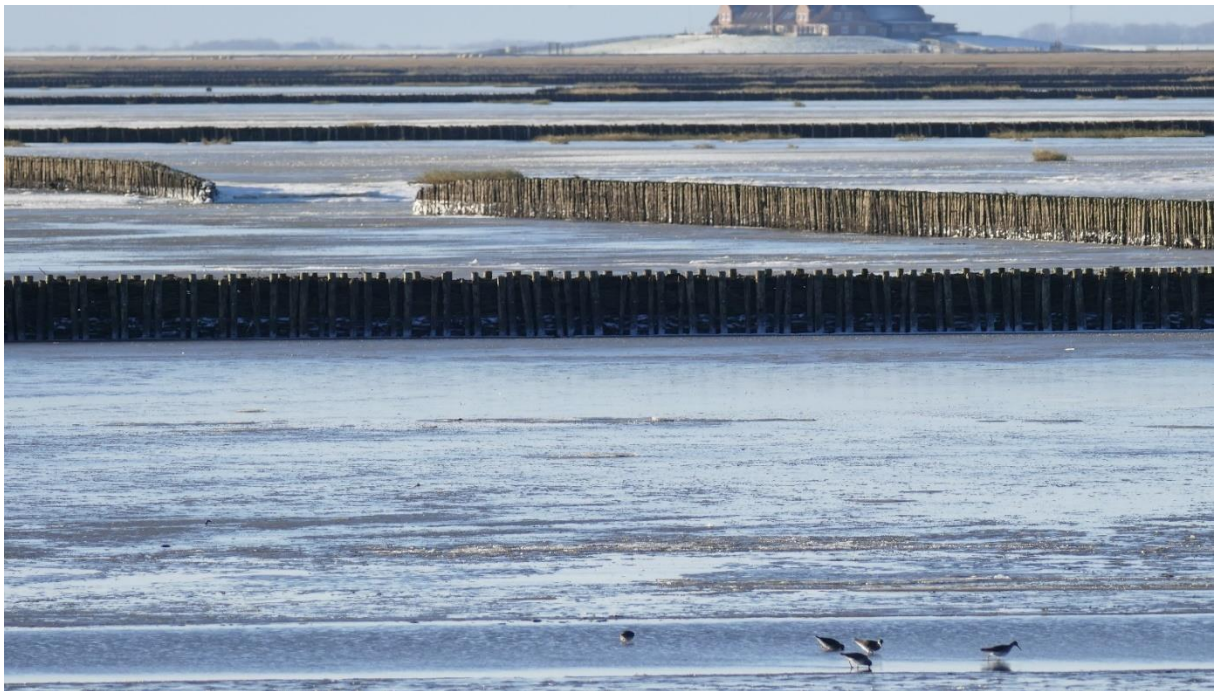


Exploring the relevance and perception of
 non-conventional coastal protection measures to increase
 coastal resilience at the Schleswig-Holstein Wadden Sea



Master Thesis | April 2024

Faculty of Spatial Sciences at the University of Groningen

Carl von Ossietzky University Oldenburg

Study Programmes: M.Sc. Environmental and Infrastructure Planning
 Double Degree M. Sc. Water and Coastal Management

Supervisor: Dr. Elen-Maarja Trell-Zuidema
Faculty of Spatial Sciences at the University of Groningen

Second Reader: Dr. Cormac Walsh
Department for Ecological Economy at the Carl von Ossietzky University Oldenburg

Author: Nina Caroline Lindstedt
Student number 55343143 at the University of Groningen
Student number 6443187 at the University of Oldenburg
Contact: nina.caroline.lindstedt@uol.de

Groningen, April 2, 2024

Table of Contents

Abstract	8
1. Introduction	9
2. Theoretical framework	13
2.1 Coastal resilience	13
2.1.1 Coastal resilience perspectives	13
2.1.2 Challenges and drivers for coastal resilience	16
2.2 Towards non-conventional coastal protection measures	21
2.2.1 Operationalizing coastal resilience through different coastal protection measures	21
2.2.2 Relevance of non-conventional coastal protection measures.....	24
2.3 Stakeholder perception	26
2.3.1 Relevance of stakeholder perceptions for coastal management.....	26
2.3.2 Factors influencing stakeholder perceptions.....	27
2.4 Summary and conceptual model	33
3. The case: The SH Wadden	36
3.1 Coastal management and resilience at the Wadden Sea: a brief look into its history	37
3.2 Stakeholders at the SH Wadden	38
4. Methodology	40
4.1 Interviews.....	41
4.2 Policy Document Analysis	44
5. Findings	46
5.1 Coastal resilience perspectives at the SH Wadden	46
5.2 Stakeholder perceptions of coastal protection measures	50
5.2.1 Conventional coastal protection measures	50
5.2.2 Nature-based solutions	53
5.2.3 Accommodating Measures	56
5.2.4 Managed retreat.....	57
5.3 Exploring future visions for a resilient Wadden Sea	60

6. Discussion and reflection.....	63
6.1 Shifting Tides: Integrating transition theory and environmental psychology in coastal management	63
6.2 Reflections on research bias and limitations	65
7. Conclusion	67
References	70
Appendix	83
A1: Information sheet for the interview.....	83
A2: Consent form for the interview	84
A3: Interview guide with pictures.....	85
A4: Coding Tree.....	88
A5: Policy Document Analysis	89
Acknowledgement	92

List of Figures

Figure 1: Map of the Wadden Sea. The Schleswig-Holstein Wadden Sea Region is the unit of analysis for this study and indicated with blue line. Source: Heron et al. (2020), p. 6.	11
Figure 2: Paradigm Shifts. Based on: de Roo (2016b), Laeni et al. (2019), Plummer and Baird (2021), Rölfer et al. (2022), Schoeman et al. (2017).	16
Figure 3: A five-step approach for addressing coastal resilience in social-ecological systems by Rölfer et al. (2022). The approach differentiates between three different types of knowledge: 1) systems knowledge (What is?); 2) target knowledge (Where to?); and 3) transformative knowledge (How to get there?).....	19
Figure 4: Flood Resilience Rose by Karrasch et al. (2021). At the centre of the rose is flood resilience, which can be enhanced through an integrated coordination between three different operational levels: 1) the action level (multi-layer safety approach, dark grey); 2) the institutional context (medium grey petals surrounding the level of action); and 3) the wider societal and environmental context (outer, light grey petals).	20
Figure 5: Conventional and non-conventional approaches to coastal planning and management according to the resilience perspective. The triangle in the centre shows the three different resilience perspectives, while the surrounding circles show the operationalization of each resilience perspective (inner rings: response to climate change impacts, see Table 2; outer rings in lighter grey: coastal management approach). The dashed line indicates the differentiation between conventional and non-conventional approaches within this study, evoked by the paradigm shift indicated by the arrow at the bottom.....	23
Figure 6: Coastal Resilience Bloom (CRB), conceptual model of the study. Source: Author.....	35
Figure 7: Flooded marsh-island or "Hallig", from which only the residential mounds stick out. Source: https://www.wwf.de/fileadmin/_processed_/1/7/csm_Landunter-Halligen-im-Wattenmeer-c-M-Stock_20f92c8d74.jpeg [November 2023].	36
Figure 8: Stakeholders relevant for the Schleswig-Holstein Wadden Sea. The symbols represent the interview partners for this study and indicate the different sectors they come from. One person is depicted twice, as this person works both in the agricultural sector as well as on a voluntary basis for a dike association. Source: Author.....	38
Figure 9: Development of the case study database: research phases, data collection method, and the research questions (RQ) investigated in each phase. Source: Author.	40
Figure 10: Overview of the methods used to capture the influencing factors of stakeholder perception. Source: Author.....	41
Figure 11: Steps undertaken to conduct and analyze semi-structured interviews.....	42

Figure 12: Dominant themes in stakeholder perspectives of coastal resilience at the SH Wadden. Source: Author.....	46
Figure 13: Boundaries caused by path dependencies (dike line and differing jurisdictions) which result in differing resilience perspectives. Source: Author.	48
Figure 16: Impressions of the mainland of SH Wadden: old dike lines with roads passing through them, sluice (top left) and dredged channel (bottom right) for inland drainage. Source: Author.....	51
Figure 17: Second dike line or “middle dike” between two polders whereby the older polder lies lower below sea level than the younger one as the older was cut off from sediment input earlier. Source: Author.....	51
Figure 18: Climate Dike with a flat and wide dike crest to improve dike reinforcement in the future. Source: Author.....	52
Figure 19: Fenced off dunes with information sign "Dune protection is coastal protection! No trespassing". Source: Author.....	53
Figure 20: Saltmarshes in summer (left) and winter (right). Source: Author.	54
Figure 21: Sand nourishment on the island of Sylt. Source: Author.....	55
Figure 22: Accommodating measures. A house built on stilts (left) in St. Peter-Ording and a dam leading to the Hallig Nordstrandischmoor with its typical terps (right). Source: Author.	56
Figure 23: Sea birds searching for food in the Wadden Sea with groynes and a terp of the Hallig Nordstrandischmoor in the background. Source: Author.	56
Figure 24: Dockkoog Project "Husumer Hallig". Source: WWF (2016), p. 24.	59
Figure 23: A five-step approach for addressing coastal resilience in social-ecological systems through three different knowledge types. Source: Rölfer et al. (2022).....	60
Figure 25: Impressions from the Wadden Sea - a unique and diverse ecosystem. Source: Author.	62
Figure 26: Coastal Resilience Bloom. Source: Author.	67
Figure 27: Living with water, a vision to move towards to? Source: Reise (2016), p. 153.....	69

List of Tables

Table 1: Coastal resilience perspectives. Based on Beatley (2009), Davoudi (2012), Folke (2006), Garmestani et al. (2019), Laeni et al. (2019), Lloyd et al. (2013), Rölfer et al. (2022), Trell et al. (2017), White and O'Hare (2014).....	14
Table 2: Responses to coastal climate change impacts based on a categorization by the IPCC, with slight adjustments to better fit the context of this study. The dashed lines show the division between conventional and non-conventional coastal protection measures. Source of the figures included in the table: Oppenheimer et al. (2019), p. 386.	21
Table 3: Build-up of the conceptual model for this thesis, the "Coastal Resilience Bloom" (CBR).	34
Table 4: Area of expertise of the 14 interviewees and their pseudonyms.....	42
Table 5: Selected policy documents for the analysis.	44
Table 6: Aspects with guiding questions for the policy document analysis based on Cardno (2018), p. 631.	44

Abbreviations

CRB	Coastal Resilience Bloom
EBA	Ecosystem-based approach / adaptation
EEZ	Exclusive Economic Zone
ICZM	Integrated Coastal Zone Management
IPCC	Intergovernmental Panel on Climate Change
LKN	Landesbetrieb für Küstenschutz, Nationalpark und Meeresschutz Schleswig-Holstein <i>(Schleswig-Holstein Agency for Coastal Defence, National Park and Marine Conservation)</i>
MEKUN	Ministerium für Energiewende, Landwirtschaft, Umwelt, Natur und Digitalisierung des Landes Schleswig-Holstein <i>(Schleswig-Holstein Ministry for the Environment)</i>
NbS	Nature-based solutions
SES	Social-ecological system
SH Wadden	Schleswig-Holstein Wadden Sea Region

Abstract

In view of climate change, the Schleswig-Holstein Wadden Sea in Germany is facing the challenges of rising sea levels, more frequent and severe extreme events, and increasingly unsustainable engineering coastal protection measures that limit the system's adaptive capacity. More than ever, there is a need for finding new ways of dealing with the coast to enhance coastal resilience, including nature-based solutions, flood-adapted housing and managed retreat. Insights into stakeholder perceptions are essential for planning practice, as they provide an understanding of the complex spectrum of interests, concerns, and values of different stakeholders in which coastal management practices are embedded. Through a combination of literature research, semi-structured interviews including photo elicitation, regional observations and policy document analysis, this master thesis explores the relevance of non-conventional coastal protection measures, how different stakeholders at the Schleswig-Holstein Wadden Sea perceive such measures and how they envision a resilient coast.

Results reveal a diversity of stakeholder perception, with members of coastal protection authorities tending to favour hard engineering measures for flood protection. Factors such as place attachment and path dependencies do not only influence stakeholder perceptions, but are often in the way of fostering more innovative coastal protection measures. Overcoming these challenges requires open dialogue, strategic visioning, political commitment, integrated management, and the initiation of pioneering projects like the ECOHAL project to demonstrate alternatives to the current path. Such pilot projects and the consensus among stakeholders on the need for mixed, context-specific measures point to an emerging transition towards more diverse and integrated coastal management and planning.

This research provides valuable insights into stakeholder perceptions for coastal managers and planners at the Schleswig-Holstein Wadden Sea, thereby significantly enriching the emerging academic field of ocean perception research and underscoring the importance of including social and cultural dimensions into planning practice. In addition, the study advocates for more integrated management and community involvement to develop shared visions for a resilient coast, thereby overcoming the ambiguity of the concept of resilience.

Key words: *Schleswig-Holstein, Wadden Sea, coastal resilience, coastal protection measures, stakeholder perception, managed retreat, nature-based solutions, path dependency, place attachment.*

1. Introduction

Coastal systems worldwide are under pressure. Overexploitation of resources, pollution, and climate change are affecting these highly productive and dynamic systems, leading to a loss of biodiversity and an overall degradation of ecosystems with drastic impacts on human livelihoods and well-being (Beatley, 2009; Steven et al., 2020). In particular, the effects of climate change, ranging from sea level rise, ocean acidification and rising water temperatures to the increasing frequency and severity of extreme events, pose major challenges for both coastal ecosystems and coastal communities (Portner et al., 2022).

Located between land and sea, coastal areas have been strongly shaped and altered by humans over the course of centuries (Ratter & Walsh, 2019). It is the age of the Anthropocene, in which coastal biomes are so heavily modified by humans that, according to Lazarus (2017), the term "coastal anthrome" seems to be more fitting instead. Today, hard infrastructures that armour the coasts against the water are not only a material manifestation of human influence on the system (Ratter & Walsh, 2019), but also a common occurrence that can be observed even along outstanding coastal systems such as the Wadden Sea. It is the largest contiguous tidal system in the world and stretches in the south-eastern part of the North Sea from Esbjerg in Denmark over Germany to Den Helder in the Netherlands (Heron et al., 2020; Kock, 2015). Due to its size and its outstanding universal value in terms of its dynamic biological and geological processes, it was declared a UNESCO World Heritage Site in 2009.

Climate change will have a major impact on the Wadden Sea in the coming decades and centuries and could not only affect species diversity and distribution, but also transform the entire tidal ecosystem into a lagoon-like system (Becherer et al., 2018; Heron et al., 2020). In the past, tidal flat systems have been able to migrate landward or accumulate sediment vertically to counteract sea level rise (Torio & Chmura, 2013). However, nowadays, accelerated sea level rise combined with coastal protection measures that impede the system's dynamics, threaten the resilience of the Wadden Sea (Hofstede, 2019; Oost et al., 2017; Osswald et al., 2019; Torio & Chmura, 2013). For example, shoreline armoring of the mainland coast can block the landward migration of tidal wetlands, a phenomenon referred to as "coastal squeeze", as the ecosystem becomes trapped between a rising sea level on one side and a hard dike line on the other (Hofstede, 2019; Torio & Chmura, 2013).

In his book "Changing course coast. What to do when the North Sea rises?", Reise (2016) questions the approach of coastal protection on the German North Sea or Wadden Sea coast, which relies on hard coastal protection measures. Instead, he argues for a softer and more integrated approach that takes into account the tightly interwoven ecological and social dimensions of coastal systems (Reise, 2016).

For example, the tidal flats function as wave attenuators and therefore significantly contribute to the protection of the mainland during storm surges (Hofstede & Stock, 2018). The shift postulated by Reise (2016) from an engineering to a more social-ecological perspective is referred to as a “resilience turn” in academia. For flood risk management or coastal protection, this means a shift from a risk-based approach of "fighting the water" to a resilience-based approach of "living with the water," accepting that flooding is inevitable and provides an opportunity to learn from (McClymont et al., 2020; Restemeyer et al., 2017).

The term *resilience* has been trending in both academia and policy over the past decades and can be defined in a number of ways (Davoudi, 2012; Trell et al., 2017). This can lead to confusion and impede its operationalization and assessment (Davoudi, 2012; White & O'Hare, 2014). Creating a shared vision or understanding among stakeholders of what a resilient coast should look like is therefore crucial (Dobie et al., 2022; Rölfer et al., 2022). Furthermore, Townend et al. (2022) note that the shift toward more resilience-based coastal management requires not only a clear commitment from the government, but also explicit consideration of the perspectives and values of various stakeholders (p. 1). *This master thesis contributes to these studies by exploring stakeholders' views on coastal resilience at the Wadden Sea coast, the arguments underpinning these perceptions, and what this might mean for moving towards coastal resilience in practice.*

According to Bennett (2016), perceptions can be defined as “[...] the way an individual observes, understands, interprets, and evaluates a referent object, action, experience, individual, policy, or outcome” (p. 4). Perceptions can be influenced by a variety of factors (Bennett, 2016) and are highly place-dependent (Döring et al., 2022; Ratter & Leyshon, 2021). This study therefore zooms in on a specific place, the *Schleswig-Holstein Wadden Sea Region* (hereafter *SH Wadden*). The SH Wadden belongs to the German part of the Wadden Sea and is bordered to the north by Denmark and to the south by the Elbe estuary (Figure 1).



Figure 1: Map of the Wadden Sea. The Schleswig-Holstein Wadden Sea Region is the unit of analysis for this study and indicated with blue line. Source: Heron et al. (2020), p. 6.

The history of the SH Wadden is marked by a battle between coastal settlers and the North Sea, characterized by alternating phases of storm surges with land loss and land reclamation processes (Bantelmann, 1939; Lotze et al., 2005; Schmidtke & Lammers, 1993). It is a story that portrays the struggle between human desire for stability and the dynamics of nature, which eventually led to the formation of a hard boundary of dikes and embankments between the land and the sea, between nature and culture (Liburd & Walsh, 2022). However, such hard technical coastal protection measures are reaching their limits: on the one hand, they influence the natural dynamics of the ecosystem, negatively impacting its resilience, and on the other, they lead to constantly rising maintenance and new construction costs (Beatley, 2009; Garmestani et al., 2019; Oost et al., 2017). Innovative measures are needed that go beyond purely engineering-based approaches in order to counter the increase in flooding and coastal erosion caused by climate change. Such measures, which focus on the resilience of the coastal system as a whole and take into account both ecological and social aspects and their inextricable interdependence, are referred to in this study as *non-conventional coastal protection measures*.

Stakeholder perceptions of such non-conventional coastal protection measures can both facilitate and hinder their implementation, which makes understanding the perceptions highly relevant for coastal

management and planning practice. *This study therefore aims to explore how different stakeholders at the SH Wadden perceive non-conventional coastal protection measures zooming in on nature-based solutions, managed retreat, and accommodating measures such as flood-adapted construction.* The thesis thereby contributes to ocean perception research, which is an emerging academic field in marine and coastal research that recognizes the significance of including the social dimension, perceptions, in both marine and coastal management and planning (Jefferson et al., 2021; Lotze et al., 2018). At the core of the research are questions about how people understand, evaluate or deal with an environment, an issue, or a management measure (Jefferson et al., 2021, p. 1). It thereby accounts for a diverse, heterogenous world and can provide valuable information with regard to the design, implementation and evaluation of management measures (Jefferson et al., 2021; Lotze et al., 2018).

In order to contribute to the above aims, this thesis poses the following primary research question:

What is the relevance of including non-conventional coastal protection measures in coastal management for coastal resilience at the Schleswig-Holstein Wadden Sea and how are these measures perceived by different stakeholders?

To answer the primary research question, five secondary research questions (RQ) were formulated:

RQ 1: What is coastal resilience and why is it relevant to include non-conventional coastal protection measures to become resilient?

RQ 2: Why is the perception of key stakeholders relevant for coastal management and what factors influence stakeholder perception?

RQ 3: (How) Does the perspective of coastal resilience differ between stakeholders at the SH Wadden?

RQ 4: Does the perception of (non-conventional) coastal protection measures differ between stakeholders at the SH Wadden and how do stakeholders experience those measures and their resilience potential?

RQ 5: What do stakeholders see as desirable for coastal management and planning at the SH Wadden?

Beginning with a look at the relevant literature to establish the theoretical basis of this study (Chapter 2), the study continues with a more detailed description of the case, paying particular attention to its history and the relevant interest groups (Chapter 3). A variety of methods were used to answer the above research questions, ranging from literature research, semi-structured interviews and observations to the analysis of policy documents, which are explained in more detail in Chapter 4. The results are presented in chapter 5 and discussed in chapter 6. The thesis concludes with an answer to the primary research question and recommendations for future research in Chapter 7.

2. Theoretical framework

In the following section, the key concepts of this study - coastal resilience, coastal protection measures, stakeholder perceptions - are explored by reviewing relevant academic literature in order to establish the theoretical basis and develop a conceptual model for this study.

2.1 Coastal resilience

Coastal resilience is an extremely ambiguous concept, which not only makes it difficult to operationalize, but also leads to varying implementation outcomes (Dobie et al., 2022; Folke, 2006; White & O'Hare, 2014). The following sections therefore aim to shed light on the concept of coastal resilience and the broader context in which it is embedded.

2.1.1 *Coastal resilience perspectives*

Resilience has many facets: it can be a rate, a property, or a process (Allen et al., 2019); it can be a normative concept for managing risk (White & O'Hare, 2014), an approach for dealing with uncertainty (Karrasch et al., 2021), or a new way of thinking in coastal planning (Beatley, 2009). In essence, resilience is about remaining functional while dealing with disturbances (McClymont et al., 2020). These disturbances can be expected or surprising, gradual or immediate, fast or slow, external or internal (Folke, 2006; Masselink & Lazarus, 2019). While sea level rise might be expected, gradual, and slow, the magnitude and impact of a storm surge can be surprising, immediate, and rapid.

Originating from mechanics, the term resilience has broadened across disciplines (Alexander, 2013), becoming a cross-cutting, multidisciplinary, and socially constructed concept widely discussed in academia (see e.g., Davoudi, 2012; Folke, 2006, 2016; McClymont et al., 2020; Trell et al., 2017) and trending in policy (White & O'Hare, 2014). Trell et al. (2017) caution that “[t]he term ‘resilience’ therefore runs the risk of becoming a heavily contested buzzword.” (p. 7). Allen et al. (2019) speak of an attractive simplicity of the term on the one hand and a rich underlying complexity that puts key aspects up for discussion on the other (p. 1). This ambiguity not only renders the operationalization of the concept difficult (Garmestani et al., 2019; Rölfer et al., 2022), but can also result in different planning approaches and outcomes when ‘applying’ resilience (Dobie et al., 2022; Folke, 2006; Laeni et al., 2019; White & O'Hare, 2014). Clarifying the concept's various meanings is therefore key to enabling and enhancing (coastal) resilience (Flood & Schechtman, 2014; Garmestani et al., 2019; Rölfer et al., 2022; White & O'Hare, 2014). There are three dominant perspectives of resilience: engineering resilience, ecological resilience, and social-ecological resilience.

In order to develop a better understanding of coastal resilience for this thesis, the three resilience perspectives with their key characteristics are presented in Table 1 below.

Table 1: Coastal resilience perspectives. Based on Beatley (2009), Davoudi (2012), Folke (2006), Garmestani et al. (2019), Laeni et al. (2019), Lloyd et al. (2013), Rölfer et al. (2022), Trell et al. (2017), White and O'Hare (2014).

	Equilibrist perspectives			Evolutionary perspective
	Engineering resilience (1960/70s)	Ecological resilience (1980s)		Social-ecological resilience (1990s / 2000s)
Visualisation				
Focus on	Constancy and efficiency of single stable state (equilibrium). Recovery time after a disturbance; Resistance to shocks.	Robustness and persistence of current stable state by withstanding shock and preserving key structural and functional aspects of the current state to prevent shift to another state.		Sustaining, adapting, and transforming in the face of external and internal, immediate and gradual disturbances. Emphasis on proactive, long-term adaptation.
System characteristics	Single steady state; linear; predictable.	Multiple stable states; unpredictable surprises; tipping points.		Social-ecological system; cross-scale interactions; non-linear; unpredictable; continuous change; dynamic.
Planning approach	Techno-rational; top-down; reactive; command-and-control strategies.	Favoring ecosystem-based and adaptive over purely engineering approaches.		Communicative-rational; collaborative; adaptive; integrated; process-oriented; proactive; holistic.
Case study: Wadden Sea	Resist disturbances by maintaining the dike line in its current state to protect people and material assets. Recovery to original state after shocks such as storm surges.	Maintaining the structure and function of the current stable state of a tidal flat system by withstanding the perturbations caused by climate change. Prevent the transition toward a lagoon-like system state.		Evolve and adapt to climate change through flexible and adaptive measures using windows of opportunity for transformation; focus on resilience of coastal communities, the ecosystem, and their interconnections.

While the engineering perspective focuses on maintaining a stable state, a status quo, the ecological perspective recognizes the existence of multiple equilibria, but aims to prevent the system from shifting to another equilibrium by preserving the main functions and structures of the current system (Davoudi, 2012; Folke, 2006; Holling, 1996). In contrast to these two so-called equilibrist perspectives of resilience, the evolutionary or social-ecological perspective relinquishes the notion of equilibria by asserting that systems are constantly evolving, adapting and transforming (Davoudi, 2012; Folke, 2006, 2016; White & O'Hare, 2014). The objective is to move toward more desirable states for both people and nature that are better suited for dealing with complexity, constant change, and inherent uncertainty (Rölfer et al., 2022; White & O'Hare, 2014). In this context, Folke (2016) points out that “[d]etermining when resilience is on a desirable or undesirable path, and for whom, is an inherently value-laden, subjective and political question, a question that, if sustainability is in focus, needs to be connected to human wellbeing as part of the biosphere” (p. 6). It is the recognition - that social and ecological systems are inextricably intertwined and constantly influence each other - that is at the core of the social-ecological perspective. The social system is seen as embedded in the biosphere, building the base on which society depends (Berkes et al., 2008; Folke, 2016). These so-called *social-ecological systems (SES)* are *complex adaptive systems* (Berkes et al., 2008), as they are nested within other systems operating on different levels and influencing each other (Folke, 2006) and constantly deal with change by undergoing alternating phases of system establishment, conversion, breakdown and renewal (also known as the “adaptive cycle” by Holling and Gunderson (2002)). Conventional planning and management approaches largely ignore the phases of breakdown and renewal, emphasizing instead the establishment, reinforcement and maintenance of system structures and functions (Folke, 2006). This can be a danger, for it means that systems become more rigid and less adaptive to change, potentially resulting in a social-ecological rigidity trap characterized by self-reinforcing and inflexible institutions (Carpenter & Brock, 2008).

Given that the SH Wadden is a dynamic SES and faces increasing complexity and uncertainty in the face of climate change, this study applies the *socio-ecological resilience perspective*, which is characterized by adaptive, integrated, holistic and collaborative management approaches (Beatley, 2009; Flood & Schechtman, 2014; Lloyd et al., 2013). *Coastal resilience then is the ability of coastal communities and ecosystems to adapt or transform in response to external and internal perturbations without compromising future adaptive capacities* (Berkes et al., 2008; Folke, 2016). This approach potentially ensures a comprehensive strategy for the Wadden Sea's long-term adaptation to climate change, recognizing the intertwined fate of its ecological health and the well-being of surrounding communities.

