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Storbjörk, S., Hjerpe, M., (2021), Climate-proofing coastal cities: What is needed to go from envisioning to enacting multifunctional solutions for waterfront climate adaptation?, *Ocean and Coastal Management*, 210, 105732. <https://doi.org/10.1016/j.ocecoaman.2021.105732>

Original publication available at:

<https://doi.org/10.1016/j.ocecoaman.2021.105732>

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Climate-proofing coastal cities: what is needed to go from envisioning to enacting multifunctional solutions for waterfront climate adaptation?

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Abstract

Climate-proofing coastal cities is an important part of the current policy agenda for climate adaptation, particularly in a situation where waterfront redevelopment is accelerating. Cities call for innovative approaches integrating climate protection with urban attractiveness and waterfront endeavors. There is a lack of studies targeting policy processes for coastal protection, including the choice of adaptation strategies and impediments for implementation. Sweden is an interesting case due to the decentralized character of coastal adaptation. Consequently, this paper aims to analyze the status of and conditions for large-scale multifunctional coastal protection by means of qualitative analyses of policy documents and interviews with frontline practitioners in four Swedish coastal cities: Malmö, Gothenburg, Helsingborg and Landskrona. The analysis documents a predominant focus on envisioning/planning for coastal protection rather than implementation of adaptation measures. While waterfront development functions as a window of opportunity in the more populous cities it also risks creating fragmentation and social imbalances in coastal protection between cities and their various coastal areas. Key implementation determinants emphasize formal institutional aspects, where politics and political decision-making need to set the necessary terms ensuring implementation. Current public-private and national-local distribution of responsibilities, stepwise planning and limited funding-mechanisms create uncertainties in system robustness and coherency. The consequences of a system for coastal protection heavily reliant on decentralized action needs to be properly considered by adaptation policy-makers.

Key words

waterfront climate adaptation, coastal protection, urban experimentation, multifunctionality, implementation determinants, institutional structures,

1. Introduction

Coastal zones are highly vulnerable in a changing climate (IPCC, 2014; Wong, et al., 2014) and are dependent on effective policies and strategies for adapting to climate-related risks (Few, et al., 2007; Vasey Ellis, 2009; Nicholls, 2011; Alexander, et al., 2012; Jeuken, et al., 2015; Francesch-Huidobro, et al., 2017). However, in many cities the level of action does not match the degree of vulnerability (Nicholls, 2011; Barnett, et al., 2014; Hurlimann, et al., 2014; Huang-Lachmann and Lovett, 2016; Gibbs, 2016; Valente and Veloso-Gomes, 2020). Rather, coastal cities continue to direct their urban development towards the sea, and proceed with intensified exploitation of coastal zones, which risks increasing their vulnerability to climate change (Moser, et al., 2012; Wilby and Keenan, 2012; Zeppel, 2012; Dyckman. et al., 2014; Francesch-Huidobro, et al., 2017; Harvey and Smithers, 2018; O'Shaughnessy. et al., 2019). This is often done to gain competitive advantages and attractiveness by branding themselves as waterfront cities (Desfor and Laidley, 2011; Storbjörk and Hjerpe, 2014; Storbjörk and Uggla, 2015; Granberg, et al., 2016; Rulleau and Rey-Valette, 2017). Consequently, current development decisions rather increase dependency on adaptation measures in the form of large-scale coastal protection infrastructure. While there exists a catalogue of different types of strategies and measures (Few, et al., 2007; ICE, 2010; Nicholls, 2011), coastal impacts of climate change also accelerate the need for innovative strategies (Dyckman, et al., 2014). Not the least this involves identifying and creating added values from coastal protection by means of built-in multifunctional secondary ecological and/or socio-economic benefits (Lu and Stead, 2013; Vikolainen, et al., 2017; Antunes do Carmo, 2019; O'Shaughnessy, et al., 2019).

Interest in novel multifunctional coastal protection is growing, and studies increasingly suggest their viability. Despite this, few practical examples exist (Evans, et al. 2017; Valente and Veloso-Gomes, 2020). Currently, several cities have initiated work of large-scale coastal protection by means of visions, strategies and plans. They are in a first-mover position, taking on the role of exploring innovative, attractive and effective solutions to manage climate risks in the urban coastal zones. It is both of theoretical and practical importance to analyze what adaptation strategies are chosen by decision-makers to manage vulnerability in the urban coastal zones, and why they are chosen (Moser, et al., 2012; Siders and Keenan, 2020). Also, there is a lack of knowledge regarding the process of coastal adaptation and what the implementation impediments and enablers are for novel multifunctional approaches in coastal climate adaptation planning (Wong, et al., 2014; Evans, et al., 2017; Gibbs, 2019; Valente and Veloso-Gomes, 2020).

Consequently, the aim of this paper is to analyze the status of and conditions for climate-proofing coastal cities by means of large-scale multifunctional coastal protection. Empirically the paper explores processes for coastal climate-proofing in Sweden, using qualitative analysis of policy documents and interviews with frontline practitioners. Whereas responsibility for coastal protection lies at the national level in the Netherlands (Lu and Stead, 2013) or state and territory level in Australia (Harvey and Smithers, 2018), Sweden has employed weak national governing mechanisms, and instead handed over responsibility for coastal adaptation to municipal spatial planning and risk management (Storbjörk and Hedrén, 2011; Granberg, et al., 2016). This means that the ability of the local level to take on the task of coastal protection becomes pertinent to study. The following research questions (RQs) have guided the analysis:

- 1) How far has the process of coastal protection come, in terms of initiating, envisioning and enacting change?
- 2) What visions, principles and proposed strategies for coastal protection are chosen and why? What is the role of multifunctionality?
- 3) What critical determinants – barriers and enablers – influence the implementation of coastal protection measures?

