Planning for heat resilience - A comparative study between Greater Gothenburg´s and Skåne´s work on heat

Rebecca Johansson

Degree of Master of Science (120 credits)
with a major in Geography
30 hec

Department of Earth Sciences
University of Gothenburg
2023 B1255

Faculty of Science

UNIVERSITY OF GOTHENBURG

UNIVERSITY OF GOTHENBURG
Department of Earth Sciences
Geovetarcentrum/Earth Science Centre

Planning for heat resilience - A comparative study between Greater Gothenburg´s and Skåne´s work on heat

Rebecca Johansson

ISSN 1400-3821

B1255
Master of Science (120 credits) thesis
Göteborg 2023

Mailing address
Geovetarcentrum
S 405 30 Göteborg

Address
Geovetarcentrum
Guldhedsgatan 5A

Telephone
031-786 19 56

Geovetarcentrum
Göteborg University
S-405 30 Göteborg
SWEDEN

Abstract

Due to climate change, it is expected that heat waves will be intensified and occur more frequently in Sweden; hence, heat-related risks are anticipated to increase, i.e., morbidity and mortality. Through heat mitigation strategies, risks associated with heat can be prevented. Since Swedish municipalities have a monopoly on urban planning, the municipalities play a crucial role in climate adaptation. Based on a questionnaire and interviews, the overall aim of this thesis is to investigate how 24 Swedish municipalities within the two geographical regions of Greater Gothenburg and Skåne work on heat using heat mitigation strategies. It is also investigated how work on heat is prioritised against work on other climate risks Further, it is investigated if there are differences between the municipalities' heat work and prioritisation based on coastal-inland municipalities and urban population size. Lastly, it is examined which factors affect the work and how.

46% (11/24) of the municipalities had conducted heat analysis of the risks and identified measures. 29% (7/24) of the municipalities had implemented measures. Municipalities in Skåne worked with heat to a greater extent than municipalities in Greater Gothenburg. This could be explained by the fact that planners' in Skåne ranked heat higher than planners' in Greater Gothenburg, based on their own knowledge and expertise, and that there were examples given regarding initiatives on heat work from municipal personnel. Coastal municipalities worked on heat to a greater extent than inland municipalities, which could be explained by the fact that coastal areas face both coastal and non-coastal climate risks, thus the risks are higher and could impact the levels of work. No differences could be identified based on urban population size. One reason why few municipalities had started to work with heat can be explained by the fact that heat received the lowest rank compared to other climate risks in the municipalities' climate adaptation work, which could be further explained by the fact that the perception of heat differed from the perception of other climate risks. It can also be explained by identified factors affecting the municipalities' heat work. The most critical factors influencing municipalities' heat mitigation work was knowledge, followed by legislation, local government, support from authorities, and financial resources. The planners expressed the need for tools, development of standards, guidelines, guidance from authorities, political decisions, and resources to allow the development of work on heat.

Keywords: climate adaptation, heat mitigation, heat stress, urban planning

Acknowledges

This master's thesis marks the end of a five yearlong study period in Geography at the University of Gothenburg. Through this 30-credit master's thesis course, I had the opportunity to research a topic of interest, which has given me a deeper understanding, new knowledge, and continued interest in heat planning.

I would like to express my deepest gratitude towards my supervisors, Sofia Thorsson, Fredrik Lindberg & Jerry Olsson, for your support and advice during this period. With your guidance, this thesis has been made possible.

I would like to thank my fellow master's students for your support but also for making this period of thesis writing memorable, thanks for all the fun and interesting discussions. A special thanks to Sandra Lujic and Mikaela Torell for your inputs and encouragement during the writing of this thesis, as well as during these past five years of education. Thanks for all the laughs in our shared office.

Thanks to Joanna Friberg at The Gothenburg Region (GR), who helped me with contact details through the climate adaptation network and supported me during the design of the questionnaire. Finally, I would like to thank all the planners who participated in this study, both through the questionnaire and interviews. Your experiences and opinions regarding heat planning have been valuable for this thesis.

Rebecca Johansson
May 2023.

Table of Contents

1. Introduction

1.1 Background

Climate change and the effects of the urban heat island (UHI) are increasing the number of days with extreme heat in urban areas worldwide (IPCC, 2022). Research from The Swedish Meteorological and Hydrological Institute (SMHI) (2019) shows that heat waves in Sweden will be intensified and occur more frequently. Consequently, it is expected that the risk of heat will increase. Besides increasing the risks of health issues such as hyperthermia, heart cramp, and heat stroke, there is a correlation between heat and increased mortality (World Health Organization, 2018). Correspondingly, the need for heat adaptation is evident. One approach to managing heat is through heat mitigation strategies, which implies that technical cooling solutions modify the local and microclimate (Meerow & Keith, 2021). Urban characteristics which affect the local and microclimate is, for instance, building density, street orientation, materials of pavements and buildings (albedo), and vegetation (Oke et al, 2017). Modifying these urban characteristics can maximize the cooling effect through shadowing and transpiration (ibid).

Nordgren et al (2016) stated that heat adaptation is less researched than climate adaptation on other climate risks; only 4% of 3500 online resources related to climate adaptation dealt with heat. Further, most of the research on heat has dealt with mapping and modelling rather than the planning perspective (Keith et al, 2020). Accordingly, how planners practically apply research from mapping and modelling is less researched (ibid).

The Swedish municipalities have a monopoly on spatial planning (The Swedish Planning and Building Act [PBL], 2010). Consequently, the municipalities have considerable responsibility regarding the implementation of climate adaptation measures. Hence, municipalities have a crucial role in Swedish urban planning and are ideally positioned to address the risks of heat. In previous research from The Swedish Environmental Research Institute (IVL) (2021) and SMHI (2019), work on climate adaptation has been examined in its entirety. Both studies showed that climate adaptation levels varied considerably between the municipalities, and climate risks such as flood and erosion were dealt with to a greater extent than heat (ibid).

However, it was not clear why these differences in adaptation occurred. Studies examining how Swedish municipalities work on heat and what affects the work are lacking.

1.2 Aim and research questions

The overall aim of this thesis is to investigate how Swedish municipalities within the two geographical regions of Greater Gothenburg and Skåne work to reduce heat using heat mitigation strategies. It will be investigated if work on heat differs between the municipalities, how work on heat is prioritised against work on other climate risks, and lastly, identify factors affecting the work on heat.

To fulfil the aim, the following research questions will be answered:

- How do the municipalities work on heat using heat mitigation strategies, and does the work differ based on Greater Gothenburg-Skåne, coastal-inland, and urban population size?
- How is work on heat prioritised against other climate risks, and does the prioritisation differ based on Greater Gothenburg-Skåne, coastal-inland, and urban population size?
- Which factors affect the work on heat and how?

A questionnaire of 24 planners and interviews with six planners within the regions of Greater Gothenburg and Skåne was conducted in spring 2023 to answer these research questions.

2. Theory

2.1 Climate change and heat waves

As a consequence of the ongoing climate change, extreme heat has become more frequent and intense and will continue to increase even at a stabilisation of global warming at 1.5° Celsius (C) (IPCC, 2021:1517). It also appears that some of the recent hot extremes would have had an extremely low probability of occurring without anthropogenic influence on climate (ibid). Further, Wilcke et al (2020) claim that the extreme heat event in Sweden during the summer of 2018 would have had a low probability of occurring without human-induced climate change.

According to SMHI (2011), there is a high probability that heat waves will occur more frequently in Sweden in the future. SMHI (2013) has identified two different definitions of heat waves. The first definition implies a period of at least five consecutive days when the highest temperature is at least 25°C. The second definition is similar, the difference is that it is instead, the diurnal temperature must be at least 25°C (ibid). Extreme heat, which occurs, on average, every twenty years, may by the end of the century, occur every three to five years. In southern Sweden, temperatures of 40° C may occur every twenty years (ibid).

2.2 Heat stress

Heat is deemed to be one of the most significant risks to public health in Sweden, based on the degree of severity and probability of occurrence (The Public Health Agency of Sweden, 2021). Heat stress is a physiological and behavioural condition that occurs when thermal comfort is exceeded. Symptoms of the condition range from mild to severe. The mild symptoms consist of, i.e., general condition and dehydration, while severe effects are heat stroke and death (The Public Health Agency of Sweden, 2022). Demographic groups that are at particular risk of being negatively affected by increased temperatures are, for instance, the elderly, children, and chronically ill (ibid). Vicedo-Cabrera et al (2021) states that more than one-third of the global heat-related deaths during the last three decades can be attributable to human-induced climate change. During the summer of 2018, unusually warm temperatures occurred in Sweden, and 600-750 deaths are considered to be related to the extreme heat event (The Public Health Agency of Sweden, 2022:14).

2.3 Urban heat Island (UHI)

The majority of the world's population lives in urban areas, which is expected to increase to 68% by 2050 (UN Habitat, 2022:4). In Sweden, it is estimated that 88% of the total population currently lives in urban areas (Statistics Sweden, 2022). Due to anthropogenic modifications of the atmospheric environment, urban areas tend to be warmer than surrounding non-built-up areas, which makes people living in urban areas vulnerable during heat waves (IPCC, 2022:909). This phenomenon is called urban heat island and is affected by factors such as urban structure, surface properties, and proportion of vegetation. The phenomenon is mainly a nocturnal event and is most prominent during clear and windless conditions (Oke et al, 2017). Previous research has shown that there is a relationship between the intensity of UHI and city size measured based on population (Manoli et al., 2019). This means that the intensity of UHI increases with city size (ibid). The UHI effect is particularly noticeable during extended periods of high temperatures and can contribute to intensifying and prolonging heat waves (The Swedish Expert Council on Climate Adaptation, 2022, IPCC 2022).

2.4 Climate risk

The IPCC (2022) defines risk as follows:

*"The potential for adverse consequences for human or ecological systems, recognizi*ng *the diversity of values and objectives associated with such systems"* (IPCC, 2022: 2921).

In a context of climate change impacts, risks are shaped by three determinants and the dynamic interaction between them. These are 1) climate-related hazards, 2) exposure and 3) vulnerability and can change over time and space because of factors such as magnitude of the hazard, likelihood of occurrence and human decision-making. Climate risks are also shaped by the behaviour of complex systems, which means that multiple stressors can result in cascading or compounding interactions, and non-linear responses, and consequently, cumulative effects and unexpected risks (IPCC, 2022). Another aspect of climate risk is that it is shaped by responses themselves. The risks of climate change responses can imply, for instance, that the response does not achieve what it aimed for or that it results in other consequences or effects for other objectives on both local and global scale. Due to climate risks' complexity, risks can

be assessed differently by different individuals and groups in society, which thus shapes climate adaptation (ibid).

2.5 Climate adaptation

Although climate change is a global phenomenon, climate change tends to be experienced at regional and local scales, which are also the scales at which decisions are made (IPCC, 2021). IPCC defines "Adaptation" in the following way:

"Adaptation in this report, is defined, in human systems, as the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities" (IPCC, 2022:134).

Previous research distinguishes between various climate adaptation strategies, such as anticipatory and reactive climate adaptation, autonomous and planned adaptation, and incremental and transformational adaptation. Anticipatory adaptation is defined as adaptation that takes place before climate change has been experienced. Meanwhile, a reactive approach implies that adaptation takes place after climate change has been experienced. Incremental implies that a system or process maintains its attributes. Meanwhile, transformational is defined as changing the fundamental attributes of a system to adapt. Autonomous implies adaptation in response to climate change without acknowledging climate change directly, and planned adaptation implies that adaptation is based on factors such as knowledge, awareness, and political decisions (IPCC, 2001, IPCC, 2007, IPCC, 2022). Since there are different takes on climate adaptation, the work varies greatly. However, research suggests five general stages for climate adaptation. These are (1) awareness, (2) assessment, (3) planning, (4) implementation, and (5) monitoring and evaluation (IPCC, 2022). Work on climate adaptation has continued to develop globally. Despite progress, there are gaps between work and levels needed to respond to impacts and establish resilience. Global climate adaptation is described as fragmented and mainly focuses on responding to current or near-term risks and planning rather than implementing measures (ibid).

