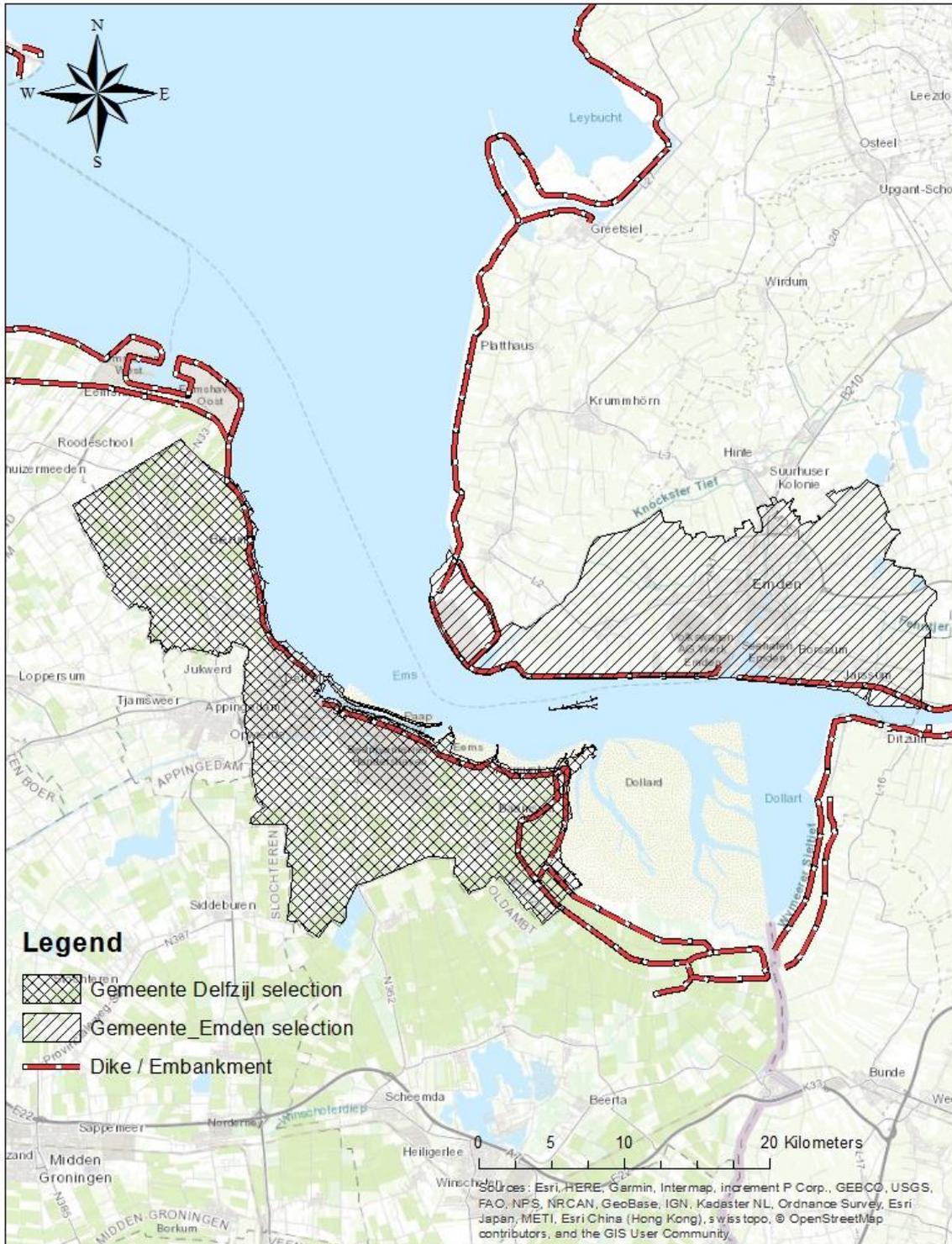


Figure 3: GIS-map with the location of the municipalities Delfzijl and Emden, and the dikes along the coast (own work)

The most critical stakeholders regarding coastal defense for the city Delfzijl are waterboard Noorderzijvest, Rijkswaterstaat, the Province of Groningen, and the municipality of Delfzijl. For Emden, these are the dike board Krummhörn, NLWKN (Aurich), the state Lower Saxony, and the municipality of Emden. To get an idea of the involved stakeholders concerning coastal defense in

these cities, take a look at appendix 3 and 4. The appendix shows which stakeholders are essential for which city regarding coastal protection.

The structure of coastal management organization focused on a more local area is a bit different. For the region around Delfzijl, Rijkswaterstaat and water board Noorderzijlvest are responsible for the maintenance of the dikes, while these stakeholders have a lot of other tasks related to water management as well. In Emden, dike board Krummhörn is the responsible stakeholders for the maintenance of the dikes and dike board Krummhörn does not have other tasks related to water management. Also, dike board Krummhörn gets assistance with the calculations and cross-sections of the dike from consultancy agency NLWKN.

## 2.5 Finance

The endless fight against water obligates the central government of the Netherlands and Germany to include financial support into the institutional context. In order to protect their coastline, dikes need to be improved once in a while which needs to be financed. In the Netherlands, the Hoogwaterbeschermingsprogramma (HWBP) is a part of the Deltaprogramma (Hoogwaterbeschermingsprogramma, 2018). HWBP is a program where the Rijkswaterstaat and the Union of Waterboards intensively work together. Both finance the HWBP for 50% each (Hoogwaterbeschermingsprogramma, 2018). This money is used for projects regarding dike improvements. In Germany, the German Republic finances the dike improvements for 70%, and the other 30% is for the involved Federal State (German Environmental Agency, 2018). The budget in the Netherlands (waterboard Noorderzijlvest) is significantly higher than the budget of Germany (Lower Saxony) regarding coastal protection (European Commission, n.d; Waterschap Noorderzijlvest, 2017; Zijlstra et al., 2019). Appendix 5 shows an overview of the financial situation regarding the coastal defense of the waterboard Noorderzijlvest, which has the responsibility of the area wherein Delfzijl is located, and the financial situation regarding the coastal defense of Lower Saxony, the Federal State wherein Emden is located.

