RESILIENCE TO WAD? EXPLORING DIFFERENT PERCEPTIONS OF RESILIENCE AND COASTAL PROTECTION MEASURES AMONG KEY STAKEHOLDERS AT THE GERMAN WADDEN SEA

Nina Caroline Lindstedt and Elen-Maarja Trell

With 5 figures and 4 tables
Received 28 February 2025 · Accepted 12 December 2025

Summary: Climate change is challenging coastal resilience worldwide, with hard engineering coastal protection measures reaching their limits and becoming increasingly unsustainable. The Wadden Sea, a UNESCO World Heritage natural site, illustrates this dilemma, hemmed in between a rigid dike line and an encroaching North Sea. While the term resilience gains traction in both policy and academia, its meaning remains contested: Is the goal to keep the shoreline unchanged, safeguard communities, protect ecosystems or something else? To clarify what Resilience to Wad could look like, we examine how key actors along the Schleswig-Holstein Wadden Sea perceive coastal resilience and which coastal protection measures they favour. Semi-structured interviews, observations, and policy document analysis were used to understand these perceptions and key influencing factors. Findings reveal that stakeholders tend to favour conventional hard engineering solutions to coastal management due to entrenched path dependencies and strong place attachment. Yet where those lock-ins are weaker and cultural landscapes align more with the tidal flats, a shift in coastal management is evident. Institutions continue to prioritise people and material assets while treating the ecosystem as separate from the social fabric. Broadening the political agenda to embrace social-ecological interdependence is therefore pivotal for negotiating a shared, stakeholder-driven vision of a climate-resilient Wadden Sea. Collectively, our study advances the literature by (1) introducing the Coastal Resilience Bloom linking perceptions and practice, (2) evidencing an emerging - albeit uneven and place-specific - resilience turn, and (3) showing how policy framing and path dependencies shape acceptance of more innovative coastal protection measures.

Keywords: Schleswig-Holstein, Wadden Sea, coastal protection, resilience, stakeholder perception

1 Introduction

The Wadden Sea, a UNESCO World Heritage natural site and the world's largest contiguous tidal system, faces multiple climate change impacts (Heron et al. 2020). It stretches across Denmark, Germany and the Netherlands working together under the Trilateral Wadden Sea Cooperation (TWSC). Located between land and sea, coastal areas such as the Wadden Sea 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 more fitting. This is also true for large stretches of the Wadden coast. The history of the German Wadden Sea is marked by a battle between coastal settlers and the North Sea, characterized by alternating phases of storm surges along with land loss and land reclamation processes (Lotze et al. 2005). It is a story that portrays the struggle between the human desire for stability and the dynamics of nature. This eventually resulted in the formation of a hard boundary of dikes and embankments between the land and the sea, between nature and culture (Liburd & Walsh 2022).

These hard engineering coastal protection measures are reaching their limits. On the one hand, they influence the natural dynamics of the ecosystem through 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). At the same time, they lead to constantly rising maintenance costs, increasing capital expenditure for new construction and negative ecological side-effects making them unsustainable in the long run (Beatley 2009, Garmestani et al. 2019, Markus-Michalczyk 2023). Innovative measures are therefore needed that go beyond purely engineering-based approaches in order to adequately deal with the increasing flood-risk and coastal erosion caused by climate change.

Our analysis combines *resilience theory* (engineering, ecological, social-ecological strands) with *ocean-perception* research to examine how stakeholders frame adaptation options. In this study, 'stakeholders' are persons or organisations that influence, or are affected by, decisions on coastal adaptation in

https://doi.org/10.3112/erdkunde.2025.03.07 ISSN 2702-5985 (Online)

the Schleswig-Holstein Wadden Sea. Our sample focuses on professional stakeholders with recognised expertise or formal responsibilities (e.g., public authorities, NGOs, researchers).

The above illustrates that the resilience of the system is under threat. Not only the ecosystem, but also coastal communities are affected by a variety of climate change impacts such as increased severity and frequency of extreme events (Oppenheimer et al. 2019). Given accelerating sea-level rise, ageing defences, and contested land-sea trade-offs in a UNESCO World Heritage site, we ask one core question in this study: Resilience to Wad? To answer this, we raise three sub-questions: (1) What do key stakeholders mean by 'coastal resilience' at the Wadden Sea? (2) Which experiential, place-based, and institutional factors shape these meanings? (3) How do these meanings translate into preferences for coastal protection measures?

Since resilience is a highly power-laden, political concept up for debate (Porter & Davoudi 2012, White & O'Hare 2014), the above questions need to be looked at in close dialogue with those affected. Drawing on interviews, observations and policy document analysis, this paper therefore sets out to explore stakeholders' perceptions of resilience, the factors influencing certain perceptions and the associated actions taken that shape current and future coastal management practices.

Drawing on resilience theory and ocean perception research, this study provides insights into the ways resilience is understood and practiced in coastal management and planning (Section 2). It then zooms in on the case of the Schleswig-Holstein Wadden Sea (hereafter SH Wadden), located in the German part of the Wadden Sea, to examine stakeholder perceptions of resilience. Using a combination of methods described in Section 3, stakeholder perceptions of coastal resilience and associated preferred coastal protection measures are analysed (Section 4). Looking at underlying factors influencing the stakeholders these findings are further discussed in Section 5. Finally, the question 'Resilience to Wad?' is reflected upon and future fields of research are identified (Section 6).

2 Understanding resilience in coastal management and planning

Coastal resilience is a highly 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). To understand resilience and its operationalization, we will draw from resilience theory looking at differing resilience perspectives and from ocean perception research exploring how stakeholder perception influences prevailing resilience perspectives.

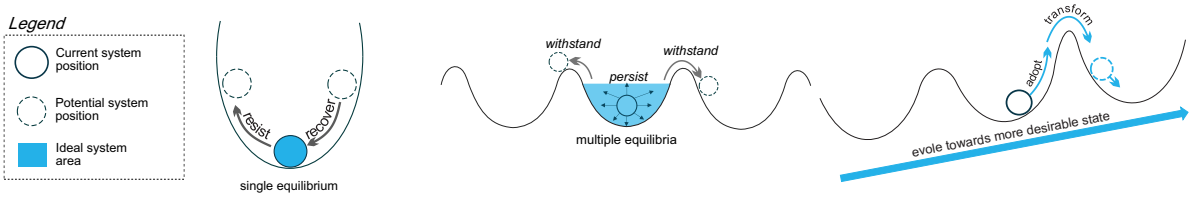
2.1 Resilience – ambiguous concept, ambiguous operationalization

Resilience has many facets (Allen et al. 2019), in essence, it 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 spread across disciplines, becoming a cross-cutting, multidisciplinary, and socially constructed concept widely discussed in academia (e.g., Davoudi 2012, Folke 2006, McClymont et al. 2020, Trell et al. 2017) and trending in policy (White & O'Hare 2014). Trell et al. (2017: 7) caution that "[t]he term 'resilience' therefore runs the risk of becoming a heavily contested buzzword." Allen et al. (2019: 1) 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. 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, White & O'Hare 2014). Clarifying the concept's various meanings is therefore key to enabling and enhancing (coastal) resilience (Garmestani et al. 2019, Rölfer et al. 2022, White & O'Hare 2014). As shown in Table 1, there are three dominant perspectives of resilience: engineering resilience, ecological resilience, and social-ecological resilience.

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). In contrast to these two so-called equilibrist perspectives of resilience, the evolutionary or social-ecological perspective relinquishes the notion of equilibria by asserting

Tab. 1: An overview of the resilience perspectives

	Equilibrist perspectives		Evolutionary perspective
	Engineering resilience (1960/70s)	**Ecological resilience (1980s)**	**Social-ecological resilience (1990s / 2000s)**
			
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.

Sources: Beatley (2009), Davoudi (2012), Folke (2006), Garmestani et al. (2019), Rölfer (2022), Trell et al. (2017), White & O'Hare (2014)

that systems are constantly evolving, adapting and transforming (Davoudi 2012, Folke 2006, 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).