2.5.1 Heat adaptation

In a study by Nordgren et al (2016), it emerged that a minority of 3500 online resources concerning climate adaptation dealt with extreme heat (4%). Further, Keith et al (2020) state that most of the studies on heat focus on heat mapping and modelling, while few studies investigate heat planning. Researchers who investigate heat through mapping and modelling tend to emphasize that the result can be used in urban planning but do not explain how this would work practically or with consideration to the constraints the planners face. How planners practically apply information from mapping and modelling studies is less researched (ibid).

Heat adaptation differs from other types of climate adaptation due to heat's temporal and spatial complexity, invisibility, and historical lack of institutional and legal regulation (Keith et al, 2020). Further, Luber & McGeehin (2008) stated that since heat leaves no physical trails, the risks of heat tend to be forgotten once cooler weather occurs. One of the issues that are considered to affect the work on heat-related climate adaptation is that heat can be handled in several approaches to improve heat resilience (Meerow and Keith, 2021). The approaches can be divided into two types of strategies, "heat management" and "heat mitigation" (figure 1).

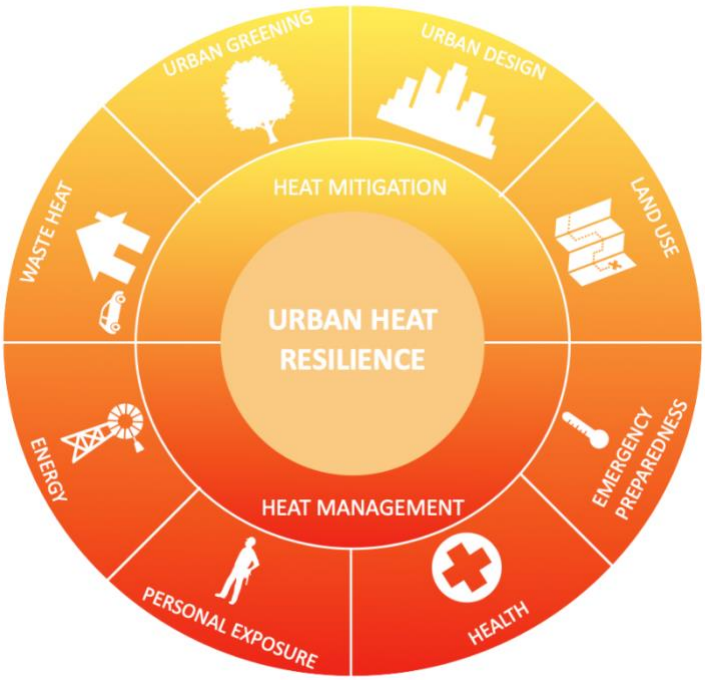


Figure 1: The figure shows the division of heat mitigation and heat management strategies (Modified after Meerow & Keith, 2021).

Heat management strategies imply that heat is handled within health departments, risk management, and preparedness. Measures imply, for instance, warning systems and information which intend to encourage certain behaviour and consequently can prevent mortality. Heat mitigation strategies are defined as technical cooling solutions which imply modification of urban design. Examples of measures are the implementation of greenery, increased reflectivity, or albedo, of surfaces and buildings (Taleghani et al, 2019). Besides its cooling effects, most heat mitigation strategies contribute to multiple additional benefits, such as recreational values and enhanced biodiversity (Meerow & Keith, 2021). Still, heat mitigation strategies' main disadvantages are their financial costs and the long timespan for implementation of measures. Consequently, heat management strategies are often motivated by their low-cost and short time frame for implementation. From a health perspective, it is important to empathise that communities should not only rely on heat management strategies and rather work to implement heat mitigation strategies as well (ibid).

2.5.2 Climate adaptation in Sweden

Spatial planning in Sweden is decentralised, which implies that the municipalities have a monopoly on spatial planning within their geographical areas [1] (PBL 2010:900). Thus, the municipalities have extensive responsibilities regarding spatial planning and land use. Municipal planning is based on two different types of plans, municipal comprehensive plans (MCP) and local development plans (LDP) (Storbjörk & Uggla, 2014). The MCP is not legally binding but aims to define goals around land use, priorities, and, for example, how national interests and environmental qualities are considered (The Swedish Housing Agency, 2011). The LDP is legally binding and contains concrete and detailed plans regarding how the land is to be used within a specific area, which may, for example, involve the development of new residential areas, roads, or industrial areas (ibid).

Climate adaptation is expected to take place primarily at a municipal level. However, it tends to be divided and handled by several departments, which means that collaboration and co-learning are absent (Wamsler & Brink, 2014). The municipalities are politically governed by regional and local politics. Hjerpe et al (2015) argue that insufficient knowledge, incentives, and conflict of aims related to local government have resulted in climate adaptation being

[1] Chapter 1 2§ PBL.

limited. Eliasson (2000) established that climate knowledge had a low impact on the spatial planning process in Sweden. Five explanatory variables which affected climate adaptation were conceptual and knowledge, technical, policy, organisational, and the market, which resulted in unsystematic climate adaptation (ibid). In 2007, the Committee on Climate and Vulnerability addressed the need to integrate climate adaptation into spatial planning (SOU 2007:60). This resulted in the former PBL (1987:10) being supplemented with considerations of risks of flooding and erosions that must be made in the planning. In 2010, legislative changes were made, which resulted in a new act (PBL 2010:900), this implied that the consequences of climate change were dealt with in MCP [2], LDP [3] and building permits[4] . In the new act, it was further clarified that the municipalities have the responsibility to plan for new settlements with respect to climate change. Broadly, this implied that the focus of responsibility lies with the municipalities, which can be held accountable for decisions regarding spatial planning for up to ten years (SOU 2007:60). Despite there were several risks being identified in the work of the Committee on Climate and Vulnerability, including heat, the legislative changes have implied a prevailing focus on flooding, erosion, and sea-level rise (Nilsson et al, 2012).

The Country Administrative Boards and the national expert authorities have tasks that aim at supporting the municipalities in their climate adaptation work. In 2018, greater responsibility was given to the Country Administrative Boards through the regulation (2018:1428) on authorities' climate adaptation work. The Country Administrative Boards shall initiate, support, and follow up on the municipalities' climate adaptation work [5]. In 2018, The Swedish Housing Agency was given a particular responsibility regarding climate adaptation in built-up areas. This implies, more specifically, that the authority shall support the municipalities on climate adaptation in terms of providing knowledge and recommendations (2017/18:163). The task is carried out in collaboration with other expert authorities such as The Swedish Civil Contingencies Agency (MSB), Swedish Geotechnical Institute (SGI), and SMHI (SMHI, 2021). Municipalities can also apply for financial state subsidies from MSB regarding

[2] Chapter 3 5§ 4p. PBL, Chapter 3 10§ 5p. PBL.

[3] Chapter 4 12§ 1p PBL, Chapter 4 14§ 4p PBL, Chapter 4 22§ 5p. PBL, Chapter 11 second paragraph 10 § 5p. PBL.

[4] Chapter 2 5§ 5p. PBL

[5] 5 § 1p. The regulation on authorities' climate adaptation work (SFS 2018:1428).

preventive measures against natural hazards [6]. Comparable to the legislation in PBL, this regulation has defined hazards as floods, landslides, and erosion.

The regions of Skåne, Halland and Stockholm have legal requirements which, among other things, imply that the regions must work for initiatives that can reduce the region's climate impact and its effects [7]. It appears that this can, for example, imply reducing the risk of floods (Prop 2017/18:266). Although there are no legal requirements for other Swedish regions to carry out equivalent work, many regions tend to work with this to a large extent (The Swedish Expert Council on Climate Adaptation, 2022).

2.5.3 Heat adaptation in Sweden

In research from SMHI (2020) and IVL (2021) regarding Swedish municipalities' climate adaptation, it emerged that climate adaptation related to water-related risks, such as floods and rising sea levels, tended to take place to a greater extent than heat adaptation. An important factor that influenced whether the municipalities worked with climate adaptation was the experience of previous climate events (SMHI, 2020). In addition, large cities and coastal municipalities generally tended to work with climate adaptation to a greater extent than smaller cities and inland municipalities. Still, coastal municipalities worked to the least extent with heat (ibid).

Heat adaptation in a Swedish context has partly been investigated less but also received less attention in national, regional, and municipal spatial planning (Jonsson & Lundgren, 2015). Even though heat is considered more deadly than other climate risks, this has had a limited effect on decision-making at various scales in Sweden (ibid). Rather, Swedish climate adaptation has tended to focus on water management, which is explained by previous experience of mainly water-related hazards and that the work on climate adaptation traditionally has been focused on climate risks of rural areas (Wamsler & Brink, 2014). Hence heat adaptation has been deprioritised due to its urban characteristics (ibid). Financial constraints are also considered to limit work on heat, according to IVL (2020). A heat analysis

[6] Regulation on state subsidy to municipalities for preventive measures against natural hazards (SFS 2022:1395).

[7] Chapter 7 1§ 7p. PBL

for a smaller municipality was estimated to cost 100,000 SEK, something that the municipality could not afford, which thus limited the work (ibid).

3. Study area

3.1 Greater Gothenburg

Greater Gothenburg is a geographically defined metropolitan region in south-western Sweden (Statistics Sweden, n.d.a), which consists of both coastal and inland municipalities with varying population sizes (Figure 2). All 13 municipalities are part of a municipal association named The Gothenburg Region (GR). The municipal association runs authority assignments and various networks to decide on the municipalities' joint initiatives. One of the networks which GR organises is the climate adaptation network, which aims to create common knowledge and consensus regarding climate adaptation (The Gothenburg region, 2021). According to SMHI (2015a), the proportion of heat waves is projected to increase within Greater Gothenburg. Projections of the annual proportion of heat waves based on RCP8.5 indicate that the geographical region may have an annual average of 18 days in a row with a daily average temperature of over 20 degrees at the end of the century. This can be compared to observations from 1961-2013, which had an annual average of 0-8 days in a row.

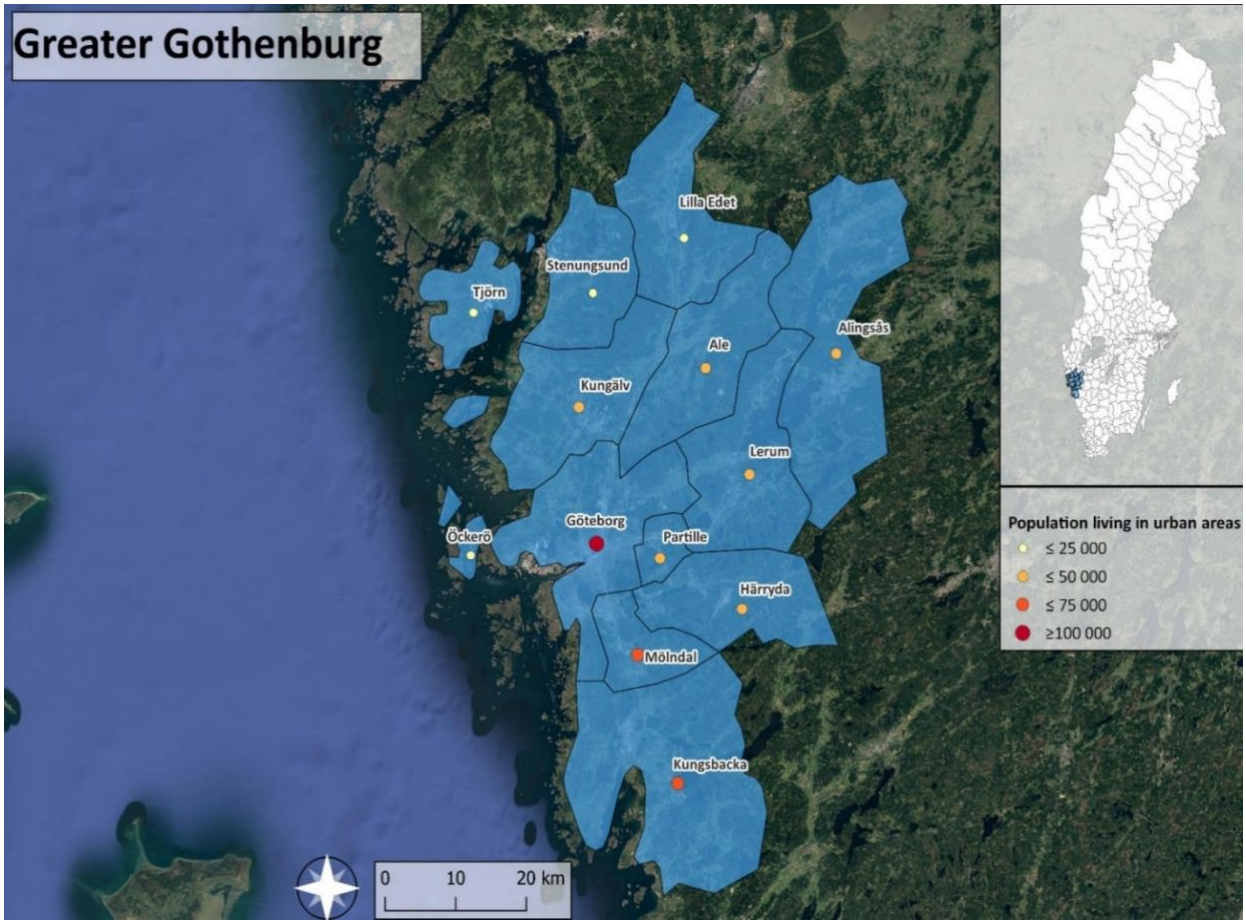


Figure 2: Map over Greater Gothenburg. Sources: Municipal: Statistics Sweden (n.d.a), Population data: Statistics Sweden (2020) & Google Satellite.