This shift away from engineering approaches towards more communicative, integrated and adaptive approaches can be found not only in relation to the resilience perspective, but also in the overarching *paradigm shifts* in planning theory and water management (see Figure 2). It is a shift from viewing the world as predictable and stable to recognizing its unpredictability and complexity (de Roo, 2016b). Rockström et al. (2014) note that there is “[...] increasing scientific evidence for a rapidly changing global water resources agenda, shifting from a general focus on water-resource efficiency under assumptions of stability and predictability, to a focus on water resilience in a world of instability and surprise” (p. 1255). This development is referred to as the *resilience turn* (Evans & Reid, 2014; Shaw, 2012; Trell et al., 2017). White and O'Hare (2014), view this shift towards an evolutionary resilience perspective primarily in science, but question its implementation in practice. Other researchers indeed found that the engineering perspective in flood risk or coastal management practice often prevails (Masselink & Lazarus, 2019; Restemeyer, 2018). *One aim of this study is therefore to find out whether the stakeholders at the SH Wadden adopt a more socio-ecological resilience perspective in view of the dynamic and complex challenges posed by climate change or whether the engineering perspective prevails and what this would then mean for coastal management practice.*

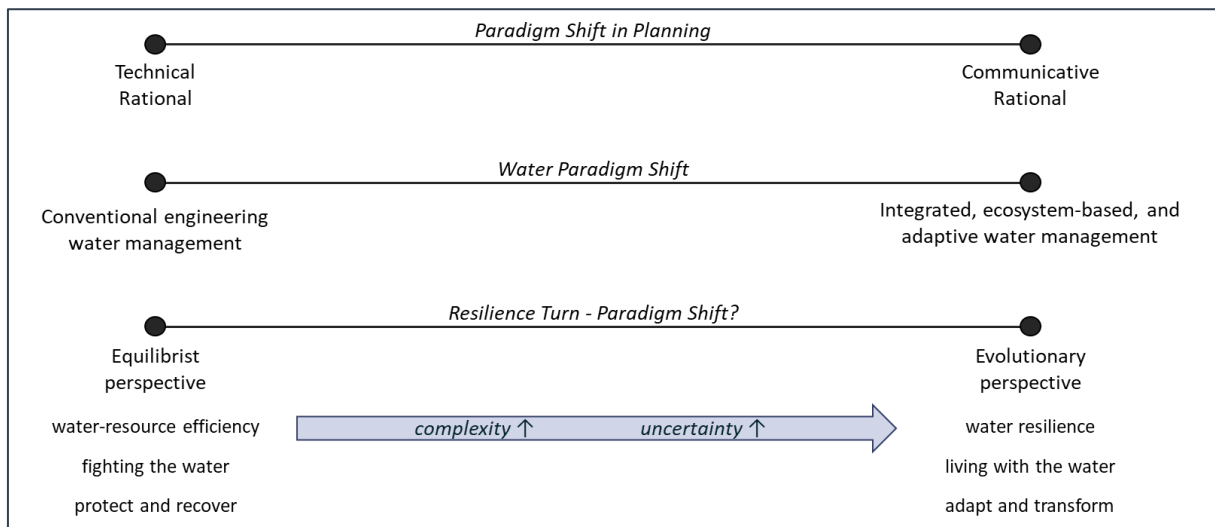


Figure 2: Paradigm Shifts. Based on: de Roo (2016b), Laeni et al. (2019), Plummer and Baird (2021), Rölfer et al. (2022), Schoeman et al. (2017).

2.1.2 Challenges and drivers for coastal resilience

Challenges for coastal resilience

The resilience of one system can reduce the resilience of another system, a short-term increase in resilience can decrease it in the long term, an increase in resilience at the local level can decrease it at the global level, and vice versa (Beatley, 2009; Carpenter et al., 2001). Examples include river management practices that protect upstream areas but increase flood risks downstream, and coastal defences that may compromise ecosystem resilience. It is therefore essential not only to develop a thorough understanding of the three resilience perspectives, but to also clarify resilience of what, for

what and to what, taking into account the spatial and temporal scales of the system in question (Beatley, 2009; Carpenter et al., 2001; Flood & Schechtman, 2014).

Even with a clear definition of coastal resilience using the social-ecological perspective, many questions remain regarding its operationalization. Most of them revolve around the question of what can be considered a desirable state to evolve towards (Folke, 2016; Rölfer et al., 2022). The answer to this question is highly subjective, open to social, political, and cultural construction, and leads to a variety of tensions and trade-offs that planners and policy-makers need to navigate (Allen et al., 2019; Folke, 2016; White & O'Hare, 2014). There are tensions between achieving resilience of built (i.e., coastal settlements) and natural environments (i.e., ecosystems) (Dobie et al., 2022; Masselink & Lazarus, 2019), the desire for stabilization on the one hand and transformation on the other (Rölfer et al., 2022), and between economic interests of private property and the broader public, socio-cultural interest (Beatley, 2009; Norton, 2022). There will always be winners and losers when planning and managing for coastal resilience (White & O'Hare, 2014). For example, Dobie et al. (2022) point out that social equity and equality, the unequal distribution of resources and thus of resilience, are often omitted from the debate about coastal resilience (p. 1373). It is not uncommon for the most vulnerable communities to also live in the most flood-prone areas (Laeni et al., 2019). Moreover, Beatley (2009) emphasizes that building the resilience of coastal communities through hard structural measures often comes at a high cost for the environment (p. 7).

In addition, the multitude of actors with their different, often competing interests with sometimes mutually exclusive uses (e.g., offshore wind and shipping) (Rölfer et al., 2022; Steven et al., 2020), as well as the division between terrestrial and marine management, make it difficult to plan for coastal resilience (Rölfer et al., 2022). Limited resources must be allocated for competing priorities (Beatley, 2009). Furthermore, potential disasters connected to sea level rise are often given little priority because other local concerns are seen as more pressing (ibid.). Short-term decision-making frames combined with limited willingness to address large-scale and elusive future issues such as climate change pose further obstacles to coastal resilience (ibid.). It is difficult to respond to slow, continuous changes because they are either overlooked or there is a sense of lack of capability to deal with them (Walker et al., 2012). Related to this are “non-computable unknowns” described by Carpenter et al. (2009). Meant by this is the fact that some system properties or behaviours (i.e., unforeseen extreme events and their consequences) are completely unpredictable due to a variety of interacting factors or unknown unknowns (unknowns that we do not know exist) which cannot be captured by quantitative models (ibid.). Nevertheless, there is a clear tendency to rely on model results, thus emphasizing the quantitative aspects of a problem rather than its inherent uncertainties (ibid.). This techno-rational

approach may reduce coastal resilience by preventing preparation for these non-computable unknowns, such as through adaptive and flexible measures.

Last but not least, White and O'Hare (2014) question whether planners have the power to change prevailing engineering approaches not only in spatial planning, but also the associated institutions that might stand in the way of this change (p. 942). Institutions are “the rules of the game” and can be both formal, like laws and regulations, as well as informal, such as social norms and values (Beunen & Patterson, 2019). In line with White and O'Hare's (2014) reflections on the power of planners and institutions, Porter and Davoudi (2012) warn against depoliticizing the concept of resilience, as it is a highly power-laden, socially constructed, and politicized concept (p. 332 f.). White and O'Hare (2014) conclude that “the desirable political imperative to appear to pursue evolutionary resilience may conflict with existing governance tools that underpin techno-rational rather than sociocultural approaches, significantly diluting the impact of a potentially powerful agenda” (p. 942).

Due to all the challenges mentioned above, the operationalization of coastal resilience is highly context-dependent (McClymont et al., 2020). It is therefore not possible to develop a universal tool for increasing resilience. However, there are some general principles that can enhance social-ecological resilience.

Drivers for coastal resilience

To overcome the ambiguity of the resilience concept, resilience needs to be clearly defined *to provide a common understanding of the concept as a basis for developing a shared vision of the future, a vision of what can be considered a desirable system state to evolve toward* (Beatley, 2009; Dobie et al., 2022). Looking at how coastal resilience is perceived by different stakeholders can contribute to this (Dobie et al., 2022). Rölfer et al. (2022) suggest a five-step approach for enhancing coastal resilience in social-ecological systems, emphasizing three knowledge types (Figure 3): system knowledge (understanding the system's characteristics), target knowledge (envisioning future coastal resilience), and transformative knowledge (how to achieve this vision). The process involves two feedback loops connecting these knowledge types and encourages stakeholder participation, particularly from local actors, to merge diverse insights and bridge the gap between science and society. This co-produced knowledge aims to clarify and agree on resilience strategies tailored to local contexts, addressing the ambiguity of resilience concepts and fostering stronger coastal resilience.

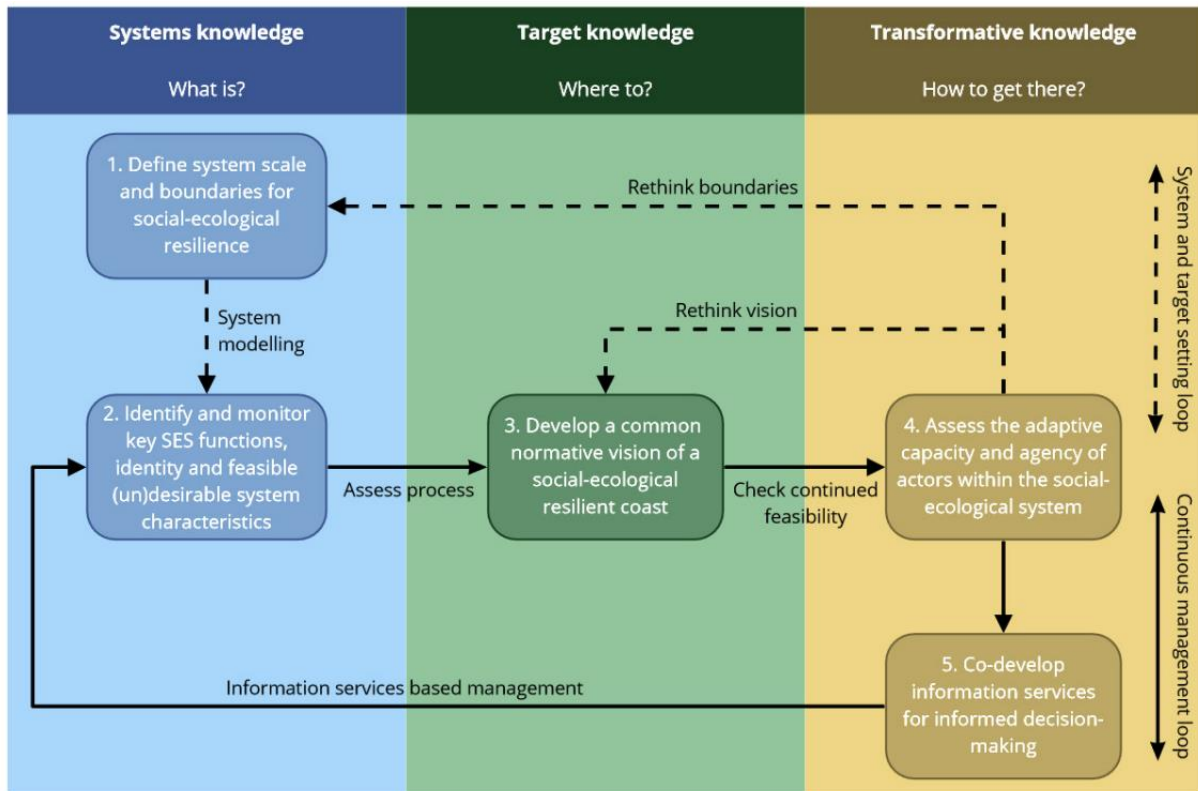


Figure 3: A five-step approach for addressing coastal resilience in social-ecological systems by Rölfer et al. (2022). The approach differentiates between three different types of knowledge: 1) systems knowledge (What is?); 2) target knowledge (Where to?); and 3) transformative knowledge (How to get there?).

To create a desirable future, it is crucial to address existing tensions through collaborative efforts that prioritize social justice and holistic management, linking social and ecological, terrestrial and marine systems (Beatley, 2009; Norton, 2022). Integrated Coastal Zone Management (ICZM) embodies this approach by advocating for sustainable, equitable, and culturally sensitive coastal zone management, focusing on stakeholder engagement and multidisciplinary integration (2002/413/EC, 2002; European Environment Agency [EEA], 2000) (Burke et al., 2020; EEA, 2000).

Both Berkes et al. (2008) and Biggs et al. (2012) describe features or principles of resilience building. Enhancing resilience, then, is about fostering diversity, incorporating different types of knowledge (e.g., local, traditional, and scientific), being prepared for change, and emphasizing (social) learning (Berkes et al., 2008; Biggs et al., 2012). The authors further agree that the level of governance should be tailored to the size of the ecosystem or problem. In this context, there is a need to increase the willingness and capacity or ability at the local level to both build resilience (Norton, 2022; Refulio-Coronado et al., 2021; Steven et al., 2020) and ensure effective environmental governance (see Zuidema, 2016). Furthermore, it is a matter of the capacity to implement not only short-term but, above all, long-term adaptation measures and strategies (Refulio-Coronado et al., 2021; Restemeyer et al., 2017). Adaptive and flexible management strategies with a proactive, long-term, and process-oriented focus are a key driver of resilience, as they enable adjustment to disturbances and leave

opportunities open for future change (Fünfgeld & McEvoy, 2012; Masselink & Lazarus, 2019; Walker et al., 2012). Adaptive management also involves preparing for surprises or “noncomputable unknowns”. This requires recognizing the limitations of models and humans in predicting and forecasting system behaviour (Carpenter et al., 2001; Fünfgeld & McEvoy, 2012). According to Carpenter et al. (2009), transparency about such limitations, as well as interdisciplinary teams with a broad range of different perspectives, can help achieve this.

To increase coastal resilience, efforts should focus on maintaining and restoring ecosystems essential to communities (Beatley, 2009; Steven et al., 2020), implementing innovative coastal protection strategies while incorporating both local and scientific knowledge (Steven et al., 2020), researching coastal dynamics (Norton, 2022), and promoting continuous social learning (McClymont et al., 2020). Furthermore, education and collaborative approaches can be used to make coastal risk and coastal resilience more tangible and present in coastal communities thereby increasing the willingness and commitment to adaptation and change (Beatley, 2009). Last but not least, because (coastal) resilience and its operationalization are highly context-dependent, it requires culturally sensitive and place-based planning approaches (Norton, 2022).

Recognizing the need for more holistic management tools for improving flood resilience, Karrasch et al. (2021) developed the Flood Resilience Rose, a comprehensive approach to reduce flood risk by considering a variety of factors through the integration of three different operational levels (see Figure 4). As will be seen, the relevance of the social context and the interdependence of different levels, as demonstrated by Karrasch et al. (2021), was taken up in the conceptual model for this study.

In summary, despite some challenges, there are also drivers for enhancing coastal resilience that revolve primarily around overcoming the ambiguity of the concept as well as the prevailing technical-rational approaches.

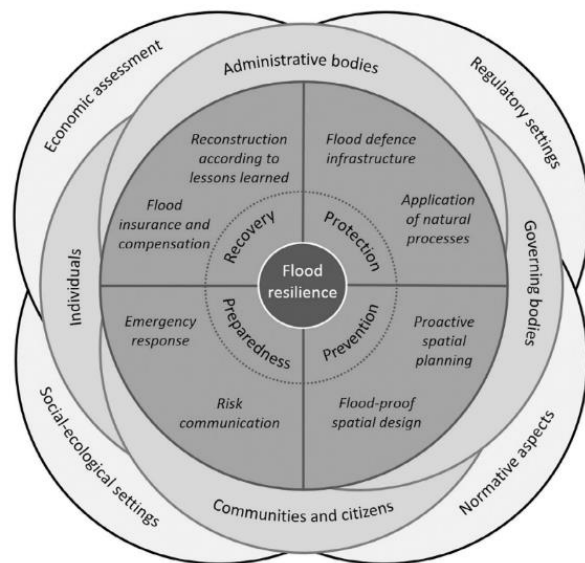


Figure 4: Flood Resilience Rose by Karrasch et al. (2021). At the centre of the rose is flood resilience, which can be enhanced through an integrated coordination between three different operational levels: 1) the action level (multi-layer safety approach, dark grey); 2) the institutional context (medium grey petals surrounding the level of action); and 3) the wider societal and environmental context (outer, light grey petals).




2.2 Towards non-conventional coastal protection measures

A variety of coastal protection measures exist ranging from dikes, revetments, and beach nourishments to saltmarsh restoration, elevated housing structures, and early flood warning systems. The following chapter looks at different types of coastal protection measures and how they are used to operationalize coastal resilience depending on the respective resilience perspective.

2.2.1 Operationalizing coastal resilience through different coastal protection measures

The contrasting perspectives on coastal resilience are reflected in their different operationalization through coastal protection measures (see Garmestani et al., 2019; Laeni et al., 2019; Rölfer et al., 2022). The IPCC (Oppenheimer et al., 2019) differentiates between five responses to sea level rise and flooding, based on which different coastal protection measures are grouped in this thesis to distinguish between conventional and non-conventional coastal protection measures (see Table 2).

Table 2: Responses to coastal climate change impacts based on a categorization by the IPCC, with slight adjustments to better fit the context of this study. The dashed lines show the division between conventional and non-conventional coastal protection measures. Source of the figures included in the table: Oppenheimer et al. (2019), p. 386.

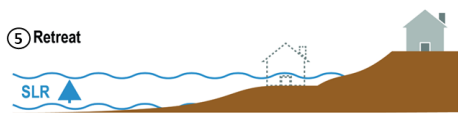
Reaction to climate change impacts	Explanation and related coastal protection measures
----- conventional measures -----	
<p>① Advance</p> 	<p>Creation of new land by advancing on the seaward side, such as land reclamation through polderization.</p>
<p>② Protection</p> 	<p>Protection of people and material assets, the built environment, through:</p> <ul style="list-style-type: none"> i) <i>hard engineering or hard structural protection measures</i> such as dikes, groynes, or revetments; ii) <i>soft engineering measures</i> such as sand nourishment, planting of marram grass for dune stabilization, or sand trap fences to improve the dune profile;
----- non-conventional measures -----	
<p>③ Ecosystem-based adaptation</p> 	<p>iii) <i>hybrid measures</i>, a combination of the above measures and ecosystem-based adaptation, such as combining a dike with a salt marsh.</p> <p>Ecosystem-based adaptation is an umbrella term for approaches like Building with Nature (BwN), Nature-based Solutions (NbS), green infrastructure, natural and nature-based features (NNBF), or eco-engineering. These approaches focus on using or mimicking natural processes and elements to maintain and enhance underlying ecosystem services while protecting the built</p>

environment by attenuating storm surges, raising seaward land through sediment trapping, and reducing coastal erosion.

Examples: Conservation and restoration of tidal wetlands (e.g., saltmarshes) and coastal reefs (e.g., oyster reefs), or mega-nourishment for gradual and more environmentally friendly sand distribution through natural processes.



Preparing for and adapting to climate change impacts in coastal areas through *biophysical measures* such as elevated housing (e.g., dwelling mounds) or flood shelters, as well as *institutional measures* such as building codes, insurance, or early flood warning systems.



The abandonment and retreat of flood-prone areas, referred to as managed retreat or managed realignment, when initiated and guided by the government.

Advance (e.g., land reclamation) and protection (e.g., dikes) measures have been practiced in the Wadden Sea region for centuries against flooding (Bazelmans et al., 2012; Knottnerus, 2005; Lotze et al., 2005), with hard and soft engineering measures (e.g., dikes, revetments, groynes, sand nourishment) being the dominant coastal protection measures on the Schleswig-Holstein Wadden Sea coast (see LKN.SH, 2022). Therefore, these measures are defined as conventional coastal protection measures in this study. Due to the paradigm shift in water management, the other three responses to coastal risks (Table 2), namely ecosystem-based adaptation, accommodation, and managed retreat, are increasingly being incorporated or at least considered in coastal management and planning on the Wadden Sea (see e.g., Deicke, 2018; Hofstede, 2019; Jordan et al., 2023). Since these are comparatively newer approaches that also go beyond purely engineering measures (e.g., ecosystem-based adaptation) as well as the built environment (e.g., institutional accommodating measures like early flood warning systems) by incorporating environmental and social aspects, they are referred to as *non-conventional measures* in this study. The focus is on the resilience of the coastal system as a whole, taking into account both ecological and social aspects and their inextricable interconnectedness.

Conventional coastal protection measures aim to maintain or, if necessary, return to a given steady state. Examples include dike maintenance to preserve the current dike line, or sand nourishment to compensate for coastal erosion and return to pre-flood conditions. Conventional coastal management approaches also assume that the natural system and its hazards are predictable and controllable (e.g., calculated dike heights). Conventional measures therefore correspond to the engineering perspective of coastal resilience (Fünfgeld & McEvoy, 2012; see Garmestani et al., 2019; Laeni et al., 2019) (Figure 5).

Hybrid measures can be seen as symbolizing the transition between an engineering and an ecological resilience perspective, as they consider ecological aspects of coastal protection measures as opposed to purely engineering measures. They often represent the blurred line between ecosystem-based adaptation measures, i.e. green or natural infrastructure, and purely technical measures, i.e. grey or built infrastructure, as they are a combination of the two (Singhvi et al., 2022; Sutton-Grier et al., 2015). Ecosystem-based approaches to coastal management emphasize the preservation and restoration of underlying ecosystem services to be able to withstand shocks. Such ecosystem-based adaptation measures or Nature-based Solutions (NbS) of conservation and restoration thus represent an ecological perspective of coastal resilience (Garmestani et al., 2019), as illustrated in Figure 5.

While ecosystem-based adaptation is primarily concerned with ecological aspects of coastal protection, accommodating measures and managed retreat tend to emphasize more social aspects of dealing with coastal hazards. For this reason, all of these measures combined can be considered as expressions of the social-ecological perspective of coastal resilience, a more holistic approach to climate adaptation (see Fünfgeld & McEvoy, 2012; Laeni et al., 2019; Rölfer et al., 2022).

In summary, Figure 5 illustrates the operationalization of coastal resilience in terms of the coastal management approach and associated measures as a function of the resilience perspective. It also shows the differentiation between conventional and non-conventional coastal resilience measures and approaches.

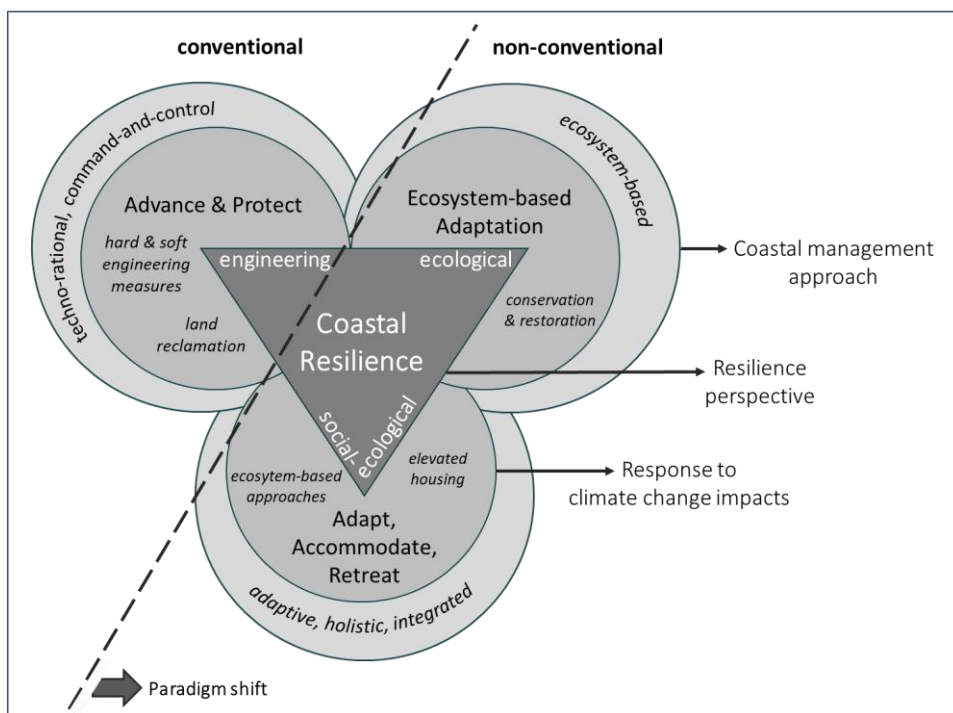


Figure 5: Conventional and non-conventional approaches to coastal planning and management according to the resilience perspective. The triangle in the centre shows the three different resilience perspectives, while the surrounding circles show the operationalization of each resilience perspective (inner rings: response to climate change impacts, see Table 2; outer rings in lighter grey: coastal management approach). The dashed line indicates the differentiation between conventional and non-conventional approaches within this study, evoked by the paradigm shift indicated by the arrow at the bottom.

2.2.2 *Relevance of non-conventional coastal protection measures*

Much of the relevance of incorporating nonconventional coastal protection measures into coastal management and planning stems from two factors: 1) the failure of conventional measures in the face of climate change; and 2) the potential of non-conventional measures to enhance coastal resilience by overcoming the shortcomings of conventional measures. Both factors will be explained in more detail in the following.

The researchers van Slobbe et al. (2013) write that, “[t]raditional engineering approaches optimizing for safety are often suboptimal with respect to other functions and are neither resilient nor sustainable.” (p. 947). Indeed, conventional or traditional engineering measures for coastal protection seem to be failing in times of increasing complexity and uncertainty caused by climate change. For example, conventional measures cannot adapt to gradual change like sea level rise and will weaken over time (Sutton-Grier et al., 2015), resulting in ever-increasing maintenance costs, e.g., for dike raising and widening or continuous sand nourishment (Temmerman et al., 2013). In addition, conventional coastal protection measures often have a negative impact on the environment (Beatley, 2009). Their construction can, for example, lead to the loss of coastal habitats (Sutton-Grier et al., 2015), can increase land subsidence (Temmerman et al., 2013), or impede the natural sediment accumulation and thus the adaptive capacity of the ecosystem (Temmerman et al., 2013). Conventional measures are therefore becoming more and more unsustainable from both an economic and an environmental perspective (Morris et al., 2018). Last but not least, levees in particular can provide a false sense of security (Montz & Tobin, 2008), contributing to an impaired perception of flood risk (Liao, 2014). The so-called escalator effect (Parker, 1995) or levee effect (Tobin, 1995) refers to the phenomenon that hard structural flood protection measures such as dikes or levees trigger increased development in the respective flood-prone areas, thus increasing the potential damage in the event of a flood (see e.g., Ding et al., 2023). This underscores the need to incorporate other measures that increase the perception of flood risk. Accommodating measures (see Table 2) can be a solution to this, either by keeping development away from flood-prone areas through non-structural and institutional measures such as building codes, or by making the risk more tangible through biophysical measures such as elevated housing. The latter has proven to be additionally beneficial on the Halligen of the SH Wadden with regards to the adaptive capacity and thus resilience of the underlying ecosystem. Due to the residential dwelling mounds, these marsh islands can be flooded during storm surges in winter, leading to sediment accumulation and thus natural surface growth, urgently needed in times of sea level rise (Deicke et al., 2009; Karius et al., 2016; Schindler, 2015).

Not only adaptation measures, but also ecosystem-based adaptation measures, also referred to as nature-based solutions, can improve coastal resilience by overcoming the drawbacks of conventional

measures. Folke (2016) points out that “[...] it will become central for human well-being in the urbanized 21st century to create incentives for transformation of human actions toward stewardship of complex adaptive social-ecological systems in ways that are in tune with the resilience of the biosphere.” (p. 13). Ecosystem-based adaptation (EBA) focuses on exactly that, the conservation and restoration of the underlying ecosystem services, the biosphere, to provide benefits for both, people and nature (Albert et al., 2021). By mimicking or utilizing natural processes and elements, these measures can provide significant co-benefits in addition to flood protection, such as biodiversity, water quality improvement, coastal habitat creation, carbon sequestration and storage, as well as recreational use and human well-being (Powell et al., 2019; Singhvi et al., 2022; Sutton-Grier et al., 2015; Terton & Greenwalt, 2020; United Nations World Water Assessment Programme [WWAP], 2018; Zari et al., 2019). While conventional protection measures are only of use during storm surges, nature-based solutions have potential to be beneficial at all times (Sutton-Grier et al., 2015) and in the long term (Albert et al., 2021; Moraes et al., 2022). Furthermore, the more dynamic nature of such measures makes them more flexible and adaptive, especially with regards to climate change (Masselink & Lazarus, 2019; Singhvi et al., 2022; Sutton-Grier et al., 2015). For example, nature-based solutions like saltmarshes can adapt to sea level rise and even self-recover after a storm surge by accumulating sediment (Powell et al., 2019; Sutton-Grier et al., 2015). EBA is therefore often seen as a low-regret strategy, as the measures strengthen the underlying ecosystem without compromising future opportunities for action (Singhvi et al., 2022). This and the multifunctionality of these measures make them not only economically feasible, but often even more cost-effective than conventional engineering approaches (Bassi et al., 2021). Despite the many advantages of nature-based solutions in comparison to conventional measures, the effectiveness of them depends on a variety of different factors (Albert et al., 2021; Saleh & Weinstein, 2016; Sutton-Grier et al., 2015). This makes it more difficult to replicate them; there is no universally applicable solution (Saleh & Weinstein, 2016). Furthermore, these measures often require space, which can be challenging in densely populated areas (Albert et al., 2021; Sutton-Grier et al., 2015). In addition, ecosystem restoration can take time (Sutton-Grier et al., 2015), and cost savings due to co-benefits are rarely included nor adequately accounted for in economic considerations (Bassi et al., 2021). For all these reasons, there is a need for more research and expertise, best practices, and knowledge sharing in the field of EBA (Moraes et al., 2022; Sutton-Grier et al., 2015; Vojinovic, 2020).

