Sweden's Adaptation Communication

A report to the United Nations Framework Convention on Climate Change
November 2022

Government Offices of Sweden
Ministry of the Environment

Foreword

Climate change poses an unprecedented challenge to our lives and societies here and now. The impact of climate change is already being experienced across the globe and affects all of us living now. The reports of the Intergovernmental Panel on Climate Change (IPCC) affirm the seriousness of this challenge already today and the risks ahead if we do not enhance action on mitigation and climate change adaptation.

As a young Minister for Climate and the Environment, it is abundantly clear to me what future I want to experience during my lifetime – a future of resilient and prosperous societies, filled with green innovation and a climate transition that offers opportunities to people and societies. For this to happen we need to act now.

First and foremost, we need to drastically reduce our emissions of greenhouse gases and phasing out fossil fuels. At the same time, we need to enhance the adaptive capacity and resilience to reduce the vulnerabilities of our societies.

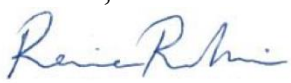
In Sweden, climate change is faster than the global average. The average temperatures have already increased by almost 2 °C compared to pre-industrial time and we have taken significant steps to adapt to climate change. This Adaptation Communication sets out to reflect on the adaptation progress Sweden has made both at home and abroad.

Sweden has a strong track record of performance under the Paris Agreement, and we are committed to continue taking action on implementing the Agreement and its Global Goal on Adaptation.

Sweden submits this Adaptation Communication at the 27th UN Climate Change Conference of the Parties (COP27) to enhance the visibility and profile of adaptation.

I look forward to the continued action and sharing of adaptation practice through COP27 and beyond.

Stockholm, November 2022



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Introduction

Sweden is, together with other Member States of the European Union (EU), fully committed to the Paris Agreement, its long-term goals and associated ambition cycle, including on adaptation, and aims to ensure a just transition. This submission constitutes the Swedish Adaptation Communication (ADCOM). It is submitted in accordance with Article 7 of the Paris Agreement, and the Conclusion of the Council of European Ministers for the Environment on the new EU Adaptation Strategy. The Swedish submission constitutes part of the Adaptation Communication of the EU and takes due consideration of the guidance from the Katowice Climate Package in relation to the adaptation communication and the transparency framework.

Sweden contributes to the objectives of the Paris Agreement through many processes and activities, including information on our adaptation actions through National Communications and other existing reports under the UNFCCC. This ADCOM systematises the latest developments on adaptation in Sweden, in particular the implementation of the 2018 National Adaptation Strategy. The document does not aim to reflect in an exhaustive manner all the progress achieved in Sweden. Instead, to keep this ADCOM useful for all stakeholders, we chose to showcase a selection of good practices, actions and lessons learnt from national initiatives. It can also serve as input to the global stocktake. Sweden will continue to engage in international joint efforts to share information and knowledge about approaches to adaptation and practical experiences and lessons learned.

(a) National circumstances, institutional arrangements and legal frameworks

i. National circumstances

Unless otherwise indicated, the information in this section originates from the Swedish database on land and vegetation cover managed by Swedish Statistics.

Sweden extends in a south-south-westerly/north-north-easterly direction from latitudes 55 to 69 degrees north and from longitudes 11 to 23 degrees east, with a land area of 406,550 km².

Urban land makes up 3 % of the land area, while productive forest land account for 58 %, farmland 8 %, wetlands 12 %, alpine areas, subalpine woodlands and rock surface, 17 %, and other land 2 %. Inland water systems total more than 40,000 km², or more than 9 % of Sweden's total area. Southern Sweden is low-lying, with agricultural land predominating in the far south. Along the Norwegian border in the north-west is a mountain chain, with peaks rising to over 2,000 meter above sea level.

Sweden's proximity to the North Atlantic and prevailing south-westerly to westerly winds result in a climate that, for the latitude, is mild in the winter months. The northernmost part of the country, however, has a sub-Arctic climate with long, cold and snowy winters. In the period 1961–90 the mean temperature in January was 0 °C in southernmost Sweden, while the coldest northern valleys had −17 °C. The maximum daily mean July temperature was approximately 17 °C in south-eastern Sweden and just over 10 °C in the north. The mean temperature was about 1 °C higher in the years 1991–2020 than in 1961–90. The largest rise, over 2 °C, took place in the northern parts of Sweden in winter. Overall, owing to the rise in temperature, the densely populated areas (including Greater Stockholm) have undergone a shift from a cold-temperate to a warm-temperate climate.

Land rise (postglacial rebound) is taking place in most of Sweden because of the melting of land ice since the last ice age, except for the far south.

Sweden's forest land amounts to 27.9 million hectares (ha). Of the total forest area, 23.5 million ha is productive forest, corresponding to 58 % of the total land area and 4.4 million ha unproductive forests (11 % of the total land area).

The total area of agricultural land in Sweden in 2020 was 3.0 million ha, which is equivalent to some 7 % of the country's total land area. Farmland comprises both arable and grazing land. The area under cultivation has shrunk by over 10 % since 1990[1]. The trend towards fewer, larger farming enterprises has been underway for many decades. The predominant use of arable land is cultivation of forage crops, green fodder and cereals.

