Urban climate change adaptation: an assessment of Malmö municipality's Cloudburst Management Plan

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Abstract
Climate change is affecting societies all over the world. Cities are especially vulnerable to climate change due to their particular features such as high proportion of hard surfaces, high interconnectedness between systems and lack of protection from natural ecosystems. The urban planning processes suit well for implementing climate change adaptation (CCA) measures to protect the cities from the effects of climate change, nonetheless, CCA in urban planning is a novel topic. In this thesis, criteria for successful implementation of CCA strategies in urban planning are identified through a scoping study. The criteria are used to assess the strengths and weaknesses of the Cloudburst Management Plan of Malmö, Sweden – a role model city for urban resilience – through document analysis and interviews. The success of Malmö municipality's cloudburst management can be derived from their strong internal organization through cross-departmental coordination and high competence staff, and their focus on mainstreaming of "cloudburst consideration" into standard operating procedures and their collaborative learning culture. The main weaknesses are the limited resources allocated and the lack of clearness regarding what can be considered "acceptable risk", which influence the possibility to set appropriate goals and monitor and evaluate the management strategy. The current legislation does not assign responsibility for CCA to any actor, which influences the city's incentives to do more than what is obliged by law. A clearer strategy for stakeholder inclusion in urban planning could strengthen the adaptive capacity, however how this can be done is a suggestion for future research.

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Malmö, May 2020
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Summary

Urban areas, where more than half of the world's population lives is especially sensitive to climate change due to particular features, such as many hard surfaces, and a high concentration of vulnerabilities (Revi et al., 2014; Wamsler, 2014). Likewise, urban development can reinforce risk, for example through removal of natural protection from ecosystems (Adger et al., 2007). Despite the urgency to adapt climate change adaptation (CCA) in urban planning is still a novel topic (Aguiar et al., 2018). Malmö, Sweden's third largest city has a sustainability profile and is considered a role model for urban resilience (Brink & Wamsler, 2018; UNDRR, 2019a). There is a need and willingness in Malmö municipality to address CCA and disaster risk strategically. Its Cloudburst Management Plan (CMP) is currently the only high-level policy document on CCA that is being implemented. In this thesis, the CMP is assessed to learn from the work that has been done and inform further CCA strategy development.

The purpose of the study is to assess Malmö municipality's CMP from a risk-based urban planning perspective. A scoping study answers the first research question: *According to scientific literature, what are the criteria for successful implementation of climate change adaptation strategies, from a risk-based urban planning perspective?* The strategy assessment was performed through a document analysis and interviews answering the second research question: *What are the strengths and weaknesses of Malmö municipality's Cloudburst Management Plan, according to the identified criteria?* The document analysis covered to documents; the CMP and the supporting Action Plan for Cloudburst Measures (APCM). Four interviews were conducted with experts involved in implementing the plans.

The scoping study resulted in the identification of a process where CCA measures are implemented iteratively through three phases: scoping, planning and implementation. Lessons learned from the implementation are used to inform the revision of the strategy (see Chapter 4). Through this process uncertainty associated with climate change can be addressed and managed, since it enables action without having to wait until all information needed is available. Within the three phases, 26 "what" criteria (describing successful content of a CCA strategy) and 68 "how" criteria (providing examples of successful implementation of this content) were identified and summarized into 13 categories (see Figure 2 and Table 3, 4 and 5). The criteria found in this study can be used to describe the strengths and weaknesses of a CCA strategy qualitatively. A strategy that fulfills many "how" criteria is not necessarily better than one that fulfills fewer; a good strategy links the "how" and "what" criteria in a way that supports implementation. The narrow scoping criteria limit the use of this assessment framework to similar contexts.

The document analysis and interviews highlighted the important role that structures for coordination, collaboration, learning and mainstreaming are playing in the implementation of the CMP (see Chapter 5). The plan is successful in structuring the internal organization in a way that supports the coordination between departments and the mainstreaming of measures into standard operating procedures. Furthermore, the internal organization, through dedicated staff and cross-

departmental coordination, supports the knowledge enhancement of staff as well as of external stakeholders. The use of soft, hard and green measures exemplifies how several context-specific measures can be combined to enhance urban resilience. The main weaknesses of the CMP are the lack of decision regarding what can be considered acceptable risk – influencing goal setting as well as prioritization of measures and monitoring – and the lack of resources to support implementation. The results also indicate that there is room for more extensive stakeholder involvement in the urban planning processes. Moreover, the importance of a detailed and thorough risk assessment that enables goal setting and robust decision-making is emphasized. Challenges that are common in CCA strategies, such as long-term commitment, resources availability and conflicting interests need to be addressed continuously. Moving the responsibility for CCA to the Urban Planning Committee could strengthen the mandate for CCA, however, this approach could risk that the other committees to back off of it. One barrier is the current legislation that does not assign responsibility for CCA to any actor.

While the CMP emphasizes individual learning for capacity building, a revision of the strategy could inform organizational learning (Pelling, 2011; Renn & Klinke, 2013). The lessons learned from the development and implementation of the CMP can be used to inform a broader CCA strategy or other hazard-specific strategies, such as for heatwaves or sea-level rise (Malmö stad, 2015). The development process itself can enhance successful implementation through the collaboration and inclusion of several stakeholders. Likewise, the existence of a strategy can be a catalyst for the implementation of adaptive measures. A CCA strategy has to be developed in accordance with the context in which it is implemented, nonetheless, the development and implementation process of the CMP can serve as an inspiration to cities that are developing CCA strategies.

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List of acronyms

APCM	Action plan for Cloudburst Measures
CCA	Climate change adaptation
CMP	Cloudburst Management Plan
DRM	Disaster risk management
DRR	Disaster risk reduction
SOP	Standard operating procedure
VCA	Vulnerability and capacity assessment

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1 Introduction

1.1 Climate change adaptation in urban planning

Climate change is contributing to profound changes in the Earth's system, with increased frequency of extreme weather events as the global mean temperature continues to rise (IPCC, 2014). Much of the risk associated with climate change is concentrated to urban areas, where more than half of the world's population lives and a high proportion of economic activities and built assets are found (Revi et al., 2014). Urban areas have particular features such as a high density of hard surfaces, people, assets and services, as well as high interconnectedness between systems such as electricity, transports and telecommunications, making cities particularly sensitive to extreme weather events (Revi et al., 2014; Wamsler, 2014). Furthermore, urban development can reinforce risk, for example through removal of natural protection from ecosystems (Adger et al., 2007; Wamsler, Brink, & Rivera, 2013). Due to the high system-interdependency, insufficient consideration of climate-related risks in urban planning can lead to lock-in effects with increased risk and high costs of adapting after development (Hallegatte, Lecocq, & Perthuis, 2011; Urich & Rauch, 2014).

Despite the urgent need to embrace CCA in urban planning, it is still a novel topic, often complementing climate change mitigation or resilience strategies (Reckien et al., 2019; Tyler et al., 2016; Woodruff, Meerow, Stults, & Wilkins, 2018). The adaptation challenges are diverse and city specific, since local CCA strategies have to consider their unique combination of hazards, vulnerabilities and governance structures (Abarca-Alvarez, Navarro-Ligero, Valenzuela-Montes, & Campos-Sánchez, 2019; Aguiar et al., 2018). Nonetheless, implementation of effective urban CCA is possible and can be accelerated (Revi et al., 2014).

Historically, disaster risk management (DRM), climate change adaptation (CCA) and urban planning have been separate fields, developed independently and operated by different professions, however integrating the fields can strengthen urban climate resilience (Johnson, 2011; O'Brien, O'Keefe, Rose, & Wisner, 2006; Wamsler et al., 2013). Risk-based urban planning builds on a holistic understanding of the current and future risks of the city and how they will be altered by urban development as well as dynamic pressures including climate change (Svalova, 2018; Wamsler et al., 2013; Wisner, Blaikie, Cannon, & Davis, 2003). Through this notion, the consequences of urban planning decisions in altering short- and long-term risks are illuminated, providing a basis for robust decision-making (Hallegatte et al., 2011; Kingsborough, 2016). Conclusively, successful urban CCA is based on local risk assessments and the integration of CCA into local investments, policies and regulatory frameworks (Revi et al., 2014).

1.2 Climate change adaptation in Malmö municipality

Malmö, Sweden's third largest city has an ambition to be "Sweden's most climate friendly city" by 2020, through climate change mitigation and adaptation (Malmö stad, 2009, p.7). Malmö municipality has a sustainability profile and is considered to be highly engaged with CCA (Brink & Wamsler, 2018). The city had an "Action Plan for CCA" 2012-2014 and have assessed its resilience

to weather-related hazards, with the purpose of investigating how to coordinate risk reduction related to natural hazards (Malmö stad, 2012, 2015). Furthermore, since 2013, Malmö is a role model city in the UNDRR campaign "Making Cities Resilient" (UNDRR, 2019a), for "[having] implemented innovative, creative, inclusive and efficient measures to realize strong political will in the field of Disaster Risk Reduction (DRR) at local level" (UNDRR, 2019b). The Comprehensive Plan's overall goal is for Malmö to be a socially, environmentally and economically sustainable city by building a dense, green and mixed land use city (Malmö stad, 2018b).

Malmö has a population of 344,000 people[1] and is growing by approximately 5000 people every year (Malmö stad, 2020). The coastal location, flat topography and relatively high density makes the city sensitive to pluvial floods due to cloudbursts and sea-level rise due to storm surge as well as heatwaves (Malmö stad, 2015). Climate change is expected to increase the likelihood of cloudbursts and heatwaves in the region in the coming decades (Ohlsson et al., 2015). Malmö has experienced three major floods due to cloudburst between 2007 and 2014 with severe economic consequences (Malmö stad, 2017). To mitigate the flood risk a strategic Cloudburst Management Plan (CMP) was adopted in 2017 (Malmö stad, 2017). The CMP is currently the only high-level policy document on CCA that is being implemented in Malmö, however, meanwhile strategies for sea-level rise and cloudbursts have been integrated into comprehensive planning (Malmö stad, 2018b).

Conclusively, there is a need and willingness in Malmö municipality to strategically address CCA and DRR to reduce the impact of extreme weather events. By assessing the CMP from a risk-based urban planning perspective, there is potential to gain learning outcomes that can be used to inform Malmö's aspirations to become climate resilient and to reach its goal to be Sweden's most climate friendly city. The learning outcomes can furthermore be used to inform other cities who are currently developing CCA strategies.

1.3 Scope of thesis

The purpose of the study is to assess Malmö municipality's CMP from a risk-based urban planning perspective. This is done through the following research questions:

1. *According to scientific literature, what are the criteria for successful implementation of climate change adaptation strategies, from a risk-based urban planning perspective?*

2. *What are the strengths and weaknesses of Malmö municipality's Cloudburst Management Plan, according to the identified criteria?*

[1] As of 2019-12-31

2 Conceptual framework

2.1 The city-disasters nexus

Urban planning consists of technical and political processes used in cities to control land use, design the urban environment, provide infrastructure, services and welfare, as well as protection and enhancement of the natural environment (Hagen, 2016; Johnson, 2011; Renn & Klinke, 2013). Cities are built up of complex inter-dependent systems of infrastructure, buildings and services in a densely populated area (Revi et al., 2014; Wamsler, 2014). Urban systems have unique physical, environmental, socio-cultural, economic and political features which influence as well as create disaster risk (Birkmann, Garschagen, Kraas, & Quang, 2010; Wamsler et al., 2013). For example, a high proportion of hard surfaces decrease infiltration capacity which intensifies flood risk and expanding housing into a hazard-prone area creates new disaster risk (Wamsler et al., 2013). Furthermore, urban-based activities are the source of much of the greenhouse gas emissions leading to climate change, exacerbating climate related hazards (Revi et al., 2014; Wamsler et al., 2013). Altogether, cities and disasters influence each other in a city-disasters nexus (Birkmann et al., 2010; Wamsler & Brink, 2016; Wamsler et al., 2013). Disturbance to one urban system can create ripple effects of such a complex nature that it is difficult to understand all of the consequences (Wamsler, 2014). Consequently, cities are particularly sensitive to the effects of climate change, manifested as an increased frequency of extreme weather events.

2.2 Risk-informed climate change adaptation

Urban CCA – the process of adjusting the urban systems in response to actual or expected climate change – can reduce the risks to households, communities and businesses in cities while at the same time exploiting beneficial opportunities (Revi et al., 2014; UNISDR, 2009). CCA is strongly linked to the field of DRM. CCA can be seen as a top-down approach, primarily addressing laws and regulations of importance for governance and decision-making while DRM addresses strategies, policies and measures involved in the implementation of risk reducing activities from the bottom-up perspective of the involved stakeholders (O'Brien et al., 2006; Rivera, Tehler, & Wamsler, 2015). Similarly to urban planning, the DRM process addresses physical, environmental, socio-cultural, economic as well as political/institutional aspects (Aven & Renn, 2010; Becker, 2014; Coppola, 2011; Wamsler, 2014; Wisner et al., 2003). DRM aims to address root-causes as well as dynamic pressures that affect particular groups within the system, to reduce disaster risk (Becker, 2014; IPCC, 2012; Wisner et al., 2003). Hence, by applying a DRM perspective to CCA in urban planning, climate resilience – the capacity to absorb, accommodate to and recover from the effects of a hazard – can be enhanced (Becker, 2014; Revi et al., 2014; UNISDR, 2009). The resilience can be increased by reducing the vulnerability to the hazards or enhancing the adaptive capacity (Nelson, Adger, & Brown, 2007; Tyler et al., 2016). If the planning, design and resource allocation processes are responsive to climate risks, infrastructure and services can be enhanced to build climate resilience (Revi et al., 2014).

2.3 Successful CCA

CCA has no end-point as long as the climate continues to change and societies continue developing (Becker, 2014; Nelson et al., 2007). Therefore, successful adaption is not a goal, but an indefinitely sustained adaptation process, transforming the development pathways to sustain within planetary and social boundaries (Kates, Travis, & Wilbanks, 2012; Pelling, O'Brien, & Matyas, 2014). Important elements for creating sustainability in the adaptation process are effectiveness, efficiency, equity and legitimacy (Adger, Arnell, & Tompkins, 2005; Kirshen et al., 2015). Short- and medium-term incremental steps towards adaptation can lead to long-term transformation of the urban systems if they manage to address root causes to climate risk as well as the dynamic pressures (Moser & Ekstrom, 2010; Wisner et al., 2003). Mainstreaming – modifying existing structures, mechanisms and procedures to integrate adaptation, without abandoning the core work – is considered crucial for this transformation (Hagen, 2016; Wamsler et al., 2013). Mainstreaming entails revising policies as well as the day-to-day work of urban actors.

Implementation of a CCA strategy that increases the urban system's resilience to climate change impact over time in an effective and resource-efficient manner can be considered successful (Adger et al., 2005; Birkmann et al., 2010). National legislation and frameworks that support local CCA are imperative for success (Lehmann, Brenck, Gebhardt, Schaller, & Süßbauer, 2015). One example is building codes that consider disaster risk (Johnson, 2011). Housing that is of good quality, well-located and affordable provide a strong base for urban CCA by minimizing exposure to hazards and vulnerability (Revi et al., 2014). Appropriate financing is another fundamental part in the implementation of adaptive measures (Hamin, Gurran, & Emlinger, 2014; Revi et al., 2014).