Managed retreat has similar ecological advantages like EBA by allowing landward migration of tidal wetlands and thus preserving coastal habitats (Powell et al., 2019). It can also create retention space during floods and reduce the potential for flood damage by directing development away from highly flood-prone areas (ibid.).

Although non-conventional measures have their advantages over conventional measures, they are not applicable or feasible everywhere. Therefore, a mix of conventional and non-conventional measures, often hybrid measures, is needed to improve overall coastal resilience (Oppenheimer et al., 2019; Singhvi et al., 2022; Sutton-Grier et al., 2015). To summarize with the words of Bridges et al. (2015): “An integrated approach to coastal resilience and risk reduction will employ the full array of measures, in combination, to support coastal systems and communities” (p. xvi).

2.3 Stakeholder perception

The previous chapters showed, that the coastal resilience perspective and the measures used for operationalizing coastal resilience are closely interlinked. It is therefore crucial to not only explore the stakeholder perception of non-conventional coastal protection measures, but also the underlying perception or rather perspective of coastal resilience.

The following sections take a closer look at the relevance of stakeholder perception for coastal management and describe different factors that influence these perceptions.

2.3.1 *Relevance of stakeholder perceptions for coastal management*

Stakeholder perceptions are of great relevance for coastal management and planning for three reasons:

First, insight into different stakeholder perceptions enable the identification and integration of intangible, cultural values as well as local knowledge and experience in coastal management and planning. Stakeholder priorities as well as intangible, place-based, cultural values are often overlooked in coastal and marine management (Acott et al., 2023; Döring & Ratter, 2018; Gee et al., 2017; Jordan et al., 2023; de Juan et al., 2017; Walsh & Döring, 2018). There is further a need to integrate different types of knowledge, especially local knowledge, to enhance coastal management practice and coastal resilience (Hemmerling et al., 2022; Restemeyer et al., 2017; Rölfer et al., 2022). Investigating stakeholder perceptions of coastal protection measures and coastal resilience therefore contribute to a more holistic and integrated coastal management (Gray et al., 2014; de Juan et al., 2017) and promotes trust (Hemmerling et al., 2022), which can increase public acceptance (Steg & Groot, 2019) for coastal protection measures. Furthermore, it can inform and facilitate decision-making processes (Gelcich & O'Keeffe, 2016).

Secondly, taking into account the different perceptions of stakeholders help to identify areas of conflict and agreement between stakeholders as well as obstacles to the implementation of measures to increase coastal resilience. SES consist of a multiplicity of perspectives that must be taken into account in order to understand the system as a whole (Berkes et al., 2008). The Wadden Sea is a highly

contested area with a large number of different groups of interests, some of which are mutually exclusive (Walsh & Kannen, 2019). Identifying areas of conflict and agreement can therefore facilitate collaboration in coastal management and planning processes. A related approach to this is the mutual gains approach, which aims to identify common interests and shared objectives between stakeholders in order to resolve conflicts and facilitate negotiations by focusing on finding win-win situations (Susskind & Landry, 1991). Finding shared objectives can help to overcome inter-group conflicts (Mason et al., 2015), which could otherwise pose an obstacle to the implementation of certain coastal protection measures. As stakeholders can both enable and hinder adaptation (Hoerterer et al., 2020), stakeholder perceptions can be used to assess the effectiveness and acceptance of current measures and to predict likely responses to new measures (Gelcich & O'Keeffe, 2016). With regard to non-conventional measures, Jordan et al. (2023) emphasize that underlying perceptions form the foundation for any negotiations on coastal protection and the move towards more innovative approaches (p. 25).

Third, assessing and incorporating stakeholder perceptions helps to create a shared understanding of and vision for coastal resilience and to identify what coastal management practices are considered desirable to achieve this vision. Due to the ambiguity of the term resilience, it is essential to establish a common understanding and shared vision for coastal resilience (Dobie et al., 2022; Rölfer et al., 2022), as this has impacts on its operationalization and therefore coastal management and planning. De Roo (2016a) describes how actor consulting, gaining insights into stakeholder perceptions of their desired, actual, and potential contributions to an issue, can reduce fuzziness in complex situations. As described in chapter 2.1, coastal resilience is one such fuzzy and complex issue that could be addressed using actor consulting as a planning tool. Perception research provides a platform to investigate what is seen as desirable and achievable (Gelcich & O'Keeffe, 2016). After all, as McElduff and Ritchie (2018) put it, “Actions, or behaviours, considered to be successful, effective or legitimate in enhancing resilience are dependent on what people perceive as worth achieving and protecting.” (p. 192).

To conclude, identifying and including differing stakeholder perceptions is essential to realize integrated, collaborative, and holistic coastal management and planning. They offer insights into and an understanding of the complex spectrum of interests, concerns and values held by the various stakeholders in which coastal management practices are embedded.

2.3.2 Factors influencing stakeholder perceptions

Risk perception is closely related to stakeholder perceptions of non-conventional coastal protection measures and coastal resilience. As Ratter and Leyshon (2021) point out, “The ways in which individuals, societies, and politics respond to climate change are in many cases contingent on

perceptions of its causes, consequences, and wider implications.” (p. 1). Without perceiving climate change as a risk in need to be managed through innovative and adaptive approaches, non-conventional coastal protection measures become of little relevance for stakeholders. Due to the link between risk perception and resilience, Ratter and Leyshon (2021) investigated the perception of and resilience to coastal climate risks at the Wadden Sea. Döring and Ratter (2018) examined different framings of climate change in North Friesland, while Döring et al. (2022), on the other hand, studied how climate imaginaries or perceptions are anchored in places on the North Frisian Wadden Sea coast. Stakeholder perceptions of coastal resilience and coastal protection are thus influenced indirectly by perceptions of risks such as climate change.

However, there are also factors directly influencing stakeholder perceptions that need to be considered for gaining a deeper understanding and further insight into stakeholder perceptions. The following section discusses five influencing factors that affect stakeholder perceptions of coastal resilience and non-conventional coastal protection measures. These are path dependency, policy framing, social identity, experience, and place attachment.

Path dependencies

Path dependencies describe how actions and events in the past influence decisions and actions in the present and future (Tubridy et al., 2022). This can pose obstacles for new trajectories, resulting in so-called lock-ins when the system becomes too rigid to change and adapt (Restemeyer et al., 2017). Path dependencies influence stakeholder perception of how the coast should be managed by providing a reference point of how the coast was managed in the past. Path dependencies are not only deeply embedded in the minds of the people, but also in institutions, and are often also materialized in the physical environment (Restemeyer et al., 2017; Tubridy et al., 2022). Institutions can be regarded as the reflectance of shared beliefs (Beunen & Patterson, 2019), of a reality that is agreed upon by the society. Tubridy et al. (2022) therefore state that “[...] how the institutionalisation of certain professional perspectives regarding how the coast ‘should’ be managed decreases future possibilities for how the coast ‘could’ be managed.” (p. 10).

With regards to the Wadden Sea area, several path dependencies exist. The centuries-long struggle against flooding in the North Sea has led to the dominance of engineering, vertically integrated and sectoral coastal management on the one hand, and to a separation between land and sea in people's minds, in management practice, and in material terms through a kilometre-long dike line on the other (Tubridy et al., 2022; Walsh, 2018, 2020; Walsh & Kannen, 2019). Hard engineering measures such as dikes are preferred (González-Riancho et al., 2017), having become taken-for-granted and widely accepted components of the landscape (Walsh, 2020). This poses obstacles to more integrated,

collaborative, and innovative coastal management approaches (Jordan et al., 2023; Tubridy et al., 2022).

Framing of coastal resilience

Resilience is a highly political, and power-laden concept (Porter & Davoudi, 2012; White & O'Hare, 2014). The way resilience is framed or presented in policy has a significant impact on its operationalization and enforcement (Chmutina et al., 2016; Wardekker, 2021; White & O'Hare, 2014). What makes the term so popular in both academia and politics is its versatility of interpretation and thus malleability (Shaw, 2012). However, this means that one term can lead to a variety of different policy outcomes (Dobie et al., 2022). For this reason, it is important to look at (coastal) resilience from a framing perspective, as it influences how coastal resilience is perceived and operationalized by different stakeholders.

A framing perspective sheds light on both the way policymakers understand complex issues and the way they use language strategically (van den Brink, 2009), using metaphors (Schön, 1993), specific names (Schön & Rein, 1995), or narratives (van Hulst & Yanow, 2016) to create a particular vision or version of that complex issue (Laeni et al., 2021). Framing effects, i.e., different descriptions of the same issue, can influence people's decision-making and preferences (Steg & Groot, 2019). An example of this is loss aversion, where people tend to prefer something that is presented as avoiding a loss compared to something that is presented as a gain (ibid.).

In policy, resilience is commonly presented as a "[...] singular, vague, but optimistic goal" (White & O'Hare, 2014, p. 934), overlooking its multiple meanings and often failing to provide clear guidance or recommendation on how to operationalize it (Rölfer et al., 2022; White & O'Hare, 2014). When guidance is provided, it focuses on recovery and resistance reflecting an engineering or equilibristic resilience perspective (White & O'Hare, 2014). Framing resilience within an evolutionary or social-ecological perspective makes it more difficult to define, operationalize, or recommend specific actions (ibid.), so the engineering perspective often prevails in practice (Davoudi, 2012; Fünfgeld & McEvoy, 2012; Restemeyer, 2018; White & O'Hare, 2014). Resilience through short-term, reactive actions is easier to define, achieve, and measure than resilience through long-term adaptation and transformation (Davoudi, 2012; White & O'Hare, 2014). The latter might be more desirable because it pursues a broader sociocultural interest, but it could be at odds with prevailing techno-rational planning approaches and institutions, making it politically undesirable (White & O'Hare, 2014). So far, an evolutionary perspective of resilience has been promoted primarily in the context of climate change adaptation strategies (ibid). Resilience is often presented in this context as an aspiration (White & O'Hare, 2014), as a way of dealing with change and uncertainty (Shaw, 2012), indeed as a way of

turning these crises into opportunities (White & O'Hare, 2014). It is thus framed through the strategic use of reassuring language that conveys hope and political confidence in times of adversity (ibid.).

In addition, the abstractness and fuzziness of the concept can lead to unclear responsibilities between government agencies and the community in terms of its implementation in practice (Laeni et al., 2019). Resilience might even be intentionally framed by policymakers in a way that shifts the responsibility for operationalizing it, for "becoming resilient", from government agencies to communities and private actors (Chmutina et al., 2016; Shaw & Maythorne, 2013; White & O'Hare, 2014).

This opaque treatment of the concept of resilience can lead to different stakeholder perceptions of coastal resilience and create confusion (Dobie et al., 2022; White & O'Hare, 2014). Framing in terms of resilience for what or whom further shapes stakeholder perceptions of coastal resilience by providing a point of reference. For example, if resilience is framed in terms of an engineering perspective, environmental and social aspects of coastal protection may be overlooked, reinforcing stakeholder perceptions of a predictable and non-dynamic coastal system with dikes and revetments as the primary mode of coastal protection. This could undermine the perceived need for alternative, non-conventional coastal protection measures. In contrast, if resilience is viewed from a socio-ecological perspective, people may become more committed to resilience and see more rationale for non-conventional measures.

In summary, the way in which resilience is formulated in policy can influence which resilience perspective and associated coastal protection measures are seen as legitimate by stakeholders. This has implications for resource allocation (e.g., depending on the framing of resilience for what and whom), social and ecological considerations, and community engagement (e.g., framing resilience as a task for coastal authorities versus local communities).

Social identity

Drawing from the field of psychology, social identity theory describes how people's attitude and behaviours are shaped by their group memberships (Steg & Groot, 2019). Thus, stakeholder perceptions are shaped by the attitudes, norms, and behaviour of the social group they see themselves as belonging to (Mason et al., 2015). Multiple social identities exist (Mason et al., 2015; Steg & Groot, 2019). Depending on the context, different social identities are made salient (Steg & Groot, 2019) – a person could for example view themselves as a fisher when working on a fishing boat, but as a community member during a town hall meeting. With regards to the Wadden Sea, Siedschlag and Gee (2021) could show for the island of Pellworm, how the shared beliefs and values in relation to seeing oneself as part of the community, influences how islanders perceive their ability to deal and cope with climate change.

As people like to view their social group (in-group) in a more positive light than other groups (out-group), conflicts can arise or increase in situations where differences between groups are of relevance. Other stakeholder groups are often viewed in a negative or stereotypical way, which can hinder cooperation and collaboration processes (Mason et al., 2015). Ever since the establishment of the Schleswig-Holstein Wadden Sea National Park in 1985, there have been conflicts between coastal protection authorities and nature conservation agencies, as the establishment of the national park was seen as an obstacle to coastal protection and economic exploitation (Jordan et al., 2023). These conflicts can still be seen today (ibid.). Identifying shared objectives can help to find common ground between the groups, and to overcoming such conflicts (Mason et al., 2015). The Wadden Sea Strategy 2100 developed in 2015 (further explained in the Policy Document Analysis of this thesis) represents a first step in solving the struggles between nature conservation agencies and coastal protection authorities.

Experience

Stakeholders' perceptions are influenced by experience, as they shape knowledge and understanding of risk (Vanderlinden et al., 2017) both through direct experience (e.g., experiencing a storm surge) and indirectly (e.g., stories of past flooding) (Kettle & Dow, 2016). Experience can therefore provide a frame of reference (Jordan et al., 2023) or a vivid image of a coastal risk giving insight into the assumed coastal resilience. Severe storm surges and floods emphasize the relevance of coastal protection and provide opportunities for learning, which is why they have continuously (re)shaped coastal protection and coastal resilience (Jordan et al., 2023; Ratter & Leyshon, 2021). In their study on ecosystem perceptions in flood-prone areas, Baird et al. (2016) showed that people who had personally experienced flooding tended to favour resilience-based system management over risk-based management, thus favouring an evolutionary over an equilibrist perspective on resilience. Similarly, Harries and Penning-Rowsell (2011) found that people with flood experience were often better prepared for floods than people without experience. Experiencing storm surges can make the intangible challenges of climate change more tangible.

However, a lack of experience can have the opposite effect. Both González-Riancho et al. (2017) and Jordan et al. (2023) were able to show that since the last severe storm surge at the SH Wadden in 1962, individual responsibility for coastal protection and emergency preparedness declined while the role of the coastal authorities moved to the fore. As Jordan et al. (2023) point out, "Hence, the topic of coastal protection is slipping out of the individual and common focus in the context of an increasing security and prosperity achieved by a well-executed coastal defence. A process, that is conceived by some interview partners as being amplified by the increasing institutionalisation of coastal protection and growing social prosperity in recent decades." (p. 18).

Drawing on resilience theory, Folke (2006) emphasized the role of memory, meaning "the accumulated experience and history of the system" (p. 259), in the renewal of the system after a disturbance. Consequently, personal and collective experiences play a major role in how stakeholders perceive coastal resilience and associated coastal protection measures. Decades of positive experience with dikes often lead to scepticism and doubts about non-conventional, innovative measures and can hinder their implementation (Jordan et al., 2023). In the case of non-conventional coastal protection measures, it can therefore be advantageous to give people the opportunity to get to know and experience them in small-scale projects (ibid.).

Place attachment

Place attachment refers to the emotional connection to a place, which is socially constructed (Steg & Groot, 2019). These emotions can be positive, negative, or ambiguous (ibid.). Place attachments are dynamic, as they can change over time (ibid.).

Non-conventional coastal protection measures are needed for climate adaptation and to increase coastal resilience. Place attachments can be either a hindrance for adaptation, if those affected perceive the action as contradictory to the place-based meanings and want to prevent any change, or a facilitator, if those affected are motivated to take adaptive action to preserve their place (McElduff & Ritchie, 2018; Ratter & Leyshon, 2021; Steg & Groot, 2019). Change should therefore be communicated as an opportunity for a place rather than a threat (Steg & Groot, 2019).

Displacement can evoke a variety of negative emotions, such as grief or anxiety over the loss of a highly valued place (Steg & Groot, 2019). Place attachments should therefore be taken into account when considering managed retreat as an adaptation strategy.

With regard to the Schleswig-Holstein Wadden Sea, Siedschlag and Gee (2021) showed that place attachment to the island of Pellworm has social, economic, cultural and natural dimensions that are closely linked to past and present processes of land reclamation and coastal protection. The authors also point out that attachment to place is closely linked to familiarity with a place and a sense of belonging to the community (p. 107). Sayings like "God created the sea, the Frisians the coast" underline such a sense of belonging, the emotional bond to the North Frisian Wadden Sea coast (Döring & Ratter, 2018; Jordan et al., 2023; Siedschlag & Gee, 2021).

To conclude, people-place relationships need to be given greater consideration in coastal management and planning to facilitate coastal resilience building (McElduff & Ritchie, 2018), as they can influence stakeholder perceptions of coastal protection measures and their ability to cope with risks. They are therefore closely related to resilience (Siedschlag & Gee, 2021). Walsh (2018) conclude that, "The management of coastal change consequently requires not only attention to interlinked socio-natural

processes of continuity and change, but an understanding of coasts as meaningful places culturally constituted through social practices, processes of attachment and belonging at community and individual levels.” (p. 147).

2.4 Summary and conceptual model

The theoretical exploration of various concepts related to coastal resilience, the operationalization of resilience through various coastal protection measures, and stakeholder perceptions enabled to provide a theoretical basis for this thesis and to answer the first two secondary research questions presented below.

RQ1: What is coastal resilience and why is it relevant to include non-conventional coastal protection measures to become resilient?

Coastal Resilience (Chapter 2.1) within this study is the ability of both coastal communities and the tightly coupled underlying ecosystem to sustain itself in the face of external and internal, gradual and immediate perturbations from climate change by adapting to change without compromising future adaptive opportunities, or by transforming when the system becomes untenable or undesirable.

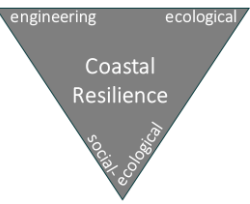
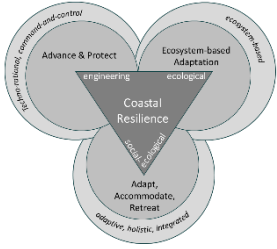
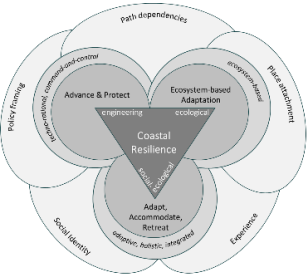
Non-conventional coastal protection measures (Chapter 2.2) are all measures for dealing with coastal risks that go beyond purely engineering approaches and the built environment. The focus is on the resilience of the coastal system as a whole, taking into account both ecological and social aspects and their inextricable interconnectedness. The need to incorporate non-conventional coastal protection measures to become resilient is driven by two reasons: 1) the failure of conventional measures in the face of climate change challenges, for example, in terms of ever-increasing and unsustainable maintenance costs, negative ecological side effects, and impaired risk perceptions; 2) non-conventional measures offer additional benefits beyond protection, are often more flexible and adaptable, and account for the uncertainty and complexity of the underlying system.

RQ2: Why is the perception of (key) stakeholders relevant for coastal management and what factors influence stakeholder perception?

The perceptions of key stakeholders (Chapter 2.3) are relevant for coastal management as they allow to identify potential conflicts as well as areas of agreement that can facilitate the implementation of non-conventional, innovative coastal protection measures needed to increase coastal resilience. Moreover, they provide insights into the prevailing resilience perspective at the SH Wadden, which can help to determine whether the resilience turn towards an evolutionary perspective propagated in academia has already been put into practice or is still rather theoretical. Five factors that influence stakeholder perception were identified to be of relevance for this study: path dependencies, (policy) framing, social identity, experiences and place attachment.

Answering these research questions using theory allowed for the development of a conceptual model. Inspired by the Flood Resilience Rose by Karrasch et al. (2021), the “Coastal Resilience Bloom” (CRB) was developed as a conceptual model for this thesis (Figure 6). The CRB consists of three levels that each represent a different concept: 1) coastal resilience; 2) coastal planning and management approach; and 3) stakeholder perception. Table 3 illustrates how these three different levels build up the Coastal Resilience Bloom and provides a more detailed explanation of each level.

Table 3: Build-up of the conceptual model for this thesis, the “Coastal Resilience Bloom” (CRB).

Level (L) of the CRB	Explanation
<p>L1: Coastal Resilience</p> 	<p>The way coastal resilience is defined and managed for depends on the respective resilience perspective. Three resilience perspectives can be differentiated: engineering, ecological, and social-ecological (evolutionary) resilience.</p> <p><i>Chapter: 2.1</i></p>
<p>L2: Operationalizing coastal resilience</p> <p>L2.1: Response to climate change impacts (inner circles)</p> <p>L2.2: Coastal management and planning approach (outer circles)</p> 	<p>Depending on the resilience perspective, coastal resilience is operationalized differently. The inner circles illustrate the different responses to coastal climate change impacts, underpinning different coastal protection measures (see Table 2 in Chapter 2.2). The outer circles illustrate the associated coastal management approach in which the coastal protection measures are embedded.</p> <p><i>Chapter: 2.2</i></p>
<p>L3: Stakeholder Perception</p> 	<p>Stakeholder perceptions influence which coastal resilience perspective and coastal management approaches are pursued. It is shaped by path dependencies, social identity, place attachment, experience, and the framing of resilience.</p> <p><i>Chapter: 2.3</i></p>

Coastal resilience (level 1) is embedded in the coastal management and planning practices (level 2), which in turn are embedded and influenced by stakeholder perceptions (level 3). All of the three levels (see Table 3) in turn are nested within the overarching context of climate change threatening coastal resilience (see Introduction) and paradigm shifts in water management and resilience (dark grey arrows in Figure 6). This overall contextualization completes the conceptual model for this thesis, the Coastal Resilience Bloom:

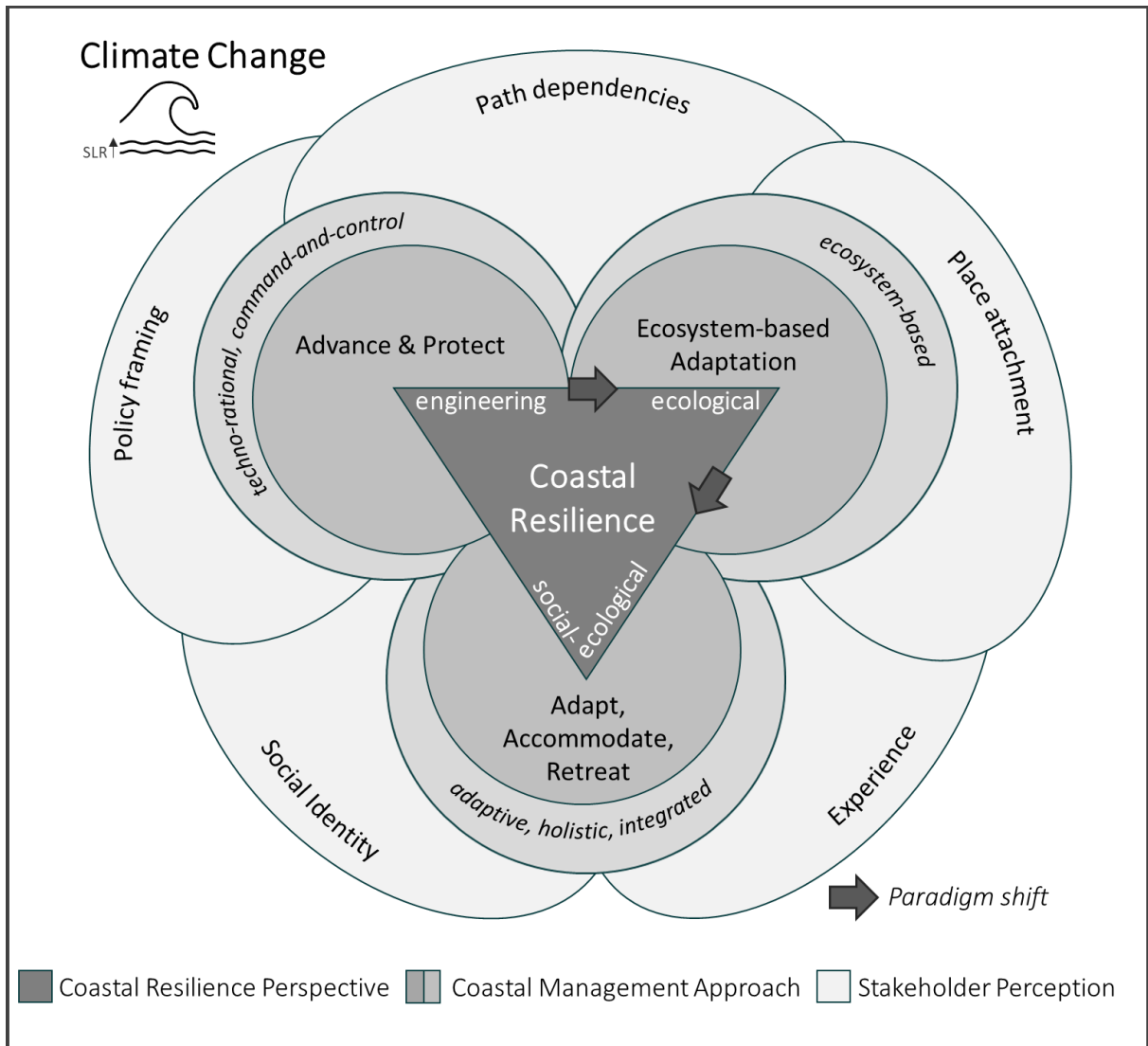


Figure 6: Coastal Resilience Bloom (CRB), conceptual model of the study. Source: Author.

3. The case: The SH Wadden

The SH Wadden, the unit of analysis for this study, is a diverse SES consisting of mudflats and saltmarshes, sandbanks, dunes, marshland, islets and barrier islands. Next to the Wadden Sea itself, which is located between the islands and the mainland and was declared a national park in 1985, the case includes the surrounding coastal communities on the mainland, the barrier islands, and Halligen. Halligen are flat marsh islands that lie just a few decimetres above sea level. They are protected only by comparatively low dikes that are not capable of holding back larger floods. Houses are therefore built on dwelling mounds to protect people and livestock when the Hallig is flooded during winter storm surges (see Figure 7).

The SH Wadden is home to around 290,000 people and consists of the districts of North Frisia in the north and Dithmarschen in the south (Nationalpark Wattenmeer, 2024). The majority lives on the mainland, about 32 000 people live on the five North Frisian Islands, and about 300 people live on six out of ten Halligen (Hofstede & Stock, 2018).

