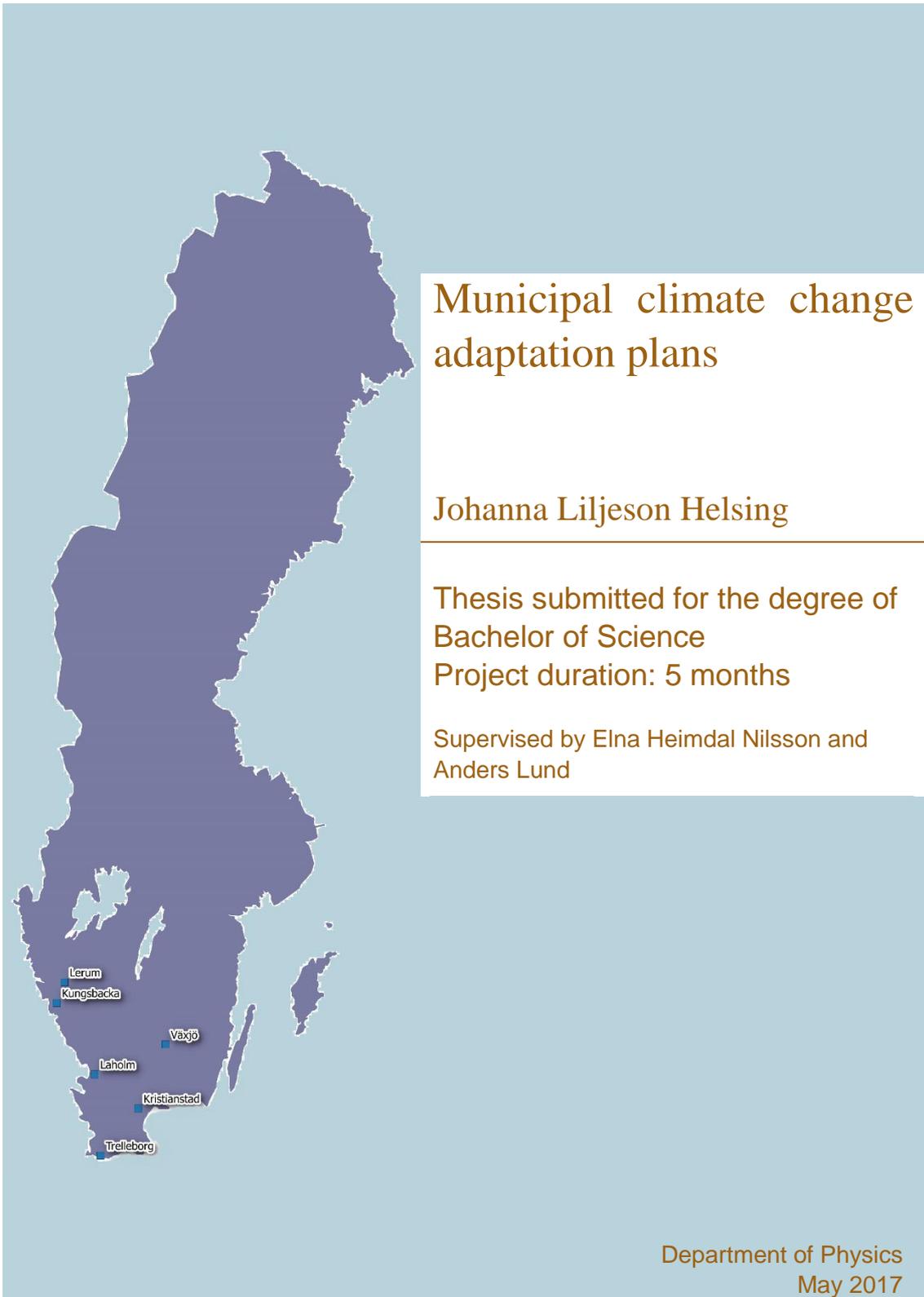




**LUND UNIVERSITY**  
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# Municipal climate change adaptation plans

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## Abstract

Swedish municipalities carry the main responsibility for adapting to a changing climate, but receive little guidance from regional or national authorities. A municipal climate change adaptation plan can be used to get a comprehensive look at all areas of the municipality's activities that will be affected by climate change and to better understand the implications and how to lessen the extent of damages. This paper explores how five Swedish municipalities have worked with their plans, what is included and who were part of the preparation, and looks at different problems a municipality might face when working with adaptation.

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# 1 Introduction

The climate is changing and society needs to adapt to new challenges. In 2016 the Swedish Environmental Research Institute IVL did a survey (Thörn, Bonnier, & Roth, 2016) amongst Swedish municipalities with questions regarding climate change adaptation. Ninety eight percent believe they will be affected by climate change or extreme weather events. Eighty percent of municipalities work with climate change adaptation today, foremost in decreasing vulnerability to flooding. Forty percent have a political resolution to work with climate change adaptation, and only 20 percent have an action plan.

The aim of a municipal climate change adaption plan is to identify vulnerabilities from a future climate in all areas of a municipality's operations, and to suggest actions to lessen the extent of the damages. To ensure that individual adaptation measures do not move problems to new areas instead of solving them, a municipal adaptation plan that looks at all parts of a municipality's vulnerabilities to climate change is key.

In the fall of 2016 Kungsbacka municipality signed the Covenant of Mayors which in part entails to write a climate change adaptation plan. This paper was written as a preparation and surveys how five Swedish municipalities (Laholm, Lerum, Växjö, Trelleborg and Kristianstad) have worked with their plans. What is included in the plans and who were part of the preparation? The County Administrative Boards acts as a link between municipalities and the state and are commissioned to coordinate the regional adaptation work and give guidance to the municipalities. What are their recommendations? There is plenty of research into climate change and adaptation to it. Are the municipal plans based on this and is it helping the people working with adaptation on a municipal level?

Firstly a description of climate change and adaptation is given, thereafter results and discussion.

## 2 Method

To get as a complete picture as possible, information have been gathered both through literature studies and through interviews. Suggestions for literature have come from the staff at the Environmental and Health protection Administration of Kungsbacka municipality, my supervisors, searches online, and from the reference lists in articles already read. The persons who have been interviewed are the representatives for the municipal climate change adaptation plans of Laholm, Lerum, Växjö, Trelleborg, and Kristianstad municipalities, and from the County Administrative Board of Halland. Literature studies and interviews have been carried out in parallel.

The introduction to the subject was the County Administrative Board of Halland's regional action plan *Regional handlingsplan för klimatanpassning i Hallands län*. The municipal climate change adaptation plans that have been studied were chosen with the criteria of not being more than three years old. From the regional and municipal action plans came ideas for keywords and other literature.

The interviews have been informal and over the telephone, with a few standard questions and some specific for each municipality, that the interviewees got to reason freely around (Annex 1).

The interviewees are:

- Margareta Lindgren, Environmental Strategist for Laholm municipality
- Anna Engström, Environmental Manager for Lerum municipality
- Henrik Johansson, Environmental Coordinator for Växjö municipality
- Anitha Ljung, Climate and Sustainability Coordinator for Trelleborg municipality
- Lennart Erfors, Climate Strategist for Kristianstad municipality
- Karin Stenholm, Climate change adaptation Coordinator for the County Administrative Board of Halland

## 3 Background

This section describes climate change from different perspectives. It starts with a physical description of climate change, and a definition of adaptation to it. A short explanation of the report *Sweden facing climate change- threats and opportunities* is followed by a regional and local description of future climate change and risks due to it.

### 3.1 Climate change

Climate is the average weather over several decades, climate change thus infers changes over long periods of time. The basic concept is that when the earth's radiation budget is perturbed, the mean temperature will start to shift to try to find a new equilibrium. This will induce climate change.