It is relevant to discuss the different possible perspectives on resilience, since the way resilience is understood, also influences the way it is operationalized in practice and thus what is prioritised, and which interests and values may suffer the consequences or are overlooked.

Coastal protection measures currently in place reflect a diversity of understandings of what resilience could mean in practice. For example, conventional coastal protection measures reflect the engineering, as they aim to maintain or, if necessary, return to a given steady state. Examples include dike maintenance to preserve the current dike line, land reclamation or sand nourishment to compensate for coastal erosion and return to pre-flood conditions. Ecosystem-based adaptation measures or Nature-based Solutions (NbS) are characteristic for an ecological resilience perspective and emphasize the preservation and restoration of underlying ecosystem services to be able to withstand shocks (Garmestani et al. 2019).

While ecosystem-based adaptation is primarily concerned with ecological aspects of coastal protection, accommodating measures (e.g., flood-adapted building on terps) and managed retreat tend to emphasize the 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, which

can be considered a more holistic approach to climate adaptation (see Fünfgeld & McEvoy 2012, Rölfer et al. 2022).

In this paper, *non-conventional coastal protection measures* (Fig. 1) encompass all approaches to dealing with coastal risks that go beyond purely engineering-based solutions. 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 (Temmermann et al. 2013), negative ecological side effects (Beatley 2009), and impaired risk perceptions (Liao 2014);

(2) non-conventional measures offer additional benefits beyond protection (e.g., Singhvi et al. 2022, Sutton-Grier et al. 2015), are often more flexible and adaptable (Masselink & Lazarus 2019, Singhvi et al. 2022, Sutton-Grier et al. 2015), and account for the uncertainty and complexity of the underlying system (Singhvi et al. 2022).

However, although non-conventional measures can help overcome some shortcomings of conventional measures, they are not applicable or feasible everywhere. For example, densely built-up coastal areas often lack sufficient space for extensive tidal zones, and accommodation measures such as terps are costly, making them unrealistic behind existing dike lines. Therefore, a mix of conventional and non-conventional measures is considered desirable to improve overall coastal resilience (Oppenheimer et al. 2019, Singhvi et al. 2022, Sutton-Grier et al. 2015).

2.2 Resilience and stakeholder perception

To understand how resilience is put into practice, in addition to identifying the predominant resilience perspective applied, it is crucial to clarify stakeholder perceptions in which these practices are embedded. As McElduff & Ritchie (2018: 192) state, "[a]ctions, or behaviours, considered to be successful, effective or legitimate in enhancing resilience are dependent on what people perceive as worth achieving and protecting." Questions about how people understand, evaluate or deal with an

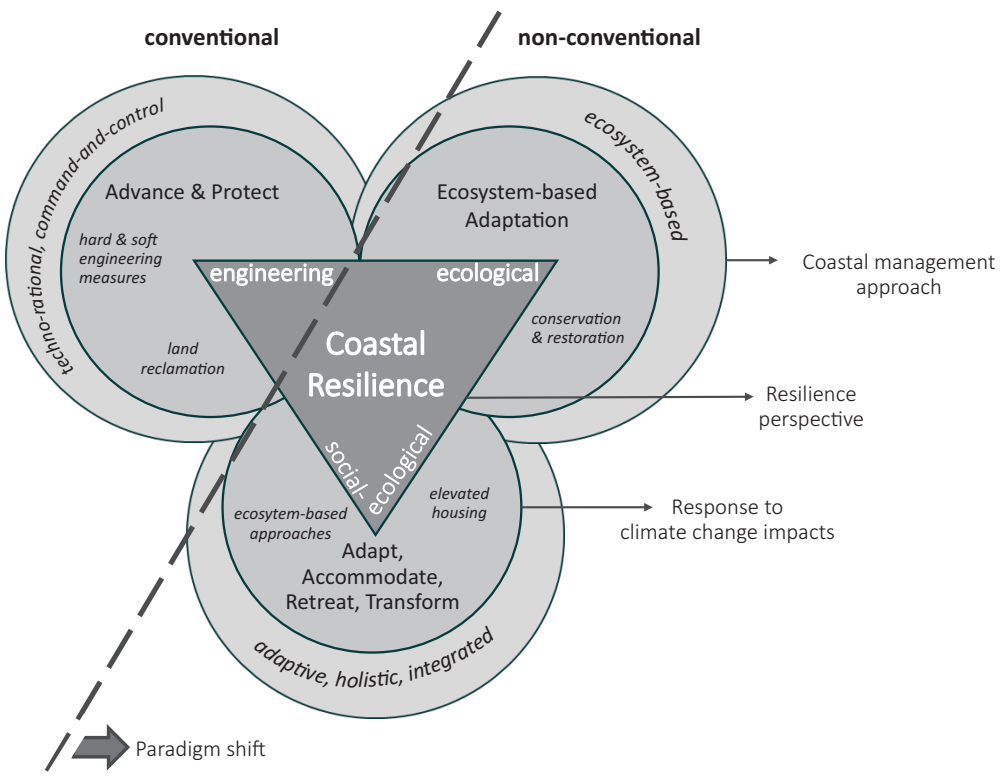


Fig. 1: Different resilience perspective, different resilience practice

environment, an issue, or a management measure are at the core of what is called 'ocean perception research' (Jefferson et al. 2021: 1). This field of research recognizes the significance of including the social dimension in general and stakeholder perceptions in particular, in both marine and coastal management and planning (Jefferson et al. 2021).

Coastal management and planning can benefit from better exploring stakeholder perceptions for three reasons:

(1) *Insight into different stakeholder perceptions enables 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 (Döring & Ratter 2018, Jordan et al. 2023, de Juan et al. 2017). There is a need to integrate different types of knowledge, especially local knowledge, to enhance coastal management practice and coastal resilience (Restemeyer et al. 2017, Rölfer et al. 2022). Investigating stakeholder perceptions of coastal protection measures and coastal resilience can contribute to a more holistic and integrated coastal management (de Juan et al. 2017), and promote trust, which can increase public acceptance of coastal protection measures and inform and facilitate decision-making processes (Gelcich & O'Keeffe 2016).

(2) *Accounting for differing stakeholder perceptions helps identify areas of conflict and agreement between stakeholders. It further reveals obstacles to implementing measures for increasing coastal resilience.* Identifying areas of conflict and agreement can facilitate collaboration in coastal management and planning. 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, stakeholder perceptions can help 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.

(3) *Assessing and incorporating stakeholder perceptions helps to ideally create a shared understanding of and vision for coastal resilience. It also shows 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. Perception research provides a platform to investigate what is seen as desirable and achievable (Gelcich & O'Keeffe 2016).

However, stakeholder perceptions are influenced by a variety of factors. For example, risk perception is closely related to stakeholder perceptions of non-conventional coastal protection measures and coastal resilience. As Ratter & Leyshon (2021: 1) 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." Without perceiving climate change as a risk to be managed through innovative and adaptive approaches, non-conventional coastal protection measures become of little relevance to stakeholders.

Five key factors influencing stakeholder perception were identified from literature to further explore the selected case-study area: 1) path dependency, 2) policy framing, 3) social identity, 4) experience, and 5) place attachment. While the former two (path dependency and policy framing) relate to systemic and political aspects, the latter three bring in a more individual and psychological dimension to complete the picture. Collectively they are all found to influence perceptions and will be further elaborated upon in section 5.1.

To better deal with the ambiguity of the resilience concept, it is necessary to keep searching for *some common ground in the 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.* Looking at how coastal resilience is perceived by different stakeholders can help answering the question of and developing a vision for 'Resilience to Wad?'.