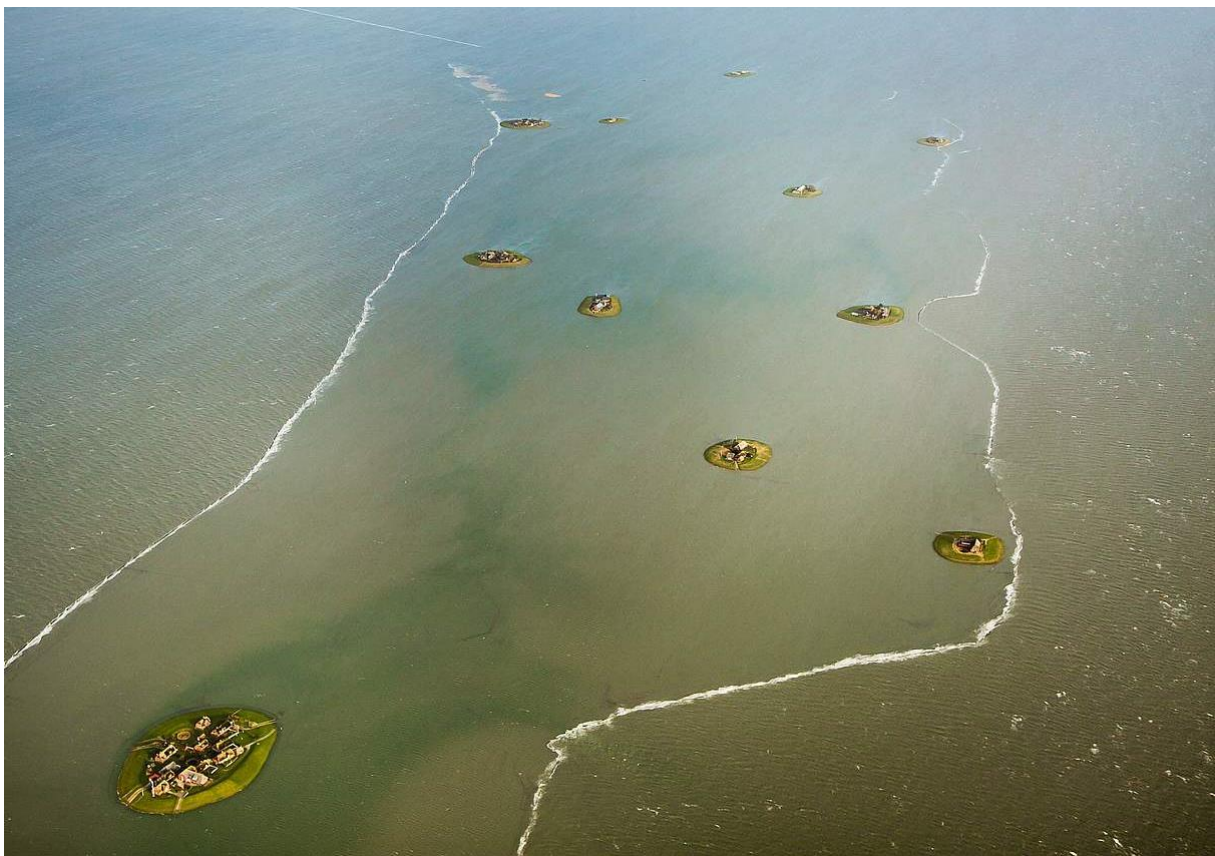


Figure 7: Flooded marsh-island or "Hallig", from which only the residential mounds stick out. Source: https://www.wwf.de/fileadmin/_processed_/1/7/csm_Landunter-Halligen-im-Wattenmeer-c-M-Stock_20f92c8d74.jpeg [November 2023].

3.1 Coastal management and resilience at the Wadden Sea: a brief look into its history

In order to understand coastal management practices and resilience at the Wadden Sea, it is essential to take a closer look at the history and characteristics of this unique tidal system. As Jordan et al. (2023) note, “Knowledge and learning about and from the past hold the potential to reshape current images and productively reflect existing perspectives” (p. 25).

Geologically speaking, the Wadden Sea is a comparatively young ecosystem, as it was formed at the end of the last ice age about 10,000 years ago, when the melting of the ice masses led to a rapid rise in sea level and a rearrangement of sediments (Schmidtke & Lammers, 1993). It is a highly dynamic system that not only changes its appearance every six hours as the high and low tides alternate, but its geomorphology also changes continuously over time due to a variety of dynamic processes (Oost et al., 2017). These natural dynamic processes, ranging from channel migration to sediment transport and exchange by waves, wind, and currents, to salt marsh development, are the reason that tidal flat systems have been able to withstand disturbances such as sea level rise or storm surges in the past (ibid.). Driven by the need for stability, man began to intervene in this natural dynamic over 1000 years ago, which impaired the resilience of the ecosystem: from the construction of terps to dikes, land reclamation and drainage, peat extraction and the prevention of channel, dune and landward island migration through various coastal protection measures (dredging, planting of marram grass, embankments) (Bazelmans et al., 2012; Knottnerus, 2005; Lotze et al., 2005), the coastal landscape turned more and more into an increasingly homogeneous and usable land (Knottnerus, 2005; Lotze et al., 2005), a coastal anthrome. In this constant struggle against the dynamics of nature, the mentality of the coastal settlers, the Frisians, was shaped by the fear of floods, the wild North Sea, such as the Great Flood of 1362 and 1634 (Ratter & Walsh, 2019). From the 18th century onwards, the dikes became a guarantor of safety, despite higher storm surges and further sinking land (Reise, 2016, p. 19). Houses were no longer built on mounds (also for cost reasons), but directly in the marsh, which was now lower than the areas outside the dikes due to drainage, peat extraction and agricultural use (ibid.). A boundary between nature and culture, land and sea, was created by the construction of an almost continuous line of dikes on the mainland (Liburd & Walsh, 2022; Reise, 2016; Walsh, 2018, 2020). Since the middle of the last century, the importance of nature, also for coastal protection, began to be recognized, which is reflected in the (albeit controversial) establishment of the national park in 1985 (Jordan et al., 2023).

To conclude, the resilience of the ecosystem Wadden Sea is highly dependent on coastal management practices and whether they impede or promote natural dynamics (Hofstede, 2019; Oost et al., 2017; Osswald et al., 2019; Torio & Chmura, 2013).

3.2 Stakeholders at the SH Wadden

Within the framework of the Trilateral Wadden Sea Cooperation, Germany, Denmark, and the Netherlands collaborate to protect the Wadden Sea. Decisions made at this trilateral level are required to align with the national legislation of each participating country and do not supersede it. This ensures that international cooperation in the conservation efforts is consistent with the legal frameworks and policies of the three countries.

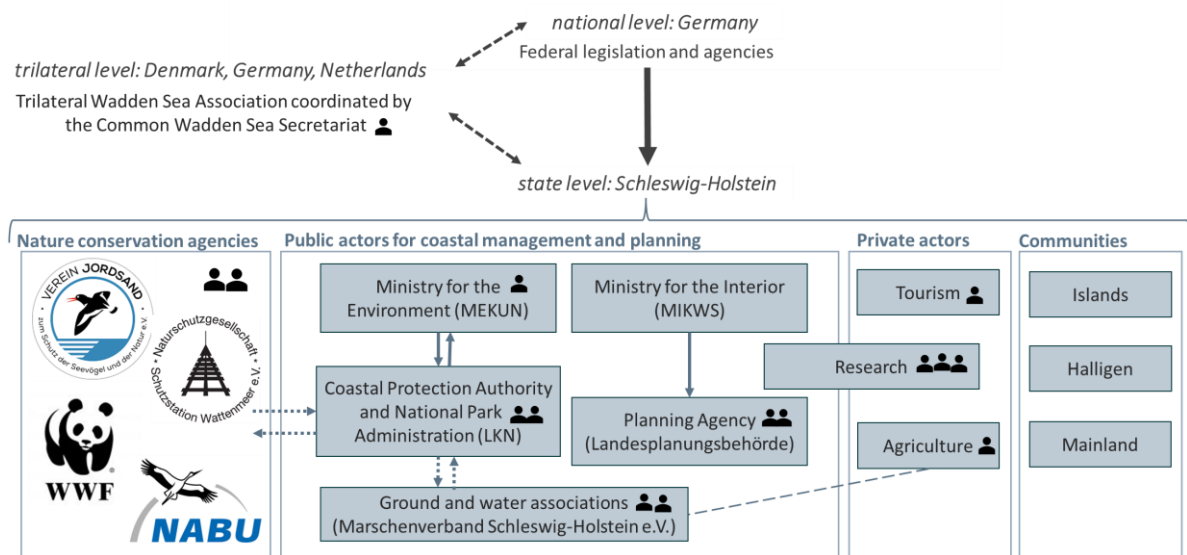


Figure 8: Stakeholders relevant for the Schleswig-Holstein Wadden Sea. The symbols represent the interview partners for this study and indicate the different sectors they come from. One person is depicted twice, as this person works both in the agricultural sector as well as on a voluntary basis for a dike association. Source: Author.

Figure 8 illustrates the key stakeholders in coastal management at the Schleswig-Holstein Wadden Sea (SH Wadden), governed by federal legislation. The Ministry of the Environment (MEKUN), as the upper coastal protection authority, and the Schleswig-Holstein Agency for Coastal Defence, National Park and Marine Conservation (LKN), the lower authority, are central to this framework. Both have distinct departments for coastal protection and nature conservation.

The “Marschenverband Schleswig-Holstein e.V.,” comprising soil and water associations, collaborates with these authorities on management behind the main dike line, focusing on the second dike line and inland drainage. Many of the voluntary members of these associations are from the agricultural sector.

Although other private sectors exist along the coast, tourism and agriculture are the ones most affected by flooding and sea level rise which is why they are considered of relevance for this study. In addition, research plays an important role in coastal management by addressing a variety of issues ranging from biotic and abiotic to socio-cultural aspects.

Nature conservation organizations work in partnership with the LKN, contributing to the management of large parts of the national park. The coastal plans within Schleswig-Holstein's state development

plan are crafted by the Planning Agency in collaboration with the MEKUN, which oversees strategic planning and approval for coastal protection measures.

Interviews were conducted to explore stakeholder perceptions on coastal protection measures and resilience in the SH Wadden. While acknowledging the importance of coastal communities in coastal management and planning, this study primarily focused on key stakeholders such as private actors, public authorities, and NGOs. This specific approach was adopted because insights from a select group of experts within these categories are likely to be more targeted and reliable. Attempting to cover the perspectives of over 70 diverse communities, which include those from sandy islands, mainland diked areas, and the distinctive dwelling mounds on the Halligen, would have significantly broadened the scope, potentially diluting the depth and specificity of the findings. This strategic focus allows for a more concentrated analysis of stakeholder perceptions in coastal management. Figure 8 in the thesis illustrates the distribution of interviewed experts from these interest groups. The methodology and rationale for selecting these stakeholders, and the process of data collection and analysis, are further detailed in the following chapter.

4. Methodology

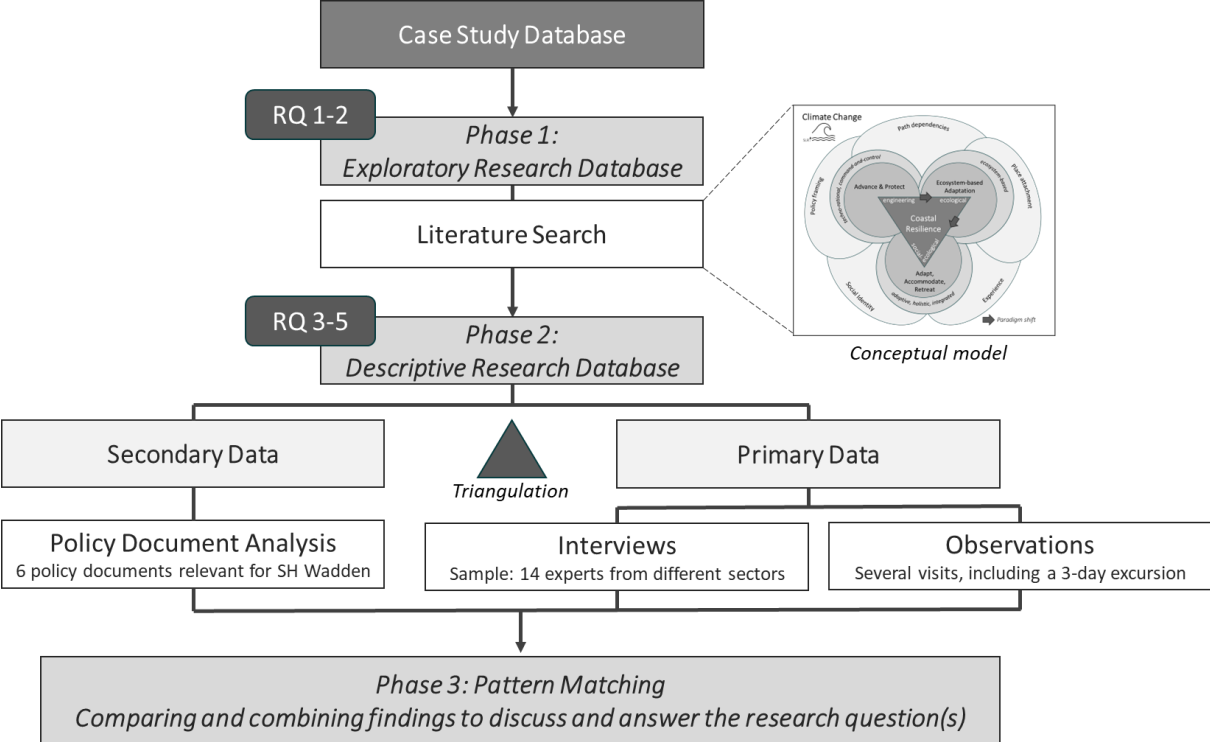


Figure 9: Development of the case study database: research phases, data collection method, and the research questions (RQ) investigated in each phase. Source: Author.

The creation of a case study database and a case study protocol can enhance the reliability of a study (Yin, 2003). Figure 9 shows chronologically how a case study database was developed and which data collection methods were used to answer the different (secondary) research questions of this study. In the first phase, a literature search was carried out to explore the research topics of coastal resilience, non-conventional coastal protection measures and stakeholder perception, with the aim to answer the first two research questions and create a theoretical framework with a conceptual model. The latter ensures a high level of external validity of the study (Yin, 2003, p. 34). Various methods such as snowball method, pearl-growing method, and citation searching were used for the literature search to develop a reliable and comprehensive theoretical framework.

Based on the theoretical framework (Chapter 2), two main methods were used in the second research phase to collect descriptive secondary and primary data for answering the other three secondary research questions (Figure 9): policy document analysis and semi-structured interviews. These two data collection methods were supplemented by observations made during a three-day excursion to the Schleswig-Holstein Wadden Sea coast in January 2024 and by observations I made during previous stays such as my ecological volunteer year 2016/17 on the island of Sylt or my bachelor thesis on the Hallig Nordstrandischmoor. This use of multiple sources of evidence contributes to the construct

validity of a case study (Yin, 2003, p. 34). As depicted in Figure 10, the three methods were chosen as they combinedly address all relevant influencing factors of stakeholder perception.

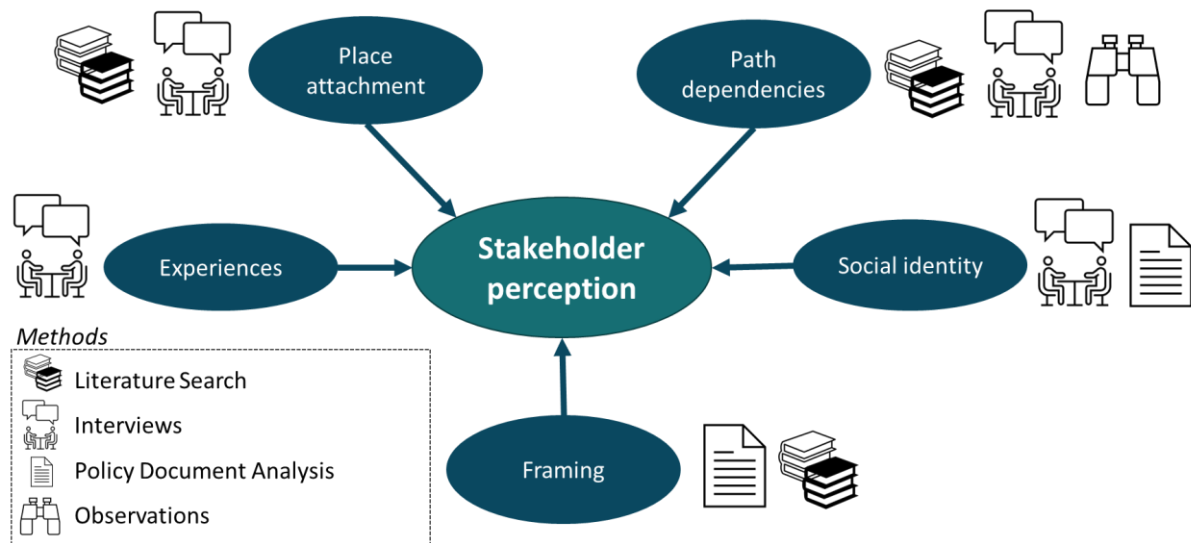


Figure 10: Overview of the methods used to capture the influencing factors of stakeholder perception. Source: Author.

However, there are limits to the methods, as not every method is suitable for obtaining data on every influencing factor (Figure 10), which makes triangulation difficult to achieve. High internal validity can still be obtained through pattern matching, i.e. by comparing patterns in the collected data with a pattern that a theory would predict, while accounting for competing explanations or contradictions in the collected data (Yin, 2003). Table 1 in Section 2.1.1 summarizes the theoretical pattern for the coastal resilience perspectives which were matched with the data collected in the second phase of research to explore the prevailing coastal resilience perspective at the SH Wadden. The following subchapters take a closer look at how semi-structured interviews and policy document analysis were used to collect data.

4.1 Interviews

To allow replication or comparison with similar studies, Bird (2009) advocates to provide methodological details with regards to the response format, the mode of delivery, and the sampling technique (p. 1307). In this Master thesis, semi-structured interviews with open questions (*response format*) were carried out by the researcher (*mode of delivery*). This method allowed for a structured interview with the possibility to change the order of questions depending on the course of the interview and to ask follow-up questions to learn more about interviewees' perceptions (Kallio et al., 2016). Moreover, semi-structured interviews are a well-suited method to explore participants' experiences and beliefs (Bird, 2009; Kallio et al., 2016).

The aim of the interviews was to gain insight into stakeholder perceptions of different coastal protection measures as well as into the prevailing coastal resilience perspective held by different stakeholder (groups) at the SH Wadden. Using a non-random and purposive *sampling technique*, interviewees were therefore chosen based on their profession and experience. In order to best represent the perceptions of the stakeholder groups to which the interviewees belong, people in senior positions with many years of experience were approached. To prevent interviewees from being harmed by their participation and to make them feel more comfortable in sharing their perceptions and opinions, the identities of the interviewees are kept anonymous. This may contribute to reducing social desirability biases. Table 4 lists the areas of expertise of the 14 interviewees and their pseudonyms used for this study. From the area of research, three researchers with different research focuses were selected to cover the diversity of the interest group: one researcher focused on biotic aspects of the Wadden Sea, one on innovative coastal protection measures, and one on social and cultural aspects of the Wadden Sea.

Table 4: Area of expertise of the 14 interviewees and their pseudonyms.

Expertise in	Pseudonym of the interviewee
Nature conservation / National Park	N1, N2, N3
Coastal protection	CP1, CP2, CP3
Planning	P1, P2
Research	R1, R2, R3
Agriculture	A1
Tourism	T1
Trilateral perspective of the Wadden Sea	TRI1

As shown in Figure 11, several steps were undertaken to ensure a reliable and proper conduct of the interviews. To contribute to the objectivity and trustworthiness of the study, the 5-step approach proposed by Kallio et al. (2016) was used to develop an interview guide. This included the development of a preliminary interview guide based on a theoretical framework, a pilot testing of this interview guide both through external assessment (in this case by the supervisor) and field-testing the interview through a potential interviewee (in this case a person knowledgeable in coastal management at the Wadden Sea), as well as the presentation of the final interview guide with the associated concepts (see Appendix A3).

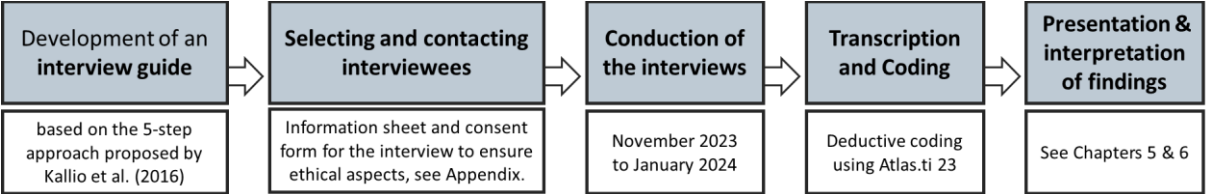


Figure 11: Steps undertaken to conduct and analyze semi-structured interviews.

One special element was the use of pictures during the interview, a method known as photo elicitation. The brain area for processing visual information is evolutionary older than the one for processing verbal information, which is why photo elicitation can provide additional information about participants' values, beliefs, and perceptions by evoking feelings and memories on a deeper level of consciousness (Harper, 2002; Richard & Lahman, 2015). To identify stakeholders' perceptions of non-conventional coastal protection measures, participants were shown pictures of such measures (see Appendix A3) and prompted to sharing their thoughts and feelings.

The interviewees were purposefully selected as described above. Each interviewee received an information sheet and a declaration of consent to ensure transparency and that the ethical aspects of the study were adhered to (see Appendix A1 and A2). A total of 13 interviews with 14 experts from different sectors (see Figure 8) were conducted between the end of November 2023 and mid-January 2024, most of them online. Interviews lasted between 35 minutes and slightly over an hour. To facilitate the data analysis, the interviews were transcribed verbatim. From the conceptual model of the thesis (Chapter 2.4) a deductive coding tree was derived (see Appendix A4). Following Mayring's (2022) recommendation for qualitative content analysis, the categories were revised after 10 to 50 % of the coding to determine whether they adequately reflected the content of the interviews. As a result, inductive codes were included to better reflect stakeholder perceptions of future visions for the SH Wadden, changes and trends in coastal management practice, and threats and risks. The software "Atlas.ti" (version 2023) was used to facilitate the coding process.

The information sheet, the consent form, the interview guide and the deductive coding tree can be found in the Appendices A1 through A4 to ensure the transparency and replicability of the study.

Finally, it is essential to acknowledge that a researcher's own perspectives and expectations regarding the outcomes can potentially introduce bias into the research. As a female researcher who has both worked as an ecological volunteer at the SH Wadden and conducted research on the Halligen as part of my bachelor thesis in the field of innovative coastal protection measures, I am naturally biased towards hard engineering solutions for coastal protection. To mitigate this risk, I made a conscious effort to maintain an open and receptive attitude in each interview, and to include several stakeholders working in the field of coastal protection with which I was less familiar. Employing a semi-structured interview methodology enabled me to adaptively ask follow-up questions. This approach not only allowed for the clarification of points raised by interviewees but also facilitated the incorporation of insights gained from previous discussions. By doing so, I aimed to ensure that the research remained grounded in the perspectives of the participants, thereby enriching the study with a diversity of viewpoints and minimizing the influence of my own preconceptions. Furthermore, as outlined below,

I have also included a wide range of policy documents to minimize bias, ranging from coastal protection and planning to trilateral perspectives and statements from nature conservation agencies.

4.2 Policy Document Analysis

Policy document analysis is a well suited to data collection method for this study as it provides background information and context for current developments in coastal management, which are often informed by policy. It also represents a method for examining how coastal resilience at the SH Wadden is framed, which is one of the factors influencing stakeholder perceptions. However, the analysis of policy documents not only provides additional or supplementary information, but can also be used to compare and verify results obtained from interviews and observations, making the study results more reliable and robust (Bowen, 2009).

The policy documents were selected for their relevance to coastal management at the SH Wadden and include both documents that are exclusively relevant to Schleswig-Holstein and documents that also inform other Wadden Sea areas (see Table 5).

Table 5: Selected policy documents for the analysis.

Relevant exclusively for Schleswig-Holstein	Relevant for Schleswig-Holstein and other areas
Strategy for the Wadden Sea 2100 (2015)	Trilateral Climate Change Adaptation Strategy (2014)
General Plan for Coastal Protection (2022)	Call for Action (2022)
State Development Plan Schleswig-Holstein (2021)	Cuxhaven Declaration (2023)

In order to conduct a comprehensive and reliable analysis of policy documents, Cardno's (2018) recommendations and tools for analysing policy documents were adopted, which focus on five aspects that are considered essential for analysing policy documents. These aspects are presented in the following table together with the guiding questions proposed by Cardno (2018), which have been slightly adapted to better fit the context of this study. The content of the policy documents was analysed with particular regard to the framing of coastal resilience. Therefore, the 5W+H resilience framework originally developed by Meerow and Newell (2021) and extended by Dobie et al. (2022) was used in the content analysis. It is a practical tool to explore how policy makers frame resilience. An overview of the results of the policy document analysis is presented in Appendix A5.

Table 6: Aspects with guiding questions for the policy document analysis based on Cardno (2018), p. 631.

1) Document production and location Where was the document produced and when? Was it easy or difficult to access?
2) Authorship and audience Who wrote the document? Who was it written for?
3) Policy context What is the purpose of the policy (for the organisation or the state)? Are drivers or forces behind the policy evident? Are there multiple values that might create tensions?

4) Policy text and content analysis with a focus on resilience

What aspects (that you are looking for) are evident in the language of the policy? Does the policy language refer to these aspects directly or indirectly?

What is specifically stated in the policy? What is not stated in the policy? Are there related procedures specified in the text that provide guidance for practice?

5 W + H of resilience framework suggested by Dobie et al. (2022): resilience for **whom**, **what**, **where**, **when**, **why**, and **how**.

5) Policy consequences

What is the intended overall impact of the policy? How is policy implementation intended to be monitored? How and when is the policy to be reviewed?

5. Findings

The following sections present the findings from the interviews, policy document analysis and observations to answer the three remaining secondary research questions (RQ 3-5). Overall, the research findings reveal a diversity of stakeholder perceptions of coastal resilience, non-conventional coastal protection measures, and visions of what constitutes a resilient coast. As will be shown, factors influencing stakeholder perceptions can help explain this diversity and provide a better understanding of where prevailing views stem from. All of the influencing factors identified in the theoretical framework were indeed observable, although their significance varied by subject.

5.1 Coastal resilience perspectives at the SH Wadden

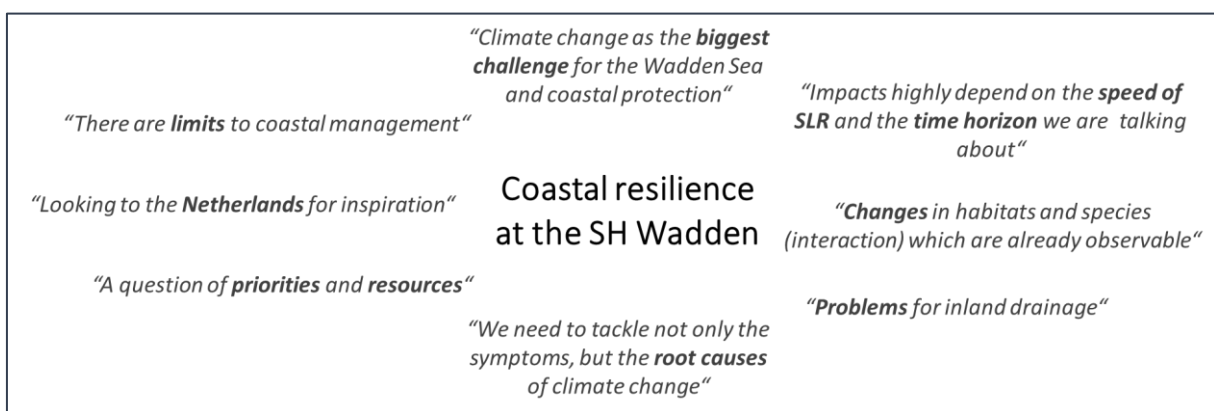


Figure 12: Dominant themes in stakeholder perspectives of coastal resilience at the SH Wadden. Source: Author.