There are several examples of effective, efficient, fair and legitimate CCA, many of which are interrelated. Firstly, an essential component for effective CCA is a scientific evidence base, including local risk and vulnerability assessments and information on which to consider current and future risk as well as adaptation and development options (Revi et al., 2014; Woodruff & Stults, 2016). Uncertainty management – balancing uncertainty associated with climate change projections with actions that addresses current vulnerabilities and adaptation costs – helps to assist implementation (Abunnasr, Hamin, & Brabec, 2015; Woodruff & Stults, 2016). Robust decision-making aims at managing uncertainty through planning for measures that perform well under many different climate scenarios and avoid maladaptation through the use of optimization models (Hallegatte et al., 2011; Jones et al., 2014; Kingsborough, 2016).

Secondly, multi-level risk governance can transform the systems in a resource-efficient way that enables synergies between urban development, DRM and CCA (Aven & Renn, 2010; Revi et al., 2014). Risk governance refers to "the totality of actors, rules, conventions, processes, and mechanisms concerned with how relevant risk information is collected, analyzed, and communicated, and how regulatory decisions are taken" to deal with risks surrounded by uncertainty, complexity, and/or ambiguity (van Asselt & Renn, 2011, p. 432). Leadership, locally as well as across scales, is essential to risk governance, ensuring the long-term commitment to CCA

through envisioning and definition of appropriate goals (Hamin et al., 2014; Woodruff & Stults, 2016). Important aspects of risk governance, are division of responsibility and compliance and enforcement mechanisms which effectively addresses the complexity and conflicts between the measures taken and secondary consequences (Hamin et al., 2014; Kingsborough, 2016; van Asselt & Renn, 2011). Communication about the risks and coordination of the interdependent actions of multiple organizations are other essential aspects of risk governance (Moser & Ekstrom, 2010; Woodruff & Stults, 2016).

Thirdly, strengthening human and institutional adaptive capacity can accelerate the implementation and increase the likelihood to cope with extreme weather events (Hagen, 2016; Smit & Wandel, 2006). The adaptive capacity can be seen from an individual as well as a systems perspective, as the ability to cope with the complex, ambiguous and uncertain nature of a changing environment (Pelling, 2011; Renn & Klinke, 2013). Strengthening the resilience of urban infrastructure, such as stormwater drains, transport and telecommunication, can significantly reduce hazard exposure and climate change vulnerability (Revi et al., 2014). Monitoring of adaptation measures is essential to track progress towards the goals, and provide feedback that can be translated into learning, informing the planning of future measures, and thus increasing the resource-efficiency (Wamsler et al., 2013; Woodruff & Stults, 2016). Involving stakeholders such as community members, the private sector and civil society can further strengthen the adaptive capacity (Aven & Renn, 2010; Woodruff & Stults, 2016). Enabling the capacity of vulnerable communities through partnership with governments can be an effective CCA strategy. Strategic concerns of importance are the mobilization of institutional support, addressing political interests, and ensuring influence to those most at risk (Revi et al., 2014).

3 Methodology

The research was designed with an evaluative approach (Ritchie & Spencer, 2002), to assess Malmö municipality's Cloudburst Management Plan (Malmö stad, 2017, hereafter referred to as the CMP) according to pre-set criteria. The criteria were defined in a scoping study. The CMP was assessed using document analysis. Furthermore, interviews were conducted to get a better understanding of how the CMP is being implemented and a complementing document: "Action Plan for Cloudburst Measures in Malmö Municipality" (Malmö stad, 2018a, hereafter referred to as the APCM) was added to the analysis for further comprehension.

3.1 Scoping study

The scoping study was done through a five stage process as described by Arksey and O'Malley (2005): (1) identifying the research question (section 1.3), (2) identifying relevant studies, (3) study selection, (4) charting the data, and (5) collating, summarizing and reporting the results.

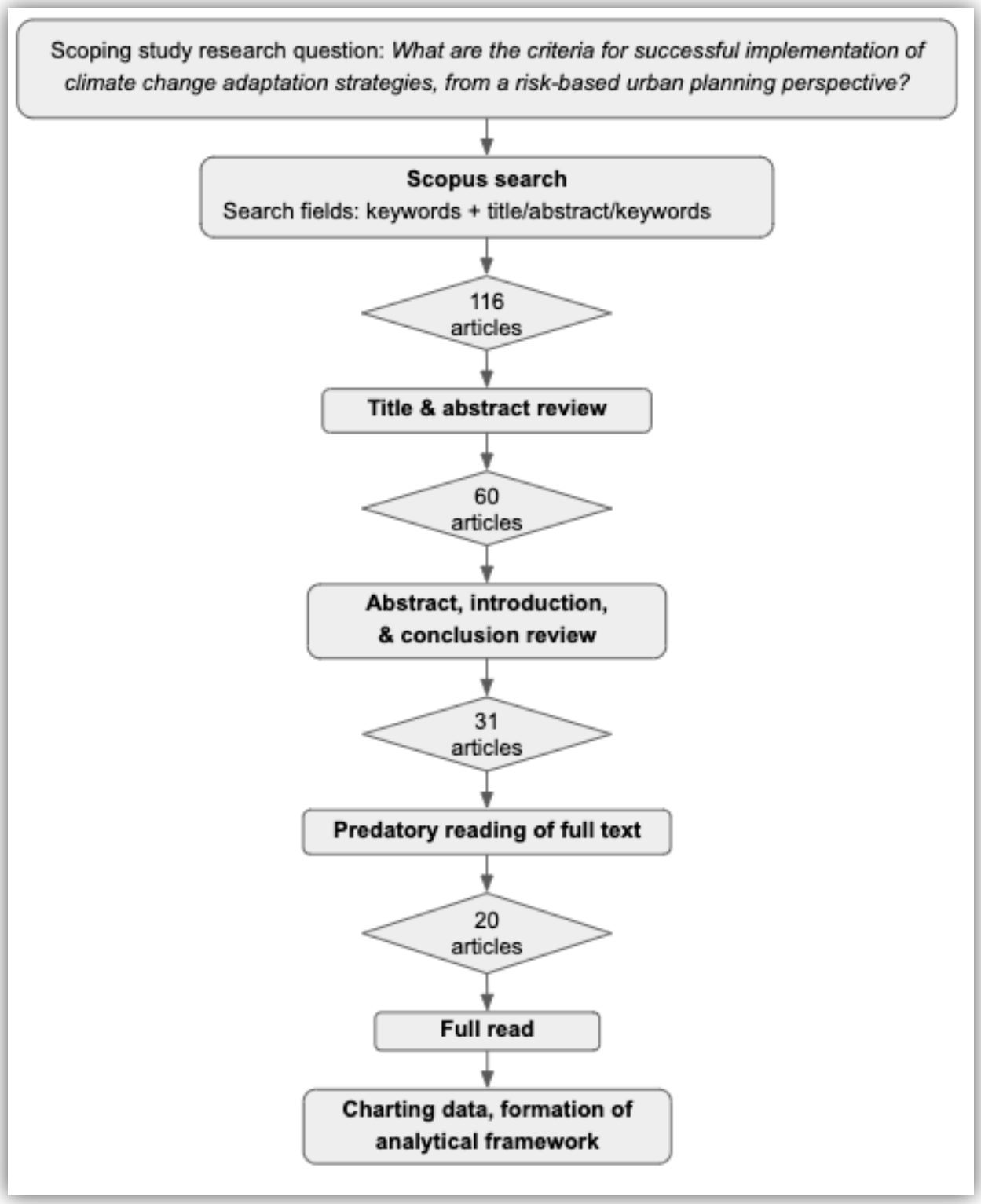
3.1.1 Identifying relevant studies

The identification of relevant studies was limited to one Scopus search string. The criteria for a good search string was that it provided a reasonable number of relevant articles on assessment of CCA strategies or description of successful strategies. The transdisciplinary nature of the field leads to terminological diversity. "Climate change adaptation", "climate adaptation", "climate resilience" or "adaptation for climate change" are used similarly, as are "urban planning", "city planning" and "municipal planning". Synonyms for "strategy" are "plan" and "policy". Due to diversity of terminology, an iterative trial process was used, trying different keywords and comparing search string results to find a combination which contained the most relevant studies (Efron & Ravid, 2019). The main keywords were "climate change adaptation", "urban planning", "assessment", "strategy" and their synonyms. The relevance of the synonyms was tested through the trial process, by reading titles and abstracts, and synonyms were deselected if they gave too many irrelevant results (Efron & Ravid, 2019). The trial process resulted in the exclusion of the keywords "resilience", "local" and "municipal" since they provided too many results falling outside of the scope of urban CCA. The combinations "stormwater/cloudburst/downpour management", "urban flood", etcetera, gave narrow results focusing on flood management from an engineering perspective. To limit the number of results, the final search string emphasizes the keywords "adaptation", "urban planning" or synonyms and "climate change" or "floods" but limits the results to those containing "strategy" and "mainstreaming" or "implementation" (and their synonyms). The following search string was selected, resulting in 116 results on January 21st, 2020:

KEY (adaptation AND "urban planning" OR "city planning" OR ("spatial planning" OR "land use planning" AND urban OR city) AND (flood OR "climate change")) AND TITLE-ABS-KEY ((strateg OR polic*) AND (integrat* OR mainstream* OR implement*))*

Figure 1.

Overview of the scoping study process.



3.2 Study selection

The first step of the selection process was to read the titles and abstracts of the 116 articles, which resulted in the selection of 60 articles which were deemed useful. In a second step abstracts, introductions and conclusions of the 60 articles were read and 31 articles were selected for further analysis. In a third step the predatory reading technique was used, focusing on the introduction, results and conclusion of the 31 articles, resulting in the selection of 20 articles for the analytical framework. The selection criteria for the three steps are found in Table 1.

Table 1.

Inclusion and exclusion criteria for data selection.

Inclusion - Step 1	Exclusion – Step 1
- English - Urban context focus - Municipal level focus	- Non-English - Rural or urban-rural comparison - Too broad focus (e.g. National or regional strategies) - Too narrow focus (e.g. neighborhood plans or zoning)
Inclusion - Step 2 & 3	**Exclusion – Step 2 & 3**
- CCA implementation focus - Flood management process focus - Success factors for the CCA processes - Contains analytical framework to assess CCA strategies - Contains case studies with similar context e.g. type of country or city size	- Only climate change mitigation focus - Quantitative assessments of number of cities that have CCA assessments and what type - Risk assessment of a specific area - Specific data needed for CCA - Correlation between physical environment and CCA strategy type - Lack of generalizable concepts - Case studies with very different context e.g. in non-democracy or developing setting

3.2.1 Charting the data

The 20 articles that were selected for the analytical framework were read in full for familiarization, while making notes of their content in an Excel file. Starting out with the articles that provided assessment frameworks, all concepts mentioned in the frameworks were listed using quotes that exemplify the concepts together with the author names, year of publication and page number. From the quotes, keywords were extracted to provide a coding system. Articles which shared the same concept were listed as “supporting sources” (see Appendix 1 for two examples).

When all articles were charted in Excel, the computer software NVivo was used to chart all articles again with “nodes” using the identified keywords. The search function was used to look for missing data on each keyword. To make sure that all articles were coded in the same way, the overview of the charting of each node was examined several times.

3.2.2 Collating, summarizing and reporting the results

Parallelly to the charting process in Excel, the quotes collected were sorted according to keywords as the articles were charted. The data was primarily organized into broad categories around three CCA process phases, a structure which was identified through the charting process. Based on the keywords, data with similar content was grouped into categories (see Appendix 1). With the broad categories in place, NVivo was used to examine all data within each category and divide it into success criteria with a suitable level of detail.

Categories that did not fit in the first CCA process structure (regarding the institutional environment and organizational structures) were analyzed separately. With the nodes overview function in NVivo, a comparison of how these categories related to the rest of the data was made and success criteria were extracted. To fit all criteria into the CCA process structure the criteria were split into two groups: criteria for the content of a successful CCA plan ("what" criteria) and criteria for the successful implementation of a CCA plan ("how" criteria). The results are presented in chapter 4.

3.3 Document analysis

The CMP was analyzed using framework analysis (Ritchie & Spencer, 2002). The purpose of the analysis was to answer the second research question (section 1.3). The indexing was done using the criteria resulting from the scoping study. The CMP was examined to see which criteria it contained and which it lacked. The criteria that were not present or only briefly described in the document formed the basis for the interview questions. After the interviews another document: "Action Plan for Cloudburst Measures in Malmö Municipality" (APCM) was added to the document analysis, since the informants emphasized the interdependence between the two documents. The APCM was analyzed using the same method.

3.4 Interviews

To complement the document analysis, interviews were conducted with the purpose of gaining a deeper understanding of how the CMP is implemented and the extent to which the written plan enables implementation. The data collection process was constructed following the four steps described by Brinkmann (2013): preparation, interviewing analysis and reporting.

3.4.1 Preparation

A purposeful sampling strategy was used to select relevant informants (Creswell, 2013). Staff within the municipal organizations that are working with the implementation of the CMP were considered key informants. Informants participating in the inter-departmental coordination group for cloudburst management in Malmö municipality were identified through snowball sampling (Biernacki & Waldorf, 1981; Blaikie, 2009). Five informants with key insight into the cloudburst management process were approached. All agreed to participate; however, one confirmed too late in the process and was therefore discarded (see Appendix 2 for an overview of the interviews).

The questions were based on the result of the first document analysis. Success criteria that the CMP lacked and criteria that needed further explanation to comprehend the intentions of the plan were subject to questions. Due to the limited time of each interview, not all types of success factors were covered. Themes around adaptive capacity were prioritized and clustered as follows: (1) coordination and communication, (2) robust decision-making, (3) responsibility and compliance, (4) financing and (5) monitoring, evaluation and revision (see Appendix 5 (Swedish) and 6 (English)). Specific questions were conducted under each category, with follow-up questions listed to select, depending on the answers. Since the APCM was analyzed after the interviews, some questions were answered by the additional document analysis.

3.4.2 Interviewing

A first letter explaining the study's purpose was sent to possible interviewees. When confirmed, a longer letter describing the purpose and the themes that would be discussed was provided (see Appendix 3 (Swedish) and 4 (English)). A short introduction to the background and purpose was given again at the beginning of the interviews. Most interviews were around one hour long (see Appendix 2). Due to the Coronavirus pandemic, all interviews were held on Skype or telephone. The interview guide was used flexibly, to cover as many areas as possible with detailed questions on the CMP. Detailed questions that had already been answered were sometimes not given to following respondents, to give time for questions which needed further elaboration. To keep a natural flow and facilitate the understanding of the connection between themes, the order of the question followed the answers of the respondents. Occasionally, questions outside of the protocol were raised for clarification.

3.4.3 Analysis and reporting

The coding of the interviews was concept-driven (Brinkmann, 2013), using the pre-developed categories from the scoping study. The results are presented in chapter 5. The quotes are translated from Swedish to English by the author. The original quotes are found in the endnotes.

3.5 Ethical considerations

The researcher has an obligation to society, the university and colleagues to conduct the research in an ethical manner. This requires research integrity, including consideration of a systematic data selection process to avoid only selecting data that fits a pre-established perception and making sure that data is not fabricated or falsified. Transparency has been considered through the presentation of a conceptual framework to clarify the author's understanding of key terminology and through the presentation of limitations and delimitations to the research. The document analysis is presented including page numbers, to facilitate validation.

The interviews were done following the four ethical principles of the Swedish Research Council (2002): *information, consent, confidentiality* and *use*. Before the interviews, respondents were informed about the purpose of the interviews, the themes that were going to be discussed and gave their consent to participate and having the interviews recorded. Respondents' personal information

has been kept confidential. The descriptions of respondents have been approved by the respondents. After the data analysis process, respondents have been given the opportunity to confirm their data before the publishing of this thesis. Respondents have been offered to have the full report after publishing. During the interviews, methodological decisions were taken when the selection and order of questions was made (Kvale & Brinkmann, 2009). It was considered more important to cover several aspects of the CMP and get a broad understanding than to have all informants answer the same questions. As an outsider to the municipal organization, it is not possible to claim to fully understand the processes. The intention is to describe the findings in an as objective manner as possible by concentrating on the existence and understanding of success factors or lack thereof and describe how they are connected.