1.1. Climate-proofing coastal cities

The intensified trend of waterfront urban development increases the need of considering and adapting to climate risks in the coastal areas (Storbjörk and Hjerpe, 2014; Storbjörk and Uggla, 2015; Granberg, et al., 2016; Rulleau and Rey-Valette, 2017). While the importance of “preventing property interests from vesting in undeveloped and vulnerable areas” to reduce local vulnerability is acknowledged (Dyckman, et al., 2014), case studies show that in practice, expert advice is often disregarded in waterfront planning. There is “no fail-safe mechanism to prevent residential development being built too close to the coast” which tends to “increase capitalization in already vulnerable areas” (Harvey and Smithers, 2018: 246). Also, while the climate risks may be increasingly clear to decision-makers, continued waterfront exploitation is often motivated by the fact that no matter what approach is taken, the existing city will still need protection from sea level rise in the future. Decision-makers therefore see no point in saying no to new developments, accelerating waterfront development (Storbjörk and Hjerpe, 2014; Storbjörk and Uggla, 2015; Granberg, et al., 2016). This intensifies the need to identify when and how coastal adaptation comes about (Moser, et al., 2012: 65), as well as what and why certain adaptation strategies are chosen by decision-makers in the urban coastal zones (Siders and Keenan, 2020). Also, there is a lack of knowledge regarding the process of coastal adaptation and implementation impediments for novel multifunctional approaches in coastal climate adaptation planning (Wong, et al., 2014; Evans, et al., 2017; Gibbs, 2019; Valente and Veloso-Gomes, 2020).

The main strategies for approaching adaptation in coastal cities are defend, retreat, accommodate and attack (Few, et al., 2007; ICE, 2010; Nicholls, 2011; Alexander, et al., 2012; Dyckman, et al., 2014). Defend means armouring and holding the shoreline, i.e. controlling risks by way of hard or soft structural protection such as seawalls, breakwaters, beach nourishments and protective dunes. Retreat is a strategy targeted instead at pulling back and relocating vulnerable settlements from the coastline landwards. The third strategy, accommodate, involves adjusting continued coastal land use to accommodate risks with e.g. stricter building codes to limit expansion, land elevation or flood-proofing of buildings (Few, et al., 2007; ICE, 2010; Nicholls, 2011; Dyckman, et al., 2014). Fourthly, attack aims at advancing the line and stepping seaward to expand urban development onto the water by e.g. artificial land creation or stilted or floating structures where climate risks are considered in the design (ICE, 2010; Nicholls, 2011).

As for the application of these strategies, there has “throughout human history /.../ been a move from retreat and accommodate to hard protection and active seaward advance” (Nicholls, 2011:

152). In densely populated coastal areas with high income and property values, defend has been the preferred strategy (Moser, et al., 2012; Gibbs, 2016; Siders and Keenan, 2020). While hard stabilization continues to be seen as a viable option in urban areas, soft stabilization is increasing in use (Dyckman, et al., 2014; Vikolainen, et al., 2017). This trend is motivated by the search for added values, i.e. additional multifunctional services to society by the coastal defences (Vikolainen, et al., 2017). Managed retreat is considered a less attractive strategy, expected to be applied in low-lying and more peripheral coastal communities, where attracting necessary investments proves difficult (Alexander, et al., 2012; Siders and Keenan, 2020). However, in the United States, some states proactively work with fixed setbacks, land acquisition and avoidance through hazardous area zoning, as examples of managed retreat (Dyckman, et al., 2014). Hybrid, mixed approaches are also expected, based on what might be appropriate for a specific area (Nicholls, 2011; Alexander, et al., 2012).

Coastal adaptation that builds on continued waterfront urban planning also increases the need for innovation and experimentation regarding appropriate approaches and measures (ICE, 2010; Lu and Stead, 2013; Dyckman, et al., 2014; Vikolainen, et al., 2017). So far, the few existing studies of experimentation in coastal climate adaptation have used Rotterdam as a case study, illustrating different adaptation measures adopted (Tillie and van der Heijden, 2016; Huang-Lachmann and Lovett, 2016; Francesch-Huidobro, et al., 2017). There is a call for innovation studies that target how added values from built-in multifunctional secondary ecological and/or socioeconomic benefits such as enhanced habitats, recreation, aquaculture and landscape values can be created (Lu and Stead, 2013; Evans, et al., 2017; Vikolainen, et al., 2017; Antunes do Carmo, 2019; O'Shaughnessy, et al., 2019). This means focussing on inherent opportunities and co-benefits instead of only meeting risks. Despite a promising agenda for multifunctionality, there are few practical examples of “truly and purposefully-designed multifunctional coastal defences around the world”, except artificial reefs (Evans, et al., 2017:144; Nicholls, 2011) and mangroves (Gracia, et al., 2018).

When it comes to planning and implementing coastal protection infrastructure, studies show that while there may be plans, implementation is unclear (Nicholls, 2011; Hurlimann, et al., 2014; Jeuken, et al., 2015; Evans, et al., 2017; Gibbs, 2019; Valente and Veloso-Gomes, 2020), meaning that increased understanding of implementation impediments is needed (Wong, et al., 2014; Evans, et al., 2017; Gibbs, 2019; Valente and Veloso-Gomes, 2020). In political science, implementation studies have evolved towards an understanding of implementation processes as dynamic, intertwined and negotiated orders influenced by micro-political power structures and interactions among key actors. Practical outcomes are determined by various implementation drivers and barriers, serving as determinants for change (Pressman and Wildawsky, 1984; Sabatier and Weible, 2014; Hupe and Hill, 2016). Recent coastal protection studies have suggested that institutional and governance structures in decision-making is critical for ensuring sufficient adaptation measures (Harvey and Smithers, 2018; Francesch-Huidobro, et al., 2017; Wong, et al., 2014; Hurlimann, et al., 2014; Moser, et al., 2012; Storbjörk and Hedrén, 2011). The effectiveness of governance and institutional arrangements, in turn, is dependent on aspects such as lack of knowledge and understanding (Evans, et al., 2017), weak vertical and horizontal integration/agreement, policy tensions and conflicting political priorities (Storbjörk and Hedrén, 2011), limited legal frameworks and allocation of costs (Hurlimann, et al., 2014;

Valente and Veloso-Gomes, 2020). The funding of multifunctional measures particularly triggers questions of how to distribute and share costs for the multifunctional elements between the involved actors, and what costs are considered justified with heavily restricted budgets (Evans, et al., 2017; Asplund and Hjerpe 2020). The process is further complicated by multiple actors with different interests, risk perceptions and preferences for adaptation options (Valente and Veloso-Gomes, 2020).