## 2.6 Conceptual model

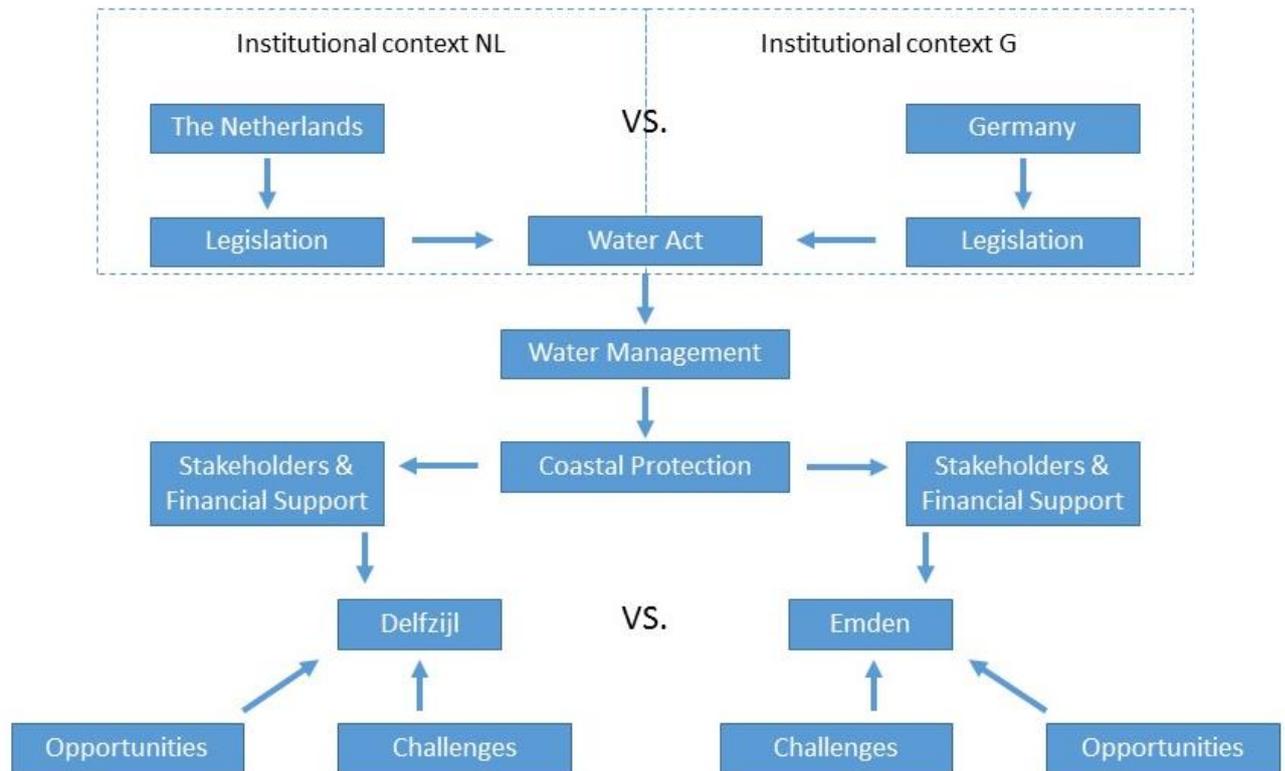


Figure 6: Conceptual model (own work)

### Explanation

The theoretical framework can be considered as a basis for the conceptual framework (see figure 6). First, the legislation of the Netherlands and Germany determines the content of the National Water Act. The central theme of the Water Act is Water Management and Coastal Protection is the relevant subject of Water Management for this research. Within the subject Coastal Protection, stakeholders arise with specific tasks regarding coastal defense and a certain amount of finance is reserved for projects around coastal zones. The relevant Stakeholders & Financial Support, together with the challenges and opportunities for a city regards Coastal Protection, determines the structure of coastal defense within a city/region. At the end, differences or similarities in the organization of coastal projection between the cities Delfzijl and Emden can occur.

### 3. Methodology

This chapter explains the choices that are made concerning the data collection of this research. Paragraph 3.1 shows the research process with its different phases. Section 3.2 highlights the choice of qualitative or quantitative data collection. Paragraph 3.3 introduces the respondents of the interviews, and paragraph 3.4 shows the data analysis. Ethical considerations for the interviews are discussed in the last paragraph (3.5).

#### 3.1 Data collection

For this research, a qualitative research method using interviews has been chosen. In comparison with a survey, an interview allows the development of the research to include a more complete and accurate account of income sources (Kalil et al., 2008). By interviewing the stakeholders of coastal defense for the two cities, more knowledge of the specific regions was required to make a clearer distinction. Quantitative research has not been included in this research because the research questions do not contain physical concepts, mathematical models, or statistical techniques, which are required for a quantitative research method (Taylor, 2016). For one person an email was sent with a few questions, because there was no time left to interview this person who could have relevant information about coastal defense in Emden, because he works for the dike board that is responsible for the maintenance of the dikes in Emden. Appendix 7 includes the questions. This thesis is comparative research between two cities from different countries, and therefore interviews with specialists were required to gather information. These specialists work for stakeholders regarding coastal defense, therefore, these participants had more inside information about the process of projects during coastal management.

Semi-structured interviews were chosen to gather the required data for this research. The questions of the semi-structured interviews to be found in appendix 6. Using a semi-structured interview, the researcher made predetermined questions but ensured flexibility that caused space for probing questions. With this technique of interviewing, it is possible for the interviewer to get to the core of the issues addressed by the interviewee (Longhurst, 2010). In this way, more information can be deducted from the interview as some topics could be more important for the participant than expected.