3.6 Methodological limitations

The success criteria presented are limited to those found through the scoping study. Grey literature was excluded due to time limitations. Furthermore, the informants constitute a quite homogeneous group, for example no informant works explicitly with mainstreaming the strategy in urban planning. Finally, the document analysis was limited to two documents. Other documents that were referred to in the interviews, such as the Technical Handbook of Malmö municipality (Malmö stad, 2019) containing guidelines and requirements for planning and implementation of public facilities, were excluded.

4 Scoping study results

The scoping study results are organized around the three phases of the CCA process, which were identified through the charting process. The concepts are sorted into categories and success criteria under each CCA process phase. In section 4.1 the CCA process is described, and in section 4.2 the success criteria for implementation of CCA strategies are presented.

4.1 The CCA process

Climate change poses uncertainty regarding the future changes in weather patterns, the effects they may have on the urban systems as well as the consequences (positive and negative) of the measures that are implemented (Jabareen, 2014; Macintosh, 2013; Urich & Rauch, 2014). As more knowledge becomes available, more precise and effective measures can be planned, but then it is too late to start acting (Abunnasr et al., 2015; Lehmann et al., 2015). A CCA strategy that allows for adaptive measures to be implemented iteratively, in pace with, and through the overall urban development can address uncertainty (Abunnasr et al., 2015; Birkmann et al., 2010; Galderisi, 2014; Grafakos, Trigg, Landauer, Chelleri, & Dhakal, 2019; Kirshen et al., 2015; Macintosh, 2013; Shi, Chu, & Debats, 2015). Likewise, the CCA strategy itself needs to develop in cycles, as new knowledge about the expected climate change is gained and experiences from the implementation are evaluated.

Six of the articles described an iterative cycle of implementation and learning; a "CCA process" through which the measures are implemented and improved. The number of phases within the CCA process differ between three and five but contain the same building blocks (see Table 2). Four of the articles (Dai, Wörner, & van Rijswick, 2018; Galderisi, 2014; Grafakos et al., 2019; Shi et al., 2015) divide the CCA process into three phases: (1) Scoping, (2) Planning, and (3) Implementation (names adopted from Shi et al. (2015)). This division is used throughout this thesis.

Table 2.

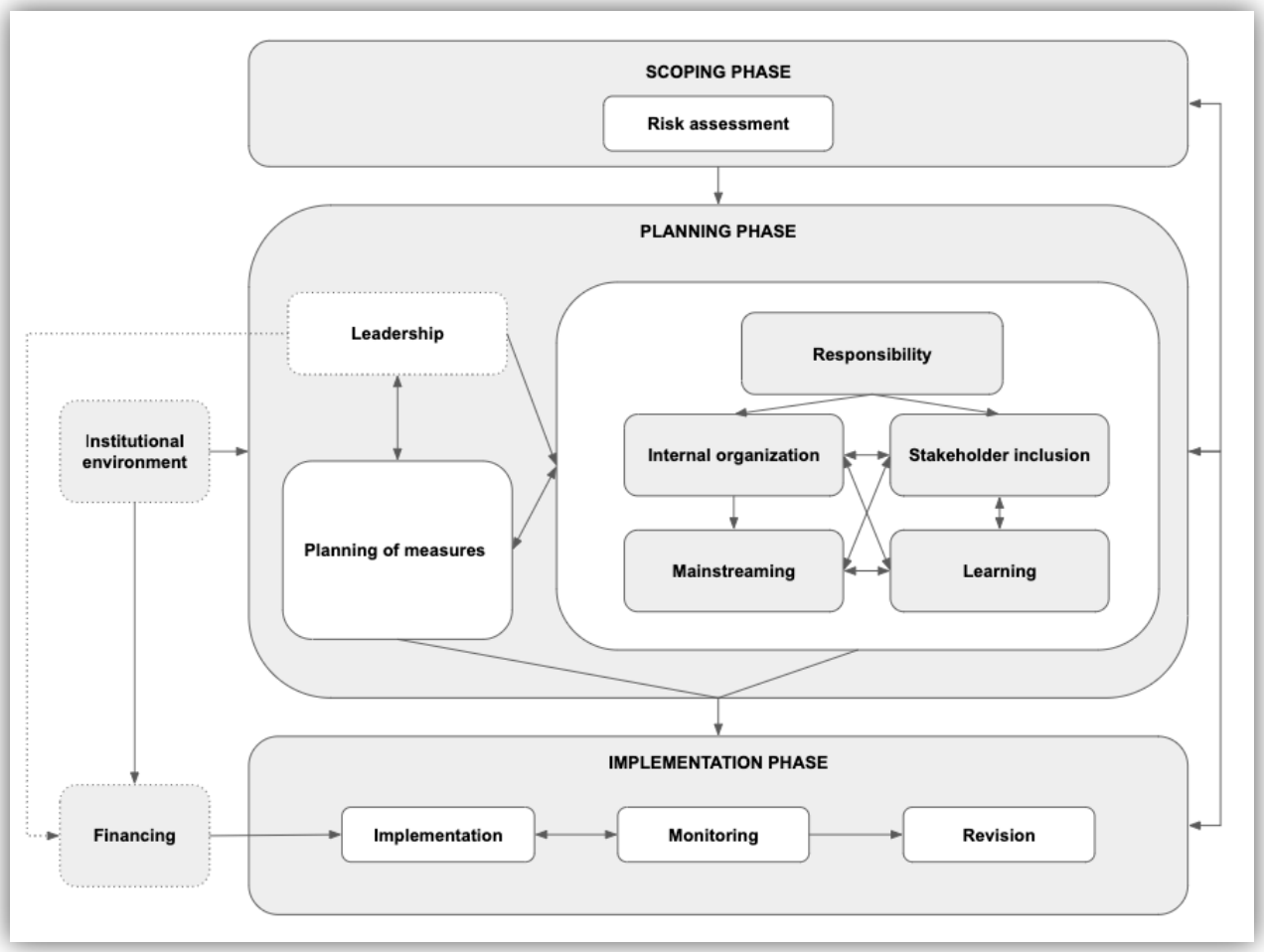
The phases of the climate change adaptation process as described in six articles.

	The phases of the climate change adaptation process			
Source	**Scoping**	**Planning**	**Implementation**	
Birkmann et al., 2010	1. Assessment	2. Planning	3. Implementation	4. Evaluation
Dai et al., 2018	1. Content	2. Organization	3. Implementation	
Galderisi, 2014	1. Knowledge	2. Preparation	3. Response and revision	
Grafakos et al., 2019	1. Identifying and understanding	2. Envisioning and planning	3. Implementation, management and monitoring	
Shi et al., 2015	1. Scoping	2. Planning	3. Implementing	
Wamsler et al., 2016	1. Assessing current risk 2. Reviewing current risk-reducing practice	3. Assessing potential measures 4. Prioritizing and implementing certain measures		5. Evaluating and managing

Through the collating process 13 categories were obtained into which the criteria for successful implementation of CCA strategies can be divided. While some articles put the organizational structures or required resources outside of the CCA process (e.g. Galderisi, 2014; Grafakos et al., 2019), in most cases they were described within one or several process phases. In Figure 2, the relationships between the three phases and their respective categories are shown.

Figure 2.

The three phases of the climate change adaptation process



Note. The three phases of the climate change adaptation process are based on frameworks by Birkmann et al. (2010); Galderisi (2014); Grafakos et al. (2019); Shi et al. (2015). Within the three phases there are 13 interrelated categories for successful implementation of CCA strategies (own work).

4.1.1 Scoping

The scoping phase contains one category: risk assessment in which hazard characteristics as well as the vulnerabilities of the city and the capacities to manage the risk are assessed (e.g. Dai et al., 2018; Galderisi, 2014), Figure 2 shows how the scoping phase relates to the other phases.

4.1.2 Planning

The planning phase contains eight categories: (1) institutional environment, (2) leadership, (3) responsibility, (4) internal organization, (5) mainstreaming, (6), stakeholder inclusion, (7) learning and (8) planning of measures (see Figure 2).

The institutional environment (1) should guarantee a clear legal mandate to work with CCA locally and the development of strategies in line with national or regional policies (Göpfert, Wamsler, & Lang, 2019; Shi et al., 2015). Leadership (2) is another prerequisite for the implementation, ensuring political support over time, setting clear vision and goals and determining an acceptable level of risk (Abunnasr et al., 2015; Birkmann et al., 2010; Lehmann et al., 2015). Furthermore, the organizational structures and their adaptive capacity influence implementation. The division of responsibility (3) enhances governance mechanisms between stakeholders (Dai et al., 2018; Wamsler, 2015). The internal organization (4) structures the coordination and implementation of measures (Hardoy & Velásquez Barrero, 2014; Wamsler, Luederitz, & Brink, 2014), mainly through mainstreaming (5) of CCA into the city's ordinary processes (Göpfert et al., 2019; Reckien et al., 2019). According to some authors, the CCA process is not to be separated from urban development, but mainstreamed into the ordinary processes of the city (e.g. Göpfert et al., 2019; Wamsler et al., 2016). Others say that mainstreaming is not enough; a dedicated approach focusing on one hazard or site is necessary to achieve effective results (Lyles, Berke, & Overstreet, 2018; Reckien et al., 2019). Stakeholder inclusion (6) supports the implementation of measures by actors outside the municipal organization through coordination, collaboration and communication (Grafakos et al., 2019; Hurlimann et al., 2014). Learning (7) enhances the adaptive capacity of staff as well as external stakeholders (Lyles et al., 2018; Mabon, Kondo, Kanekiyo, Hayabuchi, & Yamaguchi, 2019). The last category of the planning phase is planning of measures (8), where the selection, timing and prioritization of effective measures takes place (Abunnasr et al., 2015; Kirshen et al., 2015).

4.1.3 Implementation

The implementation phase contains 4 categories: (1) financing, (2) implementation, (3) monitoring, and (4) revision (see Figure 2).

Financing (1) is affected by the intuitional environment, which can provide external funding, and the leadership, which decides upon internal budget allocations (Shi et al., 2015; Wamsler, 2015). In turn, financing is fundamentally affecting the possibility to implement the measures (Lehmann et al., 2015). Successful implementation (2) of measures are guided by compliance and enforcement mechanisms (Dai et al., 2018; Göpfert et al., 2019). Monitoring (3), which requires suitable indicators (Abunnasr et al., 2015; Kirshen et al., 2015), informs the revision (4) of the strategy through evaluating the implementation as well as the strategy as a whole (Galderisi, 2014; Wamsler et al., 2014).

4.2 Criteria for successful implementation of CCA strategies

The success criteria are presented for each category within the CCA process. Within the categories, two types of success criteria for CCA strategies were identified. The first type lists the *content* that a successful strategy should cover for the implementation to be successful (hereafter called "what" criteria). The second type lists *how* this content can be implemented successfully (hereafter called "how" criteria). (see Table 3, 4 and 5). 26 "what" criteria and 68 "how" criteria were identified.

Conclusively, the identified criteria provide success factors for the content and implementation of CCA strategies. While the main categories are too broad to assess the quality of a strategy, the identified criteria provide a framework for assessing the strengths and weaknesses of a CCA strategy.

Table 3.

Criteria for successful implementation of climate change adaptation strategies: Scoping phase

CATEGORY	WHAT CRITERIA	REFERENCES	HOW CRITERIA	REFERENCES
Risk assessment	**Hazard assessment**	[3]; [10]; [4]; [2]	**Use disaggregate information**	[5]; [3]; [11]; [16]; [4]; [18]
			Hazard mapping	[13]; [3]; [7]; [9]
			Base on climate change models and future projections	[5]; [10]; [11]; [16]; [4]; [17]; [2]
			Make it a multi-hazard assessment	[10]; [4]; [2]
	Vulnerability and capacity assessment	[5]; [15]; [3]; [1]; [10]; [16]; [19]; [4]; [17]	**Addresses different types of vulnerabilities and capacitates**	[4]; [9]; [2]
			Involve stakeholders	[1]; [2]
	Consequence assessment	[5]; [3]; [10]; [11]; [16]; [19]; [4]; [17]; [18]; [2]	**Base on hazard scenarios**	[1]; [17]; [18]
			Address different types of consequences	[12]; [4]; [9]; [14]; [2]
			Address uncertainty	[5]; [1]; [4]; [9]; [17]; [14]

Note. "What" categories are content identified as successful for a CCA strategy. "How" criteria describe how the content can be implemented successfully. The numbered list of references is found in Appendix 7

Table 4.

Criteria for successful implementation of climate change adaptation strategies: Planning phase

CATEGORY	WHAT CRITERIA	REFERENCES	HOW CRITERIA	REFERENCES
Institutional environment	**Supportive international frameworks**	[6]; [10]; [19]; [18]	**Participate in networks and collaborative projects**	[16]; [19]; [18]
	Supportive national legislations and frameworks	[6]; [13]; [3]; [12]; [11]; [16]; [19]; [4]; [8]; [7]; [18]	**Base strategy on legal mandate**	[6]; [13]; [3]; [12]; [11]; [16]; [4]; [7]
			Develop strategy in line with national/regional frameworks	[6]; [11]; [4]; [7]; [18]
			Use guidelines for CCA planning	[15]; [11]; [8]; [18]; [14]
Leadership	**Political support**	[6]; [15]; [11]; [16]; [7]; [18]	**Ensure long-term commitment**	[13]; [7]; [8]
	Risk acceptance statement	[3]; [1]; [10]; [8]	**Stakeholder involvement**	[3]; [1]; [10]; [8]
	Vision and goals	[5]; [6]; [15]; [1]; [4]; [2]	**Holistic perspective**	[5]; [15]; [3]; [10]; [1]; [19]; [4]; [2]
			Bottom-up inclusion of shared values	[6]; [3]; [16]; [4]; [8]; [9]
			Appropriate, well-defined goals	[5]; [6]; [15]
			Make sure policies are fair and apply across jurisdictions	[7]; [8]; [9]; [14]
Responsibility	**Division of responsibility**	[6]; [3]; [10]; [19]; [7]; [8]; [18]	**Address mismatches between scales**	[2]

Note. "What" categories are content identified as successful for a CCA strategy. "How" criteria describe how the content can be implemented successfully. The numbered list of references is found in Appendix 7.

Table 4. cont.