2. Methods

Analyzing the status of and conditions for climate-proofing coastal cities in Sweden involved a careful selection of case cities. We specifically aimed at targeting progressive cities that were actively engaged in a process of coastal climate-proofing. Since implementation is often said to be dependent upon municipal size, with larger municipalities having greater capacity to act (Amundsen et al 2010), the study was designed to also capture variation in terms of both more and less populous cities. After an initial mapping of potential candidates, the two more populous cities of Malmö (316,588 inhabitants) and Gothenburg (567,377 inhabitants), the city of Helsingborg (108,334 inhabitants) and the large town of Landskrona (32,968 inhabitants) were selected. They were considered progressive in the sense of having identified the need and initiated planning for coastal protection, while simultaneously expanding their waterfront urban development with multifunctionality as a key position.

Combined qualitative methods were employed to draw a rich picture of local coastal adaptation planning, encompassing both document analysis and interviews. Qualitative content analysis of local visions, reports, strategies and plans for coastal protection allowed us to capture the initiation and development of a local approach as it appeared “on paper”. These policy documents were mapped gradually, by independent internet search and by asking interviewees for relevant documentation. The content analysis focussed on documenting policy developments and evolving key positions for coastal protection. This meant that we used the policy documents to outline how far the process of coastal protection had come in the four municipalities: what had been done in terms of initiation, envisioning and enactment. We also documented what approaches were taken in terms of local visions, principles and concrete coastal protection strategies. This was then used to write the story of ongoing activities in the four municipalities in section 3.1, where we combine summarizing key messages from the text with the use of verbatim quotes to strengthen and substantiate our analysis. The documents however gave sparse indications of practical challenges in terms of initiating, envisioning and enacting coastal protection. This was where the interviews became necessary.

Semi-structured interviews with frontline practitioners, i.e. officials charged with the strategic task of planning and implementing large-scale coastal protection, were selected after mapping who was knowledgeable and had a strategic role in the ongoing practical work in the four cities. Interviewing frontline practitioners was adopted, following Healey (2009) and Clifford (2013). Seven interviewees were included in the study. Since there were large variations in how the work was organized locally it was less important for us to make certain that the number of interviewees per municipality was the same. Rather we interviewed those actors that were mentioned as having a strategic role in the local work. The comparatively small number of

interviewees was motivated by the fact that the aim was not to capture perceptions among a larger variety of officials to triangulate data within municipalities, but rather to gain deep insights from the frontline practitioners in charge of coastal climate-proofing. To be able to extract significant in-depth knowledge, using fewer informants is a valid research approach (Kvale and Brinkmann 2014: 97ff).

Table 1 interviewees.

Interviewee	City	Position
1	Malmö	Environmental strategist targeting climate change at the strategic unit, department of urban development. Key role in coastal adaptation.
2	Gothenburg	Climate strategist targeting climate adaptation at the department of urban development. Key role in coastal adaptation.
3	Gothenburg	Project leader for the district Frihamnen at the department of urban development. Expert in climate adaptation at strategic municipal level.
4	Helsingborg	Project leader at the department of urban development, working with the waterfront urban development district H+ and sea level rise.
5	Helsingborg	Area developer at the department of urban development, operation and maintenance in the coastal zone.
6	Landskrona	Head of department of urban development with a key role in coastal adaptation.
7	Landskrona	Head of operations at the local rescue services with expertise in crisis management and flooding.

The interviews followed an interview guide where questions of initiation, envisioning and enacting multifunctional coastal protection were put in focus. Initially, open questions were posed, evolving into specific follow-up questions making it possible to pinpoint theoretical aspects of coastal adaptation found in the scientific literature related to strategies, policy process and implementation. The interview guide can be found as supplementary material. The interviews took place in the spring of 2019 at the municipal administrative offices and lasted approximately two hours each. All interviews were audio-recorded and transcribed verbatim.

The qualitative analysis of transcripts was inductive and undertaken stepwise. First, we started with a process of meaning concentration, where transcripts were read and reread to explore and sort out the specific messages found in each interview. This meant that individual perspectives were put in focus. Second, we proceeded with a process of meaning categorization, highlighting reoccurring analytical themes with a particular bearing on the aim and research questions of the paper, for more thorough analysis. Here we identified analytical patterns by relating interview responses to each other, thus exploring differences and similarities in messages and perspectives. In 3.1 this was done city-by-city, interlinking RQ 1 (process of coastal protection) with RQ2 (vision, principles and strategies) for a more coherent presentation of individual city characteristics. In 3.2 we focussed on broader trends among cities and various interviewee responses regarding determinants for implementation. The following eight themes were identified: politics and political decisions, internal responsibility and organizational structures, balancing political priorities, continued knowledge-building and innovation, visualizing appropriate protection measures, funding mechanisms, prioritizing protection measures and engaging private actors. The validity of interpretations was strengthened by comparing statements from different cities (Silverman, 2011; Baxter and Eyles, 1997), where we identified

a high level of agreement in many of the response patterns. The regular use of verbatim quotes from interviewees allowed us to illustrate what led us to draw certain analytical conclusions. Many of the quotes thus functioned as examples of analytical patterns. We systematically noted where similar statements were made by several interviewees to increase transparency and validity of interpretations. We also presented individual perspectives, when these highlighted important alternative perspectives that deepened our understanding of the issues at hand. To further increase the validity of the analysis, a preliminary compilation of the result and analysis (3.1 and 3.2) was sent to the interviewees for member checking (Baxter and Eyles, 1997).

3. Results and analysis

The presentation and analysis of empirical results is divided in two main parts. First, in section 3.1 we illustrate the initiation, envisioning and enacting of strategies for coastal protection in the four case-cities, including their visions, principles and proposed strategies. This section ends with a summarizing table 2, illustrating main differences and similarities in the case-cities. Second, in section 3.2 we clarify analytically what would be required to enable implementation.

