



Progress in local climate change adaptation against sea level rise: A comparison of management planning between 2013 and 2022 of Swedish municipalities

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ABSTRACT

This paper uses content analysis of urban planning and guiding documents to research and evaluate relative adaptation approaches by categorising and comparing relevant indicators of progress. The scope of the paper is covering the 33 coastal municipalities that experience particularly exposure to negative consequences of climate change induced sea level rise. The findings indicate that the number of municipalities that address sea level rise has increased notably (~43%) based on planning documents during the past ten years (2013–2022), which supports international trends of increased attention to urban climate change adaptation. Furthermore, the content analysis qualitatively shows based on a newly developed categorization the large variation in planning documents used by municipalities in terms of purpose and approach. Lastly, a comparison of the municipalities indicates that, while there are notable differences in approach and progress, municipalities with established adaptation plans are similarly structured in terms of ambition and level of detail, and could be considered frontrunners in sea level rise adaptation work. Thus, paper provides - based on a replicable and innovative method - current comparative results about progress in latest practices of planning management, relevant as a potential benchmark and/or blueprint for similar adaptation measures of urban coastal communities worldwide.

1. Introduction

The effects of climate change are progressing rapidly, and are forced by anthropogenic emissions of greenhouse gases to the atmosphere. As a result, global mean sea levels are expected to increase with 0,43–0,84 m by the year 2100, relative to the turn of the millennium (IPCC, 2019). Although several mechanisms contribute to rising sea levels, the most prominent is the increasing temperatures of the oceans, leading to rising sea levels caused by both thermal expansion of water and from ice sheets melting in the polar regions (IPCC, 2019; Wright and Boorse, 2014). Furthermore, an observed increase in the speed of which sea levels are rising is cause for concern for inhabitants of coastal communities. Direct consequences from sea level rise (SLR) include flooding, erosion of coastal areas, damaged ecosystems and salt water intrusion (IPCC, 2019). While sea levels in Sweden on average have approximately followed the global average, regional differences occur. One prominent factor is that the northern parts of Sweden are still experiencing post-

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glacial rebound from the last ice-age, which means that the landmasses are rising as well as the sea level (SMHI, 2021). This effectively makes climate change adaptation to future SLR more of an imminent concern in the southern parts of the country than in the north. SLR adaptation approach and progress varies on global as well as regional scales. A recent study (McEvoy et al., 2021) shows that in Europe, 23 out of 32 countries with a maritime border have some form of planning for SLR, most of which are organised on a national level. There are however differences in approach to planning depending on structure of governance, as well as other factors. A more detailed analysis of countries (the Netherlands and England) or states (Schleswig-Holstein, Germany) that are considered frontrunners in the area due to a relatively long history of SLR adaptation, shows that formal planning of management and developing policy principles takes place on a national or federal level, while mapping and implementation processes are typically decided on a local level (Van den Hurk et al., 2022).

Local climate change adaptation planning in general varies greatly on an international level. A 2015 survey study including 350 municipalities across several continents show that attention to adaptation planning has increased rapidly in a short time (Aylett, 2015). Furthermore, the study found that while adaptation planning is increasingly implemented into local government planning, there are differences in how it is done. 28% of respondents stated that adaptation was addressed separately in a climate change adaptation plan, and 39% in a plan covering both adaptation and mitigation. Other common strategies were inclusion into sectoral or long range plans, and plans addressing sustainable development in general (Aylett, 2015). Other studies focusing on adaptation strategies in Europe have found that triggers for adaptation planning vary depending on geography and vulnerability, with coastal flooding being more of a prominent factor in northern Europe (Aguar et al., 2018). Heidrich et al. (2016) showed that only 23% of 200 surveyed European cities across eleven countries had developed adaptation strategies, though this frequency varied greatly between countries (Heidrich et al., 2016). Similarly, a broader survey of 885 European cities from all European Union member states showed that 26% had adaptation plans available, also with national variances. Of the thirteen Swedish cities included in the study, four (30.8%) had developed adaptation plans (Reckien et al., 2018). While covering the broader spectrum of climate change impacts, rather than only SLR, these numbers are in line with Aylett (2015). In the case of Sweden, while national policies on climate change adaptation are in place, municipalities are relatively autonomous and are required by law to manage, among other things, environmental- and health protection as well as planning of the built environment (SKR, 2021). Previous studies of municipal SLR adaptation work in Sweden has shown notable differences in terms of both approach and progress (Wedin, 2021; Von Oelreich et al., 2013).

1.1. Current state and challenges in Swedish and international climate change adaptation

Municipalities are important actors in local climate change adaptation, as they are responsible for physical planning, administering building permits, and environmental protection within their borders. In this role, they also have a responsibility to minimise risks to the inhabitants' health by preventing accidents from flooding and erosion, as dictated in the Swedish planning and building code (*Plan- och bygglag* (SFS 2010c:900), 2023). From a legal standpoint, municipal climate change adaptation work is mostly governed by the Swedish planning and building code, and the environmental code (*Nationella expertrådet för klimatanpassning*, 2022).

While municipal governance arguably is on the forefront of climate change adaptation to SLR in Sweden, recent studies indicate large discrepancies in terms of municipal progress (*Nationella expertrådet för klimatanpassning*, 2022; Wedin, 2021). The National expert council for climate change adaptation (*Nationella expertrådet för klimatanpassning*, 2022), points out that the present legal requirements of municipal climate change adaptation work to some extent fall outside of national and regional frameworks, as strategic approaches are focused on CABs and national agencies. Wedin (2021) argues that one of the reasons for the discrepancy in municipal climate change adaptation planning is that there are questions as to what the responsibilities of municipalities entails, again pointing to the legal frameworks. It is also noted that one of the reasons that some municipalities have developed specific climate change adaptation plans while others have not, is due to a limited knowledge of solutions, and how municipalities dispense their available working hours on the matter (Wedin, 2021).

As noted in the latest IPCC assessment report, local adaptation planning to climate change has progressed in the sense that more cities and settlements have developed adaptation plans since the last assessment report. It is however also noted that few of these plans have been implemented (Pörtner et al., 2022). As stated by Bednar-Friedl et al. (2022), there are knowledge gaps in terms of assessing available adaptation options related to coastal flooding in Europe, as current evaluations typically consider incremental adaptation measures rather than transformative ones such as planned relocation of settlements and changes in land-use. They also state that while adaptation planning in Europe is transitioning towards more adaptive strategies, traditional structural protection measures are still dominant, which may hinder future transformative planning. Furthermore, they find that planning instruments such as guidance documents, laws and policies are increasingly mainstreamed in terms of the impacts of climate change and what options are considered (Bednar-Friedl et al., 2022).

As adaptation planning is growing, research on plan quality as a field has increased as well. Guyadeen et al. (2019) defines plan quality as "a measure of the extent of the presence or absence of key components within a plan" (Guyadeen et al., 2019, p 122). Frameworks for plan quality assessments have evolved during the last decades but rely on identifying key characteristics when analysing the quality of plans. While initially focused on a set of core characteristics such as having a strong fact-base, clear goals and relevant policies, plan quality frameworks have expanded to include characteristics for social aspects such as justice and public participation, and for the implementation and reviewing processes (Guyadeen et al., 2019). When evaluating climate change plans, characteristics focusing on accounting for uncertainties has been suggested as another key factor, as the need for adaptive or iterative planning increases (Meerow and Woodruff, 2020). Recent studies using similar qualitative approaches in assessing adaptation plans on different scales have identified challenges to both planning and the method. Olazabal et al. (2019) measured adaptation progress in 136 of the world's

largest coastal cities using a method of identifying, characterising and analysing publicly available adaptation policy documents on national, regional and local scales. Using this method, the authors found notable differences in plans in terms of commitment, concreteness and implementation, which allowed for comparison (Olazabal et al., 2019). A similar approach was used by Olazabal and Ruiz De Gopegui (2021) in assessing the effectiveness of 59 adaptation-related plans in large coastal cities by identifying comparable indicators relating to credibility and legitimacy. The findings in these studies indicates that there are large differences in planning policy and progress globally (Olazabal et al., 2019) and that there is much room for improvement current adaptation planning in terms of effectiveness (Olazabal and Ruiz De Gopegui, 2021). There are however limitations and challenges to these methods as well. Most prominently, there is generally a lack of implementation of actions suggested in plans and policies, which makes the effectiveness difficult to measure (Olazabal and Ruiz De Gopegui, 2021; Olazabal et al., 2019). Secondly, there is still a need for systems for monitoring and following up policy practices to be implemented, although recent studies proposals for such systems are increasingly prominent in adaptation plans (Olazabal et al., 2019).