The above figure illustrates dominant threats in stakeholder perceptions on coastal resilience at the SH Wadden. Climate change was identified as the greatest challenge for SH Wadden not only in the interviews, but also in all the documents analysed. This is an extremely important finding, as risk perception is closely linked to the perception of resilience (see Ratter & Leyshon, 2021). It provides the impetus for action, which is reflected in several policy documents dedicated to climate change and its challenges (see Appendix A5). While the authorities are beginning to give coastal protection a higher priority in the form of coastal priority areas in the current State Development Plan in order to create space for dike reinforcements and avoid land use conflicts, other stakeholders emphasize that the root causes as well as other environmental stressors such as the intensification of marine use, as addressed in the Cuxhaven Declaration, must be addressed.

“Those who use must also protect.” (Cuxhavener Declaration, 2023, p. 1).

“We have to aim for making the system as resilient as possible. Look at other stressors that impact the system. [...] Resilience by allowing interconnectivity, by allowing natural dynamics, by looking at this local.” (TRI1, December 2023)

As pointed out by both Folke (2006) and Beatley (2009) when considering coastal resilience, temporal and spatial scales matter. This was also highlighted by interviewees who emphasized that coastal resilience depends on the one hand on the time horizon considered and the rate of sea level rise, and on the other hand on the availability of resources now and in the future. In relation to the latter, several limitations of coastal management were brought up, whether due to financial resources, or spatial constraints.

Addressing RQ 3, "How does the perspective of coastal resilience differ between stakeholders at the SH Wadden?", the exploration of coastal resilience perspectives through interviews and documents revealed a complex landscape and seem to be even more ambiguous than in academia. It turned out to be difficult to categorize respondents and documents into one of the three resilience perspectives as characteristics of several resilience perspectives could be found within one interview. For example, while many participants from public authorities highlighted the potential of hard engineering measures and the reliance on prognosed scenarios typical for an engineering perspective, they also acknowledged uncertainties due to the complex challenges caused by climate change and tried to integrate other perspectives from tourism and nature conservation into their engineering perspective, showing therefore also characteristics from the ecological and social-ecological resilience perspectives (see Table 1). This indicates a somewhat more progressive engineering perspective, as one participant from coastal protection noted:

"In this respect, it is of course a maintenance strategy [...] At the same time, it is also always a transformation process. Coastal protection and nature conservation strategies have changed in the last few decades." (CP2, November 2023).

The historically evolved boundary between land and sea or nature and culture (Liburd & Walsh, 2022; Walsh, 2018, 2020) is evident in practice creating two systems with differing resilience perspectives (see Figure 13). This **path dependency** is reinforced by institutions in which the different departments work siloed in their area of responsibility, with nature conservation on the seaward side trying to preserve the ecosystem and withstand shocks typical of an ecological resilience perspective, and coastal protection authorities on the landward side focusing on hard protection measures to protect people and property. This delineation is challenged in transitional areas like foreshore management, pointing to the potential for more integrated management practices. "The boundary between the mainland and the North Sea is always, with very few exceptions, the dike" (T1, November 2023), illustrates how deeply ingrained these divisions are, influencing both perception and action in coastal resilience efforts. The planning efforts of the Planning Agency are also focused on the land side, where Regional Development Plans do not even include the coast, further reinforcing the boundary. Planning efforts of the Planning Agency also focus on the landward side, where regional development plans do not

even include the coast, further reinforcing the boundary (Figure 13). The emergence of marine spatial planning and the increasingly outdated status of ICZM in practice appear to further reinforce the boundary between sea and land (see Walsh & Kannen, 2019), while creating an additional boundary between territorial waters and the EEZ where planning responsibilities change (Figure 13).

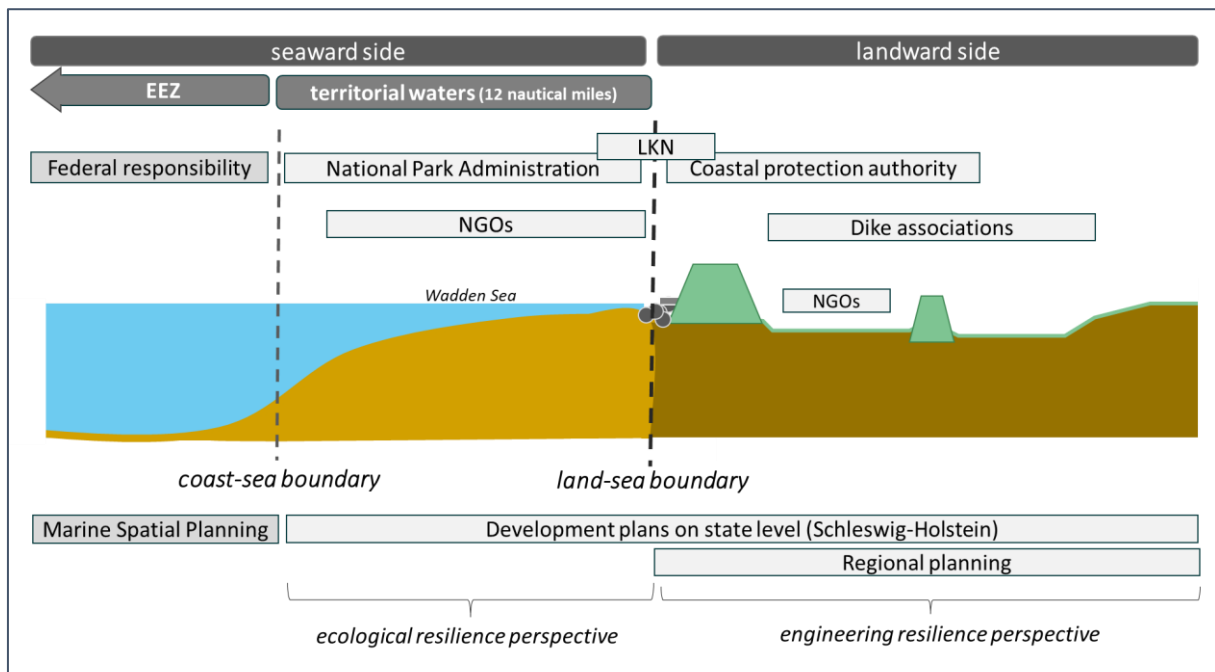


Figure 13: Boundaries caused by path dependencies (dike line and differing jurisdictions) which result in differing resilience perspectives. Source: Author.

Social identity effects, in particular tensions between nature conservation and coastal protection due to perceived differences in goals and values (*"Nature conservation protects nature from people. And coastal protection protects people from nature."* - CP1, January 2024), can further exacerbate this boundary. The Strategy for the Wadden Sea 2100 from 2015 can be seen as a first step towards overcoming this boundary, as nature conservation and coastal protection authorities came together for the first time to discuss the future of the Wadden Sea. However, they discussed the future of the ecosystem and not that of the coastal area as a whole. This is a common element in the policy documents analysed, which either address only the ecosystem (such as the Trilateral Climate Change Adaptation Strategy) or discuss the ecosystem and the social system separately (such as in the General Plan for Coastal Protection with a separate chapter for the Wadden Sea). Treating the SH Wadden as two different systems can be dangerous, as the resilience of one system can reduce the resilience of the other (Beatley, 2009). A look at the past shows exactly that: the human desire for stability has reduced the ecosystem's dynamics and thus its adaptive capacity which in turn has affected its resilience. This underlines how **policy framing** significantly impacts stakeholder perceptions of resilience, offering a point of reference that can either support or limit the exploration of integrated approaches. The general optimism in policy documents about coastal ecosystems' resilience might

inadvertently reinforce a status quo biased towards engineering solutions, as stakeholders may not feel encouraged to pursue alternative, potentially more holistic strategies. *“First you have an abstract strategy and then you develop concrete projects or measures and activities”* (N3, January 2024), this quote underscores the critical role of strategic framing in legitimizing and guiding resilience efforts.

Despite a historical reliance on technical measures, underpinned by confidence in the sufficiency of such approaches, with the Netherlands often portrayed as a pioneer (*“The Dutch are leading the way and are the first to think about this because they are the lowest located.”* - CP3, January 2024), it is increasingly recognized that a broader, more comprehensive approach to resilience is required. This includes acknowledging the dynamic and open nature of coastal ecosystems (*“Coastal ecosystems are not closed systems”* - R3, December 2023) as well as the shortcomings of conventional coastal protection measures (*“I believe that it is technically feasible [...] but then we will lose nature and lose parts of the Wadden Sea.”* - N3, January 2024), and considering socio-ecological transformations as climate change impacts increase (*“With climate change, there's a need for social-ecological transformation on the coast and on the islands and that should be linked to nature protection and nature restoration of the Wadden Sea as well.”* - R2, November 2023). However, as interviewee N1 pointed out, such a paradigm shift requires both political will and careful communication strategies. This is in line with Davoudi (2012) and White and O'Hare's (2014) notions that resilience is a power-laden, political construct.

To conclude and answer RQ3, stakeholders at the SH Wadden navigate a complex landscape of resilience perspectives, shaped by path dependencies, social identity and framing effects. While the overall prevalence of the engineering perspective in flood and coastal protection is consistent with the findings of Laeni et al. (2019), Restemeyer et al. (2017), and Masselink and Lazarus (2019), the presence of other resilience perspectives and a coastal management that, according to the interviewees, integrates more and more nature and tourism concerns (at least compared to 30 years ago) and thus presents a more advanced engineering perspective, indicate that the resilience turn is slowly emerging in practice. These findings therefore challenge White and O'Hare's (2014) assumption that the resilience turn is primarily taking place in academia. Reaching a shared understanding of coastal resilience and bridging the divergent perspectives in practice through integrated coastal management strategies that recognize the interconnectedness between land and sea remains a key challenge.

5.2 Stakeholder perceptions of coastal protection measures

RQ 4: Does the perception of (non-conventional) coastal protection measures differ between stakeholders at the SH Wadden and how do stakeholders experience those measures and their resilience potential?

As will be shown in the following sections, the perceptions of coastal protection measures and their resilience potential differs between stakeholders. Interviewees associated with coastal protection tend to advocate for technical solutions or more conventional measures, viewing them as the most effective means to safeguard people and material assets from flooding. In contrast, nature conservation agencies including the national park authority lean towards nature-based solutions, valuing their ecological benefits. Meanwhile, researchers are in pursuit of innovative concepts and strategies to enhance coastal resilience for both the ecological and social system.

When it comes to accommodating measures such as terps, the majority highlight concerns over their financial viability. However, the concept of floating houses frequently emerged as a topic of interest.

Although many of the interviewees see managed retreat as a viable approach that has the potential to provide valuable co-benefits, they believe it faces significant resistance from local residents. This opposition is deeply rooted in the local community's traditions, arising from a long-standing history of contending with the untamed North Sea.

Despite the varied views on coastal protection strategies, there is agreement on the need for a range or combination of measures tailored to specific local contexts, pointing out that there is no one-size-fits-all solution. This is in line with scientific recommendations (see e.g., Singhvi et al. (2022), Fünfgeld and McEvoy (2012), Reise (2016)), which point to the need for diverse and flexible adaptation strategies that are tailored to the local context.

“In order to secure local resilience, on the basis of a common knowledge base, site-specific “tailor-made” solutions should be developed.” (Trilateral Climate Change Adaptation Strategy, 2014, p. 6).

5.2.1 Conventional coastal protection measures

As observations show, conventional coastal protection measures are omnipresent at the SH Wadden (see Figure 14 and Figure 15): several dike lines in succession, telling the story of past land reclamation and maintaining the stable state achieved, supported by pumping stations, sluices and dredged channels for inland drainage. This is especially observable on the mainland. Just as Berkes et al. (2008) suggest, humans have created a homogenous, usable system that seems rigid to change in light of historical **path dependencies**.



Figure 14: Impressions of the mainland of SH Wadden: old dike lines with roads passing through them, sluice (top left) and dredged channel (bottom right) for inland drainage. Source: Author.



Figure 15: Second dike line or "middle dike" between two polders whereby the older polder lies lower below sea level than the younger one as the older was cut off from sediment input earlier. Source: Author.

This reliance on hard engineering solutions, which are perceived to be most effective against flooding, represents a **rigidity trap** described by Carpenter and Brock (2008), in which institutions seem to have become too inflexible and entrenched in 'business as usual' to change. In line with this observation one interviewee critically describes this situation as a "dead end", highlighting the limitations of traditional dike construction in facilitating natural processes like sediment deposition:

"I would say that this dike construction, which has been carried out on the German North Sea coast for over thousand years, has actually led to a dead end: The result is that no water can penetrate during storm surges, no sediment can be brought in and the consequence is that the land behind the dike is now significantly deeper than the few foreshore areas that exist." (R1, November 2023).

The General Plan for Coastal Protection introduces the "climate dike", a dike concept that aims to facilitate future dike reinforcements through a wider dike crest, thus contributing to long-term, climate-proof adaptation. However, the underlying problems such as land subsidence and coastal erosion are not addressed. Despite its innovative design, this solution underlines a persistent path

dependency, as it does not deviate from the conventional paradigm that prioritizes static protection measures over dynamic, adaptive strategies.

“The continuation of the dike reinforcement program is of paramount importance, 74 km of dikes are to be reinforced.” (General Plan for Coastal Protection, 2022, p. 81).



Figure 16: Climate Dike with a flat and wide dike crest to improve dike reinforcement in the future. Source: Author.

Restemeyer et al. (2017) question the realism of resilience thinking in the absence of catastrophic floods and given the advanced state of existing protection systems, a query that resonates with the findings from the SH Wadden. As there has been no **experience** of severe and destructive storm surges in SH Wadden since 1962, as proudly highlighted in the General Plan for Coastal Protection, there seems to be little impetus for change and people feel safe behind the dike. As an interviewee (A1) from the agriculture sector states, people behind the dike are more concerned about inland water drainage than flooding. Nevertheless, many of the interviewees also perceive the drawbacks of hard infrastructure as postulated in academic literature (Sutton-Grier et al., 2015; Temmerman et al., 2013) ranging from negative ecological side effects such as impeded habitat connectivity (e.g. for chick migration) to spatial constraints and low aesthetic values. In addition, in regions where traditional hard dike structures are absent, such as the sandy islands, the Halligen, or the sandy coastal area around St. Peter Ording there is a noticeable shift in coastal management strategies towards embracing more natural dynamics. This is evidenced by the ECOHAL project on the Halligen to increase sediment deposition and thus vertical growth of the Halligen, or the “Sandy coast of St. Peter-Ording” project which aims to improve dune dynamics and biodiversity. This evolution in approach reflects a learning process from past experiences, recognizing the limitations and drawbacks of rigid infrastructure in certain landscapes.

Furthermore, nature conservation initiatives are evolving to integrate human activity with the goal of enhancing biodiversity, especially in dune ecosystems that have been fenced off for decades to keep them in place (Figure 17). *“For Sylt in particular, the dunes are overprotected [...] And that's why it's all about how we can get dynamics back into the dunes so that more biodiversity is possible again”* (N2,

December 2023), illustrates a promising direction in coastal management that harmonizes ecological protection with community engagement.

In summary, while conventional coastal protection strategies remain prevalent, underscored by a deep-seated reliance on hard engineering solutions, there is a growing recognition of the need for alternative, more flexible approaches. The challenge lies in overcoming the rigidity trap and path dependencies that currently dictate coastal management practices, moving towards a more integrated and dynamic approach.



Figure 17: Fenced off dunes with information sign "Dune protection is coastal protection! No trespassing". Source: Author.

5.2.2 Nature-based solutions

Nature-based solutions (NbS), particularly saltmarshes and sand nourishment, are recognized for their multiple benefits, including their aesthetic value and contributions to coastal protection. Saltmarshes (Figure 18), known for their ability to grow with rising sea levels, play a crucial role in attenuating waves, thereby reducing pressure on dikes. However, coastal managers emphasize that while saltmarshes contribute significantly to coastal defences, they are not sufficient to prevent flooding entirely, necessitating the integration of hard infrastructure measures. According to stakeholder perceptions, the natural beauty and ecological function of saltmarshes also make them aesthetically pleasing, enhancing their value as a sustainable coastal protection measure.



Figure 18: Saltmarshes in summer (left) and winter (right). Source: Author.

The discourse around nature-based solutions in coastal protection reveals a tension between their perceived novelty and their historical application. A Coastal Protection Agency interviewee's comment, *"We have been doing this for at least 200 years..."* (CP1, January 2024), challenges the notion that these practices are recent developments, suggesting that what might be seen as innovative by some has been standard practice for others for centuries or at least decades. This perspective may reflect a **framing effect** in how nature-based solutions are understood and valued, both in policy and academic circles and in practice. It also raises questions about the criteria for labeling an approach as "nature-based," particularly when historical methods aimed at land reclamation, though utilizing natural processes, did not necessarily prioritize ecological benefits or sustainability, which is often seen as an important feature of NbS.

Sand nourishment is another strategy widely discussed among stakeholders for its softer impact compared to hard coastal defences. It is recognized for its role in climate adaptation strategies, offering a more sustainable option for coastal protection, especially on sandy islands like Sylt (Figure 19). Despite its benefits, the method is not without its critics, who point to its high costs and energy requirements alongside environmental impacts like seabed destruction and the disturbance of marine organisms. With regards to the latter, one researcher (R3) noted that recent research indicates that the affected sand gap fauna can recover relatively quickly, offering a counterpoint to concerns about long-term ecological damage. Apart from this, Garmestani et al. (2019) point out that while sand nourishment may be a softer coastal protection approach, it focuses on the continuous restoration of a specific steady state and thus reflects an engineering resilience perspective.



Figure 19: Sand nourishment on the island of Sylt. Source: Author.

Another interesting NbS project takes place on the Halligen, the ECOHAL project as part of the EU Interreg “MAinstreaming NAture-BASed Solutions” (MANABAS) initiative. As each flood deposits sediments on the Hallig, it has the potential to grow vertically with rising sea levels (Deicke et al., 2009). This significant adaptation process has therefore been the subject of research at the Geoscience Center of the University of Göttingen (Germany) since 2007 (see e.g., Deicke, 2018; Deicke et al., 2009, 2012; Hache et al., 2020; Karius et al., 2016; Schindler, 2015). First research results indicate that the current sediment accretion rate on the Halligen is not sufficient to withstand sea level rise (Deicke et al., 2009). Measures are therefore currently being designed and researched within the ECOHAL project to overcome the sediment-inhibiting coastal protection measures in order to increase sediment deposition on the marsh islands (Deicke, 2018; Deicke et al., 2012). Local residents often view these efforts positively, recognizing the Halligen as a pioneering region for innovative coastal protection strategies.

To conclude, the perception of NbS with regards to its resilience potential varies among stakeholders. While there is a clear acknowledgment of the benefits these solutions bring, from coastal protection to ecological enhancement and aesthetic value, there remains a critical need for dialogue and debate to reconcile differing views on what constitutes a nature-based solution and how best to integrate these with existing coastal defence strategies. However, the growing relevance of nature-based solutions is also visible in the State Development Plan (2021) and General Plan for Coastal Protection (2022) of Schleswig-Holstein, both of which state that coastal protection measures should be as nature-friendly as possible and that nature conservation concerns are always to be taken into account. Looking at resilience literature, Folke (2016) and Berkes et al. (2008) emphasize the need for such ecosystem-based approaches, i.e. the recognition and protection of the underlying ecosystem, which is closely connected to the social system, in order to achieve resilience.

5.2.3 Accommodating Measures

As the following pictures show, a typical example of flood-adapted construction on the SH Wadden are the Halligen, where people built their houses on terps or dwelling mounds to protect them from flooding in winter (Figure 20 and Figure 21). Old terps with buildings from the time before the polderization of the area can also be found on the mainland behind the dikes. Terps are thus a very traditional method of adaptation that is nowadays only practiced on the Halligen, as the mainland and the islands are protected by high dikes and dunes that make building on terps superfluous in the eyes of the residents. Another type of flood-adapted building can be found in St. Peter-Ording in the form of piled buildings, although these are primarily used for gastronomic purposes (see Figure 20).



Figure 20: Accommodating measures. A house built on stilts (left) in St. Peter-Ording and a dam leading to the Hallig Nordstrandischmoor with its typical terps (right). Source: Author.



Figure 21: Sea birds searching for food in the Wadden Sea with groynes and a terp of the Hallig Nordstrandischmoor in the background. Source: Author.

In general, these flood-adapted measures were perceived as a suitable method of ensuring flood safety, especially for new buildings. This is reflected in the State Development Plan (2021), which states that the construction of critical infrastructure should be flood-adapted in coastal flood risk areas (p. 411).

However, several interviewees pointed out the high costs associated with the construction of terps. For example, the terp strengthening programs on the Halligen are heavily subsidized by the state with several million euros, as this would otherwise not be affordable for the Hallig inhabitants themselves. Due to the high costs, such measures are therefore unattractive and unlikely in areas with high flood protection, i.e. on the mainland behind the dike. As one interviewee (CP3) noted, this method might only play a greater role in these areas in the more distant future (after 2100).

Uncertainty around the extent of sea level rise adds another layer of complexity, raising concerns about the future adequacy of these adaptations. *"With a terp, you always have the problem of how high the sea level really is..."* (CP2, November 2023), pointing towards the potential need for future adjustments to these structures.

The priority zones for coastal protection as stated in the State Development Plan can also be viewed as an accommodating measure, as it prevents the development of new houses in high flood risk areas. As one interviewee from the coastal protection authority stated (CP2), flood-adapted building might be a suitable structure when people want to build in the priority areas as this might then be possible as an exception.

Two other, more innovative adaptation measures were mentioned by respondents as potential future options: The concept of sponge cities was mentioned by a member of a dike association for better inland water management, and the concept of floating cities as a more flexible method compared to terps was referred to by several stakeholders with different backgrounds. Although floating cities are an interesting option to explore, one interviewee from coastal protection (CP2) pointed out that they may be less suitable for the Wadden Sea than for estuaries or the Baltic Sea coast.

5.2.4 Managed retreat

Most stakeholders view managed retreat as a positive adaptation strategy, recognizing its potential benefits for coastal protection, nature conservation, and tourism enhancement. For nature conservation, the opening of dikes and flooding of polders would give the Wadden Sea more room to migrate, creating space for natural sedimentation and preventing coastal squeeze. Such a natural area can also be of value for tourism. However, a coastal protection stakeholder emphasized that managed retreat is only an option under certain conditions (see quote below), as managed realignment is often

associated with an extension of the dike line and thus higher costs, which is considered undesirable from the perspective of the coastal protection authorities.

“1) Coastal protection should not increase financially or technically in any way as a result, i.e. more effort, although this is also something that can be talked about; 2) the coastline to be protected should not be lengthened as a result and here [Dockkoog project] it would be a classic example where it would become shorter and therefore a good measure from our point of view; 3) it must be accepted locally, and that was not the case here.” (CP1, January 2024).

The "Dockkoog project" serves as a prime example for a managed realignment project at the SH Wadden, envisaging a transformation where nature and tourism could harmoniously coexist. The initiative proposed to flood the Dockkoog polder close to the town of Husum and reconstruct the previously burnt-down hotel on a terp within the polder, creating a distinctive tourist destination in Schleswig-Holstein (see Figure 24). However, despite the innovative approach, the project was thwarted by local political resistance, primarily fuelled by concerns that it would bring water closer to town and reduce flood protection levels—a misconception that was not grounded in the project's actual plans. Misunderstandings about the project's impact on flood protection levels proved to be a significant barrier, highlighting how **place attachment** influences stakeholder perceptions leading to a failure of innovative projects (see Steg & Groot, 2019).

“This hotel stands there as a burnt ruin, which is of course a real shame, an eyesore - both for locals who use it as a recreational area and for guests. It's just a great, great pity that nothing is being done about it.” (T1, November 2023). This quote captures the regret and missed opportunities perceived by many stakeholders in the wake of the project's failure.

The concept of **loss aversion** (people would rather lose nothing than gain something of equal value, see Steg and Groot (2019)) became apparent in the Dockkoog project: the people of Husum thought that they would lose a dike line, as the scenario envisaged that the second dike line behind the polder would be reinforced and become a main dike line. However, the first dike line would have been preserved and would have continued to function as a breakwater; only a gap would have been built in to flood the polder (the coastal protection status would have remained the same and would not have been affected).

Change should therefore be communicated as an opportunity for a place rather than a threat (Steg & Groot, 2019). Regarding the Dockkoog project, it appears that the local community perceived it more as a threat. An interviewee highlighted that residents of Husum were opposed to the project because it implied the water would encroach closer to their homes. Criticism also came from an interviewee from the coastal protection authority, who pointed out that the project's recommendation by a nature

conservation agency might have contributed to scepticism regarding its impact on coastal protection. This indicates that the trustworthiness of the project's proponents plays a significant role in public reception.



Figure 22: Dockkoog Project "Husumer Hallig". Source: WWF (2016), p. 24.

Local reluctance to embrace managed retreat strategies is not merely about the fear of physical loss but is deeply intertwined with **cultural identity** and a historical defiance against the sea. *"Manage realignment will not work everywhere, because people will not give up everything they have fought for thousand years, they will not do that, because of course structures have developed there that will not be given up."* (R3, December 2023). This sentiment underscores the challenge of balancing the need for adaptive coastal management while respecting and preserving local traditions and values.

The necessity of navigating these complex socio-cultural dynamics points to the importance of proactive stakeholder engagement and the development of adaptation projects that are clearly communicated as enhancements rather than threats to the community (as highlighted by Steg and Groot (2019)). The Dockkoog project, despite its failure, has contributed to an evolving dialogue around managed retreat, suggesting pathways for future acceptance and implementation of similar initiatives. Managed retreat, while technically and financially viable in certain scenarios, faces its most significant challenges at the societal level, where perceptions of loss, place attachment, and traditional values heavily influence local acceptance and support.

5.3 Exploring future visions for a resilient Wadden Sea

Addressing the final (secondary) research question RQ5, "What do stakeholders see as desirable for coastal management and planning at the SH Wadden?", the results emphasize the role of the three different types of knowledge described by Rölfer et al. (2022) – *systems knowledge*, *target knowledge*, and *transformative knowledge* – for developing a shared vision of a resilient SH Wadden (Figure 23).

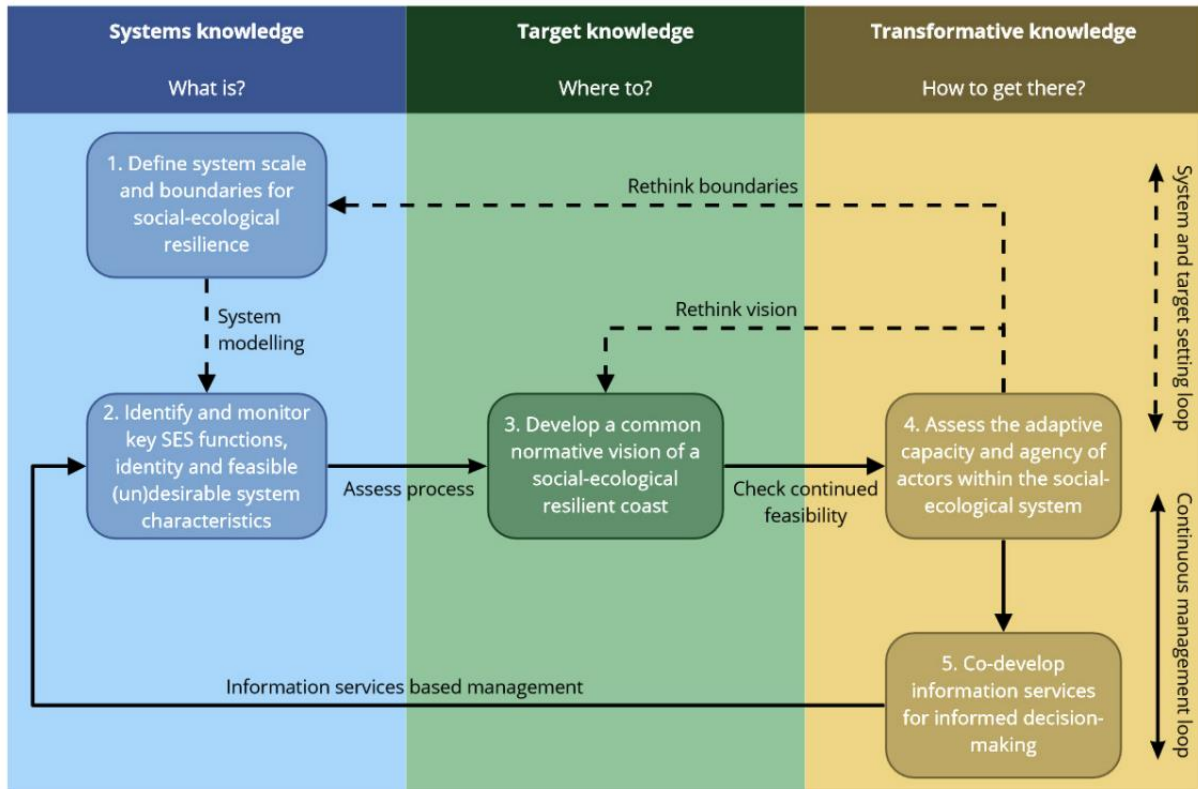


Figure 23: A five-step approach for addressing coastal resilience in social-ecological systems through three different knowledge types. Source: Rölfer et al. (2022).