2.3 Summing up: The Coastal Resilience Bloom

Inspired by the Flood Resilience Rose of Karrasch et al. (2021), the 'Coastal Resilience Bloom' (CRB) was developed as a conceptual framework for this study. The CRB illustrates the connections between the respective resilience perspective, its operationalization and its embeddedness in perceptions and influencing factors. As shown in Fig. 2, the CRB consists of three levels that each represent a different concept. The coastal resilience perspectives at the center of the bloom (level 1) are operationalized differently through coastal management

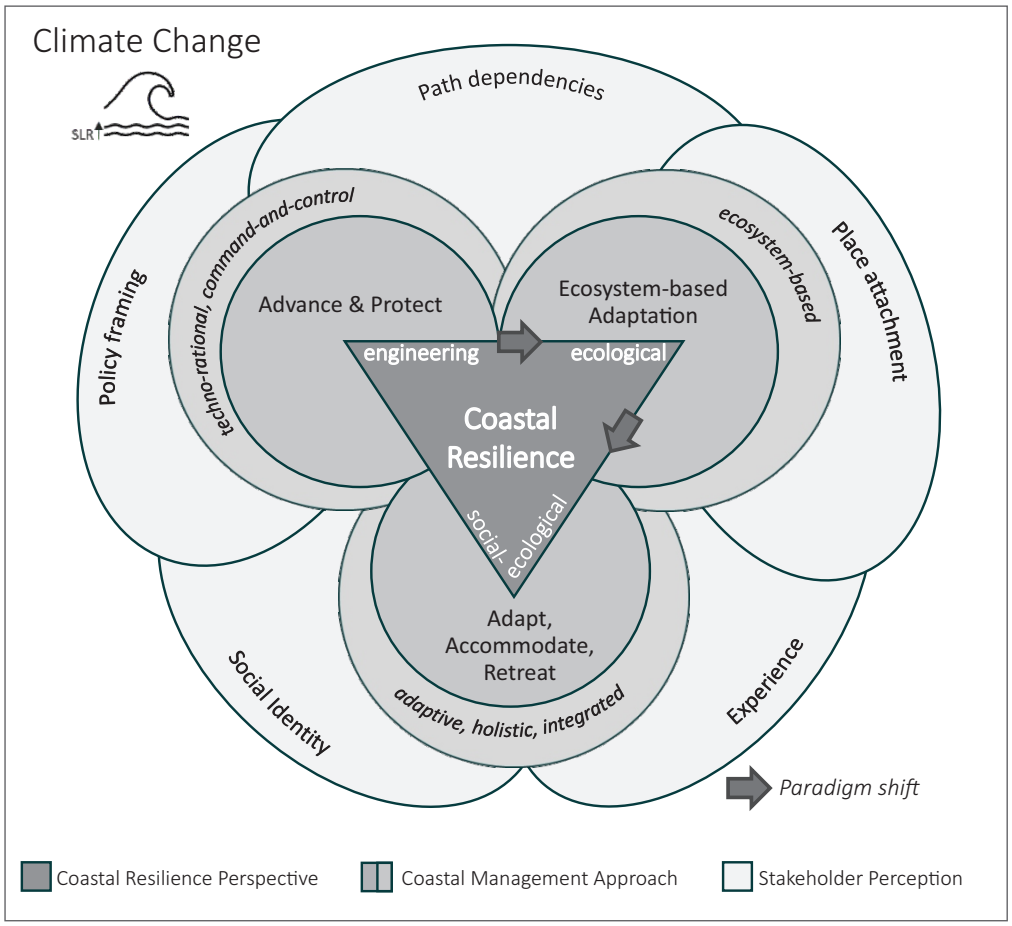


Fig. 2: The Coastal Resilience Bloom (CRB), conceptual framework of the study

and planning practices (level 2), which in turn are influenced by stakeholder perceptions and factors influencing those (level 3). All the three levels (Fig. 2) are nested within the overarching context of climate change threatening coastal resilience.

The CRB further illustrates a paradigm shift in resilience (dark gray arrows in Fig. 2), which is referred to in academia as the resilience turn (Shaw 2012, Trell et al. 2017). It is a shift from an engineering resilience perspective, which presumes a predictable and stable world, to a social-ecological perspective that recognizes the unpredictability and complexity of systems. White & 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 tends to prevail (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 social-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.

3 Methodology

This paper focuses on the Schleswig-Holstein Wadden Sea (SH Wadden) located in Germany. It was declared a national park in 1985 and spans from the Elbe estuary in the south to the island of Sylt in the north (see Fig. 3). In addition to the Wadden Sea, the study area 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

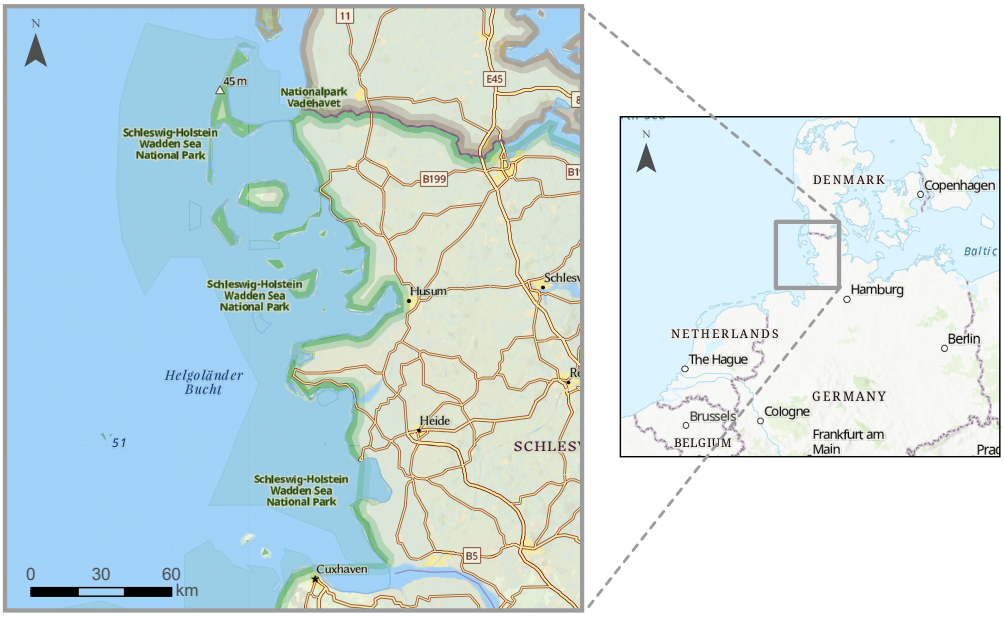


Fig. 3: Case study area. Source: Esri & contributors (USGS, NOAA, FAO, TomTom, Garmin); administrative data: GeoBasis-DE/LVermGeo SH; LGV Hamburg; LGLN).

surges. Together with the national park, the Halligen form a UNESCO Biosphere Reserve, a unique model region for sustainable development.

We chose the Wadden Sea as our study area because its exceptional ecological diversity is accompanied by a diversity of stakeholders, each with different and at times contradicting views on how to best manage the area and what constitutes a resilient future for the area. As a UNESCO World Heritage where coastal management will need to adapt to changing circumstances and balance the different values in the region, it provides a highly relevant setting to explore perceptions of resilience and strategies for enhancing it.

As depicted in Figure 4, different methods were used to understand stakeholder perceptions and factors influencing them to explore 'Resilience to Wad?'. Between November 2023 and January 2024, a total of 14 semi-structured interviews were conducted with key stakeholders, most of them online (Fig. 4). Semi-structured interviews are a well-suited method to explore participants' experiences and beliefs, provide flexibility and the possibility to ask follow-up questions (Kallio et al. 2016). To identify stakeholders' perceptions of non-conventional coastal protection measures in particular, photo elicitation was used during the interviews. Pictures of different coastal protection measures were shown to prompt interviewees to share their thoughts and feelings. As the brain area for processing visual information is evolutionary older than the one for processing verbal information, photo elicitation can provide additional information about participants' values, beliefs, and perceptions (Harper 2002). Beyond the visuals, we asked about participants' professional roles, connection to the Wadden Sea, perceptions and lived experiences of climate change and flooding, and their views on coastal protection - past, present, and desired futures.