#### 3.1.1 Radiation budget

All objects with a temperature above absolute zero emit radiation. If it is a blackbody (absorbing all radiation and emitting maximum radiation at given temperature) Wien's law can be used to find out at what wavelength the maximum emission is occurring. The maximum depends on the temperature of the blackbody as

$$\lambda_{max} = \frac{b}{T} \quad (\text{Wien's law}) \quad [1]$$

where  $\lambda_{max}$  is the wavelength at maximum intensity,  $b$  is Wien's displacement constant, equal to  $2.8977729 \times 10^{-3}$  mK, and  $T$  is the absolute temperature (Ahrens, 2013).

The sun is a blackbody and radiation from it is mostly in the ultraviolet and visible range of wavelengths, and is referred to as shortwave radiation. At the earth's surface and in its atmosphere some of the radiation is reflected and some is absorbed, see figure 2. The fraction that is reflected is dependent on the albedo, which is a measure of the amount of radiation reflected. On average 30 % of the total incoming solar radiation is reflected from the earth. The albedo depends on ice and snow cover, cloud cover and aerosol content, topography and vegetation, and therefore the actual amount of the solar radiation being reflected varies depending on location and time of year. The radiation that is absorbed heats the earth which also acts as a blackbody and emits radiation in the infrared range because of the earth's much lower temperature. This radiation is referred to as long wave radiation. The amount of emission is given by

$$E^* = \epsilon \sigma T^4 \quad (\text{Stefan-Boltzmann law}) \quad [2]$$

where the Stefan-Boltzmann constant  $\sigma = 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$  and  $\epsilon$  is the emissivity which describes how well an object can be described as a blackbody. For a perfect blackbody the emissivity is 1 and this value can be used for simplified descriptions of the radiative balance of the earth (Stull, 2000).

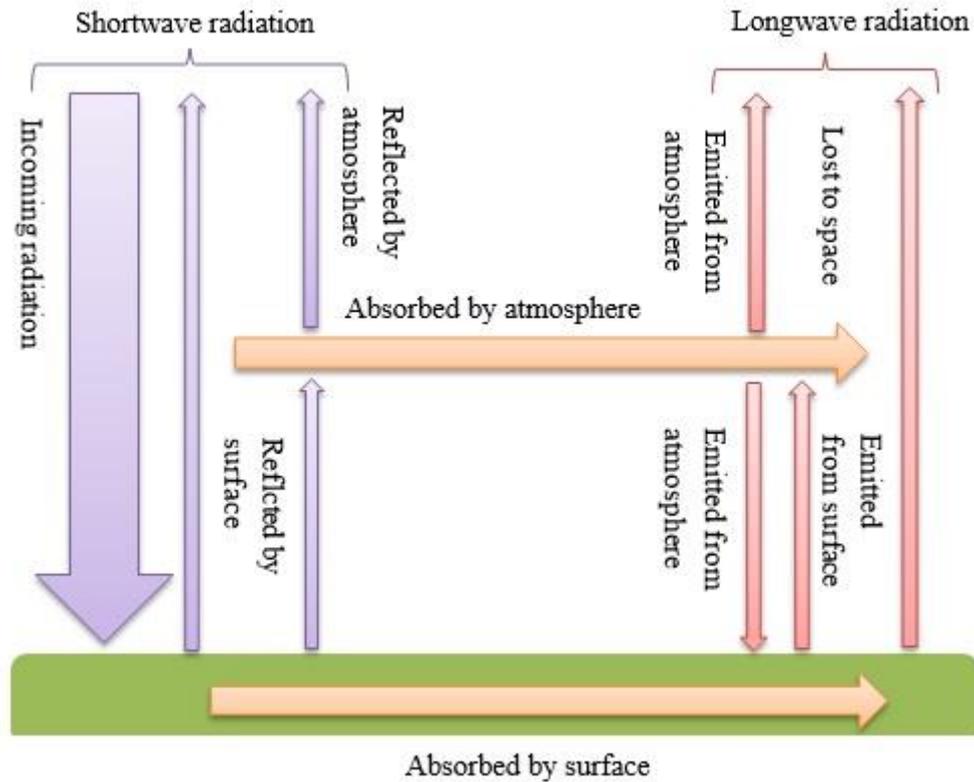


Figure 1 Earth's radiation budget. Arrows not to scale.

### 3.1.2 The greenhouse effect

The earth's atmosphere keeps the temperature higher than it would be without one, as a result of absorption of radiation by atmospheric gases, this is called the greenhouse effect. The most important greenhouse gases are water vapor and carbon dioxide. Both are selective absorbers which means that they are transparent to some wavelengths and opaque to others. Greenhouse gases let the solar short wave radiation through but absorbs the infrared wavelengths of the earth, reemitting longwave radiation to the surface (Ahrens, 2013). If the content of the atmosphere is altered the amount of energy absorbed by it will in turn change. This will alter the radiative equilibrium temperature and induce climate change. This can be described mathematically by

$$C \frac{dT_s}{dt} = \frac{(1-\alpha)S}{4} - \epsilon\sigma T_s^4 \quad [3]$$

where it is assumed the amount of incoming shortwave radiation being absorbed by the earth is  $(1 - \alpha)S/4$  where  $S$  is the solar constant ( $1370 \text{ W/m}^2$ ) and  $\alpha$  is the albedo, and the second term on the right hand side is the outgoing radiation.  $C$  is the effective heat capacity of the Earth equal to  $2.08 \times 10^8 \text{ JK}^{-1}\text{m}^{-2}$ . When there is balance between incoming and outgoing radiation the left hand side of the equation is zero and thus:

$$\frac{(1-\alpha)S}{4} = \epsilon\sigma T_s^4 \quad [4]$$

The factor  $1/4$  between incoming and outgoing radiation comes from the fact that the earth is constantly emitting radiation from the entirety of its surface area, but only receiving radiation over its cross sectional area.

These equations above do not take into account any atmosphere so the temperature given by them will be cooler than the actual surface temperature. For a more realistic representation of the earth and its atmosphere, a single layer model can be used. The earth's emissivity was approximated as one but the atmosphere also has an emissivity of  $\epsilon_{atm}$ , therefore  $1 - \epsilon_{atm}$  is the fraction of incident longwave radiation that is transmitted through the atmosphere without being absorbed.  $\epsilon_{atm} = 0$  corresponds to no greenhouse effect at all and  $\epsilon_{atm} = 1$  would be total greenhouse effect. It is important to remember that there is a natural greenhouse effect keeping the earth at an inhabitable average temperature, and that the anthropogenic effects result in an added greenhouse effect. The true  $\epsilon$  somewhere between zero and one. By balancing the incoming and outgoing energy at the top of the atmosphere, in the atmospheric layer and at the surface and solving the system of equations the earth's mean temperature is given by

$$T_e = \frac{\left[ \frac{(1-A)S}{4\sigma(1-\frac{\epsilon}{2})} \right]^{1/4}}{2^{1/4}} \quad [5]$$

With a standard albedo of 30% ( $\alpha=0.3$ ) and the emissivity at zero ( $\epsilon = 0$ ) which describes an earth without an atmosphere the radiative equilibrium temperature would be  $-18^\circ\text{C}$  because all longwave emissions would be lost to space. Instead the average temperature is  $15^\circ\text{C}$  because different gases in the atmosphere absorb different wavelengths and reemit them back to earth, and can be shown by putting  $\epsilon = 0.77$ .

## 3.2 Mitigation and adaptation

Up until now focus has been on trying to mitigate climate change through different emission control actions. Despite this work the global greenhouse gas emissions in 2010 were  $49 \pm 4.5$  Gt carbon dioxide equivalents, and it is extremely likely that more than half of the observed increase in global mean surface temperature from 1951 to 2010 is due to human interaction (IPCC, o.a., 2014). Because of the inertia of the climate system, the results of the control actions made today will not be noticeable until the middle of the century. This also means that the climate change that we notice today is because of earlier emissions (SOU, 2007), and societies need to adapt to the inevitable changes that will come. It will not be possible to eliminate the need for adaptation by mitigation. It is now essential that the understanding for climate change adaptation is increased (Andersson, o.a., 2015). The definition used is from the IPCC:

### *Adaptation*

*The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects. (IPCC, Mach, & Stechow, IPCC, 2014)*

Wamsler and Brink (2014) studied different Swedish municipal adaptation approaches and how they relate to institutional structures and found that there is no comprehensive approach to adaptation planning, neither at local or institutional level. This is in contrast to the success of mitigation where there were much more support (both financial and guiding) from a

national level, and citizens were encouraged to take an active role (Wamsler & Brink, 2014). The authors call for a more top-down and bottom-up approach to all the parts of adaptation: risk-assessment, information sharing, prioritization, implementation, monitoring and institutionalization of measures. This has been achieved in the city of Manizales in Colombia where a long tradition of environmental work and strong participation from the community and universities, is backed and supported by legislation and government (Hardoy & Velásques Barrero, 2014).