1.2. Research questions and purpose

The aim of this paper is to attempt to identify and compare the progress of climate change adaptation to future sea level rise on a municipal level in Sweden and identify similarities or differences in an international context. Previous studies have highlighted a lack of coherent principal guidelines and directives in Sweden (Wedin, 2021), and interview studies with municipal representative's express similar sentiments (Von Oelreich et al., 2013). Recent similar evaluations are primarily based on non-mandatory questionnaires (Nationella expertrådet för klimatanpassning, 2022), and thus rely on self-reporting from the municipalities. To the extent of the authors' knowledge, no attempt to evaluate SLR adaptation through content analysis of municipal planning documents has previously been made. Since municipalities are on the frontline of SLR adaptation in Sweden, an analysis of their intentions and strategies as stated in public documents could prove to be an additional instrument in determining progress.

The research questions are:

1. How have Swedish municipalities progressed in their adaptation work regarding SLR when compared to a 2013 baseline?
2. How do municipalities approach climate change adaptation to SLR in planning documents, and what differences can be identified?
3. How do municipalities compare in terms of relative effort or progress based on documented adaptation work?

The paper consists of four further sections. The research methods and selection of scope are explained in section 2, followed by the results of the analysis in section 3, a discussion of the results in a broader context in section 4, and ending with concluding remarks in section 5.

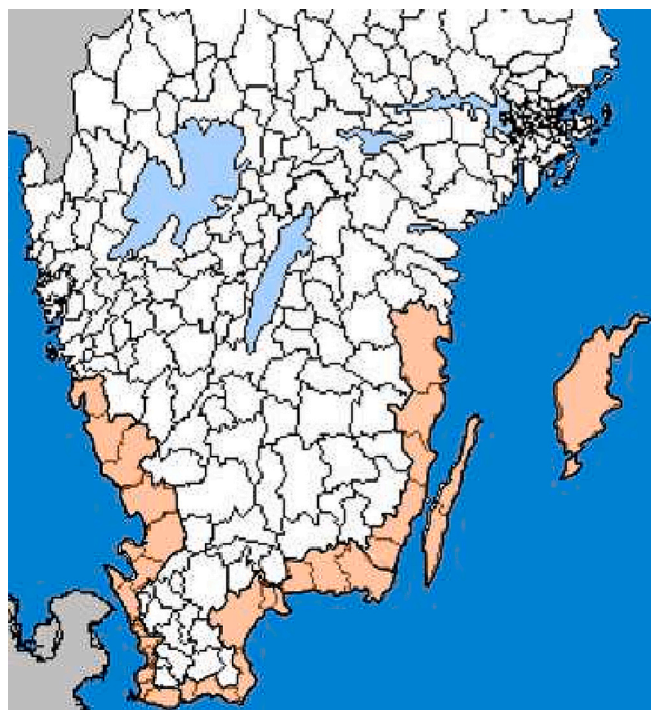


Fig. 1. Outline of the 33 municipalities included in the study. Image source: modified from Fred (2005) Creative Commons BY-SA 2.5.

2. Data and methods

The paper is primarily based on a literature review and content analysis of municipal guiding documents regarding future sea level rise. The approach used in this paper is based on how climate change adaptation towards SLR is expressed in official municipal guiding plans and reports, and builds upon the method used in [Von Oelreich et al. \(2013\)](#), in which ten of the 33 municipalities surveyed lacked any guiding documents for sea level rise. This study uses the same municipalities as research subject in order to identify progress accurately. Furthermore, a content analysis on municipal planning documents is carried out to identify potential differences in the respective municipalities' approach and progress. Lastly, an attempt to measure and compare the progress of the municipalities is made by categorising the documents included in the paper.

2.1. Selection of geographical scope and data

The method for selecting municipalities was adopted from [Von Oelreich et al. \(2013\)](#), in which only the 33 Swedish coastal municipalities that experience 1 mm or less postglacial uplift per year were included ([Figs. 1 and 2](#)).

This selection is necessary for the first research question, as it is a direct comparison. The same choice was made for the second and third research questions, based on the same principle that these municipalities are particularly exposed to SLR due to minimal post-glacial rebound.

The method for finding data draws upon methods used in similar recent studies ([Aguar et al., 2018](#); [Reckien et al., 2018](#)), in which public planning documents and policies were gathered from the websites of the selected municipalities. A survey was made of the websites of the 33 included municipalities in order to identify documents relevant for the study. Documents that after screening were found to be relevant for the study were chosen on the criteria that they did not predate 2010 as these were either included in [Von Oelreich et al. \(2013\)](#) or no longer in effect, and that they include some form of consideration to future sea level rise. Typically, the selected documents included comprehensive plans, as they are required to be provided publicly by Swedish municipalities, but also other guiding or strategic documents, reports or other plans that met the criteria. Ultimately, 77 documents were included in the study.



Fig. 2. Position of researched area (black rectangle) within Sweden and Europe. Image source: modified from [Google \(2023\)](#).

2.2. Method for content analysis, comparison and categorization

The method for analysing, categorising and comparing the data and findings are addressed in this section (Fig. 3).

All identified documents were first analysed in order to identify the primary indicators that allowed for a comparison with the results from the 2013 baseline study. The two criteria were:

- 1) Municipal guiding documents or plans that address future SLR.
- 2) Documents that provide estimates on future local levels of SLR.

The second part of the analysis was made to identify similarity and differences in the approach to climate change adaptation and SLR. As the included documents varied significantly in regards to purpose and attention to SLR, a first step was to categorise and interpret mentions of climate change adaptation in regards to SLR and identify indicators of progress or engagement. This was done by first categorising the documents based on type and/or purpose similar to the method used in Reckien et al. (2018), but modified for the purpose of this study with further distinction between adaptation and mitigation plans. In total, seven categories were established and a database in which the different documents were categorised based on content relevance was created (Fig. 4).

Depending on the category, different indicators were then identified to allow for a fair comparison between the municipal documents. Several studies provide guidelines and frameworks for suitable indicators (Guyadeen et al., 2019; Aguiar et al., 2018), but as the indicators used in this study have to be different depending on document category, and specifically targeting SLR, they are not identical to previous research.

For documents that were primarily focused on climate change adaptation measures (*Climate change adaptation plans* and *Adaptation plans specifically aimed at SLR*), comparative indicators were: Type of measures (informative, research-related, physical) and level of detail for implementation (time, priority, costs consideration, assigned responsibility).

Documents in the category of *sea-, coast- or water management* in broader terms were compared based on: Consideration for SLR adaptation; whether suggestions of adaptation measures were specific in terms of consideration for measure and area, or more a general suggestion; level of detail for implementations suggested (time, cost, assigned responsibility).

The categories consisting of *thematic additions to comprehensive plans*, and *general plans and PMs* were compared on more general terms as their purposes were more varied than previous categories. The indicators compared were: Expressed consideration for SLR in general; expressed consideration for adaptation measures related to SLR; suggested adaptation measures; and whether a need for the