CATEGORY	WHAT CRITERIA	REFERENCES	HOW CRITERIA	REFERENCES
Internal organization	**High-level CCA office**	[5]; [7]; [18]	**Locate CCA at planning agency**	[13]; [12]; [19]; [8]; [18]
	Appointed staff	[6]; [12]; [20]; [11]; [16]; [19]; [4]; [18]	**Assign responsibility for coordination and implementation**	[6]; [12]; [10]; [11]; [19]; [7]; [8]
			Encourage adaptation champions	[6]; [16]; [19]; [18]
			Use informal collaboration	[11]; [19]; [18]
	Decentralized cross-cutting management structures	[6]; [13]; [19]; [18]; [2]	**Assign responsibility to staff from several departments**	[6]; [19]
			Use as implementation taskforce	[6]; [19]; [2]
Mainstreaming	**Mainstreaming strategy**	[15]; [12]; [20]; [11]; [19]; [4]; [8]; [18]; [2]	**Integrate CCA into standard operating procedures (SOPs)**	[5]; [6]; [12]; [20]; [16]; [19]; [4]; [17]; [18]; [14]
			Integrate CCA into the urban planning process	[12]; [19]; [11]; [4]; [8]; [18]; [14]
			Integrate CCA into other cross-cutting strategies	[5]; [6]; [13]; [15]; [12]; [10]; [10]; [16]; [19]; [4]; [7]; [2]
			Hazard specific plans	[12]; [2]
			Combine "vertical and horizontal" mainstreaming	[15]; [12]; [19]; [8]; [18]
Stakeholder inclusion	**Coordination mechanisms**	[10]; [11]; [4]; [8]; [2]	**Formal and informal committees**	[6]; [19]; [18]; [2]
	Collaboration/ participation mechanisms	[5]; [13]; [3]; [10]; [1]; [10]; [11]; [16]; [19]; [8]; [9]; [18]	**Structured cooperation with other authorities**	[3]; [10]; [1]; [11]; [16]; [7]; [8]; [18]
			Collaboration through joint projects	[13]; [10]; [19]; [7]; [18]
			Stakeholder integration into the planning process	[10]; [10]
			Incentives for participating	[10]; [11]: [19]; [9]
	Communication strategy	[5]; [13]; [3]; [10]; [1]; [16]; [4]; [2]	**Interactive knowledge tools**	[3]; [4]
			Adjust information/education campaigns to the receiver	[5]; [7]; [8]; [9]

Table 4. cont.

CATEGORY	WHAT CRITERIA	REFERENCES	HOW CRITERIA	REFERENCES
Learning	**Mechanisms for knowledge transfer/ capacity building**	[6]; [3]; [12]; [10]; [4]; [11]; [18]; [2]	**Build on previous processes and Integrate lessons learned**	[13]; [3]; [12]; [19]; [18]
			Educate staff to enhance internal competence	[5]; [13]; [16]; [19]; [18]
			Science-policy collaboration	[13]; [10]; [11]; [7]; [18]; [2]
			Integrate local knowledge	[8]; [18]; [2]
Planning of measures	**Combination of measures**	[5]; [15]; [3]; [12]; [1]; [10]; [11]; [19]; [9]; [18]; [2]	**Context-specific measures**	[15]; [3]; [4]; [8]
			Combine hard, soft and green measures	[3]; [19]; [18]; [2]
			Integrate measures from several disciplines	[15]; [10]; [9]; [18]
			Integrate measures of different levels (household, municipal, regional)	[15]; [10]; [8]; [9]; [14]; [2]
			Use pilot projects	[13]; [3]; [10]; [18]
			Implement through iterations	[1]; [10]; [16]; [19]; [17]; [8]; [18]; [14]; [2]
			Apply safe-to-fail experimentation	[18]
			Set multi-objective measures	[5]; [3]; [10]; [4]; [11]; [19]; [9]; [17]; [18]
	Timing of actions	[1]; [10]; [8]; [17]; [2]	**Use trigger events as "windows of opportunity" for implementation of action**	[1]; [10]; [16]; [8]
			Flexible implementation	[1]; [10]; [8]; [14]
	Decision-support	[6]; [3]; [10]; [11]; [4]; [18]; [14]; [2]	**Cost-benefit and/or cost-efficiency analysis**	[5]; [3]; [1]; [10]; [8]; [14]
			Optimization models	[5]; [10]
			Address trade-offs, potential conflicts and consequences of actions	[5]; [6]; [15]; [3]; [12]; [10]; [16]; [8]; [17]; [18]; [14]; [2]

Table 5.

Criteria for successful implementation of climate change adaptation strategies: Implementation phase

CATEGORY	WHAT CRITERIA	REFERENCES	HOW CRITERIA	REFERENCES
Financing	**External funds**	[3]; [12]; [10]; [11]; [16]; [19]; [7]; [18]	**Apply for specific CCA funding**	[10]; [11]; [19]; [7]
			Mainstream CCA into externally funded projects	[18]; [10]
	Internal budget allocations	[5]; [15]; [11]; [16]	**Fund specific projects/actions**	[5]; [18]
			Support individual adaptation measures	[3]; [2]
Implementation	**Compliance and enforcement mechanisms**	[6]; [3]; [10]; [11]; [16]; [14]; [18]	**Use informal rules to change working procedures**	[18]
			Set non-binding soft policies	[3]; [18]
			Make rules/regulations binding	[6]; [3]; [10]; [11]; [14]
			Ensure transparency	[3]; [7]; [2]
Monitoring	**Indicators**	[5]; [3]; [1]; [16]; [10]; [4]; [17]	**Combine top-down and bottom-up indicators**	[1]; [8]; [2]
			Ensure thresholds (tipping points) contain enough time to avoid critical state	[17]; [1]; [10]; [2]
Revision	**Evaluation**	[5]; [3]; [1]; [10]; [16]; [4]; [17]; [18]	**Multi-criteria (social, economic, environmental) evaluation**	[10]
	Strategy revision	[5]; [3]; [4]; [7]; [18]	**Use lessons learned to inform strategy revision**	[5]; [3]; [1]; [16]; [9]; [14]; [2]
			Use lessons learned to inform mainstreaming	[19]; [18]

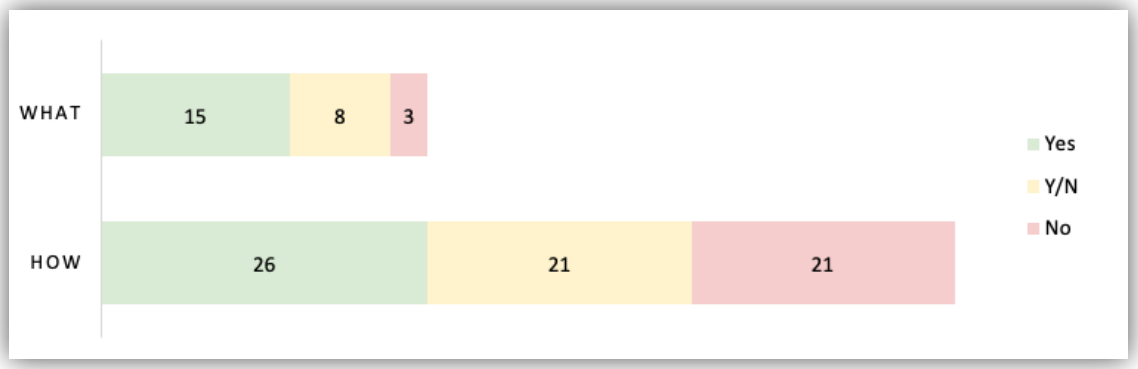
Note. "What" categories are content identified as successful for a CCA strategy. "How" criteria describe how the content can be implemented successfully. The numbered list of references is found in Appendix 7.

5 Assessment of Malmö municipality's Cloudburst Management Plan

In this chapter the analysis of the Cloudburst Management Plan (CMP) and the Action Plan for Cloudburst Measures (APCM) is presented according to the three phases of the CCA process and their corresponding categories and success criteria. In total, 15 out of 26 "what" categories were covered by the two documents, eight were covered briefly and three were not covered. Of the 68 "how" criteria, 26 were covered, 21 were covered briefly and 21 were not covered (see Figure 3).

Figure 3.

Overview of the coverage of success criteria from the document analysis.



Note. The criteria are either covered (Yes), not covered (No) or briefly covered (Y/N) by the Cloudburst Management Plan.

The success criteria coverage for each CCA process phase is described in section 5.1, 5.2 and 5.3, respectively. Most of the criteria that were not covered in the CMP, or only briefly described, were subject to interview questions (see Table 5, 6 and 7). Data from the interviews complements the document analysis at the end of each section.

5.1 Scoping phase

The scoping phase contains one category; risk assessment, three "what" criteria; hazard assessment, vulnerability and capacity assessment and consequence assessment, and nine corresponding "how" criteria (see Table 6).

Table 6.

Summary of the document analysis results for the scoping phase.

CATEGORY	WHAT	In doc.	HOW	In doc.	Q
Risk assessment	Hazard assessment	Yes	Use disaggregate information	Yes	-
			Hazard mapping	No	-
			Base on climate change models and future projections	Yes	-
			Make it a multi-hazard assessment	Y/N	*
	Vulnerability and capacity assessment	Yes	Addresses different types of vulnerabilities and capacitates	Yes	-
			Involve stakeholders	No	*
	Consequence assessment	Yes	Base on hazard scenarios	Yes	-
			Address different types of consequences	Yes	-
			Address uncertainty	Y/N	-

Note. Success factor coverage in the CMP or the APCM (in doc.) are marked with Yes, No or Y/N, for existing, but in need of further description. Criteria subject to interview questions (Q) are marked with *.

5.1.1 Risk assessment

Hazard assessment

The CMP contains a hazard assessment based on historical data (CMP, p.16) and regional climate projections (CMP, p.6). One scenario, a 100-year rainfall[2], is used throughout the strategy (CMP, p.17). Hazard mapping is not possible since the likelihood of cloudbursts is not location specific. The CMP considers multiple hazards by stating that the risks of high sea level and cloudbursts do not need to be considered together, however no other hazards are mentioned (CMP, p.9).

The informants were asked about the effect of other climate risks to the cloudburst management. Informant 4 could see benefits of broadening the scope by looking at all aspects of CCA, since there are other climate change related hazards that are not being addressed that could have been attended with co-beneficial measures. Informant 1 and 2 only referred to the lack of connection to high sea level.

Vulnerability and capacity assessment (VCA)

The VCA contains a map of previously flooded areas (CMP, p.14) and a vulnerability map (CMP, p.10). Difference in vulnerability related to topography and history is highlighted (CMP, pp.14-15). Furthermore, vulnerabilities are addressed through mainstreaming: sensitive areas are identified in comprehensive planning as well as in zoning (APCM, p.11). The sewage system capacity is assessed (CMP, p.19) and the response capacity of the crisis management organization (CMP, p.12) and the involved committees (APCM, pp.13;15) are described. Uncertainty is briefly addressed, pointing out that a complete overview of areas vulnerable

[2] A rainfall with the likelihood of occurring once in 100 years.

to pluvial floods is missing (CMP, p.14-15). Flood maps with calculated flow paths are mentioned as tools to assess vulnerability, but not presented (CMP, p.36). Stakeholder involvement in VCA was not mentioned. This was included in the general questions on stakeholder inclusion (section 5.2.6).

Consequence assessment

The 100-year rainfall scenario is used as the basis for the consequence assessment (CMP, p.27). The local consequences of cloudbursts are based on historical data and considers the uncertainty that other vulnerable places might have not been affected before. Theoretical modelling of flood risk in a 100-year rainfall event and a coarse consequence estimate are used (CMP, p.18). Direct and indirect consequences are described, as well as consequences that are difficult to measure, such as loss of items of sentimental value (CMP, p.23). Uncertainty regarding where a cloudburst will fall is emphasized (CMP, p.14), but not regarding the climate change models and projections.

5.2 Planning phase

The planning phase has eight categories: institutional environment, leadership, responsibility, internal organization, mainstreaming stakeholder inclusion, learning and planning of measures. In total the categories have 20 "what" criteria and 47 corresponding "how" criteria, assessed under each category (see Table 7).

Table 7.

Summary of the document analysis results for the planning phase.

CATEGORY	WHAT	In doc.	HOW	In doc.	Q
Institutional environment	Supportive international frameworks	No	Participate in networks and collaborative projects	No	-
	Supportive national legislations and frameworks	Y/N	Base strategy on legal mandate	Yes	-
			Develop strategy in line with national/regional frameworks	Yes	-
			Use guidelines for CCA planning	Y/N	*
Leadership	Political support	Yes	Ensure long-term commitment	Y/N	-
	Risk acceptance statement	Y/N	Stakeholder involvement	No	*
	Vision and goals	Yes	Holistic perspective	Yes	-
			Bottom-up inclusion of shared values	Yes	-
			Appropriate, well-defined goals	Y/N	-
			Make sure policies are fair and apply across jurisdictions	Y/N	-
Responsibility	Division of responsibility	Yes	Address mismatches between scales	Yes	-

Note. Success factor coverage in the CMP or the APCM (in doc.) are marked with Yes, No or Y/N, for existing, but in need of further description. Criteria subject to interview questions (Q) are marked with *.

Table 7. cont.

CATEGORY	WHAT	In doc.	HOW	In doc.	Q
Internal organization	High-level CCA office	No	Locate CCA at planning agency	No	-
	Appointed staff	Yes	Assign responsibility for coordination and implementation	Y/N	*
			Encourage adaptation champions	No	-
			Use informal collaboration	No	*
	Decentralized cross-cutting management structures	Yes	Assign responsibility to staff from several departments	Yes	-
			Use as implementation taskforce	Yes	-
Mainstreaming	Mainstreaming strategy	Yes	Integrate CCA into SOPs	Yes	-
			Integrate CCA into the urban planning process	Yes	-
			Integrate CCA into other cross-cutting strategies	Yes	-
			Hazard specific plans	Yes	-
			Combine “vertical and horizontal” mainstreaming	Yes	-
Stakeholder inclusion	Coordination mechanisms	Yes	Formal and informal committees	Y/N	*
	Collaboration/ participation mechanisms	Y/N	Structured cooperation with other authorities	No	*
			Collaboration through joint projects	No	-
			Stakeholder integration into the planning process	No	*
			Incentives for participating	Y/N	*
	Communication strategy	Y/N	Interactive knowledge tools	No	-
			Adjust information/education campaigns to the receiver	Y/N	*
Learning	Mechanisms for knowledge transfer/capacity building	Yes	Build on previous processes and Integrate lessons learned	Y/N	*
			Educate staff to enhance internal competence	Y/N	*
			Science-policy collaboration	Yes	-
			Integrate local knowledge	Y/N	*
Planning of measures	Combination of measures	Yes	Context-specific measures	Yes	-
			Combine hard, soft and green measures	Yes	-
			Integrate measures from several disciplines	Yes	-
			Integrate measures of different levels (household, municipal, regional)	No	*
			Use pilot projects	Y/N	*
			Implement through iterations	Yes	-
			Safe-to-fail experimentation	Yes	-
			Multi-objective measures	Yes	-
	Timing of actions	Y/N	Use trigger events as “windows of opportunity” for implementation of action	Y/N	*
			Flexible implementation	No	*
	Decision-support	Yes	Cost-benefit and/or cost-efficiency analysis	Yes	-
			Optimization models	No	*
			Address trade-offs, potential conflicts and consequences of actions	Yes	-

5.2.1 Institutional environment

Supportive international frameworks

International frameworks are not mentioned in the CMP, other than that the EU floods directive regulates Swedish law (CMP, p.11).

Supportive national legislations and frameworks

The national laws and directives that govern cloudburst management are described (CMP, pp.11-12). The CMP is based on the legal responsibilities of the municipality, with an ambition to go further than the law obliges (CMP, p.6). An official report on responsibilities and financing of CCA measures by a committee assigned by the Swedish government had not yet been finalized by the time of the publication (CMP, p.11). In the APCM (p.8), the results of that report are presented, stating that the municipalities are responsible for considering flood risk in new urban development, but the current regulations hamper property owners to claim liability. The municipalities have no responsibility to adapt existing buildings; property owners are responsible for protecting themselves. National standards or guidelines for the use of scenarios are missing (CMP, p.27). "There is currently no legislation or business standard that can be used as a basis for formulating quantitative and follow-up targets that can be linked to budget." (APCM, p.15).