3.2 Skåne

Skåne is a county located in southern Sweden and consists of 33 municipalities, of which 13 were available to participate in this study (Figure 3). The 13 municipalities consist of both coastal and inland municipalities with varying population sizes. The county is, on average, the warmest landscape in Sweden during all seasons except summer, but the summer season tends to be longer in Skåne than in other parts of Sweden (SMHI, 2022). According to projections (SMHI, 2015b:67), Skåne's future climate could be characterised by an increased proportion of heat waves. Projections of the annual proportion of heat waves based on RCP8.5 indicate that Skåne may have an annual average of 3 weeks in a row with a daily average temperature of over 20 degrees at the end of the century. This can be compared to observations from 1961-2013, which had an annual average of 2-10 days in a row.

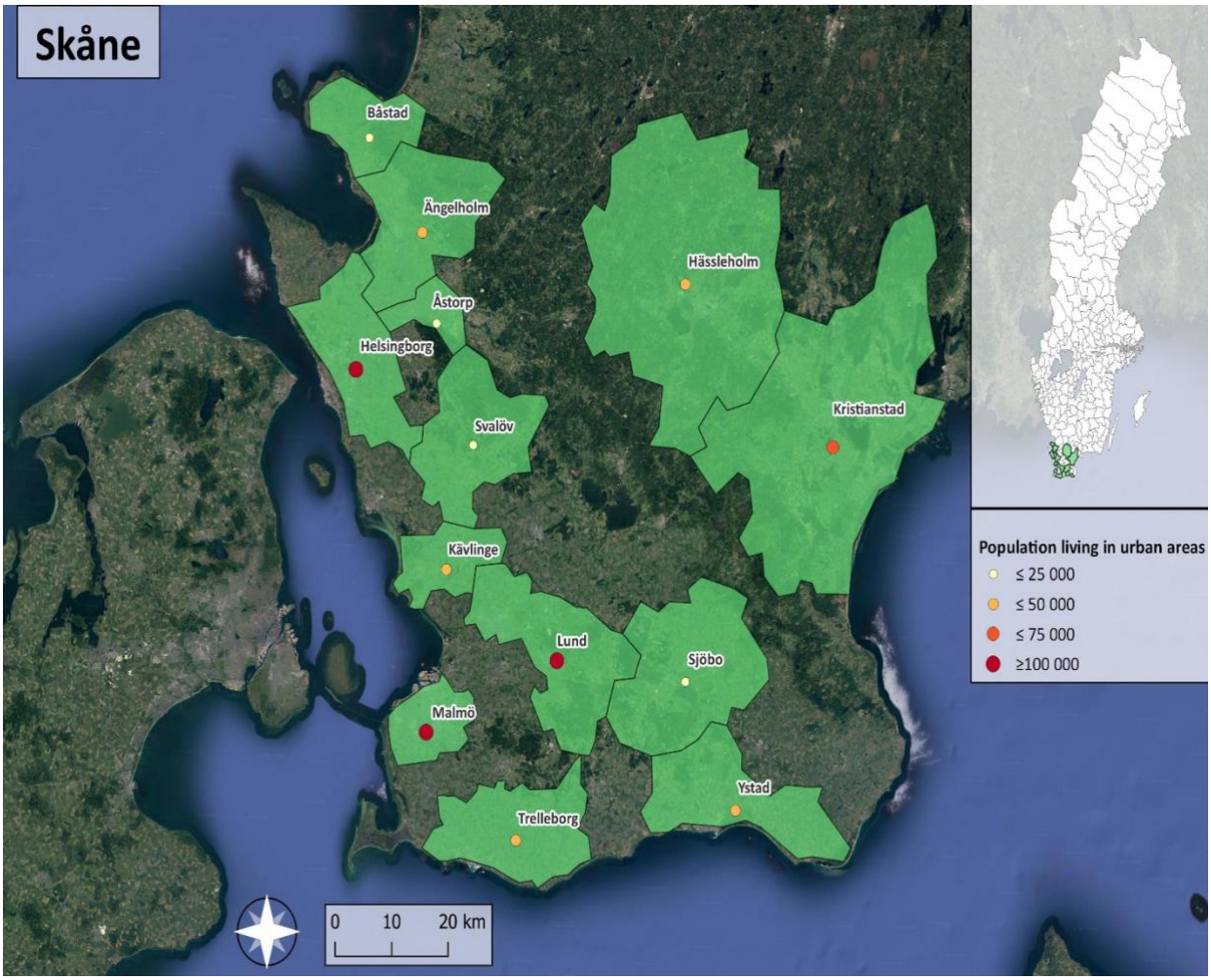


Figure 3: Map over Skåne and municipalities included in the study. Source: Municipal division: Statistics Sweden (n.d.b), Population data: Statistics Sweden (2020) & Google Satellite.

4. Data and methodology

4.1 Research design - Mixed methods

To answer the study's research questions, a mixed method approach has been used, which consisted of quantitative and qualitative methods. The study had a sequential design, which implied that the study initially consisted of a questionnaire but was supplemented with semi-structured interviews. By using a quantitative method, which consisted of a questionnaire, a larger population of 26 municipalities could be selected, and thus broad patterns and frequencies of answers could be identified and compared. The results from the questionnaire were then supplemented with a qualitative method, which consisted of six semi-structured interviews with planners. By conducting interviews, a deeper understanding of the municipalities' work on heat using heat mitigation strategies could be achieved. Explanations and factors affecting the municipalities' work on heat could be established. Using mixed methods was considered beneficial in this study to achieve an overall perspective within the research field (Elwood, 2010; Bryman et al, 2022). The first sections of this chapter will present the methodology of the quantitative part and will be followed by the qualitative part of the study. Lastly, the methodology for the identification of factors is presented.

4.2 Quantitative method - Questionnaire

4.2.1 Sample strategy

The sample selection was initially based on the two geographical regions Greater Gothenburg and Skåne. Since it was considered beneficial to get in touch with planners who could give first-hand information about how the municipalities work to reduce heat-related risks through heat mitigation strategies, this sample was based on a purposive sampling (Bryman et al, 2022). Initial contact with municipalities was thus directed towards technical departments at the municipalities.

Planners were contacted using two different methods. Contact with municipalities in Greater Gothenburg took place through participation in one of Greater Gothenburg's meetings for the climate adaptation network. At the meeting, the opportunity was given to present the study and collect contact details from representatives of the municipalities. All representatives were then contacted via email about the questionnaire. The second method involved initial contact by email. Since three municipalities were not members of the network, they were contacted

directly via email. Representatives from all the municipalities within Greater Gothenburg were available to participate in the study when the representatives were asked. Contact with municipalities in Skåne also took place via email. All 33 municipalities in Skåne were asked to participate in the study, of which 13 municipalities were available to participate.

4.2.2 Conducting the questionnaire

The questionnaire consisted of 19 standardised questions, of which 16 questions were mandatory. To motivate planners to take part in the questionnaire, the number of questions was limited. The questionnaire was estimated to take 6 minutes to complete, according to the program's estimation. This decision was taken since web-programmed questionnaires should not take longer than 10 minutes to conduct (Esaiasson et al, 2017). The questionnaire mainly contained questions with fixed-answer options. However, it was possible for the informant to add a comment to some of the questions. Questions were asked about previous work, for instance, analyses, identification of measures, and implementation of measures. Some of the questions were based on the Likert scale, which means that a statement was made, and the informant could indicate whether on a measured scale whether they disagreed, agreed to a low degree, agreed partially, agreed to a high degree, or completely agreed. The advantage of using the Likert scale in this questionnaire was that the planners' responses to various statements could be measured on a scale, which is one of the Likert Scale's advantages (Harris & Jarvis, 2014). These questions contained statements about financial resources, level of knowledge, support from expert authorities, such as The Swedish Housing Agency and The Swedish Civil Contingencies Agency, and support from the County Administrative Board.

To compare the work on heat against the work with other climate risks, two questions were asked where the informant had to rank the climate risks partly based on the municipality's work but also based on the planners' own knowledge and expertise. Selected defined climate risks were based on a previous questionnaire from IVL (2021), which was also sent out to Swedish municipalities. The questionnaire also contained an open question that gave the planners the opportunity to write a comment in addition to the questions asked. The questionnaire was anonymous, but if the planner had the opportunity to participate in a subsequent interview, the planner could choose to write their contact details. See Appendix 1 for the structure of the questionnaire.

On 2023-02-03, the questionnaire was opened, and the invitation to participate in the questionnaire was sent out to the planners via email. The email contained an informative text about the aim of the study and a link to the questionnaire. It received responses for two weeks, and two reminders were sent out. The response rate was 92% (24 out of 26 municipalities).

4.2.3 Analysis of questionnaire

The questionnaire was analysed descriptively. This was considered beneficial for this study because key information about the variables, such as the most common values, could be summarised through figures (Harris & Jarvis 2013). Initially, the analysis implied that the questions from the questionnaire were categorised based on which research question it aimed to answer. Thereafter, the data was analysed by compiling it into different types of figures, such as bar charts and pie charts. The Fisher Freeman Halton exact test was conducted to investigate if there were significant differences when comparing Greater Gothenburg-Skåne, coastal-inland, and urban populations. The tests did not show any significant differences; these were thus excluded.

Among the planners' answers was information about how the municipalities' worked with heat management strategies, these were excluded since this was not the focus of this study

4.3 Qualitative methods - Interviews

4.3.1 Sampling strategy

11 out of 24 planners answered in the questionnaire that they could participate in a subsequent interview. The selection of informants for interviews was based on three criteria. The first criteria were to include representatives from both Greater Gothenburg and Skåne to gain a comparable understanding of the work. Consequently, three representatives were selected from municipalities in Greater Gothenburg, respectively three representatives from municipalities in Skåne. The second criterion implied including both inland and coastal municipalities. Therefore, three coastal municipalities and three inland municipalities were chosen. The last criterion was to include municipalities with varying levels of work on the matter. Consequently, the questionnaire was analysed before choosing the informants. See Table 1 for the selection of informants for interviews.

Table 1: The table shows selected informants for semi-structured interviews.

Name of the informant	Profession	Municipality	Inland/coastal
Emanuel Toft	Investigator, The environmental department	Malmö, Skåne	Coastal
Tobias Varga	Plan architect	Svalöv, Skåne	Inland
Johannes Hagström	Sustainability strategist, the municipal management department	Trelleborg, Skåne	Coastal
Linda Andreasson	Comprehensive planner, society, and development	Kungälv, Greater Gothenburg	Coastal
Barbro Lundqvist West	Project leader	Ale, Greater Gothenburg	Inland
Naima Linderson	Strategic urban planner – climate adaptation, sector urban management	Lerum, Greater Gothenburg	Inland

4.3.2 Semi-structured interviews

The interviews supplemented the questionnaire by explaining the patterns and frequencies found in the questionnaire, which was not possible to achieve through a quantitative method independently. By using a qualitative method, a deeper understanding of the situation of selected municipalities could be achieved, which Bryman et al (2022) argue is an advantage of semi-structured interviews. Since the interviews were semi-structured, they could be adapted depending on the situation. The order of the questions could be changed, and there was room to ask spontaneous questions that arose during the conversation. The same interview guide was used for all interviews and was formulated to identify factors that shaped the municipalities' heat mitigation work. To achieve this, questions were asked about current work, whether there were obstacles that limited the work, and what the municipalities needed to develop the work further. The interview guide was also based to some extent on the five general stages in climate adaptation that were mentioned under *2.4 Climate adaptation*. The stages were visualised in a

figure, and based on it, the planners had to choose which stage the municipality was on in its work on heat. See Appendix 2 for the interview guide.