Another difficulty municipalities face when working with adaptation is that many municipal services such as water and energy supply and care of the elderly have been outsourced and privatized, and the municipalities are dependent on decision makers in other organizations (Carlsson-Kanyama, Carlsen, & Dreborg, 2013).

### 3.3 Sweden facing climate change - threats and opportunities

In 2005 the Swedish Government decided to survey the vulnerability of the Swedish society to global climate change, and appointed the Commission on Climate and Vulnerability. Bengt Holgersson, Governor of the County Administrative Board of Skåne, was appointed Head of Commission and a committee of experts from different government authorities, research institutes, the economy sector and other organizations advised during the preparation. *Sweden facing climate change- threats and opportunities* (SOU, 2007) was published in 2007 and describes how the climate in Sweden will develop during the twenty first century based on the knowledge of the time, and the following consequences for a number of sectors. These were:

- Communications
- Technical support systems
- Developments and buildings
- Rural bussinesses and tourism
- Natural environment and environmental goals
- Human health
- Changes in the world around us and their impact on Sweden
- Combined effects in society

### 3.4 Climate change in Halland

The Swedish Meteorological and Hydrological Institute, SMHI, have developed climate scenarios for each county that stretches to the end of the century. The resulting report is called *Framtidsklimat i Hallands län – enligt RCP-scenarier*. The scenarios are based on two of the scenarios, RCP4.5 and RCP8.5, from IPCCs latest report. Both scenarios describe the likely effects of different concentrations of greenhouse gas concentrations in the atmosphere 2100. RCP4.5 represent a future with strong climate policies and extensive emission cuts while RCP8.5 represents continuing on the path we are now. (Persson, et al., 2015)

I have chosen to present here the results from RCP4.5 assuming that this is path the world will chose.

The annual average temperature is expected to rise more in Sweden than the global average (SOU, 2007). According to *Framtidsklimat i Hallands län – enligt RCP-scenarier* from SMHI, the expected temperature rise by the end of the century is 2,5°C, with the greatest

increase in the winter months. During summer months the heat waves are likely to be both longer and more frequent (Persson, et al., 2015). There is no international accepted definition of a heatwave. The SMHI uses “a period of at least five days with maximum temperatures above 25°C” (Persson & Wern, *Värmeböljor i Sverige*, 2011). The lack of a single definition is probably due to that people in different climate zones are adapted to different temperature ranges. For example, according to *Värmeböljor i Sverige* (Heatwaves in Sweden) by Persson and Wern the optimal temperature to have the least amount of deaths is 11-12°C in Sweden and Norway, 20°C in London and 25°C in Athens. A warmer climate means that the vegetation period becomes longer, and could by the end of the century be as much as two months longer compared to the reference period 1961-1990 (Persson, et al., 2015). The greatest difference is expected in spring, the start of the vegetation period may be in late February.

Compared to other counties Halland receives a substantial amount of precipitation because of its exposure to the most common weather systems in Sweden: the wandering lows that are created over the Atlantic and proceed east (Persson, et al., 2015). A warmer climate means more evaporation and faster circulation, which will bring increased precipitation in Halland by as much as 15-25 percent, and days with heavy downpours above 10 mm increasing by a third (Persson, et al., 2015). The inflow to the waterways will be highest in wintertime, when most of the precipitation is received. Snowfalls will become scarce so the water will enter the waterways immediately instead of being stored as a snow cover (Persson, et al., 2015; SOU, 2007).

These changes correspond to a best-case-scenario with extensive emission cuts, forceful climate policies, limited population growth and changed patterns of consumption. If we instead continue on the path we are on now, the changes will be even greater (Persson, et al., 2015). Since we cannot be sure of how much the climate will have changed by the end of the century, it is important to act based on the trend of the changes and not on exact numbers (Länsstyrelsen i Hallands län, 2014)

### 3.5 Risks for Kungsbacka

The county Administrative Board of Halland (Länsstyrelsen i Hallands län, 2014) have listed several risk for Kungsbacka municipality that may be affected by climate change:

- Flooding
  - Coastal
  - Creek
  - Storm water
- Many development plans in areas sensitive to flooding
- City center risks flooding from creek
- Landslides and erosion
- Heatwaves
- Cultural environment
  - Remnants
  - Buildings
- Agriculture and forestry
  - Storms
  - Drought
  - Animal husbandry

- Drinking water
  - Pollution
  - Shortage
  - Contamination
  - Viruses
- Plants and animals

Heatwaves and floods are two examples of effects that can be seen already. In *Värmeböljor i Sverige* it is explained that more factors than the maximum temperature affects people during heat waves. Cool nights can be alleviating, high humidity diminishes the effectiveness of perspiration, and long duration of the heat wave worsens the situation further. Another important factor is the urban heat island effect which can increase the temperature in cities by several degrees compared to neighboring rural areas. Swedish houses are built to keep warm, so the inside temperature can be much warmer than the outside (Persson & Wern, *Värmeböljor i Sverige*, 2011).

Along the west coast the prevailing winds are south westerly (SMHI, 2015). When storms come in from this direction, the wind surge rises the sea level in the Kungsbacka Fjord (Svensson & Nilsson, 2015). How large the wind surge becomes is dependent on several factors:

- Fetch (the distance the wind travels over open water): longer distances give greater effect
- Wind force: higher winds give greater effect
- Duration: longer duration gives greater effect
- The shape of the seabed: shallow sea gives greater effect
- The shape of the coastline: bays give greater effect

In the Kungsbacka Fjord all these factors contribute to high wind surge during storms (Svensson & Nilsson, 2015). The Kungsbacka Creek then risks flooding the city center since the lower parts (from the mouth to Kraftvägen) is affected primarily by the sea level (DHI, 2009). In 2004 the storm Gudrun created record high levels (+1,83 m) in the lower parts of the Kungsbacka Creek (downstream of Hamntorget) due to high sea level in the Kungsbacka Fjord (DHI, 2009). During this century the sea level is expected to rise by one meter, but will continue to rise long after this (Andersson, o.a., 2015). In 2006 the Kungsbacka Creek flooded due to high flows, estimated as a 100-year flow, creating considerable damage in the city center (DHI, 2009). The Swedish Civil Contingencies Agency, MSB, have prioritized the Kungsbacka Creek as one of 18 areas in Sweden with considerable risk of flooding (MSB, 2013).

## **4 Results**

In this chapter the results from the municipal adaptation plans and the interviews are presented, including two summary tables, Table 1 and 2. A brief section covers financing opportunities.

### **4.1 Literature study and interviews**

The following sections covers the municipal climate change adaptation plans and interviews divided under three parts

- Aim, participants, and process
- Content
- Follow up

One subchapter concerns the County Administrative Board Halland.

#### **4.1.1. Aim, participants, and process**

The common aim of the municipal climate change adaptation plans is to identify what vulnerabilities the municipalities are facing in a future climate and to suggest actions to lessen the extent of the damages. The plans from Lerum municipality and Våxjö municipality aims at pointing out any opportunities a changing climate might bring as well. Kristianstad municipality have updated an earlier version from 2011.

