Shifting shorelines

Reflection on visualization of sea level rise

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Swedish University of Agricultural Sciences, SLU
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Abstract

Sea level rise is predicted to radically transform coastal landscapes in the coming centuries. Caused by climate change, the impact is already felt in low-lying communities around the world. Although the consequences of rising sea levels will be severe and irreversible, the slow pace of change and high level of uncertainty regarding its future trajectory make the issue challenging to plan for. However, adaptation to changing coastlines is necessary, especially in densely built urban areas. Climate adaptation initiatives are unlikely to be successful without public support. Yet research shows that people are likely to dismiss or underestimate the personal impact of climate change due to perceived psychological and temporal distance. Research on new approaches to climate communication have found that visualizing the impact of climate change, including sea level rise, has yielded promising results in both raising awareness as well as increasing engagement in local climate adaptation.

The aim of this study is to look at how sea level rise and possible adaptation measures can be visually communicated to facilitate dialogue between planning experts and lay audiences. This report describes the process and considerations involved in the production of sea level rise visualizations of a chosen site in Kalmar, Sweden. The produced imagery was presented to the public during an exhibition where participants were invited to engage in a discussion on sea level rise and give their feedback on the visualizations. These responses were analyzed and discussed to assess the effectiveness of the produced visuals in facilitating dialogue.

The result of this study shows how illustrating climate change impact on local level, tailored to the community, is a powerful tool for facilitating communication. The project also revealed the challenges in illustrating climate futures from accommodating uncertainty to visualizing potential solutions. This study supports previous findings on the power of imagery in reshaping collective imaginations and evoking emotions. Thus visualization justifiably has an important role in visioning possible futures for transforming coastal communities.

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Introduction

Sea level rise, hereafter referred to with the abbreviation SLR, is predicted to radically transform coastal landscapes in the coming centuries. Caused by climate change, the impact is already felt in low-lying communities around the world. Although the consequences of rising sea levels will be severe and irreversible, the slow pace of change and high level of uncertainty regarding its future trajectory make the issue challenging to plan for.

However, adaptation to changing coastlines is necessary, especially in densely built urban areas. Historically, coastal communities have relied on so-called "gray infrastructure" solutions, protecting the existing shoreline with physical structures, such as seawalls and levees. The accelerating pace of SLR has called into question the long-term sustainability of maintaining existing shorelines. Instead, a growing number of experts are advocating for a shift towards a long-term approach to adaptation, such as managed retreat through a gradual withdrawal from at-risk areas, allowing the water to reclaim land (Lawrence et al., 2020). Several scholars find that these strategies are often met with resistance on economic, governance, and ethical grounds (Göransson et al., 2021; Lawrence et al., 2020). By rethinking land use in coastal zones, the public and decision-makers must accept the reality of living with an uncertain future and forge a new relationship with the dynamic processes of the sea.

This approach to climate adaptation is unlikely to be successful without public support, as several international organizations point out (e.g., UN, 2017). However, due the slow onset of SLR, strategies such as managed retreat can be difficult to argue for. As Pahl et al. (2014) note, people are likely to dismiss or underestimate the personal impact of climate change due to perceived psychological and temporal distance, making it more challenging to gain support for radically new adaptation strategies. Research on new approaches to climate communication have found that localizing and visualizing impact of climate change, including SLR, has yielded promising results in both raising awareness as well as increasing engagement in local climate adaptation. Visualizing impacts in a local landscape can help bridge the perceived distance to SLR, thus facilitating a productive dialogue between citizens and planning professionals (Gammelgaard, 2018; Nicholson-Cole, 2005; Plate et al., 2020; Sheppard et al., 2011).

The aim of this study is to look at how SLR adaptation through leaving space for water can be visually communicated to facilitate dialogue between planning experts and lay audiences. In addition to informing the local community of potential future outcomes, I also explore whether the visual material produced can be used to help collect and record local knowledge from the community. This thesis relates to an on-going research project on coastal adaptation through flexible land-use (COALA) taking place in Kalmar. The project explores strategies mitigating the impact of sea level rise and coastal erosion by adopting flexible land use strategies in zones likely to be impacted by the withdrawal of coastline in Kalmar region (SLU, 2022).

Research questions

How can sea level rise be illustrated to make the issue accessible to lay audiences?

How could this visual material be used to facilitate communication between expert and non-expert audiences?

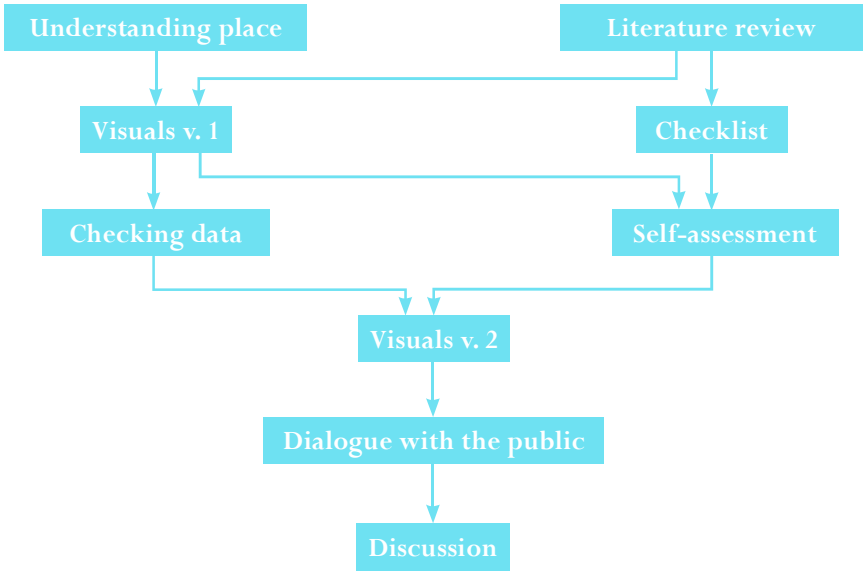


Figure 1: Process diagram.

Method

In order to explore the potential of visualization, the project followed a process laid out in figure 1. It has been adapted from a number of previous research projects on the subject (see for instance, Sheppard et al., 2011). This report is structured according to the work flow below, allowing the reader to follow the process in chronological order.

The first part of this project focuses on how SLR can be visualized to make the issue concrete for a public without prior expert knowledge on the subject. This was carried out through a review of existing writing on visual climate communication, its challenges, and opportunities. I examined three different methods of visualizing SLR: maps, 3D renderings, and art installations, analyzing their limitations and advantages in facilitating community engagement, and finally summarized my findings in a checklist for SLR visualizations. Parallel to the literature review, I acquainted myself with the chosen site of Sylvanderparken as well as the local context in Kalmar. Applying the findings to the chosen site in Kalmar, I then produced a short animation based on climate data provided by the Swedish Meteorological and Hydrological Institute (SMHI) and the Swedish Geotechnical Institute (SGI). After producing the first draft of the animation, I reviewed it against the checklist compiled from the literature review.

The second part of the research assessed how the visualization could be used to encourage dialogue with the public. For this, the animation produced in the first part of the study was shown at an exhibition taking place in Konstkiosk, a mobile art space that seeks to promote discussion about public space between arts, architects, public sector, and citizens (Konstkiosk, 2023). Participants were encouraged to share their views during semi-structured interviews that mapped their relationship with the place, feelings about climate change as well as reactions and thoughts on the animation. As a data collection method, informal interviews allow the researcher to discover and explore previously unknown meanings and occurrences in a fluid situation that can be naturally adapted through the interaction between the interviewer and the interviewee (Starrin & Rennick, 1996). As my research focused on two-way communication, the active participation from both parties is an essential part of the research design.

In addition to in-person interviews, an online survey was created to collect data even when I couldn't be on site. Questions followed themes similar to those in the interview guide but were reformulated to better suit the format of an online survey with short answers and sliding scale style questions. Using two different methods not only gave the possibility to reach more people, but also potentially reach a more varied demographic as those not comfortable joining the conversation in person could anonymously reply to the questions online. By showing the animation online without supporting material or the presence of the researcher also allowed me to assess the effect of the film as a stand-alone piece. In order to ensure that the respondents had visited Sylvanderparken at some point, the survey was only distributed through QR codes placed in the park as well as in Konstkiosk. The code was also included in the final frames of the animation itself. According to Gillham (2000), surveys often have low overall participation rates and even lower completion rates. The type of data that can be collected through surveys is also limited to simple and factual. To counter this, the survey included a possibility to sign up for a follow-up interview.

In addition to the methods mentioned above, I also observed the participants, recording my perception of their reactions, as well as estimated how long they spent watching the animation. As Starrin & Renck (1996) argue, testing several different methods gives a more complete picture of the research subject. It adds to the reliability of the results as they have been found using a variety of methods. Differences and similarities in the results collected through different methods can also reveal interesting patterns in the research topic.

Theory

SLR with its irreversible impact on coastal landscapes is what Rittel & Webber (1973) call a "wicked problem". This is defined as a problem that is complex, difficult to articulate and lacks a simple solution. The long time perspective and gradually unfolding impact as well as the high level of uncertainty related to projected changes, make SLR and adapting to its consequences challenging topics to communicate to an uninitiated audience.

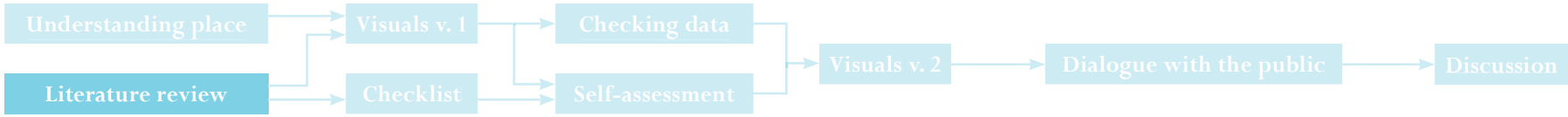
Scientific communication, including communicating climate data to a non-expert public, has traditionally relied on supplying the audience with facts and knowledge. When dealing with wicked problems that require urgent action, this has proven an inadequate approach. This so-called "information deficit model" has been criticized for a simplistic belief that lack of knowledge is the main obstacle preventing effective climate action. Researchers suggest instead that a multi-way communication between different stakeholders and multiple knowledge productions are required to tackle apathy, misinformation, and the subsequent erosion of trust. SLR adaptation measures are likely to have far-reaching consequences in everyday life of coastal communities, therefore building engagement should be at the forefront of climate communication. Engagement is defined in this context as "a personal state of connection" based on perceived relevance and assigned significance (Gammelgaard, 2018). It goes beyond awareness to include caring, motivation, and willingness to act (Scannell & Gifford, 2013). This thesis explores how visualizations of SLR futures in a local context can be used to engage local citizens in a dialogue about adaptation planning.

Everyday landscapes are an excellent starting point for communicating climate change impact. They are by definition local, experiential, and provide an immediate interface between people and the underlying social and natural processes shaping the environment (Sheppard, 2015). Showing how familiar places and views might be affected could tap into place attachment which has been shown to increase engagement in climate action (Scannell & Gifford, 2013). Both Sheppard (2012) and Wiberg (2018) argue that skill in reading landscapes is essential in recognizing subtle changes due to climate change. Referred to as "visual literacy" by Sheppard and "landscape literacy" by Wiberg, these skills involve the ability to see and identify physical, ecological, and social qualities in geographically specific sites, as well as potential future affordances in everyday places. Landscape professionals have a combination of skills that is well-suited for this purpose. Routinely working in multidisciplinary public design processes, they are used to visioning alternative futures through design and planning proposals, mostly communicated through visual media. Sheppard (2012, 2015) advocates for landscape architects to take an active role in supporting citizens' visual literacy learning which allows them to be vigilant about how climate change affects local landscapes. Wiberg (2018) argues that making visible the potential affordances in future landscapes could be used to build support for new approaches in adaptation planning.

I will explore these theories by visualizing the changes a local landscape in Kalmar might undergo in the future due to SLR. By making future affordances of managed retreat perceivable through visualization, I will provide a starting point for a discussion on Kalmar adapting to SLR.

Coastal landscapes in transformation

This chapter provides a basic overview of sea level rise and the factors that contribute to its future course. I also discuss the concept of resilience in relation to climate adaptation and look at SLR adaptation through managed retreat in more detail.



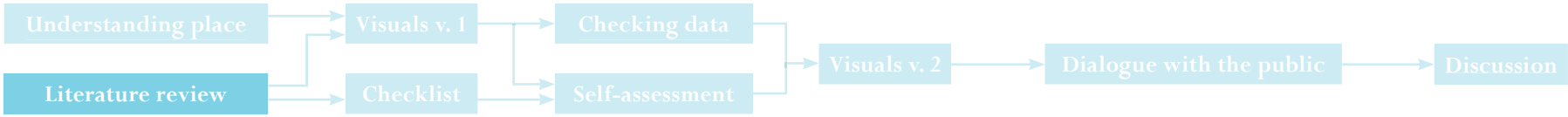
Sea level rise

Inevitable and irreversible, SLR is a growing challenge for coastal communities around the world. The gradual rise in mean sea level has been observed since the 1970s, with an accelerating pace since the 1990s. SLR is mainly caused by two factors: the melting of polar ice sheets and inland glaciers, as well as thermal expansion due to rising temperatures in the ocean. The phenomenon is not evenly distributed globally. Due to the Earth's irregular form and the gravitational pull from land masses, SLR disproportionately affects tropical regions. In addition to the long-term trends in SLR, coastlines experience significant temporary fluctuations due to local geography, tides, and prevailing winds (Oppenheimer et al., 2019). In Sweden, SLR is partially compensated by land rise after the latest ice age. However, land rise is at its strongest in the northern Baltic, leaving southern and western coastal areas vulnerable to SLR (SMHI, 2022).

That sea level will rise is already certain but future speed and extent depend on multiple factors. Both thermal expansion and the melting of ice sheets are closely tied to the future course of climate change. Whether the global community can abide by the commitments in international treaties, potential carbon capture technologies, and long-term development of population and economic growth all play a part in future emission models. In order to predict and model future climate change the Intergovernmental Panel on Climate Change (IPCC) has proposed five plausible scenarios with varying levels of climate impact, termed Shared Socio-economic Pathways (SSP) (Riahi et al., 2017). SLR projections also follow these scenarios.

Regardless of future emissions, sea level will continue to rise for centuries. The slow progression of SLR combined with the general uncertainty around future climate change make predicting local impact particularly challenging. Uncertainty in climate modeling increases in the distant future, resulting in a larger variation even within one climate projection. Although few SLR models reach beyond the year 2100, sea level will continue to rise and remain elevated for millennia (Oppenheimer et al., 2019).

With climate change, coastal communities are faced with growing flood risk both due to higher mean sea level but also due to more frequent extreme weather events. Higher mean sea level causes storm surges, waves and other weather-related floods to reach further inland, putting more people and larger areas at risk. IPCC estimates that flooding damages are expected to increase by magnitude of 2-3 by the end of the century. Up to 11% of the global population, including several mega-cities such as Mumbai, New York, and Jakarta reside in low-lying coastal areas likely to be affected by SLR. This is made worse by continued urban development and changes in land use in coastal zones. As with most climate related risks, groups in the most vulnerable positions, such as informal settlements, are most likely to be severely impacted (Oppenheimer et al., 2019).

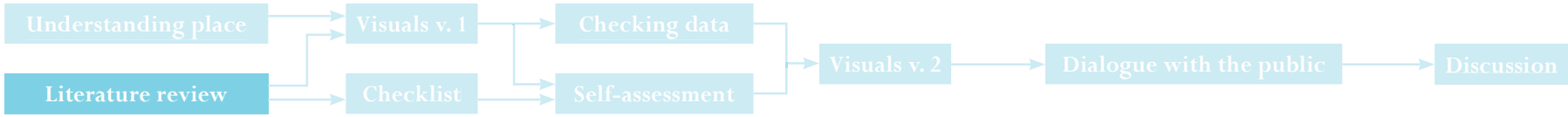


Sea level rise and related flooding also come with significant costs. The European Commission calculates the cost of coastal flood damage at €1.9 billion annually, estimated to rise to over €200 billion by the end of the century (Vousdoukas et al., 2020). The Swedish National Board of Housing, Building and Planning has predicted that the cost of damage due to erosion and flooding will reach 20-50 billion SEK by 2100, putting around 150 000 properties at risk (Gramstad & Löfgren, 2021). In addition to risk to human life and infrastructure, coastal ecosystems are likely to suffer. Loss of habitat due to moving coastline and salination can force ecosystems to withdraw inland. As coastal zones are often densely built, natural habitats don't have space to migrate, resulting in a phenomenon known as "coastal squeeze" (Oppenheimer et al., 2019).

Soft coastal adaptation

As the impact of SLR on coastal communities grows, so does the need to respond to it. Davoudi (2014) argues that climate change "has revealed our complex and precarious relationship with nature and the fallacy of the modernist assumption about our ability to conquer and exploit nature with little or no consequences". Since the Industrial Revolution, urban coastlines have been controlled through the construction of physical structures, such seawalls, jetties, and levees (Wiberg, 2018). Hard engineering strategies are still the most commonplace approach to coastal adaptation. Current practices favor structural defenses to protect infrastructure and property in desirable seaside areas of often high economic value (Göransson et al., 2021; Lawrence et al., 2020). This is problematic in many ways. Giving coastal communities, property owners, and investors a false sense of certainty with protective infrastructure further increases demand for these short-term solutions instead of adopting strategies which would be economically more viable in the long term (Davoudi, 2014; Lawrence et al., 2020). The demand for control through gray infrastructure solutions also reinforces the concept of nature as a security risk to be tamed and policed (Davoudi, 2014).

However, the frequent failures of engineering approaches, disappearance of coastal wetlands, and recent disasters have raised questions on the long-term sustainability of relying on hard engineering solutions in SLR adaptation. Instead, there have been growing calls to move towards the so-called "soft engineering" approach which seeks to work with the dynamism of natural processes by rethinking the planning of urban coasts as an interplay between urbanization, landscape, and social environment. Some examples of this kind of water-based urbanism are reconstructed wetlands or landscapes accommodating increased flooding, that successfully combine adaptation to SLR with added social value for city dwellers (Shannon, 2013). While these solu-



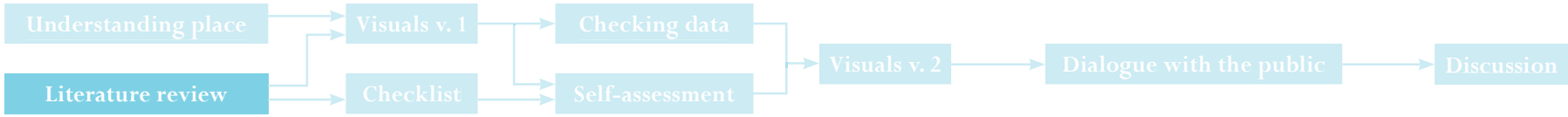
tions have only recently appeared in mainstream urban planning through terms such as "resilience" or "nature-based solutions", they are by no means new. Indigenous methods of water management as well as migrating coastal settlements have been around for millennia (Lawrence et al., 2020; Shannon, 2013). The concept of resilience has been criticized for its portrayal of nature on one hand as a threat cities need to be protected from and on the other hand as a commodity or service for human populations. Instead of interpreting resilience as an opportunity for radical transformation, mainstream resilience often focuses on stabilizing urban infrastructure to recover from shocks back to an assumed "normality" (Davoudi, 2014).