Interviewees from different disciplines were purposefully selected 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. While acknowledging the importance of coastal communities in coastal management and planning, this study primarily focused on key stakeholders such as public authorities and NGOs who are in charge of making or developing coastal management plans.

Each interviewee received an information sheet and signed an informed consent form to ensure transparency and that the ethical aspects of research were safeguarded. To prevent interviewees from being harmed by their participation and to make them feel more comfortable in sharing their perceptions and opinions, pseudonyms are used when referring to the interviewees throughout this paper. This approach may also contribute to reducing social desirability biases. Tab. 2 lists the areas of expertise of the 14 interviewees and their pseudonyms used in this paper. The trilateral perspective in Tab. 2 refers to the cooperative

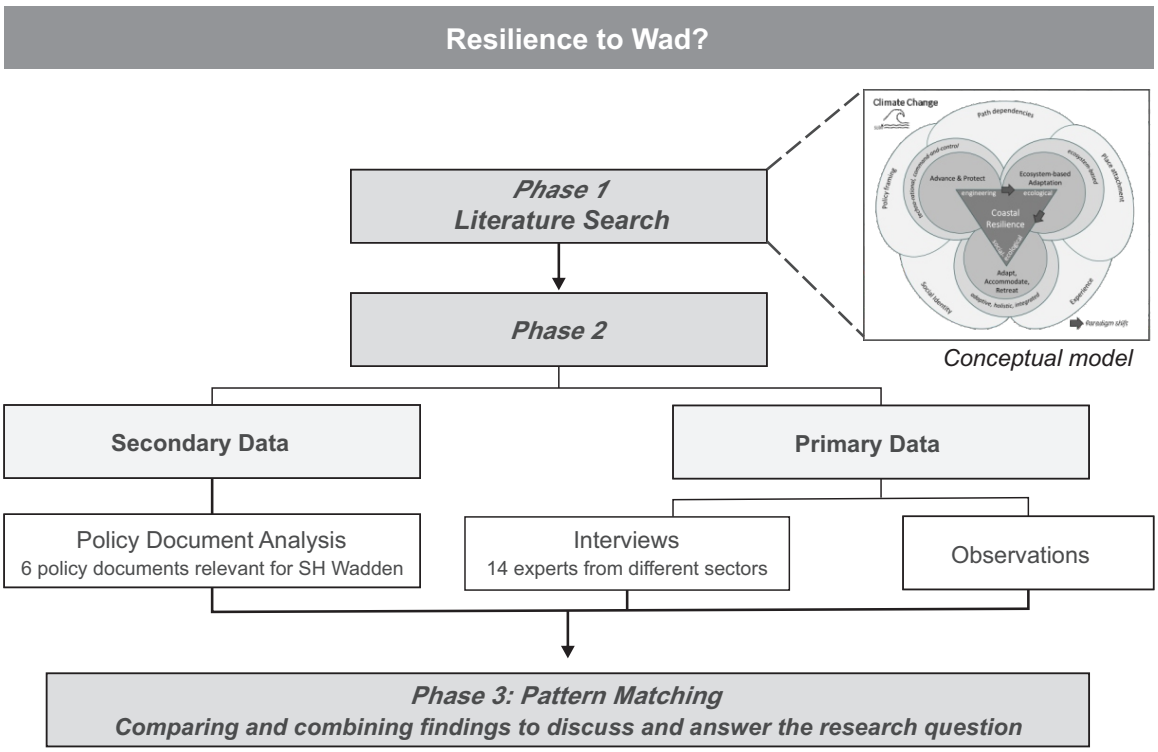


Fig. 4: Methods used to answer the research question 'Resilience to Wad?'

governance arrangement among Denmark, Germany and the Netherlands under the Trilateral Wadden Sea Cooperation (TWSC). The interviews were transcribed verbatim and analyzed using a deductive coding tree, based on the conceptual framework (Fig. 2).

In addition to the interviews, the lead author conducted observations in the research area, including a 3-day excursion to the SH Wadden and several shorter visits in 2023 and 2024. The aim of the observations was to gain an insight and first-hand impression of the coastal protection measures used along the mainland coast, and the types of settlements present in the area. Observation data included field-notes and photos which were coded following Figure 2.

Tab. 2: 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

In addition, policy document analysis was used to provide background information, insight into priorities and plans for current and future developments in coastal management, which is informed by policy. Policy document analysis provided an insight into how coastal resilience at the SH Wadden is framed by key decision-makers, which is one of the factors influencing stakeholder perceptions. The analysis of policy documents was also used to compare and verify results obtained from interviews and observations, making the study results more reliable and robust. 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 areas of the Wadden Sea (Tab. 3). To ensure a comprehensive and reliable analysis of policy documents, we adopted the recommendations and tools for policy-document analysis proposed by Cardno (2018). The content of the policy documents was analysed with particular regard to the framing of coastal resilience by key institutions influencing coastal management.

Tab. 3: Selected policy documents for the analysis

Relevant exclusively for Schleswig-Holstein	Relevant for Schleswig-Holstein and other areas
MELUR (2015) Strategie für das Wattenmeer 2100 (Strategy for the Wadden Sea 2100)	Common Wadden Sea Secretariat (2014) Toender Declaration. Ministerial Council Declaration of the 12th Trilateral Governmental Conference on the Protection of the Wadden Sea. Annex 4: Climate change adaptation strategy
MEKUN SH (2022) Generalplan Küstenschutz des Landes Schleswig-Holstein. Fortschreibung 2022 (General Plan for Coastal Protection)	Nature NGOs of the Wadden Sea Region (2022) The 2022 Call for Action for the Wadden Sea
MILIG (2021) Landesentwicklungsplan Schleswig-Holstein. Fortschreibung 2021 (State Development Plan Schleswig-Holstein)	BUKEA, MEKUN SH, MU (2023) Cuxhavener Erklärung (Cuxhaven Declaration)

4 Perceptions of resilience and coastal protection measures at the SchleswigHolstein Wadden Sea, Germany

Several different perceptions and themes regarding coastal resilience in the SH Wadden emerged from the interviews. Climate change was, for example, identified as the greatest challenge for SH Wadden not only in the interviews (CP2, N2, R3), but also in all the documents analysed. This is an extremely important finding, as risk perception is closely linked to the perception of resilience (Ratter & Leyshon 2021). Acknowledging the risk provides an impetus for action. While the authorities give coastal protection a higher priority in the form of dedicated coastal priority areas in the current State Development Plan in order to create space for dike reinforcements and to avoid land use conflicts, other stakeholders (N2, R1, R3, TRI1, N2) 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 to become resilient. Many interviewees (N2, CP1, CP2, CP3) see the Dutch counterparts as leading the way towards coastal resilience, especially with regard to technical solutions.

The exploration of coastal resilience through interviews and document-analysis revealed a complex landscape of intertwined perspectives making it a challenge to categorize respondents and documents into one of the three resilience perspectives. 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 management plans, showing therefore also characteristics from the ecological and socialecological resilience perspectives (Tab. 1). This indicates a somewhat more progressive engineering perspective, as one participant from coastal protection noted:

> "In this respect, it [coastal management] is of course a *maintenance strategy* [engineering perspective] […] At the same time, it is also always a *transformation process* [social-ecological perspective]. Coastal protection and nature conservation strategies have changed in the last few decades." (CP2).

These findings illustrate that the resilience turn postulated in academia may be gradually emerging in coastal management practice, even if the engineering perspective on resilience prevails. With regard to coastal protection measures and their resilience potential, perceptions differed between stakeholders. Interviewees representing coastal protection tended to prefer more conventional measures as the most effective means to safeguard people and material assets from flooding. In contrast, nature conservation agencies including the national park authority leaned towards NbS, valuing their ecological benefits. Meanwhile, researchers attempted to develop innovative concepts and strategies to enhance coastal resilience for the overall social-ecological system.