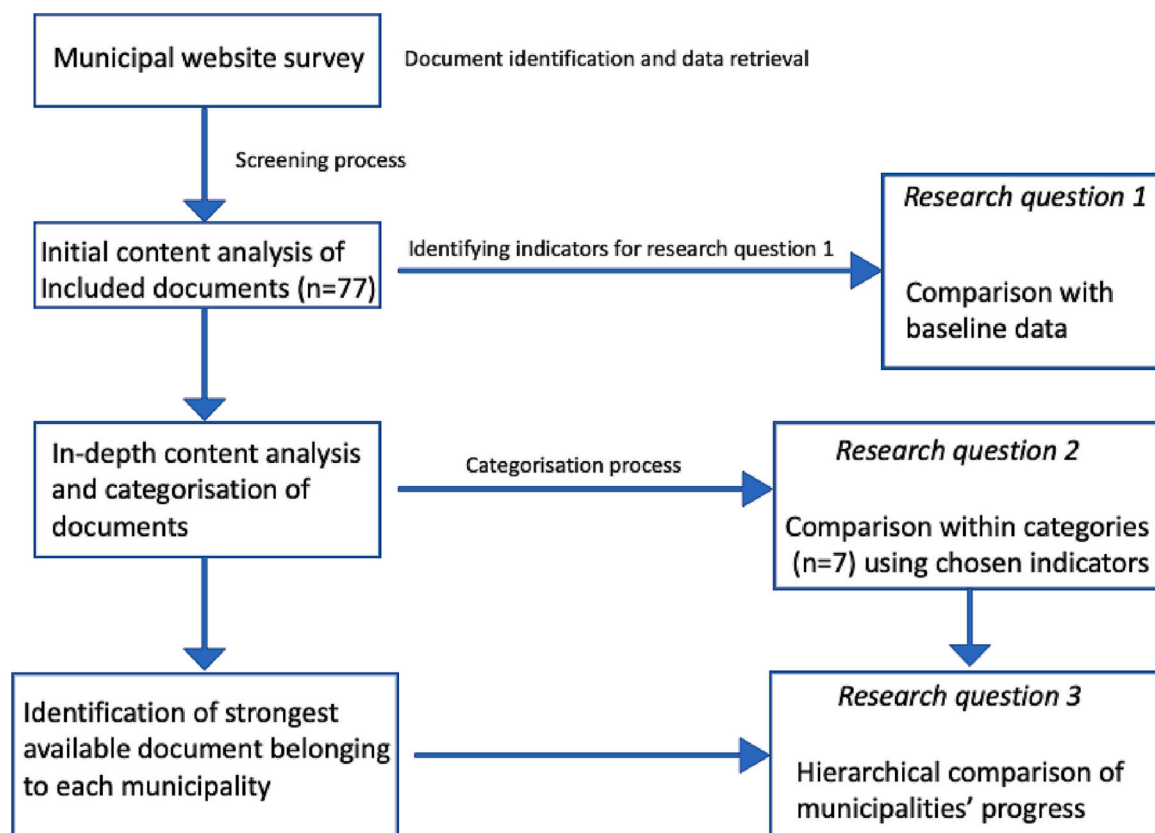


Fig. 3. Schematic of the methodological approach.

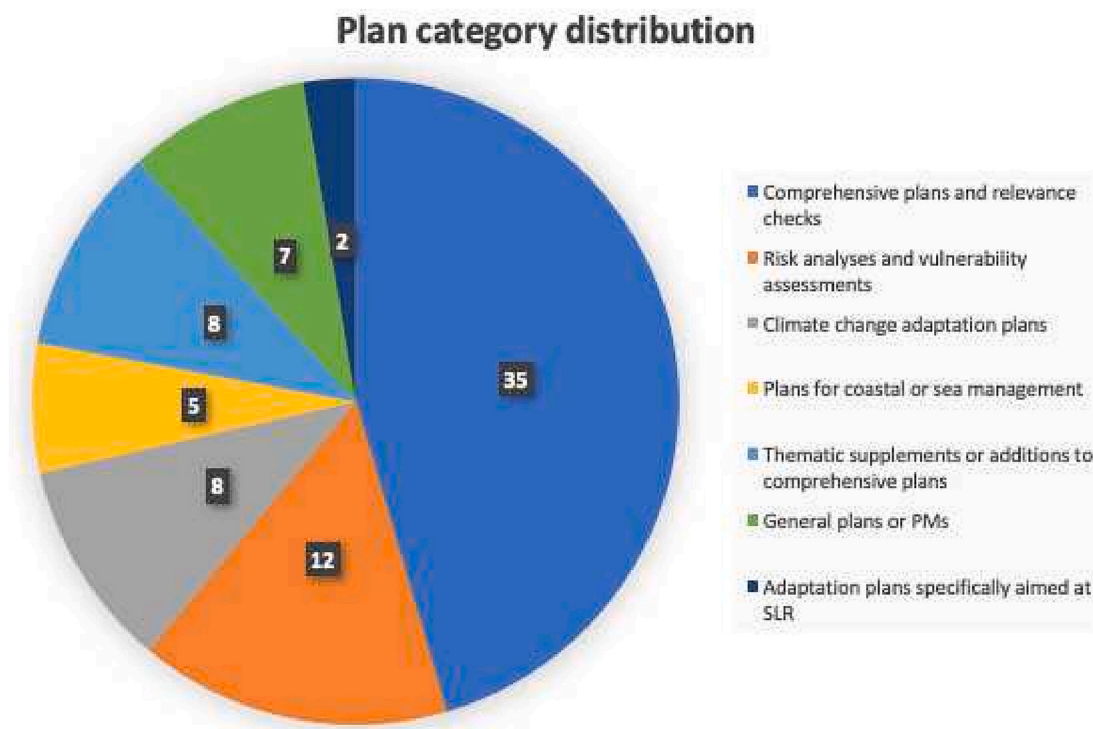


Fig. 4. Number and type of plans included in the study.

development of strategies or plans for climate change adaptation were expressed.

The categories consisting of *risk- or vulnerability assessments* were compared on indicators expressing: Whether consequences of SLR were assessed in general or in detail; and whether adaptation measures were suggested in general or in detail.

Lastly, as *comprehensive plans* are required guiding documents for municipalities and are supposed to cover all municipal interests and responsibilities, this category was used only for those municipalities to which no other relevant plans were found. The identified indicators used for comparison were: Whether climate change was addressed; whether SLR was addressed; whether the need for climate change adaptation to SLR was expressed; and whether any adaptation measures were suggested.

The last step used for comparing relative progress or effort was determined using the results from the content analysis. A hierarchical comparison was conceptualised based on the relevant and comparable indicators identified in each category. For this comparison, only categories in which the purposes of the different documents were similar were included, as categories in which the types of documents had different functions (e.g. the General plans and PMs category), the emphasis on SLR were too varied. The resulting comparisons include the categories for Climate change adaptation plans, Coastal-, sea- or water plans, and comprehensive plans.

Lastly, an overall comparison of all municipalities was created based solely on four levels of progress in their respective adaptation work. This overall comparison only includes the “strongest” document found for each municipality, and does therefore not consider multiple documents for any municipality.

3. Findings

The contents of the following subsections show the results of the study in relation to all three research questions respectively.

3.1. Municipal climate change adaptation to SLR in 2022

The present study finds that 30 of the 33 surveyed municipalities provide estimates for local SLR in official documents. Of these 30, 29 municipalities provide estimates in guiding documents (comprehensive plans, climate change adaptation plans etc.), while one municipality provide this information based on a report from an external company.

The results show that only three of the surveyed municipalities fail to provide estimates for future SLR in their guiding documents. The survey also found that 15 of the 33 municipalities had at least two documents within the selected timeframe in which estimates of local SLR were provided. Furthermore, it could be noted that the three municipalities from whom no estimates of future SLR could be found, all mention the need to consider the effects of climate change-induced SLR in the future, in their current comprehensive plans (Bromölla kommun, 2014; Münsterås kommun, 2012; Torsås kommun, 2010).

The main criteria determined by Von Oelreich et al. (2013), whether the municipalities addressed future SLR in their planning

documents, and if so, what levels of SLR were estimated, was replicated for this comparison. A direct comparison of the current situation and the findings in [Von Oelreich et al. \(2013\)](#), gives an indication on how this has changed over time ([Table 1](#)).

The result of the comparison shows that all 33 of the surveyed municipalities have planning documents that to some degree address climate change-induced SLR. This is a noticeable increase of 43.5% compared to the 2013 baseline study, in which this information was found in only 23 of the municipalities. Similarly, the 2013 study showed that only 19 of the municipalities provided information on local estimations of SLR, whereas the present study shows that this number has increased to 30, which is an increase of 58%.

3.2. Progress on municipal level

The results of the content analysis indicate that there are differences in both approach and progress between the 33 municipalities. By listing the number and type of documents found to be used as guidelines by the municipalities, a comparison can be made. The number of guiding documents identified per municipality range from one to six. It should be noted that preliminary documents that were available, but not yet approved by a municipal board, are not included in this comparison.

A total of 77 documents across the 33 municipalities were identified during the survey which contained information on future SLR. The main guiding documents found were comprehensive plans including relevance checks (35), thematic additions to comprehensive plans (8), climate change adaptation plans (8), coastal, sea or water management plans (5), general plans, strategies or PMs (7), risk or vulnerability analyses or climate related assessments from external consultancy firms (12), and two (2) plans specifically targeting SLR adaptation.

Seven type of categories could be identified from the analysis, and are determined as follows:

- 1) “Climate change adaptation plan” is considered a guiding document specifically aimed at adaptation rather than mitigation.
- 2) “Adaptation plans specifically aimed at SLR” are plans that solely focuses on SLR adaptation.
- 3) “Plans for coastal or sea management” are guiding documents specifically aimed at a municipality’s coastal or sea-area. These are either municipality-specific or in the case of Karlskrona, Karlshamn, Ronneby and Sölvesborg, a shared document.
- 4) “General plans and PMs”, contain plans or analyses on climate change or sustainability, or thematic PMs used as guiding documents.

Table 1

Comparison of estimates for local future SLR from 2013 and 2022 respectively.