The interviews were conducted both in person and digitally. The audio recording was considered important for the reliability of the study. Consequently, permission was asked for the recording of the interviews. Thus, systematic, and random errors, such as mishearing or writing errors, could be avoided, which is otherwise a risk according to Esaiasson et al (2017).

4.3.3 Thematic analysis

The interviews have been analysed through thematic analysis (TA). By carrying out TA, themes could be identified in the data in a systematic way (Braun & Clark, 2017). TA was beneficial since analytical observations in the data could be organised and categorised in accordance with the study's research questions. The study's TA followed the six phases identified by Braun and Clark (2006). Below are the six phases presented and how they were applied to this study.

1. *Familiarise yourself with the data:* This phase of TA meant in this study that the interviews were transcribed and then read through.
2. *Generating initial codes.* The data were coded based on categories identified while reading each transcript.
3. *Searching for themes.* Based on the previous phase, themes were identified. This meant that several codes were included under the same theme.
4. *Reviewing themes.* TA was carried out, and some themes had to be changed.
5. *Defining and naming themes.* Definitions and names for each theme were identified and clarified. Codes were renamed to sub-themes.
6. *Producing the report.* The final TA can be found in the thesis results section under the respective research question.

Through the six phases, main themes and sub-themes were identified that aimed to answer the research question (Table 2).

Table 2: The table shows the identified main themes and sub-themes for thematic analysis.

Main theme	**Sub-themes**
Prioritisation of climate risks	Reasons heat was prioritised
	Reasons heat was deprioritised
Factors affecting the municipalities' work on heat	Knowledge
	Legislation
	Local government
	Support from authorities
	Financial resources

4.4 Identification of factors affecting the municipal work on heat

Based on the questionnaire and the interviews, factors that affected the municipalities' work on heat could be identified. These either prevented or enabled work. Through the questionnaire, deficiencies in the work on heat could be identified, while the interviews contributed to a deeper understanding of how different factors affected the work and what was needed to develop the work. The factors were ranked based on their importance for developing work on heat among the municipalities, of which one was the most important, and five was the least important. What the prioritisation of factors has been based on appears in the section for the results.

5. Results

In this section, how far the municipalities have come in their work around heat will be presented. Further, there will be comparisons based on Greater Gothenburg and Skåne, coastal and inland municipalities, and urban population size. It will also be given how the municipalities prioritise work on heat compared to other climate risks. Lastly, factors influencing the work on heat will be presented.

5.1 The municipalities' work on heat

According to the questionnaire, a majority (18/24) of the municipalities had been affected by heat in the built environment (not shown). Despite this, less than half (11/24) of the municipalities had conducted analysis regarding where or when heat could occur within the municipalities (figure 4a). The analyses that had been carried out were either at a comprehensive scale or targeting certain vulnerable groups, i.e., preschool yards and elderly care homes. Different measures used for analysis were UHI mapping, discomfort index (air temperature and relative humidity), wet bulb temperature (WBT), land surface temperature (LST), and mean radiant temperature (T_{mrt}). Some of the municipalities did not specify the measure used for analysis; in these cases, heat mapping was given as an answer. Some of the municipalities had conducted several measures, while some had only conducted one.

Of the municipalities that conducted analysis, all municipalities had identified measures to mitigate heat (figure 4b). Identified measures were increased tree canopy coverage, sun protection (i.e., shading fabrics), and greenery (of which several planners specifically mentioned trees). Some of the identified measures were identified to regulate the local microclimate within specific areas, i.e., preschool yards or elderly care homes. Of the municipalities that had identified measures, more than half (7/11) of the municipalities had implemented measures (figure 4c). Measures taken were, for instance, the implementation of greenery (trees in many cases) and sun protection. Implemented measures targeted mainly vulnerable groups, for example, through implementation at preschool yards and elderly care homes.

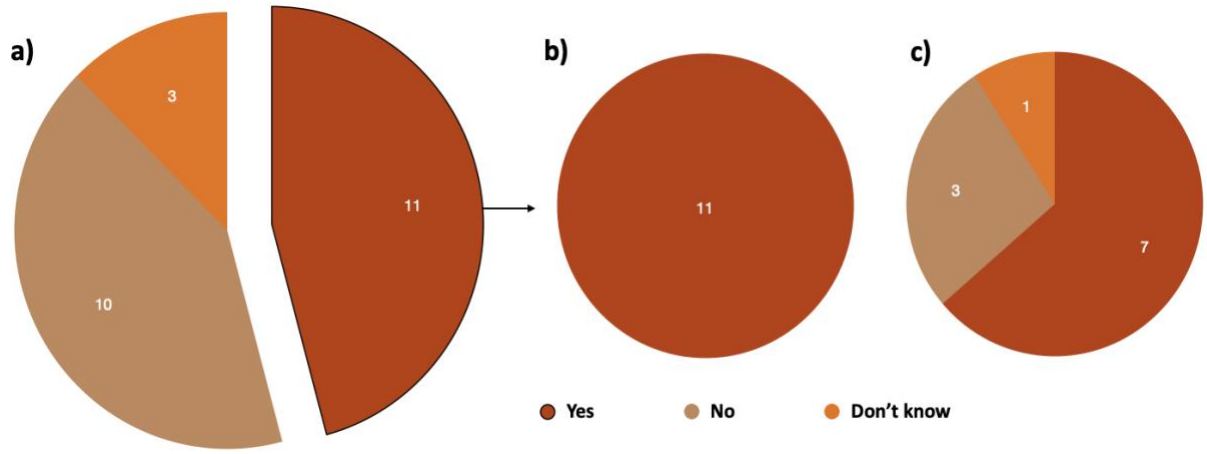


Figure 4: a) shows the planners (n=24) answers regarding if there had been heat analysis carried out, b) shows the planners (n=11) answers regarding if the municipality has identified measures to mitigate heat; c) shows the planners (n=11) answer regarding if the municipality has implemented measures to mitigate heat.

Some of the municipalities that had not carried out analysis had plans to carry it out in the future. Municipalities that did not have plans to carry out analyses expressed a need to identify risks within the municipality. It was evident that most of the planners (22/24) considered to some extent that the municipality did not do enough work on heat (Not shown). It emerged from interviews that municipalities that did not work with heat, tended to lack work on climate adaptation in general, except for what was required by law to work with.

Municipalities in Skåne carried out analysis and identified measures to a greater extent compared to municipalities in Greater Gothenburg (Figure 5). Still, almost as many municipalities in each geographical region had implemented measures. More than half (8/12) of the municipalities in Skåne had worked with heat to some extent. One-fourth (3/12) of the municipalities in Greater Gothenburg had worked with heat to some extent.

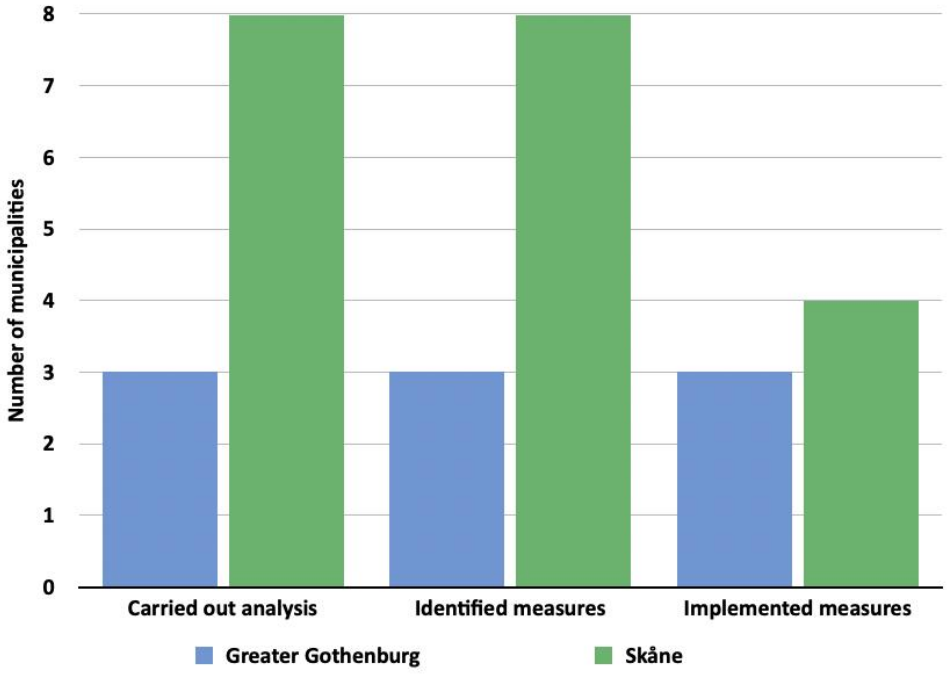


Figure 5: Comparison between Greater Gothenburg and Skåne's work on heat.

Coastal municipalities carried out heat analysis, identified measures, and implemented measures to a greater extent than inland municipalities (Figure 6). About half (7/13) of the coastal municipalities had worked with heat to some extent. More than one-third (4/11) of the inland municipalities had worked with heat to some extent.

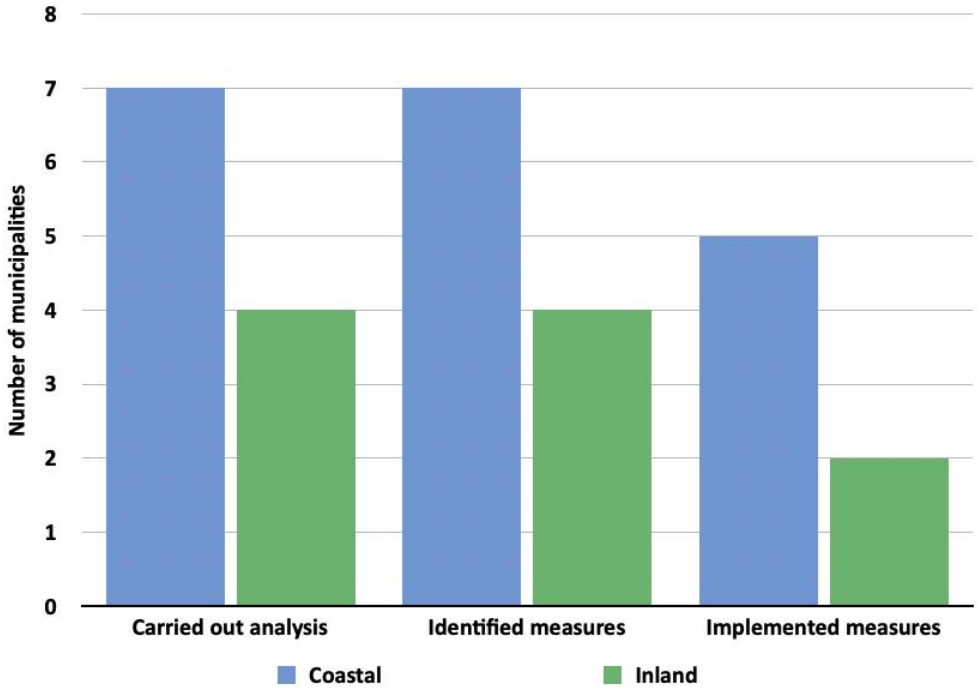


Figure 6: Comparison between coastal and inland municipalities' work on heat.

There were no differences in work on heat based on urban population size. Of the municipalities that had worked with heat, there were both smaller and larger municipalities.

5.2 Prioritisation of heat in comparison with other climate risks

Heat received the lowest ranking of the defined climate risks in the municipalities' climate adaptation work (Figure 7). Torrential rain/extreme amounts of snow received the highest ranking, followed by changed water flows in lakes and water courses, landslides and erosion and other risks. Climate risks mentioned under "other climate risk" were forest fires, drought, increased sea levels in combination with storms, water shortages, groundwater levels related to changing precipitation patterns, fluctuating food prices, and irrigation restrictions due to drought.