All municipalities have had different administrations and businesses involved in the preparation of their plans, see Table 1. Laholm municipality had a management group consisting of politicians and Laholmsbuktens VA (the joint water and sewage administration for Laholm and Halmstad municipalities). Våxjö municipality started the process with a meeting where the County Administrative Board of Kronoberg informed the politicians and officials about the societal effects of climate change and the importance of cooperation across sectors. Kristianstad municipality hired a consultant to update their earlier climate change adaptation plan, which sped up the process. The other municipalities prepared their plans for about one to one and a half years.

**Tabel 1** Contributors

Municipality	Management group	Project group	Work group	Other contributors	Follow up
<i>Laholm</i>	Politicians from the Municipal preparation committee, the Environmental and Planning committee. Laholmsbuktens VA		Officials from the different municipal administrations. Laholmsbuktens VA	Laholmsbuktens VA	In conjunction with the preparation of the Official Community Plan
<i>Lerum</i>		Ullacarin Lundgren	Different groups that investigated specific areas. The Administration Heads	The community planning, learning, support and care, infrasupport administrations. The development coordinator for public health Lerum Energy Lerum District heating The emergency response service of the greater Gothenburg area	To be actualized by the management group every few years
<i>Växjö</i>	The Municipal government's planning office	Technical Administration, the Planning Office, the City Planning Administration, the Emergency Services, the Environmental and Health protection Administration, the Care Administration, Växjö Energi AB, and Växjö kommunföretag AB	Four work groups that analyzed separate areas	The county Administrative Board of Kronoberg	Each administration should report to the municipality's environmental coordinator
<i>Trelleborg</i>	The Head of the local government and the Administration Heads		A group from the Environmental administration consisting of an environmental engineer, an ecologist, a zoning architect, and an environmental coordinator	The County Administrative Board of Skåne Officials from the different municipal administrations and activities Politicians Representatives from the healthcare and the agriculture sector	Most administrations have a "climatist" in charge of reporting to the climate change adaptation group
<i>Kristianstad</i>	Politicians from all parties		A consultant	The different administrations	The responsible for each action and the management group

#### 4.1.1.1 Laholm municipality

Laholm is the southernmost municipality in the county of Halland situated by the Bay of Laholm. The Lagan River runs through the municipality.

The aim of Laholm municipality's climate change adaptation plan has been to investigate how the municipality will be affected by climate change and what actions needs to be taken to lessen the effects (Laholms kommun, 2015). The plan is intended to be a knowledge base and guiding document when working with planning questions.

Margareta Lindgren, environmental strategist for Laholm municipality and a part of the group of officials for the preparation of the plan, informed me that when working with the latest Official Community Plan (a document created by every municipality describing the direction of the long term development of the physical environment in the municipality) it was decided that there were to be made a separate climate change adaptation plan instead of treating these question as a part of the Official Community Plan (Lindgren, 2016).

In the preparation of the climate change adaptation plan officials from all administrations and from Laholmsbukstens VA have been involved, and a management group with politicians from the Municipal preparation committee, the Environmental and Planning committee, and Laholmsbukstens VA (Laholms kommun, 2015). Lindgren continues by saying that it has been beneficial to have the politicians involved from the get go, and that it is important that they can make informed decisions. During the preparation of the plan a day of lectures with meteorologist Pär Holmgren as main speaker was held. The preparation of the plan took about a year (Lindgren, 2016).

#### 4.1.1.2 Lerum municipality

Lerum is situated north east of Gothenburg in the County of Västra Götaland. Amongst the municipalities of western Sweden Lerum is the most densely covered by lakes.

The aim of Lerum municipality's plan has been both to describe the climate changes that will affect the municipality and the risks, vulnerabilities and possibilities they bring, and to suggest actions with priority, time plan and where the responsibility lies (Lundgren, 2015).

Anna Engström, Environmental Manager for Lerum municipality, informed me that that the politicians commissioned the climate change adaptation plan. Ullacarin Lundgren was the responsible official and prepared templates for each subchapter with the County Administrative Board of Västra Götaland's regional action plan as a base. Different working groups then analyzed each subchapter (Communications, Technical support systems, Developments and buildings, Rural businesses and tourism, Natural environment, Human health), and the Administration Heads filled in what actions were necessary in their particular field. Some administrations did not hand in any suggested actions, because climate change adaption is not considered vital to their field. In these cases the suggested actions were to investigate further how they will be affected. The preparation of the climate change adaptation plan took 1-1.5 year (Engström, 2016).

#### 4.1.1.3 Växjö municipality

Växjö is situated in the central parts of Småland, in the County of Kronoberg. The municipality is surrounded by forests (mostly coniferous), lakes and water courses.

The aim of Växjö municipality's plan is to mitigate negative effects and costs and to take advantage of new possibilities by identifying where actions are needed, and to make climate change adaptation an integrated part of the municipality's daily processes and planning in all administrations (Växjö kommun, 2013). Växjö municipality has been a part of the Covenant of Mayors since 2008 and were asked to participate in the EU financed project CLIPART which was aimed at developing guide lines for working with climate change adaptation on a local level (Johansson, 2016). As a part of this project the municipal's climate change adaptation plan was prepared. Henrik Johansson, environmental coordinator for Växjö municipality, continues by saying that after twenty years of mitigation efforts, adaptation felt

like a natural and necessary step, especially since the municipality already had had some problems with flooding.

The management group came from the Municipal government's planning office (Växjö kommun, 2013). Below them was a project group from the Technical Administration, the Planning Office, the City Planning Administration, the Emergency Services, the Environmental and Health protection Administration, the Care Administration, Växjö Energi AB, and Växjö kommunföretag AB, which analyzed which activities, places and groups of people that were vulnerable to climate change. Four work groups then investigated the systems that the project group deemed as focus areas (Technical supports systems/infrastructure, Developments and buildings, Natural environment, Rural businesses and tourism, Human health). Johansson states that having several work groups has been beneficial since they were able to look more closely at different activities and the positive aspects of climate change.

The process started with a meeting where the County Administrative Board of Kronoberg informed the municipal officials and politicians about the effects on society from climate change and the importance of coordination (Växjö kommun, 2013). A work shop treating possible effects on municipal activities ended the meeting. The preparation of the plan took about a year and a half (Johansson, 2016).

#### 4.1.1.4 Trelleborg municipality

Trelleborg is Sweden's southernmost municipality and a part of the County of Skåne, situated on the plain Söderslätt by the Baltic Sea.

Trelleborg municipality's climate change adaptation plan is aimed at dealing with the climate changes that are already affecting the area, and to adapt to future changes (Trelleborgs kommun, 2013). Anitha Ljung, climate and sustainability coordinator for Trelleborg municipality, reports that homeowners in the municipality had recurrent problems with flooded basements following heavy downpours, and that the County Administrative Board of Skåne started a project about climate change adaptation to which the municipalities were invited. The County Administrative Board of Skåne developed guidelines for preparing a climate change adaptation plan (Ljung, 2016).

The Head of the local government and the Administration Heads have been in the management group (Trelleborgs kommun, 2013). A work group from the environmental administration consisting of an environmental engineer, an ecologist, a zoning architect, and an environmental coordinator have prepared the plan. During the preparation officials from all administrations and representatives from healthcare and agriculture participated. Three workshops with officials from the County Administrative Board of Skåne and officials and politicians from Trelleborg municipality have been held. There have also been lectures by meteorologists, Ljung reports. She deemed it important that the plan was widely anchored from the start, so she invited herself and her colleagues to one of the meetings of the Head of the local government and the Administration Heads. It was there decided that they would be the management group (Ljung, 2016). The climate change adaptations plan took about a year and a half to prepare (Ljung, 2016).

#### 4.1.1.5 Kristianstad municipality

Kristianstad is situated in the north eastern parts of the County of Skåne, by the Bight of Hanö. Skåne's largest water course, Helge Creek runs through the municipality, and about ten percent of the area is covered by lakes.