Municipality	Local SLR from Von Oelreich et al. (2013)	Local SLR present study (most recent estimates found)
Falkenberg	#	0,8 m (2021)
Halmstad	“about 1 m”	0,89 m (2021)
Kungsbacka	0,8 m	“likely up to 1 m” (2018)
Laholm	*	Approx. 1 m (2015)
Varberg	0,4-1 m	0,64 m (2020)
Ängelholm	*	0,66 m (2019)
Båstad	0,22–0,66 m	0,8–1,0 m (2020)
Bromölla	*	#
Burlöv	*	1,0 m (2019)
Helsingborg	“about 1 m”	0,92 m (2019)
Höganäs	0,89 m	0,85 m (2019) or 1,0 m (2019)
Kävlinge	0,7 m	Approx. 0,7 m (2010)
Kristianstad	0,8 m	0,98 m (2019)
Landskrona	“about 1 m”	0,97 m (2015)
Lomma	0,66 m	0,66 m (2011)
Malmö	0,22–0,66 m	0,9 m (2018)
Simrishamn	#	Approx. 1 m
		1,15 m also mentioned (2017)
Skurup	*	0,78 m or 0,57–1,02 m (2019)
Trelleborg	0,32-0,92	0,79 m or 0,58–0,03 m (2020)
Vellinge	“about 1 m”	0,7 m-1,0 m (2022)
Ystad	0,32–0,92 m	0,9 m (2018)
Karlshamn	*	0,3-1,3 m (2019)
Karlskrona	#	0,8 m (2020)
Ronneby	0,32–0,92 m	0,3–1,3 m (2019)
Sölvesborg	0,22–0,9 m	0,3–1,3 m (2019)
Borgholm	0,2–1,2 m	1,2 m (2018)
Kalmar	*	0,9-1,1 m (2021)
Mönsterås	#	#
Mörbylånga	*	Approx. 1 m (2022)
Oskarshamn	*	Approx. 1 m (2014)
Torsås	*	#
Västervik	0,2-1,3 m	“up to 1 m” (2014)
Gotland	0,1–0,6 m	0,1–0,6 m (2010)

* No documents addressing future SLR were identified.

Document(s) were identified, but no estimate of future local SLR was found.

- 5) “Thematic supplements or additions to comprehensive plans”, contain separate additions to existing or co-developed comprehensive plans, focusing on specific areas or themes.
- 6) “Risk analyses and vulnerability assessments” include both internally developed reports and those credited to external companies where relevant.
- 7) “Comprehensive plans” include the legally required comprehensive plan, but also include relevance checks of-, or changes to the plan currently in use if discussions on SLR are present.

The results show that apart from the mandatory comprehensive plans, documents related to risk and vulnerability assessments are most frequent, followed by thematic supplements to comprehensive plans or coastal or sea plans. Eight of the 33 municipalities (24%) have established a climate change adaptation plan. General plans or PMs are found in seven instances, and two plans specifically addressing SLR adaptation were identified in the survey. While the number of documents addressing future SLR per municipality may indicate the relative progress made on the subject, it is important to remember that different municipalities have different geographical conditions to factor in, and that SLR therefore may be of less immediate concern to some than to others. Furthermore, it could be noted that no municipality were found to have documents belonging in every category.

Considering the contents of the documents, the results vary from single mentions of future need for adaptation, to fully developed plans containing details on timeframes and cost. Using the predetermined categories which are focused on specific levels of engagement, comparisons within the categories are presented in this section. Indicators used for the different categories were chosen based on purpose of the document (Table 2).

3.2.1. Climate change adaptation plans

Eight of the 33 studied municipalities have a climate change adaptation plan (CCAP) in effect as of this study: Laholms kommun (2015); Sölvesborgs kommun (2016); Kristianstads kommun (2018); Trelleborgs kommun (2018); Karlskrona kommun (2020a); Falkenbergs kommun (2021); Kalmar kommun (2021) and Halmstads kommun (2021). While there are no set requirements on what a climate change adaptation plan should include, the structure and purpose found in the studied cases exhibits similar traits. All municipalities describe the purpose of the plan as identifying the local effects of climate change, and the adaptation measures best suited

Table 2
Overview of the municipalities analysed in each category, and indicators used.

Category	Municipalities	Indicators used for comparison
Climate change adaptation plans	Halmstad, Falkenberg, Laholm, Kristianstad, Trelleborg, Karlskrona, Sölvesborg, Kalmar	<ul style="list-style-type: none"> • Types of adaptation measures suggested • Assigned responsibilities • Financial considerations • Timeframes established
Adaptation plans specifically aimed at SLR	Kristianstad, Vellinge	<ul style="list-style-type: none"> • Types of adaptation measures suggested • Assigned responsibilities • Financial considerations • Timeframes established
Plans for coastal- and sea management	Sölvesborg, Karlshamn, Ronneby, Karlskrona, Ystad, Burlöv, Lomma, Vellinge	<ul style="list-style-type: none"> • Adaptation measures suggested in general terms or specific • Assigned responsibilities • Financial considerations • Consideration of timeframes
Thematic supplements or additions to comprehensive plans	Landskrona, Västervik, Borgholm, Skurup, Mörbylånga, Malmö, Oskarshamn, Vellinge	<ul style="list-style-type: none"> • SLR Adaptation measures considered • SLR Adaptation measures suggested • Need for development of adaptation plans stated
General plans or PMs	Malmö, Simrishamn, Mörbylånga, Västervik, Helsingborg, Höganäs, Karlshamn	<ul style="list-style-type: none"> • SLR Adaptation measures considered • SLR Adaptation measures suggested • Need for development of adaptation plans stated
Risk analyses, consequence assessments and pilot studies	Kungsbacka, Borgholm, Båstad, Helsingborg, Kristianstad, Trelleborg, Mörbylånga, Varberg, Ängelholm, Båstad, Höganäs, Skurup	<ul style="list-style-type: none"> • Assessments limited to parts of the municipality or in general • Consequences of SLR assessed specifically, generally or not at all • Adaptation measures suggested in detail, generally or not at all
Comprehensive plans	Kävlinge, Torsås, Varberg, Ängelholm, Bromölla, Mönsterås, Gotland	<ul style="list-style-type: none"> • Climate change addressed • Consideration for SLR • Climate change adaptation addressed • Adaptation measures addressed

to avoid negative consequences. The analysis of the CCAPs shows that there are differences in some aspects that are independent of geographical situation. This analysis takes into consideration only information that is provided specifically in relation to adaptation measures, i.e. general mentions of possible measures are disregarded.

All surveyed plans include some form of suggested actions to specific areas. Types of adaptation measures range from informative guidelines such as lowest recommended floor level for new buildings (Laholms kommun, 2015; Sölvesborgs kommun, 2016; Karlskrona kommun, 2020a; Falkenbergs kommun, 2021; Kalmar kommun, 2021), to research-related measures such as identifying built environment that is susceptible to flooding along the coastline (Trelleborgs kommun, 2018), or carrying out risk analyses for specific areas (Kristianstads kommun, 2018; Halmstads kommun, 2021). Physical adaptation measures are mostly limited to the creation of local wetlands (Sölvesborgs kommun, 2016), or smaller flooding areas (Kalmar kommun, 2021) to limit the damages from flooding. Actions intended to reinforce stormwater systems to withstand intrusion from rising sea levels and flooding were also found (Laholms kommun, 2015; Trelleborgs kommun, 2018). Other physical measures are mentioned more generally and on a distant timescale, such as the measure to preserve cultural- and natural environments by moving valuable coastal zones (Sölvesborgs kommun, 2016).

In terms of assigned responsibility, this is considered and assigned for most adaptation measures in all eight CCAPs. Responsibilities are typically divided between several different divisions within different sectors in the municipality. A similar structure was found in the other CCAPs as well.

Regarding financial costs, only Falkenbergs kommun (2021) and Kristianstads kommun (2018) provide estimates in relation to specific adaptation measures in their respective CCAPs. Details on expected costs vary between adaptation measures, and some measures are yet to be calculated, but are a considered factor in the list of suggested adaptations. The remaining six municipalities discuss costs in general in their respective CCAPs, but provide no estimates.

All adaptation measures listed in the CCAPs are given a degree of priority or are set within a timeframe of sorts. Three municipalities mention that the adaptation measures are intended to be carried out or initiated within a three to six-year frame (Trelleborgs kommun, 2018; Falkenbergs kommun, 2021; Kalmar kommun, 2021). Four municipalities (Laholms kommun, 2015; Sölvesborgs kommun, 2016; Kristianstads kommun, 2018; Karlskrona kommun, 2020b) have established priority orders in direct relation to each specific adaptation measure. While still operating within set timeframes, measures are given individual priorities. Halmstads kommun (2021) list measures in a fixed order of priority.