A more radical resilience strategy allows the sea to reclaim areas permanently. Terms managed retreat, planned retreat, and managed realignment all refer to an approach where SLR and flooding is accommodated by relocating important infrastructure, housing, and other structures of value to higher ground in a systematic manner while restoring the land left behind (Göransson et al., 2021; Lawrence et al., 2020). This strategy has been successfully implemented in New Zealand, France, and the UK, to name a few examples. However, it is often a reactive measure after catastrophic flooding has already taken place. As a pre-emptive strategy to retreat from at-risk areas, managed retreat hasn't been widely adopted in coastal planning. This is partly due to the practical and economic challenges of implementing such a drastic action but also due to the controversy and ethical questions surrounding this strategy (Göransson et al., 2021, Lawrence et al., 2020). In a recent survey of local governments and policymakers in Sweden, Göransson et al., (2023) find that the rigidity of the current planning system combined with short term political interests, and expected resistance from the public is likely to make managed retreat an unpopular approach. Instead, the researchers have coined the term "flexmark" (from "flexible" and Swedish "mark" meaning land) which refers to "land areas that are subject to flooding risk but could be used for non-permanent and non-critical urban planning purposes such as recreation, greenery, landscaped wetland, parking, temporary events, provisional structures etc. in the interim". Although sharing similarities with managed retreat, this term acknowledges the inherent uncertainty of SLR and emphasizes the potential uses for areas that can be both wet and dry depending on the circumstances. Indeed, well-planned retreat can have a positive contribution towards other societal goals, such as community revitalization and greater fairness (Lawrence et al., 2020). A new relationship between city and nature could emerge if the ecological, social, and long-term economic value of integrating water management is recognized as a part of a new urban reality (Shannon, 2013; Wiberg, 2018).

Regardless of how retreat strategies are framed, moving towards flexible land use planning in coastal areas would require a major shift in public opinion as well as rethinking the planning system in these zones. Several researchers, as well as national and international guidelines call for a participatory process to anchor any such adaptation strategies in public support (e.g., Göransson et al., 2021, 2023; Lawrence et al., 2020; UN, 2017, Wiberg, 2018).

Communicating sea level rise

In this chapter I make an argument for the importance of visual climate adaptation communication in engaging the public. Firstly, I discuss the challenges related to communicating both SLR and potential adaptation strategies to lay audiences. I follow this by making a case for using visualization in climate adaptation communication according to existing literature. This is followed by three examples of visual SLR communication. I conclude with a summary of findings compiled in a checklist for SLR visualizations.



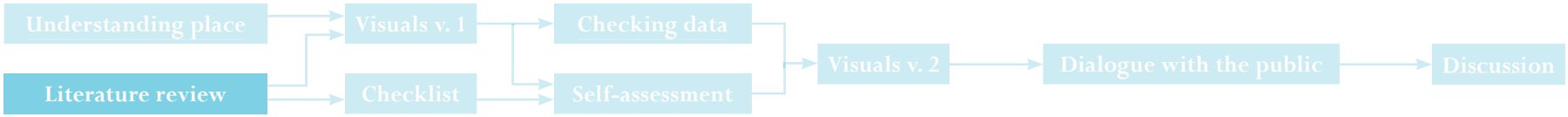
The problem with the information deficit model dominating traditional scientific communication has already been described in the introduction. In her dissertation on climate visualizations, Gammelgaard (2018) defines communication as "a social and cultural process that acknowledges interpretation and meaning as key elements, in constituting social reality". Hahn & Berkers (2021) who have done research on the role of art in climate communication refer to the Encoding-Decoding Model of Communication, which includes both the production of visuals as well as the process of engaging with them. These definitions share the understanding of communication as a two-way process requiring participation both from the communicator as well as the audience in creating meaning. Historically, climate communication has relied on simply transferring facts to the audience with little feedback from the recipients of the information (Gammelgaard, 2018). This study looks at how communication can be elevated and improved with the use of visualization, positioning it within Gammelgaard's (2018) and Hahn & Berkers' (2021) understanding of communication.

Global disaster or local challenge?

"The impact of rising seas is already creating new sources of instability and conflict … We would witness a mass exodus of entire populations on a biblical scale."

António Guterres, 2023

In February 2023, United Nation Secretary-General António Guterres alerted the public of the impacts of sea level rise in this opening statement at the UN's Security Council meeting (UN, 2023). The quote above illustrates many of the challenges with communicating SLR. As has been noted in the introduction, SLR - and climate change more widely – is typically seen as a global phenomenon with catastrophic consequences (Davoudi, 2014; Gammelgaard, 2018; Nicholson-Cole, 2005). Research finds that as a result most view climate change as a personally distant issue, global rather than local in nature, with most severe impact felt by future generations in far-away places (Gammelgaard, 2018; Pahl et al., 2014; Scannell & Gifford, 2013; Sheppard, 2015). The temporal dimension of SLR spanning over centuries adds to the challenge. Most people define "future" as 10-15 years ahead which is in stark contrast with the timescale of climate change (Pahl et al., 2014; Retchless, 2014). Moreover, climate change impacts are often framed in the media as sudden shocks with little relation to long-term trends in urban planning. According to Davoudi (2014), focusing on extreme weather, sudden flooding and other disasters can draw attention away from long-term capacity building, instead focusing on quick fixes against emergencies. Although the gravity of climate change should not be dimin-

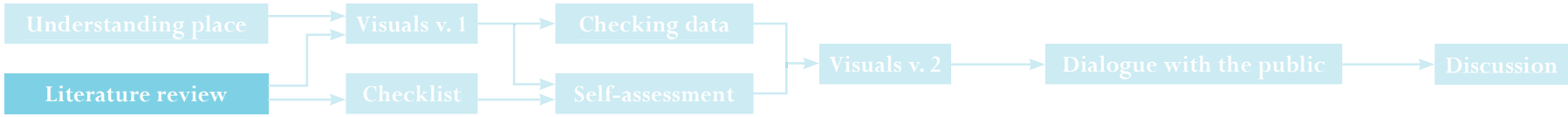


ished, he argues that construing nature as a constant threat also affects how the environment is seen and valued – more as a risk and less as an asset. On the other hand, Nicholson-Cole (2005) found that these "shock-horror stories" are memorable and easily digestible by a lay audience indicating that dramatic descriptions of climate change have a power to attract attention.

Planning for long-term SLR adaptation requires public engagement but overly pessimistic messages focusing on global threats and risks have been found to be counterproductive. The most severe impact of SLR will likely be felt by future generations, so successful civic engagement must attempt to overcome this distance. Several scholars argue that salience, the perceived importance of an issue, is a central factor in building engagement (e.g., Gammelgaard, 2018; Nicholson-Cole, 2005; Sheppard, 2015; Sheppard et al., 2008). Many international institutions have made recommendations on effective climate communication. These commonly include basing it on data from reputable scientific institutions, avoiding unnecessary complexity, and utilizing storytelling to create a more personally relevant narrative (UN, n.d.; EU, n.d.). Furthermore, several researchers have found that presenting SLR through locally relevant information increases levels of engagement in the public (Gammelgaard, 2018; Nicholson-Cole, 2005; Plate et al., 2020; Sheppard et al., 2011). Perceived temporal distance could be reduced by framing SLR as an immediate issue (Gammelgaard, 2018; Scannell & Gifford, 2013).

Another challenge in communicating SLR is the complexity of climate modeling as well as its high level of uncertainty. Davoudi (2014) argues that the scientific community produces an imaginary of climate change through seemingly neutral climate models, calculations, and scenarios that renders the uncertain future more palatable. In contrast, Scannell & Gifford (2013) call for acknowledging the uncertainties in projected impacts as it is necessary to retain the audience's trust. However, people often crave certainty about the future even if it's only information about "what is likely to happen" (Nicholson-Cole, 2005).

Compared to climate mitigation communication, which focuses on trying to prevent and minimize future changes, climate adaptation communication requires first accepting that changes are inevitable and then finding practical solutions. Emphasizing solutions through collective action has been found to be an effective way of engaging the public (Scannell & Gifford, 2013; Sheppard, 2015). This leaning towards optimism was already present in the Brundtland Report, best known for its definition of sustainable development. It reassured that continued technological development combined with accumulating knowledge and capacities will allow for limitless growth while preserving a livable planet for future generations (WCED, 1987). Davoudi (2014) argues that the explicit faith in human capital and positive outlook contributed to wide distribution of the report. Instead of a general sense of optimism the public would appreciate concrete proposals for action and more community involvement (Nicholson-Cole, 2005; Scannell & Gifford, 2013).

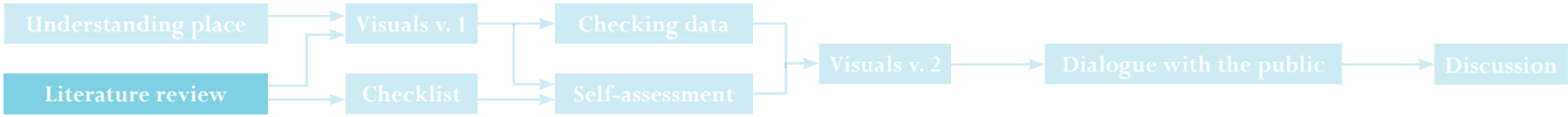


Visualizing sea level rise

As mentioned previously, the complexity of SLR makes it a demanding issue to grasp. Several researchers suggest that climate communication should have an experiential element (e.g., Gammelgaard, 2018; Nicholson-Cole, 2005; Scannell & Gifford; Sheppard, 2015). This could mean experiencing climate change impacts firsthand (Gammelgaard, 2018; Lawrence et al., 2020; Nicholson-Cole, 2005), using novel or immersive communication methods (Calil et al., 2021; Scannell & Gifford, 2013), or emotionally evocative messaging (Hahn & Berkers, 2021; Scannell & Gifford, 2013).

As discussed previously, long-term SLR adaptation planning, especially for potentially controversial strategies, such as managed retreat, public support is crucial. Several studies agree that mobilizing stakeholder participation is an important step for climate adaptation planning (Göransson et al., 2021; Lawrence et al., 2020). In their analysis of several climate adaptation initiatives, Plate et al (2020) find that providing information is the first step of establishing positive contact with local stakeholders. If the local community is to make informed decisions about their environment, there needs to be a clear communication of future risks and threats. However, personally relevant information alone can't eliminate all resistance to change. Place-attachment can cause opposition to implementation of novel strategies, like managed retreat, as many people have strong ties to their place of residence and relying on old habits can cause complacency (Lawrence et al., 2020; Sheppard, 2015). Sheppard (2012) argues that this could be countered by educating the public to recognize signs of adaptation measures in their local landscapes and make visible their long-term benefits. Similarly, Göransson et al. (2021) suggest that framing adaptation as something positive could be a way to make managed retreat more acceptable to local decision-makers.

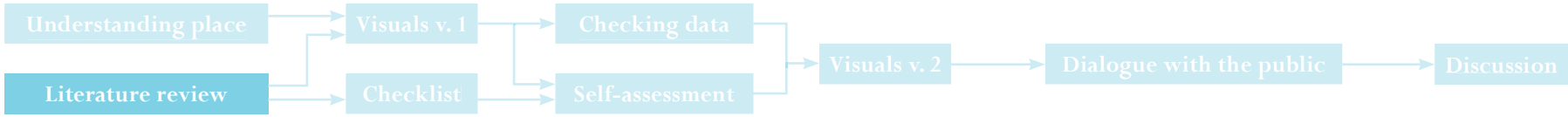
Several studies mention visualization as a powerful tool in both communicating SLR as well as engaging the public in adaptation initiatives (Gammelgaard, 2018; Nicholson-Cole, 2005; Pahl et al., 2014; Plate et al., 2020; Sheppard et al., 2008, 2011). Climate change is in many ways invisible. Caused by colorless gas, the major impacts affect factors, such as temperature, that are not perceivable through vision (Sheppard, 2015). Visual and scenic factors are a significant part of our perception of the physical environment. Perceptions of climate change are strongly associated with imagery (Nicholson-Cole, 2005). Pictures can help reduce the temporal distance of SLR impacts by using time lapse or "time travel" images. Making SLR visible by illustrating it in familiar places has also been shown to increase engagement and provide a sense of place (Pahl et al, 2014; Sheppard et al., 2011). This can also tap into the locals' place attachment which might further decrease psychological distance to the issue (Scannell & Gifford, 2013). Images have been shown to evoke emotional response which in turn has been found to increase engagement. Strong imageries are memorable and can elicit an emotional response which could bring about a meaningful experience (Nicholson-Cole, 2005). Not just useful in transferring information - which climate communication has been criticized previously – visual methods can also be used to facilitate dialogue. Plate et al (2020) found that using visual tools in climate adaptation planning helped foster collaboration with the local stakeholders. In a study on visualizing SLR adaptation options in Canada, participants who were shown images of different options reported higher levels of engagement than those who did not see the illustrations. Participants directly referred to the visualization as a motivating factor for supporting adaptation measures (Sheppard, 2012).



As discussed in the previous chapter, presenting solutions as a part of SLR communication was favored among the public. A powerful method to imagine alternative futures, combining scientific data with artistic imagination could open space for visioning radically different ways of adapting to climate change (Lübker et al., 2023). Landscape architecture profession has a long tradition of visioning alternative futures for familiar, recognizable places. As Wiberg (2018) argues, landscape literacy i.e., the ability to see not only the physical and visible elements of landscape but also identify qualities that could be turned into future affordances, reveals factors often invisible to an untrained eye. She advocates for the use of visualization as a tool for making these affordances perceivable to facilitate discussion. Imagining future landscapes is particularly effective when done as a collective activity. Through a structured participatory visioning process, participants reported increased agency in and support for SLR adaptation strategies, as well as greater understanding of cost of inaction (Sheppard, 2015; Sheppard et al., 2011).

Producing SLR visualizations is not without its challenges. Image-making is never a value free or objective activity, especially when producing images based on complex and uncertain data and showing scenarios that reach far into the future. The inevitable simplification of data involves constantly making decisions on what to include, leave out, and how to represent different aspects of the scene. Hence, these choices should be discussed explicitly and motivated convincingly. It is also worth reminding that just as the process of visualizing is subjective, so is the interpretation of the images by the viewer (Nicholson-Cole, 2005). Viewers' interpretation of visualizations might differ significantly from the author's intention (Hahn & Berkers, 2021). Historically, scientific visualizations, usually in the form of graphs or tables, were intended for communication within the scientific context rather than between scientists and lay audiences. This is still reflected in the public perception of scientific visualizations as abstract and difficult to relate to. Despite this, they enjoy a wide trust, seen by non-expert audiences as scientific truths (Gammelgaard, 2018). Visualizing local landscapes could help marry scientific models with social realities in communities. However, there is a power dynamic between the author and the audience. Sheppard et al. (2008) argue this dynamic should be acknowledged and ethical dilemmas taken into consideration when moving away from the scientific communication traditionally perceived as "neutral". Several scholars recommend multidisciplinary, participatory processes, and rigorous reviews to ensure the quality of visual representations (Lübker et al., 2023; Sheppard et al., 2008). Lay audience isn't a homogeneous group and response to images is likely to vary depending on multiple factors which further increases the need for collaboration.

In the case of SLR, the inherent dynamism of shorelines can be difficult to convey, especially through static images. While most commonly shown as a hard line in landscape, water level is in constant flux. The entire concept of "shoreline" itself can be contested as in many cases (such as wetlands) the precipitation of coastal landscape gradually increases until land finally blends into a body of water. The multisensorial nature of the coast is difficult to get across, risking flattening the experience of sea when represented only through images (Mathur & da Culha, 2014). Communicating future affordances of waterscapes through two-dimensional visual representations also has its limitations. As Heft (2010) argues, unlike static images, affordances are all about action, how landscape can be experienced by a specific individual. Especially the affordances of water are tactile, relating to sensations of humidity, temperature, and texture. These will inevitably be lost when landscape is reduced to an image.



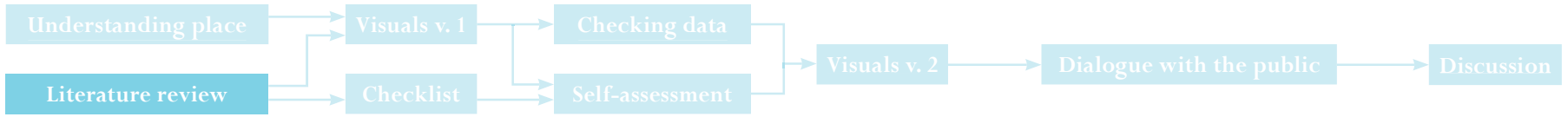
To investigate the pros and cons of different methods of visual communication, I draw from three examples of visuals used in SLR communication. I assess strengths and weaknesses of maps, landscape visualizations, and art installations in climate adaptation communication. Maps and landscape visualizations have been chosen because of their wide-spread use. I also used both as supporting material to the animation while carrying out the dialogue with people in Kalmar. I have also included art installations in this study since my own visualizations were exhibited at Konstkiosk, placing them in an artistic context, at least through association. Although the animation I produced is based on scientific knowledge, I have drawn lessons from art-based visual communication to enhance the experiential and emotional aspects of my visualizations.

Maps

Maps are commonly used to communicate the extent of SLR over a geographical area (Retchless, 2014). A quick search on the visual material used by reputable institutions, such as SGI, Copernicus Centre in the EU and the National Oceanic and Atmospheric Administration (NOAA) in the US, found that maps are used as a central method of visual communication. Also, the city of Kalmar communicates future flood risk mainly through maps (Kalmar kommun, 2023b). In the COALA project, detailed Kalmar-specific maps were produced to aid communication with local policymakers and the public.

Typically, SLR maps show projected sea level changes over a geographic area. Usually, more than one scenario is included either through interactivity, by showing several maps, or through color coding. The popularity of SLR maps is justified. Maps can spatialize otherwise abstract and complex data. They allow the viewer to locate landmarks or places of personal significance to see how they might be affected by rising sea levels, thus making the issue personally relevant (Retchless, 2014; Sheppard, 2012). In his classic essay on mapping, James Corner (1999) argues that maps are often seen as neutral, and objective even though the mapping process requires a great deal of abstraction and omission, hence making it a highly subjective and cultural activity. Rather than trying to represent "what is", he suggests mapping should focus on creating new realities by making future potentials visible. Wiberg (2018) relates this to the traditional ways of visually communicating flood risk by showing the extent of at-risk areas. According to her, emphasizing threat doesn't do justice to the values water can bring to urban space. Corner (1999) also advocates for collaborative map-making, where local histories, and lived experiences are given space. A project by Stephens & Richards (2020) recorded community stories of flooding on an interactive SLR map to add local voices to otherwise technocratic illustration seen as lacking humaneness.

Research on how lay audiences read maps has found that SLR maps have suffered from variations in subjective interpretations, particularly regarding risk and uncertainty (Stephens & Richards, 2020; Gammelgaard, 2018; Retchless, 2014). Although interactivity has shown to help (Retchless, 2014; Gammelgaard, 2018), simplification of data is inevitable. Even professional viewers can struggle with interpreting maps correctly. A recent article reported that flood maps are often misread by Swedish municipalities responsible for flood adaptation planning (Christiansen, 2023).