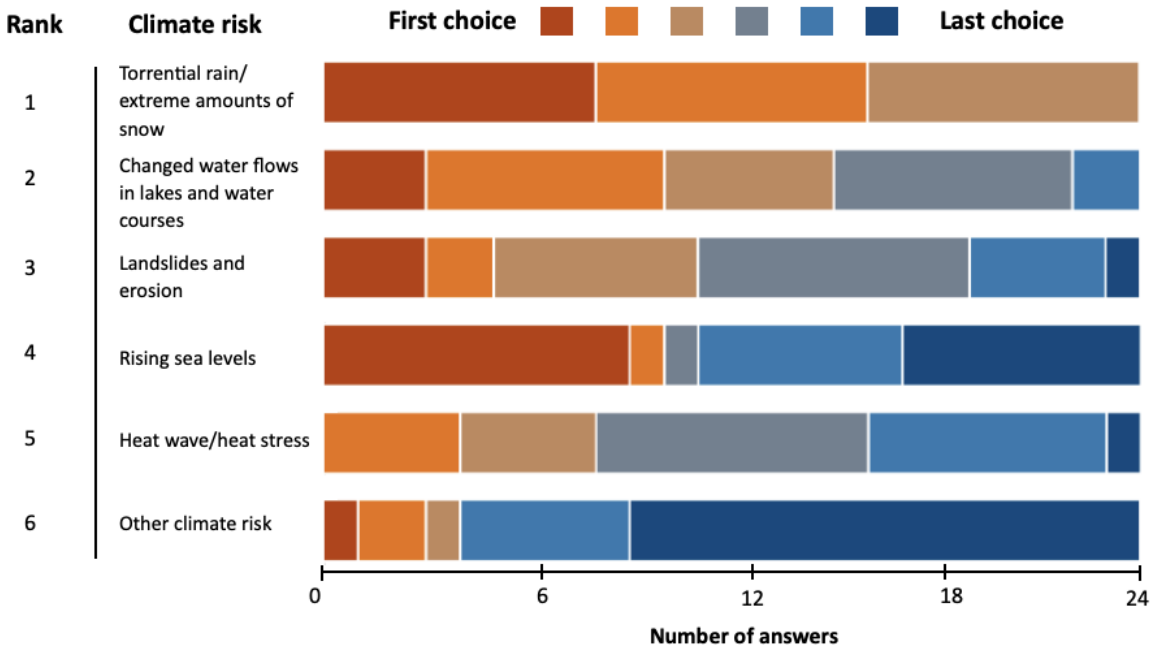


Figure 7: Rank of climate risks when planners (n=24) were asked how the climate risks were prioritised in the climate adaptation work at the municipality.

Heat was ranked as the third most prioritised when the planners prioritised climate risks based on their own knowledge and expertise (Figure 8). The risks that received the highest ranking were torrential rain/extreme amounts of snow followed by changed water flows in lakes and water courses. Landslides and erosion were ranked as the least prioritised of the defined climate risks.

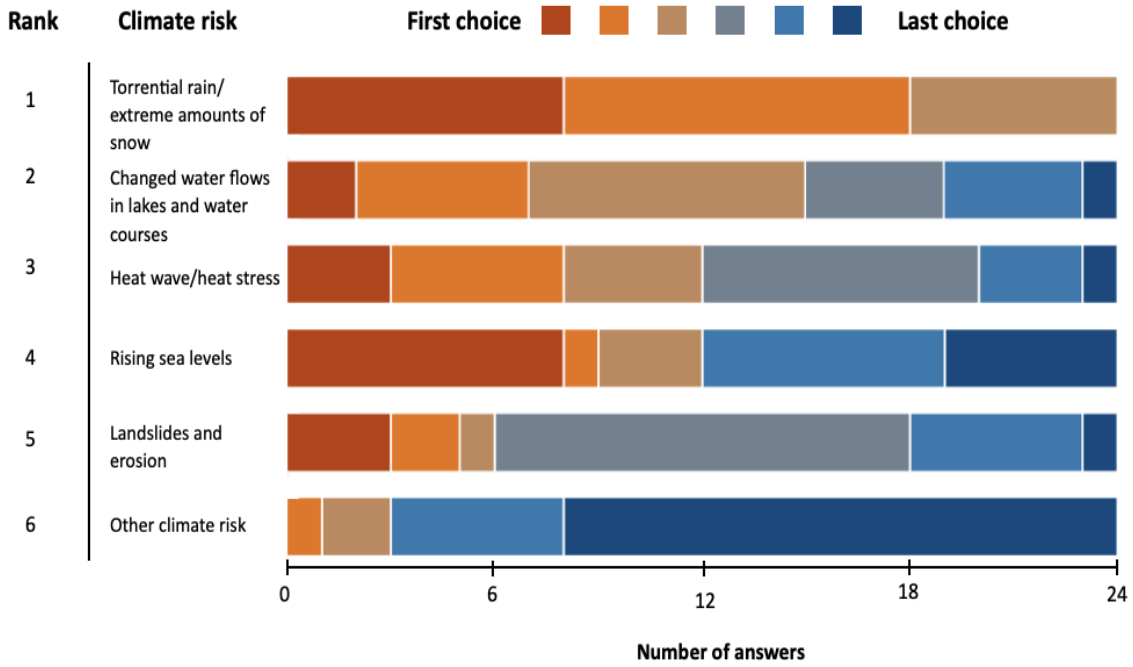


Figure 8: Rank of different climate risks when planners (n=24) were asked how the climate risks were prioritised based on the informant's own knowledge and expertise.

There were no differences in how heat was prioritised against other climate risks based on a comparison between Greater Gothenburg and Skåne. Regardless of geographic region, heat was the least prioritised of the defined risks in the municipal work. However, based on the planners' own knowledge and expertise, planners in Greater Gothenburg ranked heat as the third most prioritised climate risk, while planners in Skåne prioritised heat as the second most prioritised.

Coastal municipalities prioritised heat as the least prioritised of the defined climate risks in the municipalities' work (5/6). Meanwhile, heat received a higher ranking from inland municipalities (4/6). Further, planners from inland municipalities prioritised heat higher (2/6) than planners from coastal municipalities (3/6) based on their own knowledge and expertise.

No differences in prioritisation based on urban population size could be identified.

Work on heat had, in some cases, been prioritised at the municipality due to initiatives from municipal employees who had knowledge of the risks related to heat. An example of this was a municipal employee who perceived the need to identify risks related to heat and thus initiated that the municipality ordered a heat analysis from a consulting company, even though there was no requirement to do so. The planner identified this action as one of the factors that made it possible for the work on heat to advance. Equivalent initiative was observed through the questionnaire; an anonymous planner expressed the following:

"[…] I would like to highlight a small initiative that has been carried out by the environmental office in the municipality where, through their own initiative, they designed guidelines for outdoor environments in schoolyards for how large proportion that should be shaded from a health protection aspect. Hopefully, the initiative will catch on in the municipality and be applied to other places such as outdoor environments at nursing homes or outdoor environments in the municipal and parks." Anonymous comment from the questionnaire.

The result suggests that the municipal employee's own knowledge and expertise could impact the work on heat.

5.3 Factors affecting the municipalities' work on heat

Table 3 shows the identified factors affecting the municipalities work on heat.

Table 3: Identified factors which affected the municipalities work on heat and how they have been prioritised based on information from the questionnaire and interviews from highest (1) to lowest (5).

Factor affecting the municipalities' work on heat and its priority from 1-5	**Data from questionnaire used for the prioritisation**	**Data from interviews used for the prioritisation.**
1. Knowledge	18/24 municipalities either agreed to a low extent, or agreed partly regarding the statement that there was enough knowledge to work on heat. Comments from open-ended question included information about how knowledge affected the work on heat.	Data was used from the interviews.

2. Legislation	20/24 municipalities did either disagree, agreed to a low degree, or partly agree regarding the statement that the division of responsibility was unclear. Information about how legislation affected the work also appeared in an open-ended question.	Data was used from the interviews.
3. Local government	20/24 municipalities had not made a political decision were work on heat was included directly or indirectly.	Data was used from the interviews.
4. Support from authorities	16/24 municipalities agreed to a low degree, or partly agreed regarding the statement that there was enough support from the Country Administrative Boards. 15/24 municipalities agreed to a low degree, or partly agreed regarding the statement that there was enough support from expert authorities.	Data was used from the interviews.
5. Financial resources	21/24 municipalities did either disagree, agree to a low degree, or partly agreed regarding the statement that there were enough financial resources to work on heat.	Data was used from the interviews.

5.3.1 Knowledge

Knowledge was considered the most crucial factor influencing the municipalities' work on heat. Most municipalities experienced, to some extent absence of adequate knowledge at the municipality to be able to work with heat. It was reasoned that lack of knowledge could imply that heat was not perceived as an issue within the work for climate adaptation and that municipalities did not have knowledge about the local risks in the municipality. Heat had in some municipalities not been considered as a matter that affected the planning and design of the physical environment. Other climate risks, such as flood and erosion, were acknowledged as threats to the physical environment and were considered to result in financial and health-related consequences if work did not occur on these issues. Heat was not considered to involve the same consequences. Planners referred to the summer of 2018 and explained that similar

extreme heat must occur more frequently for it to be perceived as a bigger issue. One planner considered the term "climate adaptation" to be associated with the management of water-related risks and did not know how to work with heat as a part of the municipality's climate adaptation work. A planner explained that the level of knowledge was low among employees outside the department that the planner worked on, and thus there was a lack of understanding on why the department would work with heat as a matter for the technical administration. Since no analysis of the risks had been carried out in some of the municipalities, interviewed planners perceived that there was a lack of knowledge about where or when heat could occur. One planner explained that analyses of the risks could be used as a tool to raise knowledge about heat in other departments or to show the politicians the risks if work on heat was not carried out. The planners experienced the absence of knowledge of the local risks as an issue that was missed in the planning around future densification within the municipality. The planner said the following about the matter:

" There's going to be a lot going on here in the central parts, we might build ourselves into a problem. From that perspective, I think it is important to know what we are doing." One of the interviewed planners.

It also emerged that planners felt it could be challenging to know what to fund to mitigate heat, due to lack of knowledge. A planner in a municipality that had recently started to work with on heat explained that the reason for the initiation was that the municipality had gained knowledge about the risks. The planner said the following:

"When I looked at these local forecasts from SMHI linked to RCP 8.5, you can see how the risks related to heat are growing incredibly much faster than the other risks. Today, the average length of a heat wave in the region is 6 days per year and in 100 years it is forecasted to increase by 38 days according to SMHI's local scenario. Sea level rise change very slowly but will do so over a very long time, torrential rain will also change but not as much, so you could see that heat will just become a greater issue of priority now." One of the interviewed planners.

The planner had conducted workshops and lectures on the risks of heat to increase the knowledge internally at the municipality, with the aim of involving several departments in

work on heat. The planner believed that this made a difference and got several departments to be part of a new research project around work with heat stress.

5.3.2 Legislation

Legislation was considered the second most important factor influencing the municipalities' work on heat. Since there were no legal requirements to work with heat-related risks, work related to heat became voluntary and was thus deprioritised. It appeared that the absence of legalisation caused deprioritisation of heat in comparison with regulated climate risks such as floods and erosion. A planner expressed it in the following way:

"I feel that the biggest obstacle is that there is no legal requirement for us to work on this. In detailed plans, it can be difficult to get a developer to pay for more investigations if it is not required". Anonymous comment from the questionnaire.

Consequently, the planners expressed the need for legal requirements to be able to work with heat equivalent to work with other climate risks. For instance, it was mentioned by a planner that heat could be integrated into the Country Administrative Boards' review grounds [8]. This would imply that the Country Administrative Boards would have to review LDP based on the risks of heat, and consequently, the municipalities would have to prove that the land is suitable from a heat perspective for urban development. The planner argued that it could imply that heat analysis would have to be carried out in each LDP in the same way that torrential rain analysis is done.