When it comes to accommodating measures such as terps, many respondents (CP3, CP2, R1) highlighted concerns about their financial viability. However, the concept of floating houses frequently emerged as a topic of interest for a resilient future (R3, CP3, N2, TRI1).

Although many of the interviewees saw managed retreat as a viable approach with a potential to provide valuable co-benefits, they acknowledged it would face resistance from local residents. In place attachment literature, loss of place is equated to a loss of a beloved person, triggering similar reactions

(Trell & van Hoven 2012). In addition, this opposition is deeply rooted in the local community's traditions, arising from a long-standing history of attempting to conquer the untamed North Sea.

Despite the varied views on preferred coastal protection strategies, there was agreement among stakeholders and in policy documents that a combination of measures tailored to specific local contexts is needed, acknowledging there is no one-size-fits-all solution (R3, R2, TRI1, N3, CP2, CP3). This is in line with scientific recommendations (e.g., Singhvi et al. (2022), Fünfgeld & McEvoy (2012), Reise (2016)).

> "In order to secure local resilience, on the basis of a common knowledge base, site-specific 'tailormade' solutions should be developed." (Common Wadden Sea Secretariat 2014: 6).

Table 4 shows different resilience perspectives present in the region and underscores the need for developing a shared vision and find some common ground for a resilient Wad. The latter is acknowledged in the following quote:

> "What makes sense will be to have future visioning or scenario exercises which are informed by and include people's perspectives and values. […] And part of the issue here is that planning is very much focused on regulations and not strategic visions or looking at potential alternatives. It's very much set within the 'business as usual' type of approach which doesn't open a space for discussion essentially." (R2).

Below we discuss five influential factors behind the differing stakeholder perceptions which also highlight the difficulty of implementing non-conventional coastal protection measures.

5 Discussion

Section 5 interprets our empirical findings through the lenses of resilience theory, ocean perception research and insights from environmental psychology: Section 5.1 examines the five factors that influence stakeholder perception relating them to previous work; 5.2 revisits the core research question – how 'Resilience to Wad' could look like; and 5.3 reflects on the study's research limitations.

5.1 Factors influencing stakeholder perceptions at the SH Wadden

5.1.1 Path dependency

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

Tab. 4: Different resilience perspectives among stakeholders

Resilience to Wad?		
Engineering perspective	Ecological perspective	Social-ecological perspective
"We have extremely good dikes […] So, our coastal protection is really good." (A1)	"The research is about what we have to do to preserve the ecological function […] But there will be tipping points." (R3)	"I believe you have to understand social structures in order to ultimately be able to develop protection strategies." (R3)
"We will then have to adapt to the climate and that will mostly only be possible with traditional measures, i.e. foreshore management is not enough. We will also have to reinforce dikes." (CP1)	"The concern is that the Wadden Sea will disappear […]" (N1)	"It's all a social-ecological system. You can't separate the social system from the ecological system." (TRI1)
"I don't see any major problems over the next few decades either. So, the Wadden Sea as such is simply a natural system and that will adjust." (CP1)	"So, we never know exactly when things are going to tip over." (T1)	"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 really of the Wadden Sea as well." (R2)
	"[…] we should place stronger emphasis on resilience of the ecosystem […]" (Call for Action by Nature NGOs 2022: 5)	

dependencies are not only deeply embedded in the minds of the people, but also in institutions, and have often also materialized in the physical environment (Restemeyer et al. 2017, Tubridy et al. 2022).

In the Wadden Sea area, the centuries-long struggle against flooding of the North Sea has led to the dominance of engineering, vertically integrated and sectoral coastal management. Moreover, it created a separation between land and sea in people's minds, in management practice, and in material terms through a kilometre-long dike line (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), as illustrated by one interviewee: "The boundary between the mainland and the North Sea is always, with very few exceptions, the dike" (T1). This poses obstacles to more integrated, collaborative, and innovative coastal management approaches (Jordan et al. 2023, Tubridy et al. 2022). It is further reinforced by institutions in which the different departments work in siloes (Fig. 5), 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 (see MILIG (2021), MEKUN SH (2022), MEKUN SH (2022), MELUR (2015), or interviews with P1, P2, CP1, N2). The planning efforts of the planning agency are solely focused on the land side, where regional development plans completely exclude the coast, further reinforcing the boundary. The emergence of marine spatial planning and the increasingly outdated status of integrated coastal zone management in practice appear to further reinforce the boundary between sea and land (Walsh & Kannen 2019).

Observations confirmed that conventional coastal protection measures are omnipresent at the SH Wadden: 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 visible on the mainland. Just as Berkes et al. (2008) suggest, humans have created a homogenous, usable system that seems rigid to change due to historical path dependencies.

This reliance on hard engineering solutions represents a lock-in, in which institutions seem to have become too inflexible and entrenched in 'business as usual' to change. 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

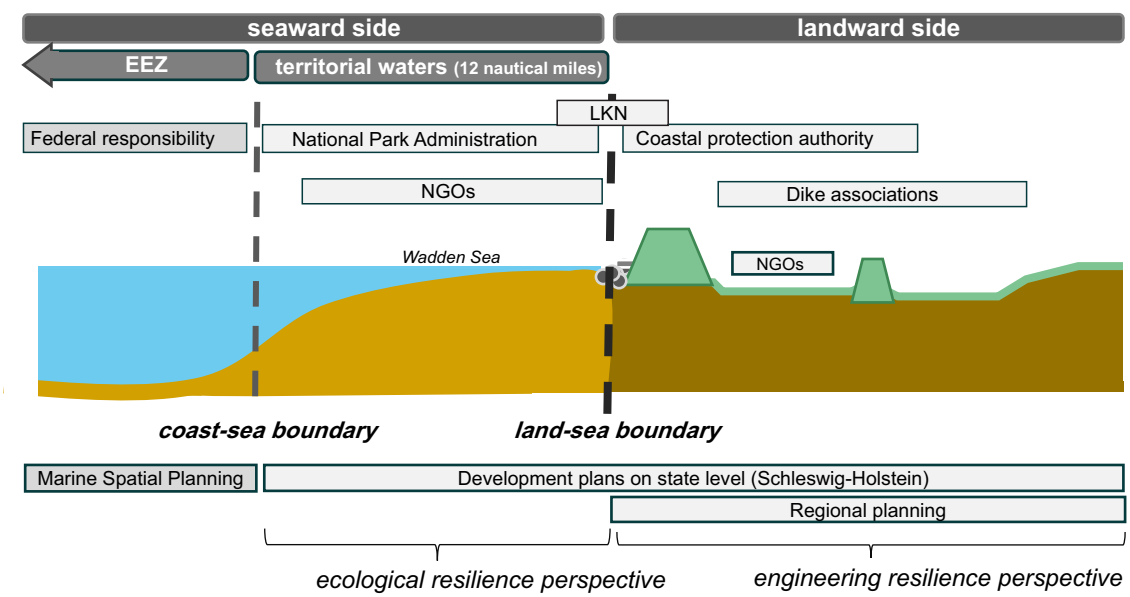


Fig. 5: Boundaries and scattered responsibilities between land and sea

now significantly deeper than the few foreshore areas that exist." (R1).

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 in the plan. Despite its innovative design, this solution underlines the difficulty of turning back from a path taken in the past where rigid structures have been developed over centuries to interfere with a highly dynamic system.

> "The continuation of the dike reinforcement programme is of paramount importance; 74 km of dikes are to be reinforced." (MEKUN SH 2022: 81)

Findings show that in areas that are less locked into a certain coastal protection pathway, where natural conditions are less disturbed such as on the Halligen islands or on sandy coasts, more innovative and non-conventional coastal protection measures emerge (see e.g. ECOHAL and Sandy Coast St. Peter-Ording projects). This signals an emerging social-ecological resilience lens. Overall, the pattern underscores how path dependency shapes protection trajectories and, ultimately, place-based resilience, with engineering and ecological perspectives remaining dominant and spatially segregated.