Since Kristianstad municipality adopted its climate strategy focusing on both mitigation and adaptation in 2011, much has happened. Some actions have been implemented, others have become obsolete or are lacking financing, the County Administrative Board of Skåne have developed an action plan, and a new knowledge have emerged (Kristianstads kommun, 2016). Due to this the adaptation part of the plan was recently updated. Lennart Erfors, climate strategist for Kristianstad municipality, states that the new climate change adaptation plan is being kept separate from the earlier climate strategy to get a better focus on the adaptation issues, which had become lost amongst mitigation efforts. A climate change adaptation coordinator is yet to be recruited (as of August 2016). He continues by saying that a consultant was hired to develop the updated adaptation plan, which sped up the process. To develop the action program workshops focusing on different areas were held (Erfors, 2016).

#### 4.1.2 Content

All the plans describe which climate changes are expected up until the year 2100 and how each municipality will be affected by them. The suggested action are presented in various ways. Växjö municipality have sorted the actions under which administration/business is responsible, Lerum municipality and Trelleborg municipality present the actions following each subchapter. Laholm municipality have gathered all actions in a list, and Kristianstad municipality have them in a separated annex. See Table 2 for sectors in where actions are suggested.

**Table 2** Sectors with suggested actions

<b>Municipal ity</b>	<b>Communications</b>	<b>Technical support systems</b>	<b>Developments and buildings</b>	<b>Rural businesses and tourism</b>	<b>Natural environment</b>	<b>Human health</b>
<i>Laholm</i>	Information to the public Roads	Storm water Waste water Electric systems	Flooding Erosion			
<i>Lerum</i>	Roads Railroad	Electric systems and grid production Hydroelectric dams District heating Waste and storm water systems Drinking water supply	Buildings Heating and cooling Flooding Landslides and erosion Polluted grounds Planning, zoning and building permits Green and blue planning	Agriculture Forestry Tourism and outdoor recreational activities	Natural environment Biological diversity and ecosystem services	Extreme temperatures Food quality Drinking water Bathing water Air quality Disease control and contamination Social unrest and economic marginalization Flooding, storms and landslides
<i>Växjö</i>	Roads	Storm water Drinking water Dams Electric systems, heating and cooling	Urban heating Flooding and waterfront developments Landslides and erosion Buildings Spreading of pollutions Green structure	Rural businesses Tourism and outdoor recreational activities	Natural environment	Health impact of extreme weather events Outdoor environment and indoor air quality
<i>Trelleborg</i>	Roads Seafaring Tele-communications, radio and television Dialogue with the public	Power production and distribution Heating and cooling District heating Drinking water supply Storm water systems and overflow of waste water	Flooding and waterfront developments Landslides and erosion Coastal erosion Buildings and building environment Spreading of pollution during floods, landslides and erosion Green and blue structure	Agriculture Tourism and outdoor recreational activities	Terrestrial ecosystems Freshwater environment The Baltic Sea and the marine environment	Extreme temperature Contamination
<i>Kristianstad*</i>	Dialogue with the public, business sector and organizations Roads The port	Drinking water supply	New and existing developments Landslides and erosion Flooding Spreading of pollution Cooling Green and blue structure		Wetlands	Extreme temperature

\*Kristianstad municipality have updated an earlier version of their plan and there are ongoing and finished actions that are not mentioned here.

#### 4.1.2.1 Laholm municipality

The climate change adaptation plan start off with describing the climate factors that will be affecting Laholm municipality in the year 2100 (Laholms kommun, 2015). It then continues by describing how society will be affected, divided into 14 headlines (Agriculture, Forestry, Natural environment, Waterways and lakes, Ground water and water supply, The ocean, Tourism, Health, Storm water and sewage, Developments and buildings, Roads and railways, Electrical systems, Dams, and Erosion) Four scenarios of coastal flooding, two because of rising sea level and two because of heavy downpours, describe how water will flow and where it would gather, and the consequences of the flooding (Laholms kommun, 2015). Figure 2 shows the a storm scenario of 2100, the red areas are below 3.5 meters above todays sea level and the black line is one meter above todays sea level. Lindgren says that these maps made a strong impression on the politicians who understood the importance of strengthening the storm water systems in coastal areas, and put a lowest floor level of 4.5 meters above sea level. She continues by saying that the storms in the recent years have washed away much of the sand dunes so that the sea already creeps close to developments during storms. To point out alternatives to coastal development a number of possible development sites on the shores of lakes have been studied concerning risks of rising water levels and landslides. This part of the plan were sponsored by the National Board of Housing, Building, and Planning (Lindgren, 2016).

The proposed actions are based on the first four scenarios. No cost assessment have been made.

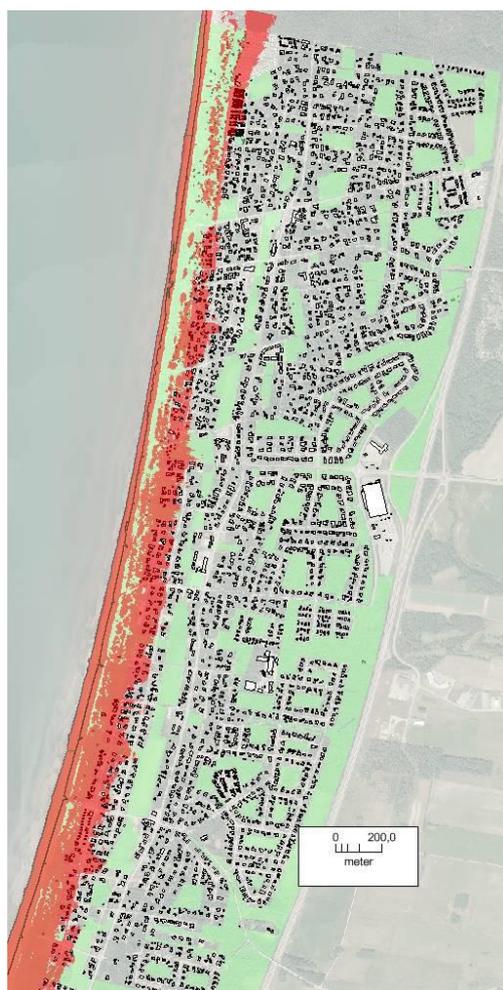


Figure 2 Red areas risk flooding during storms in the year 2100 (Laholms kommun, 2015).

#### 4.1.2.2 Lerum municipality

The plan takes its base in *Sweden facing climate change- threats and opportunities* and describes the risks facing Lerum municipality (Lundgren, 2015). Divided into six chapters (Communications, Technical supports systems, Developments and buildings, Rural businesses and tourism, Natural environment, Human health), each subchapter then begins with a summary of what *Sweden facing climate change- threats and opportunities* have concluded followed by what the situation is like in the municipality today and what the consequences will be in a future climate. Each subchapter ends with suggested actions. These are also summed-up in a table together with where the responsibility lies, if it already has or when it should start, and possible tools for implementation.

A short chapter discusses whether or not to adapt to a changing climate. It points to several severe weather events in Sweden and describes how society suffers both economically, environmentally, and in peoples reliance to societal services (Lundgren, 2015). The cost of adapting to a changing climate should be compared to the gain in ensuring the functionality of society.

No cost assessments have been made, but some of the proposed actions are already a part of different administrations directives (Lundgren, 2015).

#### 4.1.2.3 Växjö municipality

Twelve factors that will affect Växjö municipality in a future climate (increasing mean temperature, milder winters, increased precipitation, more heave downpours, both wetter and drier during each year, increased evaporation, ground water, changed flow of water, changed 100-years flow, vegetation period, ground frost, extreme winds) are described (Växjö kommun, 2013). The consequences of these are analyzed under the four focus areas (Technical supports systems/infrastructure, Developments and buildings, Natural environment, Rural businesses and tourism, Human health) and possible actions are suggested. The suggestions were then prioritized by the project group and presented as a list sorted under which administration is responsible. A map describing the risk of flooding in the catchment basin of the Mörrum Creek can be seen in figure 3. No cost assessments have been made, but should be treated in each administration's internal budget.