The population of Sweden at the end of 2020 was 10.4 million, with 21 % aged up to 17 and 20 % 65 and over. Since 1990, the mean annual growth rate has been 0.6 % and by 2030 the population is expected to reach 10.9 million. Average population density is 25.5 inhabitants per km^2, ranging amongst Swedish counties from under 3 per km^2 in northern Sweden to 127 per km^2 in the south. Stockholm's county has a population density of 367 inhabitants per km^2.

ii. Climate research and climate services

In Sweden, extensive research is carried out on climate change and its current and potential future effects, as well as on adaptation and mitigation options. Information from state agencies is freely available and open to all. Although it is not always easy to use for the uninitiated user, efforts are underway to ensure that citizens and stakeholders receive relevant and useable information to enable further adaptation activities.

The Government provides targeted investments for both national, regional (European) and international research programmes. Swedish research councils fund national research and innovation of the highest scientific quality and relevance for adaptation to climate change. The Research Council for Sustainable Development, Formas, is for example together with other research councils, engaged in the Mission for Adaptation to climate change under the EU framework programme for research and innovation, known as Horizon Europe. Thereby a solid foundation is laid for Swedish stakeholders to contribute to the designated adaptation mission. Research and education within climate change adaptation takes place at most large Swedish universities and research institutes.

[1] Swedish Board of Agriculture 2021.

Research on climate and climate change is also carried out at many universities and institutes around Sweden. As an example, the Rossby Centre at the Swedish Meteorological and Hydrological Institute (SMHI), focuses on improving the understanding of the future climate with regards to meteorological, oceanographic, and hydrological aspects . The Centre conducts work both on climate model development and analysis, as well as process studies, scenarios, and other research in support of impact and adaptation studies.

Scenarios and indices of climate change in Sweden are extensively available at SMHI's website. Climate information in the form of open data through maps, diagrams and downloadable data, free of charge, on both national and regional scales are presented. Information is also available explaining the results, including uncertainties, and how they have been developed. The site also contains guidance (in Swedish) that provides support for interpreting and using climate scenarios. As the national Focal Point for the IPCC, the SMHI also informs about the IPCC's reports and other activities.

iii. Institutional arrangements and legal frameworks

Successive Swedish Governments have committed to national action on adaptation and understood that further action is required as the climate will continue to change and impact on communities, environments, and industries. As the work on adaptation cuts across many different disciplines, adaptation is to a large extent guided by existing legislation, frameworks, and targets, both national and international. Examples include the work on Agenda 2030 and on the Swedish Environmental Quality Objectives.

Government and Government Offices

The Government is responsible for national leadership on adaptation, managing Swedish Government assets and services including significant investments in public infrastructure, and providing national climate science and information. Sweden is a parliamentary democracy, meaning that all public power proceeds from the people. At the national level, the people are represented by the Riksdag (Swedish parliament). The Riksdag is the highest decision-making assembly in Sweden. Its tasks include making laws and determining the central government budget. Legal frameworks and financing supporting adaptation actions are thereby decided by the Riksdag.

Adaptation is a cross-cutting issue and is being considered in the Swedish governance across many different policy areas. A joint management across

sectors is contributing to effective climate adaptation ensuring that decisions made by the government do not increase climate risk.

An intergovernmental forum is in place where national strategic adaptation issues and cross-government actions are discussed to improve on Sweden's adaptation to climate change.

A Swedish National Expert Council for Climate Adaptation is appointed by the Government and tasked to evaluate adaptation work in Sweden. The Expert Council is submitting proposals for ongoing work and provides input for the Government's revision of the national climate change adaptation strategy.

State agencies

State agencies have an important role in adaptation with significant influence through their respective sectoral responsibilities, planning laws and other preventive measures and investments in public infrastructure. Several agencies are state property owners and thus have a responsibility to adapt the properties to climate change. The agencies also play an important role in building knowledge, providing guidelines, and improving resilience.

The National Board of Housing, Building and Planning is specifically tasked with coordinating the national adaptation work for the built environment.

Regional Agencies and Regions

At the regional administrative level, it is mainly the 21 County Administrative Boards but also the regions that have responsibility for adaptation. Both regions and the County Administrative Boards have essential roles in ensuring that local circumstances are adequately considered in the overall adaptation response. The County Administrative Boards are tasked with coordinating adaptation work regionally and supporting the municipalities' adaptation work, ensuring that the national targets are implemented. The County Administrative Boards also have a responsibility for coordinating regional emergency preparedness, and are the highest civilian defence authority within each county.

The regions are responsible for sectors such as health and medical care, public transport, and regional development, but they do not have any specific assignments linked to climate change adaptation. However, the regions' assignments within regional growth work and Swedish emergency preparedness should be understood to also include responsibility for climate change adaptation.

Local Governments

Local governments have an essential role in ensuring that local circumstances are adequately considered in the overall adaptation response. Compared with, for example other EU member states, Swedish municipalities and regions have wide-ranging responsibilities. Sweden has 290 municipalities that are responsible for many operations affected by climate change, such as spatial planning and infrastructure for water, the emergency services, elderly and social care, schools, and childcare.

The Swedish Association of Local Authorities and Regions (SKR) monitors and supports the municipalities' climate change adaptation work, for example by producing information materials and arranging conferences and seminars. SKR also manages an online network for dialogue and sharing experiences in connection with climate change adaptation issues.