The differences are mostly in regard to whether costs related to adaptation measures have been calculated or considered, or not. In this regard, only Falkenberg and Kristianstad appear to be further along the way. Kristianstad, along with Laholm, are also the only municipalities that explicitly include consideration for post-2100 scenarios in their respective lists of adaptations.

3.2.2. Adaptation plans specifically aimed at SLR

Two plans specifically directed at SLR adaptation were identified in the survey. The analysis indicators used are the same as for the climate change adaptation plans.

The main difference in regards to the CCAPs, is that the specific plans are primarily directed at physical adaptation measures. In both documents, the primary type of measures involves reinforcing or expanding existing levees, or planning for future establishment of such. The main difference found between the two documents is in the details of financing and time of implementation. Kristianstads kommun (2021) includes a detailed schedule on when measures are to be started, as well as an estimated cost. Vellinge kommun instead establish a list of priorities based on short-term, medium-term or long-term need (Vellinge kommun and SWECO Environment AB, 2011).

3.2.3. Plans for coastal or sea management

Eight municipalities have developed plans for coastal or sea management (CSP). As previously mentioned, four municipalities, Sölvesborg, Karlshamn, Ronneby and Karlskrona (Sölvesborgs kommun et al., 2019), have developed a shared plan for the sea, which is described as a change to the comprehensive plans of the respective municipalities. The remaining four are stand-alone plans (Ystads kommun, 2018; Burlövs kommun, 2019; Lomma kommun, 2019; Vellinge kommun, 2020).

Unlike climate change adaptation plans, the CSPs were found to be less homogenous in terms of both structure and content, which is likely due to the different purposes of the documents. For instance, the shared sea plan used by four municipalities, which constitutes a change to existing comprehensive plans of the respective municipalities, has a stated purpose of determining the municipal views on water use and identifying potential conflicts of interests between actors relevant to the sea area (Sölvesborgs kommun et al., 2019). Others, such as the water plan in Burlövs kommun (2019), has a stated purpose of identifying, and suggesting adaptation measures to, risks of flooding and other challenges. For this reason, the factors used for comparison are different than in previous categories. The main focus of the analysis in this case is whether SLR was addressed, if adaptation measures were suggested specifically or in more general terms, and whether responsibility, costs, and time for implementation were considered.

All CSPs identified are found to consider future SLR in the documents. The shared sea plan (Sölvesborgs kommun et al., 2019), however, limits the consideration to identifying certain risks, with no elaboration on adaptive measures. The stand-alone plans of the other four municipalities however, do suggest adaptation measures to varying degrees. Burlövs kommun (2019) provides detailed evaluations of different parts of the municipality, and in instances where SLR is identified as a challenge, specific adaptation measures are provided. An emphasis is placed on physical adaptation measures, but informative measures are suggested as well (Burlövs kommun, 2019). Lomma kommun (2019) provide a similar list on adaptive measures, although with a focus on informative and research-related measures. Vellinge kommun (2020) has a different approach, in which adaptation measures suggested are kept less specific. In turn, the document refers to the 2011 plan with a focus on developing protection against SLR (Vellinge kommun and SWECO Environment AB, 2011). The CSP provided by Ystads kommun (2018) contains adaptive measures to SLR in a structure similar

to those found in climate change adaptation plans. Adaptive measures listed in regards to SLR are mostly research-related, but informative and physical measures are included as well.

Regarding assigned responsibility, the CSPs from [Burlövs kommun \(2019\)](#) and [Lomma kommun \(2019\)](#) respectively, address the question of responsibility primarily on an overarching municipal level. [Burlövs kommun \(2019\)](#) however, specifies certain departments in several instances. The CSP belonging to [Lomma kommun \(2019\)](#) provides no information on which specific actors or departments within the municipality are tasked with carrying out suggested adaptation measures. Responsibility for the general adaptation measures suggested in [Vellinge kommun \(2020\)](#) is not listed. In the CSP developed by [Ystads kommun \(2018\)](#) responsible municipal divisions are assigned in the same format as in a CCAP, and cover most of the measures related to SLR.

Implementation costs in economic terms are estimated and reported in the CSPs available for [Burlövs kommun \(2019\)](#) and [Ystads kommun \(2018\)](#). In both cases, estimates are provided for some adaptive measures, whereas other measures are still unknown. No estimates of costs are provided for either [Lomma kommun \(2019\)](#) or [Vellinge kommun \(2020\)](#).

Regarding established time of implementation, [Burlövs kommun \(2019\)](#) and [Ystads kommun \(2018\)](#) provide systems of priority which are applied to each suggested adaptation measure. Considerations regarding SLR in the order of priority based on fixed time frames can be seen in the CSP for Burlöv, where some adaptation measures to SLR are “*less urgent, and have therefore been placed later in the order of priority.*” ([Burlövs kommun, 2019](#), p.20). The priority system used in [Ystads kommun \(2018\)](#) is instead an estimated time-plan for what year an adaptation measure is implemented or started. [Lomma kommun \(2019\)](#) reports a status for each adaptation measure in terms of “started” or “not yet started”, but provides no further estimates. The CSP of [Vellinge kommun \(2020\)](#) contains no priority system.

3.2.4. Thematic supplements or additions to comprehensive plans

Eight thematic supplements or additions to comprehensive plans relevant for SLR were identified as relevant in the survey. As comprehensive plans and thematic add-ons mainly are used as guiding documents, they do not provide detailed plans for adaptation measures. For this reason, they are instead analysed based on if and how adaptation measures are considered, and whether a need for specific plans for SLR adaptation is recognised.

The additions or thematic supplements to comprehensive plans vary greatly in terms of relevance for climate change adaptation, which is expected due to their different thematic purposes. [Landskrona stad \(2015\)](#) and [Västerviks kommun \(2014\)](#) for instance, are developed with climate change adaptation as a stated purpose, while others, such as [Borgholms kommun \(2018\)](#) are developed with a more general purpose of highlighting development plans for a specific part of the municipality. Thus, direct comparisons are difficult to weigh. Nevertheless, SLR is discussed as a stand-alone segment in each report, and future estimates are provided. All documents discuss the need for adaptation measures in general, with the exception being [Skurups kommun \(2010\)](#), which does not address adaptation measures at all beyond precaution when planning. Neither of the studied documents suggest any specific measures other than a recommended lowest level for buildings. General information on potential measures are mentioned in some documents and [Mörbylånga kommun \(2022\)](#) provides risk assessments for flooding in general for specific areas, and some suggested measures, but none that are directly related to SLR. Similarly, [Malmö stad \(2018\)](#) addresses the need for protective barriers, but states that several investigations need to take place prior to implementation.

The need to develop specific plans for climate change adaptation is expressed in six of the eight thematic plans. It is for instance stated in [Oskarshamns kommun \(2014\)](#) that the municipality should “*devise a climate change adaptation plan with the purpose of analysing the consequences of climate change in regards to flooding, rising temperatures, intense heatwaves, freshwater supply etc.*” ([Oskarshamns kommun, 2014](#), p.79). Similar statements are found in [Västerviks kommun \(2014\)](#) and [Landskrona stad \(2015\)](#). [Vellinge kommun \(2021\)](#) instead refers to the municipality’s adaptation plan for SLR.

3.2.5. General plans or PMs

Seven general plans or PMs were identified in the survey. Four are general plans or analyses regarding climate change or sustainability, and three are Climate PMs. While the purposes of the documents vary, one common denominator is that they are all addressing the challenges related to SLR in some form. As with the thematic supplements to comprehensive plans, they are analysed based on if and how adaptation measures are considered, and whether specific plans for SLR adaptation are recognised. The results are presented in groups based on type of document.

All four of the general plans or analyses identified recognise SLR as a challenge. The documents also contain consideration for adaptation measures, but only in [Malmö stad \(2021\)](#) are specific measures addressed together with a time plan and a department in charge. It should be mentioned that these measures are administrative, and not as detailed as in CCAPs. The need for more research or development of adaptation plans are mentioned in all four documents to some degree, most notably in [Simrishamns kommun \(2021\)](#), in which the development of a climate change adaptation plan is explicitly mentioned as a priority. In the case of [Mörbylånga kommun \(2017\)](#) and [Västerviks kommun \(2021\)](#), there are instead ambitions stated that planning documents on the subject needs to be either developed or improved.