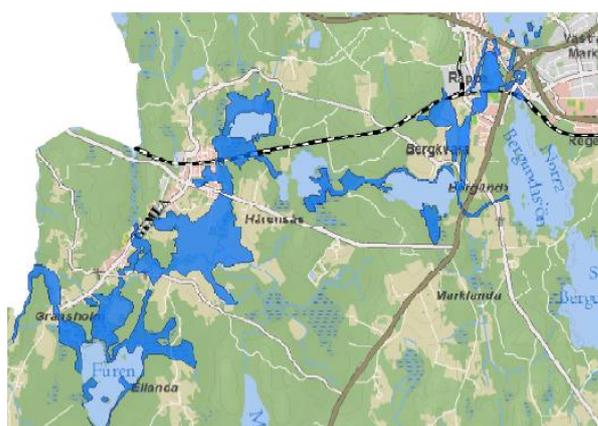


Figure 3 Risk of flooding in the catchment basin of Mörrum Creek (Växjö kommun, 2013).

#### 4.1.2.4 Trelleborg municipality

The plan starts by briefly describing, using charts from the SMHI, the expected future climate changes (Trelleborgs kommun, 2013). Then follows how Trelleborg municipality

will be affected, described under eight headlines (Communications, Technical supports systems, Developments and buildings, Agriculture and other rural businesses, Tourism and outdoor recreational activities, Natural environment, Human health, Changes in the world around us and their impact on Sweden). Each chapter is divided into subchapters which all start with a paragraph from *Sweden facing climate change- threats and opportunities* and then describes effects and questions that has been raised during the workshops. Concluding each subchapter is a list with actions with priority, time plan, and where the responsibility lies. No cost assessments have been made.

#### 4.1.2.5 Kristianstad municipality

The plan is divided into two parts, a descriptive part and action program as an annex. Firstly the challenges facing Kristianstad municipality are described (Kristianstads kommun, 2016). It goes on by describing the expected climate changes during this century followed by the consequences for Kristianstad municipality (Kristianstads kommun, 2016).

The suggested actions are divided under four headlines: Organization and cooperation, Long term strategic work, Short term risk reduction (heat waves), and Short term risk reduction (water) (Kristianstads kommun, 2016). Already implemented and ongoing actions have been listed as well. Charts with where the responsibility lies, priority, and in some cases comments and/or financing ends the annex.

### 4.1.3 Follow up

#### 4.1.3.1 Laholm municipality

The actions are going to be monitored and revised in conjunction with the preparation of the Official Community Plan (Laholms kommun, 2015). Lindgren says that the plan has been useful and that the dedication of the politicians has been of great importance. Before releasing the maps of the flooding there were some concern about the reactions of the inhabitants, but to Lindgren's surprise the reactions never came.

#### 4.1.3.2 Lerum municipality

The climate change adaptation plan should be kept separate from the Official Community Plan for a while but they can eventually become joint, and should be monitored and updated by the management group every few years (Lundgren, 2015). Any extreme weather events during the year and how they were handled should be reported along with implemented actions and their costs.

Engström informs me that the actions are now being implemented, and that the plan is used to promote climate change adaptation in other administrations. The plan has been useful in specific questions where things tend to come to a halt when it comes to financing. The recruitment of a person responsible for a climate change adaptation group which will continue the work/monitoring of the plan is ongoing (as of August 2016) (Engström, 2016).

#### 4.1.3.3 Växjö municipality

Monitoring was supposed to be presented in interim and annual reports, but these have not been as thorough as expected, Johansson tells me. Starting in the fall of 2016 Johansson will be in charge of monitoring, and each administration should report which actions have been implemented directly to him (Johansson, 2016).

#### 4.1.3.4 Trelleborg municipality

A climate change adaptation group have been put together, and most administrations have appointed a “climatist” in charge of reporting progress to the group (Ljung, 2016). In the fall of 2016 a report system is going to be implemented, Ljung states. She considers it easier to work with questions concerning climate change adaptation since the plan was adopted.

#### 4.1.3.5 Kristianstad municipality

Starting April 1st 2015 there is a climate committee in charge of the climate issues for two years (Kristianstads kommun, 2016). The committee consist of politicians from all parties, and Erfors is secretary (Erfors, 2016). Erfors says that the administration or company in charge of an action is responsible of reporting progress.

### 4.1.4 County Administrative Board Halland

Karin Stenholm, climate change adaptation coordinator for the County Administrative Board of Halland, informs me that there are no general requirements on what a climate change adaptation plan should consist of and that it is up to each municipality to assess what is relevant. There are no requirements on whether it should be independent or part of the Official Community Plan, if it should be one plan or one for each administration. It is however recommended to get the plan widely anchored amongst politicians from the start, and to have representatives from all administrations involved in the preparation. Geriatric care and home care services are very important to get involved, but often hard to motivate to why they should work with climate change adaptation. Stenholm has given lectures to explain the width of climate change effects to inform and motivate administrations to which it is not obvious why it is relevant (Stenholm, 2016).

The County Administrative Board Halland developed a regional action plan *Regional handlingsplan för klimatanpassning i Hallands län* in 2014 aimed at surveying the state of climate change adaptation progress in the county’s municipalities, and to be a guide for the continued work. There is a short summary of which climate changes are expected in the county up until the year 2100, and how these may affect the municipalities. A description of the current work in adaptation, what different regional actors are doing, and a list of statutory obligations and government missions that are present in the area is included in the action plan (Länsstyrelsen i Hallands län, 2014).

The report points out that the Swedish food supply is moving towards more and more import, which makes us vulnerable to changes in other parts of the world. Halland have good conditions for agriculture, and locally produced food have several positive effects; shorter transports, opportunities to choose more sustainable methods, reduced vulnerability to global changes, and reduced competition for recourses in more vulnerable areas (Länsstyrelsen i Hallands län, 2014).

The inconsistency of societal systems, different availability to observations and studies of climate effects globally (best for Europe), differences in the structure of calculation models, choice of global climate model, and the natural variability of the climate, makes it difficult to rely on exact numbers from the models (Länsstyrelsen i Hallands län, 2014). The focus should lie on the direction of change that the models point to. This approach could increase the flexibility in the climate change adaptation plans, but at the same time might make it more difficult to make cost assessments which could help motivate actions.

The County Administrative Board of Halland can offer help with a climate change adaptation plan in the form of lectures and seminars, and to brainstorm with (Stenholm, 2016). The report concludes that the knowledge about climate change adaptation amongst governing politicians needs to improve, so also the commitment and coordination between administrations (Länsstyrelsen i Hallands län, 2014). The complexity of climate change adaptation makes it difficult for municipalities to designate a responsible official, but such a coherent function would favor cooperation across administrations.

#### 4.1.4.1 County Administrative Board Halland's recommendations

##### *Interdepartmental cooperation*

- A municipal adaptation plan should be well integrated into administrations, Councils, and education programs.
- Assessment of risk for, and ability to cope with, natural disasters in a changes climate.
- Adaptation needs to be a part of policy documents
- Information to the public

##### *Storm water management*

- Clarify in zoning where the responsibility lies between municipality and private owner for storm water management.
- Identification of vulnerable areas for heavy downpours and assessment of ability to handle such events.

##### *Coastal areas*

- Secure a future beachfront further inland by giving necessary function such as food supply, infiltration of ground water, and biological diversity enough space.
- Clarify questions about responsibility, reasonable requirements of zoning, and financing.

##### *Management of ground water conditions*

- Changes in sea levels changes ground water levels which leads to salt water intrusion, difficulties infiltrating storm water, wet grounds and changed conditions when building.
- A warmer climate can lead to more/new pests and more pesticides.
- More harvests can increase the need for fertilization and the risk for nitrate leaching.
- What happens to buried cultural heritage when water conditions are changed?

##### *Flooding of watercourses*

- More detailed flooding maps

##### *Action plans for heat waves*

- Care facilities need to update their action plans.
- Mapping of areas vulnerable to urban heat island effects.

##### *Agriculture and forestry*

- Many effects (both positive and negative) for agriculture. Questions of lessening the extent of flood damages, lack of irrigation, and other issues need to be addressed.
- Areas in higher grounds should be inventoried and viable opportunities for agriculture secured.