Legal framework

Existing legislation is supportive to take adaptation action in line with Sweden's commitments under the Paris Agreement. Examples of legislation with objectives specific to adaptation are:

- Planning and Building Act (amendments made 2018).
  The legislation specifies planning and building regulations requiring local authorities to outline their views on climate-related risks in their comprehensive planning. The local authorities also have the power to introduce specific adaptation measures, such as requiring a permit for landowners to fell trees or take measures increasing soil imperviousness, if stated in detailed development plans.
- Ordinance on Adaptation (2019).
  The ordinance regulates the adaptation work of 32 national agencies and the 21 County Administrative Boards. The agencies shall initiate, support, and evaluate their adaptation work within their areas of responsibility and within the framework of their assignments. They shall complete climate- and vulnerability analyses, complete adaptation action plans, take account of adaptation in their public procurement, and monitor the results of their work. Each year, the agencies shall also report on their work. The Swedish Meteorological and Hydrological Institute (SMHI), is tasked to analyze these reports, submit a summary analysis to the Government and support the agencies in their work according to the ordinance.

Three ordinances control adaptation for preventing disasters related to climate change:

- Ordinance on preventing flood risks (2009).
- Ordinance on Government grants for preventive measures against landslides along Göta älv (2018).
- Ordinance on Government grants to municipalities for preventive measures against natural disasters (2022).

(b) Impacts, risks and vulnerabilities

The first national vulnerability assessment of climate change impacts in Sweden was initiated in 2005 and resulted in a report to the Government in 2007[2]. An updated assessment was made in 2015[3]. The National Adaptation Strategy from 2018 identifies the most important risks and prioritises the current work on adaptation.

State agencies, including the County Administrative Boards, complete and continuously update vulnerability assessments within their areas of responsibility and within their missions, in accordance with the Adaptation Ordinance. In addition, the Swedish National Expert Council for Climate Adaptation evaluates the effects of climate change on society every five years. The first evaluation report was delivered to the Government in February 2022[4].

As a result of global warming, the climate in Sweden will continue to become milder. The temperature rise will vary depending on location, with the most significant rise in temperature expected in the northern part of Sweden. The increase will be more substantial in winter than in summer, which will result in milder winters with decreasing snow cover. Average annual temperatures in Sweden already rise approximately twice as fast as the global average. Climate change will also result in changing precipitation patterns, with an expected increase in precipitation in the north. The most pronounced increase will be during winter, and scenarios also point towards more heavy precipitation[5].

i. Two degrees globally – projected effects on Sweden

The goal of the Paris Agreement is to limit global warming to well below 2 °C, preferably to 1.5 °C, compared to pre-industrial levels. According to the IPCC, global surface temperature was 1.09 °C higher in 2011-2020 than 1850-1900. The rate of warming is approximately 0.2 °C per decade. If the current rate remains, this means that 1.5 °C could be reached already in about 15 years, and 2 °C in about 40 years. Estimates of the rate of warming beyond the next few decades depend in particular on climate action and future emissions[6]. Different warming levels show the same pattern of

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[2] SOU 2007:60. Sverige inför klimatförändringarna – hot och möjligheter.

[3] SMHI 2015. Underlag till kontrollstation 2015 för anpassning till ett förändrat klimat.

[4] National Expert Council for Climate Adaptation (2022). Assessment Report Nr 1.

[5] Swedish Portal for Climate Change Adaptation (2022)

[6] 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.

temperature increase, with the greatest warming taking place in the north of Sweden[7].

ii. Climate change impacts on physical systems

Unless otherwise indicated, the information in this section originates from SMHI:s climate services, and from the Swedish portal for climate change adaptation, to where the information has been provided by the national authorities responsible for each area.

Wildfire and drought

Compared to many other countries, Sweden has mostly been spared from extreme drought. During dry years, however, water shortages pose challenges both locally and regionally, not least in the eastern parts of southern and central Sweden. The extremely hot and dry summer of 2018 resulted in water shortages, damaged grazing, and lack of fodder for grazing animals, reduced water levels in certain lakes, and led to very low groundwater levels in smaller aquifers at the end of summer.

Climate scenarios indicate a decrease in water availability in large parts of southern Sweden. This is mainly due to an increased water consumption of plants in a warmer climate with longer growing seasons. The greatest changes in the occurrence of drought are expected in southern Sweden and in areas around the large lakes Vänern and Vättern, with an increase of over 60 days of drought every year by the end of the century.

Drought increases the risk of wildfires. Every year, on average 3,000–4,000 wildfires occur in Sweden. The extent of forest fires varies from year to year, but often more than 2,000 ha of land are affected. The financial impacts can be large in terms of emergency response and damage to forests and buildings. Almost half of all forest fires are caused by human behaviour.

The summers of 2014 and 2018 were characterized by unusually large and fierce forest fires in Sweden. In the biggest single wildfire for at least 60 years, almost 14,000 ha burned in one location in central Sweden in 2014. During the exceptionally hot and dry summer of 2018, many wildfires raged at the same time, consuming more than 25,000 ha of forest in mid-north Sweden[8]. Due to EU assistance the forest fires were battled. The Commission mobilised firefighting aircrafts from Italy and France through the EU's Civil Protection Mechanism, and further EU support was gratefully

[7] SMHI (2022). Website Climate Services

[8] SMHI (2022) Knowledge bank.

also offered by several other EU Member States such as Austria, Germany, Lithuania, Poland, Portugal and Denmark.