### 3.2 Participants

Different actors were approached for the interviews. The interviewees work at stakeholders regarding coastal defense in the regions around Delfzijl and Emden. The participants were contacted by sending e-mails and by making phone calls. Because this research is a comparison between two cities in different countries, the choice was made to do three interviews in the Dutch region around Delfzijl and three interviews in the German region around Emden. The choice to interview three persons was made because less interviews would have been not enough information, and more than three interviews would have been too much information for the guidelines of this thesis. In chapter 4, the quotes of the interviewees are cited, and the interviewees are referred in terms of their function. Table 1 shows the details of the participants.

<b>Name:</b>	<b>Function:</b>	<b>Organization:</b>	<b>Date of interview:</b>
Marco Veendorp	Research leader	Arcadis (hired by waterboard Noorderzijlvest)	31-10-2018
Jornand Veldman	Program manager Marconi	Municipality of Delfzijl	6-11-2018
Ate Wijnstra	Project manager	Waterboard Noorderzijlvest	20-11-2018
Hartmut Fresemann	Head of the environmental office	Municipality of Emden	28-11-2018
Frank Ahlhorn	Managing Director	Küste und Raum – Ahlhorn & Meyerdirks GbR	3-12-2018
Thomas Schoneboom	Business manager	NLWKN Aurich, the German Agency for Coastal Protection	11-12-2018
Frank Rosenberg	Managing director	Dike association Krummhörn	11-12-2018

*Table 1: details of the interviewees*

The interviewed participants are all stakeholders regarding coastal protection. For both cities, someone of the municipality was interviewed. For the region Delfzijl, two persons of the waterboard Noorderzijlvest were interviewed. Instead of two participants of the waterboard Noorderzijlvest, one would have been better. If an interview with someone of Rijkswaterstaat could have been added, insights in a different angle of approach could have come to light which had given a more complete answer to the research questions. When it comes to Emden, the interview with the managing director of dike association Krummhörn did not go through, which would have been helpful. Therefore, the email with a few questions was answered instead. The three interviewees of the region Emden all worked at different stakeholders regarding coastal protection. The data collected however is of high quality and can thus be used for this research.

### 3.3 Data analysis

The data collection for the primary data was done through interviews. The collected data helped to answer the sub-questions as stated in 1.3. All meetings were recorded with audio equipment. After this, these records were transcribed. These documents were implemented in a program called; Atlas.ti. In this program, head- and sub-codes were made to find relevant information for this research. The codes were based on the content of the interviews, which means that an inductive coding approach was made, making use of open and axial coding. Inductive coding allows theory to emerge from the content of the raw data (Cope, 2010). An inductive method was chosen because this research is explorative and therefore no pre-conceived hypothesis will be tested (Cope, 2010). Table 2 shows which head codes are relevant for each sub-question. These head codes are divided into sub-codes which give different insights in a particular subject. Appendix 8 and 9 show the

relevance of every head- and sub-code in a code tree and codebook. Based on this analysis, a vision is given of the current situations in the cities of Delfzijl and Emden regarding coastal defense.

<b>Research question:</b>	<b>Head code:</b>
<i>1. What are the biggest challenges regarding coastal defense for both Delfzijl and Emden?</i>	<i>Challenges and opportunities</i>
<i>2. What impact does coastline defense have on the spatial planning of the cities Delfzijl and Emden?</i>	<i>Spatial design</i>
<i>3. How is the communication between the involved stakeholders regarding coastal defense?</i>	<i>Communication and stakeholders</i>

*Table 2: Link between the research questions and head-codes*

At the beginning of the interviews, it could be noted that the interviewees were interested in this research and wanted to explain everything about their role in coastal management. Some participants had more experience in the involvement of a project regarding coastal protection resulting in more practical answers. The data deducted from this research can partly be generalized, but only if the data is compared to an area in the same country. Overall, the quality of the data for this research was useful.

### 3.4 Ethics

According to Richie et al. (2014), qualitative research comes with ethic and integrity. There are main categories regarding ethical consideration that the researcher should have in mind during the research. First, ethical behavior protects the rights of individuals, communities, and surroundings that are involved in this research. Second, ethical behavior gives a positive attitude towards the continuation of scientific research. Thirdly, there is the growing demand for accountability and the feeling that institutions need to protect themselves against unethical behavior of students and employees (Hay, 2010).

There are several rights for the interviewees. First, the interviewees had to agree with the interview being recorded to be able to transcribe the conversation. The interviewees were also allowed to cancel the interview at any moment. Furthermore, the used quotes were sent to the participants and only used with permission. Concerning anonymity, the participants were asked if it was a problem to mention their names beneath the used quotes. At last, all interviewees had the right to receive a copy of this research if wanted.

## 4. Results

In this chapter, the results of this research are presented. The structure of each paragraph will be the same. The first part will discuss the Dutch situation, followed by a discussion of the German situation. At the end of each paragraph will be discussed what the similarities and differences are.

### 4.1 What are the biggest challenges regarding coastal defense for both Delfzijl and Emden?

During the endless process of strengthening the dikes around the coastal zones against water, new challenges arise, and new innovative strategies are necessary. Although many people claim that global warming is a scam or hoax, the ones who can analyze and understand the scientific articles know global warming does exist (Allchin, 2015). A consequence of global warming is sea level rise, one of the challenges in the future for coastal protection (Church et al., 2013). Other problems are coastal erosion (Ahlhorn, 2018), the financial situation and other aspects in the structure of the coastal zones and ecosystems around it (Prazini et al., 2015). The challenges according to the literature correspond with the answers of the interviewees. The biggest challenges according to the Dutch interviewees were sea level rising, differences in thinking between the stakeholders, materials, and finance. Both cities have to deal with the available amount of building materials. It is not allowed to excavate more sand, nor clay in the world heritage area Wadden Sea (Ahlhorn, 2018). As a consequence of the continuous development of the dikes, the project manager of Noorderzijlvest said the following about the financial situation:

*"We cannot maintain this level of safety. It is no longer affordable, and I think that will be a problem for the future as well. So we will have to start playing more with nature to guarantee safety, which means that you have to accept that water sometimes transcends the dike."*

- Ate Wijnstra of water board Noorderzijlvest

In Emden, the challenges are quite the same, but in Emden, there is less trouble with the sea level rise than in Delfzijl because the surface area around the coast of Emden is on average higher above the sea level than around the coast of Delfzijl. However, this is more comforting for parts away from the coastal zone. The areas around the coastal region do feel consequences from the sea level rising. Although according to the Head of the Environmental office in Emden, at the moment, the coastal zone of Emden is not in trouble. The managing director of Ahlhorn & Meyerdirks GbR explained that materials and finance would be the most significant challenges. About these challenges he said:

*"Of course, in my opinion, there are problems with coastal protection in the future, because you need building material. Sand and clay. The question is where and how to get it? Today, we have this conference of the heritage area Wadden Sea, the national park in front of the main dike in Lower Saxony and it is not allowed to excavate clay, nor sand. So, we have to think about where we can gain the materials. This is a big problem we have to solve. Another problem is financial support. In Lower Saxony, we get around 50 to 60 million a year for the whole dike line, and the entire dike line is about 680 kilometers. 50 to 60 million sounds much, but it is not so much if you think about it because of 1 kilometer of dike cost between 5 to 8 million euros. You have to prioritize where to invest it"*

- Frank Ahlhorn of Küste und Raum – Ahlhorn & Meyerdirks GbR

These challenges will keep all stakeholders of coastal defense busy for the upcoming decades, but there are opportunities to counteract the obstacles. According to the Dutch and German interviewees, the stakeholders who are responsible for the maintenance of the dikes are trying to

find new strategies that sustain longer and cost less. The project manager of Noorderzijvest explained about an LCC-approach (Life Cycle Cost), which is used to find the best sustainable solution for a project. The LCC-approach estimates the overall costs of project alternatives and selects the design that ensures the facility that provides the lowest overall cost of ownership consistent with its quality and function (Fuller, 2016).

The projects about coastal defense in Emden and Delfzijl can count on financial support. With the financial support of the Hoogwaterbeschermingsprogramma (Delfzijl), German Republic (Emden) and the state Lower Saxony (Emden), the responsible stakeholders can prioritize where to invest. Another opportunity during projects around coastal zones is economic impulses. When the safety of an area is at its highest, more companies want to locate in that area. Learning from each other can be seen as an opportunity as well. During the interviews, it seemed that there was not much communication between the Netherlands and Germany, or with other countries regarding coastal defense. In every country, state, or province, different problems around coastal zones occur, and therefore some countries have more knowledge about specific topics. According to the managing director of Ahlhorn & Meyerdirks GbR, the willingness to communicate more is there, but some barriers make it difficult. He said the following:

*"They are interested in international communication, but they are reluctant, for example about language. We cannot speak Dutch or English very well, but they have experienced it with the dike board excursion. They saw that it is not that difficult to make it understandable for each other. We can really talk to the people, and they are trying to do it in German, Dutch, or English. We can talk together. It is only a point of doing it".*

- Frank Ahlhorn of Küste und Raum – Ahlhorn & Meyerdirks GbR

Concerning the available amount of building materials, the stakeholders need to discuss with the farmers who live in the hinterland of the dikes about excavating clay and sand from their land. The farmers need compensation for the holes that need to be dug to collect sand and clay. According to the Dutch and German interviewees, another solution is to start playing more with nature to guarantee safety, because than it allows the water to transcend the dike sometimes which causes less need for materials and costs (Waddenzeedijken, 2014).

#### 4.2 What impact does coastline defense have on the spatial planning of the cities Delfzijl and Emden?

In appendix 1 & 2, an overview is given of the involved stakeholders regarding water- and coastal management in the Netherlands and Germany. Appendix 3 & 4 shows the involved stakeholders regarding projects about coastal defense. Stakeholders such as the municipality, nature organizations and other local authorities are not only benefiting from more safety against the water. The boards of the cities want an attractive environment and a better ecosystem to get more visitors, which is good for the economy of the area. The Marconi project is an excellent example of this because dike improvement is not the only goal for this project. The Marconi project is organized to improve the dikes around the region Delfzijl, but to increase the environmental quality, for people and nature as well. The targets of the project is to recover the livability and to increase the attractiveness of the city for the citizens, visitors, and investors which can be achieved by the integration of spatial development into water safety (Gemeente Delfzijl, 2016). An integrated approach combines all aspects that are relevant to tackle the problems. Depending on area, site and context different aspects together or parallel to each other can be used (Rijkswaterstaat, 2013). For many years now,

the government of the Netherlands is busy with "de Nieuwe Omgevingswet" (new environmental law) that should decrease the juridical complexity and aims for a more area-oriented and integrated approach (Aan de slag met de Omgevingswet, 2018). The stakeholders of the Marconi project try to integrate as many possibilities as possible during this project, such as a bird island, a boulevard, a city beach, and a plan to make the city center more attractive (Gemeente Delfzijl, 2016). This approach reflects the approach of the Marconi project, which is confirmed by the program manager of Marconi:

*"you are also obliged to do what is in the law, that means that you try to return the values of the area as much as possible. If you have a natural value, or you have a landscape value or a cultural-historical value, you are obligated to take this into account. So you have to keep in mind, the 'Omgevingswet,' the new 'Omgevingswet,' you have to take the interests of residents, citizens, and nature organizations into account, so you are simply obligated to integrate all relevant aspects during the process".*

- *Jornand Veldman of the municipality Delfzijl*

When looking at the Marconi project in Delfzijl, it is visible that spatial development is integrated into water safety. Maintaining a high level of water safety remains the first priority, but every possible integration of spatial development is taken into account. As a result of the integration of spatial development into water safety, the physical character of Delfzijl undergoes changes, therefore coastal protection has impact on the spatial planning of the city Delfzijl.