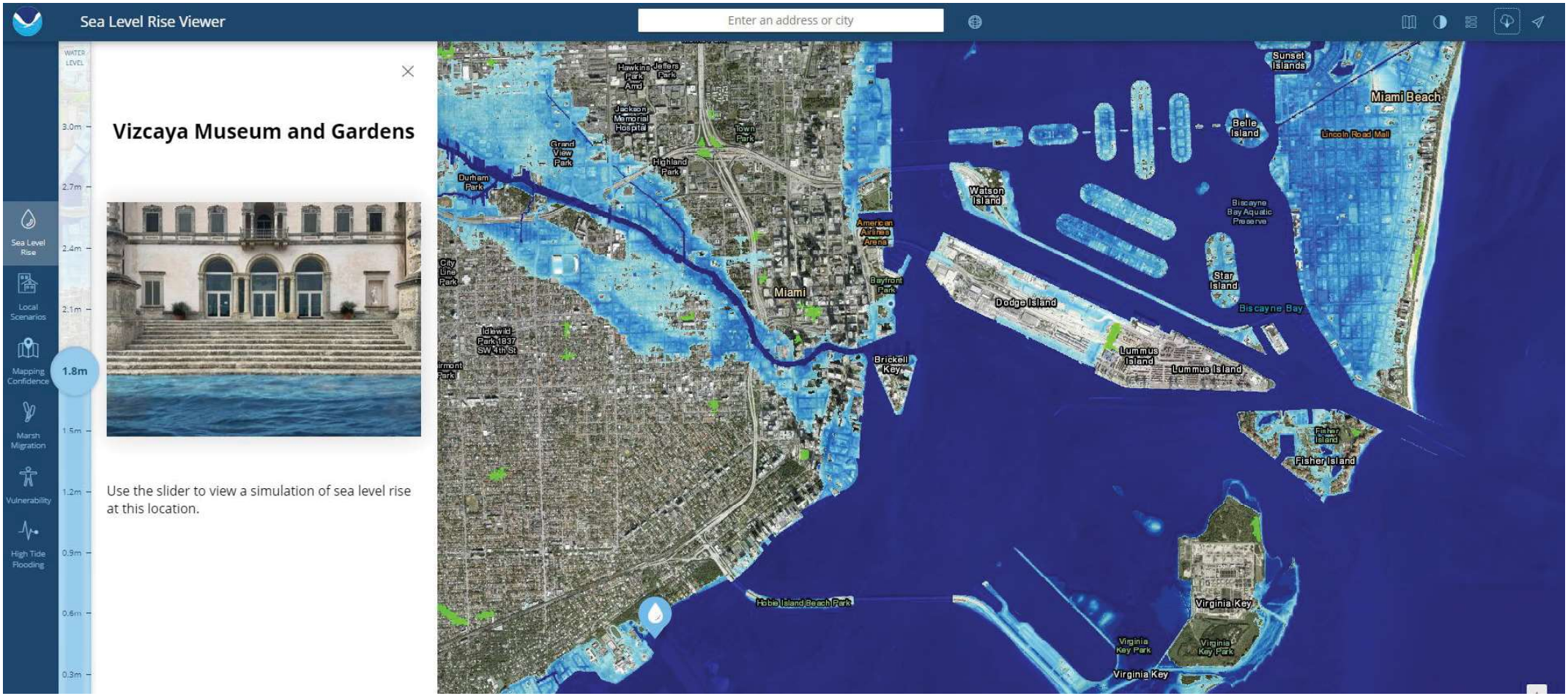
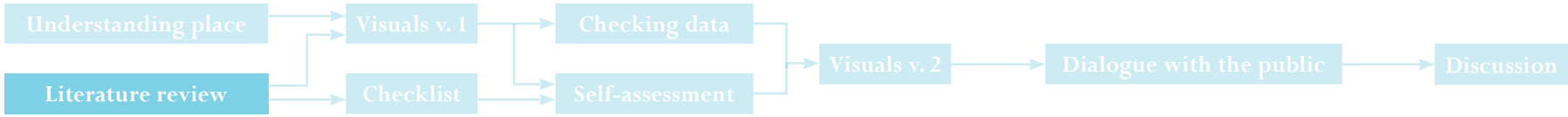


Figure 2: Screenshot of Sea Level RiseViewer showing the coast of Miami, Florida. NOAA uses perspective views of selected places to allow the viewer to see how SLR would impact everyday landscapes at eye-level.

NOAA (2023), https://coast.noaa.gov/slr/#/layer/slr/6/-8925013.508693404/2970031.6082804357/14/satellite/189/0.8/2050/interHigh/midAccretion

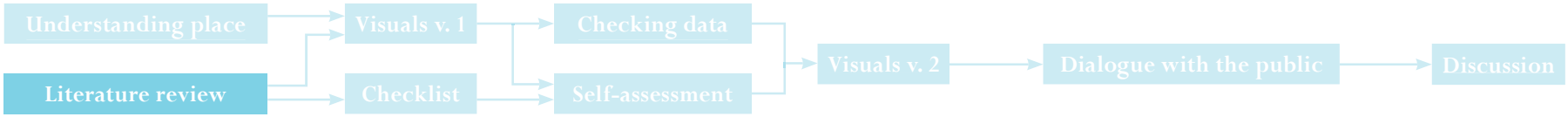


Landscape visualizations

Another commonly used method to communicate SLR are landscape visualizations. I use the term to refer to a still image showing the impact of SLR on a local scale in realistic style. They are often used to accompany SLR maps to provide a street-level view of locally recognizable places. Several scholars have found that landscape visualizations can facilitate climate adaptation communication by making the issue visible and more concrete, understandable, and meaningful. Imagery of recognizable, everyday places can tap into place attachment, making SLR feel locally relevant which helps to bridge the psychological distance people often report in relation to climate change (Gammelgaard, 2018; Nicholson-Cole, 2005; Sheppard et al., 2011). Using images with a high degree of realism from a human perspective can allow "time travel", experiencing the landscape as though having been there. This in turn could inspire new thoughts and imagine new courses of action (Sheppard, 2012).

As has been noted previously, images always reflect the author's values, cultural background, and worldview. Landscape visualization is often the domain of professionals (landscape architects, urban designers); therefore, the produced images will be informed by expert knowledge. As Nicholson-Cole (2005) points out, there is no homogeneous "public", hence the images are subject to multiple different interpretations influenced by "prior perceptions, experiences, attitudes, social background, cultural orientation and behavioral dispositions". Especially when working with photo-realistic visualizations of recognizable places, and potentially triggering subject matter such as SLR, authors of such visualizations should exercise caution in the use of symbolism and emotive imagery. Both Nicholson-Cole (2005) and Sheppard & al. (2011) also raise the issue of visualizing complex and uncertain data. As simplification and exclusion is inevitable, the balance between scientific validity and realistic visual style needs to be considered carefully. Sheppard et al. (2011) found that many participants wished to know what the future will look like. This suggests the power of visualization in communicating SLR, as well as the level of responsibility of the people making these images.

There have been calls to carefully consider the ethical implications of visualizing future landscapes impacted by climate change. Traditionally, landscape architects have strived to maintain a neutral position in their representations of landscape. However, by illustrating uncertain futures, the moral dilemma of remaining neutral as opposed to taking an active advocacy role becomes more critical. Images are visual arguments with the power to shift public perception. Therefore, validity and defensibility are extremely important when visualizing SLR in local landscapes (Sheppard et al., 2008). By reviewing the visualizations in multi-disciplinary teams as well as with relevant stakeholders, the quality of the images could be ensured. The context, source data, and uncertainties should always be disclosed (Sheppard, 2012).



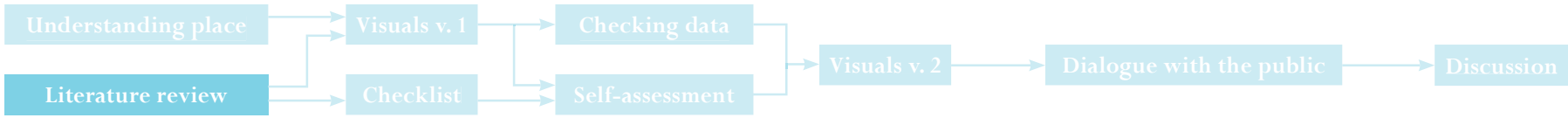
Art

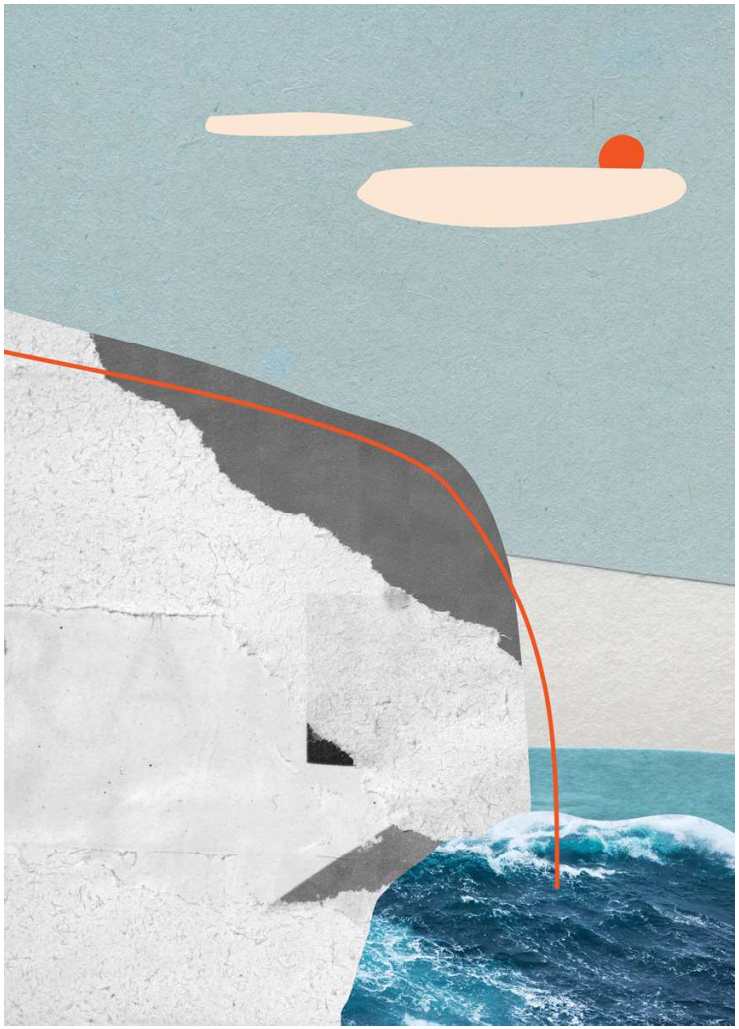
As I conduct my field study in Konstkiosk, a relocating exhibition space, the visualizations I show were, to some extent, associated with the artistic space. To understand how this context might influence the perception of my images, I have looked at how art has been used to interpret and communicate climate science.

As I argued on page 16, climate communication has been criticized for relying too heavily on facts and the rational. Although more attention has been paid to the experiential and emotional factors in recent years, the perceived temporal and geographical gap between lived experience and climate change has remained a challenge (Pahl et al., 2020). Some researchers have suggested that public art could help bridging this divide (Aragón et al., 2019; Galafassi et al., 2018; Hahn & Berkers, 2021).

Few would argue against the value of expert knowledge coming from the scientific community, but art could be used as a complement where scientific data falls short, such as emotional awareness, engagement and fostering dialogue (Galafassi et al., 2018; Hahn & Berkers, 2021). Artistic freedom, using novel methods and unexpected interpretation can be used to provoke, challenge, and inspire. A study on public perception of a landscape installation visualizing flooding due to SLR in Boston was found to help the local residents to understand the neighborhood's vulnerability. The authors argue that especially site-specific public art can connect to the invisible qualities of the place (Aragón et al., 2019). Additionally to raising awareness, art can provide a different forum to imagine alternative futures and creative solutions (Galafassi et al., 2018; Hahn & Berkers, 2021).

However, there are limitations to using art in climate communication. Hahn & Berkers (2021) have found that artistic interpretations of climate change were perceived as less engaging when compared with other types of climate communication, lacking in clarity, immediacy, and emotional engagement. However, this was dependent on the style and content of artwork shown. Aragón et al. (2019) make a similar argument, noting that artistic interpretation of the information could be a key contributing factor.

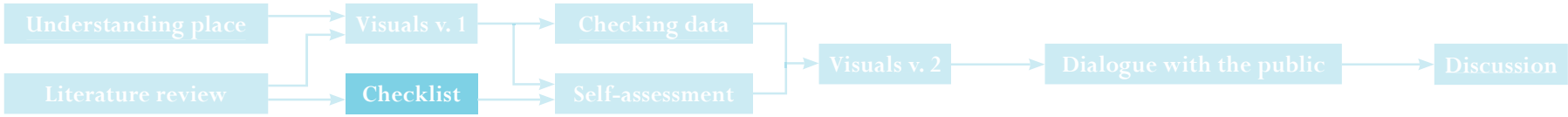




Summary

The findings of this literature review indicate that visualizing SLR has great potential in facilitating engagement in the issue on a local level. However, challenges with the complexity and uncertainty of climate data, multiple possible scenarios, and the subjectivity in both producing and interpreting the images complicates the visualization process. Balance between attracting and holding attention in a society increasingly saturated by images while conveying the complexity of source data can be difficult to achieve. Visualizations should effectively communicate the gravity of projected impacts while keeping an optimistic outlook on future solutions. They should also be persuasive while honest and defensible (Sheppard, 2012; Sheppard et al., 2011). Achieving this with visualization alone is nearly impossible. However, based on this literature review, I have summarized some guidelines for effective visual SLR communication. These checkpoints can be found as recommendations throughout the reviewed literature. I used the following checklist in assessing the SLR animation I produced for Sylvanderparken in Kalmar to make sure it complied with the best practices found in previous research prior to the exhibition.

Figure 3: When The Sea Talks. European Commission collaborates with independent artist to enhance official climate communication with evocative artwork.
Crucinski, K. (n.d.) for Artists for Climate.
CC-BY-NC-SA. https://thegreats.co/artworks/when-the-sea-talks#



Although the list is not comprehensive, it could be used as guidelines to both guide the making of images based on scientific data, as well as evaluating them once completed. As indicated previously, complying with all of them may prove a challenge, hence some factors, such as emotional content might have to be weighed against scientific accuracy.

Intended use

- ☐ Identify intended audience
- ☐ Tailor style, technique, and method to suit the public and the purpose of the visualization exercise
- ☐ Consider own subjectivity and how it might influence the visualizations
- ☐ If possible, collaborate with the intended audience in producing the visualizations

Scientific legitimacy

- ☐ Base visualization on relevant and up-to-date data
- ☐ Choose scenario and timescale according to intended use
- ☐ Legitimacy through transparency in choices, systematic review, and validation
- ☐ Transparency regarding uncertainty

Content and style

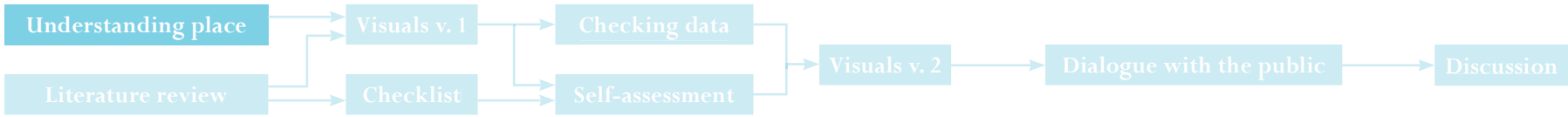
- ☐ Show recognizable places with local landmarks and other familiar elements
- ☐ Include locally relevant issues
- ☐ Add experiential or interactive elements if possible
- ☐ Use emotionally charged imagery mindfully
- ☐ Balance visually realistic style with the uncertainty of the data

Message and narrative

- ☐ Clear and immediately understandable message supported by narrative
- ☐ Illustrate affordances, potential and possibilities of future landscapes to emphasize solutions
- ☐ Include local knowledge and stories if possible
- ☐ Consider showing multiple scenarios with several mitigation and adaptation options

Sylvanderparken returns to the sea

Following the literature review, this chapter provides a description of the visualization process from understanding the site through secondary sources as well as site visits to the production and review of SLR visualizations following the guidelines compiled on page 25.



Understanding the place

Kalmar is located on the south-east coast of Sweden. A city of 72 000, it is currently the 33rd largest municipality in Sweden. Kalmar's population is expected to reach 80 400 by 2033. The city is a lively regional center with a vibrant university campus and local businesses (Kalmar kommun, 2023a). Kalmar has a long history, with the earliest mentions dating back to the 1100th century. By the 1200s it was a flourishing market town drawing its wealth from maritime commerce and shipping (Bengtsson & Magnusson, 2014).

The chosen site, Sylvanderparken is a historic park in central Kalmar located on the east side of Slottsfjärden facing Kalmar castle. First built on land reclaimed from the sea in 1870- 80s, it formed a part of a continuous green space that connected both shores of Slottsfjärden in a network of high-quality parks. The park was named after Volmar Sylvander, a researcher and a teacher, who wrote "Kalmar Slotts och Stads historia" between 1864-1874. East of Sylvanderparken, Kalmar harbor successively expanded on landfill, a development still on-going with the filling of Nya Hamnbassängen (Bengtsson & Magnusson, 2014). Sylvanderparken is located on low-lying land, its highest point reaching no more than 2.4 m above sea level.

With a long history of existing in symbiosis with the Baltic Sea, Kalmar's proximity to the water continues to be one its main assets. In the city's new comprehensive plan, the municipality mentions strengthening its coastal character as a central development strategy. Green-blue infrastructure is also named as a vital resource for recreation, attractivity, and mitigating climate change (Kalmar kommun, 2023b). A recent survey found that Kalmar residents rated closeness to the sea as the most attractive quality in the city. Access to nature and green space were also mentioned as important factors in improving the quality of life (Kalmar kommun, 2019). Seaside areas are seen as highly valued and attractive places to build and live. Development of waterfront areas continues, with new plans for residential and mixed-use areas under way in central Kalmar (Kalmar kommun, 2023b).

However, as a low-lying city with a long coastline, Kalmar is now facing growing risk of flooding due to SLR. The Swedish Civil Contingencies Agency (MSB, 2009) identifies Kalmar as one of the 25 cities in Sweden most vulnerable to flooding. Local SLR projections produced under the COALA project predict SLR ranging between 6-140cm by the end of the century. During an extreme storm, sea level would temporarily rise an additional 1,5m (SGI, 2022). In the latest comprehensive plan, the figure used as a worst-case scenario for SLR is 110cm by 2100. SLR adaptation is identified as an important consideration in future city planning in Kalmar. The comprehensive plan states that new buildings should be constructed so that they can withstand flooding up to 2.8m (Kalmar kommun, 2023b). However, the document doesn't explicitly recommend against building in areas with lower elevation. On the other hand, the city's climate adaptation plan (2021) recommends limiting the development of areas at risk of flooding. The document also addresses the potential impacts of SLR on green spaces and coastal ecosystems, as well as recognizes the value of green-blue infrastructure in managing these impacts. Managed retreat is mentioned as a strategy to leave space for ecologically valuable wetland meadows to migrate inland where necessary. Also, multi-functional seaside green spaces are mentioned as a possible adaptation strategy.