The debate around coastal management at the Wadden Sea reveals a significant divergence in stakeholder perspectives, particularly concerning what coastal protection should encompass, with views ranging from prioritizing human and material asset protection to incorporating natural conservation areas and local cultural values. This discrepancy underscores the importance of engaging in comprehensive discussions and visioning exercises to reach a shared understanding of how a resilient coast should look like (see Rölfer et al., 2022). Such dialogue is essential for aligning diverse interests and ensuring effective, inclusive coastal management strategies. Critical questions raised by the interviews include *what coastal protection actually protects (R2)*, *whether everything needs to be protected (CP2)* and *whether the coastline is really as untouchable as claimed (N3)*.

A consensus emerges around the desire for a comprehensive approach that preserves the Wadden Sea's ecological and cultural significance. The statement, "The Wadden Sea is the main reason why

most guests go on vacation to the North Sea...” (T1, November 2023), reflects the area's value beyond its environmental attributes, highlighting its role in local tourism and cultural identity.

Amidst bureaucratic challenges (*systems knowledge*, see Figure 23), stakeholders express the need for more flexible, pragmatic approaches to enable real cooperation and innovation (*target knowledge*), as articulated by one interviewee: “[...] *this real cooperation, thinking up new things, developing them, implementing them, that's what's repeatedly failing [...]*” (N2, December 2023). The shift towards more integrated coastal management is evidenced by collaborative strategies such as the Strategy for the Wadden Sea 2100, demonstrating a move towards aligning diverse interests (*systems knowledge*), “*But over the last 10 to 15 years, we've actually been on a very good path towards doing things together.*” (T1, November 2023).

Incorporating local knowledge into coastal management strategies is crucial and advocated for by several actors (*target knowledge*), as local residents possess invaluable insights and ideas born from their intimate understanding of the region. Their inclusion ensures that a broader range of experiences and perspectives are considered, leading to more effective and culturally sensitive solutions. Furthermore, especially researchers see a pressing need for an increase in social research within the field of coastal management (*target knowledge*). A closer interaction between natural and social sciences is imperative to develop holistic strategies that account for both environmental and societal dynamics. This interdisciplinary approach can provide a more comprehensive understanding of the coastal ecosystem and the human factors influencing it, as highlighted in the following quote.

“I think the big challenge in terms of research is to bring social sciences and natural sciences together in order to generate added value. Because I think a lot of energy has been lost over decades in convincing people to implement nature conservation measures. And if we had invested all this time in taking people with us and identifying their needs from the outset, and not just the people, but also the needs of the ecosystem and the cultural needs, then we would probably already be a step further and I hope that this will be the case in the future.” (R3, December 2023).

Nature conservation agencies in contrast, would like to see greater collaboration with coastal protection (*target knowledge*), not only conceptually, but also in terms of providing sufficient financial and human resources to be able to operate on an equal footing.

To realize these future visions (*transformative knowledge*), interviewees frequently emphasized their hope for the current generational shift in coastal management perspectives, with newer generations thinking differently and challenging conventional approaches: “[...] *that has now changed with the new generation.*” (CP1, January 2024). This new generation brings hope for innovative solutions; however, it

also introduces potential tension due to differing *social identities*, i.e. norms and values, compared to the old generation.

Responding to RQ5, findings from interviews and policy document analysis reveal that stakeholders have different visions for the future, with the majority desiring a future where coastal management at the SH Wadden is characterized by integrated, innovative, and collaborative approaches. They advocate for a management paradigm that effectively balances nature conservation and coastal protection, incorporates local knowledge and cultural values, remains open to transformative ideas and practices, and recognizes the Wadden Sea's unique value (Figure 24).

To summarize, the integration of system, target, and transformative knowledge, facilitated by visioning processes and the engagement of diverse stakeholder perspectives (see Rölfer et al., 2022), outlines a path towards a more resilient and collectively envisioned future for coastal management at the SH Wadden. This approach underscores the importance of overcoming existing barriers, including bureaucratic inertia and the challenges posed by path dependencies and social identity effects, to facilitate the implementation of more non-conventional coastal protection measures and realize a shared vision for the region.



Figure 24: Impressions from the Wadden Sea - a unique and diverse ecosystem. Source: Author.

6. Discussion and reflection

In this discussion, I will draw on insights from transition theory and environmental psychology to explore how a resilience turn, and thus more integrated and inclusive coastal management, can be realized in practice and how the different stakeholder perceptions can be incorporated to facilitate this process. Finally, I will reflect on research bias and the limitations of this study.

6.1 Shifting Tides: Integrating transition theory and environmental psychology in coastal management

The research findings from this thesis align with findings from related topics such as groundwater salinization in northwestern Germany investigated by Karrasch et al. (2023), which underscore a prevalent reliance on technical and rational approaches within expert communities. Experts tend to rely on predefined scenarios and often overlook possible outcomes that lie outside these projections (ibid.). Given the increasing complexity and uncertainty of the challenges posed by climate change, the cascading effects of multiple stressors and extreme events also need to be considered (see WAKOS project, 2024). The work of Karrasch et al. (2023) highlights the critical need for greater participatory collaboration and suggests that the inclusion of a broader range of stakeholder perspectives could enrich anticipatory governance required for effective climate adaptation strategies.

Since Reise's (2016) call for a change of course in coastal management at the North Sea, a lot has happened, particularly in the development of more long-term (climate dike concept) and multifunctional dike strategies (e.g., integration of a barrier-free grandstand for tourism as part of the dike reinforcement in Büsum). However, the primary climate strategies of coastal protection, sand nourishment and climate dike, are still largely focused on maintaining the current status quo and not on changing the way we deal or live with the coast and water. Only where natural conditions are more dynamic and less path-dependent, such as on the Halligen islands (ECOHAL project) or on sandy coasts ("Sandy Coast St. Peter-Ording" project), are more innovative and unconventional coastal protection measures being developed. Drawing on transition theory (see Loorbach, 2010; van der Brugge et al., 2005), such small-scale changes at the niche level are characteristic for the take-off phase of a transition, the tipping point at which the system begins to change (van der Brugge et al., 2005). This transition is often encouraged by processes at the macro level (ibid.), as evidenced by the EU Interreg project MANABAS, which promotes more nature-based solutions. For the SH Wadden, it represents a transition or turn from an engineering and partly ecological resilience perspective to a more social-ecological perspective and thus to a more integrated and holistic coastal management. While White and O'Hare (2014) note that the resilience turn is primarily observable in academia, this research suggests that it is also starting in practice. However, lock-ins resulting from rigid institutions at the

regime level can impede the take-off phase of a transition and therefore require active transition management (see Loorbach, 2010). Transition management to enhance social-ecological coastal resilience should centre around ecosystem restoration, innovative strategies and local knowledge (Beatley, 2009; Steven et al., 2020), as well as place-based, culturally sensitive planning processes (Norton, 2022). Stakeholder perceptions are crucial in this process as they provide insights into prevailing views, local knowledge, and cultural values. A boundary spanner can not only facilitate the inclusion of a broad range of stakeholder perceptions, but also help to prevent lock-ins by bridging mental, socially constructed or physical boundaries and tensions between different social groups (e.g. between nature and coastal protection, research and practice, or old and new generations) through trust building and comprehensively addressing stakeholder concerns and conflicts (Burbach et al., 2023; Delozier & Burbach, 2021; van den Brink et al., 2022).

Visioning exercises, which could be supported by boundary spanners (van den Brink et al., 2022), are needed to develop long-term, strategic visions for the realization of a resilient coast. Design-led approaches, as described by Kempenaar et al. (2022), offer a promising avenue for fostering such a dialogue. These approaches involve crafting visions of potential futures, which can help bridge gaps between stakeholders by providing a common ground for discussion (ibid.). By visualizing alternative scenarios, these design-led exercises encourage stakeholders to consider innovative solutions, challenge conventional approaches and develop a shared vision for the future of coastal management (Kempenaar et al., 2022; Rölfer et al., 2022). This process is critical for moving beyond conventional practices and exploring more progressive, integrated approaches to coastal protection.

Using insights from environmental psychology (see e.g., Steg & Groot, 2019), incorporating diverse perceptions into stakeholder management advocates for tailored information campaigns to effectively promote coastal resilience concepts and the necessity for innovative coastal protection measures. To alter behaviours and attitudes, messages must be tailored to the respective target group, demonstrating that mere information dissemination is insufficient (ibid.). This tailored communication could facilitate a mutual gains approach, highlighting the shared benefits derived from multifunctional coastal protection efforts and identifying common interests among stakeholders.

In summary, enhancing coastal resilience at the SH Wadden demands a paradigm shift towards more inclusive, future-oriented, and integrated planning. This involves integrating diverse stakeholder perspectives, embracing innovative coastal protection measures, and fostering a culture of collaboration and open dialogue (Beatley, 2009; Steven et al., 2020). Through such an approach, coastal management can move beyond traditional barriers, leveraging local knowledge and community engagement to navigate the challenges posed by climate change.

6.2 Reflections on research bias and limitations

Although I was able to answer all of the secondary research questions of this study, it is essential to also reflect on shortcomings, biases, and limitations of this research.

A notable challenge encountered during the interview process is the social desirability bias, which occurred particularly during interviews with public authorities, where some responses were more diplomatic or socially desirable and less direct and open.

Moreover, the research relied on a limited number of representatives, sometimes only one, from each stakeholder group. This approach means that the findings may not be fully representative of the entire group, offering instead preliminary insights into the perceptions of these stakeholders. To mitigate this limitation, the study prioritized individuals with extensive experience and senior positions within their respective fields, assuming their insights would provide valuable depth to the research. Looking ahead, future studies could benefit from incorporating surveys as a methodological tool to engage a broader and more diverse participant base. Surveys offer the potential to gather data from a wider array of respondents, enhancing the possibility of generalizing findings across larger groups. This approach could significantly expand the scope of research outcomes, providing a more comprehensive understanding of stakeholder perceptions and contributing to a richer, more nuanced exploration of the subject matter.

Photo elicitation proved to be a valuable method of capturing perceptions throughout the study, although it was not used to the same extent in all interviews. There were limitations to the use of this method, notably when it was not employed with certain interviewees due to practical constraints. For instance, one participant faced a weak internet connection, which hindered the use of photo elicitation, while another interviewee had extensively discussed the measures of interest before the opportunity to introduce photographs arose. This suggests that initiating the interviews with images could potentially enhance the depth and quality of insights gathered from the outset, rather than saving them for later in the conversation. Photo elicitation was deemed unsuitable for the interview with the Planning Agency as interviewees repeatedly referred to the detailed knowledge of the Coastal Protection Authority (social desirability bias), highlighting the need to adapt the research methods to the context and expertise of the participants.

Another research limitation was the scope of this study. As mentioned in section 3.2, exploring the concept of community resilience and thus the communities' perception of coastal management practice was beyond the scope of this thesis. Nonetheless, this area offers fertile ground for future research. Especially the way of life on the Halligen is a prime example of striving for a sustainable balance between humans and nature on the coast. Further research could more closely examine the

resilience tactics specific to each community, shedding light on the different ways in which communities at the Wadden Sea are adapting and dealing with their changing environments. In regards to this, future studies could focus on community leaders, as one interviewee emphasized that they play a central role in the integrated management of coastal areas.

"Mayors are truly integrated people, they have to bring all the issues together within their community, they have to listen to every citizen, they have to somehow try to look at everything together and not just coastal protection with nature conservation, but everything - it's about wastewater, it's about rain, it's about everything and everything has to be taken care of." (CP 1, January 2024).

This underlines the importance of considering coastal areas not just as geographical boundaries, but as complex entities that are intertwined with political, administrative and cultural levels. Greater inclusion of local community perspectives allows for a broader range of viewpoints and local knowledge to be incorporated into more holistic and inclusive strategies to enhance coastal resilience.

Lastly, on a more personal note, I feel it is vital to reflect on the prevalence of mental health issues in academia, as they can significantly impact research endeavours. Recent studies highlight the high prevalence of mental health concerns among faculty and students, ranging from stress to anxiety and depression, and highlight the need for support and intervention (see e.g., Eleftheriades et al., 2020; Hammoudi Halat et al., 2023; Hyseni Duraku et al., 2023; Lau & Pretorius, 2019; Urbina-Garcia, 2020). While writing my thesis, I had my fair share of ups and downs, which affected my mental well-being. By acknowledging my own struggles, I aim to raise awareness and advocate for change within the academic community. In my opinion, only researchers who are physically and mentally healthy can truly excel in their work. Therefore, fostering open dialogue and actively pursuing avenues for change are essential.

7. Conclusion

The research has revealed a significant correlation between perspectives on coastal resilience and the implementation of coastal protection measures, as depicted in the Coastal Resilience Bloom (Figure 25). A dominant engineering perspective, characterized by a reliance on dikes and pumping stations, prevails in current coastal management strategies. However, in areas where path dependencies do not pose a barrier and where there is a cultural landscape that is more in harmony with nature,

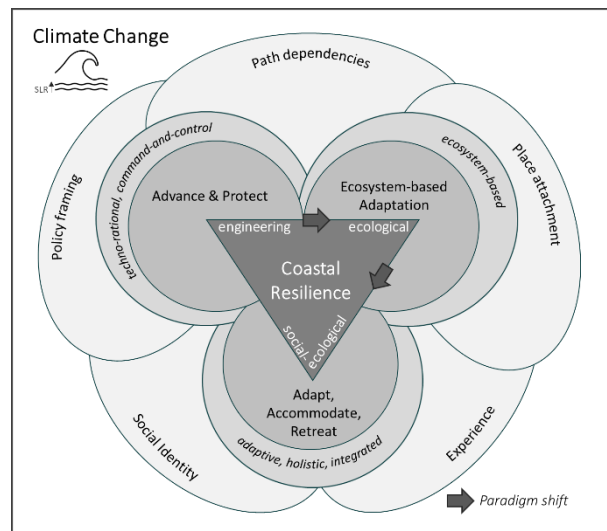


Figure 25: Coastal Resilience Bloom. Source: Author.

a shift in coastal management is evident. Projects such as the ECOHAL project on the Halligen or foreshore management practices demonstrate an alternative approach to dealing with the coast, contributing to enhancing coastal resilience by relying on diverse strategies and considering the ecological and social dimensions of a system as closely interlinked, as both Berkes et al. (2008) and Biggs et al. (2015) advocate. This, coupled with the increasing recognition among stakeholders of the need for diverse coastal protection measures that respond to the dynamics of nature and are adapted to the local context, challenges White and O'Hare's (2014) assertions that the resilience turn remains largely theoretical and restricted to academic discussions. Rather, the research results indicate that such a transition is also slowly emerging in practice.

However, the findings also show that coastal protection authorities see themselves constrained in their actions by institutions that clearly prioritize the protection of people and material assets while continually treating the ecosystem as separate from the social system. Until the political agenda opens up, innovative projects will stay confined to niches (see Loorbach, 2010; van der Brugge et al., 2005). This need for policy change and active transition management complements and confirms the observations of Davoudi (2012), Folke (2006), and White and O'Hare (2014) that resilience is not only a socially constructed concept, but also a highly political one. As the failed Dockkoog project demonstrated with regard to the sensitive topic of place attachment, changes to business-as-usual need to be carefully communicated and require local acceptance, underlining the need to incorporate insights from environmental psychology (see Steg & Groot, 2019) into planning practice. It further emphasizes the relevance of identifying place-based, cultural values, as presented in several studies from the field of cultural geography along the German North Sea coast (Döring and Ratter (2018),

Döring et al. (2022), Gee et al. (2017), Ratter and Leyshon (2021), Ratter and Walsh (2019), Tubridy et al. (2022), Walsh and Döring (2018), Walsh (2018), Walsh (2020)), to which this study contributes.

Coming back to the primary research question, "*What is the relevance of including non-conventional coastal protection measures in coastal management for coastal resilience at the Schleswig-Holstein Wadden Sea, and how are these measures perceived by different stakeholders?*", this thesis has underscored the critical importance of integrating innovative, non-conventional coastal protection measures into the broader strategy for enhancing coastal resilience. In line with studies by Oppenheimer et al. (2019), Sutton-Grier et al. (2015), Temmerman et al. (2013), and many others, this research revealed that such measures are not only relevant but essential in the wake of increasing complexity and uncertainty caused by climate change. They address the limitations of conventional engineering approaches and offer significant co-benefits that align with the objectives of sustainable and resilient coastal management and planning. Moreover, they represent a forward-thinking approach to coastal protection that acknowledges the necessity of working within the socio-ecological context of the coast. The thesis thus adds to Reise's (2016) call for new ways of dealing with the North Sea coast and to the recently published brochure by the Helmholtz Institute Hereon (Meinke and Weisse (2024)), which points to the lack of sustainability and the limits of hard engineering measures and the resulting need for new, more ecosystem-based concepts for sustainable coastal development.

Regarding the second part of the primary research question, the results show differing perceptions of non-conventional coastal protection measures and future visions of a resilient coast, with researchers and nature conservationists more willing to explore new avenues than coastal protection authorities. This variety can be attributed to several influencing factors. Path dependencies, institutional rigidity and a deep-rooted attachment to place, driven by a historically ingrained aversion to returning land to the sea, present significant obstacles to non-conventional measures. Social identity effects that lead to tensions between different stakeholder groups can exacerbate these barriers. Furthermore, the operationalization of resilience in policy documents is often framed vaguely and, together with the lack of recent experience with severe storm surges on the North Sea coast, means that there is little political impetus for change. These barriers underline the need for a more integrated approach to coastal management, particularly at the interface between land and sea and between different administrative bodies. It further illustrates the relevance of exploring stakeholder perceptions and factors influencing them for planning practice in order to both understand and alter the prevailing engineering approaches.

This study contributes to the emerging field of ocean perception research (see Jefferson et al., 2021; Lotze et al., 2018), e.g. by highlighting the effectiveness of photo elicitation in exploring perceptions, thereby pointing to its potential use for similar studies in the future. The insights into stakeholder

perceptions not only reveal areas of conflict and common interests, but also provide a starting point for a more open dialog on coastal management practices as advocated by Jordan et al. (2023). Gaining further insight into perceptions through visioning exercises, as demonstrated by Rölfer et al. (2022) and Kempenaar et al. (2022), is a promising area for future research as it may help to align the different stakeholder perceptions identified in this study into a shared understanding of coastal resilience. Moreover, this would prevent the term from becoming a "heavily contested buzzword", as Trell et al. (2017) warned (p. 7). In the future, communities, their perceptions, visions and local knowledge need to be explored in order to widen the range of stakeholder viewpoints and improve the acceptance and effectiveness of coastal management strategies. Last but not least, the investigation of methods for actively managing a transition towards these visions (see Loorbach, 2010) and the ongoing research into innovative measures such as floating houses and their suitability are crucial areas for future research.

In conclusion, this thesis not only reaffirms the significance of including non-conventional measures in coastal resilience strategies but also highlights the role of stakeholder perceptions in identifying and overcoming challenges and opportunities associated with this transition. As shown, it contributes to a wide range of scientific literature by bridging the gap between the theoretical concept of coastal resilience and its practical application in coastal management and planning, which is anchored in the perceptions of stakeholders and influenced by a variety of factors (see Figure 25).

With this master thesis, I call for recognizing and seizing the window of opportunity that is opening for a transition towards more sustainable and integrated ways for dealing with the coast, for living with and not against water, as depicted by Reise (2016) (see Figure 26). Now, as we increasingly feel and see the effects of climate change, is the time for rethinking, for visioning, and for questioning the paths taken centuries ago so we can create a future in which coasts are treated as the highly interconnected social-ecological systems they are to become truly resilient. In my eyes, this can only be accomplished if everyone is given the opportunity to get involved, and therefore further exploring stakeholder perceptions is key.

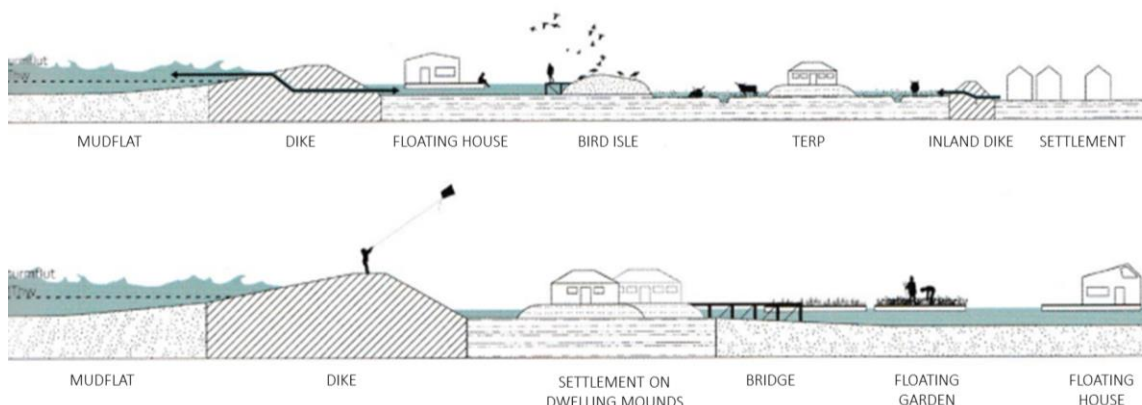


Figure 26: Living with water, a vision to move towards to? Source: Reise (2016), p. 153.

References

- Acott, T. G., Willis, C., Ranger, S., Cumming, G., Richardson, P., O'Neill, R., & Ford, A. (2023). Coastal transformations and connections: Revealing values through the community voice method. *People and Nature*, 5(2), 403–414. <https://doi.org/10.1002/pan3.10371>
- Albert, C., Hack, J., Schmidt, S., & Schröter, B. (2021). Planning and governing nature-based solutions in river landscapes: Concepts, cases, and insights. *Ambio*, 50(8), 1405–1413. <https://doi.org/10.1007/s13280-021-01569-z>
- Alexander, D. E. (2013). Resilience and disaster risk reduction: An etymological journey. *Natural Hazards and Earth System Sciences*, 13(11), 2707–2716. <https://doi.org/10.5194/nhess-13-2707-2013>
- Allen, C. R., Angeler, D. G., Chaffin, B. C., Twidwell, D., & Garmestani, A. (2019). Resilience reconciled. *Nature Sustainability*, 2(10), 898–900. <https://doi.org/10.1038/s41893-019-0401-4>
- Baird, J., Dzyundzyak, A., Plummer, R., Bullock, R., Dupont, D., Jollineau, M., Kubik, W., Pickering, G., & Vasseur, L. (2016). Ecosystem Perceptions in Flood Prone Areas: A Typology and Its Relationship to Preferences for Governance. *Water*, 8(5), 191. <https://doi.org/10.3390/w8050191>
- Bantelmann, A. (1939). *Das nordfriesische Wattenmeer, eine Kulturlandschaft der Vergangenheit*. <https://henry.baw.de/server/api/core/bitstreams/eb3b27c4-8c48-44fd-a114-333a11c3ff2b/content>
- Bassi, A., Bechauf, R., & Casier, L. (2021). *How Can Investment in Nature Close the Infrastructure Gap?* IISD: International Institute for Sustainable Development. <https://policycommons.net/artifacts/1859966/how-can-investment-in-nature-close-the-infrastructure-gap/2607478/>
- Bazelmans, J., Meier, D., Nieuwhof, A., Spek, T., & Vos, P. (2012). Understanding the cultural historical value of the Wadden Sea region. The co-evolution of environment and society in the Wadden Sea area in the Holocene up until ... <https://www.sciencedirect.com/science/article/pii/S0964569112001238>
- Beatley, T. (2009). *Planning for coastal resilience: Best practices for calamitous times*. Island Press.
- Becherer, J., Hofstede, J. L. A., Gräwe, U., Purkiani, K., Schulz, E., & Burchard, H. (2018). The Wadden Sea in transition - consequences of sea level rise. *Ocean Dynamics*, 68(1), 131–151. <https://doi.org/10.1007/s10236-017-1117-5>
- Bennett, N. J. (2016). Using perceptions as evidence to improve conservation and environmental management. *Conservation Biology*, 30(3), 582–592. <https://doi.org/10.1111/cobi.12681>

- Berkes, F., Colding, J., & Folke, C. (2008). *Navigating Social-Ecological Systems: Building Resilience for Complexity and Change*. Cambridge University Press.
- Beunen, R., & Patterson, J. J. (2019). Analysing institutional change in environmental governance: Exploring the concept of 'institutional work'. *Journal of Environmental Planning and Management*, 62(1), 12–29. <https://doi.org/10.1080/09640568.2016.1257423>
- Biggs, R., Schlüter, M., Biggs, D., Bohensky, E. L., BurnSilver, S., Cundill, G., Dakos, V., Daw, T. M., Evans, L. S., Kotschy, K., Leitch, A. M., Meek, C., Quinlan, A., Raudsepp-Hearne, C., Robards, M. D., Schoon, M. L., Schultz, L., & West, P. C. (2012). Toward Principles for Enhancing the Resilience of Ecosystem Services. *Annual Review of Environment and Resources*, 37(1), 421–448. <https://doi.org/10.1146/annurev-environ-051211-123836>
- Biggs, R., Schlüter, M., & Schoon, M. L. (2015). *Principles for Building Resilience: Sustaining Ecosystem Services in Social-Ecological Systems*. Cambridge University Press.
- Bird, D. K. (2009). The use of questionnaires for acquiring information on public perception of natural hazards and risk mitigation – a review of current knowledge and practice. *Natural Hazards and Earth System Sciences*, 9(4), 1307–1325. <https://doi.org/10.5194/nhess-9-1307-2009>
- Bowen, G. A. (2009). Document Analysis as a Qualitative Research Method. *Qualitative Research Journal*, 9(2), 27–40. <https://doi.org/10.3316/QRJ0902027>
- Bridges, T. S., Paul W. Wagner, Kelly A. Burks-Copes, Matthew E. Bates, & Ty V. Wamsley. (2015). *Use of Natural and Nature-Based Features (NNBF) for Coastal Resilience*. https://www.researchgate.net/profile/burton-suedel/publication/271763884_use_of_natural_and_nature-based_features_nbnf_for_coastal_resilience
- Burbach, M. E., Eaton, W. M., & Delozier, J. L. [Jodi L.] (2023). Boundary spanning in the context of stakeholder engagement in collaborative water management. *Socio-Ecological Practice Research*, 5(1), 79–92. <https://doi.org/10.1007/s42532-023-00138-w>
- Burke, L., Larsen, G., Lau, W., Kushner, B., & Hori, T. (2020). *Climate-Resilient Integrated Coastal Zone Management Performance Indicators*. <https://doi.org/10.18235/0002164>
- Cardno, C. (2018). Policy Document Analysis: A Practical Educational Leadership Tool and a Qualitative Research Method. *Educational Administration: Theory & Practice*, 24(4), 623–640. <https://eric.ed.gov/?id=ej1305631>
- Carpenter, S [S.], & Brock, W. A. (2008). Adaptive Capacity and Traps. *Ecology and Society*, 13(2). <https://doi.org/10.5751/es-02716-130240>
- Carpenter, S [S.], Folke, C., Scheffer, M., & Westley, F. (2009). Resilience: Accounting for the Noncomputable. *Ecology and Society*, 14(1). <https://doi.org/10.5751/es-02819-140113>

- Carpenter, S [S.], Walker, B., Anderies, J. M., & Abel, N. (2001). From Metaphor to Measurement: Resilience of What to What? *Ecosystems*, 4(8), 765–781. <https://doi.org/10.1007/s10021-001-0045-9>
- Chmutina, K., Lizarralde, G., Dainty, A., & Bosher, L. (2016). Unpacking resilience policy discourse. *Cities*, 58, 70–79. <https://doi.org/10.1016/j.cities.2016.05.017>
- Davoudi, S. (2012). Resilience: A Bridging Concept or a Dead End? *Planning Theory & Practice*, 13(2), 299–307. <https://doi.org/10.1080/14649357.2012.677124>
- Deicke, M. (2018). Antrag Lüttmoor-Projekt. Maßnahmen zur Förderung des Oberflächenwachstums auf der Hallig Nordstrandischmoor.
- Deicke, M., Karius, V., & Eynatten, H. von. (2009). *Bestimmung der Sedimentaufwachsrate auf den Halligen Hooge, Langeness, Nordstrandischmoor und Süderoog (SAHALL)*.
- Deicke, M., Karius, V., & Eynatten, H. von (2012). Sedimentakkumulation Halligen II (SAHall II): Förderung der Sedimentation auf den Halligen Hooge und Nordmarsch-Langeness.
- Delozier, J. L [Jodi Lynn], & Burbach, M. E. (2021). Boundary spanning: Its role in trust development between stakeholders in integrated water resource management. *Current Research in Environmental Sustainability*, 3, 100027. <https://doi.org/10.1016/j.crsust.2021.100027>
- Ding, M., Lin, P., Gao, S., Wang, J., Zeng, Z., Zheng, K., Zhou, X., Yamazaki, D., Gao, Y., & Liu, Y. (2023). Reversal of the levee effect towards sustainable floodplain management. *Nature Sustainability*, 1–9. <https://doi.org/10.1038/s41893-023-01202-9>
- Dobie, S., Doran, P. J., Norton, R. K., Hughes, S., & Goode, M. J. (2022). Defining coastal resilience in the Great Lakes: A systematic review and critical comparison. *Journal of Great Lakes Research*, 48(6), 1361–1374. <https://doi.org/10.1016/j.jglr.2022.08.001>
- Döring, M., & Ratter, B. (2018). The regional framing of climate change: Towards a place-based perspective on regional climate change perception in north Frisia. *Journal of Coastal Conservation*, 22(1), 131–143. <https://doi.org/10.1007/s11852-016-0478-0>
- Döring, M., Walsh, C., & Ratter, B. (2022). Emplaced climate imaginaries: The regional construction of climate futures on the German Wadden Sea Coast. *Geoforum*, 137, 222–229. <https://doi.org/10.1016/j.geoforum.2022.02.010>
- Eleftheriades, R., Fiala, C., & Pasic, M. D. (2020). The challenges and mental health issues of academic trainees. *F1000Research*, 9, 104. <https://doi.org/10.12688/f1000research.21066.1>
- RECOMMENDATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 30 May 2002 concerning the implementation of Integrated Coastal Zone Management in Europe, May 30, 2002.