Regarding the three Climate PMs identified in the survey, [Helsingborgs stad \(2012\)](#) and [Höganäs kommun \(2012\)](#) cover the municipalities in their entirety and have a clear focus on climate change adaptation. Karlshamns Climate PM ([Sweco environment AB, 2018](#)) is an addition to a detail plan for a specific area of the municipality, and SLR is only discussed briefly along with recommendations for lowest building levels. Both [Helsingborgs stad \(2012\)](#) and [Höganäs kommun \(2012\)](#) provide in-depth information on the expected consequences of SLR, and provide an overview of adaptation measures that will be considered. [Helsingborgs stad \(2012\)](#) in particular provides an estimated time table for when certain general measures need to be taken into effect. It should be said that measures and time frames mentioned are more general and not as specific as those found in CCAPs. A need for the development of plans

are mentioned by both [Helsingborgs stad \(2012\)](#) and [Höganäs kommun \(2012\)](#).

3.2.6. Risk analyses, consequence assessments and pilot studies

The twelve documents included in this category are mostly, but not exclusively carried out by consultancy firms on the behalf of municipalities. Two documents are general risk or vulnerability assessments, five are assessments for climate change adaptation strategies, and five are assessments of consequences of SLR or specific effects of SLR. The analysis is based on the following criteria:

- 1) Whether the assessments are limited to specific parts of the municipalities or not;
- 2) Whether consequences related to future SLR are assessed specifically, in general, or not, and;
- 3) Whether adaptation measures are suggested in detail, in general or not.

It should be noted that suggested adaptation measures in documents from consultancy firms are generally suggestions to the municipality, as opposed to previous categories where measures were identified and considered by municipalities.

The subcategory containing risk and vulnerability assessments concern Kungsbacka and Borgholm municipalities. [Kungsbacka kommun \(2018\)](#), contains a general assessment on the impacts of future climate change in the municipality, including SLR, and consequences are discussed in general terms. No specific adaptation measures are suggested, although a need for consideration is mentioned. The document regarding Borgholm is an external assessment carried out by [DHI \(2014\)](#), and specifically focuses on consequences from SLR for two communities within the municipality. Consequences are assessed in detail, although suggested adaptation measures are discussed in more general terms.

All five climate change adaptation strategies are carried out by consultancy firms, and serve as a research basis for further planning in each municipality. All documents included focus on consequences and adaptation measures towards SLR, and all are limited to specific coastal areas. All documents provide details on consequences for the specific areas, while cost estimates for consequences of flooding are included only in the case of Helsingborg ([WSP Samhällsbyggnad, 2019](#)). Suggested adaptation measures are found to be quite specific in all documents, with details on financial costs being prevalent for Helsingborg ([WSP Samhällsbyggnad, 2019](#)) and Mörbylånga ([Ramböll Sverige AB, 2016](#)). Specific recommendations on adaptation measures are found for Helsingborg ([WSP Samhällsbyggnad, 2019](#)), Kristianstad ([DHI, 2018](#)), Mörbylånga ([Ramböll Sverige AB, 2016](#)) and Trelleborg ([Sweco environment AB, 2020a](#)), while recommendations mentioned for Båstad ([Sweco environment AB, 2019a](#)) are more general.

The documents in the category for assessments of SLR contain various areas of focus, and are designed for different purposes by consultancy firms. The documents for Höganäs ([Sweco environment AB, 2017a](#)) and Skurup ([Sweco environment AB, 2019b](#)) are carried out with the aim of establishing coastal management strategies for the municipalities. Both documents contain considerations for consequences of SLR for specific areas, and provide suggestions and timelines for adaptation measures. The other three documents are specifically focused on wave-run-up and SLR in Ängelholm ([Sweco environment AB, 2019c](#)), erosion in Båstad ([Sweco environment AB, 2017b](#)) and flooding in Varberg ([Sweco environment AB, 2020b](#)). The three documents all provide assessments of consequences, but are limited to the area of focus of each report. Adaptation measures are suggested in some detail for Båstad and Varberg, but more general in terms of location for Ängelholm.

With few exceptions, adaptation measures in this category are suggested in detail for documents that focus primarily on specific areas and conditions, which can be expected as they are in large carried out by external companies and are therefore not necessarily to be considered in official municipal planning.

3.2.7. Comprehensive plans

For this comparison, only comprehensive plans from municipalities where no other plans were found are included, as separate plans typically supersede or function as additions to the comprehensive plan. Municipalities where the only other documents found in the survey were external reports, are also included. In total, seven comprehensive plans are included in this category.

Analysis for this category is based on:

- 1) Whether climate change is addressed as a separate section or subsection in the comprehensive plan, mentioned in passing, or not at all;
- 2) Whether consideration for future sea level rise is addressed in any form;
- 3) Whether climate change adaptation is addressed as a separate section, mentioned in passing, or not at all;
- 4) Whether general adaptation measures are discussed or not.

Six of the seven comprehensive plans analysed contain chapters or subchapters labelled climate change, in which the concept is described, along with consideration for future SLR. The main differences are found in regards to an expressed need for climate change adaptation, which in three cases are addressed under specific sections ([Kävlinge kommun, 2010](#); [Ängelholms kommun, 2017](#); [Gotlands kommun, 2010](#)), in three instances mentioned in less detail ([Torsås kommun, 2010](#); [Mönsterås kommun, 2012](#); [Bromölla kommun, 2014](#)), and in one case not addressed at all ([Varbergs kommun, 2010](#)). General adaptation measures are discussed in each of the three documents containing climate change adaptation sections. The use of levees as a form of coastal protection is mentioned in both [Ängelholms kommun \(2017\)](#) and [Gotlands kommun \(2010\)](#). [Kävlinge kommun \(2010\)](#), similarly discuss the practical use of levees as protections, as well as permanently raising the ground level. In [Torsås kommun \(2010\)](#) and [Bromölla kommun \(2014\)](#), the need for future adaptation is mentioned without naming specific measures, and in [Varbergs kommun \(2010\)](#) no mentions of adaptation measures were found. [Mönsterås kommun \(2012\)](#) mentions climate change and climate change adaptation in general but does not

elaborate on any details.

3.3. Conceptual comparisons

Based on the content analysis in sections 3.2.1. to 3.2.7., the documents belonging to each municipality has been compared based on perceived effort or progress in regards to climate change adaptation to SLR. The first section contains an evaluation based on the different categories in which comparisons were possible. The second section shows an overarching comparison using the most relevant document found for each municipality.

3.3.1. Determining effort/progress based on categories

Considering the determining factors in each category of documents, a hierarchical comparison can be visualised. For this comparison, some categories of documents showed too much variation in purpose to allow for a fair comparison. The categories that are compared in this section are therefore limited to Climate change adaptation plans (Fig. 5), Coastal or Sea plans (Fig. 6) and Comprehensive plans (Fig. 7).

As previously mentioned, the climate change adaptation plans are fairly homogenous, based on the eight documents included in this analysis. The main differences are found in the details to which measures have been assessed in terms of costs and time for implementation, and a distinction can be made based on this. A specified time plan for implementations outweigh a priority system in this instance, as it can be considered more precise in terms of planning. Cost estimates similarly are considered an important factor that indicates that this aspect has been taken into account prior to the development of the plans.

The coastal or sea plans are slightly more varied in purpose, and are therefore more difficult to compare internally than the CCAPs. Nevertheless, with the exception of the shared sea plan (Sölvesborgs kommun et al., 2019), the plans share a focus on a need for adaptation measures (Fig. 6).

In this regard, the level of detail to suggested measures can be identified in a similar manner to that of the CCAPs, showing that some municipalities are further ahead in the process. Unlike the CCAPs category, a factor used for this comparison is also whether adaptation measures are suggested in general or specific terms. The results are however more varied due to the variety of other content in the documents.

Regarding a comparison of comprehensive plans, only those plans included in the main analysis are considered here. As these plans are not used to suggest specific adaptation measures, the comparison is instead based on the emphasis given to climate change adaptation and SLR, and whether general adaptation measures are suggested as a solution with examples or mentioned without examples (Fig. 7).

With the exception of Varbergs kommun (2010), in which adaptation is not addressed, three further categories can be identified. The distinction is made based on how climate change adaptation is framed in the plans, which is interpreted as the level of concern given for municipal planning. Those belonging to the first category frame adaptation within an own section in the documents, and provide suggestions on possible solutions to SLR. The second category provides less detail on adaptation, but mentions examples of measures, and the third category indicates that adaptation measures are mentioned without examples.