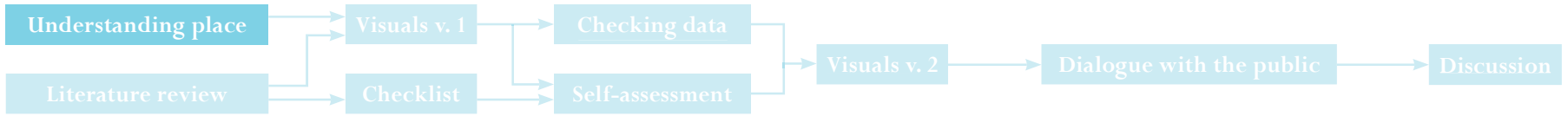
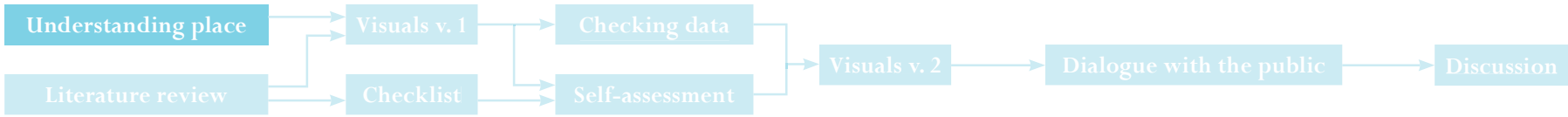
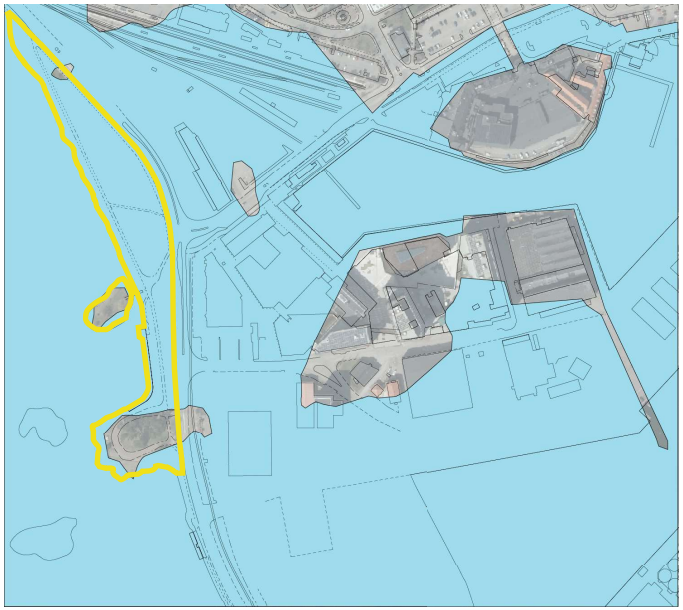


Figure 4: Sylvanderparken's location in Kalmar.
(Background ©Lantmäteriet)

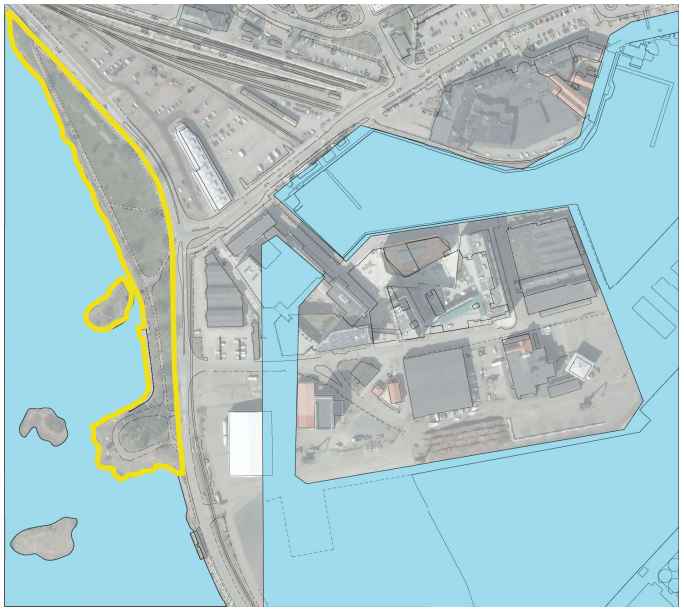
Figure 5: Sylvanderparken is located in central Kalmar in the vicinity of the harbor, Kalmar castle and the central station.
(Background ©Lantmäteriet)



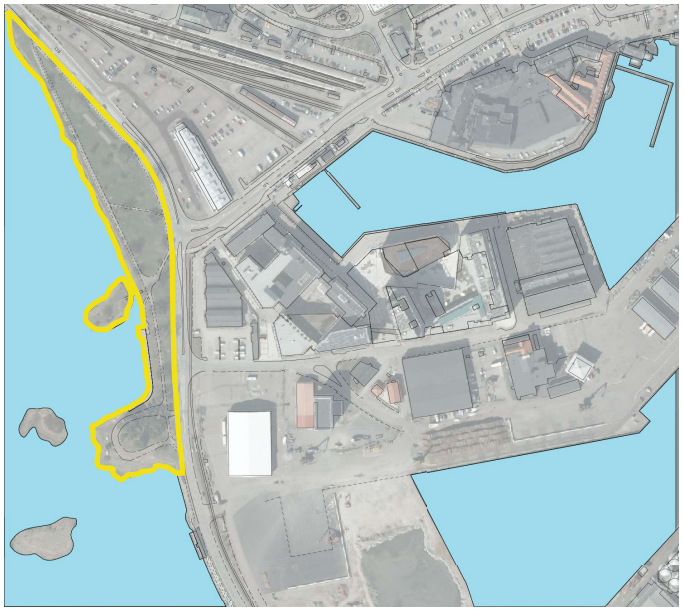
Figures 6-8: Evolution of shoreline in Sylvanderparken and Kalmar harbor. The park appears on the late 1880s as the harbor expands thanks to landfill. (Background ©Lantmäteriet)



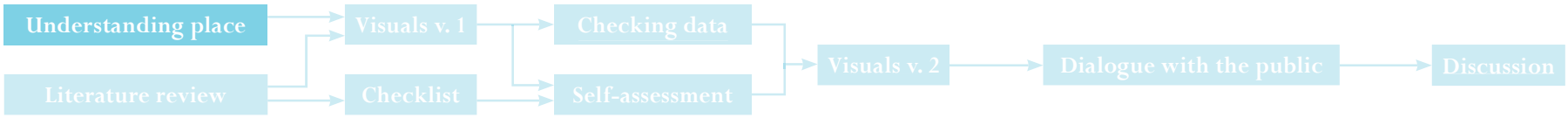
1858



1907



2023

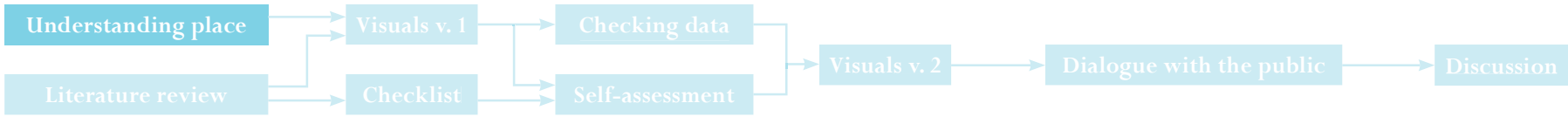


Site exploration

During this project, I visited Sylvanderparken on three separate occasions in 2023: February 15th, June 9-10th and July 14-16th. During these visits I made extensive field notes of my observations through sketching, sound recording, and writing.

The sea is always present in Sylvanderparken. The long shoreline with Slottsfjärden varies from built quays to soft shorelines gradually sloping into the water. Signs of past fluctuations in sea level are visible in several places. Evidence of erosion can be seen in areas where the shoreline hasn't been fortified with rocks or walls. Solitary rocks that presumably once marked the shoreline are now surrounded by water from all sides. Accumulation of seaweed extends inland from the waterline. Other small traces of marine life, such as seashells, fish bones, and scatterings of algae, have been transported several meters from the current shoreline. The soundscape is dominated by the sound of waves, wind, and seagulls as well as boats passing by. Although open to winds, the park is relatively sheltered from waves by small islands and reeds in Slottsfjärden.

The footpath connecting the park from north to south was well-trafficked during my visits in June and July, used frequently by pedestrians, cyclists, and dog walkers alike. Seating can be found around the park, facing Slottsfjärden and the castle. In July, hammocks were suspended between the pine trees in the southern part of the park. A small recreational harbor in the park was only used on one occasion during my visits, by a small sailboat docked there in July. Lycksalighetens ö ("Isle of Bliss"), a small island connected to the park by a small bridge, was a popular picnic spot. Sylvanderparken provides a fantastic view over Slottsfjärden towards the castle from several viewing points. Many visitors were observed taking photos with the castle as a backdrop. Human park users shared Sylvanderparken with a grazing colony of geese in the summer.



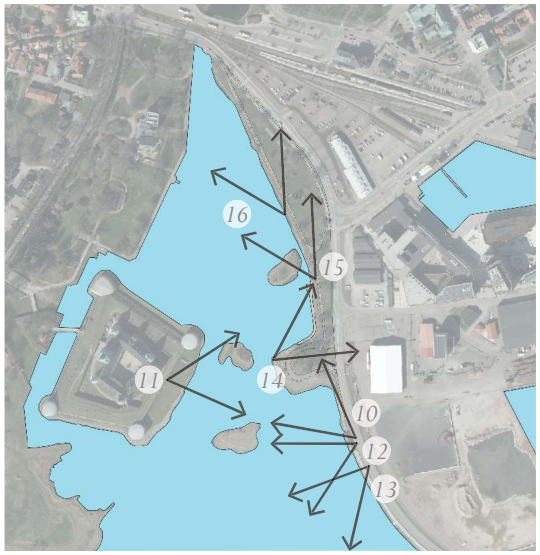


Figure 9:Views
(Background ©Lantmäteriet)

Figure 10:View of Kalmar castle and the park from Tjärhovsgatan

Figure 11:View of Sylvanderparken from Kalmar castle

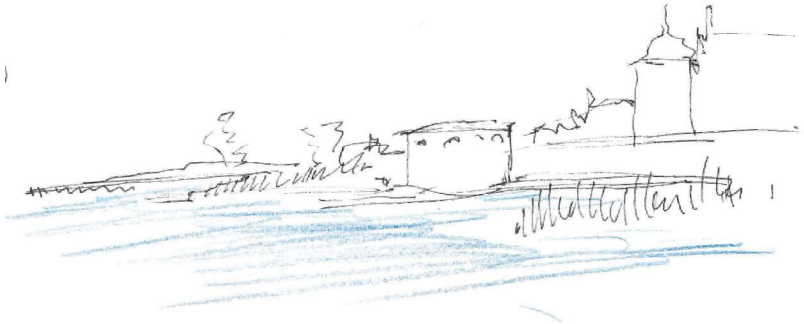


Figure 12: Sketch from site

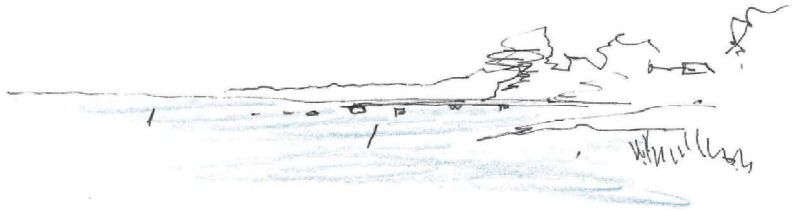


Figure 13: Sketch from site

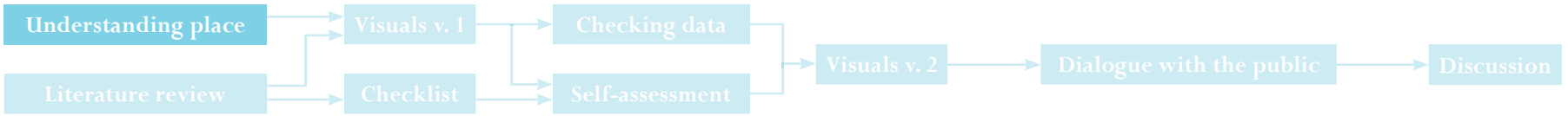


Figure 14: Different types of shoreline in Sylvanderparken: soft shoreline

Figure 15: Shoreline fortified with rocks

Figure 16: Small harbor with stone quays in Sylvanderparken

Figure 17: Sketch section of signs of water level fluctuations in soft shoreline in Sylvanderparken

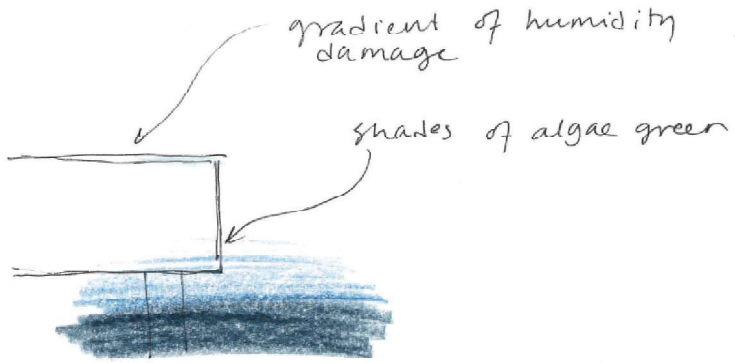


Figure 18: Sketch section of built quay

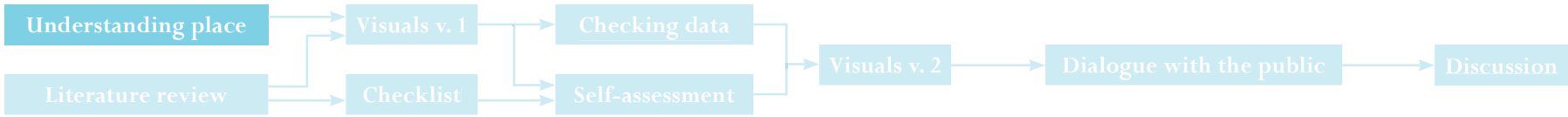


Figure 20-21: Signs of erosion in Sylvanderparken showing the already visible consequences of fluctuating sea level

Figure 22: Erosion around bridge foundations. ©Vilborg Thorildsdottir

Figure 19: Photo locations. (Background ©Lantmäteriet)

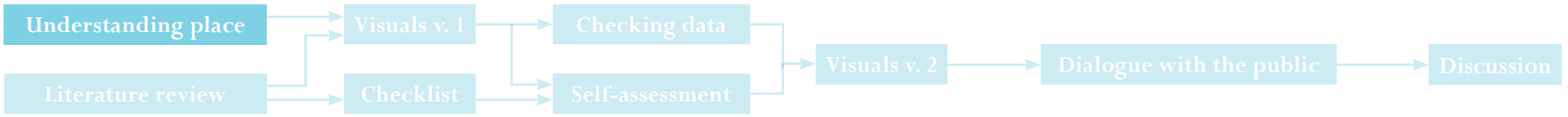
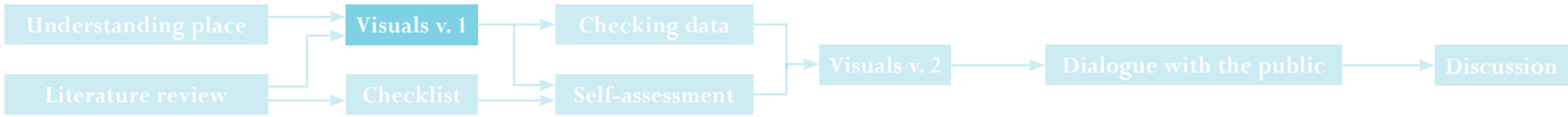


Figure 23: Signs of erosion in soft shoreline.
©Vilborg Thorildsdottir

Figure 24: Coastline has started to withdraw from rocks marking the past shore.

Figure 25: Signs of changing humidity in wooden decks.



Visualizing Sylvanderparken

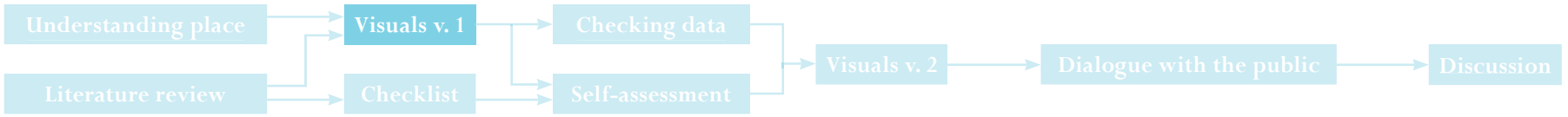
In the following pages, I describe the process of visualizing Sylvanderparken with future SLR. Following recommendations of transparency proposed by Nicholson-Cole (2005), I discuss and motivate the choices made during the process. As many scholars have pointed out, making images is always a subjective activity influenced by the author's cultural background, experience, and previous knowledge (Corner, 1999; Nicholson- Cole, 2005). Therefore, it is inevitable that the values and affordances I assigned to the chosen landscape are influenced by all these factors. My education in landscape architecture and my Nordic background inform the way I perceive and visualize landscapes. On the other hand, as I had no previous relationship with Kalmar prior to this project, it is not impossible that I have omitted details of local significance.

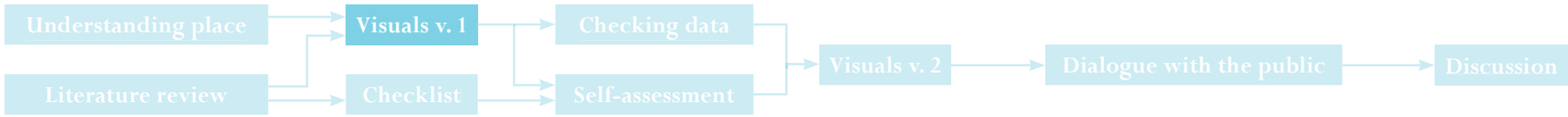
Site

Sylvanderparken was selected for this case study for several reasons. Firstly, it was chosen as the location for Konstkiosk where the visualizations were exhibited. Illustrating the site in which the images would be viewed provided an immediate link between the landscape and the projected future, even for visitors who didn't have a previous relationship with the park. The park with its flat topography and mostly low lying shoreline is likely to be affected by SLR and coastal erosion early, as signs of this are already visible in the landscape (see fig. 20-25). Finally, its central location and iconic views towards the castle make it recognizable to locals and tourists alike.

The chosen view shows the southern tip of Sylvanderparken seen from Tjärhovsgatan with the castle as a backdrop. This view can be found in historic photos dating back to the 1920s, as well as several postcards, suggesting it could be a well-known vista both for local residents and visitors.