- European Environment Agency (2000). integrated coastal zone management. *EEA Glossary*.
<https://www.eea.europa.eu/help/glossary/eea-glossary/integrated-coastal-zone-management>
- Evans, B., & Reid, J. (2014). *Resilient life: The art of living dangerously*. Polity Press.
- Flood, S., & Schechtman, J. (2014). The rise of resilience: Evolution of a new concept in coastal planning in Ireland and the US. *Ocean & Coastal Management*, 102, 19–31.
<https://doi.org/10.1016/j.ocecoaman.2014.08.015>
- Folke, C. (2006). *Resilience: The emergence of a perspective for social–ecological systems analyses*.
<https://www.sciencedirect.com/science/article/pii/S0959378006000379>
- Folke, C. (2016). Resilience (Republished). *Ecology and Society*, 21(4). <https://doi.org/10.5751/es-09088-210444>
- Fünfgeld, H., & McEvoy, D. (2012). Resilience as a useful concept for climate change adaptation? *Planning Theory and Practice*, 13(2), 324–328.
https://researchrepository.rmit.edu.au/esploro/outputs/9921861822401341?institution=61rmit_inst&skipusagereporting=true&recordusage=false
- Garmestani, A., Craig, R. K., Gilissen, H. K., McDonald, J., Soininen, N., van Doorn-Hoekveld, W. J., & van Rijswijk, H. F. M. W. (2019). The Role of Social-Ecological Resilience in Coastal Zone Management: A Comparative Law Approach to Three Coastal Nations. *Frontiers in Ecology and Evolution*, 7, 410. <https://doi.org/10.3389/fevo.2019.00410>
- Gee, K., Kannen, A., Adlam, R., Brooks, C., Chapman, M., Cormier, R., Fischer, C., Fletcher, S [Steve], Gubbins, M., Shucksmith, R., & Shellock, R. (2017). Identifying culturally significant areas for marine spatial planning. *Ocean & Coastal Management*, 136, 139–147.
<https://doi.org/10.1016/j.ocecoaman.2016.11.026>
- Gelcich, S [Stefan], & O'Keeffe, J. (2016). Emerging frontiers in perceptions research for aquatic conservation. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 26(5), 986–994.
<https://doi.org/10.1002/aqc.2714>
- González-Riancho, P., Gerkenmeier, B., & Ratter, B. (2017). Storm surge resilience and the Sendai Framework: Risk perception, intention to prepare and enhanced collaboration along the German North Sea coast. *Ocean & Coastal Management*, 141, 118–131.
<https://doi.org/10.1016/j.ocecoaman.2017.03.006>
- Gray, S., Gagnon, A. S., Gray, S. A., O'Dwyer, B., O'Mahony, C., Muir, D., Devoy, R., Falaleeva, M., & Gault, J. (2014). Are coastal managers detecting the problem? Assessing stakeholder perception of climate vulnerability using Fuzzy Cognitive Mapping. *Ocean & Coastal Management*, 94, 74–89. <https://doi.org/10.1016/j.ocecoaman.2013.11.008>

- Hache, I., Karius, V., & Eynatten, H. von (2020). Suspended particulate matter for sediment accumulation on inundated anthropogenic marshland in the southern North Sea – Potential, thresholds and limitations. *Continental Shelf Research*, 207, 104214.
<https://doi.org/10.1016/j.csr.2020.104214>
- Hammoudi Halat, D., Soltani, A., Dalli, R., Alsarraj, L., & Malki, A. (2023). Understanding and Fostering Mental Health and Well-Being among University Faculty: A Narrative Review. *Journal of Clinical Medicine*, 12(13), 4425. <https://doi.org/10.3390/jcm12134425>
- Harper, D. (2002). Talking about pictures: A case for photo elicitation. *Visual Studies*, 17(1), 13–26.
<https://doi.org/10.1080/14725860220137345>
- Harries, T., & Penning-Rowsell, E. (2011). Victim pressure, institutional inertia and climate change adaptation: The case of flood risk. *Global Environmental Change*, 21(1), 188–197.
<https://doi.org/10.1016/j.gloenvcha.2010.09.002>
- Hemmerling, S. A., DeMyers, C. A., & Carruthers, T. J. B. (2022). Building Resilience through Collaborative Management of Coastal Protection and Restoration Planning in Plaquemines Parish, Louisiana, USA. *Sustainability*, 14(5), 2974. <https://doi.org/10.3390/su14052974>
- Heron, S. F., Day, J. C., Zijlstra, R., Engels, B., Weber, A., Marencic, H., & Busch, J. A. (2020). *Workshop report: Climate Risk Assessment for Wadden Sea World Heritage property*.
https://rijkewaddenzee.nl/wp-content/uploads/2020/12/2020_cvi-workshop-report-1.pdf
- Hoerterer, C., Schupp, M. F., Benkens, A., Nickiewicz, D., Krause, G., & Buck, B. H. (2020). Stakeholder Perspectives on Opportunities and Challenges in Achieving Sustainable Growth of the Blue Economy in a Changing Climate. *Frontiers in Marine Science*, 6, Article 795.
<https://doi.org/10.3389/fmars.2019.00795>
- Hofstede, J. L. A. (2019). On the feasibility of managed retreat in the Wadden Sea of Schleswig-Holstein. *Journal of Coastal Conservation*, 23(6), 1069–1079.
<https://doi.org/10.1007/s11852-019-00714-x>
- Hofstede, J. L. A., & Stock, M. (2018). Climate change adaptation in the Schleswig-Holstein sector of the Wadden Sea: An integrated state governmental strategy. *Journal of Coastal Conservation*, 22(1), 199–207. <https://doi.org/10.1007/s11852-016-0433-0>
- Holling, C. S. (1996). *Engineering Within Ecological Constraints*. National Academies Press.
- Holling, C. S., & Gunderson, L. H. (2002). *Resilience and adaptive cycles*. Washington, D.C.: Island Press. <https://vtechworks.lib.vt.edu/handle/10919/67621>
- Hyseni Duraku, Z., Davis, H., & Hamiti, E. (2023). Mental health, study skills, social support, and barriers to seeking psychological help among university students: A call for mental health support in higher education. *Frontiers in Public Health*, 11, 1220614.
<https://doi.org/10.3389/fpubh.2023.1220614>

- Jefferson, R., McKinley, E., Griffin, H., Nimmo, A., & Fletcher, S [Stephen] (2021). Public Perceptions of the Ocean: Lessons for Marine Conservation From a Global Research Review. *Frontiers in Marine Science*, 8, Article 711245. <https://doi.org/10.3389/fmars.2021.711245>
- Jordan, P., Döring, M., Fröhle, P., & Ratter, B. (2023). Exploring past and present dynamics of coastal protection as possible signposts for the future? A case study on the Islands of Amrum and Föhr in the North ... *Journal of Coastal Conservation*, 27(1). <https://link.springer.com/article/10.1007/s11852-022-00921-z>
- Juan, S. de, Gelcich, S [S.], & Fernandez, M. (2017). Integrating stakeholder perceptions and preferences on ecosystem services in the management of coastal areas. *Ocean & Coastal Management*, 136, 38–48. <https://doi.org/10.1016/j.ocecoaman.2016.11.019>
- Kallio, H., Pietilä, A.-M., Johnson, M., & Kangasniemi, M. (2016). Systematic methodological review: Developing a framework for a qualitative semi-structured interview guide. *Journal of Advanced Nursing*, 72(12), 2954–2965. <https://doi.org/10.1111/jan.13031>
- Karius, V., Schindler, M., Deicke, M., & Eynatten, H. von (2016). Sedimentologische Untersuchungen auf den Halligen. <https://core.ac.uk/download/pdf/326242393.pdf#page=103>
- Karrasch, L., Restemeyer, B., & Klenke, T. (2021). The ‘Flood Resilience Rose’: A management tool to promote transformation towards flood resilience. *Journal of Flood Risk Management*, 14(3), e12726. <https://doi.org/10.1111/jfr3.12726>
- Karrasch, L., Siebenhüner, B., & Seibert, S. L. (2023). Groundwater salinization in northwestern Germany: A case of anticipatory governance in the field of climate adaptation? *Earth System Governance*, 17, 100179. <https://doi.org/10.1016/j.esg.2023.100179>
- Kempenaar, A., Laeni, N [Naim], van den Brink, M., Busscher, T., & Ovink, H. (2022). ‘Water as Leverage’: Design-led planning for urban climate resilience. *Planning Practice & Research*, 39(1), 72–92. <https://doi.org/10.1080/02697459.2022.2104322>
- Kettle, N. P., & Dow, K. (2016). The Role of Perceived Risk, Uncertainty, and Trust on Coastal Climate Change Adaptation Planning. *Environment and Behavior*, 48(4), 579–606. <https://doi.org/10.1177/0013916514551049>
- Knottnerus, O. S. (2005). History of human settlement, cultural change and interference with the marine environment. *Helgoland Marine Research*, 59(1), 2–8. <https://doi.org/10.1007/s10152-004-0201-7>
- Kock, K. (2015). *Das Watt: Lebensraum auf den zweiten Blick*. Schutzstation Wattenmeer.
- Laeni, N [N.], van den Brink, M., & Arts, J. (2019). Is Bangkok becoming more resilient to flooding? A framing analysis of Bangkok's flood resilience policy combining insights from both insiders and outsiders. *Cities*, 90, 157–167. <https://doi.org/10.1016/j.cities.2019.02.002>

- Laeni, N [N.], van den Brink, M., Trelle, E. M., & Arts, E. (2021). Going Dutch in the Mekong Delta: A framing perspective on water policy translation. *Journal of Environmental Policy & Planning*, 23(1), 16–33. <https://doi.org/10.1080/1523908X.2020.1792858>
- Lau, R. W. K., & Pretorius, L. (2019). Intrapersonal Wellbeing and the Academic Mental Health Crisis. In L. Pretorius, L. Macaulay, & B. Cahusac de Caux (Eds.), *Springer eBooks Education. Wellbeing in Doctoral Education: Insights and Guidance from the Student Experience* (1st ed. 2019, pp. 37–45). Springer. https://doi.org/10.1007/978-981-13-9302-0_5
- Lazarus, E. (2017). Toward a Global Classification of Coastal Anthromes. *Land*, 6(1), 13. <https://doi.org/10.3390/land6010013>
- Liao, K.-H. (2014). From flood control to flood adaptation: A case study on the Lower Green River Valley and the City of Kent in King County, Washington. *Natural Hazards*, 71(1), 723–750. <https://doi.org/10.1007/s11069-013-0923-4>
- Liburd, J., & Walsh, C. (2022). Beyond sustainable development at the Wadden Sea: Towards a regenerative paradigm. *Trilateral Wadden Sea Cooperation : Annual Report 2022*, 4–10. <https://portal.findresearcher.sdu.dk/en/publications/beyond-sustainable-development-at-the-wadden-sea-towards-a-regene>
- LKN.SH. (2022). *Generalplan Küstenschutz des Landes Schleswig-Holstein: Fortschreibung 2022*.
- Lloyd, M. G., Peel, D., & Duck, R. W. (2013). Towards a social–ecological resilience framework for coastal planning. *Land Use Policy*, 30(1), 925–933. <https://doi.org/10.1016/j.landusepol.2012.06.012>
- Loorbach, D. (2010). Transition Management for Sustainable Development: A Prescriptive, Complexity-Based Governance Framework. *Governance*, 23(1), 161–183. <https://doi.org/10.1111/j.1468-0491.2009.01471.x>
- Lotze, H. K., Guest, H., O'Leary, J., Tuda, A., & Wallace, D. (2018). Public perceptions of marine threats and protection from around the world. *Ocean & Coastal Management*, 152, 14–22. <https://doi.org/10.1016/j.ocecoaman.2017.11.004>
- Lotze, H. K., Reise, K., Worm, B., van Beusekom, J., Busch, M., Ehlers, A., Heinrich, D., Hoffmann, R. C., Holm, P., Jensen, C., Knottnerus, O. S., Langhanki, N., Prummel, W., Vollmer, M., & Wolff, W. J. (2005). Human transformations of the Wadden Sea ecosystem through time: A synthesis. *Helgoland Marine Research*, 59(1), 84–95. <https://doi.org/10.1007/s10152-004-0209-z>
- Mason, C. M., Lim-Camacho, L., Scheepers, K., & Parr, J. M. (2015). Testing the water: Understanding stakeholder readiness for strategic coastal and marine management. *Ocean & Coastal Management*, 104, 45–56. <https://doi.org/10.1016/j.ocecoaman.2014.12.001>

- Masselink, G., & Lazarus, E. (2019). Defining Coastal Resilience. *Water*, 11(12), 2587.
<https://doi.org/10.3390/w11122587>
- Mayring, P. (2022). *Qualitative inhaltsanalyse: Grundlagen und techniken* (13. ed., revised edition). Beltz. <https://ixtheo.de/record/239883667>
- McClymont, K., Morrison, D., Beevers, L., & Carmen, E. (2020). Flood resilience: A systematic review. *Journal of Environmental Planning and Management*, 63(7), 1151–1176.
<https://doi.org/10.1080/09640568.2019.1641474>
- McElduff, L., & Ritchie, H. (2018). Fostering coastal community resilience: Mobilising people-place relationships. *Area*, 50(2), 186–194. <https://doi.org/10.1111/area.12419>
- Meerow, S., & Newell, J. P. (2021). Urban resilience for whom, what, when, where, and why? In *Geographic Perspectives on Urban Sustainability* (pp. 43–63). Routledge.
<https://doi.org/10.4324/9781003130185-3>
- Meinke, I., & Weisse, R. (2024). *Nordseesturmfluten im Klimawandel: Perspektiven der Küstenentwicklung* (Januar 2024). Helmholtz-Zentrum hereon GmbH.
https://www.researchgate.net/publication/377401447_NORDSEESTURMFLUTEN_IM_KLIMA_WANDEL_Perspektiven_der_Kuestenentwicklung
- Montz, B. E., & Tobin, G. A. (2008). Livin' Large with Levees: Lessons Learned and Lost. *Natural Hazards Review*, 9(3), 150–157. [https://doi.org/10.1061/\(ASCE\)1527-6988\(2008\)9:3\(150\)](https://doi.org/10.1061/(ASCE)1527-6988(2008)9:3(150))
- Moraes, R. P. L., Reguero, B. G., Mazarrasa, I., Ricker, M., & Juanes, J. A. (2022). Nature-Based Solutions in Coastal and Estuarine Areas of Europe. *Frontiers in Environmental Science*, 10, Article 829526. <https://doi.org/10.3389/fenvs.2022.829526>
- Morris, R. L., Konlechner, T. M., Ghisalberti, M., & Swearer, S. E. (2018). From grey to green: Efficacy of eco-engineering solutions for nature-based coastal defence. *Global Change Biology*, 24(5), 1827–1842. <https://doi.org/10.1111/gcb.14063>
- Nationalpark Wattenmeer. (2024, February 6). *Nationalpark Schleswig-Holsteinisches Wattenmeer - Nationalpark Wattenmeer*. <https://www.nationalpark-wattenmeer.de/sh/>
- Norton, R. K. (2022). Planning for Resilient and Sustainable Coastal Shorelands and Communities in the Face of Global Climate Change. In *Oxford Research Encyclopedia of Environmental Science*. <https://doi.org/10.1093/acrefore/9780199389414.013.817>
- Oost, A. P., Winter, C., Vos, P., Bungenstock, F., Schrijvershof, R., Rübke, B., Bartholdy, J., Hofstede, J. L. A., Wurpts, A., & Wehrmann, A. (2017). *Wadden Sea Quality Status Report: Geomorphology*.
- Oppenheimer, M., Glavovic, B. C., Hinkel, J., van de Wal, R., Magnan, A. K., Abd-Elgawad, A., Cai, R., Cifuentes-Jara, M., DeConto, R. M., Ghosh, T., Hay, J., Isla, F., Marzeion, B., Meyssignac, B., & Sebesvari, Z. (2019). Chapter 4: Sea Level Rise and Implications for Low-Lying Islands, Coasts

- and Communities. *IPCC Special Report on the Ocean and Cryosphere in a Changing Climate*. <https://www.ipcc.ch/srocc/chapter/chapter-4-sea-level-rise-and-implications-for-low-lying-islands-coasts-and-communities/>
- Osswald, F., Dolch, T., & Reise, K. (2019). Remobilizing stabilized island dunes for keeping up with sea level rise? *Journal of Coastal Conservation*, 23(3), 675–687. <https://doi.org/10.1007/s11852-019-00697-9>
- Parker, D. J. (1995). Floodplain development policy in England and Wales. *Applied Geography*, 15(4), 341–363. [https://doi.org/10.1016/0143-6228\(95\)00016-w](https://doi.org/10.1016/0143-6228(95)00016-w)
- Porter, L., & Davoudi, S. (2012). The politics of resilience for planning: A cautionary note. *Planning Theory and Practice*, 13(2), 329–333. <https://scholar.google.de/citations?user=y3bizmeaaaaj&hl=de&oi=sra>
- Portner, H. O., Roberts, D. C., & Constable, A. (2022). *IPCC, 2022: summary for policymakers*. https://figshare.utas.edu.au/articles/report/ipcc_2022_summary_for_policymakers/23200403/1
- Powell, E. J., Tyrrell, M. C., Milliken, A., Tirpak, J. M., & Staudinger, M. D. (2019). A review of coastal management approaches to support the integration of ecological and human community planning for climate change. *Journal of Coastal Conservation*, 23(1), 1–18. <https://doi.org/10.1007/s11852-018-0632-y>
- Ratter, B., & Leyshon, C. (2021). Perceptions of and Resilience to Coastal Climate Risks. In *Oxford Research Encyclopedia of Climate Science*. <https://doi.org/10.1093/acrefore/9780190228620.013.819>
- Ratter, B., & Walsh, C. (2019). Küstenlandschaften. *Handbuch Landschaft*, 699–710. https://doi.org/10.1007/978-3-658-25746-0_56
- Refugio-Coronado, S., Lacasse, K., Dalton, T., Humphries, A., Basu, S., Uchida, H., & Uchida, E. (2021). Coastal and Marine Socio-Ecological Systems: A Systematic Review of the Literature. *Frontiers in Marine Science*, 8, Article 648006, 648006. <https://doi.org/10.3389/fmars.2021.648006>
- Reise, K. (2016). *Kurswechsel Küste: Was tun, wenn die Nordsee steigt? Kurswechsel Küste: Was tun, wenn die Nordsee steigt? Kurs Universität Giessen*. <https://epic.awi.de/43357/>
- Restemeyer, B. (2018). Planning for flood resilient cities: From promise to practice? <https://research.rug.nl/en/publications/planning-for-flood-resilient-cities-from-promise-to-practice>
- Restemeyer, B., van den Brink, M., & Woltjer, J. (2017). Between adaptability and the urge to control: Making long-term water policies in the Netherlands. *Journal of Environmental Planning and Management*, 60(5), 920–940. <https://doi.org/10.1080/09640568.2016.1189403>

- Richard, V. M., & Lahman, M. K. (2015). Photo-elicitation: Reflexivity on method, analysis, and graphic portraits. *International Journal of Research & Method in Education*, 38(1), 3–22. <https://doi.org/10.1080/1743727X.2013.843073>
- Rockström, J., Falkenmark, M., Allan, T., Folke, C., Gordon, L., Jägerskog, A., Kummu, M., Lannerstad, M., Meybeck, M., Molden, D., Postel, S., Savenije, H., Svedin, U., Turton, A., & Varis, O. (2014). The unfolding water drama in the Anthropocene: Towards a resilience-based perspective on water for global sustainability. *Ecohydrology*, 7(5), 1249–1261. <https://doi.org/10.1002/eco.1562>
- Rölfer, L., Celliers, L., & Abson, D. J. (2022). Resilience and coastal governance: knowledge and navigation between stability and transformation. *Ecology and Society*, 27(2). <https://doi.org/10.5751/ES-13244-270240>
- Roo, G. de. (2016a). Actor Consulting: A Model to Handle Fuzziness in Planning. In *Fuzzy Planning* (pp. 131–150). Routledge. <https://doi.org/10.4324/9781315583730-10>
- Roo, G. de. (2016b). *A Planner's Encounter with Complexity. New Directions in Planning Theory*. Taylor and Francis.
- Saleh, F., & Weinstein, M. P. (2016). The role of nature-based infrastructure (NBI) in coastal resiliency planning: A literature review. *Journal of Environmental Management*, 183(Pt 3), 1088–1098. <https://doi.org/10.1016/j.jenvman.2016.09.077>
- Schindler, M. (2015). *Challenges and perspectives of the North Frisian Halligen Hooge, Langeness and Nordstrandischmoor: Marshland accretion and adaptation capacity to sea-level-rise*. University Goettingen Repository. <https://doi.org/10.53846/goediss-4959>
- Schmidtke, K.-D., & Lammers, W. (1993). *Die Entstehung Schleswig-Holsteins*. Wachholtz.
- Schön, D. A. (1993). Generative metaphor: A perspective on problem-setting in social policy. In *Metaphor and Thought* (2nd ed., pp. 137–163). Cambridge University Press. <https://doi.org/10.1017/cbo9781139173865.011>
- Schön, D. A., & Rein, M. (1995). Frame Reflection: Toward the Resolution of Intractable Policy Controversies. *Journal of Economic Issues*, 29(3), 965–968. <https://doi.org/10.1080/00213624.1995.11505729>
- Shaw, K. (2012). Reframing" resilience: Challenges for planning theory and practice. *Planning Theory and Practice*, 13(2), 308–312.
- Shaw, K., & Maythorne, L. (2013). Managing for local resilience: Towards a strategic approach. *Public Policy and Administration*, 28(1), 43–65. <https://doi.org/10.1177/0952076711432578>
- Siedschlag, D., & Gee, K. (2021). Climate Resilience on the Island of Pellworm: Balancing Multiple Layers in the Context of Climate Change. *Culture and Climate Resilience*, 97–118. https://doi.org/10.1007/978-3-030-58403-0_6

- Singhvi, A., Luijendijk, A. P., & van Oudenhoven, A. P. E. (2022). The grey - green spectrum: A review of coastal protection interventions. *Journal of Environmental Management*, 311, 114824. <https://doi.org/10.1016/j.jenvman.2022.114824>
- Steg, L., & Groot, J. I. M. de. (2019). *Environmental psychology: An introduction* (2. Auflage). BPS *Textbooks in Psychology*. Wiley.
- Steven, A., Kwasi, A., Addo, G., Llewellyn, V. T., & Vozzo, M. (2020). *Coastal Development: Resilience, Restoration and Infrastructure Requirements LEAD AUTHORS About the High Level Panel for a Sustainable Ocean Economy*. https://www.researchgate.net/profile/ca-vu/publication/346517536_coastal_development_resilience_restoration_and_infrastructure_requirements_lead_authors_about_the_high_level_panel_for_a_sustainable_ocean_economy
- Susskind, L. E., & Landry, E. M. (1991). Implementing a Mutual Gains Approach to Collective Bargaining. *Negotiation Journal*, 7(1), 5–10. <https://doi.org/10.1111/j.1571-9979.1991.tb00597.x>
- Sutton-Grier, A. E., Wowk, K., & Bamford, H. (2015). Future of our coasts: The potential for natural and hybrid infrastructure to enhance the resilience of our coastal communities, economies and ecosystems. *Environmental Science & Policy*, 51, 137–148. <https://doi.org/10.1016/j.envsci.2015.04.006>
- Temmerman, S., Meire, P., Bouma, T. J., Herman, P. M. J., Ysebaert, T., & Vriend, H. J. de [Huib J.] (2013). Ecosystem-based coastal defence in the face of global change. *Nature*, 504(7478), 79–83. <https://doi.org/10.1038/nature12859>
- Terton, A., & Greenwalt, J. (2020). *Building resilience with nature: Ecosystem-based adaptation in National Adaptation Plan processes*.
- Tobin, G. A. (1995). The LEVEE LOVE AFFAIR: A STORMY RELATIONSHIP? 1. *JAWRA Journal of the American Water Resources Association*, 31(3), 359–367. <https://doi.org/10.1111/j.1752-1688.1995.tb04025.x>
- Torio, D. D., & Chmura, G. L. (2013). Assessing Coastal Squeeze of Tidal Wetlands. *Journal of Coastal Research*, 290(5), 1049–1061. <https://doi.org/10.2112/JCOASTRES-D-12-00162.1>
- Townend, I., French, J., Nicholls, R., Brown, S., Carpenter, S [Stephen], Haigh, I., Hill, C., Lazarus, E., Penning-Rowsell, E., Thompson, C., & Tompkins, E. (2022). *Operationalising coastal resilience to flood and erosion hazard: A demonstration for England*. California Digital Library (CDL). <https://doi.org/10.31223/x5z31h>
- Trell, E. M., Restemeyer, B., Bakema, M. M., & van Hoven, B. (2017). Governing for Resilience in Vulnerable Places: An introduction. *Governing for Resilience in Vulnerable Places*, 7–14.