5.1.2 Social identity and the need for a constructive dialogue about coastal resilience

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 belong to (Mason et al. 2015). Multiple social identities can co-exist (Mason et al. 2015, Steg & Groot 2019). Depending on the context, different social identities are made salient (Steg & Groot 2019). Focusing on the Wadden Sea and the island of Pellworm, Siedschlag & Gee (2021) demonstrate how shared beliefs and values in relation to viewing oneself as part of the community, influence how islanders perceive their ability to 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 co-operation 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). Such tensions are still visible today as illustrated by coastal protection representative stating: "Nature conservation protects nature from people. And coastal protection protects people from nature." (CP1). Acknowledging the differing perspectives and trying to find mutual gains and common ground in the face of a shared risk and care for an area, could be a first step towards a resilient Wad. The Strategy for the Wadden Sea 2100 can be seen as a promising start, as nature conservation and coastal protection authorities came together for the first time to discuss the future of the Wadden Sea.

With regard to more innovative and holistic coastal management practices, interviewees frequently emphasized their hope for the currently ongoing generational shift in coastal management, with newer generations thinking differently and challenging conventional approaches (CP1, N3, R2, R3). This new generation brings hope for innovative solutions; however, it also introduces potential tensions due to differing norms and values with the old generation.

5.1.3 (A lack of) Experience

Stakeholders' perceptions are influenced by experiences, both by direct experience (e.g., experiencing a storm surge) and indirectly (e.g., via stories of past flooding) since they shape knowledge and understanding of risk (Vanderlinden et al. 2017). 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. Experiencing 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 fa-

vouring an evolutionary over an equilibrist perspective on resilience.

Experiencing storm surges makes the intangible challenges of climate change more tangible. CP1, CP2 and P2 considered storm surges as drivers of development in coastal protection. 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.

Drawing on resilience theory, Folke (2006: 259) emphasized the role of memory, meaning "the accumulated experience and history of the system", 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 (Jordan et al. 2023).

Restemeyer et al. (2017) question the practical feasibility 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 with 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 since people feel safe behind the dike. As the interviewee from the agricultural 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 ranging from negative ecological side effects such as impeded habitat connectivity (e.g. for chick migration) to spatial constraints and low aesthetic value. 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 and working with 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. PeterOrding' project which aims to improve dune dynamics and biodiversity. Such approaches draw on past experiences, recognizing the limitations and drawbacks of rigid infrastructure for coastal resilience.

5.1.4 Policy Framing and the SH Wadden – one system or two?

Resilience is a highly political, and power-laden concept (Porter & Davoudi 2012, White & O'Hare 2014). It is commonly presented as a "[…] singular, vague, but optimistic goal" (White & O'Hare 2014: 934), often failing to provide clear guidance or recommendation on how to operationalize it. When guidance is provided, it focuses on recovery and resistance reflecting an engineering or equilibrist 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 (White & O'Hare 2014), so the engineering perspective often prevails in practice (Davoudi 2012, Restemeyer 2018). 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, using metaphors, specific names, or narratives to create a particular vision or version of a 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). For example, during the interviews with coastal protection authorities, a discourse around NbS in coastal protection came up revealing a tension between their perceived novelty (by policymakers) and their historical application, which the Coastal Protection Agency interviewee argued they "[We] have been doing […] for at least 200 years..." (CP1). This perception challenges the novelty and thus value of NbS, suggesting that what might be seen as innovative by some has been standard practice for others for centuries. In contrast, the Call for Action by the Nature NGOs (2022: 5) states: "We call for more ambition in stimulating practical 'on the ground' adaptation measures and policy dialogue in the Wadden Sea states. In general, the philosophy and experience with 'Nature-based solutions' must guide the work on coastal protection to the utmost extent possible." This perspective may reflect a framing effect in how NbS are understood and valued, both in

policy and academic circles and in practice. It also raises questions about the criteria for labelling an approach as 'Nature-based', particularly when historical methods aimed at land reclamation, though utilizing natural processes, did not necessarily prioritise ecological benefits or sustainability, which is often seen as an important feature of NbS.

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).

The Strategy for the Wadden Sea 2100 from 2015 can be seen as a first step towards overcoming the boundary between land and sea or nature and culture. However, nature conservation and coastal protection authorities discussed the future of the ecosystem and not that of the coastal area as a whole. This is a common challenge 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). Framing the SH Wadden as two (or more) 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), 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 such approaches for reducing the probability of flooding, 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 as emphasized by R3 as well as the shortcomings of conventional coastal protection measures as illustrated by N3 stating: "I believe that it is technically feasible [to protect the coast using hard infrastructure] but then we will lose nature and lose parts of the Wadden Sea." In a similar vein, R2 emphasizes the relevance of change in thinking arguing that "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." However, as interviewee N1 pointed out, such a paradigm shift requires both political will and careful communication and stakeholder involvement strategies to shared understanding about the 'Resilience to Wad?'.

5.1.5 Place attachment

Place attachment refers to the emotional connection between people and places, which are dynamic and can change over time (Steg & Groot 2019).

Place attachment can be either a hindrance for adaptation, if those affected perceive the actions related to e.g. non-conventional coastal protection measures 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). "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." (Walsh 2018: 147). In the context of the SH Wadden, Siedschlag & 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 point out that attachment to place is closely linked to familiarity with a place and a sense of belonging to the community (Siedschlag & Gee 2021: 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 as well as confidence in the power of human intervention (Döring & Ratter 2018, Jordan et al. 2023, Siedschlag & Gee 2021).

People-place relationships need to be given greater consideration in coastal management and planning in general as they influence stakeholder perceptions of

coastal protection measures and their ability to cope with risks. This can in turn influence the success (or failure) of coastal resilience approaches (McElduff & Ritchie 2018), as the below examples illustrate.

The 'Dockkoog project' at the SH Wadden is an example of how place attachment can influence stakeholder perceptions and the fate of innovative projects. This managed realignment initiative proposed to flood the Dockkoog polder close to the town of Husum and reconstruct a burntdown hotel on a terp within the polder, creating a distinctive tourist attraction in Schleswig-Holstein. However, despite the innovative approach and its value for both nature conservation and tourism, the project was thwarted by local political resistance which was primarily fuelled by concerns that it would bring water closer to town and reduce flood protection levels (CP1, CP2, N3). It was a misconception that was not in alignment with the project's actual plans but ended in the projects failure as people felt their place, the town of Husum, threatened by the project. 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.

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). This sentiment underscores the challenge of balancing the need for adaptive coastal management and unconventional approaches while respecting and preserving local traditions and values.

The necessity of navigating these complex sociocultural 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 & Groot (2019)). Making the different opportunities that can arise for a place in relation to the changes visible to stakeholders is vital. Moreover, taking ample time to explain and clarify aspects which relate to resilience perception can help boost the motivation. The Dockkoog project, despite its failure, has contributed to an evolving dialogue around managed retreat, opening up 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 (R3), where perceptions of loss, place attachment, and traditional values heavily influence local acceptance and support.

5.2 Resilience to Wad?

Our findings on resilience (Section 4) indicate that stakeholder perspectives vary within and across groups, though the sample does not allow for clear intra-group variations. However, a noticeable generational pattern emerged: early-career engineers and planners seem to be more willing to question 'raise-the-dike' orthodoxy and to experiment with NbS, whereas long-tenured administrators tended to defend incremental heightening. Similar - though anecdotal - contrasts appeared between Halligen practitioners, who live with periodic inundation, and mainland actors invested in hard protection; respondents without flood memories also framed risk more abstractly (in line with findings by Jordan et al. (2023)). These indications remain illustrative rather than definitive and warrant testing in larger, trilateral and resident-inclusive studies.