- The forestry sector need to consider how a change climate with more/other pests, fungi, strong winds, and less ground frost should be addressed. The coniferous forest border will be displaced further north in a warmer climate.

## 4.2 Financing

In spite of the municipalities in Sweden having the main responsibility for adapting to a changing climate, little of the national resources have found its way down to this level (Andersson, o.a., 2015). Laholm municipality got parts of their climate change adaptation plan sponsored by the National Board of Housing, Building, and Planning under their rural planning in waterfront areas initiative (Laholms kommun, 2015).

EU have prioritized climate change adaptation and states in their *Strategy on adaptation to climate change* that they will support adaptation strategies for cities (Europeiska kommissionen, 2013). Joining the Covenant of Mayors makes it easier to be granted means from the EU (European Commission), which is confirmed by Henrik Johansson, environmental coordinator for Växjö municipality (Johansson, 2016). The LIFE program is the EUs funding instrument for the environment and climate action and have sponsored the development of Helsinki's, Warsaw's and several Italian cities climate change adaptation plans (European Commission, 2015). LIFE has been involved in information campaigns for local politicians and decision-makers to increase the initiative and investments in climate change adaptation, and to spread knowledge to the public. If granted means from LIFE it has to be in cooperation with another municipality or something in the interest of other cities, and there has to be a long term thought behind the reason for the application (Winter, 2016). To develop a climate change adaptation plan is to be considered basic work, and would thus be difficult to be granted means for. When it comes to implementation there are more possibilities (Winter, 2016) from for example the Civil Swedish Contingencies Agency and VINNOVA (SMHI, 2016).

## 5 Discussion

The discussion follows almost the same structure as the Results section:

- Participants and process
- Contents
- Follow up
- Problems

### 5.1 Participants and process

It is important that a municipal climate change adaptation plan is widely anchored amongst the administrations, and that as many administrations as possible are responsible. Most of the municipalities have at some level of the organization around climate change adaptation managed to get this width, either in the control or work groups, or during workshops. Both Växjö municipality and Lerum municipality have had several work groups. According to Henrik Johansson, environmental coordinator for Växjö municipality, this have been useful in the sense that the groups were able to look more closely at different activities and investigate positive aspects (Johansson, 2016). Anna Engström, Environmental Manager for Lerum municipality, told me that some administrations were harder to motivate to get involved since they do not feel that climate change adaptation is part of their focus area (Engström, 2016). Apart from the municipal administrations it is beneficial to get land owners, energy companies and emergency services involved. Compared to other countries Swedish municipalities have a large share of the public services outsourced to organizations other than the municipality itself, making it important to get these organizations involved in the climate change adaptation process (Carlsson-Kanyama, Carlsen, & Dreborg, 2013). A communicator could help make the information more accessible and to spread the knowledge to the people. One way of doing this could be to use trusted messengers from the public, people who are credible and convincing to their audience, who are given the necessary information and training to spread the information (Moser, 2006). Karin Stenholm, climate change adaptation coordinator for the County Administrative Board of Halland, have held lectures to show all the areas of society that are affected by climate change and that adaptation is a question for all municipal administrations (Stenholm, 2016).

To facilitate the plan being put into practice the local politicians should be involved from the start. To increase their knowledge about climate change and adaptation to it, makes them more confident in the decisions they will have to make. This have been done in different ways in different municipalities, for example by having the politicians in the management group, giving lectures or holding workshops.

There is plenty to learn from looking at other municipalities and countries. Hardoy and Velásques Barrero (2014) studied the city of Manizales in Colombia and found its success in working with climate issues to be due to multi-level governance and the cooperation with universities and citizens. The Covenant of Mayors, now that it includes adaptation, is a good forum for sharing knowledge and to learn from those further along in the process.

klimateanpassningsportalen.se, a cooperation between 18 governmental authorities<sup>1</sup>, have informative material and guiding tools including a ten step guide to an adaptation plan.

## 5.2 Content

Overall the studied climate change adaptation plans have similar contents. They all describe the expected climate changes up until the year 2100 and how they will be affecting each municipality. *Sweden facing climate change – threats and opportunities* have been a good starting point for the climate change adaptation plans to get a comprehensive description of the risks. In 2015 the SMHI released *Underlag till kontrollstation 2015 för anpassning till ett förändrat klimat* which was commissioned by the Government as an update of *Sweden facing climate change – threats and opportunities* with the current knowledge about climate change and its effects. The SMHI analyzed the future climate for each county (Persson, et al., 2015) which might be useful for Kungsbacka municipality in their preparation of a climate change adaptation plan.

The suggested actions in the municipal plans mainly focus on flooding; how developments and buildings should be protected, how storm water and waste water systems should be addressed, and how power production and distribution should be secured. The plans from Laholm municipality differs from the others by only suggesting action concerning flooding. It puts emphasis on the importance of saving green areas, which can be flooded during heavy downpours. Several of the municipalities takes this a step further and suggests green roofs and facades as a step in managing storm water. Green roofs can cut the run-off from roofs in half and delay the flow which facilitates the management of storm water (Vanwoert, o.a., 2005). Green roofs and facades alleviates urban heat island effects (Ackerman, o.a., 2014), which the County Administrative Board of Halland points out as something that needs to be analyzed (Länsstyrelsen i Hallands län, 2014).

A great deal of focus has been put on flooding issues since this is something that most municipalities already have problems with. Ahead the problems will increase in other areas as well and it is important not to forget the health perspective. Epidemics spread more easily in warmer climates, and vulnerable groups such as the elderly and sick are more affected by the heat itself. These groups tend to be indoors more than average and Swedish houses are not built to keep cool but to keep warm. During heatwaves the indoor temperature is often higher than the outdoor temperature, and cities are often warmer than the rural areas surrounding them (Persson & Wern, Värmeböljor i Sverige, 2011). It will thus become increasingly important to create shaded areas to where people can go, and to protect buildings by shading them so that they will not warm up as much. Another way to keep buildings from heating up too much is to use highly reflective facades, something that Växjö municipality suggests in order to mitigate urban heat island effect (Växjö kommun, 2013).

Many of the actions suggested for managing storm water, as for example letting parks and green areas flood during heavy downpours, planting more trees, green roofs and facades, and

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<sup>1</sup> SMHI, Lantmäteriet, Swedish Geotechnical Institute, Swedish Transport Administration, National Food Agency, Swedish Civil Contingency Agency, Swedish Agency for Marine and Water Management, Swedish Forest Agency, the County Administrative Boards, the National board of Housing, Building, and Planning, Swedish Board of Agriculture, the public health Agency of Sweden, National Veterinary Institute, Swedish Energy Agency, Swedish Environmental Protection Agency, Swedish Nation Heritage Board, Geological Survey of Sweden, the Sami Parliament

to reduce the proportion of hard surfaces, also acts to diminish urban heat island effects (Wamsler & Brink, 2014).

Another important aspect that should not be left out of a climate change adaptation plan is that there are positive effects of climate change as well. A warmer climate will most likely bring tourists our way as southern Europe becomes hotter, and lengthen the growing season giving opportunity for more harvests and new crops (Länsstyrelsen i Hallands län, 2014). Climate change is not necessarily all bad for society, and as Henrik Johansson said: one part is how to mitigate negative effects, the other is how to take advantage of the potential (Johansson, 2016). People easily feel hopeless when it comes to climate change, and a climate change adaptation plan is something that hopefully should be read and used by people with a wide variety of backgrounds, not just people already familiar with the subject. I think that also focusing on positives might make it easier to take in and do something about the negatives and not just give up, thinking that it is too late. Moser (2006) suggests improving the climate change communication to focus more on solutions, practical help and realistic hope, while making sure people understand the implications of not acting, but without invoking denial or apathy.

None of the municipalities studied have made cost assessments for the suggested actions. There are a variety of reasons, for example that the actions already are a part of different administrations internal budget or that the cost assessments are to be done later in the process before the implementation. Kristianstad municipality stresses the importance of cost assessments but suggest taking also ecological and societal values into account. They have listed possible ways of financing the suggested actions.