In the environmental law of Germany, roughly the same approach is mentioned. In Germany, the government aims for a method that protects the environment with an open design and legal simplification (Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, 2008). The juridical simplification should ease the integration of spatial development into water safety because the amount of laws cause complexity for stakeholders to develop the spatial planning in combination with projects regarding coastal defense. In contradiction to Delfzijl, at the time of this research, there was no project taking place about coastal protection in the region Emden which made it challenging to investigate the degree of integration of spatial development into water safety. The principles of integrated coastal-zone management dealing with proposals likely to have spatial impacts in the coastal zone are: encouragement of sustainable development within the coastal zone; themed and geo-graphically comprehensive perspective is to be adopted which integrates all the interests affected; and planning and development processes are to involve all affected stakeholders and all relevant local, regional and national authorities (CPSL, 2010). Through the absence of a concurrent project regarding coastal protection in Emden, the degree of integration of spatial development into water safety is mainly based on the answers of the interviewees. The Germans were asked the same interview questions to see if coastal management has an integrated approach as well. The Business Manager of the NLWKN in Aurich said the following about it:

*"In front of the dikes, some cities have beaches, as long as the safety of the dike comes first. You can also make other things on top or in front of the dike, as long as the safety does not decrease, but you can integrate other problems into the solution".*

- *Thomas Schoneboom of NLWKN Aurich*

The managing director of Ahlhorn & Meyerdirks GbR said the same; "it does happen, but occasionally." The statement of the managing director of Ahlhorn & Meyerdirks GbR corresponds with the statement of the managing director of dike board Krummhörn, who explained that the

safety of the dike is the most significant priority. Wherever possible, other things can be taken into account, e.g., tourism. These two respondents contradict with the opinion of the Head of the Environmental office in Emden, who stated that it almost never happened.

It seems that the Germans have less urgency with an integrated approach than the Dutch, because in all Dutch interviews, the respondents were clear about an integrated approach, while the German interviewees gave various answers about integration. Especially the Head of the Environmental office in Emden. Although it was clear that the municipality of Emden has less influence and knowledge about coastal protection than the municipality of Delfzijl.

The integration of spatial development into water safety does have impact on the spatial planning of a city, but it depends on the interests of the city itself. The Marconi project in Delfzijl integrates spatial development into water safety. As a result, the city changes a lot concerning physical appearance. For example, during the project of dike improvement, the city center will be renewed, a beach is constructed, and a boulevard is created. These are not even all the interventions (Gemeente Delfzijl, 2016). Compared to the physical consequences of Delfzijl, Emden has fewer effects concerning spatial planning in combination with coastal defense. Safety is the highest priority regards coastal protection in Emden. As a consequence, more changes are adjusted along the coast instead of the physical character of the city.

#### 4.3 How is the communication between the involved stakeholders regarding coastal defense?

In figure 4 is shown which factors have influence on a certain policy outcome. The rules-in-use can be seen as an institutional context because the answers on the rules-in-use explain who are involved and what needs to be achieved. The eventual outcome of a policy depends on the interaction between the stakeholders involved. The communication between these stakeholders is crucial because every stakeholder has different priorities. Communication is necessary to find a solution which satisfies all stakeholders. In the Delfzijl region, four times a year, the responsible directors meet together with the intern client and the project manager to discuss the project. (Waddenzeedijken POV, 2014) Together they have to discuss and change their interests. The program manager Marconi confirmed this during the interview. He said:

*“Four times a year from six to eight, we put the directors together, I was always there, and I made a report. There was one external person. Those directors all had the same feeling; we can talk openly to each other. If you have something on your mind, we can have open communication about it. If I had something which frustrated me, it was possible to say, come on Rijkswaterstaat, waterboard or municipality, do something. Open communication. Those reports were not public, not even on the website, which gave a sense of security and therefore confidence. Then the province reacted enthusiastically:” can we do something with the Marconi program and put it in our ED 20-50”. Yeah sure, as long as the Marconi program stays the Marconi program.”*  
– Jornand Veldman of the municipality Delfzijl

According to the interviews with the research manager of Noorderzjilvest, the program manager of Noorderzjilvest and the program manager of Marconi, it is clear that the communication between the stakeholders is seen as positive. Good communication during a project with the number of stakeholders as the Marconi project is vital, if the communication during years of the project goes stiff, the finishing date of the project delays.

Concerning communication, it seems that the stakeholders regarding coastal defense in the area around Emden have fewer meetings with different organizations. All Dutch interviewees had overseas experience concerning communication. The overseas experience was only the case for one of the interviewees in Germany. According to the Head of the Environmental office in Germany, there was no communication regarding coastal protection, but there was more about dewatering:

*"We don't have much communication. We have projects together, we deal with some issues regarding the dewatering of our region here together with the neighbor municipalities, but coastal protection itself is more discussed in inner circles. On a planning level, it is not really a discussion of communication with others. Everyone works for themselves. So not yet, maybe it will change in the future".*

- Hartmut Fresemann of the municipality Emden

Although this contradicts with the managing director of Ahlhorn & Meyerdirks GbR and the director of dike board Krummhörn, the managing director of Ahlhorn & Meyerdirks GbR told that two times a year, many stakeholders gather around the coast of Lower Saxony to talk about new developments. The director of the dike board even said that there are mutual visits from dike associations with Dutch waterboards and that the dike associations in Lower Saxony exchange information regularly between themselves.

As described in paragraph 4.1, communication is one of the most significant opportunities to improve the organization and execution of the process of coastal defense. The relevance of communication for this research is about improving the process of coastal protection for each other. In a more general view, everywhere in the world, each coastline has slightly different characteristics which could result in another approach regarding coastal defense. In comparison with the Netherlands and Germany, the shores in some other countries are much higher relative to the sea level. Therefore, coastal protection had never been an urgent issue. With the sea level rising in the upcoming decades, those countries could benefit a lot from the knowledge of the countries that have been active for centuries with their coastal management. In a more specific view, the characteristics around the coast of Delfzijl and Emden are quite similar because the cities are relatively close to each other. Due to differences in legislation and organization, these differences can result in different approaches regarding coastal protection. By communicating with each other, Delfzijl and Emden can implement the most efficient parts of the other into their strategy.