Figure 26 (above) and 27 (right): Chosen view, taken from Tjärhovsgatan with an iconic view of the castle as a backdrop.
(Background ©Lantmäteriet)


Understanding place
Literature review
Visuals v. 1
Checklist
Checking data
Self-assessment
Visuals v. 2
Dialogue with the public
Discussion



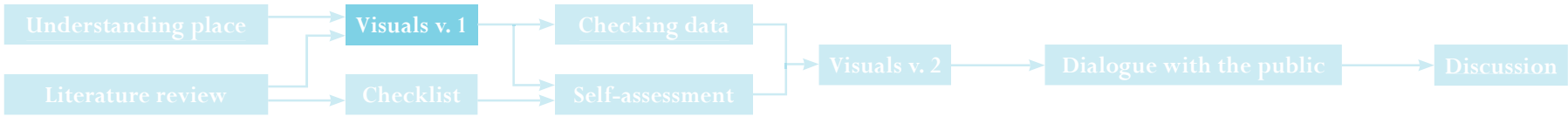
Climate scenario

The SLR shown in the visualization is based on scenario SSP5-8.5 which is one of the five main pathways IPCC proposes as a basis for climate modeling. It is a high-emission scenario where global temperatures rise well beyond the Paris Agreement goal of 1.5°C compared to the 1850- 1900 baseline. Instead, warming could potentially reach higher than 5°C (Riahi et al., 2017). This pathway was chosen for several reasons. Firstly, Göransson et al. (2023) found in their survey of Swedish municipalities and public institutions that this is an often-used scenario for the basis of climate preparedness and adaptation. The severe impacts of this scenario result in it being seen as a ”worst-case scenario”. Furthermore, Kalmar climate adaptation plan (2021) is also based on a high-emission scenario. A central premise for SSP5-8.5 is its focus on local adaptation solutions rather than mitigating climate change globally. This makes it a good starting point for showing local solutions for adaptation.

The chosen scenario with its dramatic rise in global temperature would result in equally dramatic SLR. As discussed previously, accurately modeling SLR on long timescales is very difficult, even within one climate scenario. Therefore, the margin of possible outcomes grows moving further into the future. In 2100, the majority of SLR calculations within this scenario fall between 45-140cm (SMHI, 2022). For the purposes of this visualization, I’ve chosen to follow the 95th percentile of projections, meaning 95% of all SSP5-8.5 models predict SLR to remain under the illustrated level. Using a higher figure shows a more dramatic change which Sheppard et al. (2011) have found elicited stronger emotional reactions from viewers while staying within the parameters of permissible drama.

“This world places increasing faith in competitive markets, innovation, and participatory societies to produce rapid technological progress and development of human capital as the path to sustainable development. Global markets are increasingly integrated. There are also strong investments in health, education, and institutions to enhance human and social capital. At the same time, the push for economic and social development is coupled with the exploitation of abundant fossil fuel resources and the adoption of resource and energy intensive lifestyles around the world. All these factors lead to rapid growth of the global economy, while global population peaks and declines in the 21st century. Local environmental problems like air pollution are successfully managed. There is faith in the ability to effectively manage social and ecological systems, including by geo-engineering if necessary.”

Narrative for SSP5 - Fossil Fuelled Development
(Riahi et al., 2017)



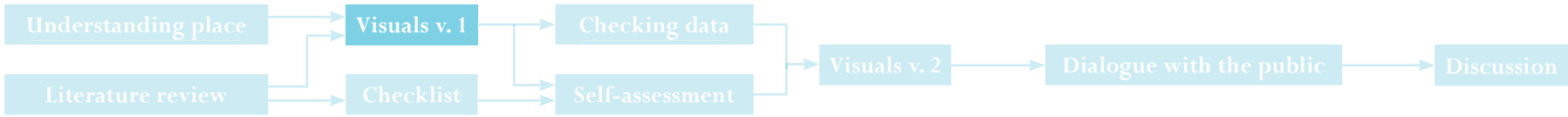
Timescale

SLR in Sylvanderparken is illustrated on a timescale ranging from present day (2023) to 2123, a hundred years from now. This interval was chosen as it is long enough to show significant change in the landscape yet still relatable from a human perspective. It is slightly longer than the average life expectancy in Sweden today (82 years), but a short time in relation to the city's history. Many elements shown in the view, such as the castle and certain trees are likely to outlive this time span if given the opportunity. Although the animation is limited to this period, SLR will continue long beyond this timeframe. With enough time, even the more conservative scenarios with lower emissions are likely to result in similar change in sea level. Two breaks in the animation pace the progression of SLR. These are chosen to pause the timing at roughly regular intervals, in 2053 and 2083. This allows the viewer to take in and process the change as well as show in more detail which other changes might happen in the landscape.

Animation

I chose to present the visualization as a short animation. Using moving images has several advantages over static landscape visualizations. Firstly, my intention was to show the material to as wide an audience as possible. Therefore, using a format that works both online and in real life was deemed necessary. Scholars have found that moving images both attract more attention and are remembered better than static pictures (Matthews et al., 2007). This format can be easily distributed via social media (Youtube) as well as exhibited on screen. Moreover, animation allows the incorporation of sound, adding a multisensorial element, which has higher potential of attracting viewers' attention. Animated images were rated highest on effectivity in a participatory SLR visioning project (Sheppard et al., 2008). However, using animation as a method has its challenges. Hahn & Berkers (2021) found that digital art visuals and cartoons got a mixed response due to their use of humor and dramatic elements.

I realized the film as a simple animated photo collage combining both moving and static elements. Some hand-drawn lines were incorporated to mark the movement of the shoreline. The total length of the animation was kept to 1 minute 40 seconds. This length is long enough to keep the speed of animation at an appropriate level to be comprehensible yet short enough to hold the viewer's attention. The relatively short length was assumed to increase the likelihood of the viewer watching it from start to finish.



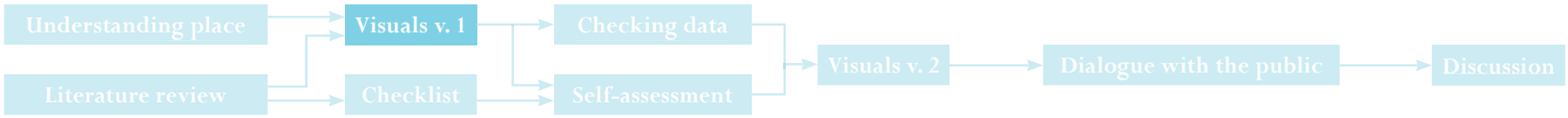
Content

Once the main decisions regarding site, timescale and scenario were made, the actual visualization process began. In addition to rising sea level, other changes in the ecology of the site and wider societal impacts were incorporated in the visuals where they were deemed relevant to the message. The animation depicts a future where the shoreline is allowed to move inland without the addition of any protective structures. This alternative is an interpretation of how the park could be adapted to much higher sea level by adopting a managed retreat or flexible land use strategy. Although an unusual strategy in the Swedish context, it is based on real-life precedents and sound scientific knowledge. According to Lübker et al. (2023) anchoring alternative future visioning in reality is particularly important when depicting experimental or novel options. For improved clarity, I focused on only illustrating changes linked with future SLR. Therefore, no changes due to aging vegetation or urban development are shown in the animation. Although the resulting images are informed by various scientific sources, imagining how the landscape might actually look is an intuitive interpretation based on an educated guess.

Sea level and shoreline

Based on the chosen scenario in Kalmar, mean sea level is projected to rise by 54cm by 2050, 97cm by 2080 and 177cm by 2120 (SGI, 2022). To assess how this would look in the landscape, I used a 3D topography model provided by the municipality. After importing the model into the 3D modeling software TwinMotion, I studied the evolution of the shoreline by placing a plane representing the sea level at the above-mentioned elevations (see fig. 32-35). By locating the chosen view in the 3D model, I could transfer the new shorelines onto a picture of the chosen site to constryct a photo collage using Photoshop and AfterEffects software. By cross-checking the results with climate data provided by SGI, the margin of error due to inaccuracies in the starting material could be minimized.

As I observed on site, the visualized area of Sylvanderparken already experiences some coastal erosion. Assuming this would keep pace with SLR, erosion is shown to move inland with the new shoreline. Also, the scatters of seaweed and other traces of the sea migrate further into the park.



I included an additional storm scene showing the effects of a 100-year weather event where sea level is pushed 277cm above the baseline (SGI, 2022). Extreme weather is predicted to become more common in the future due to climate change. As a sudden event with often dramatic consequences, it is likely to cause damage long before mean sea level rise becomes a problem (Oppenheimer et al., 2019). Including a storm scene also adds an element of visual drama which according to Sheppard et al. (2008) can help evoke a stronger emotional response in viewers.

Following the chosen adaptation strategy, the movement of shoreline is shown without any interventions to protect the green space. Although this decision was mainly based on the aim of this project, it is also supported by Kalmar's strategic planning and climate adaptation documents. In the recent comprehensive plan Sylvanderparken is designated as a local park which functions as an important meeting place. Moreover, the park is located in a historic area of national interest (Kalmar kommun, 2023b). The city's climate adaptation plan (2021) does recommend protecting places with significant cultural heritage value from flooding. However, the only examples given in the document are of historic buildings. No specific recommendations on protecting historic green spaces are provided. Multi-functional green space is given as an example of climate adaptation against flooding. Therefore, allowing the sea to gradually take over Sylvanderparken would not be in contradiction with Kalmar's current plans.

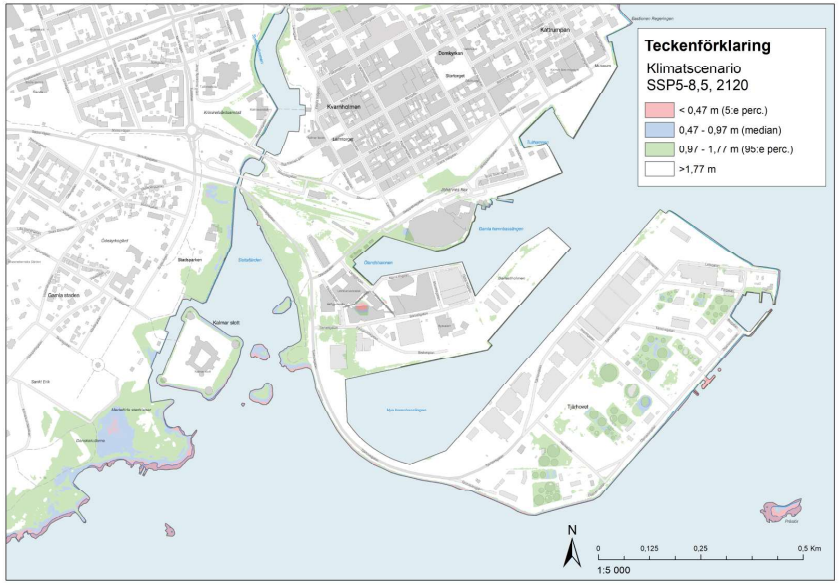
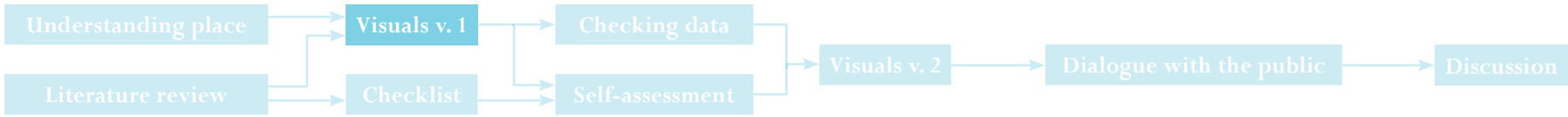
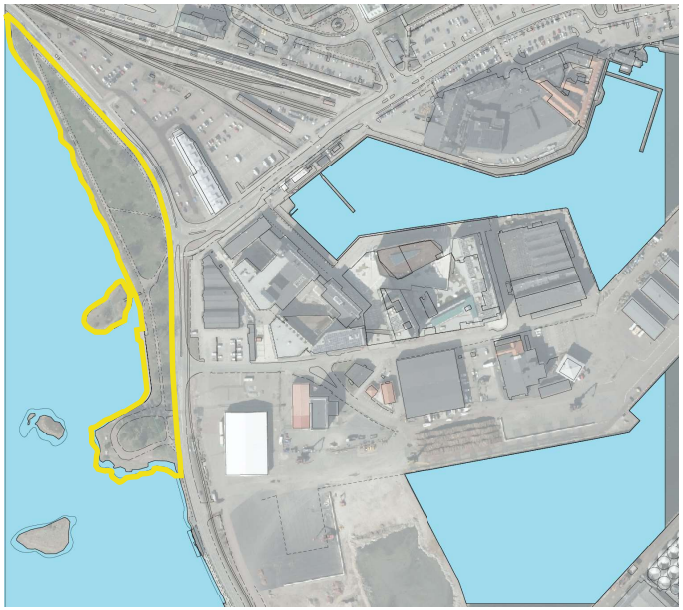


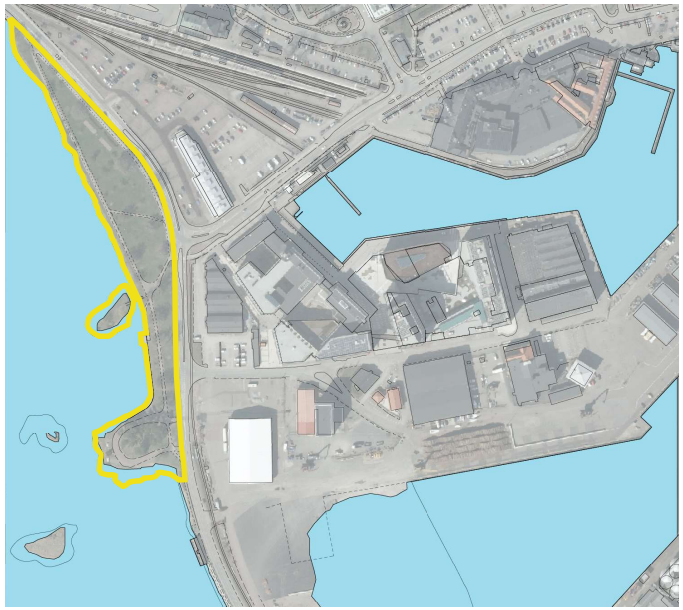
Figure 28: Sea level rise map of Sylvanderparken. Produced for the COALA project, this map shows three possible shorelines for 2120 according to SSP5-8.5.
©SGI



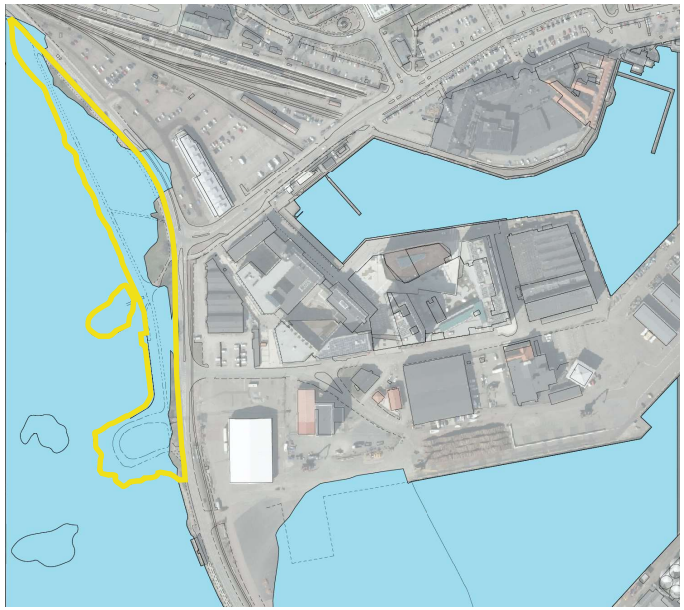
Figures 29-31: Projection of future shoreline according to SSP5-8,5 (Background ©Lantmäteriet)



2050

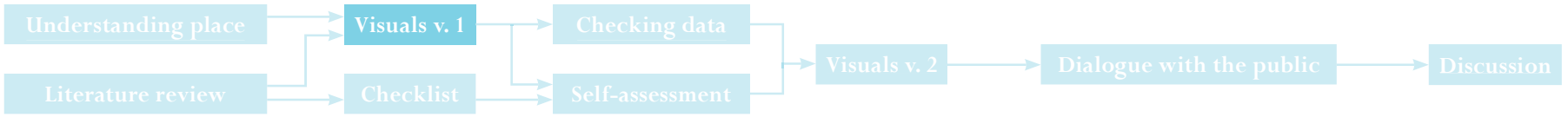


2080

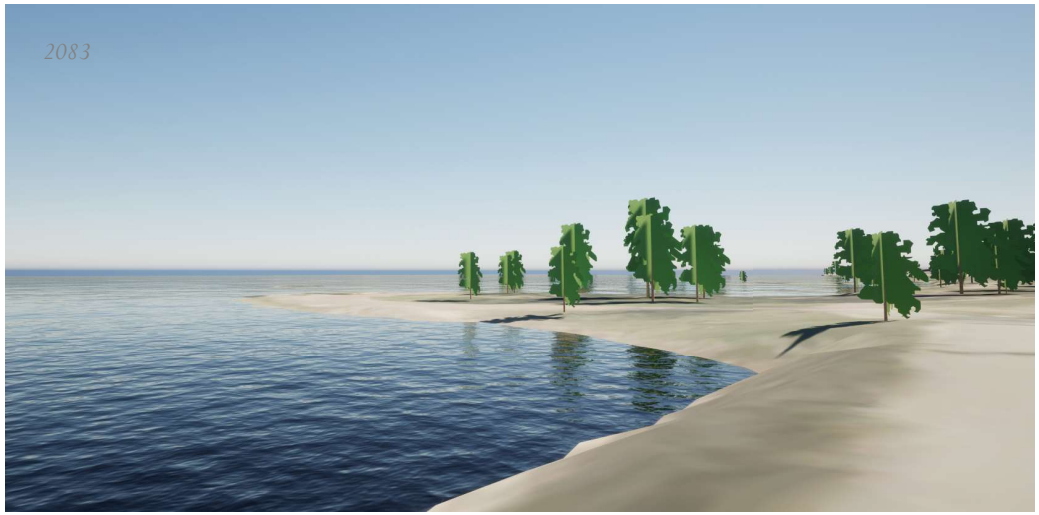


2120

Figures 32-35: Early sea level studies exported from TwinMotion where the chosen site is hardly recognizable due to lack of detail.

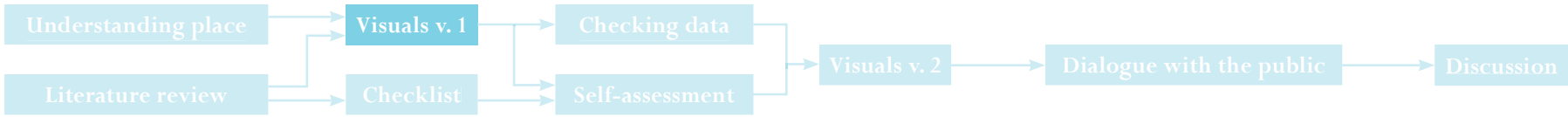

Understanding place
Literature review
Visuals v. 1
Checklist
Checking data
Self-assessment
Visuals v. 2
Dialogue with the public
Discussion


2023


2083


2053


2123



Vegetation and wildlife

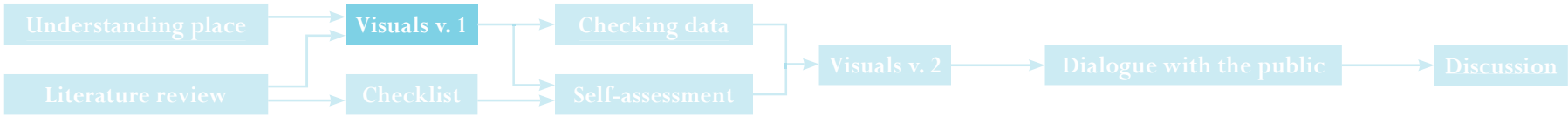
The impact of SLR is not limited to a moving shoreline. However, landscape visualizations communicating SLR often only show changes in sea level, ignoring its consequences for the coastal ecology (Sheppard et al., 2011; NOAA, 2023). As the purpose of this project was to holistically visualize the impacts for both human and non-human world, I also illustrated which other changes could happen in the park ecosystem. The aim was to make these changes as obvious as possible to a casual viewer, visually suggesting rather than detailing specific impacts. The animation culminates in the 2120 scene showing a lush wetland. This aligns with Kalmar municipality's goal of creating new wetland habitats for increased biodiversity, flood mitigation, and nutrient retention (Kalmar kommun, 2023b).