3.3.2. Overall comparison

Using only the documents that show most progress or intent for each municipality, a hierarchical comparison can be made based on

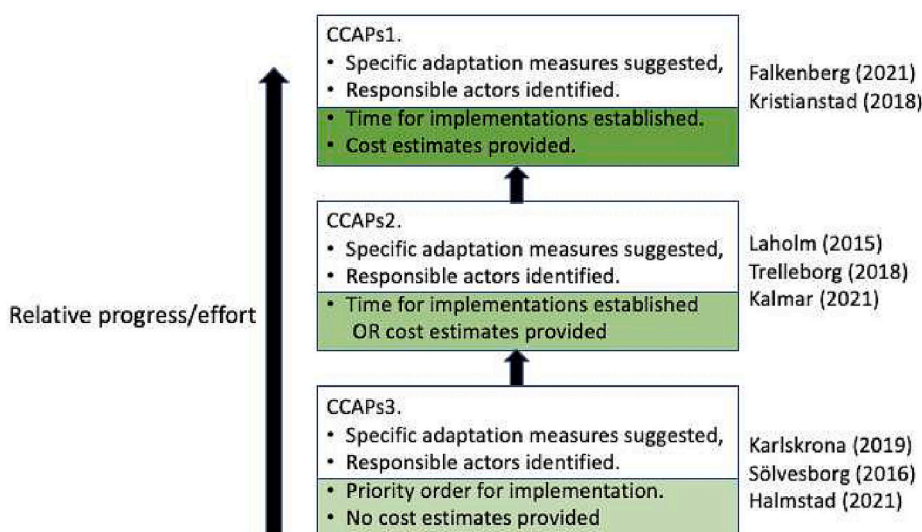


Fig. 5. Hierarchical comparison of climate change adaptation plans.

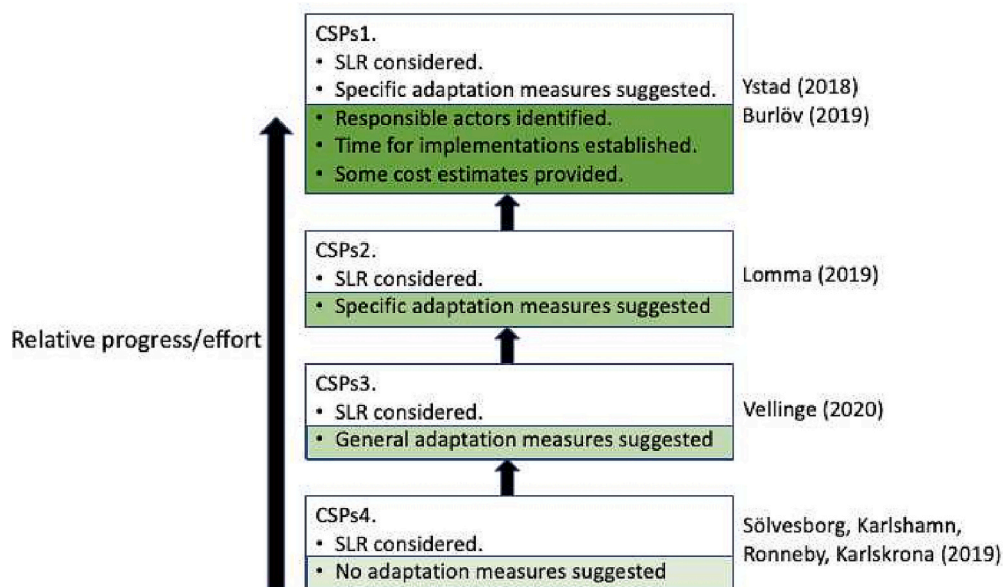


Fig. 6. Hierarchical comparison of coastal or sea plans.

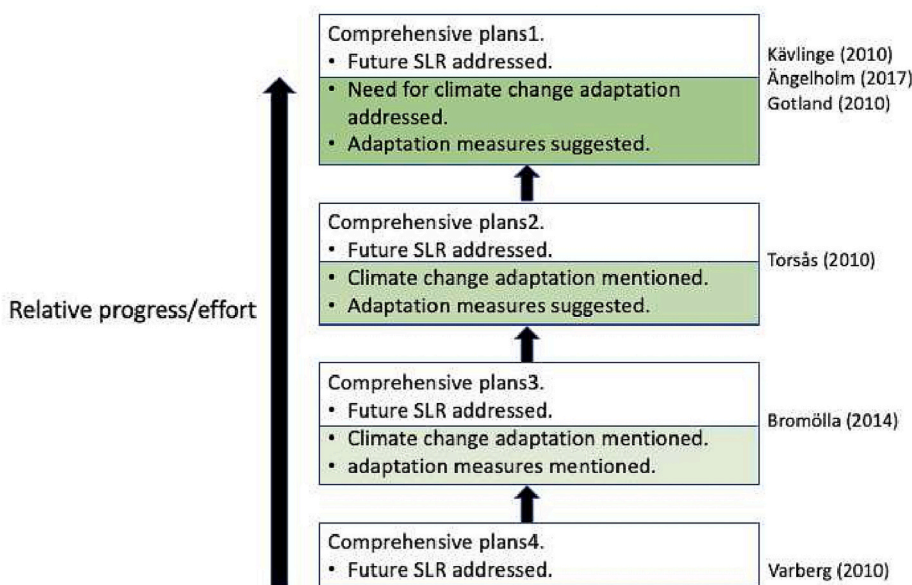


Fig. 7. Hierarchical comparison of comprehensive plans.

four overarching levels:

Level 1) Planning document containing specific adaptation measures to specific areas. The plan takes into consideration both time of implementation and financial costs, and responsible departments are specified.

Level 2) Planning document containing specific adaptation measures to specific areas. Either time of implementation, cost or responsibility are considered, but not all three.

Level 3) No specific adaptation measures are decided. General adaptation measures are suggested.

Level 4) No adaptation measures suggested, but a need for consideration to SLR adaptation measures mentioned.

Municipalities to which no documents were found meeting the criteria are excluded from this comparison (Fig. 8).

Reviewing the results in Fig. 8, it can be determined that fifteen of the surveyed municipalities are addressing climate change adaptation to SLR at the two more progressed levels. In each of these cases, adaptation measures are planned or suggested with details provided in regards to exact area, time of implementation, costs, or with responsible department considered. In the case of

	<i>Comprehensive plans</i>	<i>Thematic additions</i>	<i>General plans</i>	<i>CSPs</i>	<i>Special plans</i>	<i>CCAPs</i>	<i>External reports</i>
Level 1						Kristianstad (2018) Falkenberg (2021)	
Level 2				Ystad (2018) Burlöv (2019) Lomma (2019)	Vellinge (2011)	Laholm (2015) Trelleborg (2018) Kalmar (2021) Karlskrona (2019) Sölvesborg (2016) Halmstad (2021)	Varberg (2020) Båstad (2017) Helsingborg (2019)
Level 3	Kävlinge (2010) Ängelholm (2017) Gotland (2010) Torsås (2010)	Landskrona (2015) Borgholm (2017) Mörbylånga (2022) Oskarshamn (2014) Västervik (2014)	Malmö (2021)				Höganäs (2017) Skurup (2019)
Level 4	Bromölla (2014)		Simrishamn (2021)				

Fig. 8. Spreadsheet showing the level of progress identified in 29 municipalities based on the documents in which adaptation to SLR was found to be most prevalent. External documents highlighted in bracket.

Kristianstads kommun (2018) and Falkenbergs kommun (2021), all these factors are considered. It should be noted that three of the municipalities found in level 2, Varberg, Båstad and Helsingborg, are included in this level based on external reports. Twelve municipalities have implemented consideration for various adaptation measures in their planning, albeit on a less specific level. While not providing details on how to move forward, different measures are discussed and vulnerable areas assessed. Two of these are based on external reports. Within the last level, to which two municipalities were identified, consequences of SLR were still found to be considered, and the need for future adaptation recognised.

4. Discussion

The purpose of this study was to research 1) how municipal climate change adaptation to SLR have progressed since 2013; 2) how municipalities approach SLR adaptation and what differences can be identified, and; 3) how municipalities compare in their relative progress or effort in terms of documented SLR adaptation. The discussion section is divided into five subsections, starting with a method discussion, then addressing each of the three research questions and ending with a discussion in an international context.

4.1. Method discussion

The method used in this study shows that determining relative effort based on content analysis is possible only to a certain degree. The lack of consistency in approach found in the surveyed municipalities' planning documents make comparisons outside of homogenous types of documents difficult. As climate change adaptation plans were found to be relatively similar in terms of structure and purpose, this type of planning document will likely be most suitable for comparison of progress in the future. As previously mentioned, while all of the surveyed municipalities are in or below the +1 mm/year uplift zone, their conditions in terms of exposure to SLR vary greatly. Some low-lying areas have had a need for adaptation to high sea levels in the past, while others see it as a future concern. The comparison presented in this study disregards necessity and urgency, which is likely a determining factor in explaining how far municipalities have progressed in their adaptation work. Furthermore, the selection of indicators and categories in this study were purposely designed to allow for comparison between plans and policies with different purposes. As the focus of the assessment was limited to SLR adaptation progress within a relatively small geographical area of Sweden, the more extensive set of indicators used on international scale e.g. Olazabal et al. (2019), or as suggested in plan quality literature e.g. Meerow and Woodruff (2020), were beyond the scope of this study. Future similar research in Sweden, however, could benefit from including indicators relating to social justice, as the SLR-related impacts of climate change in some areas may entail relocation rather than protection.