## 5. Conclusion

The main question of this thesis is the following: To what degree are the challenges and opportunities regarding coastal defense in the cities Delfzijl (NL) and Emden (G) dealt with in similar ways? The data collection contains a literature review and a qualitative research method using six semi-structured interviews. The institutional context of a country, in this case, the institutional context of water management, determines the responsible stakeholders and the guidelines that need to be achieved (van den Hurk et al., 2013). The involved stakeholders of an action area discuss with each other how the desired policy outcomes can be realized (Crawford and Ostrom, 2005).

The primary stakeholders in Delfzijl regarding coastal defense are Rijkswaterstaat, waterboard Noorderzijlvest, the province of Groningen, and the municipality of Delfzijl (Rijksoverheid, 2018). The Federal State Lower Saxony, dike board Krummhörn, and the NLWKN are the primary stakeholders for coastal protection in Emden (German Environmental Agency, 2018). The central government of the Netherlands and Germany composes the institutional context of the National Water Act, the Provinces (NL) and the Federal States (G) are responsible for translating the national policy into regional measures (Rijksoverheid, 2018; German Environmental Agency, 2018). For both cities, the most significant challenges in the future are the financial situation and obtaining building materials (Ahlhorn, 2018). The impact of coastline defense on spatial planning depends on the strategy. When spatial development is integrated into water safety, more physical changes in the city appear which improves the livability and attractiveness of the city (Rijkswaterstaat, 2013). According to the Dutch interviewees, the stakeholders regarding coastal protection in the region of Delfzijl/ Groningen have much communication with other stakeholders during a project about coastal protection. This communication is experienced with ups and downs, but communication caused a solution wherein every aspect is analyzed. The answers of the German interviewees about communication were more divided. It seemed that the involved stakeholders regarding coastal protection had less communication with each other than the stakeholders in the region Delfzijl/ Groningen, especially on an international level.

### *Comparison*

Both cities used to obtain clay and sand from the Wadden Sea, but it is not allowed anymore to excavate more sand, nor clay in the world heritage area Wadden Sea (Ahlhorn, 2018). Sand and clay are required as materials to build dikes, therefore, according to the interviewees, the stakeholders need to discuss with the farmers who live in the hinterland of the dikes about excavating clay and sand from their land. In exchange for a part of the soil, a financial compromise is necessary, but not all farmers are willing to cooperate. Another solution according to the interviewees is to start playing more with nature to guarantee safety, because than it allows the water to transcend the dikes sometimes which causes less need for materials and costs (Waddenzeedijken, 2014). Concerning the financial situation, the available annual budget to invest in primary defenses for the water board Noorderzijlvest is significantly higher than the annual budget for the Federal State Lower Saxony (European Commission, n.d; Waterschap Noorderzijlvest, 2018; Zijlstra et al., 2019).

The Marconi project in Delfzijl tries to integrate spatial development within the city into the project of a dike improvement (Gemeente Delfzijl, 2016). Therefore, the physical character of the city Delfzijl changes which should have a positive effect on the livability and attractiveness of the city (Rijkswaterstaat, 2013). In Emden, the integration of spatial development into water safety seems to occur at the coastline itself, instead of the appearance of the city Emden. The communication between involved stakeholders regarding coastal projects happens more in the region around Delfzijl than in the region Emden.

In conclusion, both cities are dealing with the same challenges, but the available budget in Delfzijl is significantly higher than in Emden. As a consequence of the difference in finance, the city Delfzijl integrates more spatial development into water safety which leads to more development concerning the livability and attractiveness of the city.

## 6. Future Research

The challenges that these cities need to overcome are challenges for many coastal cities in the world. Especially the finance of dike improvements because the continuous adjustments at dikes are extremely expensive. The other challenges can differ for each city around the world because it depends on the location and characteristics of the city (see figure 4), meaning that it is not possible to draw a conclusion from this research that applies for all cities. For every coastal city, the opportunity to improve their coastal management seems to be communication. Every city has slightly different problems with coastal protection, and through communication, knowledge can be spread. The results are not compared to other researches because this research focuses on two specific regions and there was no comparative research about these two regions done yet. As for recommendations for further research, another topic that could be implemented in this research is the technical side of coastal protection. It would be interesting to see if the techniques used for dike improvement are different. Those techniques could be divided into three main categories: foreland, dike, and hinterland.

## 7. Reflection

The theoretical framework is the most important aspect of a research. It is essential to search for specific theories and concept as a frame for the research, but the exact meaning of a theoretical framework seemed to be difficult. It would have helped to be more assertive in finding out how to write a theoretical framework, which would have spared much time. For the next time, it would be helpful to spend more time on reading researches to see what a research requires. Another mistake during this research was the number of participants asked. It is possible that interviewees cancel an interview, which happened a lot during this thesis. When more candidates are proposed, the less relies on the requested participants. When a study requires participants from other countries, it is smart to start as soon as possible. During this research, three people in Germany were interviewed, but to make an appointment across the border could easily take more time. In the end, the interviews worked out well, but to avoid stress, it is better to start as soon as possible. A disappointment during the data collection of this thesis was the choice of interviewing two persons from the waterboard Noorderzijlvest. Both of them were helpful, but much of the given information overlapped which could have been expected. For the next time, choose a maximum of one participant per company. During this research, there have been doubts to add the waterboard Hunze en Aa's as well because Hunze en Aa's is responsible for a part of the municipality of Delfzijl. The choice not to include the waterboard Hunze en Aa's was because the city of Delfzijl belongs to the jurisdiction of the waterboard Noorderzijlvest.