With the receding shoreline, trees closest to the water are likely to be exposed to salt water more often. Based on a study on the impact of saltwater exposure on different trees, the maple tree seen in the foreground is likely to suffer from higher sea level, resulting in browning of leaves, ill health and finally death (Kuhns & Rupp, 2000). Similar effects were shown in other trees in later scenes. In the final scene for 2120, almost the entire park is underwater and the only trees shown to thrive are salt-tolerant species, such as willows (ibid.). Dead trees were left in the wetland landscape to visually link the emerging landscape to previous scenes, as well as to illustrate continuity. In addition to changes in present-day vegetation, changes in sea level and higher temperature are likely to bring about wider changes in ecology. As the park becomes increasingly humid, wetland vegetation is shown to slowly take hold of the landscape. These images suggest that the park is managed as an urban wetland. To highlight benefits for wildlife, birds and insects were added in the illustration. Invasive species are predicted to become a growing problem. Warmer climate and changing habitats might also allow for species from warmer latitudes to migrate northwards (Kalmar kommun, 2021; SMHI, 2023). Hence, the later scenes include species that were chosen based on their "foreign-looking" appearance that would look alien in Swedish nature. Other likely changes to the marine ecosystem were hinted at with the increasing aquatic vegetation due to higher water temperatures and eutrophication (HELCOM, 2021; Kalmar kommun, 2021).

When considering future landscapes, especially in an urban context, the importance of human intervention through management and maintenance should be noted. In this animation, a relatively light-touch approach is illustrated, with only small adjustments made to the footpath to accommodate erosion in the earlier scenes, and dead trees left in the water once the park is completely flooded.

Infrastructure

As the aim of the animation was to show how a managed retreat/flexmark strategy might look like in Kalmar, no physical flood protection structures were included. Instead, the water is allowed to rise and finally cover the entire park. Moreover, in the final 2120 scene, Tjärhovsgatan becomes a green pedestrian promenade. This is to signal that some of the functions and values of Sylvanderparken could be allowed to migrate with the shoreline. It also hints at preparation for continued SLR through nature-based solutions as Tjärhovsgatan is likely to flood regularly in the future. As the municipality has set a goal of encouraging pedestrian and cycling, converting roads to green space would serve this ambition as well. The future trend of digitaliza-



tion of urban space was suggested with the upgrade of street lighting to a smart pole with integrated functions from solar cells to loudspeakers. This also aligns with Kalmar's long-term goals of green energy and smart city ambitions (Kalmar kommun, 2019).

People

Adding people and animals has been shown to increase the relatability of climate change visualizations (Sheppard et al., 2008). I have included people in the static scenes of 2023, 2053, 2083 and 2123. The shown figures were chosen to reflect the predicted changes in population in Sweden and Kalmar over time. The future inhabitants of Kalmar are likely to be more multicultural due to continued international migration which is estimated to accelerate due to the climate crisis (Kalmar kommun, 2021). In general, the Swedish population is aging, with the biggest growth in the oldest age groups (SCB, 2023). The later scenes illustrate various water-based activities which might become more popular with warmer water temperatures. Tourism to Nordic countries is likely to increase due to extreme heat in currently popular destinations around the Mediterranean (HELCOM, 2021).

Soundscape

As I observed during the site visits, the sound of the sea is ever-present in Sylvanderparken. The soundtrack of the animation features calm waves and seagulls. This is intercepted by a flowing sound during transitions to emphasize the sense that the volume of the sea is increasing in size. Moving further into the future, an added layer of tropical insects and birds enhances the impression of warmer climate and previously exotic species becoming more common in Sweden. A low bustle of crowds was also added to static scenes to indicate continued city life. The storm scene is marked by the sound of an alarm. This signals the improved preparedness in extreme weather events made more frequent by climate change. This could also alert the viewers' attention and add a sense of drama. Sound of waves, rain and wind intensify during these scenes only to subside back to soft background waves after the storm has passed.

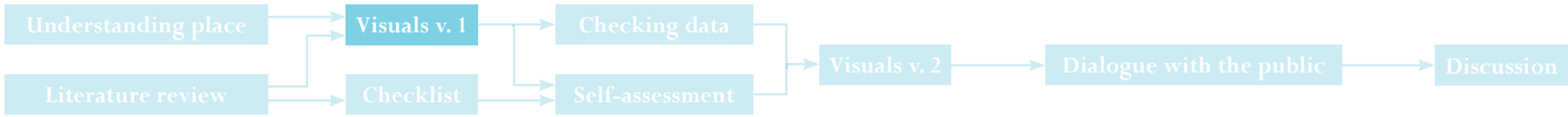
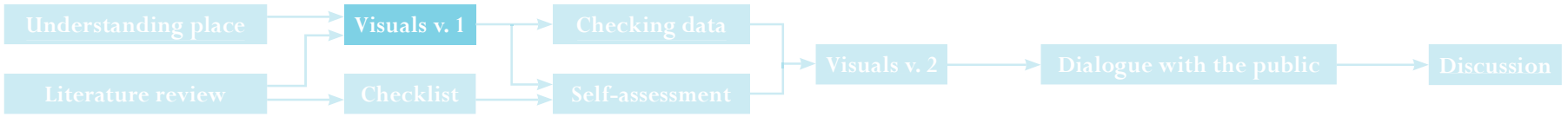
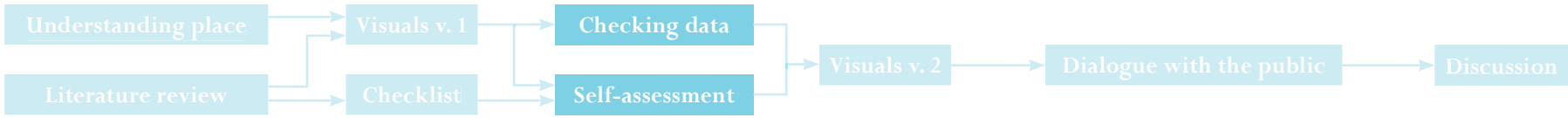


Figure 36-39: Still images exported from the final animation


Understanding place
Literature review
Visuals v. 1
Checklist
Checking data
Self-assessment
Visuals v. 2
Dialogue with the public
Discussion


2083
+ 97 cm


2123
+ 177 cm



Self-assessment

How does the animation hold up against the findings from previous research compiled on page 25? Prior to exhibiting the animation in public, I completed a self-assessment critically looking at the visuals I had produced against the recommendations found in existing literature.

Public

As stated in the introduction, the aim of this project was to study how SLR visualization can be used to communicate with a local non-expert audience. Due to the chosen research method, described in more detail in the next chapter, the focus group remained broad and rather unspecific. For this reason, the animation was designed so that anyone regardless of previous knowledge of climate change or SLR would easily be able to understand the visualization.

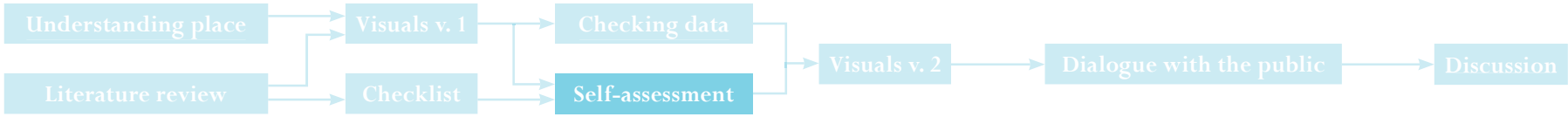
The choice of animation as a technique as well as my positionality have already been discussed in the beginning of this chapter. Although I made the visuals working from photos from the site, by editing elements, I have simplified the scenes to focus attention and highlight changes.

As this was the first showing of the visualization and no prior contact with the local audience was possible within this project, collaborative image-making was not an option. However, the animation could be reworked after recording the initial reactions from the public.

Scientific legitimacy

The data and choice of timescale used as a basis for this animation were described in detail earlier in this chapter. Sourcing climate data from reputable national institutions (SMHI, SGI) contributes to the legitimacy of the visuals. To ensure that I hadn't misinterpreted the data, earlier versions of the visuals were discussed with SMHI oceanographer Magnus Hieronymus in May 2023. As a result of this conversation, I decided that the animation should be complemented with more information on the chosen scenario and a stronger background narrative. This was included in a poster accompanying the animation in the exhibition, see fig. 40.

Apart from SLR, the visuals also depict other changes, such as changes in vegetation and population. Although these too are based on scientific sources, it is very difficult to predict how they will visually manifest in the landscape. Here, I have taken some artistic license with the source material with slightly exaggerated illustrations to make the changes more perceivable for viewers



Content and style

The chosen view shows Kalmar castle in the background making the landscape immediately recognizable even after considerable changes. The visuals are reworkings of photos taken on site in different seasons and therefore strongly anchored in place. The data used as a basis of the animation was produced specifically for Kalmar. My own observations on site were used to make sure that the content of the animation was locally relevant.

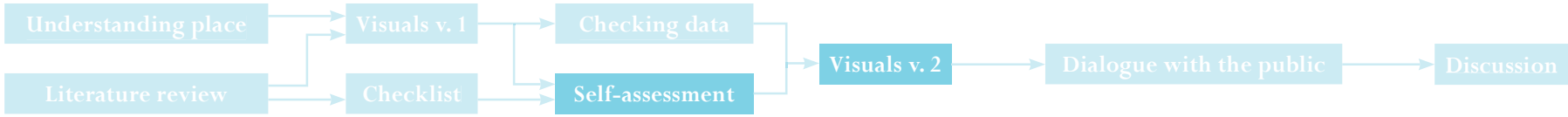
By choosing moving images to communicate SLR, the visualizations have a captivating quality with a soundscape to add more experiential dimensions. However, as the animation was shown on an ordinary TV screen or on a smartphone through the QR codes, it cannot be claimed that the display was particularly immersive.

Although the scenario chosen for the animation is a rather extreme future according to current knowledge, I tried to convey a sense of calm through showing the continuation and adaptation of city life. The storm scene which can be interpreted as alarming is followed by a return to "normality". The dead tree trunks with their strong imagery of loss could be interpreted as sorrowful but also carry a memory of the past landscape.

The animated photo-collage method gives the visuals a good starting point towards realism. However, the reworking, copying, and pasting from other images, and transitions left unrefined emphasize that the film is a creative work with considerable liberties taken in visioning a possible future. The saturated colors and rather rough editing give the animation a "cartoonish" appearance which suggests that, although based on science, it is essentially a work of fiction. The mixing of the soundscape was designed to enhance the sense of the imaginary. By balancing the realistic and imaginative elements signals that although informed by scientific knowledge, the visioned future is by no means certain.

Message and narrative

The impact of SLR is shown in a logical and clear manner. Focus was directed to the issue by selectively leaving out some other potential changes in the landscape. A running date and sea level are shown in the animation to help the viewer follow the sequence of events. The narrative of the film itself is subtle, illustrating a landscape adjusting to new conditions through retreat and flexible land use. Although the animation has no verbal narrative, this was included in a poster which was displayed with the film, see p. 52. The context was provided through a general description of past and future changes in the park, the city, and the wider society. In comparison, other narrative-based climate communication projects have included a much stronger story-telling aspect, often told through the experience of an individual character (e.g., Lund University, 2022).



The potential solution shown in this animation illustrates soft coastal adaptation to SLR through wetland restoration and managed retreat. I subtly highlighted improved access to water as an opportunity for this future. However, as the aim of this study was to encourage dialogue and collect reflections from the public, I tried not to impose too many of my ideas onto the landscape. By showing some possible functions (kayaking, birdwatching), the visuals suggest that this scenario isn't just about loss. Although these types of nature-based solutions are recommended by many experts (Lawrence et al., 2020; Shannon, 2013;), it is difficult to assess beforehand whether a lay audience will perceive the benefits.

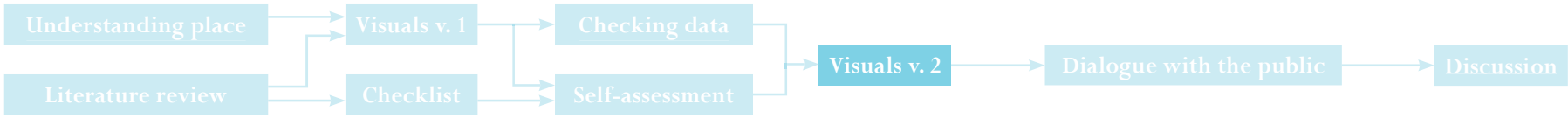
As stated previously, I had no prior relationship with Kalmar or its residents. Hence, the inclusion of local stories in this first version of illustrations would have been solely based on secondary sources. However, for added time perspective I included a short history of Sylvanderparken emerging from the sea through landfill. The animation could be developed further to include local voices after collecting reflections from the public after the first showing.

Only one scenario and adaptation option are shown in the animation. As the purpose of this project was to assess the suitability of using visualization as a method for engaging the public rather than comparing the reception of different scenarios, it didn't seem necessary to produce more than one set of visualizations for the initial study.

End result

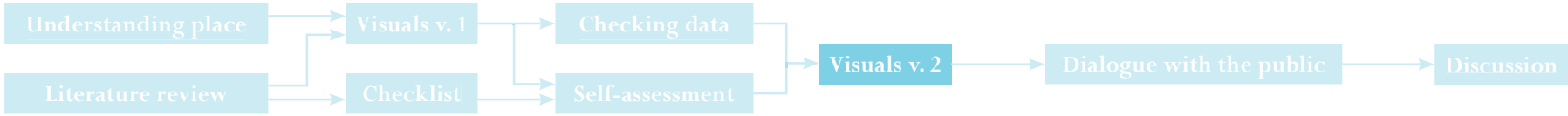
After some minor amendments, mostly concerning speed and sound volume, the final animation was uploaded to https://youtu.be/_BissQaQLYA

Since I estimated that the animation alone didn't provide enough context for the chosen scenario, an accompanying poster was made to complement the exhibition. The importance of transparency regarding source data and uncertainty has been stated previously (Nicholson-Cole, 2005; Sheppard, 2012). This was particularly important as the chosen SLR projection represents an extreme scenario. Using several visual communication methods supported by a clear narrative has been found effective in several studies. As individuals relate to different communication methods in diverse ways, using a wider range of material from text and maps to animated film is likely to result in higher level of engagement (Nicholson-Cole, 2005).



Scenario till Sylvanderparken: Tillbakadragande av befintlig strandlinje

Figure 40: Poster with context and background narrative of Sylvanderparken's history and future was displayed with the animation in Konstkiosk. See English translation on p. 52.



SCENARIO FOR SYLVANDERPARKEN: RETREAT OF EXISTING SHORELINE

"It's the year 2123 and humanity has not been able to shake its dependency on fossil fuels. The global temperature has risen by nearly 6 degrees Celsius compared with pre-industrial era. Societies around the world find innovative ways to co-exist with new climate risks with the help of new technology.

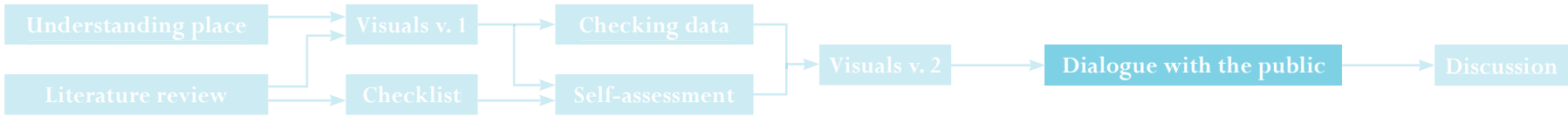
Kalmar has throughout its history grown in symbiosis with the sea. The relationship with water defines the city's economy, culture, and landscape. The city has expanded by building on landfill on past seabed but at the beginning of the 21st century this development is reversed. In pace with the rising sea level, parts of the city begin to return to the sea. By 2123 mean sea level has reached 1,77m above today's level. The city has adopted different strategies to protect and adapt the infrastructure to accommodate the new conditions.

Sylvanderparken is built during 1870-80s and gets its name from Volmar Sylvander, researcher and teacher who wrote "Kalmar Slotts och Stads historia" between 1864-1874. The aim of the new green space is to create a continuous park around Slottsfjärden. A meeting place between cultural heritage and nature , Sylvanderparken provides a magnificent view towards the castle.

When sea level rise accelerates starting from the beginning of the 21st century, the city adopts a flexible adaptation strategy where the water is allowed to take over and the park's use and functions are adapted according to the new conditions. The shoreline migrates inland with the rising mean sea level and coastal erosion increases. The park's ecology changes slowly into a natural oasis where biodiversity flourishes in a new wetland in the middle of the city. Higher temperatures in the atmosphere and in the water benefit some species, new species spread to Kalmar and others die out. Tjärhovsgatan / Järnvägsgatan is transformed into a waterfront promenade along a continuous green space on the east side of Slottsfjärden. "

Conversations on sea level rise

To collect responses from the public, the film and accompanying poster were shown to the public in Kalmar over a weekend in July 2023. The purpose of this study was to assess the suitability of the visualization in facilitating dialogue. This chapter describes the research design and summarizes the results.



Interviews and observations

The animation was exhibited at Konstkiosk in Sylvanderparken between July 15th and 16th 2023. During the weekend passers-by were encouraged to view the film and share their thoughts and impressions. Showing the animation in this context had some clear advantages. While explicitly stated to be an individual academic project, by placing it in the context of the COALA research project, it benefited from the authority of the participating institutions. As this project examined the communication between expert and non-expert audiences, the perceived association with these institutions allowed me to inhabit the position of the expert more easily, despite my clearly explained student status. By showing the animation on the visualized site, I could ensure that all participants had at least some previous impression of the place.

On the other hand, the artistic space in which the film was shown, could also have been a limiting factor. As Hahn & Berkers (2021) found, art was the least trusted communication method among climate visuals, far behind traditional scientific representations, such as graphs. In this case study, this could also be an advantage, as the subject matter has a high level of uncertainty and creative liberties were taken in the visual interpretation of the future landscape. Another limitation of using this venue was that a focus group could not be selected, for instance to only include Kalmar residents or a certain age group. Instead, participant selection was random, as anyone showing interest was invited to discuss. On the other, a mixed group of visitors allowed me to compare any differences in responses between residents and tourists resulting in potentially interesting findings.

Figure 41: Konstkiosk's location by a busy footpath in Sylvanderparken.