Most of the planners (20/24) considered to some extent that the division of responsibilities between different actors (for instance, municipalities, property owners, the Country Administrative boards, etc.) was unclear in work on heat. Property owners tend not to have knowledge about their responsibility regarding climate adaptation in already built-up environments, according to the planners, which resulted in insufficient climate adaptation work. The property owners' responsibility was also considered an issue if the municipality wanted to implement comprehensive solutions across the municipality since it is not the municipality's obligation to implement measures on the property owner's land. One of the

[8] Chapter 5, 22§ 5p PBL.

planners also explained that it was an issue that only municipalities could seek financial support from The Swedish Civil Contingencies Agency (MSB) for climate adaptation since property owners have a major obligation to adapt to the climate.

5.3.3 Local government

Local government was considered the third most important factor. 20 out of 24 municipalities had not made a political decision that included work on heat directly or indirectly. A planner explained that municipal personnel wanted to work with heat, but the work was limited due to local government. The planner explained that the citizens must have knowledge of the issue and understand the risks with heat for it to influence the politicians and consequently assign the municipal personnel to work on the issue. A planner expressed the following:

"The municipality sees a great need to investigate heat stress in the form of a heat map, especially for the municipality's densely built-up areas and for schools and health care. However, the knowledge and resources are low in such a small municipality and so far, no decision has come to investigate the matter further […]." Anonymous comment from the questionnaire.

In interviews with planners representing municipalities that were already working on heat, the local government was considered to have been decisive for the work on heat. The planners identified local government as one of the most important factors that enabled work on the matter.

5.3.4 Support from authorities

Support from authorities was considered the fourth most factor. More than half of the municipalities agreed partially or less that the County Administrative Board and expert authorities gave the municipalities sufficient support in the work on heat. It emerged during interviews that several municipalities would use a national heat map by The Swedish Civil Contingencies Agency (MSB). Due to the municipalities' limited financial resources, knowledge-enhancing material and support were considered valuable. Consequently, based on the national data, it was attainable to identify risk areas and could be used to increase knowledge-raising tools aimed at stakeholders such as politicians or municipal employees.

Work around heat could be initiated if needed. The County Administrative Board in Skåne had initiated and supported municipalities in working around climate adaptation. A planner from one of the municipalities considered that this type of support was valuable due to the municipality's limited financial resources and enabled the development of a new climate adaptation strategy, which included work on heat. This allowed analysis of risks and identification of measures to be carried out. Despite this, further climate adaptation work had been limited since the climate adaptation strategy had not yet been adopted by the local government.

The planners expressed the need for guidelines and recommendations from expert authorities regarding how the municipalities should incorporate heat in urban planning. A comparison was made between recommendations regarding climate risks such as torrential rain and recommendations on heat mitigation. It was considered that there was not as much information nor recommendations about heat compared to other climate risks that were described as voluminous. A planner explained that the municipality was going to develop an internal guideline with the aim of enabling systematic work around heat due to the perception that this type of recommendation did not exist. The informant expressed it as follows regarding the need for guidelines:

" [...] I think that all the municipalities have understood that it is important to work on it, but how, for me it is a bit unclear". Informant from interviewed municipality.

Similar initiatives were presented under *5.2 Prioritisation of heat in comparison with other climate risks,* from another municipality. The results indicate that due to a lack of recommendations, municipalities had started to form internal guidelines to enable work on heat.

5.3.5 Financial resources

Financial resources were considered the fifth most important factor. Most of the municipalities' considered that there were financial deficiencies to be able to work on heat. It was recognised that financial resources were required to assign personnel to work on heat or climate adaptation in general. In some cases, there were no financial resources to assign one person to work with climate adaptation full-time. Instead, it was a work assignment that several workers shared in

addition to their regular duties. This implied that the work on climate adaptation was generally perceived as time-limited and climate risks had to be prioritised between. Hence, heat tended to be deprioritised. It also emerged that the cost of implementing heat mitigation strategies, such as greenery, limited the work due to the cost of execution and subsequent maintenance. One planner considered that heat was a greater matter than what the municipality had financial resources to work with.

The expense of carrying out investigations and analysis constituted a deficiency in the work on heat. Planners recognised that it was demanded to carry out investigations but was limited due to financial deficiencies. From municipalities that had carried out heat-related work, it emerged that it had been financed through specially allocated finances for climate adaptation and municipal funds from which the personnel could apply for finances for various projects.

The work on heat could imply ambiguities about which department of the municipality would finance the work. It emerged that a municipality wanted to implement greenery in preschool yards, but it was unclear which department would finance the costs, which caused delays in the work.

6.Discussion

6.1 Discussion of results

About half (46 %) of the municipalities included in this study had carried out heat analyses and identified measures to mitigate heat (Figure 4), i.e., reached stages 2 (*assessment*) and 3 (*planning*) for climate adaptation according to IPCC (2022). Only less than a third (29%) of the municipalities had implemented measures to mitigate heat, i.e., reached stage 4 (*implementation*). The measures implemented were single projects aimed at particularly vulnerable groups, for example, through measures targeting preschools and elderly care. Therefore, it can be argued that the comprehensive work had not yet reached stage 4. About half (54%) of the municipalities had not worked with heat at all. Since planners experienced a lack of knowledge to work with heat, it can be reasoned that municipalities that had not worked with heat at all either had not reached stage 1 *(awareness*) or had reached the stage and had plans to work with heat in the future.

Municipalities in Skåne had come further in work on heat than municipalities in Greater Gothenburg (Figure 5). This could be explained by the fact that planners in Skåne ranked heat higher than planners in Greater Gothenburg, which could have impacted the levels of work in each geographical region since there were examples of initiatives from municipal personnel. The geographical differences could also be explained by the fact that it is legislated that the region of Skåne must work with efforts to counter climate impact and its effect [9] (Prop 2017/18:266, p.95), while the region that the municipalities in Greater Gothenburg are covered by has no legislated work around this (expect for Kungsbacka, which is included in the region of Halland). Since the UHI effect is particularly noticeable during longer periods of high temperatures and can contribute to intensifying and prolonging heat waves (The Swedish Expert Council on Climate Adaptation, 2022:476, Dodman et al, 2022:924), and the summer in Skåne tends to be longer than in other Swedish regions (SMHI, 2022), this could have impacted the levels of work in Skåne compared to Greater Gothenburg.

Coastal municipalities had come further in work on heat than inland municipalities (Figure 6). It can be argued that coastal cities are exposed to both coastal and non-coastal climate risks, thus the risks are higher and could have impacted the levels of work in the coastal

[9] Chapter 7 1§ 7p. PBL

municipalities compared to the inland municipalities. However, this contrasts with a previous study by SMHI (2019) which showed that coastal municipalities had worked the least with heat. The differences can be explained by the fact that the study done by SMHI was based on municipalities covering the whole of Sweden and can thus explain why this thesis' result differed from SMHI's.

There were no differences in how far the municipalities had come in working with heat based on the size of the urban population. On the other hand, heat can be expected to be a larger issue in municipalities with a larger urban population size since the UHI is intensified (Manoli et al., 2019). However, anthropogenic heat is one of several factors that affect UHI (Oke et al, 2017); thus, no further conclusions can be made regarding the municipalities' UHI affecting the levels of work on heat.

Heat received the lowest rank of the defined climate risks in the municipal climate adaptation work (Figure 7); thus, it corresponds to previous findings regarding the deprioritisation of heat (Wamsler & Brink, 2014; Jonsson & Lundgren, 2015). It is reasoned that the deprioritisation of heat in this study could be due to the perception of heat since previous research from SMHI (2020) stated that an important factor that influenced whether the municipalities worked with climate adaptation was the experience of previous climate events. Planners in thesis explained that heat was not perceived, by politicians, citizens, or municipal personnel, as a threat to the physical environment in the same way as other climate risks. They referred to the summer of 2018 and explained that similar extreme heat must occur more frequently to be perceived as a bigger issue. It can be argued that this perception of heat agrees with previous research by Luber & McGeehin (2008) and Keith et al (2020), who stated that heat differs from other climate risks due to its invisibility and spatial and temporal characteristics. Since it does not leave any damaging trails, the risks are forgotten when cooler weather occurs (Luber & McGeehin, 2008), which can explain the deprioritising of heat. It can also be argued that since heat primarily is a threat to certain vulnerable groups, as stated by The Public Health Agency of Sweden (2022), this can explain the lower priority of heat compared to other climate risks as it is reasoned that other climate risks can be a threat to entire populations. It is also possible to argue that based on this perception of heat, the municipalities' adaptation approach can be considered to have reactive elements, as defined by IPCC (2022), which implies that heat will only be prioritised when it is perceived as a more significant issue and that climate adaptation

tends to focus on responding to current or near-term risks rather than future risks. Sweden, and more specifically, Greater Gothenburg and Skåne, is projected to have a warmer climate in the future, which means that extreme heat and heat waves will become more intense and occur more often (SMHI, 2011;2013; 2015a; 2015b). Due to heat mitigation strategies' long time span for implementation, stated by Meerow & Keith (2020), changing to an anticipatory approach is emphasised. Further, it is essential to emphasise that heat is one of many climate risks the municipalities face and must manage through climate adaptation; thus, the optimal would be if the municipalities did not have to prioritise between climate risks at all.

Five factors were identified as affecting the municipalities' work on heat, i.e., knowledge, legalisation, local government, support from authorities, and financial resources (Table 3). It could be argued that the perception of heat, which resulted in deprioritisation of work on heat, could be related to a lack of knowledge. Knowledge was considered the most important factor since it is fundamental and influences the other identified factors. For instance, it could be argued that knowledge is required for legislation to be changed, for local governments to make decisions regarding work on heat, for the authorities to be able to support the municipalities, and for the municipalities to receive financial resources. Based on the planners' own knowledge and expertise, heat received a higher rank (Figure 8), which shows that planners want to work with heat to a greater extent than the municipalities currently work with it. It also emerged that there were examples of work initiatives on heat from municipal personnel, which shows that the planners' knowledge could affect the work on heat in the municipalities. This study has shown that planners felt that there is a lack of knowledge to work with heat. However, it is stated by Keith et al (2019) that the research on heat mainly consists of heat mapping and modelling. Thus, it can be argued that it exists knowledge on heat, and it can be assumed that there is a gap between the academia and the planners which results in the planners' experience of an absence of knowledge. Consequently, the significance of collaboration between academia and planners is emphasised to develop the work around heat in the municipalities.

Legislation was the second most prioritised factor. The planners expressed willingness to work with heat but needed legislation on heat to allow systematic work to develop. It can be argued that since Eliasson's study (2000), which suggested that climate knowledge, in general, was deprioritised, climate adaptation has gained a higher priority in municipal urban planning. The law changes in PBL (2010:900) have resulted in an increased focus on flooding, erosion, and

sea-level rise (Nilsson et al, 2012) which also were confirmed in this study since the climate risks that were given the highest ranking in the municipalities' climate adaptation work were torrential rain/extreme amounts of snow, changed water flows in lakes and water courses, and landslides and erosion. Consequently, climate adaptation has generally developed since Eliasson's study; however, only on legislated climate risks. If a similar study is to be carried out in 20 years again, there could be a more developed systematic work around heat if the work on heat follows the same pattern as other climate risks.

Local government was considered the third most prioritised factor. Planners wanted to work with heat to a greater extent than they were given the resources to work with it, which is a decision partly made by the local government. The local government's decisive role in work on heat corresponds with findings from Hjerpe et al. (2015), who argued that the local government's lack of knowledge and conflict of aims could limit climate adaptation. Consequently, the importance of knowledge initiatives aimed at local governments could be emphasised.

The fourth most important factor was support from the County Administrative Boards and expert authorities. The planners expressed that they did not know how to work with heat, which was a hindrance. Municipalities that had financial resources had started to design internal guidelines in the absence of national guidelines regarding heat. Consequently, the planners requested guidelines and measures on heat adaptation to enable the development of the work. The importance of support from the County Board and expert authorities in developing guidelines and measures regarding heat is thus emphasised to enable systematic work on the issue.