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## Appendices

### Appendix 1: Tasks of the stakeholders for Dutch water management

According to Rijksoverheid.nl, these are the stakeholders of water management in the Netherlands:

<b>Stakeholder:</b>	<b>Role:</b>
Rijkswaterstaat (RWS)	<i>Rijkswaterstaat is responsible for the management of the major waters, such as the sea and the rivers. RWS ensures that the government authorities responsible are alerted in good time to floods or stormy seas. In addition, RWS maintains dykes, dams, weirs, and storm surge barriers. Furthermore, RWS protects the coast and gives more room to rivers, for example, by deepening floodplains and constructing secondary channels (2018)</i>
Waterboards	<i>The waterboards are responsible for regional waters, such as canals and polder waterways. For example, they ensure that the water is clean in order to keep fish stock up to par. The district waterboards also protect the country from flooding and ensure that farmers have sufficient water for their crops. Furthermore, they are responsible for waste water purification” (2018) “The district waterboards draw up management plans regarding the water quality of the waters within their district. In addition, the district waterboards are responsible for the regional flood defence systems, that protect the country (2018)</i>
Rijksoverheid	<i>The central government is responsible for national policy and national measures. In addition, the central government bears responsibility for the flood protection standards pertaining to the primary flood defence systems, i.e., dykes and dunes that protect the country against water from the sea and the major rivers (2018)</i>
Provinces	<i>The provinces are responsible for translating national water policy into regional measures. The provinces have operational duties with respect to some water management issues, such as the removal of groundwater from the soil. The Soil Protection Act stipulates that the management of groundwater quality is a task vested with the provinces (2018)</i>
Municipalities	<i>Groundwater in urban areas is the responsibility of the municipalities. In addition, the municipalities are responsible for the drainage of waste water and excess rain water through the sewer systems, as dictated by the Water Act and the Environmental Management Act (2018)</i>

## Appendix 2: Tasks of stakeholders regards coastal management in the Netherlands and Germany

According to several sources, these are the stakeholders regarding coastal management in the Netherlands and Germany:

	<b>The Netherlands:</b>	<b>Germany:</b>
<b>National Law:</b>	The Water Act	Federal Water Act
<b>From national to regional implementations:</b>	<u>Rijksoverheid</u> is responsible for the national policy and the <u>Provinces</u> translate the national policy into regional measures	The <u>Federation</u> is responsible for the national policy, the <u>Federal States</u> complement the national provisions and implement them in their concurrent legislation (Except for the State Lower Saxony, regards coastal defense!)
<b>Maintenance of the dikes:</b>	<u>Rijkswaterstaat</u> and <u>waterboards</u>	<u>Dike boards</u>
<b>Inspection of the dikes:</b>	<u>Waterboards</u>	<u>Lower dike authority</u>
<b>Calculations and cross-sections for the dikes:</b>	<u>Waterboards</u> , but the <u>municipalities</u> calculates as well.	<u>NLWKN (Niedersächsische Landesbetrieb für Wasserwirtschaft, Küsten- und Naturschutz)</u>
<b>Finance for dike improvements:</b>	<u>Hoogwaterbeschermingsprogramma (HWBP)</u> , which is a collaboration between <u>Rijkswaterstaat</u> and the <u>Union of Waterboards</u>	The <u>German Republic</u> and the involved state
<b>Water supply and water disposal</b>	<u>Municipalities</u>	<u>Municipalities</u>
<b>Assess the inspection of the dikes:</b>	<u>Inspectie Leefomgeving Transport (ILT)</u> and the <u>Hoogwaterbeschermingsprogramma</u>	-

### Appendix 3: Involved stakeholders in Delfzijl regards coastal defense

According to the Dutch interviewees, these are the stakeholders regarding coastal defense in Delfzijl:

<b>Stakeholder:</b>	<b>Role:</b>
Waterboard Noorderzijlvest	The waterboard controls the dike every twelve year to see if the dike still meets the standards with an assessment. If the dike does not meet the standards, the waterboard submits a request at the HWBP for dike improvement
Inspectie Leefomgeving Transport (ILT)	ILT assess the assessment of the waterboard.
Hoogwaterbeschermingsprogramma (HWBP)	After seeing the assessment, HWBP decides whether the dike needs improvement or not. They also finance dike improvements for 90%. The HWBP is a partnership between the Rijkswaterstaat and the union of waterboards. The money of the HWBP comes for 50% from the Rijkswaterstaat and 50% from the union of waterboards.
Rijkswaterstaat	Rijkswaterstaat is responsible for the bigger waters and they do the maintenance of dikes, sluices, dams etc.
Union of the waterboards	This is a partnership between the twenty-one waterboards in the Netherlands
Taskforce Delta technology	This is one of the workgroups of the Kernteam Delta technology of Top sector Water & Maritime. Their goal is to make projects better, faster, and cheaper. To import innovations at projects and to develop new projects.
Province of Groningen	The Provinces translate the national water policy into regional measures
Municipality of Delfzijl	The municipality represent the interest of the city
Waddenfonds	The Waddenfonds is a fund that invests in initiatives and projects that strengthen the ecology and sustainable economic development of the Wadden Sea Region
Groningen Landschap	Groningen Landschap is the advanced organization to represent the interests of nature conservation organizations
Groningen Seaports	Groningen Seaports is the economic operator, developer and authority for the port of Delfzijl, Eemshaven and the adjoining industrial sites
Agriculture and Horticulture Organization (LTO Noord)	LTO Noord represent the interests of the agricultural sector in the nine provinces above the Maas.
Fishing organizations	Fishing organizations represent the interests for local fishing
Culture organizations	Culture organizations represent the interests for local culture
Resident representation	On information evenings, residents can emerge the interests of the citizens

## Appendix 4: Involved stakeholders in Emden regards coastal defense

According to the German interviewees, these are the stakeholders regarding coastal defense in Emden:

<b>Stakeholder:</b>	<b>Role:</b>
Dike board Krummhörn	Dike boards are responsible for the maintenance and constructions of the dikes
NLWKN (Aurich)	NLWKN is a consulting company in Lower Saxony that helps the dike boards with the calculations of the required dike heights and they make cross-sections of the dikes
Lower dike authority Emden	Twice a year, the lower dike authority Emden inspects the maintenance of the dike. Once before the flood season and once after
Drainage board Emden	Drainage boards are responsible for the water drainage of the city Emden
Niedersachsen Ports	Niedersachsen Ports is a service provider for port customers. They create the right conditions for further development of the seaports of Niedersachsen
German Republic	The German Republic finances the 'dike pot' for 70%
Lower Saxony	The involved Federal State finances the 'dike pot' up to 100%
Volkswagen	Volkswagen has a big factory in Emden, which they want to expand. Because Volkswagen provides a stimulant for the economy, they are a stakeholder as well
Nature organizations	They represent the interest of the nature

## Appendix 5: Annual financial situation of waterboard Noorderzijlvest and Lower Saxony regarding coastal defense

According the European Commission, waterboard Noorderzijlvest & Wadden Sea Quality Report

<b>Area:</b>	Waterboard Noorderzijlvest	Federal State Lower Saxony
<b>Budget for coastal defense:</b>	24.872.742 euro	45.000.000 euro
<b>Length of dikes:</b>	74 km	645 km
<b>Surface area:</b>	144.000 ha	476.140.700 ha
<b>Budget/ km dike:</b>	336.118 euro / km	69.767 euro / km

## Appendix 6: Interview Guide

Can you give a small introduction about yourself? Where do you work and what is your function?

1. What does your company at the moment do, that goes about coastline defense?

- What are the most important stakeholders for coastal defense?
- How is the communication with the stakeholders? Same authority?

2. Which techniques are being used to defend the coastline against water in your city?

- How much do you have to consider the financial aspects during the process of implementing concepts

3. How do you look at upcoming climate changes when you're working on a project in your city?

- which consequences can be expected and how do you deal with them when it happens?

4. What are the spatial effects on the area when you're dealing with coastline defense?

- How are the citizens involved regards spatial effects?
- Are there opportunities for the economic situation of a city when doing a dike improvement?

5. How is your communication with other municipalities about problems with coastline defense?

- How do you use the information to implement in your own projects?
- Is there also communication with people across the borders? How?
- What can be learned from each other?

(during every interview, different probing questions were asked)

## Appendix 7: Questionnaire for Frank Rosenberg

1. Can you introduce yourself, what is your role at the **Deichacht Krummhörn**?
  - What are the responsibilities of **Deichacht Krummhörn**?
  - What are the other stakeholders regarding to coastline defense?
  - Can you tell me a bit of the whole organization of coastline defense, who are responsible and also what is the hierarchy between organizations?
2. Which techniques are you using for the dikes at the coast of Emden? (I can probably find something about that in the document you sent me as well)
3. What are the upcoming challenges for the future regards to coastal protection?
4. Do you try to integrate as many problems in one solution or is maintaining and fixing the dike the only priority? (for example, In Delfzijl they make a beach in front of the dike and a boulevard on top of the dike)
5. How is the communication with other dike boards? And do you have contact across the border, for example with a waterboard in the Netherlands?

## Appendix 8: Code book

(the letter after the head code is an abbreviation of the head code, if the letter behind the sub-code corresponds with the abbreviation of the head code, those sub-codes come from that head code)

<b>Head codes:</b>	<b>Inductive or deductive:</b>	<b>Explanation/ relevance:</b>
Challenges (C)	Inductive	What are the challenges for coastal defense
Communication (CO)	Inductive	How is the communication between stakeholders during a project regarding coastal protection
Opportunities (O)	Inductive	What are the opportunities for coastal defense
Spatial Design (SD)	Inductive	What effect has coastal protection on the spatial design of a city
Stakeholders (S)	Inductive	Which stakeholders are involved during a project about dike improvement
Techniques (T)	Inductive	Which techniques are used for coastal defense
<b>Sub-codes:</b>	<b>Inductive or deductive:</b>	<b>Explanation/ relevance:</b>
Climate change (C)	Inductive	The sea level is rising due to climate change, which makes it more difficult to defend ourselves
Difference in thinking (C)	Inductive	Some of the interviewees had a different opinion
Dike (T)	Inductive	Which techniques are used for the dikes to protect us from water
Drainage (C)	Inductive	In Emden there is a problem with the drainage system
Economic (O)	Inductive	Can you improve the economy while building the dike
Finance (O)	Inductive	Waterboards and dike boards are financed
Financial (C)	Inductive	Is there enough money to protect us from water
Foreland (T)	Inductive	Which techniques are used in the foreland of the dike to protect us from water
Hierarchy (S)	Inductive	Which stakeholders have the highest authority
Hinterland (T)	Inductive	Which techniques are used in the hinterland of the dike to protect us from water
Innovative (T)	Inductive	Are there new upcoming techniques
Integrated (SD)	Inductive	Do they tackle multiple problems when they work on coastal protection
International (CO)	Inductive	How is the communication across the border
Learning (O)	Inductive	What can the cities learn from each other
Main (S)	Inductive	The most important stakeholders
Materials (C)	Inductive	Are there enough materials to build dikes
National (CO)	Inductive	How is the communication on a national level
Nature (C)	Inductive	Different circumstances due to nature effects
Nothing (SD)	Inductive	Only focusing on dike safety
People (C)	Inductive	Is there enough manpower for coastal protection
Regional (CO)	Inductive	How is the communication on a regional level

Second (S)	Inductive	Second most important stakeholders
Size (C)	Inductive	The size of a project can cause delay
Sustainable (O)	Inductive	Are the solutions good for a long time
Third (S)	Inductive	Least important stakeholders

## Appendix 9: Code tree