Informant 1 and 3 pointed out that cloudburst management is a relatively new field and that the CMP is the first plan for cloudburst management in Sweden, hence Malmö and Gothenburg are ahead of National Board of Housing, Building and Planning, knowledge wise. According to Informant 2 there is a need for general guidelines:

> *"[The Board of Housing, Building and Planning] are very good at developing knowledge summaries, and that is not helpful, it is not what we need. We need clearer guidelines"*[i]
>
> (Informant 2)

Nonetheless, according to Informant 2 and 3, there are some guiding documents: the County Administrative Boards of Stockholm and Västra Götaland have conducted useful guidelines for pluvial flood management. Furthermore, the National Board of Housing, Building and Planning has developed supervisory guidelines that say that you should not aggravate flood risk when planning for new buildings (Informant 3).

5.2.2 Leadership

Political support

The CMP has official approval from the Municipal Executive Committee, who requested the strategy in the first place (CMP, p.2). The APCM has been approved by the committees that participate in the implementation (APCM, p.5). The introduction to the CMP (p.4) describes an awareness of the need for a cloudburst management strategy that goes beyond flagship projects and is integrated into the operations in the city. The long-term goal is stormwater-proofing the city by 2045 (CMP, p.7).

Political support was not part of the interview questions, but when discussing responsibility, a discrepancy between what is stated in the documents and practice was described:

"How different committees and administrations live up to these goals, in general terms, is very dependent on how relevant municipal council politicians think they are, if anyone is monitoring them there."[ii] (Informant 1)

Risk acceptance statement

Risk acceptance is briefly addressed by justifying the usage of the 100-year rainfall scenario (CMP, p.27). In the APCM, the discussion regarding acceptable risk is further developed, as one of the goals of the Technical Committee (in collaboration with the other internal partners) is to "develop a proposal for a political decision as to what consequences of a rainfall can be accepted" (APCM, p.15), and further reasoning regarding what can be considered an "acceptable disturbance" to society and how that affects the selection of measures is provided. The importance of a political decision on acceptable disturbance is emphasized.

According to all informants, other stakeholders have not been involved in the risk acceptance assessment. Informant 1 reasoned that the public is represented by the politicians, whose task is to consider the effects of the hazard on different groups. Informant 4 said that including stakeholders when determining acceptable disturbance could be interesting and that generally there is room for more stakeholder inclusion.

Vision and goals

There is a vision: "that no damage or major inconveniences appears in any part of the city due to cloudburst" (CMP, p.6). The importance of a holistic mindset is mentioned (CMP, p.20) and was implemented through the participation of several departments in developing the CMP (CMP, p.2). External stakeholders were included through thematic groups (CMP, p.22).

There are three goals with different time horizons; (1) cloudburst consideration in relevant plans, decisions and departmental processes within two years; (2) measures to minimize risks to life and health or serious disruptions of services of vital importance are to be implemented by the year 2025; (3) being able to manage a 100-year rainfall with minimal disruption by 2045 (CMP, p.7). The goals apply across jurisdictions, since they refer to several departments. The fairness of the goals is touched upon in the prioritization of measures (section 5.2.8).

No question was asked about the goals. Nonetheless, the appropriateness of the goals was brought up in the questions about revision:

"Quite frankly, it is just too offensive, that we would have a 100-year situation with minimal disruptions, minimal disruptions, what is that to begin with? […] In the same way that we were perhaps too eager to write the word '100-year rain', without clearly knowing what it means, we were probably too early to write 'in 30 years it should be'... something. It is very difficult to follow up on. We didn't describe that well enough I would say."[iii] *(Informant 3)*

5.2.3 Responsibility

Division of responsibility

The division of responsibilities between different actors, including national, regional and local, as well as the responsibilities of different departments, companies and property owners is detailed in the CMP (pp.11-13). The APCM (pp.9-18) further details the internal division of responsibilities. Mismatches are addressed in the discussion on legal framework (section 5.2.1).

This criterion was not subject of questions, however, the discussion on compliance connected to responsibility, revealed a discrepancy between the strategy and its implementation. The official report on CCA responsibilities was expected to provide clear answers to the division of responsibility and concluded that neither the national level nor the municipalities are responsible for CCA (Informant 4). According to Informant 2, there is still some indecisiveness regarding the internal division of responsibility, even though the APCM was supposed to make it clearer. Informant 3 provided an explanation to the indecisiveness:

"It is insidious, because if we point at someone very clearly, then definitely everyone else will back off."[iv] (Informant 3)

5.2.4 Internal organization

High-level CCA office and decentralized cross-cutting management structures

There is no high-level CCA or cloudburst management office, instead the CMP is executed through a cross-departmental coordination group with staff from several municipal departments and the water management company VA SYD (CMP, pp.20-21). The coordination group is responsible for the implementation of the CMP, including coordinating with internal and external stakeholders and keeping an overview of the implemented measures (APCM, p.21).

According to the informants, the creation of the coordination group is one of the major outcomes of the CMP.

"I don't know if you have worked in a municipality before, but it is like gold to just get to some form of coordination or discussion and exchange of information between departments."[v] (Informant 4)

Appointed staff

Investment in dedicated staff is mentioned briefly: "Financial and human resources are allocated to take special preventive measures" (CMP, p.8). The Property and Traffic Management Department is responsible for assisting the other departments with experience and knowledge on water management issues (APCM, p.14), however one comment mentions that if the need for water competence remains it should be investigated whether other administrations should start financing the water competence or set up their own (APCM,

p.15). Additional know-how is available at VA SYD, who has the responsibility for communication and collaboration with external as well as internal stakeholders (APCM, p.10).

All informants explained that there is one staff working full-time as a cloudburst coordinator (the formal title is "water strategist"), located at the Property and Traffic Management Department. Informant 3 described that the role of the cloudburst coordinator has shifted from answering referral responses to supporting projects through collaboration (see section 5.2.6). Getting an assigned coordinator with the right competence and drive is a major outcome of the CMP (Informant 2, 3 and 4). Staff with know-how and personal commitment is considered vital:

"It is quite individually driven, because very few know how to do this […] I'm that expert, so if I don't have a drive to 'save the world', if I don't have the energy to fight, not much happens."[vi] (Informant 3)

Most of the internal collaboration is informal, it is easy to call someone to discuss issues and share ideas (Informant 2 and 3). There is a broad interest in stormwater management from colleagues at the involved departments and developers (Informant 3).

5.2.5 Mainstreaming

Mainstreaming strategy

The importance of mainstreaming of "cloudburst consideration" into the ordinary processes of all departments concerned is stressed, especially for the urban planning processes (CMP, pp.7-8). SOP integration as opposed to targeted cloudburst project is further highlighted in the APCM (p.9): "By integrating cloudburst consideration into ordinary operations, it is possible, at a relatively limited cost, to reduce the risks of cloudburst. Cloudburst adaptation through SOP integration can take place at the rate that the city is planned, built and managed. If cloudburst consideration is not integrated into ordinary operations, it is likely that the city's ability to deal with rainfall will instead decrease". The integration of the CMP into the urban planning process is described in the APCM (p.11). The coordinating group is responsible for making sure that other municipal strategies do not contradict the intensions of the CMP (CMP, p.21). The connection to other cross-cutting strategies is stated, by showing how the APCM is in line with other regulatory documents and municipal goals (APCM, pp.7; 24-25).

5.2.6 Stakeholder inclusion

Coordination mechanisms

For coordination, thematic groups have been appointed involving other actors, with specific responsibilities (CMP, p.22). How they work is not described.

When asked about the function of these groups, Informant 1 and 2 replied that they were only active in the creation of the strategy:

"I think there was some kind of idea that [the working groups] would continue, so that we could get input as a part of the cloudburst coordination, but we don't do that."[vii] (Informant 2).

Collaboration/participation mechanisms

Collaboration with private stakeholders is one of the main strategies to achieve the goals of the CMP (p.8), however the mechanisms for collaboration and participation are not described, hence general questions on stakeholder inclusion were asked. Structured cooperation with other authorities is not mentioned.

Informant 2 described an informal network with Stockholm and Gothenburg for information-sharing:

"*We send stuff to each other and there is quite a lot of people talking to us and we always say, 'you can have this'. Gothenburg has made a lot of investigations that they share, and that one can copy straight off. There is a large openness […] I think that is very sympathetic in this business."*[viii] (Informant 2)

"Cloudburst projects" is one of the strategies to reduce the impact of cloudbursts, although it is not explicitly connected to stakeholder inclusion (CMP, p.20). This was not an interview question, however Informant 3 described the water strategist's role in collaborative projects:

"I am always very welcome everywhere and I think that's because I don't tell people how to do their job, and I think that is a success factor. […] Everyone wants to do as good a job as possible. In practice that means, asking me [for advice]. So much of that is what the working procedure is built on. I should be requested. […] "Once you have gotten me into a meeting it should feel a bit like, although the message can be painful, I have to bring them a few steps forward so that it still feels a little bit lighter than before the meeting, when everything was unclear […] then at least I have straightened out the conditions."[ix] (Informant 3)

When asked about stakeholder integration in urban planning, Informant 4 described that in parts of the planning process, public exhibitions are compulsory, to give the opportunity to citizens to voice their opinions.

The need for incentives to engage property owners in risk prevention is brought up in the CMP, but without further specification (p.34). Support to property owners is described briefly in the APCM, since it is part of VA SYD's stakeholder program "Making room for the water – together", targeting "all stakeholders" (APCM p.8).

VA SYD reaches out to stakeholders (both internal and external) in many different ways, facilitating action through support and expertise, and communicating their message:

"We talk about 'collective consciousness movement' and 'individual action'. Collective consciousness movement is that people should start thinking about water in another way, and then, individual action is where people actually do things."[x] (Informant 2)

According to Informant 3, developers are interested in "doing climate work" since it is good for their appearance:

"I have talked to developers who have told me that they'd love to work with this issue, since it is an issue that it's quite easy to get free bonus points for."[xi] (Informant 3)

Communication strategy

Communication is the overall means of stakeholder inclusion (CMP, p.22). Citizens and businesses are to be included in the communication of the execution of the CMP as well as in how to protect their own property from the effects of floods, for example through dialogue projects. Examples of measures that can be taken are provided (CMP, pp.30-31). VA SYD's program "Making room for the water – together" is the primary channel of communication (APCM, p.8).

A group for coordination of communication has been formed parallel to the coordinating group, led by a communicator from VA SYD (Informant 2 and 4). The program has an interactive webpage[3] with information on projects to mitigate stormwater, and what different stakeholders can do to help. They also work with social media and physical outreach actions. In this work, they test different messages and how private stakeholders respond to them (Informant 2). Data is collected to measure the effectiveness of campaigns and adjust the measures accordingly.

5.2.7 Learning

Mechanisms for knowledge transfer and capacity building

Knowledge enhancement is one of the CMP's main strategies (CMP, p.8). Examples of cloudburst management measures previously implemented in the city are provided (CMP, pp.35-36), suggesting an integration of lessons learned. Education of staff on how to implement cloudburst consideration is part of the first short-term goal (CMP, p.7), but how this is done was not described. One of the tasks of the coordination group is to gain new knowledge and learn from research through science-policy collaboration (CMP, p.21). Integration of bottom-up knowledge briefly mentioned within the communication strategy (CMP, p.22).

Several information events for department staff have taken place and formal structures are needed to legitimize the work, but in practice, lot of the knowledge transfer happens informally, within the departments as staff is working together with more experienced colleagues (Informant 1). VA SYD's staff function as a discussion and knowledge-sharing

[3] https://platsforvattnet.vasyd.se/

partner to the municipality (Informant 2), however the role of the water strategist for knowledge-transfer is highlighted by all informants.

"There is a general lack of competence, and that is no one's fault. It's just that this is a new topic and we don't really know who is supposed to do what. […] but one of the results of the Cloudburst Management Plan was that we got a water strategist."[xii] (Informant 2)

There is an internal knowledge-sharing process within the coordination group through presentations and discussions (Informant 4). The first year, the group focused on internal information-sharing, knowledge-building and discussing the prerequisites for cloudburst consideration in the departments. A lot of the work of the coordinating group is informing and communicating the need for cloudburst management and sharing knowledge on how it can be achieved with internal stakeholders.

"If for example the Service Department is about to do measures on their properties, they can gain knowledge on how to do certain procurement or modelling. Then [the water strategist] can assist with that knowledge at the meeting."[xiii] (Informant 4)

Guidelines and routines are updated continuously, however implementing cloudburst consideration is a craft learned through many years of experience (Informant 3).

Local knowledge is integrated through stakeholder dialogue by getting feedback from citizens through a report system for flooded basements (Informant 2). VA SYD also receives suggestions on actions from citizens.

5.2.8 Planning of measures

Combination of measures

The need for a combination of context-specific small- and large-scale measures to reach the goals of the plan is acknowledged (CMP, p.29-30). Two approaches to the implementation are described: "targeted cloudburst projects", with the specific aim to reduce stormwater from cloudbursts, and "integration of cloudburst consideration into the ordinary processes" – mainstreaming (CMP, p.20). Examples of measures in the CMP are predominantly small-scale blue-green[4] measures to store and delay the excess water locally (CMP, pp.30-32). The actions of each department for integration of the goals into SOPs and guidelines are listed in the APCM (pp.10-18), containing hard as well as green and soft measures: blue-green infrastructure to store and delay water (p.10, 13), new complementing sewerage (p.11), mobile pumps in response to stormwater (p.14), education of staff (p.12, 14, 17-18), revision of routines and guidelines (p.12, 14, 17) and communication and collaboration campaigns with external stakeholders (p.11). Integration of household or regional measures is not mentioned.

[4] Vegetation and water surfaces (also referred to as ecosystem-based adaptation).

Integration of physical measures with other municipalities or other authorities is not needed in Malmö, since most of the city has its own drainage basin (Informant 2). Due to the division of responsibilities, measures performed by households or private property owners cannot always be accounted for, even if they want to participate, since it is the responsibility of the municipality to manage the water, and they cannot force anyone to keep their measures:

"If you later sell the property and someone else comes and don't take care of their stormwater, then our system won't work, therefore we have to build a dam anyway to ensure that it will work. It gets damn counterproductive."[xiv] (Informant 2)

Nonetheless, it is sometimes possible to use flexible measures, for example moving water from a congested sewer by blocking the sewers and leading the water on the ground to another sewer (Informant 2). Since homeowners that delay water on their property reduce the stormwater volumes, they can adjust measures accordingly.

Previous projects are presented as examples of how measures can be implemented (CMP, p.35-38). The Technical Committee is responsible for suggesting where and how to implement targeted cloudburst projects (APCM, p.14). The possibility to use the targeted cloudburst projects to showcase, test and evaluate solutions before mainstreaming is not mentioned.

When asked about project implementation, it turned out that the focus has been primarily on mainstreaming. Informant 1, 2 and 3 described mainstreaming as much more resource efficient than targeted cloudburst projects:

"It will be incredibly expensive to do what we call targeted cloudburst measures, that is redevelopments that are only for taking care of stormwater. It costs several times more than if, in every single project we do, whether it is a construction project or a planning project, we do our best. If we take cloudburst consideration in our ordinary work, it becomes much much cheaper."[xv] (Informant 1)

Furthermore, targeted cloudburst projects require context-specific solutions which are very time consuming. Due to limited staff with expertise, only a few targeted projects can be planned every year and there are thousands of places that need adaptation measures (Informant 3). Yet there is pressure to build new homes, and if new development do not take cloudburst consideration the stormwater risk may increase.

The SOP integration enables an iterative, stepwise process where every intervention contributes to lowering the cloudburst consequences (CMP, p.32). Cloudburst management can be a catalyst for city renewal, playing one part in achieving other municipal goals (CMP, p.6). The measures integrated into SOPs have another main purpose than cloudburst management, which can be considered safe-to-fail. The multi-functional approach aims at providing co-benefits such as better traffic solutions or increased recreational value (CMP, p.6). Targeted cloudburst projects have to be multifunctional (CMP, p.26).