It is not just drought and wind conditions, and the composition of the forest, that determine the size of a wildfire, but also how quickly the fire is discovered and the availability of firefighting resources. Consequently, large forest areas in the sparsely populated parts of the north, and along the coast in northern Sweden as well as inland, can suffer from large fires.

Growing season

The length of the growing season (the number of days when the average daily temperature for a continuous period is over 5 °C) has already increased in Sweden. The greatest increase is seen in the north, where the growing season has increased by around two weeks since 1980. Based on a low warming level, the vegetation period in Sweden is expected to increase by 20 to 80 days by the end of the century, depending on location and, compared to the period 1971-2000.

An increase in temperature will cause temperature zones to move northwards. Each degree of increase in average temperature corresponds to a south-north distance of about 150 kilometres in Sweden. This impacts ecosystems and plants endemic to a specific temperature zone that is shifting northwards. For example, bare mountainous areas in Sweden are in decline as the tree line progresses northward and upward when the temperature increases.

Heatwaves

While definitions vary, a heatwave normally describes a prolonged period of warm conditions for a specific area. In Sweden it is defined as "a continuous period when the highest temperature of the day is at least 25 °C for at least five days in a row".

Using this definition, heatwaves are quite rare in Sweden compared with southern Europe. However, the optimal temperature varies between different countries and since Sweden's population and nature is used to a cooler climate a comparatively small temperature increase will affect health. Recent research has shown that warm periods lead to both increased mortality and morbidity in Sweden. Heatwaves are likely to occur more frequently in the future.

Groundwater levels and groundwater quality

Groundwater levels will be affected by changes in precipitation and temperature. For the northern and western parts of Sweden, the increase in precipitation could lead to an increase in groundwater levels. However, groundwater levels are expected to decrease in the south-eastern parts of Sweden due to decreasing groundwater recharge because of decreasing precipitation and increasing evaporation.

The water table fluctuates between seasons and is lower during the summer, in most of Sweden. The length of the period with a reduced water table during summer may be extended because of earlier snow melt, higher temperatures, and longer summers. This can cause problems for domestic water supplies, especially in southern Sweden.

Groundwater quality may be affected by an increasing inflow of surface water, by changes in land use and changes in groundwater levels. Coastal aquifers can be affected due to sea level rise, with a higher risk of salt water intrusion in domestic wells. When and to what extent this will become a problem in Sweden remains uncertain.

Heavy precipitation

In a warmer climate, more frequent and more intense heavy rainfall is expected in Sweden. During the last years there have been several occasions of heavy precipitation causing flooding in urban areas. For example, in August 2021, extreme rainfall over northern Sweden's second largest city, Gävle, and the surrounding region caused significant damage. In only 24 hours, 161 mm of rain fell over the city, equal to more than double the average for the month[9]. Extensive damage to buildings and infrastructure resulted from significant flooding. Police instructed the city's population of 100,000 not to leave their homes during the event, and all public transport was cancelled. Fire and rescue services could only respond to a fraction of the flooding events.

A large part of large-scale flooding that affects Sweden is caused by the combined effect of several smaller rain events in succession, when already saturated ground is exposed to additional rainfall. Intense and local thunderstorms can also bring very large amounts of rain and can cause problems in cities where stormwater systems cannot handle large amounts of rainfall at once or put pressure on dam structures.

[9] SMHI (2022) Knowledge bank..

Snow, ice and zero crossings

Sweden is a country with large variations in temperature and precipitation. This is especially apparent when looking at snow and ice cover.

About 85 % of Sweden's exports and imports are transported via commercial shipping. This is affected by ice cover – large areas of Sweden's waters freeze every year, and every winter approximately 500–2,000 ships require icebreaker assistance to get in and out of Swedish ports. During severe winters, sea ice may also affect other infrastructure such as bridges, passenger ships and coastal communities.

With climate change, snow cover duration is expected to decrease, and in the southern parts of the country, long-lasting snow cover is expected to disappear completely. This may reduce the extent of spring floods, but increase water flows during the winter.

The ice season and its geographical extent will also be reduced. In all scenarios, the changes are greatest in the south, while the Bothnian Bay and northern Bothnian Sea are least affected. None of the scenarios indicate that sea ice will disappear completely from the Baltic region during the present century, and variations from year to year will continue to be significant. This means that relatively severe winter conditions may occur also in the future, although less frequently. The same patterns can be seen for lakes. Major changes are expected to occur during autumn with later ice formation, and during spring with earlier ice break-up. This can affect wildlife dependent on ice-cover for raising their young.

A day with zero crossing is defined as a day with temperatures both below 0 °C and above 0 °C measured two metres above the ground. Zero crossings are very common in central Sweden, with an average of 100–120 days per year. Zero crossings are less common in southern Sweden, around Lake Vänern and along the coast. Zero crossings can cause damage to roads, buildings, bridges, and other stone constructions. They also increase the risk for traffic accidents and impact reindeer grazing.