Financial resources were the least prioritised factor affecting the municipalities' work on heat. It could be argued that knowledge, legislation, support from politics, and the development of guidelines and measures from the County Board and expert authorities are needed prior to financial resources. Municipalities may have sufficient financial resources, but without knowledge, guidelines, and measures, planners felt it could be challenging to know what to fund to mitigate heat. On the other hand, limited financial resources hinder municipalities with sufficient knowledge. This confirms previous findings from IVL (2020), where a municipality wanted to carry out a heat analysis but was limited by the costs. The cost of implementing heat

mitigation strategies, such as greenery, limited the work, which is a disadvantage of heat mitigation strategies confirmed by Meerow & Keith (2021). Like other legislation on climate adaptation, there is a prevailing focus on flooding, erosion, and rising sea levels in the regulation of state subsidies for climate adaptation [10]. Like other legislation around climate adaptation, it could be argued that heat should also be included in this regulation, allowing the municipalities to apply for resources for measures against heat.

Through the questionnaire and interviews with planners, this thesis has contributed to the research on heat planning. About half of the municipalities have started to work on heat, but few municipalities have implemented measures. The results show that the municipalities are at the beginning of their work, and for the municipalities to be able to develop their work, knowledge, legislation, decisions from local government, support from authorities, and financial resources are stressed.

6.2 Discussion of methodology

Through a mixed method approach, broad trends and patterns regarding municipal work on heat have been captured in the questionnaire, while the semi-structured interviews have contributed by explaining and expanding these findings from the questionnaire, which resulted in factors being identified. Thus, the methods have complemented each other, and several perspectives of work on heat have been achieved. However, the limitations of using mixed methods are that a deeper understanding of the research field is missed, which could otherwise have been achieved by basing the study solely on one method (Bryman, 2022).

There are certain weaknesses in the design of the questionnaire that can be addressed. It is possible to argue that my prior knowledge has shaped the questionnaire and consequently, it can be argued that relevant aspects may have been missed in the design of the questionnaire. On the other hand, this could be prevented to some extent through the fact that Joanna Friberg, regional planner at GR, gave me feedback on the design of the questionnaire. Friberg works with planning and thus could give insight into what could be interesting to investigate through the questionnaire. It could also be prevented through the interviews, which allowed the planners

[10] Regulation on financial state subsidy to municipalities for preventive measures again natural hazards (SFS 2022:1395).

to express freely their experiences and opinions of work on heat. Further, the municipalities' work on heat was examined solely based on what had already been done, consequently excluding what the municipalities had planned. Instead, information about planned work emerged through an open-ended question at the end of the questionnaire, where the informants could write other comments not brought up by the questionnaire. Since several planners included information about planned work, it can be considered that they lacked a question exploring this. If the questionnaire was to follow the five stages of climate adaptation (IPCC, 2022), a question regarding monitoring and evaluation was missed regarding this as well. It was never expressed that the questionnaire had been delimited to investigate heat mitigation strategies only, which resulted in planners giving examples of heat management responses as well. Heat management strategies were excluded from this study since it was not considered comparable because not all municipalities included this information.

The composition of municipalities within the two geographical regions was considered comparable. There was the same quantity of municipalities in Greater Gothenburg and Skåne, consisting of similar numbers of coastal and inland municipalities and municipalities with varying population sizes. As mentioned in *4.2.3 Analysis of questionnaire*, The Fisher Freeman Halton exact test was conducted to investigate if there were significant differences when comparing Greater Gothenburg-Skåne, coastal-inland, and urban populations. However, there were no significant differences. A larger sample size would have been needed to investigate significant differences between the groups properly, which Harris & Jarvis (2014:107) argued should be at least 30.

The selection of informants for interviews was based on certain criteria. Municipalities with varying characteristics were chosen to represent the studied population. Themes within the identified factors were mentioned by several planners, regardless of geographical region, coast-inland municipalities, and population size in urban areas. However, the results cannot be generalized to a national context. Additional interviews with planners from other geographical regions would have been needed to confirm these factors more than the six conducted in this study.

6.3 Further research

As this thesis has investigated the municipalities' heat work using heat mitigation strategies, heat management strategies were excluded. Further research could investigate the municipalities' heat management strategies and whether it differs from work on heat mitigation.

To investigate work on heat from a national context, it could be investigated how municipalities work with heat by including municipalities from different parts of Sweden. In addition, differences between municipalities could be investigated further.

Since it was confirmed through this study that the property owners tended not to know their responsibility regarding climate adaptation in already built-up environments, further research could investigate property owners' work on climate adaptation and what hinders the work.

7. Conclusion

Slightly less than half of the municipalities that participated had analysed the heat-related risks and identified measures to mitigate heat. Only about one-third of the municipalities had implemented measures, such as greenery and sun protection. Heat was ranked as the last prioritised climate risk in the municipalities' climate adaptation work. The fact that few municipalities had started to work on heat could be due to the depriortisation of heat compared to other climate risks in the municipalities' climate adaptation work.

Municipalities in Skåne tended to work on heat to a greater extent than municipalities in Greater Gothenburg. It was argued that this could be explained by the fact that planners in Skåne ranked heat higher than planners in Greater Gothenburg based on the planners' own knowledge and expertise, since there were examples given of initiatives from municipal personnel to work on heat. It could also be explained by the fact that there are more legal requirements for the region of Skåne to work with climate adaptation than Greater Gothenburg, which could affect municipal work. Coastal municipalities worked to a greater extent on heat than inland municipalities. It was reasoned that it could be explained by the fact that coastal areas face both coastal and non-coastal risks, thus the risks are higher and could impact the levels of work on heat. There were no differences between municipalities' work based on urban population size; both small and larger municipalities worked on heat.

It was evident that the perception of heat differed from the perception of other climate risks, which was argued could explain the depriotisation of heat. Factors were identified that were considered to either hinder or develop the work around heat. The most important factors was knowledge, followed by legislation, local government, support from authorities, and financial resources. The planners expressed the need for tools, development of standards, guidelines, guidance from authorities, political decisions, and resources to allow the development of work on heat.

8. References

Braun, V., & Clarke, V. (2006) Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77-101. DOI: 10.1191/1478088706qp063oa

Braun, V., & Clarke, V. (2017) Thematic analysis. *The Journal of Positive Psychology,12*(3), 297-298. DOI: 10.1080/17439760.2016.1262613

Bryman, A., Bell, E., Reck, J., & Fields, J. (2022). Social research methods. New York, NY: Oxford University Press.

Eliasson, I. (2000). The use of climate knowledge in urban planning. *Landscape And Urban Planning, 2000, VOL.48, Pp.31-44, 48, 31-44.*

Elwood, S. (2010). Mixed Methods: Thinking, Doing, and Asking in Multiple Ways. Delyser, D., Herbert, S., Aitken, S.C., Crang, M., & McDowell, L. (Ed.) The SAGE Handbook of Qualitative Geography. London: SAGE.

Harris, R. & Jarvis, C. (2014). Statistics for Geography and Environmental Science. London: Taylor and Francis.

Hjerpe, M., Storbjörk, S., & Alberth, J. (2015). "There is nothing political in it": Triggers of local political leaders' engagement in climate adaptation. *Local Environment, 20*(8), 855-873.

IPCC. (2001). *Climate Change 2001: Impacts, Adaptation, and Vulnerability.* Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. [McCarthy, J, J., Canziani, O, F., Leary, N, A., Dokken, D, J., and White, K, S. (eds.)]. Cambridge University Press. Cambridge, UK and New York.

IPCC. (2007). *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 976pp.

IPCC. (2021). *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 2391 pp. doi:10.1017/9781009157896.

IPCC. (2022). *Climate Change 2022: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press. Cambridge University Press, Cambridge, UK and New York, NY, USA,3056 pp., doi:10.1017/9781009325844.

Jonsson, A., & Lundgren, L. (2015). Vulnerability and adaptation to heat in cities: Perspectives and perceptions of local adaptation decision-makers in Sweden. Local Environment, 20(4), 442-458. DOI: 10.1080/13549839.2014.896326

Keith, L., Meerow, S., & Wagner, T. (2020). Planning for Extreme Heat: A review. Journal of Extreme Events. 6(3&4). 27 pages. https://doi.org/10.1142/S2345737620500037

Luber, George, MA, PhD, & McGeehin, Michael, PhD, MSPH. (2008). Climate Change and Extreme Heat Events. *American Journal of Preventive Medicine, 35*(5), 429–435.

Manoli, G., Fatichi, S., Schläpfer, M., Yu, K., Crowther, T., Meili, N., Bou-Zeid, E. (2019). Magnitude of urban heat islands largely explained by climate and population. *Nature (London), 573*(7772), 55-60.

Meerow, S., & Keith, L. (2021). Planning for Extreme Heat: A National Survey of U.S Planners. *Journal of the American Planning Association, 88*(3), 319-334. DOI: 10.1080/01944363.2021.1977682

Nilsson, A., Swartling, Å.G. & Eckerberg, K. (2012). Knowledge for local climate change adaptation in Sweden: challenges of multilevel governance. *Local Environment, 17*(6-7), 751-767. DOI: 10.1080/13549839.2012.678316

Nordgren, J., Stults, M., & Meerow, S. (2016). Supporting local climate change adaptation: Where we are and where we need to go. *Environmental Science & Policy, 66*, 344-352. DOI: 10.1016/j.envsci.2016.05.006

Oke, T. R., Mills, A., Christen, A., & Voogt, J. A. (2017). *Urban Climates (1 ed.).* Cambridge: Cambridge University Press. ISBN:978-1-107-42953-6.

Prop. 2017/18:266. *En ny regional planering*. Retrieved from: https://data.riksdagen.se/fil/58E7EF5E-DB05-42B3-A3B6-94D58D19E742

Prop. 2017/18:163. Nationell strategi för klimatanpassning. Retrieved from: https://www.regeringen.se/contentassets/8c1f4fe980ec4fcb8448251acde6bd08/171816300_webb.pdf

Regulation on authorities' climate adaptation work. (SFS 2018:1428). Ministry of Climate and Enterprise. Retrieved from: https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/forordning-20181428-om-myndigheters_sfs-2018-1428

Regulation on state subsidy to municipalities for preventive measures against natural hazards (SFS 2022:1395). Retrieved from: https://www.svenskforfattningssamling.se/sites/default/files/sfs/2022-08/SFS2022-1395.pdf

SOU 2007:60. Sverige inför klimatförändringar – hot och möjligheter. Retrieved from: https://www.regeringen.se/rattsliga-dokument/statens-offentliga-utredningar/2007/10/sou-200760-/

Statistics Sweden. (n.d.a) Storstadsområden. Retrieved from: https://www.scb.se/contentassets/1e02934987424259b730c5e9a82f7e74/storstadsomr_karta.pdf

Statistics Sweden (n.d.b). Digitala gränser. Retrieved from: https://www.scb.se/hitta-statistik/regional-statistik-och-kartor/regionala-indelningar/digitala-granser/

Statistics Sweden. (2020). Befolkning, landareal och andel fritidshusområden efter region och typ av område. Vart femte år 2000–2020. Retrieved from: https://www.statistikdatabasen.scb.se/pxweb/sv/ssd/START__MI__MI0810__MI0810A/MI0811Tab01/

Statistics Sweden. (2022). Tätorter i Sverige. Retrieved from: https://www.scb.se/hitta-statistik/sverige-i-siffror/miljo/tatorter-i-sverige/

Storbjörk, S., & Uggla, Y. (2015). The practice of settling and enacting strategic guidelines for climate adaptation in spatial planning: Lessons from ten Swedish municipalities. *Regional Environmental Change, 15*(6), 1133-1143.

Taleghani, M., Crank, P., Mohegh, A., Sailor, D., & Ban-Weiss, G. (2019). The impact of heat mitigation strategies on the energy balance of a neighborhood in Los Angeles. *Solar Energy, 177*, 604–611.