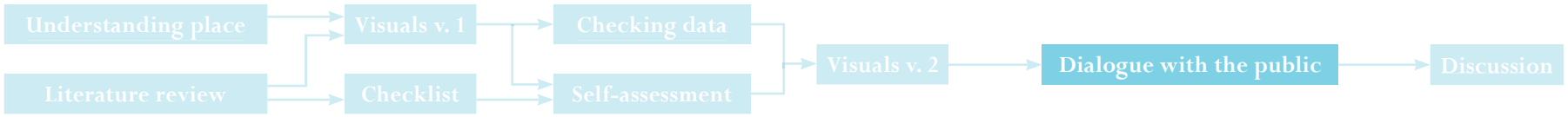
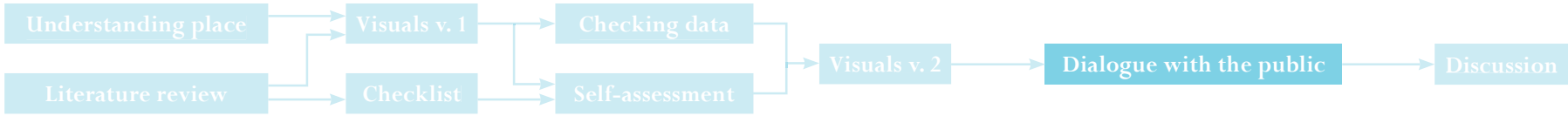


Figure 42: Konstkiosk was located centrally in the park, facing a busy footpath.

Figure 43: How will Sylvanderparken look in 2123? Animation behind this QR code shows a possible future based on climate data from SMHI.



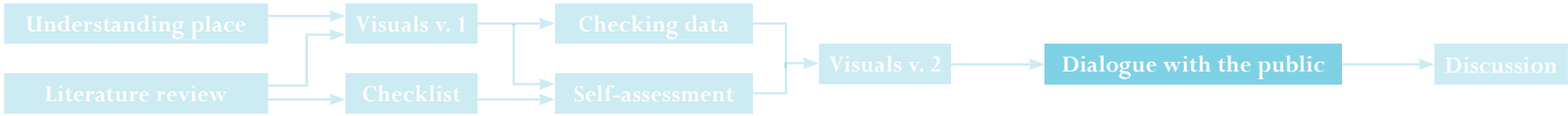
During the two days I spent at Konstkiosk exhibiting my work, I spoke to a total of 51 visitors. This included 21 women and 30 men, 9 of which were estimated to be under the age of 26. 12 of the participants either lived or were from Kalmar. There was an age bias towards more mature visitors, with a clear majority of participants over the age of 50. In my estimation, only three visitors who actively participated in the conversation were underaged. However, several more children watched the animation while accompanying adults to Konstkiosk.

During the first hours, it quickly became clear that my original plan with semi-structured interviews would not work for the venue. This was due to the situation which favored faster and more informal interaction as the visitors quickly browsed through the exhibition often unable or uninterested to stay for a long discussion. Instead, I chose to collect responses through informal conversations informed by the questions laid out in the interview guide. The main points in the discussions were recorded immediately afterwards in field notes including both a summary of the conversation as well as my observations on the person's behavior and non-verbal reactions.

"They should show a similar film for Halmstad. That would make them understand."

Woman, retired, Halmstad

The animation was commended as clear and informative. Several visitors said it made the impact of SLR concrete and real. A woman from Halmstad (a city facing similar issues due to SLR and flooding) wished a similar film of her hometown to be shown publicly to raise awareness. A mother of a school-age boy wondered whether her son's classmates wouldn't benefit from watching the animation for educational purposes. No-one expressed explicit confusion or visibly struggled to understand the content shown. Some words used to describe it included "thought provoking", "relevant" and "dramatic". The latter, however, seemed to carry different meaning for different participants, as some used the word dismissively while others appreciatively. Overall, everyone visiting Konstkiosk watched the animation in its entirety, sometimes several times, which suggests that the length was appropriate and content captivating enough to hold viewers' interest. This was in stark contrast to the still images shown on the accompanying poster which garnered much less attention, generally only looked at when actively encouraged to do so. However, the use of maps as a supporting material made continuing the conversation easier as visitors were able to point out familiar places on the map.



"We're too old to see the consequences but one worries for the coming generations."

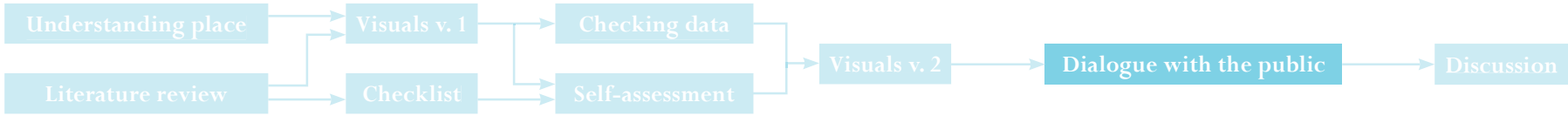
Woman, retired, Gothenburg

The animation also showed potential in evoking emotional response. Some viewers watched it with indifference and even bemusement. However, particularly those with a personal connection with the city expressed stronger emotions, most often worry and sadness. Furthermore, those with lived experience of flooding events seemed to have a more serious outlook on the shown future. Despite the small size of the focus group, there seemed to be a link between the age of the viewer and the response, with younger viewers expressing both more interest and more concern. Several elderly visitors commented that they do not need to concern themselves with SLR thanks to old age preventing them from ever experiencing the most severe impacts firsthand. On the other hand, many mentioned "future generations" or "grandchildren" as a reason to worry. A mother accompanying a younger visitor narrated the animation in relation to the boy's age. At one point she commented that the park will "look like this when you are in your 50s". These findings seem to suggest that lived experience, perceived psychological and temporal distance, and attachment to place affected the response to the visuals.

"I think Slottsfjärden is becoming more shallow. There used to be boats sailing through. Now it's just kayaks."

Man, middle-aged, Kalmar

Although some participants questioned the content of the animation, the majority seemed to accept the shown scenario without protest. On several occasions I had to give more context to the animation by explaining the scenario and data it was based on. This would suggest that visuals are a powerful means of communication, especially when backed up by science and shown in the right context. Even though the visual style didn't strive for realism, the level seemed appropriate to allow the viewer to relate it both to the site and the illustrated issue. One woman from Gothenburg commented the storm scene by comparing it to flooding she has seen in her hometown ("this is what it looks like when the riverfront floods"). Those who viewed the animation more critically mostly questioned the level of shown SLR. This manifested both as skepticism whether the sea level would actually rise to that extent as well as surprise that the situation wouldn't be worse. Many wondered whether land rise would not compensate for any projected changes in sea level. On the other hand, a local woman recalled previously seeing a SLR map that showed a radically higher projection of SLR in Kalmar. When asked, she couldn't recall where or by whom the map was presented. However, a flood risk map in Kalmar comprehensive plan matches the woman's description (Kalmar kommun, 2023b). Another couple compared the animation to an interactive SLR map of Malmö which allowed the users to move around and zoom in on areas of interest. They too had been surprised as to how little the city will be affected with only peripheral areas submerged in the future.



"Positives? There are no positives in this scenario."

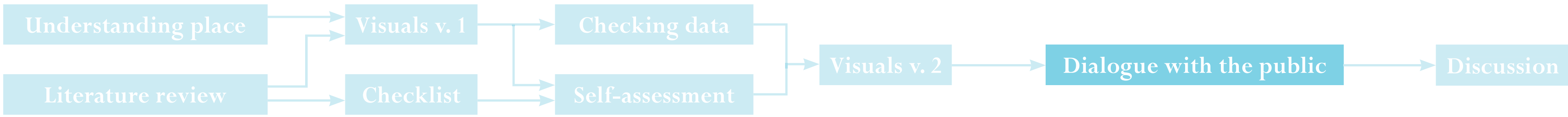
Woman, late 30s, from Morocco, lives in Kalmar

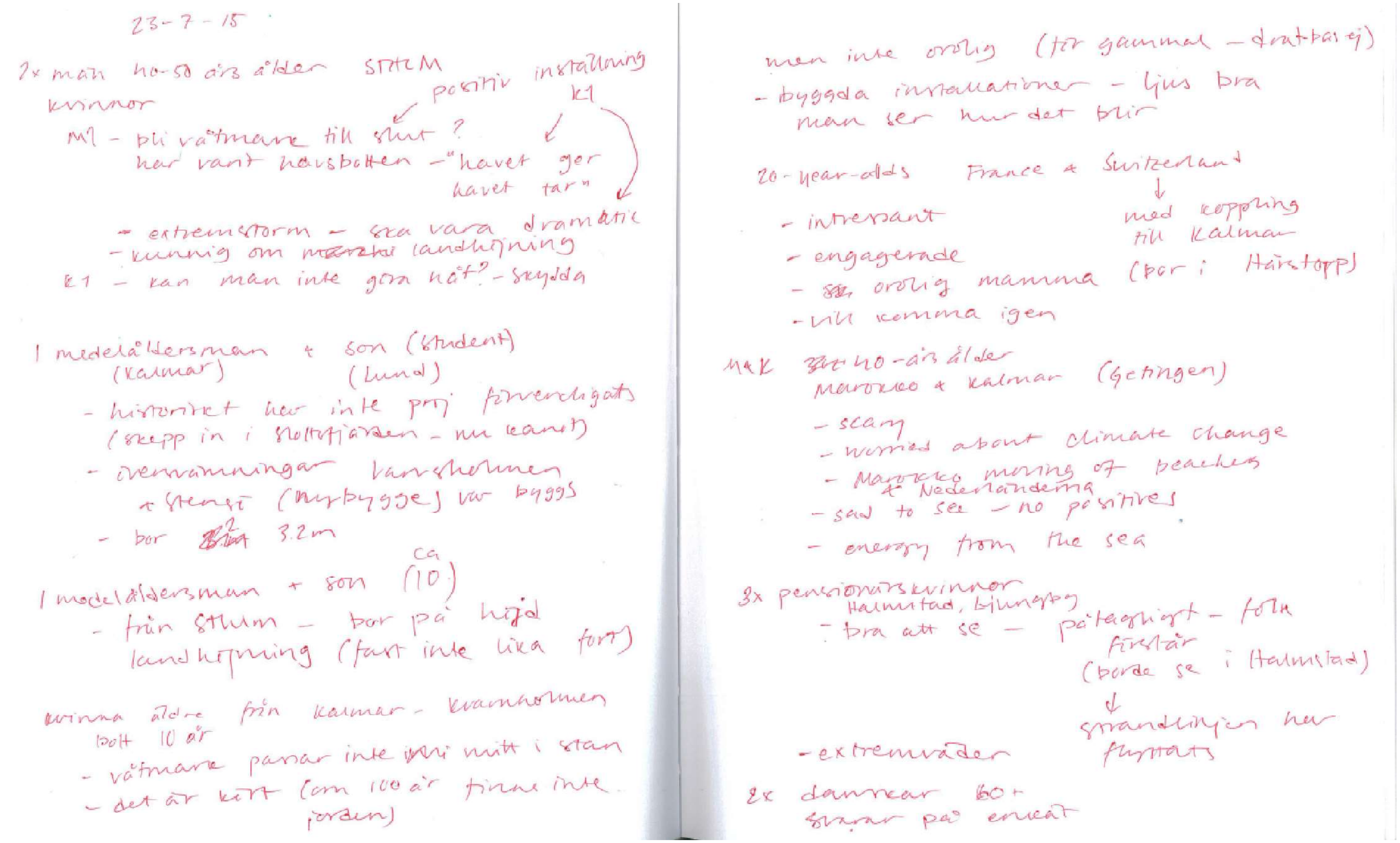
There were only a few comments made on the adaptation strategy shown. One man praised wetlands as a great nature-based solution and spoke about restoration projects as beneficial for biodiversity and flood control. However, as a visitor from Stockholm, he had no personal relationship with the shown landscape. A local woman, on the other hand, didn't see wetland as an appropriate environment for such a central location while expressing appreciation for it in more peripheral areas, referring to Kalmar dämme (a local wetland restoration project) as a good example. Another local resident, although not directly commenting on the film, questioned the long-term sustainability of building dikes and seawalls to protect the shoreline. Instead, she expressed sorrowful acceptance of inevitable change in the landscape where she had lived her whole life. Many others wondered whether something could be done to protect the park against SLR, suggesting a strong faith in engineered solutions for climate adaptation. Mostly, the emerging wetland and slow retreat away from the moving shoreline was seen more as a passive acceptance rather than an active strategy.

"The sea gives and the sea takes."

Woman, 50s, Stockholm

The weekend proved that it was easy to engage visitors in discussion based on the exhibition material. As there were several other works shown in the space at the same time, it is hard to say whether the animation alone would have resulted in as much discussion. During the conversations, I often pointed towards other supporting material such as SLR maps produced by SMHI and SGI, as well as the images I had included in my poster. As the findings above suggest, the visual material did facilitate dialogue in both illustrating the impact of SLR on a local scale as well as allowing the participants to relate their comments, stories, and reflections on the issue to the places it might affect in the future. The strength of using visuals became especially evident when trying to communicate over language barriers or different function levels, as was evident in an interaction with one visitor with limited hearing. Overall, there was a good level of engagement, with several long conversations taking place on both days. Interest was strong among visitors, although the small size of the focus group doesn't allow to draw any definite conclusions.





23-7-15

2x man 40-50 års ålder STHLM
kvinnor
positiv installning K1
M1 - bli våtmark till slut?
har vart havsbotten - "havet ger havet tar"
- extremstorm - ska vara dramatic
- kunnig om landhöjning
K1 - kan man inte göra nåt? - skydda

1 medelåldersman (Kalmar) + son (student) (Lund)
- historiskt har inte proj förverkligats (skepp in i slottsfjärden - nu kanot)
- översvämningar Varvsholmen + stängsel (nybygge) var byggs
- bor 3.2m

1 medelåldersman + son ca (10)
- från Sthlm - bor på höjd landhöjning (fast inte lika fort)

kvinna äldre från Kalmar - Kvarnholmen bott 10 år
- våtmark passar inte mitt i stan
- det är kort (om 100 år finns inte jorden)

men inte orolig (för gammal - drabbas ej)
- byggda installationer - ljus bra man ser hur det blir

20-year-olds France + Switzerland → med koppling till Kalmar
- intressant
- engagerade
- orolig mamma (bor i Hästhagen)
- vill komma igen

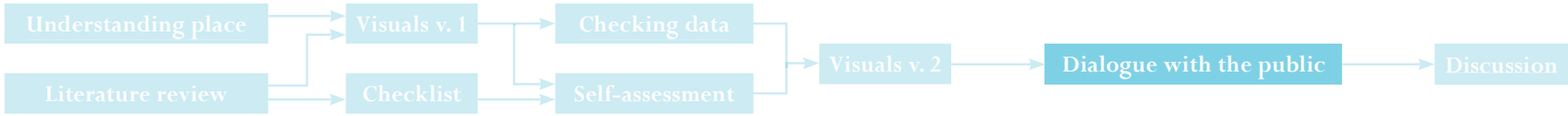
M+K 40-års ålder Marocco + Kalmar (Getingen)
- scary
- worried about climate change
- Marocko moving of beaches + Nederländerna
- sad to see - no positives
- energy from the sea

3x pensionärskvinnor Halmstad, Billingsby
- bra att se - påtagligt - folk förstår (borde se i Halmstad) → strandlinjen har flyttats
- extremväder

2x damer 60+ svarar på enkät

Figure 44: Excerpt from field notes written down after each conversation.

Figure 45: Interacting with visitors in Konstkiosk. ©Carola Wingren



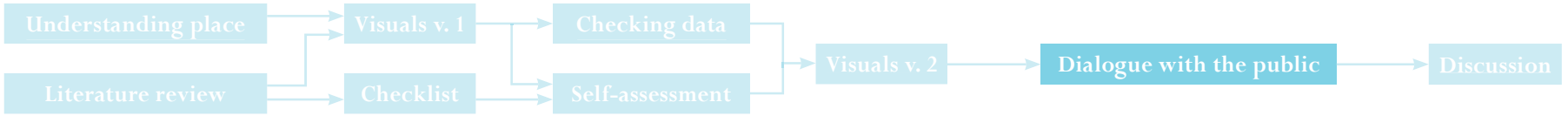
Survey

As of September 5th, the survey had been viewed 62 times, started 22 times which resulted in ten fully completed responses. The low completion rate is in line with Gillham's (2000) claim about how difficult it is to get people to fill out surveys if there is no clear personal incentive to do so. A look into the statistics of the Youtube video revealed that it had only been viewed 19 times. This result shows that although the QR codes were scanned by many, it is much more difficult to capture and retain attention for the duration of a short video, let alone a survey.

Despite the low participation, the responses indicated results similar to those of the in-person interactions. Most respondents found the animation informative and clear. The pointers for improvement included wishes to tone down the storm scene while most thought the animation was fine as it was. This suggests that the level of permissible drama is hard to assess beforehand. The realism of the scenario was rated between 5-10 on a 10-point scale (0 meaning not at all realistic), with the majority leaning towards highly realistic. The scenario was rated low to neutral on desirability, and high on informativeness. Written thoughts and feelings after seeing the film included sentiments of concern as well as recognition that something needs to change if such a future is to be avoided. One respondent commented the use of sound in evoking emotions. Most respondents found climate change to be a threat to Kalmar and climate adaptation to be an important consideration in the city's future development, with only one respondent rating both questions below 5 on the scale of 0-10.

Although the response rate is much too low to have any statistical significance, the answers seem to be in line with those recorded during the in-person conversations where little positives were found in this high-emission SLR projection and its impacts on the city space. Even emotional responses, while much harder to assess based on survey results alone, point towards the worry and sadness expressed in in-person interviews. My hope for reaching a wider and more varied participation by using an online survey was somewhat unjustified as evident from the low number of completed responses.

Figure 46: Summary of survey results.



Sylvanderparken

10 responses

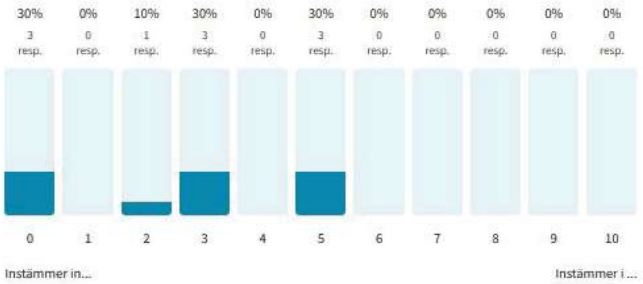
Bor du i Kalmar?