It is expected that there will be a decrease in zero crossings throughout the country during autumn and spring. In the wintertime zero crossings will decrease in the south but increase in central and northern Sweden.

Sea level and water levels in lakes

Many processes affect the sea levels along the Swedish coasts and water levels in the lakes. Processes affecting sea levels include wind, air pressure, regional sea level rise and local postglacial rebound. Water levels in lakes are

affected mostly by rainfall, snowmelt and regulation of lakes and watercourses.

Global mean sea level (GMSL) will continue to rise over the 21st century. A GMSL rise approaching 2 meter by 2100, cannot be ruled out due to deep uncertainty in ice sheet processes.

Measurements show that since the late 1800s, sea levels have risen by about 25 cm along the coasts of Sweden, corresponding to an average rate of about 2 mm per year. This is consistent with the IPCC's assessment of GMSL rise, showing accelerating sea level in recent years[10].

The actual change in mean sea level in most of Sweden has, however, been considerably smaller primarily due to postglacial rebound (Figure 1). Land uplift counteracts sea level rise to varying degrees and in Sweden varies from less than 1 mm per year in the southernmost part of the country to around 10 mm per year along parts of the coast in the Gulf of Bothnia (Figure 1). In fact, large parts of Sweden are still experiencing decreasing sea levels.

The change of regional mean sea levels in Sweden in the future is mainly determined by the global sea level rise and the postglacial rebound. The southernmost part of Sweden, where land uplift is close to zero, will be most affected by sea level rise. However, with increasing sea level, effects will be evident along other parts of the coast as well.

Factors such as land ice melt, ground water changes, steric effects and changes in large scale circulation and winds also affect changes in mean sea level regionally[11].

[10]SMHI (2022) Knowledge bank..

[11] Hieronymus, M. and Kalén, O. (2020) Sea-level rise projections for Sweden based on the new IPCC special report: The ocean and cryosphere in a changing climate. Ambio 49: 1587–1600, 2020, https://doi.org/10.1007/s13280-019-01313-8.

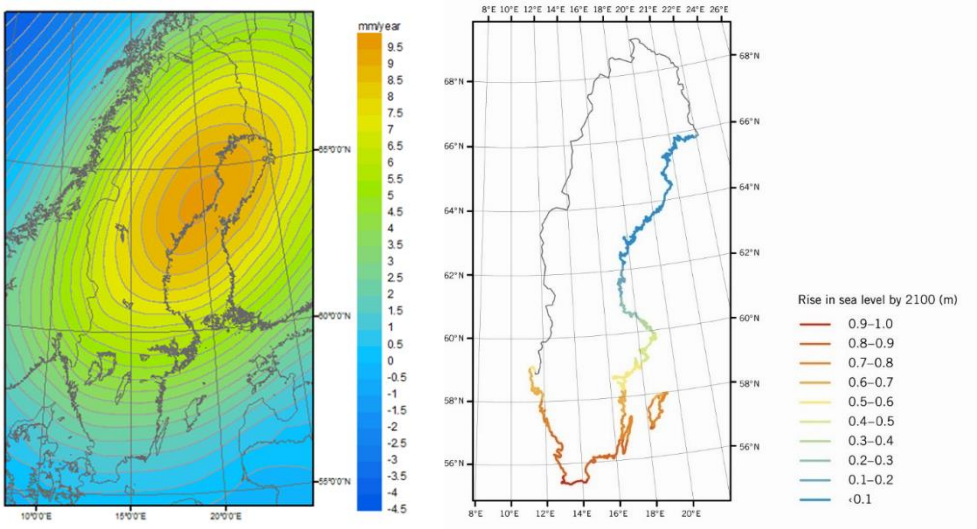

Figure 1. Levelled land uplift (mm/year) from the official land uplift model NKG2016LU, released by the Nordic Commission of Geodesy in 2016 and provided by the Swedish Mapping, Cadastral and Land Registration Authority (left) and net effect of rise in sea level (minus land rise, to the right) in Sweden, for a global sea level rise of 1 metre. The land rise estimates are based on the Swedish National Land Survey's model NKG2005LU[12].

The water level in lakes is mainly controlled by the amount of inflow and outflow to and from the lakes, how much rain falls directly on a lake and how much water evaporates. Many waterbodies are regulated, and especially in the case of the largest power producing rivers, this has a big effect on water levels. Regulation already affects river flow in ways that are similar to the projected effects of climate change at the end of the century. Regulation typically reduces the spring flood and increases winter flow. How water levels in lakes will change will likely vary. Some lakes may experience higher water levels, while other lakes, mostly in south-eastern Sweden, can expect low water levels.

Flooding

Flooding due to extreme water flows in rivers and lakes may become more common in large parts of southern Sweden and in the north-west of the country. However, local differences are significant. For large parts of Sweden, spring floods are expected to be lower and winter floods will increase. Extreme floods are expected to occur less often in northern Sweden and in the western part of central Sweden, where the most extreme floods have historically been associated with spring snowmelt. In the rest of the country, extreme floods are expected to become more common.

[12] Ågren, J., & Svensson, R. (2007) Postglacial Land Uplift Model and System Definition for the New Swedish Height System RH 2000. Reports in Geodesy and Geographical Information Systems. National Land Survey of Sweden, LMV Report 2007:4, Gävle.