Timing of actions

Temporary response measures might be an alternative to physical measures: "The need for physical measures can be reduced by strengthening the ability and capacity to deal with emergency situations. This may include, for example, storage of mobile pumps and rubber cloths, as well as routines for how, where and by whom these should be used." (APCM, p.10). The structure for crisis management is described (CMP, p.12), but response measures that will be taken are not specified. There is no other information regarding flexible implementation or the use of trigger events as a window of opportunity to implement actions.

All informants agreed that they do not wait for a trigger event to implement measures but take the chance whenever they can. The informants all mentioned the crisis management organization and the possibility to close flooded underpasses using warning systems. Flexible measures can be seen within the "Making room for the water" program, where VA SYD experiments with new solutions "outside the box" and only continue with the measures that have effect (Informant 2).

Decision-support

Flood costs in other cities are described, to show the benefits of adaptation (CMP, p.23). Detailed evaluation and cost assessments of measures and alternatives are done within the APCM (p.9; 25). Aiming for cost-efficiency is mentioned several times (APCM, p.10; 14; 16) and cost-benefit analysis is mentioned in the context of retrofitting prioritized buildings (APCM, p.17). Optimization is materialized through prioritization of multifunctional measures since they are considered the most socially and economically viable (CMP, p.26). No use of optimization models for robust decision-making is mentioned.

When asked about the use of decision-support systems, Informant 1 and 3 described that they only do qualitative assessments, there is no quantitative modelling for optimization:

"It is difficult to produce data that shows that the benefit is 'exactly this much' and relate that to the cost. This is one such obstacle, very much so that one can say that - yes but here the benefit seems to be sufficiently large."[xvi] (Informant 1)

Trade-offs and conflicts between different functions are primarily addressed through proposing multifunctionality (CMP, p.8; 26). There is a general prioritization order for targeted cloudburst projects: (1) people's lives and services of vital importance, (2) material damage to homes and (3) businesses (CMP, p.32). The APCM highlight some conflicts: high workload calls for easier processes to assess plans and building permits and the city's expansion through densification will be in conflict with cloudburst management at some point (APCM, p.12). Measures on properties that do not receive targeted funding will burden the tenants and parks, which are cost-efficient locations to store water, might contain natural or cultural values that make them unsuitable for retrofitting (APCM, p.16).

Although no questions were asked about conflict management, Informant 1 and 3 came back to this issue several times, describing the difficulty prioritizations between different municipal objectives:

"There will be conflicts with everything else. Is [cloudburst consideration] prioritized over accessibility [for disabled people]? Should this be prioritized over reducing costs in a development project, meaning fewer buildings? How much does this get to push away other things?"[xvii] (Informant 3)

When discussing "acceptable risk", the conflict of interests was also highlighted:

"If we say that we accept that we are moving towards a larger cloudburst resilience slowly, then we can do so at a reasonable cost. If we are to force it, then the cost will be tremendous, and it will affect other parts of society. If we use our societal resources only for climate change adaptation now, other things will be lost."[xviii] (Informant 1)

5.3 Implementation phase

The Implementation phase contains four categories: financing, implementation, monitoring and revision, including six "what" criteria and 13 corresponding "how" criteria (see Table 8).

Table 8.

Summary of the document analysis results for the implementation phase.

CATEGORY	WHAT	In doc.	HOW	In doc.	Q
Financing	External funds	Y/N	Apply for specific CCA funding	Y/N	*
			Mainstream CCA into externally funded projects	No	*
	Internal funds	Yes	Fund specific projects/actions	Y/N	*
			Support individual adaptation measures	Y/N	*
Implementation	Compliance/ enforcement mechanisms	Y/N	Use informal rules to change working procedures	No	*
			Set non-binding soft policies for flexibility	Y/N	*
			Make rules/regulations binding	No	*
			Ensure transparency	No	-
Monitoring	Indicators	No	Combine top-down and bottom-up indicators	No	*
			Ensure thresholds (tipping points) contain enough time to avoid critical state	No	*
Revision	Evaluation	Y/N	Multiple criteria (social, economic, environmental)	No	-
	Strategy revision	Yes	Use lessons learned to inform strategy revision	Y/N	*
			Use lessons learned to inform mainstreaming	Y/N	*

Note. Success factor coverage in the CMP or the APCM (in doc.) are marked with Yes, No or Y/N, for existing, but in need of further description. Criteria subject to interview questions (Q) are marked with *.

5.3.1 Financing

External funds

The possibility to attract large-scale investments to protect national interest against floods is mentioned, but not elaborated (CMP, p.25). In the APCM, applying for EU or national funding is suggested "when possible" (APCM, p.20). Applying for funding for CCA is one of the measures of the Environment Committee (APCM, p.18). There was hope that the official report on CCA could lead to national financing of measures (CMP, p.11).

When asked about the outcome of the report, Informant 1 explained that no new national funding mechanisms became available. Informant 1 and 3 provided a couple of examples of externally funded projects which have been used for targeted cloudburst projects, however according to Informant 3, the contribution is small compared to the funding needed to reach the goals of the plan. Mainstreaming of cloudburst management into other externally funded projects is not mentioned in the documents and is outside the scope of this thesis.

Internal funds

Internal budget allocations are appointed for cloudburst management projects, while mainstreaming does not receive additional funding (CMP, p.24). Contradicting the CMP, the APCM suggests targeted yearly funding should be investigated, since there is too little information available (APCM, p.19). "In the long term, it may be relevant to propose an annual cloudburst allocation within the city's investment management. But at present there is not considered to be a sufficient decision basis." (APCM, p.20). Targeted funding can be used on private land "if the law allows it" (CMP, p.25).

Informant 2 and 3 were asked about funding individual measures. Informant 3 explained that supporting private adaptation initiatives financially can be difficult, since it can fall under corruption. Informant 2 described that the water company has been compensating private homeowners financially, for leading their downpipes to an alternative recipient to the sewerage since the 1990's. In recent years, this offer has become more popular.

5.3.2 Implementation

Compliance and enforcement mechanisms

The enforcement mechanisms are the ones regulated by law (CMP, pp.11-12). Compliance mechanisms are not clearly stated. Phrases with "shall", "should" and "could" are used, but the consequences of non-compliance are absent (CMP, pp.26-28). Informal rules to change working procedures are not described.

Informal rules to change working procedures include updates of guidelines and routines to include cloudburst consideration (Informant 1, 2 and 3). According to Informant 1, each committee can have a higher or lower ambition level than the Executive Committee. The departments can consider the importance of cloudburst management differently. While the CMP was decided by the Executive Committee, the APCM, has been decided by the respective committees, and hence it is up to each committee to comply.

"The municipality does not function like a computer where you program instructions from above and they reach the committees and departments. It works more like a football team or a choir, that the information spreads out and spreads faster in certain parts and less quickly in other parts."[xix] (Informant 1)

According to Informant 3, the non-binding regulations highlight the conflict of interests, for example between building quickly and efficiently and integrating cloudburst consideration. More binding regulations could increase clarity, but it is difficult to say that it would lead to higher compliance.

5.3.3 Monitoring

Indicators

No indicators are specified in the CMP. Only one indicator is specified in the APCM; the Urban Planning Committee is to "calculate and report 'cloudburst balance' in the detailed plans that are established" (APCM, p.12), clarifying whether the plan reduces or increases the flood risk.

The lack of indicators was confirmed by all informants. Informant 3 explained that it has been difficult to develop good indicators. According to Informant 1, the coordinating group would like to use the cloudburst balance indicator, but they have not gotten an approval by the Urban Planning Committee. The decision on what is considered an acceptable disturbance is going to influence the formulation of indicators (Informant 3 and 4). Indicators are successfully used in the "Making room for the water" program (Informant 2).

5.3.4 Revision

Evaluation

Evaluation is integrated into the processes of the respective committees and the effects of the APCM are to be evaluated and reported in 2022 (APCM, p.6). The type of criteria is not stated, however cost-efficiency is mentioned: the evaluation is to be spread to other actors, to increase the knowledge in the stormwater sector which should lead to more cost-efficient solutions and a critical examining of the experiences, which in turn will create a more robust cloudburst management (APCM, p.21). Other sustainability measures are not mentioned.

Strategy revision

The coordinating group is responsible for monitoring the need for revision annually, for example due to new legislation (CMP, p.8). Revision for mainstreaming is briefly described (CMP p.34).

When asked about the revision process, all informants saw a need for revision. Informant 1 pointed out that there is already a distinction between the CMP and APCM in terms of understanding that targeted cloudburst projects would not be economically feasible. Detailed modelling and mapping of the consequences of a 100-year rainfall scenario had not been completed when the CMP was established (Informant 1 and 3). Malmö's CMP is the first of

its kind in Sweden, it was a new kind of strategy and there was little knowledge on cloudburst management, which implied that there was difficult to know what it should contain (Informant 1, 2 and 4). According to Informant 3 and 4, the goals need to be revised, which goes along with specifying the concept of acceptable disturbance. The revision process is resource demanding and that resources are better spent on implementation (Informant 2 and 3).

Informant 3 reasoned that it can be wise to attract attention to an issue, for example through the use of steering committees and a formal inauguration of a new strategy. A full integration of the CMP into urban planning has been discussed, through the inclusion of cloudburst management goals into the Comprehensive Plan (Informant 1). Informant 3 discussed the difficulty of integrating all the strategic plans of the city into every project, since they are sometimes in conflict with each other. In that sense, a full SOP integration can be easier to manage.

Finally, Informant 2 conclude that the process may be more important than the actual document:

"it is the fact that people have gathered and talked across [administrative] boundaries, that have brought the work forward. I find it difficult to understand municipalities that let consultants produce a cloudburst plan. It's pointless. After all, it is the fact that you meet and discuss things that make it good in the end."[xx] (Informant 2)

6 Discussion

In this chapter the methodology and results of the scoping study and strategy assessment are discussed.

6.1 Methodology and limitations

A scoping study was conducted to answer the first research question: *According to scientific literature, what are the criteria for successful implementation of climate change adaptation strategies, from a risk-based urban planning perspective?* As described in section 3.1.1, there is terminological diversity in the CCA field which may have left out articles using other keywords. Aspects that were not covered by the Scopus search may have been excluded. Moreover, aspects that did not fit preconceived ideas might have been left out inadvertently. Furthermore, the level of detail of the criteria may lead to the exclusion of aspects that do not "fit in the boxes".

Document analysis was selected as the main method to answer the second research question: *What are the strengths and weaknesses of Malmö municipality's Cloudburst Management Plan [CMP], according to the identified criteria?* The assessment of a CCA strategy has to look at the context in which the strategy is being implemented and the systems within the city have to be well-understood (Abarca-Alvarez et al., 2019; Wamsler, 2014). It is not self-evident that a document analysis can establish the success of strategy implementation, since there might be a gap between policy and practice. Therefore, interviews were added to better understand this link. The interviews provided insight into the link between a strategic CCA document and its implementation and important informal structures not mentioned in strategic documents could be highlighted. An example of disparity between the documents and interviews, is the role of directed cloudburst projects and corresponding funding, which is emphasized in the documents, but in practice, they are very few. Furthermore, according to the interview data the long-term goals were set without a detailed understanding of the scale of measures that is needed to reach them, which shows that the decision-support was insufficient. This was not captured by the document analysis. Several authors point out that due to the context-specific nature of CCA, the reason for success varies from case to case (e.g. Birkmann et al., 2010; Galderisi, 2014). Therefore, informants were given the opportunity to add aspects that were not covered by the questions; however, the interview framed the conversation and may have limited them to think of certain things.

The inclusion of the action plan (APCM) to the document analysis added insight into the implementation of the CMP. Adding other documents such as the Comprehensive Plan, the "Action Plan for CCA", the Technical Handbook and the website for the "Making room for the water – together" program (Malmö stad, 2012, 2018b, 2019; VA SYD, 2019) could have further broadened the understanding of Malmö's strategic work with CCA for resilience. Nonetheless, the benefits of combining document analysis with interviews imply that adding more documents entail adding more interviews, which was not possible within the scope of a master thesis.

6.2 Scoping study

Urban CCA can bring the DRM and urban planning fields together, to avoid an urban development that increases risk while adapting to climate change (Revi et al., 2014; Wamsler et al., 2013). Although the adaptation challenges are diverse there are common success factors (Adger et al., 2005; Hagen, 2016). In the scoping study, 26 "what" criteria and 69 "how" criteria for successful implementation of CCA strategies were identified. The high number of criteria was not expected, however the collating process made clear that a relatively high level of detail would facilitate the document analysis. Some criteria, like financial resources and staff, are considered fundamental, while the importance of others depend on the enabling environment and organizational structures of the specific case (Hamin et al., 2014; Pelling, 2011). All but four of the criteria found in the scoping study were backed up by several articles, suggesting that they have a generic value beyond the specific cases. The "what" criteria address root causes (e.g. institutional environment) as well as dynamic pressures (e.g. leadership and internal organization) that affect the implementation (Aven & Renn, 2010; Wisner et al., 2003). Furthermore the criteria overlap with aspects of risk governance, such as responsibility, stakeholder inclusion and compliance and enforcement mechanisms (Kingsborough, 2016; van Asselt & Renn, 2011). Due to the context-specific nature of CCA, the "how" criteria can be considered examples from the literature of successful implementation in similar contexts rather than a complete list.

Despite the orderly manner in which the criteria are presented, it is not self-evident what constitutes a "what" and "how" criteria. The criteria are not equally weighted; several criteria are crosscutting applying to multiple categories or aspects than where they were placed. Tables were selected to present an overview, similarly to Galderisi (2014) and Shi et al. (2015). Other articles describe the categories and their relationships in more general terms (e.g. Dai et al., 2018; Lehmann et al., 2015). Figure 2 (in section 4.1) shows how the relationship between the categories and their success factors influence each other in a more complex system than presented in Table 3, 4 and 5.

While CCA assessments of success factors or barriers to CCA outside of this scoping study share similar categories (e.g. Hamin et al., 2014; Moser & Ekstrom, 2010; Woodruff & Stults, 2016), few provide detailed success criteria. Woodruff & Stults use 124 criteria "associated with six well-established plan quality principles" for a quantitative evaluation of adaptation strategies in the United States (Woodruff & Stults, 2016, p.796). Likewise, similar categories and assessment criteria are found in DRM literature (Aven & Renn, 2010; Coppola, 2011; Wisner et al., 2003) as well as in literature on CCA in urban planning (Hagen, 2016; Johnson, 2011; Wamsler, 2014).