10 out of 10 answered

Scenariot i animationen är positivt

10 out of 10 answered

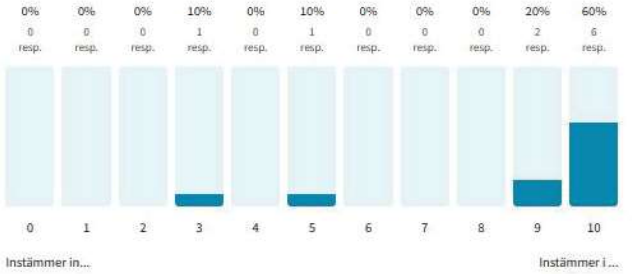
2.6 Average rating



Klimatanpassning är en viktig fråga i Kalmars framtida utveckling

10 out of 10 answered

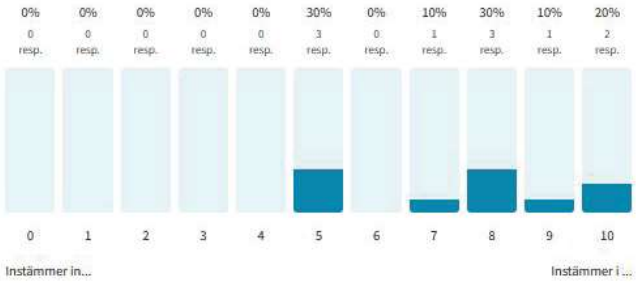
8.6 Average rating



Scenariot i animationen är realistiskt

10 out of 10 answered

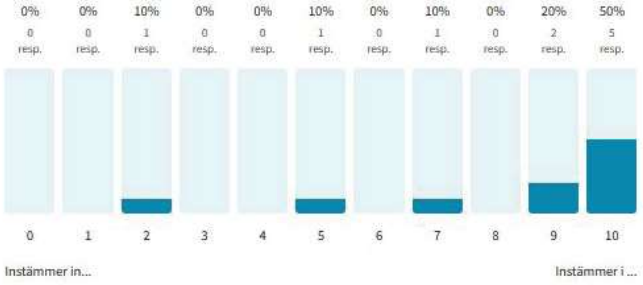
7.5 Average rating



Klimatförändring utgör ett hot mot Kalmar

10 out of 10 answered

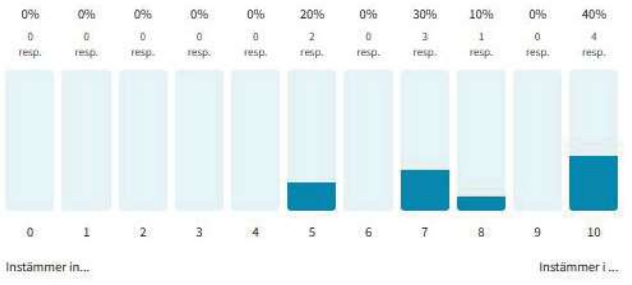
8.2 Average rating



Animationen hjälpte mig förstå vilka konsekvenser klimatförändringen har i Kalmar

10 out of 10 answered

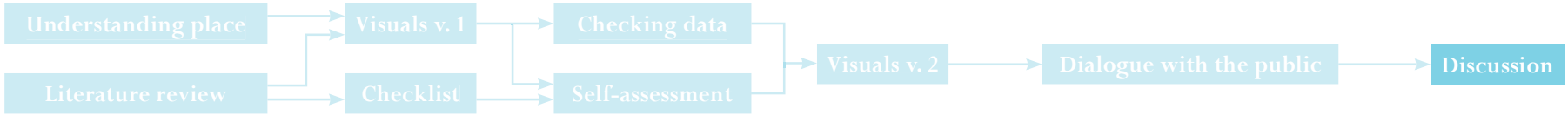
7.9 Average rating



Discussion

The results of my field study align with the findings on opportunities and challenges of visually communicating SLR to a non-expert audience described in existing literature. In this chapter, I compare the similarities and differences with previous research.

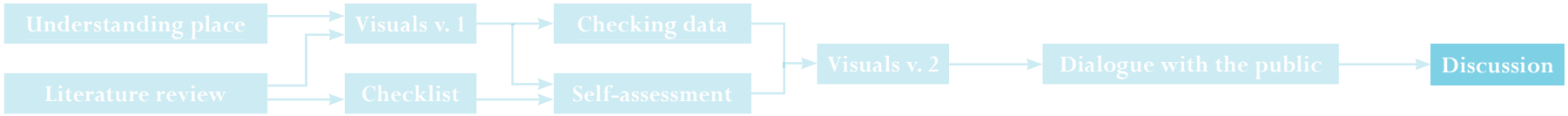
The chapter follows the structure of my work process, first discussing the visualization process and end result. This is followed by an assessment of the research design and reflections on the participants' comments on SLR and climate change adaptation. Finally, I conclude with a summary of the project and further research potential.



On visualizing sea level rise

This study showed the potential of visual communication, as well as the challenges and responsibility in visualizing possible futures. Based on this case study, the advantages of visualization in engaging in conversation about climate adaptation became obvious. My findings supported those of Gammelgaard (2018), Nicholson-Cole (2005), and Sheppard et al. (2008, 2011) in showing how images can help lay people engage with future landscapes impacted by climate change. This was evident from the words the participants used to describe their impressions, often wording it with terms related to seeing or showing, as well as adjectives such as "clear", "real" and "concrete". This aligns with Gammelgaard's (2018) and Nicholson-Cole's (2005) findings that images can concretize abstract or complex aspects of SLR. Also, as Sheppard et al. (2008, 2011) and Plate et al. (2020) argue, showing SLR impact on local level proved to be effective. Although the focus group in this study was small, Kalmar residents or visitors with strong ties to the place both showed the strongest emotional response and were most eager to engage in discussion about SLR. This supports the notion that seeing how familiar, everyday places might be affected, adds to the sense of urgency around climate change.

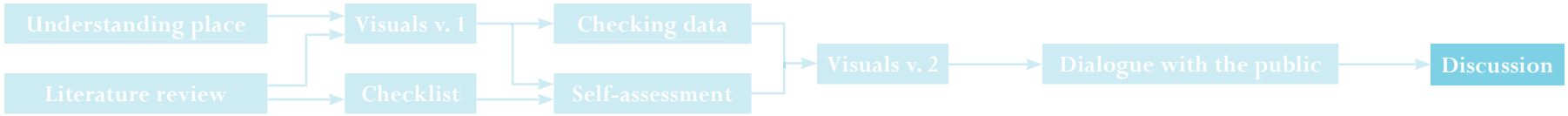
As described previously, there is a huge uncertainty around SLR and how it will affect coastal communities in the future. This uncertainty is a challenge both for the maker of the visualization as well as the viewer. Sheppard (2012) recommends showing multiple scenarios to convey this. However, during my interactions with the participants, many wished to know which scenario was "the most likely" or "correct" one when explaining the uncertain nature of climate data. Similar findings by Sheppard et al. (2011) and Nicholson-Cole (2005) indicate that uncertainty is difficult to accept. All material shown in Konstkiosk during this weekend, including my visualizations, were based on the high-emission SSP5 scenario. This is considered by some scholars an unlikely outcome (Riahi et al., 2017). While some participants questioned the validity of this scenario either based on experience or personal perception of climate change, the vast majority seemed to accept the illustrated data without any explicit criticism. Although it could be argued that the scenario shows an entirely possible (if improbable) future, there are some ethical concerns with motivating the choice with dramatic purposes alone. Thus, the balance of producing an attention grabbing film while staying truthful to the complexity of the source data is a challenging one to achieve. Although I clearly stated my student status to the participants, there seemed to be a high level of trust in the material I had produced, further emphasizing the importance of transparency in all visual communication. Prior to the field study, I chose to complement the film with written background information and explanatory maps. The benefit of using multiple visual methods backed up by text was also recommended in existing research (Nicholson-Cole, 2005). However, observing how the visitors engaged with maps and still images in the exhibition, I could quickly establish that these methods weren't successful in holding the viewers' attention for more than a few seconds unless participants were invited to look at them. Instead, the narrative and background should ideally be incorporated in the film itself.



Previous research on using visualization in climate communication has found evoking emotional response as one of the biggest strengths of the method. Sheppard et al. (2008) use the term "permissible drama" to describe captivating images with a solid base in scientific data. At the same time, researchers advise against using imagery that is too frightening (Nicholson-Cole, 2005; Sheppard et al., 2008). The maker of the visuals should therefore attempt to estimate viewers' reactions. As the exhibition showed, the animation did bring up feelings, with some viewers visibly concerned by what they saw while others seemed relatively unaffected. As discussed previously, "lay audience" is a diverse group and individual responses to the images are likely to vary. The balance of permissible drama and avoiding triggering distressing emotions is difficult to reach. This was particularly relevant to the storm scene where some visitors saw it as scary, some over-the-top, while others thought it seemed entirely plausible, even benign. Sheppard et al. (2008) report similar findings where illustrating peak events often didn't cross the line to overly dramatic. Although using exaggerated soundscape and visual expression divided opinions, conveying experience through creative interpretation of the source data, could have contributed to its effectiveness, as Galafassi et al. (2018) and Hahn & Berkers (2021) suggest.

What's more, many viewers expressed sorrow over the lost landscape while possible future affordances of the new landscape remained invisible to most. Perhaps the imagery showing traces of the old landscape, such as dead tree trunks, which were included for visual continuity, added unnecessary symbolism of loss and death. On the other hand, as Elina Erikson argues in a podcast episode about storytelling and visioning green futures, climate change and its impacts are likely to evoke complicated feelings. Shying away from these emotions could be counterproductive in adapting to a new reality (Kornfeldt & Abrahamsson, 2022).

Based on the findings from this case study, visualizations have a lot of potential in SLR communication. However, the images could be greatly enhanced through collaborative, multidisciplinary review as well as participation from the affected community. This might also help counter many of the challenges described above through fine-tuning the visualization according to feedback. As Sheppard (2012) argues, visual literacy is a skill gained through practice and experience. By actively engaging with communities impacted by SLR, landscape professionals could have a central role in establishing a collaboration between scientific community and lay audience.

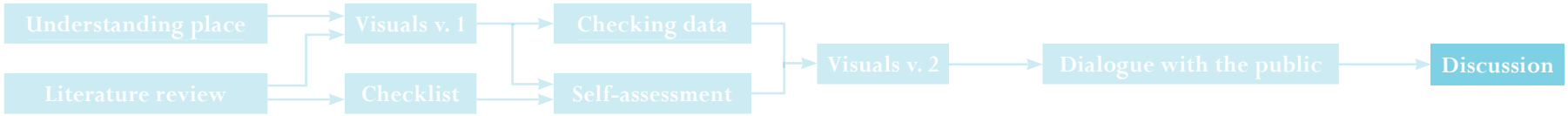


On research design

The method and context chosen for testing the visualization in public were discussed on pages 54-55. Although the selection of the focus group was seemingly random with passers-by invited to participate, there were several factors affecting the make-up of the group. Notably, the timing of the exhibition on a sunny weekend in July probably resulted in the large number of tourists visiting Konstkiosk. This allowed me to compare the responses between locals and non-locals and observe evidence on the role of place attachment in responding to climate change visuals reported by other researchers (e.g., Nicholson-Cole, 2005; Scannell & Gifford, 2013). However, as the longest discussion and strongest reactions came from those with a personal relationship with the city, focusing on the local community could be motivated in further research. A more selective recruitment of participants might have given an opportunity to gain deeper insight into how the projected changes in the landscape are seen by the community, as well as receive more specific feedback on the content of the animation. According to Nicholson-Cole (2005), visual conception of climate change is affected by several factors, such as personal experience, life stage, educational background as well as individual psychology. Therefore, further research through narrowing the focus group could examine these factors in more detail. Despite the small size of my study, the observations I made indicate that young people and children seemed particularly receptive to animation as a communication method. Based on these findings, a continued dialogue could be directed towards this age group.

As described on page 54, the prepared interviews turned into more informal led conversations once on site due to practicalities. Starrin & Renck (1996) recommend qualitative interviewing as a data collection method due to its adaptability. The interview guide is supposed to evolve during the process according to the input from participants. As the research was done within a limited timeframe, the interview guide couldn't be tested prior to the exhibition, so it had to be adapted quickly during the days. In the end, the most relevant questions from the original interview guide turned out to be those related to feelings and thoughts evoked by the film. While the relatively low pressure of shorter conversations increased the number of people participating, it limited the depth of knowledge I was able to access. Only occasionally some visitors stayed longer to chat about their relationship with Sylvanderparken and their memories of Kalmar. Although this could partly be due to the venue and interview situation, the heavy subject matter may have been a factor. Those most willing to share their views often had a personal interest in environmentalism which indicates that critical voices could be much harder to reach through this method.

The problems and limitations of using online surveys for data collection are evident from the low participation and high drop-out rate. Although there are limiting factors inherent to the method itself, some of the choices I made regarding the survey probably resulted in the lack of participation. For instance, I chose not to share the questionnaire beyond the QR codes placed in and around Sylvanderparken. Sharing the link through social media or email lists to local organizations could have resulted in more responses. However, the few completed questionnaires indicated similar results to the interviews, which suggests that the input gained through this method may not have led to new insights anyway. On the other hand, the online format



effectively removed the influence of the interviewer on the participant, giving more weight to the findings I gathered during in-person interviews. The age distribution and place of origin among the respondents followed that of the interviews. This method didn't allow me to reach a more varied group as I had hoped.

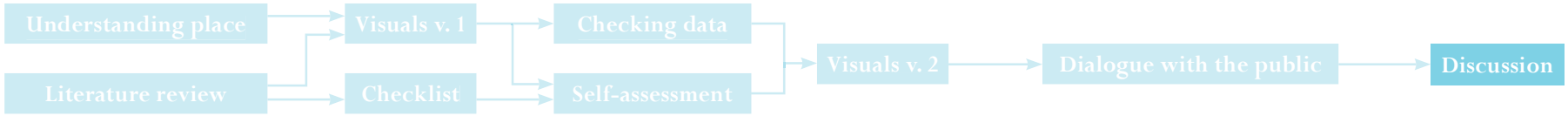
As the purpose of this case study was to test how visuals could be used for SLR communication, the context also informed the production of the images. A temporary exhibition favored a more attention-grabbing approach to the animation best suited for raising awareness rather than discussing the complexities of SLR and options in adaptation planning.

On sea level rise conversations

In addition to revealing opportunities and challenges related to using visualization in climate adaptation communication, the findings of this study also indicate wider challenges in initiating and implementing SLR adaptation strategies. As stated previously, potentially controversial strategies (managed retreat) or those with little to no real-life precedents (flexmark) would require wide public support to be successful. The slow on-set process of SLR combined with the relatively short urban planning horizon makes the planning of such strategies particularly challenging.

The results show that although there seems to be a general awareness of SLR as a phenomenon, it is mostly seen as a distant problem – either geographically or temporally. Most participants immediately dismissed it as personally irrelevant. This was often due to old age or place of residence ("we live at a height"). Some people simply didn't think SLR would affect the Nordic region. This supports research by Gammelgaard (2018) and Nicholson-Cole (2005) who found that even when exposed to locally relevant information, the personal risk of climate change was seen as low. The long time perspective contributed to the optimism bias, with a perception of abundant time to adapt to slow changes (Nicholson-Cole, 2005).

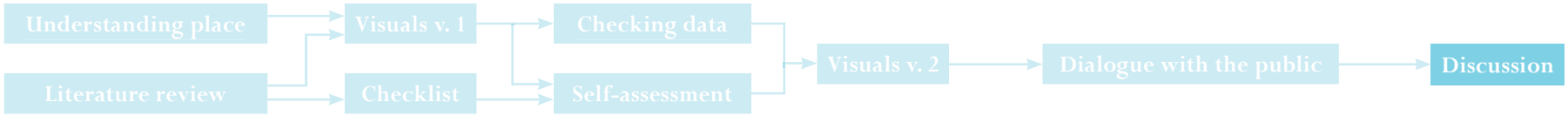
Many participants struggled to personally relate to the consequences of SLR. A long-time Kalmar resident expressed skepticism towards the SLR projections as they went against his own experience of Slottsfjärden becoming more shallow over time. Furthermore, most participants could only cite extreme weather as evidence of climate change in their living environment suggesting that slow processes, such as SLR, either haven't materialized yet or go unnoticed. This was also observed by Gammelgaard (2018) and Nicholson-Cole (2005), who argue that weather is often the most personally relevant impact as well as the easiest to relate to. Several scholars



have found that lived experience of climate change is an important factor impacting the salience of the issue. Those with direct experience report higher levels of concern but also more confidence in finding solutions and tend to associate climate change with less catastrophic imagery (Nicholson-Cole, 2005; Sheppard, 2015). My findings also indicate a correlation between higher engagement with the content of the animation and firsthand experience of flooding among the participants. Those who had witnessed flooding in their hometowns – not only in Kalmar but also in Gothenburg, Halmstad or Lidköping – seemed more convinced by the visuals and engaged in the conversation more readily. This affects the willingness to take action. Without personal relevance many simply distance themselves from proposed adaptation measures, dismissing them as irrelevant (Gammelgaard, 2018). These sentiments can be found in a paper by Göransson et al. (2023) where local decision-makers perceived the risk of SLR and flooding too low to justify managed retreat as an adaptation strategy.

The public perception of climate change as an apocalyptic global phenomenon seems to be deeply ingrained. This was also reflected in some participants' surprise at how modest the calculated extent of SLR was in the illustrated projection. A local woman doubted Kalmar will even exist in a hundred years "seeing how the world is going". No doubt reinforced by statements such as the quote on page 15, where SLR is described as an event of "biblical scale", it might be difficult to reconcile the relatively low local impact with this public perception. This could justify reframing SLR as not just an existential threat but also as an opportunity, as Wiberg (2018) suggests. Showing local, more short-term changes could help concretize the abstract global issue into more manageable local concerns that, when handled skillfully, might even add value to everyday environments.

The future of the park becoming a wetland was greeted with mixed response. The overwhelming majority saw the future wetland as an undesirable outcome for the place. Several participants suggested fortifying the shoreline, indicating that the faith in hard engineering solutions is still strong. This was reflected even in Swedish civil servants' attitudes where climate adaptation was mostly understood as protective structures (Göransson et al., 2023). So, although my animation included some possible affordances of the future landscape, the participants didn't see the benefits for themselves. This further confirms the necessity of including diverse voices in climate adaptation planning. These responses could also indicate that although working with natural dynamism of waterscapes is celebrated by many experts (Shannon, 2013; Wiberg, 2018), these attitudes are yet to reach the consciousness of lay audiences. I chose to show little visible human intervention in the changing park landscape, which might have contributed to people perceiving the retreat strategy as doing nothing. A further version of the animation could include more visible structures such as walkways in the wetland to suggest that although the park in its current physical form might be lost, recreational values could be adapted to the new reality.



Conclusion

This study set out to explore the potential of visualization both in illustrating complex environmental processes such as SLR, and how it could be used as a tool to facilitate dialogue. My research supports previous findings that illustrating climate change impact on a local level, tailored to the issues of the community is a powerful tool for communication. The animation I produced for this study was successful in engaging lay audiences in discussion on SLR in Kalmar. Its foremost advantages were perhaps in raising awareness on the local implications of SLR. This is, according to scholars, the first step in establishing a productive collaboration between stakeholders (Plate et al., 2020). The promising results of this small-scale study motivate further exploration into the subject.

However, this project also showed the challenges in illustrating climate futures from accommodating uncertainty to visualizing potential solutions. Many of the shortcomings of my visualization might have been compensated through producing images collaboratively, incorporating more elements to make this future seem less bleak. In its current version, the animation is my personal interpretation of how managed retreat or flexible land use strategy could look like in Sylvanderparken. The animation could be developed further based on the initial feedback, ideally in collaboration with the local community. However, the time-consuming process of animating could limit its usefulness in co-producing visualization. Still perspective views could be better suited for continued participatory visualization, where the use of AI tools could potentially facilitate collective image-making.

The research question was framed as communication between "expert" and "non-expert" audiences. The analysis of the discussions with the visitors revealed that there are some major differences in how landscapes facing SLR and the possible adaptation strategies are perceived by these groups. What landscape architects might call "affordances" in dynamic coastal landscapes were mostly invisible to the general public according to my findings. How much of this is due to the quality of the visualization and how much depends on public attitudes towards natural and urban environments, could be explored with further development of the images. The initial results of this small-scale study indicate that a wider shift in mindset is probably required to gain public support for solutions, such as managed retreat, that are radically different approaches to coastal management compared to the currently prevailing strategies of hard coastal engineering. As the scholars cited in this study argue, images have a power to reshape collective imaginations, evoke emotions, and imagine new solutions. Hence, visualization justifiably has a central role in visioning possible futures in transforming coastal communities.

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