The Gothenburg Region. (2021). Klimatanpassningsnätverket. Retrieved from: https://goteborgsregionen.se/natverk/klimatanpassningsnatverket.5.22a3cc881780d1faddf31674.html

The Swedish Expert Council on Climate Adaptation. (2022). *Första rapporten från Nationella expertrådet för klimatanpassning 2022.* Retrieved from: https://klimatanpassningsradet.se/polopoly_fs/1.180289!/Rapport fr%C3%A5n Nationella expertr%C3%A5det f%C3%B6r klimatanpassning 2022.pdf

The Swedish Housing Agency. (2011). *Klimatanpassning i planering och byggande.* Retrieved from: https://www.boverket.se/globalassets/publikationer/dokument/2011/klimatanpassning-i-planering-och-byggande-webb.pdf

The Swedish Planning and Building Act. (SFS:2010:900). Ministry of Rural Affairs and Infrastructure. Retrieved from https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/plan--och-bygglag-2010900_sfs-2010-900

The Swedish Environmental Research Institute. (2021). *Klimatanpassning 2021 - Så långt har Sveriges kommuner kommit.* ISBN:978-91-7883-287-3. Retrieved 2023-01-20 from https://www.ivl.se/download/18.694ca0617a1de98f4728d7/1628413462363/FULLTEXT02.pdf

The Swedish Environmental Research Institute. (2020). *Screening av nationellt arbete med klimatanpassning: utifrån tillgängliga strategier och handlingsplaner.* Retrieved from:

https://www.ivl.se/publikationer/publikationer/screening-av-nationellt-arbete-med-klimatanpassning--utifran-tillgangliga-strategier-och-handlingsplaner.html

The Swedish Meteorological and Hydrological Institute. (2011). Värmeböljor i Sverige. Retrieved from: https://www.smhi.se/polopoly_fs/1.16889!/webbFaktablad_49.pdf

The Swedish Meteorological and Hydrological Institute. (2013). Värmebölja. Retrieved from: https://www.smhi.se/kunskapsbanken/klimat/varmebolja-1.22372

The Swedish Meteorological and Hydrological Institute. (2015a). Framtidsklimat i Västra Götalands län. Retrieved from: https://www.smhi.se/polopoly_fs/1.165058!/Klimatologi_24%20Framtidsklimat%20i%20V%C3%A4stra%20G%C3%B6talands%20l%C3%A4n%20-%20enligt%20RCP-scenarier.pdf

The Swedish Meteorological and Hydrological Institute. (2015b). Framtidsklimat Skånes län. Retrieved from: https://www.smhi.se/polopoly_fs/1.165063!/Klimatologi_29%20Framtidsklimat%20i%20Sk%C3%A5nes%20l%C3%A4n%20-%20enligt%20RCP-scenarier.pdf

The Swedish Meteorological and Hydrological Institute. (2020). Kommuners arbete med klimatanpassning 2019 - Analys av statusrapportering till SMHI. ISSN: 1654-2258. Retrieved 2023-01-20 from https://www.smhi.se/polopoly_fs/1.165092!/Klimatologi_55%20Kommunernas%20arbete%20med%20klimatanpassning%202019%20%E2%80%93%20Analys%20av%20statusrapportering%20till%20SMHI.pdf

The Swedish Meteorological and Hydrological Institute. (2021). Myndigheternas regeringsuppdrag 2020. Retrieved from: https://www.klimatanpassning.se/vem-gor-vad/vad-gor-myndigheterna/myndigheternas-regeringsuppdrag-2020-1.157874

The Swedish Meteorological and Hydrological Institute. (2022). Skånes klimat. Retrieved from: https://www.smhi.se/kunskapsbanken/klimat/klimatet-i-sveriges-landskap/skanes-klimat-1.4827

The Public Health Agency of Sweden. (2021). Folkhälsa i ett förändrat klimat – Folkhälsomyndighetens mål och handlingsplan för klimatanpassning 2021–2024. Retrieved from: https://www.folkhalsomyndigheten.se/publikationer-och-material/publikationsarkiv/f/folkhalsa-i-ett-forandrat-klimat/?pub=88494

The Public Health Agency of Sweden. (2022). Hälsoeffekter av värmeböljor - en kunskapssammanställning. Retrieved from https://www.folkhalsomyndigheten.se/publikationer-och-material/publikationsarkiv/h/halsoeffekter-av-varmeboljor/

UN Habitat. (2022). *World Cities Report 2022: Envisaging the Future of Cities.* Retrieved 2021-01-20 from https://unhabitat.org/sites/default/files/2022/06/wcr_2022.pdf

Vicedo-Cabrera, A., Scovronick, N., Sera, F., Roye, D., Schneider, R., Tobias, A., . . . Gasparrini, A. (2021). The burden of heat-related mortality attributable to recent human-induced climate change. *Nature Climate Change, 11*(6), 492-500.

Wamsler, C., & Brink, E. (2014). Planning for climatic extremes and variability: A review of Swedish municipalities' adaptation responses. Sustainability (Basel, Switzerland), 6(3), 1359-1385. DOI: 10.3390/su6031359

Wilcke, R. A. I., Kjellström, E., Lin, C., Matei, D., Moberg, A. & Tyrils, E. The extremely warm summer of 2018 in Sweden - set in a historical context. Earth System Dynamics, 11(4), 1107-1121. DOI: 10.5194/esd-11-1107-2020

World Health Organization. (2018-06-01). *Heat and Health.* Retrived 2023-01-20 from https://www.who.int/news-room/fact-sheets/detail/climate-change-heat-and-health

Appendix 1 - Questionnaire

The purpose of the questionnaire is to examine the work of municipalities to reduce heat stress outdoors in the built environment. The survey is estimated to take around 10 minutes. The survey is anonymous, but if you have the opportunity to attend a subsequent interview, you can enter your contact details in question 19. After completing the survey, the answers can be saved in a PDF if needed. Thank you for participating in the study!

* = mandatory question

1. Please enter which municipality you work for *:

2. Please enter your role at the municipality *:

3. Based on what you know, please tick the climate effects that the municipality has been affected by in the built environment. Please write under "Other" if the municipality has been affected by another climate risks. *

Rising sea levels ☐
Changed water flows in lakes and water courses ☐
Torrential rain/ extreme amounts of snow ☐
Heat wave/heat stress ☐
Landslides and erosion ☐
Other climate risk:

4. Based on the municipality's work and positions regarding the built environment, rank the following climate risks from 1-6 (where 1 is the highest priority and 6 is the lowest priority) If you wrote another climate risk under question 3, please use "Other climate risk" when prioritising this. If you did not specify an additional climate risk, please prioritise "Other climate risk" as a 6th. (You rank the options by dragging one of the options up or down, or by pressing the arrows when you hover over an option) . *

Rising sea levels ☐
Changed water flows in lakes and water courses ☐
Torrential rain/ extreme amounts of snow ☐
Heat wave/heat stress ☐
Landslides and erosion ☐
Other climate risk:

5. Based on your own knowledge/expertise regarding the built environment, rank the following climate risks from 1–6 (where 1 is the highest priority and 6 is the lowest priority). If you wrote another climate risk under question 3, please use "Other climate

risk" when prioritising this. If you did not specify an additional climate risk, please prioritise "Other climate risk" as a 6th. *

Rising sea levels ☐
Changed water flows in lakes and water courses ☐
Torrential rain/ extreme amounts of snow ☐
Heat wave/heat stress ☐
Landslides and erosion ☐
Other climate risk:

6. Has an analysis been carried out regarding where/when heat stress can occur in the municipality? If yes, please write under "Other" which analysis(s) were carried out. If no, proceed to question 9. *

Yes ☐
No ☐
Don't know ☐
Other:

7. Has the municipality identified measures to reduce heat stress? If yes, please write under "Other" which measures have been identified. If not, proceed to question 9.

Yes ☐
No ☐
Don't know ☐
Other:

8. Has the municipality taken measures to reduce heat stress? If yes, please write under "Other" which measures have been taken.

Yes ☐
No ☐
Don't know ☐
Other:

9. Is the municipality part of an inter-municipal collaboration/network regarding climate adaptation where heat is included? If yes, please state which/which ones under "Other". *

Yes ☐
No ☐
Don't know ☐
Other:

10. Has a political decision been made in the municipality to work on heat? *

Yes ☐
No ☐

Don’t know ☐

11. Statement: There are enough financial resources at the municipality to be able to work with heat. *

Disagree ☐
Agree to a low degree ☐
Partly agree ☐
Agree to a high degree ☐
Completely agree ☐
Don’t know ☐

12. Statement: There is enough knowledge at the municipality to be able to work with heat. *

Disagree ☐
Agree to a low degree ☐
Partly agree ☐
Agree to a high degree ☐
Completely agree ☐
Don’t know ☐

13. Statement: The Country Administrative Board provides the municipality with sufficient support (i.e., knowledge, guidance, and recommendations) in the work on heat. *

Disagree ☐
Agree to a low degree ☐
Partly agree ☐
Agree to a high degree ☐
Completely agree ☐
Don’t know ☐

14. Statement: Expert authorities (for example The Swedish National Board of Housing and SMHI) provide the municipality with sufficient support (i.e., knowledge and guidance) in the work on heat. *

Disagree ☐
Agree to a low degree ☐
Partly agree ☐
Agree to a high degree ☐
Completely agree ☐
Don’t know ☐

15. Statement: The division of responsibility between different actors (for example property owners, municipality, The Country Administrative Board, expert authorities) is understandable in the work on heat. *

- ☐ Disagree
- ☐ Agree to a low degree
- ☐ Partly agree
- ☐ Agree to a high degree
- ☐ Completely agree
- ☐ Don't know

16. Statement: The municipality is doing enough in the work on heat. *

- ☐ Disagree
- ☐ Agree to a low degree
- ☐ Partly agree
- ☐ Agree to a high degree
- ☐ Completely agree
- ☐ Don't know

17. Please state if you have other comments about the work on heat that the questionnaire did not address.
Answer:

18. Please let me know if you would be willing to participate in a subsequent interview. *

- ☐ Yes
- ☐ No

19. Please provide contact details, e-mail and/or phone number, if you are available to be contacted for clarification or further questions. If you do not want to be contacted, enter "-" or similar in the field. *
Answer:

Appendix 2 – Interview guide

Warm-up questions

1. Can you tell me about your role at x municipality?
   (1.1) → *Follow-up question*, how do you work with climate adaptation in your role?

Theme 1 The municipality's climate adaptation work

2. Which climate challenges are included in the municipality's climate adaptation?
   (2.1) → Follow-up question. What is the selection of climate challenges that the municipality works on based on? Policy? Economy? Knowledge? Geographical location/ experience of extremes?

   (2.2) → Follow-up question. Are there climate challenges that are prioritised to a higher degree than other climate challenges? Which one/which ones? How? What is it based on?

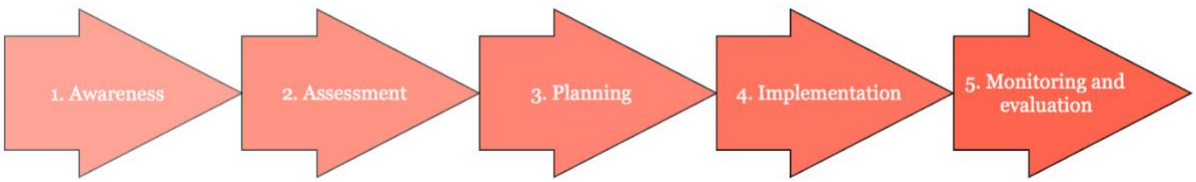
   (2.3) Is there a need to work with climate challenges other than those that the municipality is already working with now? Which one/ ones? How?

Theme 2 The municipality's work on heat

3. Can you tell me about the municipality's work on heat?
   (3.1) → Follow-up question (if the municipality does not work on the matter at all). Why isn't the municipality working on heat?

4. (If the municipality is working on the issue, otherwise proceed). Would you say that the work on heat differs from the work with other climate risks within the municipality?
   (4.1) → Follow-up question: In what way?
   (4.2) → Follow-up question: What do you think are the causes?

5. There are five general steps for climate adaptation. These are (1) Awareness, (2) Assessment, (3) Planning, (4) Implementation, (5) Monitoring and evaluation. If you base your answer on this figure, at what stage would you say that the municipality is in the work on heat?



(5.1) → Follow-up question: Can you tell me more about the stage you are at? (for example, about stage 3, what is being done in planning right now?).
(5.2) → Follow-up question (If the municipality has progressed beyond stage 1): What factors have contributed to the municipality reaching stage x?
(5.3) → Follow-up question (asked to everyone) What is needed for the municipality to be able to reach the next stage?
(5.3.1) → Follow-up question: (If, for example, knowledge or financial resources are mentioned, they may develop what knowledge they need, or what the financial resources are needed for. Or if they mention, for example, guidelines or tools, what kind of guidelines or tools?)

6. What do you think are the general challenges in Swedish municipalities' work on heat?
   (6.1) → Follow-up question: How can these challenges be handled/solved?

Endinq questions

7. Is there anything you want to add before we end this interview?