- Tubridy, F., Walsh, C., Lennon, M., & Scott, M. (2022). Contextualising coastal management and adaptation: Examining situated practices and path dependencies in Ireland and Germany. *Ocean & Coastal Management*, 220, 106095. <https://doi.org/10.1016/j.ocecoaman.2022.106095>
- United Nations World Water Assessment Programme. (2018). *The United Nations World Water Development Report 2018: Nature-Based Solutions for Water*. UNESCO.
- Urbina-Garcia, A. (2020). What do we know about university academics' mental health? A systematic literature review. *Stress and Health*, 36(5), 563–585. <https://doi.org/10.1002/smi.2956>
- van den Brink, M. (2009). *Rijkswaterstaat on the horns of a dilemma*. Zugl.: Nijmegen, Univ., Diss., 2009. Eburon.
- van den Brink, M., van den Brink, A., & Bruns, D. (2022). Boundary thinking in landscape architecture and boundary-spanning roles of landscape architects. *Landscape Research*, 47(8), 1087–1099. <https://doi.org/10.1080/01426397.2022.2091121>
- van der Brugge, R., Rotmans, J., & Loorbach, D. (2005). The transition in Dutch water management. *Regional Environmental Change*, 5(4), 164–176. <https://doi.org/10.1007/s10113-004-0086-7>
- van Hulst, M., & Yanow, D. (2016). From Policy “Frames” to “Framing”. *The American Review of Public Administration*, 46(1), 92–112. <https://doi.org/10.1177/0275074014533142>
- van Slobbe, E., Vriend, H. J. de [H. J.], Aarninkhof, S., Lulofs, K., Vries, M. de, & Dircke, P. (2013). Building with Nature: In search of resilient storm surge protection strategies. *Natural Hazards*, 66(3), 1461–1480. <https://doi.org/10.1007/s11069-013-0612-3>
- Vanderlinden, J.-P., Baztan, J., Touili, N., Kane, I. O., Rulleau, B., Simal, P. D., Pietrantoni, L., Prati, G., & Zagonari, F. (2017). Coastal Flooding, Uncertainty and Climate Change: Science as a Solution to (mis) Perceptions? A Qualitative Enquiry in Three Coastal European Settings. *Journal of Coastal Research*, 77(77 (10077)), 127–133. <https://doi.org/10.2112/SI77-013.1>
- Vojinovic, Z. (2020). *Nature-based solutions for flood mitigation and coastal resilience: analysis of EU-funded projects*. <https://scholar.google.de/citations?user=oavofqsaaj&hl=de&oi=sra>
- WAKOS project. (2024, March 23). *Projekt WAKOS*. <https://ms.hereon.de/wakos/index.php.de>
- Walker, B., Salt, D., & Reid, W. (2012). *Resilience thinking: Sustaining ecosystems and people in a changing world*. Island Press.
- Walsh, C. (2018). Metageographies of coastal management: Negotiating spaces of nature and culture at the Wadden Sea. *Area*, 50(2), 177–185. <https://doi.org/10.1111/area.12404>
- Walsh, C. (2020). Landscape Imaginaries and the Protection of Dynamic Nature at the Wadden Sea. *Rural Landscapes: Society, Environment, History*, 7(1), Article 1. <https://doi.org/10.16993/rl.55>

- Walsh, C., & Döring, M. (2018). Cultural geographies of coastal change. *Area*, 50(2), 146–149.
<https://doi.org/10.1111/area.12434>
- Walsh, C., & Kannen, A. (2019). Planning at Sea: Shifting planning practices at the German North Sea coast. *Raumforschung Und Raumordnung | Spatial Research and Planning*, 77(2), 147–164.
<https://doi.org/10.2478/rara-2019-0020>
- Wardekker, A. (2021). Contrasting the framing of urban climate resilience. *Sustainable Cities and Society*, 75, 103258. <https://doi.org/10.1016/j.scs.2021.103258>
- White, I., & O'Hare, P. (2014). From Rhetoric to Reality: Which Resilience, Why Resilience, and Whose Resilience in Spatial Planning? *Environment and Planning C: Government and Policy*, 32(5), 934–950. <https://doi.org/10.1068/c12117>
- Yin, R. K. (2003). *Case study research: Design and methods* (3. ed.). *Applied social research methods series: Vol. 5*. SAGE.
- Zari, M. P., Kiddle, G. L., Blaschke, P., Gawler, S., & Loubser, D. (2019). Utilising nature-based solutions to increase resilience in Pacific Ocean Cities. *Ecosystem Services*, 38, 100968.
<https://doi.org/10.1016/j.ecoser.2019.100968>
- Zuidema, C. (2016). *Decentralization in environmental governance: A post-contingency approach*. *New Directions in Planning Theory*. Routledge.

Appendix

A1: Information sheet for the interview (based on a template from the University of Groningen)

Information sheet – Research Ethics Committee (REC)

for masters thesis research project:

Title: Exploring the relevance and perception of non-conventional coastal protection measures to increase coastal resilience at the Schleswig-Holstein Wadden Sea

by Nina C. Lindstedt

Thank you very much for taking the time to consider getting involved in my master thesis research project.

The master's thesis with the above mentioned title focuses on coastal management and coastal resilience at the Schleswig-Holstein Wadden Sea, which are becoming increasingly important in the face of the challenges caused by climate change. I am investigating the relevance and perception of non-conventional coastal protection measures, such as nature-based solutions (e.g. renaturation of salt marshes), to strengthen the resilience of coastal areas. In order to link the theoretical findings in my master's thesis with expert opinions and insights from practice, I would like to request an interview with you to contribute to the success of my master's thesis with your experience and expertise. Below you can find information on confidentiality and the participant rights that would apply during an interview and would be ensured by a corresponding data protection agreement.

Confidentiality and participant rights

- The interviews will be audio-recorded and notes will be taken during the interview.
- You have the right to ask to have the recording turned off whenever you decide and you may also end the interview at any time.
- If you wish you will be sent a copy of the interview notes directly, and you will have the opportunity to make corrections or request the erasure of any materials you do not wish to be used.
- The information you provide will be kept confidentially in a locked facility or in a password protected file on my computer up to five years upon completion of my research.
- The main use of the information you provide will help me towards my masters thesis, which upon completion will publicly be available on Internet.
- The data may also be used for articles, book chapters, published and unpublished work and presentations.
- Your personal data / name or any other information which would serve to identify you as an informant will not be included in this research or in any future publication or reports resulting from this project.

As a participant you have the right to:

- decline to participate;
- decline to answer any particular question;
- ask for the audio-recorder to be turned off at any time;
- end the interview at any time
- withdraw from the study up until the moment the research has been published;
- ask any questions about the study at any time during participation; and
- ask for the erasure of any materials you do not wish to be used in any reports of this study.

Once again, I thank you for taking the time to find out more about my research. I am at your disposal for any questions you might have. You can also contact my supervisor at the address below.

I would be very happy if you would be willing to participate in an interview for my Master thesis.

Yours sincerely,
Nina C. Lindstedt

<i>Researcher contact details:</i> Nina C. Lindstedt n.c.lindstedt@student.rug.nl OR nina.caroline.lindstedt@uni-oldenburg.de	<i>Main Supervisor contact details:</i> Elen-Maarja Trell-Zuidema, Dr. e.m.trell@rug.nl
--	---

A2: Consent form for the interview (based on a template from the University of Groningen)

Agreement to participate - Research Ethics Committee (REC)

in research project:

Title: Exploring the relevance and perception of non-conventional coastal protection measures to increase coastal resilience at the Schleswig-Holstein Wadden Sea

by Nina C. Lindstedt

The *purpose of this research* is to explore the relevance and perception of non-conventional coastal protection measures (such as nature-based solutions) to increase coastal resilience at the Schleswig-Holstein Wadden Sea. The research focuses on key actors' perception of different coastal protection measures and is in particular interested in questions about coastal resilience and coastal management practice at the Schleswig-Holstein Wadden Sea.

- I have read and I understand the information sheet of the research project.
- I understand that taking part in this research is voluntary and that I have the right to withdraw from it up to three weeks after the interview, as well as to decline to answer a question I do not wish to answer.
- I understand that my participation in this research is confidential. Without my prior consent, no material, which could identify me, will be used in any reports generated from this study.
- I understand that the interview data will be used in a master thesis publicly available on the University of Groningen website and may be used in academic articles, book chapters, published and unpublished work and presentations.
- I understand that all information I provide will be kept confidentially either in a locked facility or as a password protected encrypted file on a password protected computer.

Please highlight with **highlighting/circling** YES or NO to each of the following:

I consent to my interview being audio-recorded YES / NO

I wish to remain anonymous for this research YES / NO

If YES

My first name can be used for this research YES / NO

OR

A pseudonym of my own choosing can be used in this research YES / NO

If you wish to choose own pseudonym, please mark it here:

“I agree to participate in this interview and acknowledge receipt of a copy of this consent form and the research project information sheet.”

Signature of participant: _____ Date: _____

“I agree to abide by the conditions set out in the information sheet and I ensure no harm will be done to any participant during this research.”

Signature of researcher: _____ Date: _____

A3: Interview guide with pictures

Interview Questions*	Purpose - Which concept(s) does the question address?
0. Organisational stuff / introduction	Gaining consent for interview and recording, creating comfortable and open space
1. How are you connected to the WS? (What does the Wadden Sea mean to you?)	Place attachment
2. Profession: What do you do for a living at the Wadden Sea?	Getting to know interviewee, social identity
3. What points of contact do you have with coastal protection?	Introduction to the topic, social identity
4. Have you had any personal experience with flooding in the last ten years?	Experience
5. Speaking of flooding: What impacts do you think climate change will have on the Wadden Sea? ... With the socio-economic space on the one hand and the Wadden Sea as an ecosystem on the other, do you think that the current coastal management and coastal planning will be able to deal with this?	Coastal resilience perspective
6. Would you say that the challenges caused by climate change are predictable (and manageable)?	Coastal resilience perspective
7. In your opinion, is coastal protection more about adaptation and possibly transformation or about maintaining the coast/the Wadden Sea in its current state?	Coastal resilience perspective
8. Who should be involved in coastal protection?	Coastal resilience perspective
9. Do you see changes in how coastal protection is done today versus in the past?	Path dependency, social identity
10. Please take a look at the following pictures** and name three key points that come to mind when you look at them. Are these measures suitable for the Schleswig-Holstein Wadden Sea? What challenges or obstacles do you see with regard to implementation?	Conventional vs. non-conventional coastal protection measures
11. What would you see as desirable for coastal protection at the Wadden Sea, especially with regards to the increasing challenges caused by climate change? What obstacles	Coastal resilience (developing a vision), path dependencies, experience

might stand in the way to this vision? (How) Could your stakeholder group contribute to this vision?	
12. Are there any guidelines or other documents that are relevant in the context of your work?	Policy Document Analysis

**Please note: The interview questions slightly differed between participants depending on their professional background.*

****Making use of photo elicitation for interview question 10:**

a) *Dike with groynes and revetment as a conventional coastal protection measure*



Source [Nov 16, 2023]: <https://weites.land/wp-content/uploads/2021/10/Klimadeich-Nordseekueste-1-800x533.jpg>

b) *Zandmotor as a beach nourishment and/or nature-based solution*



Source [Nov 16, 2023]: https://rijkswaterstaat.imgix.net/zandmotor-in-2020_tcm26-282627.jpg

c) Saltmarsh (in combination with dunes) as a nature-based solutions



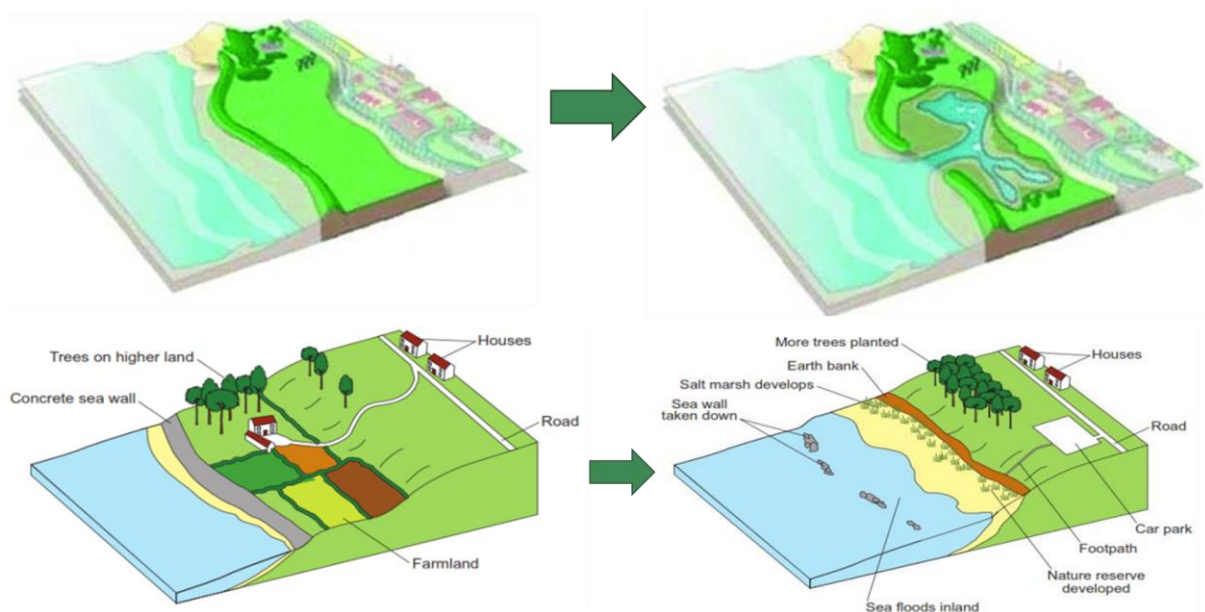
Source [Nov 16, 2023]: <https://www.ecomare.nl/wp-content/uploads/2017/05/header-kwelder.jpg>

d) Halligen as an accommodating measure



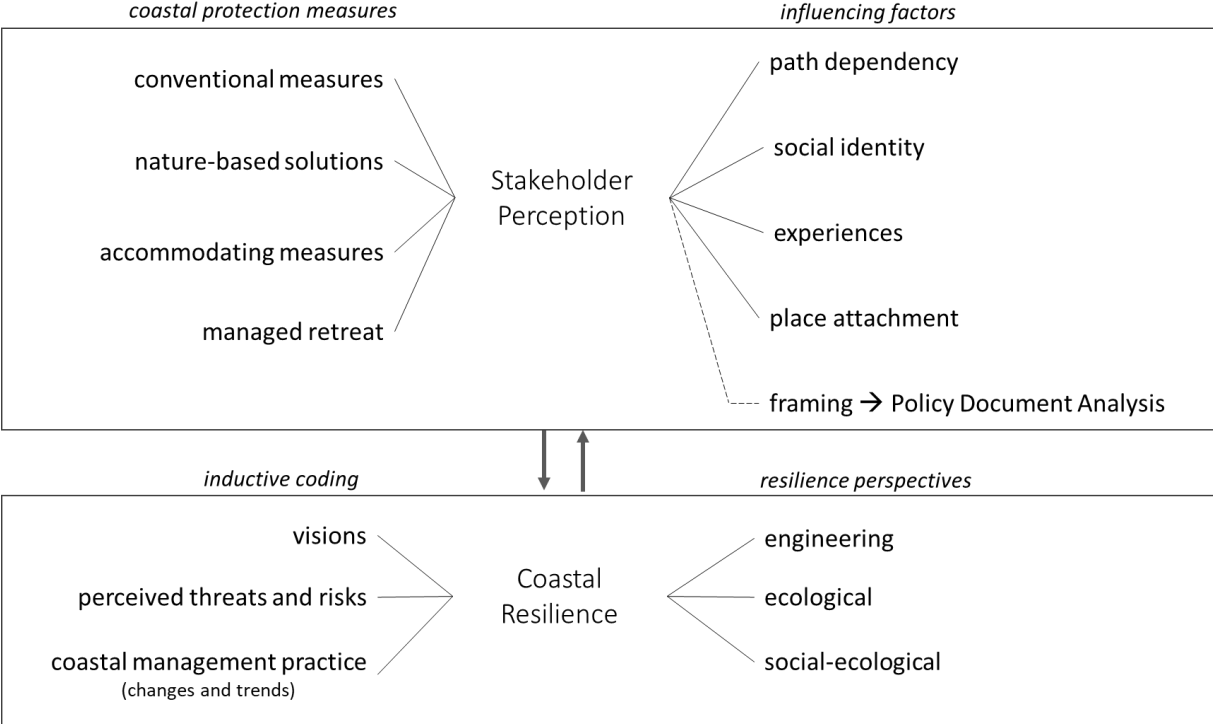
Source [Nov 16, 2023]: https://www.planet-wissen.de/kultur/nordsee/halligen_weiten_zwischen_den_wassern/introhalligenhausajpa100~v-aseopremiumxl.jpg

e) Visual for managed realignment and managed retreat



Source [Nov 16, 2023]: <https://www.researchgate.net/publication/216584246/figure/fig24/AS:669567999295489@1536648859085/The-process-of-managed-realignment.png>

A4: Coding Tree



A5: Policy Document Analysis

Document production and location			Authorship and audience			Policy context			Policy text and content analysis with a focus on resilience			Policy consequences		
Policy Document	Year, location and access	Authorship (stakeholder group)	Target audience	Purpose of the document	Resilience mentioned (yes/no)	5 W+H of resilience framework	Framing of resilience and its operationalization (opaque/clear)	Non-conventional measures mentioned (yes/no)	Intended impact	Monitoring and review				
Strategy for the Wadden Sea 2100	Year: 2015 Location: Kiel Access: easy	Government: former Ministry for Agriculture, Environment, and Rural Development of Schleswig-Holstein (MELUR)	Stakeholders at the Schleswig-Holstein Wadden Sea	The aim of the strategy is the long-term preservation of the Wadden Sea in its functions for coastal protection and nature conservation.	yes, once	<p>Resilience for</p> <p>..whom?: the Wadden Sea as an ecosystem</p> <p>..what?: climate change and sea level rise</p> <p>..where?: Wadden Sea (Schleswig-Holstein part)</p> <p>..when?: in the second half of this century; at the latest</p> <p>..why?: due to sea level rise, which will have a negative impact on the Wadden Sea (loss of mudflats and salt marshes)</p> <p>..how?: compensating for the sediment deficit caused by sea level rise (sand nourishment)</p>	Resilience framed vaguely as "the natural adaptive capacity of the Wadden Sea in the face of climate change" which can be operationalized by allowing and promoting natural processes and by avoiding measures that interfere with natural dynamics	yes, sand nourishment as a potential measure for the future to preserve the Wadden Sea (not needed until the second half of this century)	Nature conservation and coastal protection should develop a common understanding of the Wadden Sea and the challenges caused by climate change through the creation of the strategy	Monitoring and projects needed for various aspects (see knowledge gaps in the strategy)				
General Plan for Coastal Protection of the State Schleswig-Holstein. Continuation 2022.	Year: 2022 Location: Kiel Access: easy	Government: former Ministry for Agriculture, Environment and Digitalization of Schleswig-Holstein (MELUND)	Plan as a basis and rationale for those who make decisions with regard to coastal protection; but also relevant for all people living and working in Schleswig-Holstein	Fifth continuation of the General Plan for Coastal Protection with the focus on dealing with anthropogenic climate change and its consequences in the area coastal protection	yes, five times	<p>Resilience for (not clearly defined)</p> <p>..whom?: people, infrastructure/material assets, Helliggen, islands, Wadden Sea</p> <p>..what?: climate change</p> <p>..where?: Schleswig-Holstein</p> <p>..when?: 2022-2036</p> <p>..why?: flooding, coastal erosion</p> <p>..how?: emphasis on climate adaptation measures that are flexible and adjustable as well as efficient and robust</p>	Framed in terms of "climate-resilient and climate-adapted forms of use" -> very opaque and vague framing of resilience	yes, saltmarshes and foreshore management + sand nourishment	Objective of the state government of Schleswig-Holstein are coastal regions that are adapted to the consequences of climate change in the long term, firstly through sustainable coastal protection measures and secondly through climate-resilient and climate-adapted forms of land use.	Regular continuation/ update (no fixed rhythm, about every 10 years)				

Document production and location	Year, location and access	Authorship (stakeholder group)	Target audience	Policy context	Resilience mentioned (yes/no)	5-W-H of resilience framework	Framing of resilience and its operationalization (opaque/clear)	Non-conventional measures mentioned (yes/no)	Intended impact	Monitoring and review
Land Development Plan for Schleswig-Holstein. Continuation 2021.	Year: 2021 Location: Kiel Access: easy	Planning Agency for Schleswig-Holstein	Plan as a basis/guideline and rationale for those who make decisions with regard to different land uses; but also uses of land and sea people living and working in Schleswig-Holstein	The stipulations in the plan, the so-called objectives and principles of spatial development, are intended to coordinate the different potential uses of land and sea areas and to avoid conflicts.	no	/	Framed indirectly as the protection of people, settlements, material assets and critical infrastructure from sea flooding and coastal erosion as well as the preservation of the Wadden Sea with its characteristic elements and functions; operationalization through coastal protection measures that are not further specified	1) Priority areas for coastal protection (accommodating measure) 2) Eco-friendly options for measures should be explored and be given preference in the consideration	The aim is to achieve sustainable spatial development in the state, taking equal account of economic, ecological and social concerns. Intended impact for coastal protection: designation of coastal priority zones to ensure coastal protection.	Valid for a planning period of 15 years (2022 to 2036); continuous monitoring of developments with partial updates as needed
Climate Change Adaptation Strategy	Year: February 5, 2014 Location: Tønder Access: easy	Ministerial Council Declaration of the 12th Triilateral Governmental Conference on the Protection of the Wadden Sea	All partners of the Triilateral Wadden Sea Cooperation	The triilateral cooperation aims at achieving resilience to climate change.	yes, 11 times	Resilience for ...whom?: Wadden Sea as an ecosystem ...what?: climate change (sea level rise, storm surges, precipitation patterns, increase in temperature) ...where?: triilateral Wadden Sea region ...when?: now ...why?: Climate change and enhanced sea level rise may seriously impact structure, functions and the characteristic biodiversity of the Wadden Sea ecosystem as well as the safety of the inhabitants in the region. ...how?: by implementing an adaptation strategy that consists of seven basic elements: Natural dynamics, Interconnectivity, Integration, Flexibility, Long-term approach, Site specific approach and Participation	Definition of resilience according to IPCC: "The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change." vague framing of operationalization: 7 principles are formulated together with priority areas for each, but their implementation is quite vague	Only vague, e.g. "Promote and support management measures that consider, allow and/or support natural dynamics." (p. 4)	1) Safeguarding and promoting the qualities and the integrity of the area as a natural and sustainable ecosystem whilst ensuring the safety of the inhabitants and visitors, as well as the cultural heritage and landscape assets and sustainable human use 2) Enhancing and promoting policies and measures necessary for increasing the resilience of the Wadden Sea to impacts of climate change 3) Achieving optimal added value by focusing on activities with the highest triilateral relevance	Monitoring by Task Group Climate

Document production and location	Year, location and access	Authorship (stakeholder group)	Target audience	Purpose of the document	Resilience mentioned (yes/no)	5 W+H of resilience framework	Framing of resilience and its operationalization (opaque/clear)	Non-conventional measures mentioned (yes/no)	Intended impact	Monitoring and review
The 2022 Call for Action for the Wadden Sea	Year: February 2022 Location: / Access: easy	Nature NGOs of the trilateral Wadden Sea Region (Danish, German, and Dutch NGOs)	14th Trilateral Conference on the Protection of the Wadden Sea in Wilhelmshaven	Making the 14th Trilateral Conference on the Protection of the Wadden Sea in Wilhelmshaven a success. The three countries need to recalibrate their Wadden Sea management and focus on measures for effective protection and implementation.	yes, once "...! we should place stronger emphasis on resilience of the ecosystem (e.g. by reducing the human footprint)" (p. 5)	Resilience for ...whom?: the Wadden Sea ecosystem ...what?: climate change ...where?: Trilateral Wadden Sea ...when?: as part of the 14th Trilateral Conference in November 2022 ...why?: strong increase in temperature and in sea level rise are resulting from climate change and will have major impacts on the Wadden Sea ...how?: structural decisions to strengthen the trilateral work for the Wadden Sea + nature-based solutions + update of the 2014 Climate Change Adaptation Strategy after 10 years	Resilience framed vaguely with regards to the ecosystem -> ecological resilience Relatively vague operationalization: nature-based solutions, local pilot projects, mutual sharing of more concrete regional strategies	yes, promotion of nature-based solutions like saltmarshes as win-win solution for nature conservation and coastal protection or win-win-win solutions with regards to carbon storage	Improving protection of the Wadden Sea by adhering to proposals and advice given in the document	Advice/Suggestion to update the strategy after 10 years based on best available knowledge and lessons learnt from pilot projects, while also considering the influence of reducing other pressures (p. 5)
Cuxhaven Declaration	Year: October 16, 2023 Location: Cuxhaven Access: easy	Schleswig-Holstein's Environment and Energy Minister Tobias Goldschmidt, Lower Saxony's Environment and Energy Minister Christian Meyer and the Environment and Energy Senator of the Free and Hanseatic City of Hamburg Jens Kerstan	All people living and working in Northern Germany (Lower Saxony, Schleswig-Holstein, Hamburg) and all those who have an interest in the economic development and/or ecological issues in this region	Declaration as a contribution to safeguarding the ecological balance in the Wadden Sea and the coastal region of northern Germany Response to concerns raised by the UNESCO with regards to the increasing infrastructure development in the Wadden Sea region	yes, four times	Resilience for ...whom?: the ecosystem Wadden Sea incl. the lower tidal part of the Elbe river + the Wadden Sea region (socio-economic) ...what?: future challenges caused by increasing economic use of the North Sea and climate change ...where?: (German) Wadden Sea ...when?: as of October 16, 2023 ...why?: economic stressors "those who use must also protect" ...how?: conservation measures in the terrestrial areas of the Wadden Sea National Parks for enhancing the natural dynamics in the tidal flats, forlands and dunes as well as on the islands and sands + marine ranger team to improve supervision of the national park on the seaward side + strengthening of the marine casualty command due to increasing usage and consequently shipping traffic + sustainable sediment management in rivers + driving forward the expansion of renewable energies on land and at sea (Energy transition region Northern Germany)	Although measures and actions to operationalize resilience are mentioned relatively explicitly, resilience itself is framed rather vaguely, as it is referred to in different ways: 1) resilience of the ecosystem Wadden Sea with regards to future climate challenges 2) resilient precautionary standard to meet future challenges 3) using sediment of the system for building dikes as an important contribution to climate resilience 4) natural coastal protection measures to strengthen the Wadden Sea region	yes, framed as "natural coastal protection measures" which are coastal protection measures aiming to achieve synergies between coastal protection and nature conservation (with regards to natural dynamics, biodiversity, or blue carbon storage) examples mentioned in the document: saltmarshes, seagrass meadow, and potential sedimentation areas in the estuaries of the Ems, Weser and Elbe	Commitment to shared responsibility for the protection and conservation of the Wadden Sea: Strengthening expanding environmental education, ensuring sustainable regional development	/

Acknowledgement

At the end I would like to express my gratitude to all those who supported me in the process of writing my Master thesis.

First of all, I would like to thank my main supervisor, Dr. Elen-Maarja Trell-Zuidema, for her excellent advice and support during my Master thesis. From finding the research topic to conducting it, her guidance and feedback were invaluable. She was always open to questions as well as new ideas and helped me through the ups and downs I encountered during my research.

Second, I would like to thank Dr. Cormac Walsh for agreeing to be the second reader for this thesis and for providing valuable suggestions and insights for the thesis prior to that due to his extensive expertise in this research area.

Third, I would like to thank all my interviewees very much for sharing their expertise and experiences with me. Their input from practice greatly enriched my Master thesis by not only complementing the theoretical background of this study, but also providing valuable insights into stakeholder perceptions of coastal resilience and coastal management practices at the Schleswig-Holstein Wadden Sea. I highly appreciated the willingness of each interviewee to support my Master thesis through insightful discussions, in which I also learned a great deal beyond the subject area of this thesis.

Last but not least, I would of course like to thank my family for their unconditional support, on which I can always rely.