Storm surges, i.e. rapid short-term increases in sea level that typically occur during situations with strong onshore winds and low atmospheric pressure, are directly affected by changes in mean sea level. With rising sea levels, a smaller contribution from a weather event is required to reach the same water levels as in today's storm surge events. In turn, comparable weather events lead to larger storm surges when sea level rises.

Since the effect of sea level rise is counteracted by land uplift, to varying degrees in different places in Sweden, the change in mean sea level differs by location. High water levels will become more common in the future especially in the south of Sweden, where land uplift is small[13].

Hydrological flows

The average stream flow patterns in Sweden are expected to change with climate change. The changes depend mainly on how precipitation patterns and amounts will change, but also changes in snow melt, evapotranspiration, and the length of the vegetation period due to warming.

The annual average stream flow is expected to decrease in the eastern parts of Götaland (southern Sweden) and Svealand (central Sweden), while an increase is expected in large parts of Norrland (northern Sweden). High flows are expected to become less frequent in large parts of northern Sweden as the spring flood is projected to decrease. However, in parts of southern Sweden high flows may occur more regularly. In south-eastern Sweden, low water flows are estimated to become more frequent in summertime due to increasing evaporation and vegetation water demand.

Erosion and landslides

In a changing climate, increasing water flows, more intense precipitation and changing ground conditions may increase the risk of landslides in large parts of Sweden. Increased precipitation and water runoff can cause high flows and erosion along river banks and watercourses. The areas most affected by landslides in Sweden are the western parts of the country and areas in central and northern Sweden. The countryside as well as urban areas are affected.

In a changing climate, the risk of ravine development might increase in parts of south-western and central Sweden, as well as parts of the north. An increased risk of moraine landslides and mudslides is also expected in northern mountain areas.

[13] Hieronymus, M. and Kalén, O. (2020) Sea-level rise projections for Sweden based on the new IPCC special report: The ocean and cryosphere in a changing climate. Ambio 49: 1587–1600, 2020, https://doi.org/10.1007/s13280-019-01313-8.

Coastal erosion will increase along the coast, primarily along sandy coasts in southern Sweden because of rising sea levels. Frequent sand erosion takes place already today, for example, along the coast of Skåne, where the coastline has moved 200 m inland over the last 35 years in certain locations.

iii. Climate change impacts on biodiversity and ecosystems

Unless otherwise indicated, the information in this section originates from SMHI:s climate services, and from the Swedish portal for climate change adaptation, containing information provided by the national authorities responsible for each area.

An acceleration of the global mean temperature risks having far-reaching consequences for Sweden's natural environment and its unique composition of species. A warmer climate with shifting and moving climate and vegetation zones brings significant ecosystem changes. Habitats and populations risk disappearing, moving or shrinking, while others may have new and expanded distribution areas, including invasive species.

Climate change also leads to phenological changes affecting the lifecycles of species (seasonal activity, reproduction and migration), and can cause a mis-match between species adapted to each other. Changes in geographical distribution and phenological changes in turn affect interactions between species, food availability, susceptibility to predation or the incidence of pathogens, as well as pollen season. For example, in temperate aquatic systems, as in Sweden, the timing of the natural spring flowering of algae becomes destabilized or weakened with warming, thus affecting the food base of many other species.

Rapid changes to environmental conditions often favor adaptable and short-lived species at the expense of species growing more slowly. Extreme weather conditions occurring more frequently and intensively can also lead to sudden disruptions of biodiversity and species distribution. Prolonged heatwaves for instance, can cause damage to terrestrial and aquatic environments. An example of such a sudden disruption is the severe drought that hit Sweden in 2018 which contributed to the extinction of two of Sweden's day butterfly species[14].

[14] Holst et. al. 2020. Dagfjärilar som omfattas av åtgärdsprogram för hotade arter och naturtyper. Naturvårdsverket Rapport 6982, 2020.

Biodiversity and ecosystem composition are also threatened by invasive alien species that benefit from more favorable temperature conditions. This applies, for example, to various types of harmful organisms and carriers of infection that the Swedish chilly climate so far has prevented.

Mountainous areas are particularly sensitive to climate change. The warming, reduced snow cover and a rising tree line are expected to have extensive negative consequences for Sweden's unique alpine biodiversity and habitats. Northernmost parts of Sweden belong to the Arctic, which as a whole is warming more than twice as fast as the global average, putting further pressure on its ecosystems.

Coastal ecosystems are threatened as sea levels rise. Coastal wetlands and other seaside dependent ecosystems, will retreat landward, but when their retreat path is blocked by coastal areas hardened by different shoreline structures, such as seawalls or rock revetments, the coastal ecosystems are lost in what is known as "the coastal squeeze". The loss of coastal wetlands from rising sea levels, reduce wetland-dependent fish and invertebrates, and reduce the valuable natural protections to coastal communities. An increase in shore erosion can also result in a coastal squeeze and loss of ecosystems especially along the Swedish sandy coasts[15].

Elevated water temperatures can considerably affect both freshwater and saltwater species, and species needing colder water may disappear when the temperature rises. Rising temperatures in the Baltic Sea due to climate change leads to a lack of oxygen, and studies from SMHI show that around 30 percent of the ocean floor is suffering from hypoxia[16]. The salinity of the Baltic Sea is also expected to change, due to increased flows of freshwater from increased precipitation. These factors, in combination with acidification and eutrophication, have far-reaching effects on marine life.