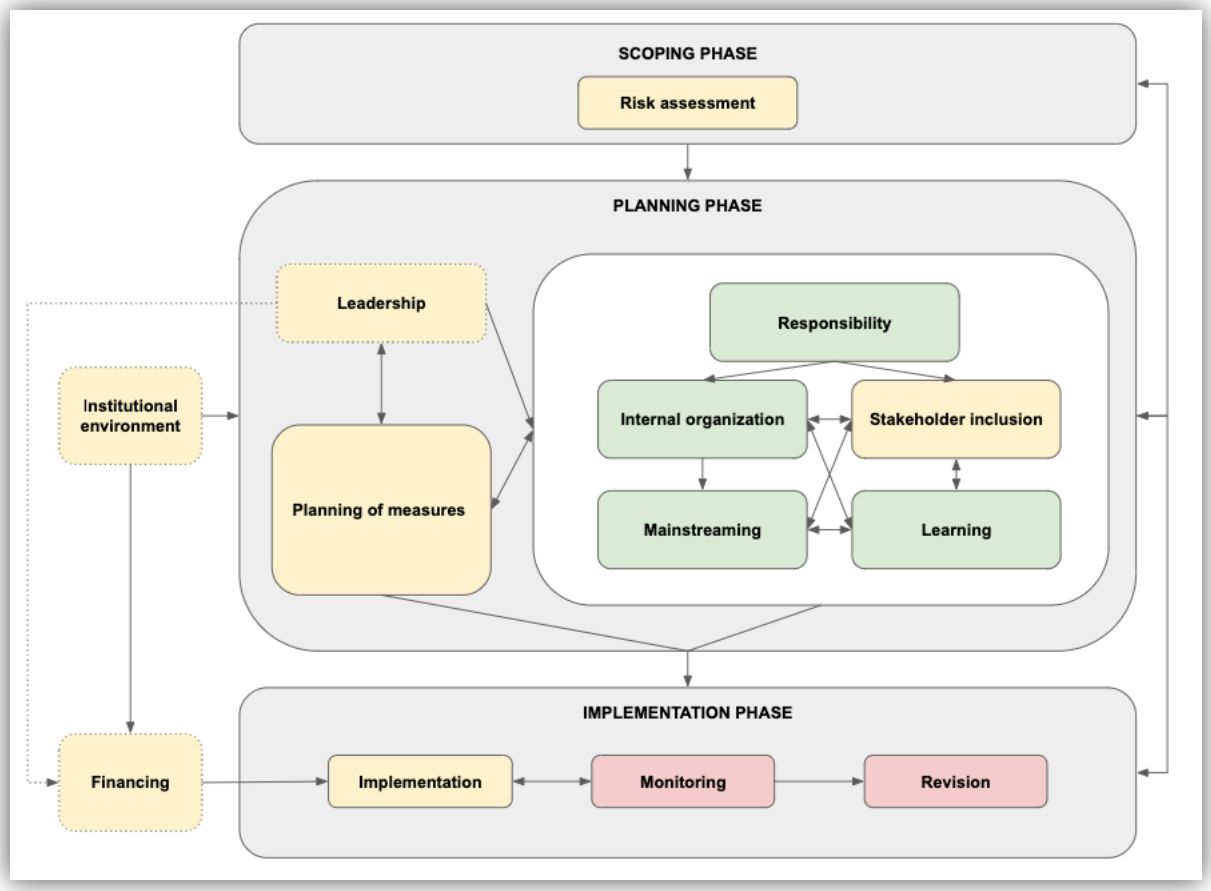
6.3 Strategy assessment

Malmö municipality's cloudburst management strategy has both strengths and weaknesses (see overview in Figure 4). Strengthening the adaptive capacity can accelerate the implementation (Renn & Klinke, 2013; Smit & Wandel, 2006). The interviews highlighted the cross-departmental coordination, the collaboration within and between the municipal

authorities – supporting knowledge sharing – and the employment of dedicated staff for implementation of measures and capacity-building. These strengths were confirmed by the document analysis and relate to the categories *internal organization*, *responsibility*, and *learning*. Furthermore, the document analysis showed a strong focus on education of staff and mainstreaming of cloudburst consideration at several departments – related to the categories *mainstreaming, learning* and *responsibility* (see green categories in Figure 4). Participation from external stakeholders can strengthen the adaptive capacity (Aven & Renn, 2010; Woodruff & Stults, 2016). The importance of *stakeholder inclusion* in all CCA process phases is highlighted in the CMP, but private stakeholders are treated outside the scope of the plans which made their role difficult to assess. There seems to be engagement from developers to add adaptation measures when building, but the current legislation complicates acting upon these efforts. Households and other private stakeholders are addressed through VA SYD's program "Making room for the water – together", however their role in reducing flood risk could not be covered within the scope of this thesis.

Figure 4.

Overview of the strengths and weaknesses of Malmö municipality's Cloudburst Management Plan.



Note. Green categories predominantly have strengths. Yellow categories have both strengths and weaknesses.

Red categories have mostly weaknesses.

Successful adaptation ensures a sustained adaptation process that transforms the development pathways within planetary and social boundaries (Becker, 2014; Nelson et al., 2007). The one-hazard approach might facilitate implementation, as the measures needed and the competence required become concrete (Lyles et al., 2018); however, it needs to be put into multi-hazards context (UNISDR, 2015). The mainstreaming of "cloudburst consideration" and coordination between departments, together with learning mechanisms support the sustainability of the CMP. Nonetheless, specific competence and know-how takes time to build, hence learning can become a bottleneck for implementation.

Multifunctional measures provide co-benefits and enhances resource efficiency (Grafakos et al., 2019; Wamsler, 2015). The mixed-use approach used in the CMP enhance robustness of measures while detailed decision-support is lacking. The implemented targeted cloudburst projects contribute to lowering the risk in the most vulnerable areas and the implementation through mainstreaming support the reduction of flood risk as the city continues developing. Nonetheless, the level of compliance depends on the long-term support from politicians, which may shift depending on their priorities. Uneven political support amongst the committees make the implementation stronger in some departments and weaker in others. Therefore, the lack of a high-level CCA office may negatively affect the weight of the CMP. The limited funding, particularly of extra costs related to cloudburst consideration and staff with the right competence, affect the possibilities to implement the measures. Additionally, the current legislation does not assign responsibility for CCA to any authority, which influences the municipality's incentives to act, with many other responsibilities to be met with a limited budget and no targeted funding is provided from the national level. There is also a lack of national guidelines to inform the decision-making process. Conclusively, the categories *institutional environment*, *leadership*, *planning of measures* and *financing* have both strengths and weaknesses which strongly influence *implementation* (see yellow categories in Figure 4).

Risk-informed CCA strategies improve the understanding of disaster risk and support the implementation of robust measures (Hagen, 2016; Johnson, 2011). According to all informants, the main weakness of the strategy is the lack of clarity regarding risk acceptance (what is referred to as "acceptable disturbance"). While the risk assessment covers most criteria, the limited understanding of the scale of measures needed to reach the long-term goal, the cost of implementation and the conflicts with other interests, has led to the goals of the CMP being too ambitious. Likewise, the lack of clarity regarding acceptable disturbance influences the possibility to set well-defined goals and prioritizing measures. This indicates a strong link between the categories *risk assessment*, *leadership* and *planning of measures* (see yellow categories in Figure 4). A process to define acceptable disturbance is currently under way and will supposedly strengthen these categories. Furthermore, without clear goals it is not possible to set indicators for *monitoring.* There are still no indicators in place; the cloudburst balance indicator may not be used to monitor the CMP. A high-level office for CCA, placed at the planning unit is a success factor which is not present in the CMP (e.g. Hurlimann et al., 2014). Had cloudburst management been the responsibility of the planning unit this

indicator might have been available. Finally, *revision* of the CMP is not prioritized due to limited time and resources, though the APCM is being revised in 2022 (see red categories in Figure 4). This indicates that lessons learned are focused on the measures rather than the strategy as a whole. A revision of the CMP could strengthen the organizational learning for strategy development, which is highly needed in the novel field of CCA (Pelling, 2011; Tyler et al., 2016).

6.4 Broader implications

The assessment framework developed in this study can be used to describe the strengths and weaknesses of a CCA strategy qualitatively rather than quantifying how many criteria are checked. In other words; a strategy that fulfills many "how" criteria is not necessarily better than one that fulfills fewer. It is a matter of having good strategy content (that covers most "what" criteria) which is linked to the implementation (the "how" criteria).

The CMP is the first strategy of its kind in Malmö, hence the room for improvements is natural. The assessment highlights the important role that structures for coordination, collaboration, learning and mainstreaming play in Malmö. The use of soft, hard and green measures exemplifies how several context-specific measures can be combined to enhance urban resilience. The assessment further emphasizes the importance of a detailed and thorough risk assessment and tools for robust decision-making to address uncertainty, prioritization of measures and secondary consequences of measures taken. Challenges such as long-term commitment, resources availability and conflicting interests are probably similar in other strategies and hence need to be addressed. Moving the responsibility for CCA to the Urban Planning Committee could strengthen the mandate for CCA, however, there is a risk that the other committees back off if one party is assigned responsibility. The results also indicate that there is need for more extensive stakeholder involvement in the urban planning processes.

Revising the CMP could support organizational learning for developing other strategies. The lessons learned from the development and implementation of the CMP can be used to inform a broader CCA strategy or other hazard-specific strategies, such as heatwaves or sea-level rise (Malmö stad, 2015). The experience of constructing the CMP suggests that the development process itself can enhance successful implementation through the collaboration and inclusion of several stakeholders. Likewise, the existence of a strategy can be a catalyst for the implementation of adaptive measures.

7 Conclusion

This thesis sought to find success criteria for the implementation of climate change adaptation (CCA) strategies in urban planning from a risk-based urban planning perspective and assess Malmö municipality's Cloudburst Management Plan (CMP) according to these criteria. A scoping study showed that successful implementation of CCA strategies are based on the strategy containing certain essential concepts (26 "what" and 68 "how" criteria). While the "what" criteria describe the content of a good CCA strategy, the "how" criteria provide examples of successful implementation. They can be placed into a CCA process containing three interconnected phases: scoping, planning and implementation. Success criteria for the scoping phase are connected to a detailed *risk assessment* that informs the planning phase. Success criteria for the planning phase are found in eight categories: *institutional environment, leadership responsibility*, *internal organization, mainstreaming, stakeholder inclusion, learning* and *planning of measures*. In the implementation phase, success criteria can be related to *financing*, *implementation* (through compliance and enforcement mechanisms), *monitoring* and *revision*. The CCA process allows for the uncertainties that characterize climate change to be addressed and managed: lessons learned from the implementation phase inform a revised risk assessment as well as the planning phase.

Through a document analysis and interviews it was concluded that the CMP is successful in structuring the internal organization in a way that supports the coordination between departments and the mainstreaming of measures into standard operating procedures. Furthermore, the internal organization, through dedicated staff and cross-departmental coordination, supports the knowledge enhancement of staff as well as of external stakeholders. The main weaknesses identified are the lack of definition of acceptable risk – influencing goal setting, prioritization and monitoring of measures – and the lack of compliance mechanisms and resources to support implementation.

The CMP and the corresponding action plan enable the municipal actors to collaborate in the development of capacities needed to reduce the risk of flooding due to cloudburst. The risk could be further reduced by enhancing resources availability and strengthening the decision-support system and internal accountability mechanisms. Furthermore, since neither the national level nor the municipalities are responsible for CCA the actions that a municipality can take are limited. It is not reasonable to expect the city to do more than the laws oblige, when many municipal obligations are competing for resources. With a clearer strategy for stakeholder inclusion into the urban planning processes, private resources could be added. How this can be done is a suggestion for future research.

8 References

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Appendix 1: Example of data charting

Quote	Source	Supporting sources	Keywords	Author's categorization
Vulnerability assessments should be multi-dimensional (physical, systemic, social, economic, environmental, institutional, etc.)	Galderisi, 2014, p.555	Birkmann et al., 2010, p.203	Vulnerability assessment, multi-dimensional	Vulnerability and capacity assessment
taking into account vulnerability factors such as exposure, sensitivity and adaptive capacity.	Grafakos et al., 2019, p.92	Abunnasr et al., 2015 Shi et al., 2015 Mabon et al., 2019, p.282 Kirshen et al., 2015, p.1	vulnerability, capacity assessment	
It is also necessary to have a clear oversight of the city's existing infrastructure and its capacity.	Dai et al., 2018, p.657	Ulrich & Rauch 2014 Wamsler, 2015 Reckien et al., 2019	capacity assessment	
mainstreaming adaptation policies into existing disaster risk management and land-use planning process.	Galderisi, 2014, p.556	Reckien et al., 2019	Mainstreaming into DRR into LUP	Mainstreaming
mainstreaming climate actions into existing plans (e.g. sectoral plans, development plans) can help to ensure proper implementation and accountability	Grafakos et al., 2019, p.93	Lyles et al., 2018, p.1996 Shi et al., 2015, p.198 Mabon et al., 2019, p.280 Lehmann et al., 2015, p.88 Hurlimann et al., 2014, p.85	Mainstreaming into existing plans	
this study shows the importance of combining mainstreaming strategies to balance the shortcomings in individual activities, including vertical and horizontal approaches.	Wamsler, 2015, p.11	Wamsler et al., 2014, p.196 Hurlimann et al., 2014, p.85 Birkmann et al., 2010, p.203	Mainstreaming combining strategies	
Systematic mainstreaming at the institutional and interinstitutional levels is an indispensable precondition for achieving sustainable implementation of on-theground measures.	Wamsler et al., 2016, p.10		Mainstreaming, cross-cutting	

Appendix 2: Overview of interviews

Number	**Organization**	**Role**	**Date & interview length**
Informant 1	Urban Planning Office	Cloudburst coordinator substitute	2020-03-20 57 min
Informant 2	Water management local federation (VA SYD)	Program manager	2020-03-20 55 min
Informant 3	Property and Traffic Management Department	Cloudburst coordinator	2020-03-24 1 h 24 min
Informant 4	Environment Department	Project manager	2020-03-25 60 min

Appendix 3: Letter to informants (Swedish)

Hej!
Tack för att du tar dig tid att delta i min studie. Jag studerar masterprogrammet ”Katastrofriskhantering och klimatanpassning” vid Lunds tekniska högskola. Intervjun jag kommer att hålla med dig kommer att ge mig data till min masteruppsats på temat framgångsfaktorer för klimatanpassningsstrategier i stadsutveckling. Det övergripande syftet är att utvärdera Malmö stads skyfallsplan för att se vilka framgångsfaktorer och utmaningar som finns, och därigenom hur lärdomar från skyfallsplanen skulle kunna användas i andra klimatanpassningsstrategier. Temat är alltså urban klimatanpassning generellt, med skyfallsplanen som exempel. Jag har identifierat framgångsfaktorer för klimatanpassning och jämfört dessa med Malmö stads skyfallsplan. Framgångsfaktorerna behandlar teman som en klimatanpassningsplan bör innehålla samt hur styrning och organisation bör se ut för att implementeringen ska vara framgångsrik. Frågorna jag kommer att ställa berör sådant som inte framgår av skyfallsplanen, eller där jag behöver förtydliganden.

De uppgifter du lämnar kommer endast att användas i forskningssyfte. Uppsatsen publiceras på Lunds universitets databas LUP-SP. Det är också möjligt att få ett fysiskt exemplar av studien, om du vill. Dina personuppgifter kommer att hållas konfidentiella, i enlighet med Vetenskapsrådets forskningsetiska principer. Namn och indikatorer som gör det möjligt att identifiera dig kommer inte att ingå i uppsatsen. Du kan välja att avbryta intervjun och ditt deltagande i studien när som helst. Jag ber om ditt samtycker till att intervjun spelas in. Inspelningen kommer endast användas för personligt bruk, för att analysera insamlade data. Ljudinspelningarna kommer att förvaras på en privat hårddisk, direkt efter intervjun.

Med vänliga hälsningar
Sanna Dufbäck Fornander

Appendix 4: Letter to informants (English)

Hi,
Thank you for participating in my study. I study the master program "Disaster risk management and climate change adaptation" at Lund University. The interview I am about to conduct with you will give me data for my master thesis on success factors for climate change adaptation strategies in urban planning. The overall purpose is to evaluate Malmö municipality's Cloudburst Management Plan to see which success factors and challenges it contains, and thereby learn how the Cloudburst Management Plan can be used in other climate change adaptation strategies. The theme hence is climate change adaptation in general, with the Cloudburst Management Plan as an example. I have identified success factors for climate change adaptation and compared them to Malmö municipality's Cloudburst Management Plan. The success factors concern themes that a climate change adaptation plan should contain and how direction and organization should look like for successful implementation. The questions I will ask concern things not shown in the plan, or where I need clarifications.