3.1 Initiating, envisioning and enacting multifunctional coastal protection

Experiences of vulnerability to climate change and the explicit local responsibility to manage risks have gradually created an awareness of the need for large-scale coastal protection, thus *initiating* a climate-proofing process. The cities have worked strategically to build knowledge regarding climate risks, urban vulnerability, costs and benefits of adaptation measures in a context of local responsibility for climate adaptation. The two largest cities were the first to act, thus taking on the position as first-movers, before climate adaptation was being properly discussed or put on the national agenda. In Gothenburg, climate adaptation was initiated in 2004 when the municipal board commissioned a cross-sectoral study of vulnerability to extreme weather in a changing climate (Gothenburg, 2006). In Malmö, discussions of sea level rise in urban planning led to gradually sharpened regulations for waterfront housing from 2000, and to an emphasis on barriers for coastal protection (Malmö, 2008). The December storm of 2013, named “Sven”, triggered a sense of urgency and concrete plans for protecting waterfront urban areas (Malmö, 2016). Sven had similar effects in Helsingborg, where the knowledge-oriented process of vulnerability and climate adaptation initiated in 2011 (Helsingborg, 2011; 2016; 2019) was intensified. In Landskrona, climate adaptation was gradually put on the local agenda with a first report commissioned in 2012 (Landskrona, 2015). In the smaller cities, adaptation was put on the local agenda after legislative changes in the Planning and Building Act (PBA) stating that climate risks need to be managed in spatial planning. While awareness and local responsibility are important for initiation, placemaking and attractiveness in the form of waterfront urban development of retrofitting old port precincts drives the continued planning for large-scale coastal protection. In Gothenburg, adaptation is a precondition for the waterfront development along the shoreline of Göta River, Älvstaden, doubling the size of the city centre (Gothenburg, 2012). The new Frihamnen district is intended to serve as a testbed for principles of adaptation, exploring innovative solutions for waterfront development (Gothenburg, 2017). Similar trends are noted in both Malmö and Helsingborg. In Landskrona, initiation was linked

to urban development and the visionary endeavor for the 600-year anniversary of the city in 2013 aimed at “thinking big and innovative” in terms of urban waterfront development.

When it comes to *envisioning*, multifunctionality is central in all cities. Coastal climate adaptation should not only protect the city but simultaneously create co-benefits in terms of urban development that facilitates attractive housing, recreation and proximity to water in the expanding city (Interviews 1-4). In the densely populated urban centres, multifunctionality is driven more by aesthetics and design than by ecological functions. In fact, a large-scale puzzle of different protective measures is needed along the coastlines of the cities.

Starting with Gothenburg, the waterfront redevelopment plans in Frihamnen led to the exploration and visualization of the three strategies defend, retreat and attack (Mistra Urban Futures, 2010). A planning programme for Frihamnen was produced in 2015 and the first detailed development plan in 2017 (Gothenburg, 2015; 2017). The idea was to support “waterfront urban expansion with built-in defence”, except for the new floodable Jubilee Park. The latter fills an important social and aesthetic function while simultaneously serving as retreat-oriented flood protection (Interview 3). Principles of multifunctionality in terms of attractive urban environment and eco-system services are highlighted (Gothenburg, 2018a:8). Urban development at Frihamnen was put on hold “since the plans for large-scale coastal protection needed to catch up” (Interview 3). However, the Jubilee Park is currently being constructed for the city’s 400th anniversary in 2021, containing a spectacular sauna, a floodable floating bath and wooden decks along the quays, providing stairways to access water. To protect coastal Gothenburg, the city advocates the construction of two outer sluice gates, seen as the most beneficial and cost-effective solution (Interview 2). A pre-study was undertaken in 2015, concluding that Gothenburg is the first Scandinavian city that plans to build outer sluice gates to protect a whole city. This outer defence is assumed to be in place in 2070. Before 2040 the city will implement building regulations for new buildings and establish an inner protection along the riverbank to protect the existing city. This is presented as a precondition for Älvstaden (Gothenburg, 2018a:26). Further investigations of economic effects of different strategies and the consequences of an early construction of coherent protection versus gradual development are warranted (Gothenburg, 2018b:24).

Moving on to Malmö, policy documents illustrate an urban development that makes use of Malmö’s waterfront position while securing ecosystem services provided by the water (Malmö, 2016). A strategy for coastal adaptation was produced 2017, involving strategies of retreat, defend, accommodate and attack. Eleven sub-areas were identified along the coastline, each with different risks, specificities and opportunities depending on whether they concern industrial sites, urban city centres or spacious green areas (Malmö, 2018b). In 2018, the vision “Malmö the coastal city of the future” suggested creating an attractive waterfront city well equipped to withstand climate change, where adaptation measures also ensure new residential and green areas. Two new climate-proof waterfront areas were visualized, the northern parts of Västra hamnen (with the suggested districts Metro City and Pier City) and the old fishing port in Limhamn (with the suggested districts Fishing Port and Water Village), involving:

“a dynamic symbiosis between urban architecture and the ecology of the ocean, located at the best spot in the port to Europe.” (Malmö 2018e:5)

The “two simmering districts” are described as constituting the backbone of the long-term climate-proofing of Malmö while also creating a stepwise transition to the water, giving residents waterfront access (Malmö, 2018e:6). Elevating the land on the former industrial site allows both for new housing along the quay and a new recreational meadow park in a sunny position “that serves well in future climate” (Malmö, 2018e:6). This park creates a buffer zone for waves including an embankment to be gradually heightened. Further, a large-scale sluice gate is suggested to protect Västra hamnen and the city centre (Malmö, 2018e:11). South of the city centre, Limhamn experiences an ongoing transition of facing the water. At the Fishing Port a gradual land elevation and low embankments protect existing and new settlements. At the Water Village, the idea is rather for new housing to co-exist with water:

“Sea level rise and more frequent flooding gradually change the areas’ character. The elevated settlements on poles are spared damages but the feeling of being close to water is palpable. It is part of the dynamic interplay with water.” (Malmö, 2018e:16)

The Water Village would also strengthen existing values of the place, functioning as a hub for water sports and recreation. A new canal invites the water closer towards land, creating an island with the benefit of breaking the waves and protecting the elevated boardwalk. The proposals build heavily on strategies of defend, accommodate and attack. The built-in flexibility with a stepwise approach means that the final step comes in effect on a long-term scale (>100 years) “if future climate change is extensive enough to require it” (Malmö, 2018e:13). As of yet, the report is “an input” to the ongoing coastal protection. The proposals are neither politically accepted, nor the focus of economical calculations (Interview1). In parallel to this, there are ongoing visualizations in the district Nyhamnen, expected to become a new display area for the future, showcasing “the creation of new and intimate rooms of water” for urban green and blue where measures for coastal protection are given several functions and serve as design configurations (Malmö, 2018a).