Overall, the pattern aligns with the literature on a resilience turn: while scholarship has shifted toward social-ecological, evolutionary framings, practice often remains engineering-centric – a phenomenon observed by multiple researchers such as Masselink & Lazarus (2019) and Restemeyer (2018). We observe the same tension at the SH Wadden and in related coastal governance work. At the same time, innovation pockets - notably on the Halligen and sandy coasts - echo reports that transitions emerge unevenly where lock-ins are weaker and measures can work with natural dynamics. This challenges White & O'Hare (2014) argue that the resilience turn remains largely theoretical and restricted to academic discussions. In practice, the concept proves as ambiguous and vague as it is in theory (Trell 2017). Resilience is a concept up for debate, a choice influenced by various factors.

Using the Coastal Resilience Bloom (Fig. 2) as a lens linking perceptions, actions, and perspectives, our study makes the choices embedded in 'Resilience to Wad' visible: the way resilience is framed dictates which interests are legitimised, and which futures stay off the table – a dynamic long noted by White & O'Hare (2014). Naming these tensions is a first practical step toward a shared vision of a resilient Wadden Sea that balances flood safety, ecological dynamics, and cultural identity.

5.3 Research limitations

This study captures an expert-centred cross-section of perspectives rather than a comprehensive census. First, the 14 purposively selected expert interviews foreground technical and administrative views while sidelining local residents. Second, elected political actors—especially mayors and council members—were not interviewed; one respondent (CP1) remarked that "In my eyes, only mayors are truly integrated coastal persons, because they must reconcile every interest and remain electorally accountable." Third, perceptions were recorded at a single point in time. Fourth, our deductive coding centred on the Coastal Resilience Bloom may have overlooked themes beyond its scope. Finally, findings are context-bound to the Schleswig-Holstein part of the Wadden Sea.

Future research should therefore: 1) adopt a trilateral lens that spans the Dutch, German, and Danish sectors; 2) engage mayors and other elected bodies to broaden the governance perspective; and 3) systematically incorporate local resident voices through surveys, focus groups, and participatory workshops.

6 Conclusion

This study combined concepts from (environmental) psychology (e.g., place attachment and social identity), ocean perception research, and resilience theory to explore stakeholder perceptions of resilience and resilience practice at the SH Wadden. Albeit limited by the relatively small sample (14 interviewees) and the focus on key decision-makers, our findings show that understanding stakeholder perceptions is paramount as they influence coastal management practice, the success of diverse resilience-aimed projects, and are crucial for developing a shared vision of 'Resilience to Wad?'.

The study demonstrated that the engineering resilience perspective at the SH Wadden still prevails in current coastal management strategies, characterized by a reliance on dikes and pumping stations. 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, a shift in coastal management is evident. Stakeholders increasingly recognise the need for diverse coastal protection measures tailored to the local context and making use of natural processes. This challenges White & 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. For practice, this suggests prioritising pilot projects in low-lock-in settings (e.g., Halligen and sandy coasts) and mainstreaming hybrid measures that combine hard infrastructure with innovative measures.

However, coastal protection authorities see themselves constrained in their actions by institutions that clearly prioritise 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 likely stay confined to niches (Loorbach 2010).

Insights into stakeholder perceptions not only reveal areas of conflict and common interests but also provide a starting point for a more open dialogue on coastal management practices as advocated by Jordan et al. (2023). Common themes among the stakeholders are the desire for less bureaucracy in coastal management, more cooperation between nature conservation and coastal protection, the combination of natural and social sciences, and the hope that the current generational change will bring about a shift towards more holistic and integrated coastal management.

Practically, we see three levers for practitioners: target pilots where lock-ins are weakest; pair measures with place-based engagement and risk communication; and align land-sea planning frameworks to enable hybrid solutions. Scientifically, the Coastal Resilience Bloom provides a reusable framework to trace how perceptions shape operational choices and outcomes. Looking ahead, we recommend that future research be trilateral and resident-inclusive. It should be paired with deeper engagement with communities - their perceptions, visions and local knowledge - and with attention to affective responses such as *solastalgia* (distress from environmental change at home; Albrecht 2005) to widen stakeholder viewpoints and improve acceptance and effectiveness of more innovative coastal protection measures. Gaining further insight into perceptions through visioning exercises (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 toward a shared understanding of coastal resilience. Moreover, this would prevent the term from becoming a "heavily contested buzzword", as Trell et al. (2017: 7) warned. Accordingly, we frame the agenda ahead as a question: 'Resilience to Wad?'

Acknowledgements

We are grateful to have presented this work at the 40th AMK Annual Meeting (Heidelberg, 12–15 June 2024) and for its publication as part of the AMK Special Issue in ERDKUNDE – Journal of Human and Physical Geographies. We thank the organizers, editors and reviewers for their constructive feedback, which refined and strengthened the manuscript.

References

Albrecht G (2005) Solastalgia: A new concept in health and identity. *PAN: Philosophy Activism Nature* 3: 41–55. https://doi.org/10.4225/03/584F410704696

Allen CR, Angeler DG, Chaffin BC, Twidwell D, Garmestani A (2019) Resilience reconciled. *Nature Sustainability* 2: 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: 191. https://doi.org/10.3390/w8050191

Beatley T (2009) Planning for coastal resilience: Best practices for calamitous times. London. https://islandpress.org/books/planning-coastal-resilience

Berkes F, Colding J, Folke C (2008) Navigating social-ecological systems: Building resilience for complexity and change. Cambridge. https://doi.org/10.1017/CBO9780511541957

BUKEA, MEKUN SH, MU (Behörde für Umwelt, Klima, Energie und Agrarwirtschaft, Hamburg, Ministerium für Energiewende, Klimaschutz, Umwelt und Natur des Landes Schleswig-Holstein, Niedersächsisches Ministerium für Umwelt, Energie und Klimaschutz) (2023) Cuxhavener Erklärung. https://www.umwelt.niedersachsen.de/download/200223/Cuxhavener_Erklaerung.pdf

Cardno C (2018) Policy document analysis: A practical educational leadership tool and a qualitative research method. *Educational Administration: Theory & Practice* 24: 623–640. https://doi.org/10.17762/kuey.v24i4.82

Common Wadden Sea Secretariat (2014) Toender Declaration. Ministerial Council Declaration of the 12th Trilateral Governmental Conference on the Protection of the Wadden Sea. Annex 4: Climate change adaptation strategy. https://doi.org/10.5281/zenodo.8199410

Davoudi S (2012) Resilience: A bridging concept or a dead end? *Planning Theory & Practice* 13: 299–307. https://doi.org/10.1080/14649357.2012.677124

de Juan S, Gelcich 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

Dobie S, Doran PJ, Norton RK, Hughes S, Goode MJ (2022) Defining coastal resilience in the Great Lakes: A systematic review and critical comparison. *Journal of Great Lakes Research* 48: 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: 131–143. https://doi.org/10.1007/s11852-016-0478-0

Folke C (2006) Resilience: The emergence of a perspective for social–ecological systems analyses. *Global Environmental Change* 16: 253–267. https://doi.org/10.1016/j.gloenvcha.2006.04.002

Fünfgeld H, McEvoy D (2012) Resilience as a useful concept for climate change adaptation? *Planning Theory and Practice* 13: 324–328. https://doi.org/10.1080/14649357.2012.677124

Gelcich S, O'Keeffe J (2016) Emerging frontiers in perceptions research for aquatic conservation. *Aquatic Conservation: Marine and Freshwater Ecosystems* 26: 986–994. https://doi.org/10.1002/aqc.2714

Garmestani A, Craig RK, Gilissen HK, McDonald J, Soininen N, van Doorn-Hoekveld WJ, van Rijswick HFM (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

González-Riancho P, Gerkensmeier 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

Harper D (2002) Talking about pictures: A case for photo elicitation. *Visual Studies* 17: 13–26. https://doi.org/10.1080/14725860220137345