The data you provide will only be used for research purpose. The thesis will be published at Lund University's database LUP-SP. It is possible to get a physical copy of the study, if you would like. Your personal information will be kept confidential, according to the ethical principles of the Swedish Research Council. Name and identifiable characteristics will not be part of the thesis. You can choose to cancel the interview and your participation in the study at any time. I ask for your consent to the interview being recorded. The recording will only be used for personal use, to analyze collected data. The audio recordings will be stored on a private hard drive, immediately after the interview.

Sincerely,
Sanna Dufbäck Fornander

Appendix 5: Interview protocol (Swedish)

Tidpunkt för intervju:

Intervjuare:

Respondent:

Formalia

- Är det okej att jag spelar in intervjun? (bara jag kommer att lyssna på filen?)
- Du kan när som helst avbryta, personuppgifter hålls konfidentiella och du får möjlighet att godkänna uppgifterna innan publicering.

Beskrivning av projektet

I min studie undersöker jag framgångsfaktorer för klimatanpassning i stadsplanering. Jag har identifierat framgångsfaktorer för klimatanpassning och jämfört dessa med Malmö stads skyfallsplan. Framgångsfaktorerna behandlar teman som en klimatanpassningsplan bör innehålla samt hur styrning och organisation bör se ut för att implementeringen ska vara framgångsrik. Frågorna jag kommer att ställa berör sådant som inte framgår av skyfallsplanen, eller där jag behöver förtydliganden. Frågorna berör samordning och kommunikation, robusta åtgärder, ansvarsfördelning, finansiering och uppföljning, utvärdering och revision.

Inledande frågor

- Vad är din yrkestitel?
- Beskriv vad din och (din förvaltnings) roll är i arbetet med skyfallsfrågor
- Hur länge har du arbetat med detta?
- Hur används skyfallsplanen i ditt arbete?

Generellt om skyfallsplanen

1) Hur tycker du att skyfallsarbetet fungerar i Malmö, generellt?
2) Vad utgör hinder för implementeringen av skyfallsåtgärder? (t.ex. strukturella, ekonomiska, etc.)
3) Vilken roll har skyfallsplanen haft i Malmös skyfallsarbete de senaste åren?

Samordning, kommunikation och lärande

Internt

4) Vilken är (din förvaltnings) roll i samordningsgruppen?
5) Hur fungerar samordningen av planering av prioritering i praktiken?
    a) Hur fungerar kunskapsutbyte och kommunikation mellan medarbetare?
    b) Hur fungerar samfinansiering?
    c) Vad är gruppens mandat?
6) Finns exempel på informella samarbeten?

Integrering i ordinarie verksamhet

7) Hur integreras skyfallshantering i (din förvaltnings) ordinarie verksamhet?
    a) Hur gör ni för att integrera nya frågor i er verksamhet?
    b) Hur använder ni tidigare erfarenheter av skyfallsplanering?
8) Hur integreras skyfallsplanering i stadsplanering (ÖP, detaljplan)?

Externa aktörer

9) Involverar ni privata verksamheter och medborgare? Hur?
    a) Tematiska grupper?
    b) Kunskapsverktyg?
    c) Informationskampanjer?
10) Hur fungerar kunskapsinhämtning från verksamheter och medborgare?

Nationellt

11) I vilken mån utgår ni ifrån nationell vägledningen kring skyfallsfrågor/klimatanpassning?
12) Hur har Klimatanpassningsutredningen påverkat Malmös skyfallsarbete?

Robusta åtgärder

13) Hur ser ni till att de åtgärder ni genomför är robusta?
    a) Hur tänker ni kring att åtgärderna ska vara robusta för ett föränderligt klimat? En föränderlig omvärld?
14) Planerar ni för flexibla åtgärder som kan genomföras ”vid behov”? Dvs. som utlöses av specifika händelser (triggers)?
15) Vad för slags verktyg (beslutsstödsystem) används för prioriteringen av åtgärder?
    a) T.ex. Optimeringsmodeller, multikriterieanalys, kostnad-nyttoanalys, kostnadseffektivitetsanalys
16) Hur integreras informella (individuella) och formella åtgärder?

Ansvar och tillämpning

17) Vad är det som styr (din förvaltnings) arbete med skyfallsplanering? (Vilka styrmedel/ styrsystem används)
    a) (Vad utgör tvingande krav, och vad är rekommendationer?)
    b) Vad är konsekvenserna ifall mål inte uppfylls?
18) Hur fördelas ansvar mellan offentliga och privata aktörer?

Finansiering

19) Hur säkerställs den långsiktiga finansieringen av skyfallsplanen?
20) Söker ni extern finansiering? – exempel?
21) Finansierar ni privata anpassningsåtgärder? – vilka?

Uppföljning, utvärdering & revision

22) Vilken typ av indikatorer använder ni i uppföljningen av skyfallsarbetet?
23) Vad skulle utgöra anledningar till att revidera skyfallsplanen, enligt dig?
    a) Klimatanpassningsutredningen?
    b) Ändrade förhållanden?
    c) Nya kunskaper?
24) Hur ser ni på hur andra klimatrisker (t.ex. havsnivåhöjning) kan komma att påverka skyfallsplaneringen?
25) Hur tycker du man kan tänka kring vad som är en acceptabel risk?
    a) Hur involveras allmänhetens och andra intressenters riskuppfattning?
26) Vilken typ av mål är rimliga att ha i en skyfalls- eller annan klimatstrategi?

Avslutande frågor

- Det var alla frågor jag hade. Finns det något mer som du vill tillägga?
- Tack för ditt deltagande. Är det okej om jag återkommer via mejl om jag har ytterligare frågor?

Appendix 6: Interview protocol (English)

Time of interview:
Interviewer:
Informant:

Formalities

- May I record the interview? (only I will listen to the file)
- You may quit whenever you'd like, personal information will be kept confidential and you will be given the opportunity to confirm your data before publishing

Description of the project

In my study, I investigate success factors for climate change adaptation (CCA) in urban planning. I have identified success factors for CCA and compared them to Malmö municipality's Cloudburst Management Plan. The success factors treat themes that a CCA strategy should contain and how direction and organization should look like for successful implementation. The questions I will ask concern things not shown in the plan, or where I need clarifications. The questions concern coordination and communication, robust measures, division of responsibility, financing, and monitoring, evaluation and revision.

Introductory questions

- What is your work title?
- Describe your and your department's role concerning cloudburst management
- How do you use the Cloudburst Management Plan (CMP) in your work?

General questions on the CMP

1) What do you think of the work on cloudburst management in Malmö, generally?
2) What are barriers to the implementation of cloudburst measures? (e.g. structural, financial etc.)
3) What is the role of the CMP in how Malmö works with cloudburst management, in recent years?

Coordination, communication and learning

Internal

4) What is the role of your department in the coordinating group?
5) How does the coordination of planning and priorities work in practice?
    a. Knowledge sharing and communication between staff?
    b. Co-financing?
    c. What is the mandate of the group?
6) Are there examples of informal collaboration?

SOP integration

7) How is cloudburst management integrated into your department's ordinary activities?
    a. How do you integrate new themes into your ordinary activities?
    b. How do you use previous experience of cloudburst management?
8) How is cloudburst planning integrated into urban planning (comprehensive planning, zoning?)

External actors

9) Do you involve private companies and citizens? How?
    a. Thematic groups?
    b. Knowledge tools?
    c. Information campaigns?
10) How do you learn from private actors and citizens? (bottom-up)

National

11) To what extent to you use national guidelines regarding cloudburst management/CCA?
12) How has the official report on CCA affected Malmö's work on cloudburst management?

Robust measures

13) How do you make sure that the measures you perform are robust?
    a. How do you reason regarding robustness towards a changing climate? A changing environment?
14) Do you plan for flexible measures to be used if needed? Triggered by specific events?
15) What type of tools (decision-support systems) are used to prioritize measures?
    a. E.g. optimization models, multi-criteria analysis, cost-benefit analysis, cost-effectiveness analysis
16) How are informal (individual) and formal measures integrated?

Responsibility and compliance

17) What controls your department's cloudburst management work? (Which compliance/enforcement mechanisms are used?)
    a. What are binding regulations and what are recommendations (non-binding)?
    b. What are the consequences of non-compliance with goals?
18) How is responsibility divided between official and private actors?

Financing

19) How do you ensure the long-term financing of the CMP?
20) Do you apply for external funds? Examples?
21) Do you finance private adaptation measures? – which?

Monitoring, evaluation & revision

22) What type of indicators do you use to monitor the work with cloudburst management?
23) What would be reasons to revise the CMP, according to you?
    a. The official report on CCA?
    b. New conditions?
    c. New knowledge?
24) How do you think other climate risks (e.g. sea-level rise) could affect the Cloudburst Management Plans?
25) How do you think one can reason regarding acceptable risk?
    a. How are citizens and other stakeholders' risk perception considered?
26) What types of goals are reasonable to have in a cloudburst or other CCA strategy?

Concluding questions

- That were all my questions. Is there anything you'd like to add that you think I should know?
- Thank you for participating. Can I come back to you via email if I have more questions?

Appendix 7: Numbered scoping study literature

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14. Macintosh, *A., Coastal climate hazards and urban planning: How planning responses can lead to maladaptation.* Mitigation and Adaptation Strategies for Global Change, 2013. 18(7): p. 1035-1055.
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18. Wamsler, C., C. Luederitz, and E. Brink, *Local levers for change: Mainstreaming ecosystem-based adaptation into municipal planning to foster sustainability transitions.* Global Environmental Change, 2014. 29: p. 189-201.
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Endnotes: Original statements in Swedish

[i] Man är väldigt, väldigt bra på att ta fram kunskapssammanställningar och det hjälper inte, alltså det är inte det vi behöver. Vi behöver tydligare riktlinjer.

[ii] Hur enskilda nämnder och förvaltningar lever upp till de målen, om vi nu pratar generellt, är ju väldigt beroende av hur aktuella kommunfullmäktigepolitikerna tycker att de är. Om det finns någon som bevakar dem där.

[iii] Rent krasst, den är alldeles för offensiv, att vi skulle ha en 100-årssituation med minimala störningar, vad är det till att börja med? […] Precis på samma sätt som vi kanske var för ivriga med att skriva ordet 100-årsregn, utan att tydligt veta vad det innebär, så var vi nog också för tidiga med att skriva ”om 30 år så ska det vara”… nånting. Den är ju väldigt svår att följa upp. Den beskrev inte vi tillräckligt bra, skulle jag säga.

[iv] Det är lömskt också för pekar man ut nån väldigt tydligt, då definitivt kommer alla andra backa.
[v] Jag vet inte om du har jobbat inom en kommun innan, men det är liksom guld att bara få till nån form av samordning eller diskussion och informationsutbyte mellan förvaltningar.

[vi] Det blir ganska individberoende, för det är så få som kan det här, […] Jag är den experten, så har inte jag nåt eget driv i detta, om att liksom, rädda världen, orkar inte jag ta de här dusterna, så händer inte mycket.

[vii] Jag tror att det fanns nån slags tanke på att [de tematiska grupperna] skulle fortsätta just för att man skulle få inputen som en underdel till skyfallssamordningen och så, men det gör vi inte.

[viii] Vi skickar saker, hej vilt liksom, och det är ju rätt många som sagt som pratar med oss och vi säger ju alltid att allt vi har får ni. Göteborg har ju gjort jättemycket utredningar som de bara lägger ut och som man bara kan kopiera rakt av. Det finns en väldig öppenhet […] Det tycker jag är väldigt sympatiskt i den här branschen.

[ix] Jag är alltid väldigt välkommen överallt och det tror jag är liksom att jag inte kör med pekpinne, och det tror jag är då en framgångsfaktor. […] Alla vill ju göra ett så bra jobb som möjligt och det betyder att i praktiken får man fråga mig. Så mycket av det bygger arbetssättet på. Jag ska bli efterfrågad. […] När man har fått dit mig till ett möte så ska det ändå kännas lite, även om det kan vara jobbiga besked, så jag måste föra dem några steg framåt så att det ändå ska kännas lite lättare än vad det gjorde innan mötet, när allt vad väldigt oklart […] då har jag i alla fall rett ut förutsättningarna.

[x] Vi pratar om kollektiv medvetandeförflyttning och individuell handling. Kollektiv medvetandeförflyttning är ju att folk ska börja tänka på vatten på ett annat sen, och sen är det ju individuella handlingen är ju det där med att folk ska faktiskt göra saker.

[xi] Jag har snackat med exploatörer som berättat om att dom jättegärna ville jobba med denna frågan, det här är ju en fråga som man ganska lätt kan få gratis pluspoäng för.

[xii] Det finns en kompetensbrist hos många, och det är ju ingens fel. Det handlar ju bara om att det är en ny fråga, att vi inte riktigt vet vem som ska göra vad. […] men ett av resultaten av skyfallsplanen var ju att man fick en vattenstrateg.

[xiii] Om till exempel Serviceförvaltningen som ska göra åtgärder vid sina fastigheter får kunskap om hur de ska göra vissa upphandlingar eller modelleringar. Då kan [vattenstrategen] bistå med den kunskapen på sittande möte.

[xiv] Om ni sen säljer marken och nån annan kommer och inte tar hand om sitt dagvatten, då funkar ju inte vårt system, därför måste vi ändå bygga en damm, för att säkerställa att det kan fungera. Och det blir ju jävligt kontraproduktivt.

[xv] Det blir ohyggligt, ohyggligt dyrt att göra det vi kallar för riktade skyfallsåtgärder, alltså ombyggnader som bara drivs av att man ska ta hand om skyfallsvatten. Det kostar flera gånger mer än om man, i varje enskilt projekt vi gör, är det ett byggprojekt eller ett planprojekt, så ska vi göra vårt bästa. Och då blir det, om man tar med skyfallshänsyn in i ordinarie arbete så blir det mycket mycket billigare.

[xv] Nu testar fastighets- och gatukontoret de här varningssignalerna i underfarter, vilket är ett sånt steg, där vi accepterar att det får stå vatten på vissa gator, men att vi i stället varnar befolkningen om att – kör inte ner där, om det står vatten.

[xvi] Det är svårt att ta fram dataunderlag som visar att nyttan är ”exakt så här stor” och relatera det till kostnaden, det är ett sånt hinder, utan, väldigt mycket är så att man får säga att – ja men här verkar nyttan vara tillräckligt stor.

[xvii] Det blir ju konflikter med allt det andra. Ska det här gå föra att man tillgänglighetsanpassar? Ska det här gå före, så att vi får lite sämre ekonomi i ett utbyggnadsprojekt, det vill säga färre nya kåkar och sådär. Hur mycket får denna rucka på annat?

[xviii] Om man säger att vi accepterar att vi rör oss mot en större skyfallsresiliens långsamt, så kan vi göra det till en rimlig kostnad. Om vi ska forcera fram det så kommer det kosta enormt mycket och då kommer det drabba andra delar av samhället, alltså rent, alltså om vi använder våra samhälleliga resurser bara för klimatanpassning nu så kommer vi att förlora mycket annat.

[xix] Kommunen fungerar ju inte som en dator där man programmerar in instruktioner uppifrån och så faller de hela vägen ner till nämnder och förvaltningar, utan det fungerar kanske mera som ett fotbollslag eller en kör, att informationen sprider sig ut och sprider sig snabbare i vissa delar och mindre snabbt i andra delar.

[xx] Det är det faktum att man har samlats och pratat över gränserna, som sen för arbetet framåt. Jag har svårt att förstå kommuner som låter konsulter ta fram en dagvattenplan. Det är meningslöst. Det är ju det faktum att man träffas och nöter saker som gör att det blir bra i slutändan.