According to the Swedish Species Information Centre, almost 750 of Sweden's species, across several different species groups, are negatively affected by climate change. For almost 200 of these species, climate impact is of great negative significance. Only for just under 60 species the effect is thought to be positive.

[15] Länsstyrelsen Skåne 2018. Verktyg för sandvolymer och erosionskänslighet. Rapport 2018:04.

[16] Hansson, M & Viktorsson, L. 2021. Oxygen Survey in the Baltic Sea 2021 – extent of Anoxia and Hypoxia, 1960-2021. Report Oceanography No.72, 2021. SMHI.

A changing climate in combination with unsustainable land use and land use change leads to extensive deterioration and loss of biodiversity, compounding the impact of. other existing environmental impacts. Conversely, a rich biodiversity is a key component of a healthy ecosystem, as this increases resilience to climate change impacts. Thus, protecting and sustainably managing biodiversity, as well as safeguarding intact and functioning ecosystems, is an important part of strengthening resilience to a changing climate. Resilient ecosystems are a key factor both for sustainable climate change adaptation and mitigation.

iv. Climate change impact, risk and vulnerability for socio-economic sectors

Unless otherwise indicated, the information in this section originates from the Swedish portal for climate change adaptation, and has been provided by the national authorities responsible for each area.

Spatial planning

In Sweden, landslides, mudslides and erosion, flooding, high temperatures and water shortage are among the priority areas for adaptation, as identified in the National Adaptation Strategy from 2018. Considerable work has been carried out to further analyse and define the risks that these climate effects can bring. For example, an investigation carried out in 2021 identifies 10 geographical areas at risk of landslides, mudslides, erosion, and flooding connected to climate change[17]. The investigation also proposes action that needs to be taken to improve conditions for adaptation work that can reduce the risks.

In general, waterfront housing, buildings and infrastructure are often already exposed to the risk of flooding and are especially vulnerable to the effects of climate change. Rising sea levels will result in an increased risk of flooding in coastal areas. Buildings close to lakes and waterways may be exposed to an increased risk of flooding and landslides as precipitation becomes more intense and frequent in the future. Adaptation measures include soft and hard coastal defences and planned retreat.

Buildings are also affected more directly by a changing climate, through changing snow loads. A warmer and damper climate increases the risk of problems caused by humidity and mould. While the demand for heating decreases in the future, the need for cooling increases, because of increasing temperatures, and longer and more intense heatwaves. The effect of

[17] SGI & MSB (2021) Riskområden för ras, skred, erosion och översvämning. Redovisning av regeringsuppdrag enligt regeringsbeslut M2019/0124/KI.

heatwaves can be reduced with spatial planning measures such as integration of parks, trees, and other nature-based solutions.

Cultural heritage represents irreplaceable values that need to be considered in spatial planning. Many built-up environments and old cities of great cultural value are located in coastal areas, vulnerable to rising sea levels and extreme weather, and will require specific adaptation measures.

Health effects

Climate change impacts human health directly and indirectly. A risk vulnerability analysis published by the Public Health Agency in 2021[18] concludes that the greatest risks to public health in Sweden in a warmer climate are heat waves and tick-borne diseases, with regards to severity as well as likelihood. The analysis also shows that there is a high probability that climate change will lead to a higher prevalence of pollen allergies and water- and food-borne infections, as well as an increase in negative health effects due to an increase in number and severity of floods and a deterioration in drinking water quality due to increased occurrence of pathogens and viruses and to contamination following heavy rainfall.

A reduction in the number of extremely cold days will have direct positive health effects in Sweden. On the other hand, more frequent and intense heatwaves have a large negative impact on health with significant increases in mortality. Identified vulnerable groups include people with pre-existing cardiovascular and respiratory diseases and socio-economically vulnerable groups. Young children and elderly people are also at risk, especially those who spend a lot of time indoors, where temperatures may be significantly higher than outdoors, particularly if buildings are not adapted to a warmer climate.

Air pollution can further exacerbate the health risks posed by high temperatures. Simultaneous heatwaves and forest fires can be especially harmful. Preventive measures include adapting buildings such as retirement homes, hospitals, and other care facilities to higher temperatures together with information for high-risk groups. In the outdoor environment, green spaces such as parks and forests reduce heat exposure and contribute to many other positive health outcomes, both in terms of prevention and health promotion.

Indirectly, a warmer climate affects pollen-producing species and increases the risk of vector-borne diseases. For example, the high-risk season for

[18] Folkhälsomyndigheten (2021) Folkhälsomyndighetens mål och handlingsplan för klimatanpassning 2021–2024.

Lyme disease and TBE may increase in length. A changing climate may also contribute to the introduction of new disease-carrying organisms, vectors and pathogens. A better preparedness for these impacts can be achieved by increased interdisciplinary and inter-sectoral collaboration on human, animal and ecosystem health, primarily concerning surveillance, particularly of zoonotic diseases.

The risk of water borne infections increases during warm summers when more people swim outdoors. Wounds infected by vibrio bacteria in water represent a new problem that emerged in the Baltic Sea region in the 2000s. These bacteria increase in number with higher water temperatures. Higher water temperatures also increase the risk of toxic algal blooms and the growth of gastro-intestinal bacteria.