Heron SF, Day JC, Zijlstra R, Engels B, Weber A, Marencic H, Busch JA (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

Hofstede JLA (2019) On the feasibility of managed retreat in the Wadden Sea of Schleswig-Holstein. *Journal of Coastal Conservation* 23: 1069–1079. https://doi.org/10.1007/s11852-019-00714-x

Jefferson R, McKinley E, Griffin H, Nimmo A, Fletcher S (2021) Public perceptions of the ocean: Lessons for marine conservation from a global research review. *Frontiers in Marine Science* 8: 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 Frisian Wadden Sea (GER). *Journal of Coastal Conservation* 27. https://doi.org/10.1007/s11852-022-00921-z

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: 2954–2965. https://doi.org/10.1111/jan.13031

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: e12726. https://doi.org/10.1111/jfr3.12726

Kempenaar A, Laeni N, van den Brink M, Busscher T, Ovink H (2022) 'Water as Leverage': Design-led planning for urban climate resilience. Planning *Practice & Research* 39: 72–92. https://doi.org/10.1080/02697459.2022.2104322

Laeni N, van den Brink M, Trell EM, Arts E (2021) Going Dutch in the Mekong Delta: A framing perspective on water policy translation. *Journal of Environmental Policy & Planning* 23: 16–33. https://doi.org/10.1080/1523908X.2020.1792858

Lazarus E (2017) Toward a global classification of coastal anthromes. *Land* 6: 13. https://doi.org/10.3390/land6010013

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

Liao KH (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: 723–750. https://doi.org/10.1007/s11069-013-0923-4

Loorbach D (2010) Transition management for sustainable development: A prescriptive, complexity-based governance framework. *Governance* 23: 161–183. https://doi.org/10.1111/j.1468-0491.2009.01471.x

Lotze HK, Reise K, Worm B, van Beusekom J, Busch M, Ehlers A, Heinrich D, Hoffmann RC, Holm P, Jensen C, Knottnerus OS, Langhanki N, Prummel W, Vollmer M, Wolff WJ (2005) Human transformations of the Wadden Sea ecosystem through time: A synthesis. *Helgoland Marine Research* 59: 84–95. https://doi.org/10.1007/s10152-004-0209-z

Markus-Michalczyk H (2023) Nature-based solutions for flood risk reduction: North Sea region, flat coasts and estuaries. Leal Filho W, Dinis MAP, Moggi S, Price E, Hope A (eds*) SDGs in the European Region:* 367–388. Cham.

Mason CM, Lim-Camacho L, Scheepers K, Parr JM (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: 2587. https://doi.org/10.3390/w11122587

McClymont K, Morrison D, Beevers L, Carmen E (2020) Flood resilience: A systematic review. *Journal of Environmental Planning and Management* 63: 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: 186–194. https://doi.org/10.1111/area.12419

MEKUN SH (Ministerium für Energiewende, Klimaschutz, Umwelt und Natur des Landes Schleswig-Holstein) (2022) Generalplan Küstenschutz des Landes Schleswig-Holstein. Fortschreibung 2022. https://www.schleswig-holstein.de/DE/fachinhalte/K/kuestenschutz/Downloads/Generalplan.pdf

MELUR (Ministerium für Energiewende, Landwirtschaft, Umwelt und ländliche Räume, Schleswig-Holstein) (2015) Strategie für das Wattenmeer 2100. https://www.schleswig-holstein.de/DE/fachinhalte/K/kuestenschutz/Downloads/strategieWattenmeer2100.pdf

MILIG (Ministerium für Inneres, ländliche Räume, Integration und Gleichstellung, Schleswig-Holstein) (2021) Landesentwicklungsplan Schleswig-Holstein. Fortschreibung 2021. https://www.schleswig-holstein.de/DE/landesregierung/themen/planen-bauen-wohnen/landesplanung/raumordnungsplaene

Nature NGOs of the Wadden Sea Region (2022) The 2022 Call for Action for the Wadden Sea. https://www.waddensea-worldheritage.org/da/node/1628

Oppenheimer M, Glavovic BC, Hinkel J, van de Wal R, Magnan AK, Abd-Elgawad A, Cai R, Cifuentes-Jara M, Deconto RM, 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-lyingislands-coasts-and-communities/

Porter L, Davoudi S (2012) The politics of resilience for planning: A cautionary note. *Planning Theory and Practice* 13: 329–333. https://doi.org/10.1080/14649357.2012.677124

Ratter B, Leyshon C (2021) Perceptions of and resilience to coastal climate risks. *Oxford Research Encyclopedia of Climate Science.* https://doi.org/10.1093/acrefore/9780190228620.013.819

Ratter B, Walsh C (2019) Küstenlandschaften. Kühne O, Weber F, Berr K, Jenal C (eds) *Handbuch Landschaft*: 699–710. Wiesbaden. https://doi.org/10.1007/978-3-658-25746-0_56

Reise K (2016) Kurswechsel Küste. Was tun, wenn die Nordsee steigt? Kiel, Hamburg.

Restemeyer B (2018) Planning for flood-resilient cities: From promise to practice? Groningen. 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: 920–940. https://doi.org/10.1080/09640568.2016.1189403

Rölfer L, Celliers L, Abson Dj (2022) Resilience and coastal governance: Knowledge and navigation between stability and transformation. *Ecology and Society* 27. https://doi.org/10.5751/ES-13244-270240

Shaw K (2012) Reframing resilience: Challenges for planning theory and practice. *Planning Theory & Practice* 13: 308–312. https://doi.org/10.1080/14649357.2012.677124

Siedschlag D, Gee K (2021) Climate resilience on the island of Pellworm: Balancing multiple layers in the context of climate change. Martinez G (ed) *Culture and Climate Resilience*: 97–118. London. https://doi.org/10.1007/978-3-030-58403-0_6

Singhvi A, Luijendijk AP, van Oudenhoven APE (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, De Groot JIM (eds)(2019) Environmental psychology: An introduction. Chichester. https://doi.org/10.1002/9781119241072

Sutton-Grier AE, 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

Temmermann S, Meire P, Bouma TJ, Herman PMJ, Ysebaert T, de Vriend HJ (2013) Ecosystem-based coastal defence in the face of global change. *Nature* 504: 79–83. https://doi.org/10.1038/nature12859

Torio DD, Chmura GL (2013) Assessing coastal squeeze of tidal wetlands. *Journal of Coastal Research* 290: 1049–1061. https://doi.org/10.2112/JCOASTRES-D-12-00162.1

Trell EM, van Hoven B (2012) Place attachment in rural areas: A participatory research project with youth in Cedar, British Columbia. den Toonder J, van Hoven B (eds) *Re-exploring Canadian Space/ Re-découvrir l'espace canadien:* 27–44. Eelde.

Trell EM, Restemeyer B, Bakema MM, van Hoven B (2017) Governing for resilience in vulnerable places: An introduction. Trell EM, Restemeyer B, Bakema MM, van Hoven B (eds) Governing for resilience in vulnerable places: 7–14. Abingdon.

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

Vanderlinden J-P, Baztan J, Touili N, Kane IO, Rulleau B, Simal PD, 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: 127–133. https://doi.org/10.2112/SI77-013.1

Walsh C (2018) Metageographies of coastal management: Negotiating spaces of nature and culture at the Wadden Sea. *Area* 50: 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. https://doi.org/10.16993/rl.55

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: 147–164. https://doi.org/10.2478/rara-2019-0020

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: 934–950. https://doi.org/10.1068/c12117

Authors

Nina Caroline Lindstedt
https://orcid.org/0009-0001-1131-1977
Independent researcher
Germany

Dr. Elen-Maarja Trell
https://orcid.org/0000-0003-4419-6474
e.m.trell@rug.nl
University of Groningen
Faculty of Spatial Sciences
Department of Spatial Planning
and Environment
Postbus 800
9700 AV Groningen
Netherlands