In Helsingborg there is similar emphasis on coastal protection that provides added value for urban attractiveness (Helsingborg, 2011:7) using combined strategies (Helsingborg, 2016). For the existing settlements in central Helsingborg defend measures were pinpointed as most appropriate, as they allow life to go on comparatively unchanged, whereas both retreat and attack would negatively influence port operations (Helsingborg, 2010:45). For outskirt areas, a strategy of adjustment was suggested and, in areas with beaches, beach nourishment and sand dunes (Helsingborg, 2016:19). The continued work is aimed at both temporary singular protective measures that demand little effort while already today providing benefits, and a coherent inner protection of walls, embankments and local adaptations along the quays, following the pace and focus of urban development and regular quay maintenance. An example here being H+, the visionary waterfront renewal in the southern part of the city centre, where extended water contact contributes to an attractive urban environment and increased quality of life while simultaneously reducing climate vulnerability (Helsingborg, 2010; 2011; 2012). A catalogue of ideas for adaptation measures in H+ was presented in 2010, either supporting a strategy of holding the line, allowing floodable areas or expanding the city by floating constructions (Helsingborg, 2010:32-43). As an experimental site and potential showcase area (Helsingborg, 2012; 2016), H+ can introduce new ways of adapting buildings to withstand

temporary flooding by elevated houses, waterproof or floodable constructions and amphibious or floating houses (Helsingborg, 2016:19). Finally, outer barriers in the form of strengthened breakwaters and sluice gates are not regarded cost-efficient today but possibly the only valid long-term protection for the city (Helsingborg, 2019). Currently, a working group at the urban planning department is in the process of developing a comprehensive strategy for coastal climate-proofing (Interview 5).

Fourthly, in Landskrona, coastal protection planning was linked to urban planning and the task to pave the way for 1500 new homes, which required a strategic take on climate vulnerability (Interview 6). A first report on climate risks was commissioned in 2012. In parallel to this, the director of urban planning suggested a creative and bold approach to envision Landskrona 2063 in a playful and unrestricted way, celebrating the pride of the city for its 600th anniversary in 2013 (Interview 6). Based on local workshops, architects sketched a visionary waterfront future, integrating coastal protection with artificial archipelagos. The vision is presented in the newspaper-article “Landskrona follows Dubai”:

“The islands make it possible for citizens to come closer to water. Building the city around the coastline creates recreational opportunities with parks and beaches at the same time as the islands serve as barriers for sea level rise” (Kvällsposten, 2012-08-29).

“A radical take”, involving multifunctional adaptation, was incorporated in the comprehensive plan for the city from 2014 (Landskrona, 2014:58). In the continued work, the need for flexible and multifunctional solutions that “blend in or contribute with new functions” to strengthen urban attractiveness is further highlighted (Landskrona, 2015; 2016). The task to develop a plan for urban adaptation was given to the planning department in 2015, leading to guidance for climate adaptation in 2017. Suggestions for coastal protection measures were produced by consultants, focussing predominantly on defend strategies in shorter and longer term, by measures to reduce erosion, enhanced quays, walls and/or embankments (Landskrona, 2017a; 2017b). The visionary multifunctional archipelago is today, in interviews, described as “less realistic” (Interview 6).

Summing up the cross-case comparison we find both differences and similarities in how far the process of coastal protection has come in the four case cities.

Table 2. Comparing approaches and focus of coastal protection

	Case Malmö	Case Gothenburg	Case Helsingborg	Case Landskrona
Role	First-mover position. Before adaptation is put on the national agenda.	First-mover position. Before adaptation is put on the national agenda.	Follower. After changes in the PBA.	Follower. After changes in the PBA.
Initiation	Early 2000: Knowledge production on coastal planning for climate change. Sharpened building-regulations.	Early 2000: Cross-sectoral knowledge production on vulnerability and adaptation.	2011: Initial knowledge production on vulnerability and adaptation.	2012: Initial knowledge production on vulnerability and adaptation.

Reason for intensification	December storm of 2013 and waterfront urban development.	Waterfront urban development.	December storm of 2013 and waterfront urban development.	December storm of 2013 and visionary work for the city's 600-year anniversary.
Knowledge production	Very large knowledge-production.	Very large knowledge-production.	Large knowledge-production.	Moderate knowledge-production.
Envisioned principles	Multi-functional costal protection emphasizing urban attractiveness.	Multi-functional costal protection emphasizing urban attractiveness.	Multi-functional costal protection emphasizing urban attractiveness.	Multi-functional costal protection emphasizing urban attractiveness.
Intended innovation	Nyhamnen as display area showcasing solutions.	Frihamnen as testbed for climate adaptation principles.	H+ as innovative site showcasing solutions.	Bold vision Landskrona 2063. Currently uncertain.
Envisioned adaptation strategy	Depends on sub-area (central/peripheral). Combined strategies of defend, retreat, accommodate and attack, including an outer sluice gate.	Predominantly attack with built-in defence protecting urban centres. Combining inner protection and outer sluice gates.	Defend is considered most appropriate for city centre. A catalogue of ideas combining defend, retreat and attack. Possibly outer barriers.	Predominantly defend-strategies.
Intended enactment	Stepwise, pending political decisions.	Stepwise, pending political decisions. Jubilee Park under construction for 2021.	Stepwise, pending political decisions.	Stepwise, pending political decisions.

While there are plans and visualizations for a stepwise coastal protection in the cities, it is equally clear that the process of enacting change has been slow and that strategic political decisions are needed for how to proceed.

3.2 Critical determinants influencing implementation

There are striking similarities in critical determinants – barriers and enablers – for implementing coastal protection, italicized in the subsequent presentation, that are emphasized by the frontline practitioners, alongside differences related to municipal size.

While *politics and political decisions* have been taken to initiate coastal protection, thus mandating local work, further political decisions for how to proceed towards implementation are needed in all cities. Interviewees suggest that politics becomes decisive, both in setting organization, concrete time plans, prioritizing between values and interests involved in multifunctional approaches, and funding local adaptation (Interviews 1-7). Political decision-making is thus heavily interlinked with several of the other key determinants.