4.2. Municipal progress since 2013

The results from the comparison with the baseline study of Von Oelreich et al. (2013), show that essential progress has been made in terms of absolute numbers. The 2013 study found that 10 of the 33 municipalities had no documents that addressed SLR at all. In contrast, guiding or planning documents that in some way address future SLR were identified for every municipality included in the present survey (33/33), which is an increase of 43,5%. This seemingly large increase is of course contingent on the availability of documents, which may have changed during the last decade. Nevertheless, this survey shows that as of 2022, all 33 municipalities

express awareness of future SLR in publicly available documents. Another factor to be considered is that municipalities as of 2018 are required by law to consider the effects of climate change on the built environment in comprehensive planning. That being said, the majority of comprehensive plans considered in this study predate this legal obligation. The other main indicator of municipal engagement to SLR used by [Von Oelreich et al. \(2013\)](#), was whether the municipalities took estimates of future SLR into account in the planning or not. The 2013 study found that 19 of the 33 municipalities provided estimates of local future SLR in various planning documents. The present study finds that as of 2022, 30 of the 33 municipalities provide such estimates, which again is a sizeable increase (58%). This is of course somewhat proportional to the fact that fewer documents on SLR were identified in the 2013 study, although it shows that local estimates are a factor for consideration to a high degree as of today. It is also worth pointing out that only three of the surveyed municipalities have the same estimates specified as in the 2013 study today. In every other instance where data was available in 2013, newer estimates have been used, indicating that municipalities are aware of the rapidly increasing progress of climate change research. All in all, compared with the 2013 baseline, it can be concluded that as far as publicly available documents indicate, awareness and attention to future SLR has increased during the last decade on a municipal level.

4.3. Differences in approach

Regarding how municipalities approach adaptation to SLR there are several differences that could be identified from the survey of documents and subsequent content analysis. First and foremost, eight of the 33 municipalities have an established climate change adaptation plan as of 2022. Based on the comparison with other planning documents, this type of plan appears to be the strongest adaptation document in regards to how measures are considered, planned and executed. In general terms, this study found that few other documents in the other categories provided the level of detail present in any CCAP. Some coastal or sea plans exhibited similar structure as the CCAPs, but with less detail, which is to be expected due to the different purposes of the plans. Secondly, the urgency of need for adaptation measures are very different geographically. Some municipalities, notably Kristianstad and Vellinge, have special plans regarding adaptation to both future and existing sea levels, as flooding in these regions have been a concern for some time. It is therefore not expected that every municipality approach the challenge identically. In general, apart from the CCAPs, and some coastal or sea plans, there are few similarities in how municipalities approach climate change adaptation. Several municipalities address adaptation measures only in general terms, and restrict considerations to comprehensive plans, while others address it as a separate instance in a general plan or to thematic additions to other plans. The use of consultancy firms prominently features in questions regarding climate change adaptation or risk analyses, indicating that these reports can be used as foundations for future planning. While there are no guarantees that this is the case in current practise, their availability among other planning documents suggest that they are of some importance in future planning. In summary, current documented practices vary among the concerned municipalities, although this is likely a question of priorities based on necessity, and not necessarily from a lack of guidelines.

4.4. Comparison of current progress

Comparing progress or effort within the categories of documents was possible using the separating factors identified in the content analysis. However, comparisons are only possible within categories of documents with similar purposes using this method. The homogeneity of the CCAPs allowed for the most distinct comparison, while the CSPs and comprehensive plans required less specific indicators. In general, as purpose and content of the different plans become less consistent, the more difficult it becomes to compare them. Furthermore, the variety of approaches and types of planning documents makes comparisons across categories possible only on a very overarching level. The overall comparison serves primarily as an indication on where municipalities stand based on currently available documents. Nevertheless, the comparisons showed that municipalities with climate change adaptation plans or adaptation-oriented coastal or sea plans are further ahead due to the level of detail found in these plans. The results therefore indicate that some comparison is possible, and can serve as an indication of progress. Assuming that more municipalities develop CCAPs in the future, more indicators can be included and compared for future studies. Similarly, international comparisons could be made provided similar indicators are available.

4.5. Swedish municipal adaptation planning in an international context

Comparing the progress of local adaptation planning with international results, the findings seem to support global trends. While this study is focused on SLR, the frequency of climate change adaptation plans found in the surveyed municipalities (24%) are close to the findings in international literature, ranging between 23 and 28% ([Reckien et al., 2018](#); [Heidrich et al., 2016](#); [Aylett, 2015](#)). Regarding suggested adaptive actions towards SLR, the more common forms suggested in the findings of this study concern protection in the form of levees and reinforcement of water systems. The lack of transformational and iterative measures, as expressed in [Bednar-Friedl et al. \(2022\)](#) and [Meerow and Woodruff \(2020\)](#), is supported by this study as there are very few mentions of land-use change and/or relocation of settlements. Furthermore, one primary challenge expressed in plan quality literature is echoed in the findings of this study. Given the time horizon of the impacts of climate change, implementation of suggested measures found in this study are yet to be carried out, which makes it hard to determine the effectiveness of such measures. This gap in planning assessment was addressed by [Olazabal and Ruiz De Gopegui \(2021\)](#) and [Olazabal et al. \(2019\)](#) as well as in the IPCC report ([Pörtner et al., 2022](#)), and is supported by the findings in this study as few of the plans assessed provided details on the specifics of implementation, indicating that in the case of SLR adaptation in Sweden, the availability of such data cannot be expected in the immediate future. Lastly, while adaptation planning assessments are increasingly common in an international context, similar research methods regarding SLR in Sweden is more

scarce and would be an opportunity for future research.

5. Conclusions

The primary conclusions that can be made from this study are that 1), municipal attention to future SLR adaptation has increased notably during the last decade, based on its frequency in municipal planning documents. The strongest indication of this is that SLR was found to be addressed to some capacity in at least one document in each of the 33 municipalities, which is a 43,5% increase from 23 in 2013. Furthermore, given that estimates of local SLR were found in 30 municipalities compared to 19 in 2013, an increase of 58%, this further highlights that municipalities are increasingly aware of the local implications of SLR. This largely supports international trends on increasing attention to climate change adaptation in local governments. Secondly 2), the large variation in terms of municipal progress found in this study supports previous findings and reports that express discrepancies in terms of SLR adaptation progress in Sweden. A lack of clarity in what is required from municipalities, as indicated by both Wedin (2021) and Nationella expertrådet för klimatanpassning (2022), is likely one of the reasons for these discrepancies. Another reason is likely the necessity factor, as some of these municipalities are already exposed to the effects of high sea levels and have therefore needed to act sooner than others. This factor was however not included in this study. Lastly 3), comparing the relative progress between municipalities showed that municipalities with climate change adaptation plans or coastal- or sea plans focused on adaptation, appear to have progressed further in terms of planning and implementation. Again, this may be an effect of necessity.

The current system of governance in Sweden, in which municipalities are tasked with adapting to SLR, seemingly bears some resemblance to countries that are considered frontrunners by Van den Hurk et al. (2022). The results from the present study, however, only considers the municipal level of governance, and need to be put into a broader context for relevant comparisons to be made. While planning and implementation efforts are similarly managed locally, there may be great differences in the systems of governance taking place on the national and regional levels as well. Comparing municipal SLR adaptation on an international scale would require a deeper analysis of the governance systems and order of operations taking place in other countries, which is outside of the scope of this study.

CRedit authorship contribution statement

Sebastian Segge: Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review & editing, Visualization. **Volker Mauerhofer:** Conceptualization, Validation, Writing – review & editing, Supervision, Project administration, Funding acquisition.

Declaration of Competing Interest

The work is all original research carried out by the authors. No part of the research has been published in any form elsewhere, unless it is fully acknowledged in the manuscript. The manuscript is not submitted yet elsewhere not being submitted or considered for publication elsewhere while it is being considered for publication in this journal. Any research in the paper not carried out by the authors is acknowledged in the manuscript. All sources of funding are acknowledged in the manuscript, and we declared any direct financial benefits that could result from publication. All appropriate ethics and other approvals were obtained for the research.

Data availability

Data sources are available in the references listed.

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