### **5.3 Follow up**

Both Växjö municipality and Trelleborg municipality have a person or group of people responsible for follow up. Växjö municipality initially had a system with annual and interim reports that all administrations should hand in, but these did not turn out as thorough as desired, so the reports are now given directly to the municipality's environmental coordinator (Johansson, 2016). Kristianstad municipality has as one of their actions to appoint an environmental coordinator (Kristianstads kommun, 2016), and Lerum municipality are in the process (as of august 2016) of recruiting a person responsible for the climate change adaptation group that will continue the work/follow up of the plan (Engström, 2016).

It is important to keep in mind that the work is not finished when the plan is, but that follow up and revision are as important and that the actions will have to be implemented (Stenholm, 2016). To have a person with a continued responsibility is essential for the plan being a support in the work with adapting to a changing climate. That each suggested action has a responsible administration will increase the likelihood of it being implemented.

### **5.4 Problems**

There is plenty of research into climate change and adaptation to it, and a great deal of knowledge. The problem as I perceive it is that every municipality has to do much of the work again. There is no clear guide on how to work with adaptation on a local level, yet the municipalities carry the main responsibility. There are different initiatives to help with this issue, as for example klimatanpassningsportalen.se and the Covenant of Mayors, but the problem remains that working with all the parts of adaptation is fairly new to many

municipalities and it is not evident who should be in charge. Wamsler and Brink (2014) see the need to better define different actors responsibilities and for more guidance from a national level.

More precise predictions of risks, including probability for different problems to occur, makes it easier to motivate spending money on adaptation. Therefore more research and development of climate models are needed.

Another issue is that many of the problems reach across municipal borders and working with adaptation need to be done at many levels: local, regional and national, and there needs to be more cooperation between them (Carlsson-Kanyama, Carlsen, & Dreborg, 2013) (Wamsler & Brink, 2014). Carlsson-Kanyama, Carlsen and Dreborg (2013) also stress that municipalities are dependent on decision makers in organizations other than the municipality itself, and asks the question of to what extent national and regional authorities grasp these dependencies.

Climate change has for a long time been associated with mitigation and Carlsson-Kanyama, Carlsen and Dreborg (2013) found in their experimental case study that the civil servants suggested as many mitigation efforts as adaptation. The five municipalities studied here have been able to keep the two separate very well. Especially Kristianstad municipality have seen the importance of the difference as they saw the adaptation questions becoming lost amongst the mitigation efforts in their previous climate strategy.

Hardoy and Velásquez Barrero (2014) studied how the city of Manizales, Colombia, is working with climate change adaptation and found that other organizations than the municipality such as universities also were involved in the process. The National University of Colombia in Manizales and the University of Caldas provide scientific support to the government of Manizales to as for example areas to be protected and have helped develop the framework of the plans (Hardoy & Velásques Barrero, 2014). This cooperation could be strengthened in Sweden too I conclude. André and Jonsson (2015) see the potential of science-practice interaction in dialogues between scientists and the practitioners in the municipalities for bridging the gap that exists between the two. To then be able to put this knowledge into action the authors see a need for national guidelines and directives (André & Jonsson, 2015). Several of the municipalities studied here have invited meteorologist to lecture during the start-up of the adaptation process, but maybe this could be developed further so that the universities take initiatives to recurring dialogues with neighboring municipalities.

## 6 Conclusion

Climate change is a global problem requiring science to be understood. Global wind and precipitation patterns gives some places more precipitation while other places gets droughts. The effects of this global problem can thus be seen on a local level, where many of the solutions can be found. The situation seem to be that many municipalities are lost as to where and how to begin. More cooperation between different levels of government and better guidance is needed (Wamsler & Brink, 2014) (Carlsson-Kanyama, Carlsen, & Dreborg, 2013) (Hardoy & Velásques Barrero, 2014).

A comprehensive approach to climate change adaptation in the form of a municipal climate change adaptation plan is a good way of ensuring that individual adaptation measures do not increase risks in other areas. The greatest problem for municipalities so far have been in working out where the responsibility for developing and managing an adaptation plan should lie, since the effects of climate change reach into most of a municipality's sectors. The solution to this problem seems to be to spread the responsibility wide, getting all administrations involved in the development of the plan and making sure that the politicians are engaged in the process. The County Administrative Board of Halland supports this approach.

Content-wise what should be included in the plan depends on local conditions, but all of the studied municipal plans have described what climate changes are expected during this century and how the municipality will be affected. *Sweden facing climate change – threats and opportunities* (SOU, 2007), *Kontrollstation 2015 för anpassning till ett förändrat klimat* (Andersson, o.a., 2015) and *Framtidsklimat i Hallands län* (Persson, et al., 2015) are good starting points to understand how the climate will change during this century and how this will affect our area. The *Sweden facing climate change* report (SOU, 2007) have been used in all the plans as a scientific foundation as to which sectors to analyze. The biggest threat for the municipalities are floods: for inland municipalities from increased precipitation which can cause both flooding of the storm water systems but also from changed flows in the watercourses, and for coastal municipalities also from rising sea level. Another risk is heatwaves and how to secure indoor temperatures. The chapters on how each municipality will be affected and which actions to take is a product of the work done during the preparation and are based on the knowledge of the people involved. The global climate models used to predict future climate cannot predict exact temperatures on specific places and dates, but gives a hint of the climate for a region in the future (SMHI, Hur fungerar en klimatmodell, 2017). The models are under constant improvement (IPCC, o.a., 2013) (SMHI, Bättre prognoser - hela produktionskedjan, 2017), but the focus should lie on starting to adapt, not to wait for more exact figures.

There is a gap between both state and municipalities, and universities and municipalities which needs to be bridged in order to achieve successful adaptation. From a national level there needs to be more guidance and economic support, and universities could reach out to municipalities to have dialogues or in other ways share their knowledge and be a concrete part of the adaptation work.

To ensure that the plan can continue to be of use after the actual preparation it seems to be necessary to have someone with a continued responsibility for follow up and revision. A communicator could help make the plan more accessible and help spread the information

beyond the City Hall. The engagement of citizens was one of the success factors in the work done in mitigating the emission of greenhouse gases (Wamsler & Brink, 2014) and it should in my opinion be obvious to continue and develop this cooperation. Financing for climate change adaptation is available from both a national and EU level, but foremost at the implementation stage.

In further studies it would be interesting to investigate if the different administrations of Kungsbacka municipality are considering climate change, or if it is a question “for the future and someone else”. Are there maybe actions plans for heat waves implemented in daycare centers and nursing homes?

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## Annex 1

## Questions for the interviews

### General

- Why did your municipality prepare a climate change adaptation plan? Was there a specific recurrent problem? Pressure from somewhere? An enthusiast? Who initiated the process?
- Would you have liked to have someone else involved in the process?
- How long did it take to prepare the plan?
- Has having an adaptation plan meant a change of attitude towards climate change adaptation?
- What is going on now? How is the plan being used?
- Something else?

### Specific for each municipality

#### *Laholm*

- Has it been helpful for implementing actions that the management group consisted of politicians?
- Which administrations have been involved in the process?
- Why are the suggested actions limited to flooding?

#### *Lerum*

- Have the climate change adaptation group been appointed?

#### *Växjö*

- What has been good/bad about the work process?
- Has it been beneficial to have such a wide-ranging project group?
- Has it been beneficial to have several work groups?

#### *Trelleborg*

- Were all the Administration Heads part of the management group? Has it been a good setup?
- Has it been useful to have workshops?

#### *Kristianstad*

- This new update is being kept separate from the previous climate strategy, why?
- Who is part of the climate advisory committee?
- Has the Care administration and Children and education administration been involved in the preparation?

### The County Administrative Board of Halland

- Are there any requirements on what should be part of a climate change adaptation plan?
- What do you recommend?
- Who should be involved in the preparation?
- Do you have a template to work from?
- Do you have any other kind of help to offer?