Political clarifications are needed regarding *internal responsibility and organizational structures*. In Malmö, Gothenburg and Helsingborg, initial mandates and responsibilities are in place for officials to work with coastal adaptation. In Landskrona, interviewees express the

need to set basic responsibilities. Here, a recommendation was made in 2017 that a coordinating role should be placed under the municipal board, but political decisions are still pending:

“We need to decide how to work with this, where to place responsibility and how to proceed organizationally. It is a political matter where municipal leaders must decide who will be in charge in the future.” (Interview 6. Similar: interview 7)

Setting such responsibilities is a way to legitimize action and provide mandate. Otherwise, the work on coastal protection “risks becoming little more than a project on the side” (Interview 7). Besides setting initial responsibilities, what remains in all cities is clarifying necessary organizational structures to ensure the implementation of coastal protection. This concerns strategically positioned officials, as emphasized in Gothenburg, with the task to facilitate an effective dialogue and anchorage between officials and politicians:

“We need a more strategic official centrally placed in the municipal administration close to politics, to enable quick decisions and keep them updated on progress.” (Interview 2)

It also concerns the internal municipal coordination of responsibilities and exchange of competence across sectors. Here interviewees uniformly advocate developing an integrated approach involving all relevant departments:

“We need one big compromise where we work together to find common solutions and build bridges between departments. Matters such as operation, economy and maintenance are critical. Our organizations are not rigged for this and innovations are needed.” (Interview 3. Similar: interviews 1-2,5-6)

Such internal dialogue is critical also for the future of multifunctionality, where both knowledge and responsibility need to be spread across departments:

“How much focus is put on multifunctional measures depends on local opportunities and the interest of sector officials. We try to spread knowledge, but our internal communication is neglected since we have been busy producing documents and reports.” (Interview 2. Similar: interview 1)

Further, politicians need to be brave and proactive when facing other pressing concerns such as economic priorities, thus *balancing political priorities* in decision-making:

“We need strategic decisions of what to do. We know that protection will cost, and the city needs to be prepared for that. I hope we can continue working in this direction and that the economy does not overturn things.” (Interview 3. Similar: interviews 1-7)

This becomes important throughout the long implementation-process, highlighting the need for continuity in balancing and settling priorities.

To be able to make appropriate decisions, *continued knowledge-building and innovation* is another key determinant. Particularly in the two larger cities, but also in the two smaller, many reports and strategic documents have been produced during the years to learn about vulnerability and adaptation options. Gothenburg, Malmö and Helsingborg have also expressed a clear ambition to take a leading role in producing knowledge by experimenting and developing new solutions for climate risk management, thus acting as national showcases for the future. Inspiration comes from abroad and cities engage in research projects and networks

to test solutions and contribute to knowledge building on coastal adaptation (Interviews 1-5). This need is important for the future:

“We cannot postpone these decisions, but we lack knowledge of in what areas particular methods are applicable and whether mixed methods can or should be used. We are particularly happy to contribute with testing soft methods working with nature e.g. eelgrass meadows or beach nourishment that would reduce the need of hard structures” (Interview 5)

For innovations, particularly the two smaller municipalities see consultants as knowledge brokers, bearers of necessary input:

“The previous experiences of our consultants play a critical role. Their knowledge of what has been done in other cities is really important for our work” (Interview 4. Similar: interviews 5-7).

However, to simply “copy-paste” innovative solutions from elsewhere is not a viable option. Knowing the characteristics of each location ensures robust measures that “do the job” without causing new problems:

“We need to know what we’re doing when we take measures along the coast. A poorly designed revetment can increase rather than reduce waves. We have installed breakwaters at the cold bath area with the unintended consequence of reducing water depth to 20 centimetres.” (Interview 5)

The two larger cities rather experience problems with consultants being limited in their perspectives and knowledge, particularly regarding innovative multifunctionality. The interviewees here emphasize the risk of leaving knowledge building to engineers where instead the combined competences of engineers, planners and landscape architects is needed (Interviews 1-3).

The determinant *visualizing appropriate protection measures* is linked to knowledge building. Interviewees in Malmö, Gothenburg and Helsingborg emphasize the importance of visualizing what the possible, appropriate and, ultimately, climate-proof waterfront adaptation measures are:

“Politicians needs to feel safe that we have managed the risks and that proposed measures are not just architectural sketches. We produced a very detailed strategy for land elevation, almost too complex, but one politician specifically said ‘now I feel assured’ and that is really important.” (Interview 2. Similar: interviews 1-5)

At the same time as strategies need to be detailed, they also need to be flexible, which is a challenging balance. In many ways coastal protection means catching a moving target (Interview 4). Creating a sense of security by visualizing what to do while at the same time allowing for flexibility is described as necessary to ensure robustness. When it comes to multifunctional approaches, visualization allows “painting a picture of possibilities” to illustrate and argue for co-benefits and values of protective measures:

“We want to strengthen our attractivity at the same time as we protect our city. It is so much easier politically with protective measures that look nice and contribute to highlighting our waterfront position.” (Interview 4. Similar: interviews 1, 3, 5).

In this respect, visualizing multifunctionality has the potential to increase the willingness to work with and, ultimately, to fund coastal protection. Generally, *funding mechanisms* are critical to the continued process:

“Now the big bucks will start rolling. We need ways to fund this.” (Interview 2. Similar: interview 1)

While officials from Gothenburg have argued for increased national funding to support local climate adaptation for over a decade, such support mechanisms are still missing, implying that costs must be covered by local budgets (Interview 2). In the more populous cities, urban development becomes a window of opportunity for sharing costs where private actors co-fund coastal protection:

“Integrating protective measures in ongoing urban development projects entails an opportunity to cover costs. The responsibility of further investigations is delegated to the new waterfront districts which will carry a lot of the cost since they are placed furthest towards the sea.” (Interview 3. Similar: interviews 1-2)

While advantages are clear, there are also risks with such an approach, according to interviewees:

“There is a risk of sub-optimization. We also have areas where we have no ongoing urban development and no exploitation to link funding to. Those are more difficult.” (Interview 3. Similar: interviews 1-2)

When comparing cities, it also becomes clear that such windows of opportunity are fewer in the less expansive and populous cities:

“A few years back there was a development project that made it possible for us to start investigating what coastal protection could look like but in the end the political will to invest was uncertain meaning that we couldn’t proceed.” (Interview 6)

The ability to co-fund protective measures thus varies depending on urban attractiveness and level of exploitation. If focus is predominantly given to attractive areas with co-funding opportunities, this risks not only fragmenting coastal protection, but also, since such *prioritizing protection measures* create both winners and losers, widening social imbalances regarding coastal protection both between attractive and less attractive municipalities and between attractive and less attractive areas within municipalities. Here considerations of where to take measures are not only determined by urgency or effectiveness but on where co-funding opportunities arise. Or, where measures are most visible, suggesting that considerations of visibility and ability to display showcase solutions can determine what efforts to prioritize:

“Before the last elections our politicians stood at the attractive quayside saying, ‘here is where we will protect the city from sea level rise’. If we would have done so it would have been a very costly measure that would have protected perhaps five per cent of the city, but in a visible area that people pass every day.” (Interview 4)

Priority difficulties are also found concerning what types of measures to take. When local budgets and co-funding opportunities are strained, like in the smaller cities, the choice is between prioritizing a few costly aesthetic and multifunctional measures and providing a more substantial system of traditional protection:

“There is a risk when we dress the protective measures with too many functions that they get very expensive. We have a budget for coastal protection that cannot only go to providing aesthetic designs. We have a long coastline where measures are needed, and we risk running out of money quickly with such an approach.” (Interview 4)

Prioritizing which areas will be protected and not and what types of measures are reasonable given budget constraints and weak co-funding incentives will determine the practice of coastal protection.

In further exploring key determinants, the interviewees highlight the importance of *engaging private actors*:

“The municipality is a key actor in concretizing and making demands, but we won’t find good solutions unless private actors are included.” (Interview 3. Similar: interviews 1-7)

For new districts, property developers play a pivotal role in providing co-funding, whereas for existing districts, property owners and other stakeholders are important to include:

“It is their living environment that is at stake and we cannot start taking measures without considering their views. We are meant to work for the people who live here, and to enable them to continue doing so.” (Interview 5. Similar: interviews 3-6)

Citizens expect municipal action, particularly when local approaches to coastal protection differ. An interviewee from the smallest city exemplifies:

“The municipality next to us is experimenting with coastal protection measures in a research project they’re involved in. Citizens living on our side of the beach expect us to do the same. They think it is unfair that their neighbours get support while they don’t.” (Interview 6).

While it is the task of property owners to ensure that their properties are safe, interviewees emphasize that the municipal administration need to keep the necessary overview, ensuring *system coherency* to avoid fragmentation of coastal protection:

“People living along the coast are becoming risk aware and want to protect themselves. We have no obligation to protect individual properties, but it can create problems if they start taking action on their own. Measures protecting one property will affect neighboring areas. We need to have a role in providing an overview of measures and their effects.” (Interview 5. Similar: interviews 4-7)

Such system coherency is also important due to the stepwise character of coastal protection where measures are taken over time and in stages:

“We draw a picture of what we want to accomplish and have an idea of how to get there but we can never make sure that it happens accordingly. The economic situation and other things can cause problems, meaning that the final pieces of the puzzle may never be added. We cannot build everything at once, we build in stages.” (Interview 3)

Here lessons from New Orleans are brought up as a warning:

“International experience says that we need to build the protection during a brief time period to guarantee an even quality. It requires long-term maintenance and must be located on publicly owned land. In New Orleans the measures had come about over a

long time period, and no one owned it as a system. The weakest link broke first and then it collapsed.” (Interview 2)

The interviewee sees this as an indication also that in Sweden, there must be a stricter role for the national level:

“We need a national responsibility like in the Netherlands. Putting all responsibility in the hands of local private property owners to protect their property means sub-optimization. You need someone to see the whole picture.” (Interview 2)

The suggestion from the municipal interviewees is thus to revise the current distribution of responsibilities between public and private actors at local and national levels, to ensure increased robustness in coastal adaptation.

4. Concluding discussion

This paper set out to analyze the status of and conditions for climate-proofing coastal cities by means of large-scale multifunctional coastal protection. By exploring the processes for coastal climate-proofing in four Swedish case cities, several important conclusions can be drawn. The impacts and consequences of the future climate for the four coastal cities are enormous, meaning that coastal protection is critical for human safety. Coastal protection measures taken can either support incremental adaptation, involving business-as-usual and potentially reinforcing rather than reducing local vulnerabilities, or transformational adaptation by renegotiating boundaries and how the interface between human settlements and the sea is constructed (Kates, et al., 2012). Both policy documents and interview statements bear witness to the large-scale transformations of development practices that are needed for coastal climate-proofing.

This study found plans and visualizations for a stepwise coastal protection in Malmö, Gothenburg, Helsingborg and Landskrona. The two largest cities were first to act, gradually followed by the others. Interestingly the results suggest that local waterfront development plans cannot only be seen as increasing local climate vulnerabilities, as emphasized in the previous literature (Storbjörk and Hjerpe, 2014; Rulleau and Rey-Valette, 2017; Harvey and Smithers, 2018). Rather this study shows that they also create windows of opportunity for cities by enabling co-funding and progression in planning and implementing coastal protection. Through the placemaking ambitions of the waterfront redevelopments, we find that cities have the opportunity to test innovative solutions that hopefully can support the identification of pathways that are both attractive and efficient. This means that waterfront redevelopments may function as “seeds of transformation”, advancing and accelerating local climate responses (Bulkeley and Broto, 2013). We will return to the inherent problems of such an approach.

The results establish that the case cities are planning a large-scale puzzle of different coastal protection measures. Malmö, Gothenburg and Helsingborg are engaged in exploring innovative showcase solutions, moving from incremental measures within existing social structures to multifunctional approaches, where adaptation works with nature supporting the dynamic interplay between city and water. The cities plan to start with varied forms of inner-city multifunctional protective measures, integrating protection with urban development, to potentially proceed with building large-scale outer barriers. Mixed strategies (Nicholls, 2011;

Alexander, et al., 2012) are planned in densely populated city centres, thus abandoning the longstanding trend of strict defence (Gibbs, 2016; Siders and Keenan 2020), to favour multifunctional strategies of attack or accommodate with built-in defence. The results show that mere defence strategies fit poorly with envisioning innovative waterfront encounters, which are perceived as necessary for designing attractive cities with high recreational values and quality of life. We find that strategies of retreat or strict defence are still being considered in less attractive outskirt areas and in the smallest city. In Landskrona multifunctionality is presented as strategically important although concrete suggestions so far are traditionally defence-oriented, with more innovative suggestions outlined above being considered less realistic. In the densely populated urban centres, multifunctionality is driven more by socioeconomic values and design perspectives, than, as in previous studies, ecological concerns (Evans, et al., 2017; O’Shaughnessy, et al., 2019). The latter are more prominent motives in outskirt areas, suggesting a place dependency of coastal protection where strategies and multifunctionality differ in central versus peripheral areas and where perceived attractiveness determines what strategies are being planned. Also, while multifunctionality is unquestionable on the ideational/visionary level, the study identifies difficulties for its practical realization, related to actor coordination, funding and maintenance. To what extent the explicit ambitions of multifunctional innovation are transformed from visions to practice thus remains to be seen. Likewise, whether the coastal protection measures will be defined as either incremental or transformational is still too early to assess. While taking stepwise action tends to be aligned with incremental adaptation, it is suggested that changes that initially may appear small and stepwise can cumulatively “coalesce into what appears in retrospect as a transitional adaptation” (Kates, et al., 2012:7156). Consequently, only when the proposed measures for coastal protection are in place can we assess them properly. This brings us to the question of implementation and what determines practical outcomes.

As concluded in previous studies (Nicholls, 2011; Hurlimann, et al., 2014; Jeuken, et al., 2015; Evans, et al., 2017; Gibbs, 2019; Valente and Veloso-Gomes, 2020), while there may be plans and strategies in place for coastal protection, cities have thus far put less emphasis on implementing the proposed measures. The Swedish case cities are no exception. Priority has been on producing knowledge regarding local vulnerabilities, visualizing consequences, and identifying viable adaptation strategies and measures. While the cities are in the process of envisioning and planning for the necessary stepwise changes, the process of enacting change has been slow. A number of implementation determinants are identified in the case cities. Here we find “the usual suspects” of institutional and governance structures required to support implementation, recognizable from previous studies (Harvey and Smithers, 2018; Francesch-Huidobro, et al., 2017; Wong, et al., 2014; Hurlimann, et al., 2014; Moser, et al., 2012; Storbjörk and Hedrén, 2011). More specifically, the Swedish analysis suggests that barriers have less to do with lack of knowledge and understanding (as found in Evans et al., 2017) or limited legal frameworks (as found in Hurlimann, et al., 2014 and Valente and Veloso-Gomes, 2020). However, we do find that politics and political decisions are deemed critical to both mandate initial work and, more urgently, to secure implementation. Currently, settling internal municipal responsibilities and organizational structures, time plans, and funding-mechanisms is required, as are the balancing of political priorities in decision-making (as found in Storbjörk

and Hedrén, 2011, Hurlimann, et al., 2014 and Valente and Veloso-Gomes, 2020). Further, the results from the Swedish case cities illustrate the importance of engaging private actors in implementation and supporting continued knowledge building and innovation. These are all mainly formal institutional requirements, visible and tangible, whereas we find less emphasis being put on informal aspects such as values, norms, traditions, codes and conducts (Young, 2002) in the case cities. The exceptions are conflicting values and traditions of sector authorities and professions such as engineers, planners and landscape architects in multifunctional design. This probably relates to the fact that the coastal protection practice is at an early preparatory rather than operational stage, where informal aspects are likely to become more dominant. Other aspects highlighted in the Swedish case cities concern visualizing attractive, flexible and robust multifunctional measures to build assurance and trust among decision-makers. Further, the study suggests that the unavoidable prioritizing between adaptation efforts risks creating social imbalances (as found in Siders and Keenan, 2020) between attractive and less attractive municipalities and areas, suggesting also that urgency and effectiveness may be less important determinants for implementation than co-funding-opportunities and visibility/ability to demonstrate showcase solutions. Municipalities with limited budgets and co-funding incentives have difficulty prioritizing certain coastal protection measures. Similar imbalances have been noted with eco districts, creating “islands of green privilege” – strengthening gentrification and urban fragmentation (Fitzgerald and Lenhart, 2016). Finally, the analysis in Swedish case cities suggests that there is a risk that the stepwise approach combined with individualized actions of citizens defending their properties creates a fragmented and incoherent system of coastal protection.

Lessons from the case cities thus suggest that the current Swedish system for coastal adaptation is not equipped to deal with the climate challenge. The Swedish approach means that national support systems are largely absent, and that responsibility is heavily decentralized and put in the hands of 290 municipalities, differing in characteristics and capacities and, ultimately, with individual property owners. This risk creating a fragmented coastal protection that is developed too stepwisely, based on windows of opportunity regarding co-funding or innovative urban redevelopment projects rather than where efforts are most needed. System imbalances between attractive and less attractive municipalities and areas within municipalities risk creating a coastal protection that lacks the necessary robustness and coherency. This does not mean that we are arguing for a strict centralization, as this would likely entail other types of dilemmas. In the Swedish system for coastal adaptation, the results point to the importance of the local level, since this is where implementation will take place. Here increased efforts are needed to coordinate priorities, roles and responsibilities and co-funding among key public and private actors involved in enacting protective measures along the coastline. It is equally important to acknowledge the need for clearer national support systems to enhance the climate-proofing of coastal cities. National support for local knowledge- and capacity-building as well as extended funding mechanisms to ensure adaptation is decisive, targeting both the more progressive coastal municipalities ready for enacting their plans and municipalities that have not yet taken on the task of preparing for coastal climate change. Instead, the existing national funds for coastal protection, administered by the Swedish Civil Contingencies Agency, have recently been reduced. While the regional administrative level in Sweden holds a coordinating role for climate adaptation and supervises local spatial planning, their mandate *vis-à-vis* municipalities

is limited and laden with conflicts (Storbjörk and Hedrén, 2011; Antonson et al., 2016). The consequences of a system for coastal protection heavily reliant on decentralized action with limited regulatory and/or financial support, as in Sweden, needs to be properly reconsidered by national policy-makers seeking to refine the Swedish way of approaching coastal adaptation. Also, strategies are needed to properly address the identified implementation determinants as they prove critical for the practice of climate-proofing coastal cities. Here local coastal planners and local decision-makers need to develop a reflexivity where they identify both what the local barriers are and how these can be properly managed.

Acknowledgments

We wish to extend our gratitude to FORMAS for funding the research project *The role of urban experiments in triggering climate transitions*, EXPECT (grant number 942-2015-356), to our interviewees for generously sharing their views, perspectives and experiences, and to the two anonymous reviewers for suggestions that substantially improved the paper.

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