Climate change also affects mental health. Climate disruption may impact mental health in a number of ways, including through eco-anxiety, i.e. fear over what may happen in a changing climate, and solastalgia, i.e. the distressing sense of loss when familiar environments are damaged or destroyed.

Drinking water

Climate change already impacts the secure supply of drinking water. Increasing average temperatures, greater volumes of precipitation, altered drainage patterns, and changing evaporation and groundwater formation all create new challenges.

Extreme weather events such as heatwaves, drought, torrential rain and storms, as well as flooding, high water levels in rivers and forest fires, lead to quantitative and qualitative changes to raw water resources. Rising sea levels can affect groundwater resources through saltwater intrusion into coastal aquifers. As the sea level rises, lakes close to the coastline used for water provisioning may be flooded by sea water and thus destroyed as drinking water supplies.

The availability and quality of both groundwater and surface water in Sweden may be affected by a changing climate. Surface water resources are more exposed than groundwater resources to a range of risk factors and are therefore more vulnerable to increases in temperature, precipitation intensity and pollution.

Even in the current climate, low water flows and water shortages occur in parts of Sweden. In the future, it is expected that low water flow will occur more often in southern Sweden, primarily in the southeast. This may lead to shortages or lack of drinking water.

Changing climate conditions place new demands on planning, water treatment and monitoring. To ensure the quality and security of Sweden's water supply in the future, stronger protection of all water supplies, not least water protection areas where drinking water is sourced, becomes even more important. This can include management of increasing microbiological and chemical risks in affected areas. Enhanced water treatment technology may need to be introduced to manage bacteria, viruses and parasites.

Stormwater and wastewater

Water drainage systems will be affected by an increasing intensity of rainfall as well as increased water levels in regional seas, waterways and lakes. In recent years, several incidents of extreme precipitation and flooding in cities have focused attention on urban water management. It is expected that climate change will bring more rain and more intense rainfall. This adds additional stress to water systems.

More cloudbursts will increase the burden on water treatment facilities, and may result in them being forced to release untreated wastewater more frequently. Even today, there is an increasing content of humus in many water sources, which places greater demands on water treatment processes.

Energy security

Climate change impacts on Sweden's energy system will vary throughout the country and may affect the energy system[19]. Sweden uses substantial amounts of energy from biomass fuels in the heating, electricity and transport sectors. Conditions for growing the biomass used for energy may be influenced by climate change. On the one hand forests may grow faster with rising temperature, but rising temperatures may also result in new diseases and pests influencing the production. Obviously the power production from wind may get new conditions with climate change. For nuclear energy it seems unlikely that there will be any major effects from climate change[20].

Account needs to be taken of the fact that Sweden's electricity system is part of a Nordic and European electricity market and the new wave of electrification[21]. According to high electrification scenarios in the Nordic countries, total electricity demand may increase by 65 %. Thus, the impacts of a changing climate need to be evaluated considering a rapidly increasing

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[19] Eneriforsk (2021) Klimatförändringarnas inverkan på energisystemet. Report 2021:738. English summary.

[20] Energiforsk (2021) The impact of climate change on nuclear power. Report 2021:744.

[21] Government Offices of Sweden (2022) National Electrification Strategy – a secure, competitive and sustainable electricity supply for a historic climate transition.

demand for electricity driven by the phasing out of fossil fuels. At the same time, climate change will require changes to the electricity system.

Extreme weather events can affect energy supply, as high temperatures, flooding, strong winds and storms may cause operational disruptions both in the production and distribution of energy[22]. More than 85 %[23] of the interruptions to the electricity supply occuring today, can be attributed to weather-related events. Although storms are not expected to become worse in a changing climate, they are (and will continue to be) a significant cause of electrical outages in Sweden due to the felling of trees across power lines. Such disruptions is being mitigated by replacing overhead lines with underground cables in low voltage grids.

Increasing unpredictability is another consequence of climate change, and a growing concern for the hydropower sector. More unpredictable seasonal changes, e.g. in terms of the magnitude and timing of winter snowfall or mild weather, make decisions on water storage in hydropower reservoirs more challenging[24]. If hydropower reservoirs are filled to their maximum in autumn (as has been the case historically), margins decrease for storing water during mild and wet winters. However, if reservoirs are not filled to their maximum, to keep capacity for a potentially mild winter, and the winter is cold, the capacity to deliver electricity from hydropower may be limited during the winter season.

As a result of global warming, the need for energy may shift somwhat from heating in winter to cooling in the summer.

Agriculture

Agriculture will be affected by an increase in temperature, a longer growing season, increased but more unevenly distributed precipitation, more unstable winters, and more extreme weather events.

Harvests may be negatively impacted because of either increased or decreased precipitation. There will be increased risks of drought and flooding, reduced water accessibility, an increased spread of disease and invasive species, changes in species distribution and increased heat stress. Climate change may also lead to more disruptions to relevant trade and infrastructure in the event of extreme weather situations. Increased domestic production of food can reduce the vulnerability to global disruptions to food production, trade, and infrastructure.

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[22] Energiforsk (2021) Klimatförändringarnas inverkan på elnätet. Rapport 2021:740. English summary.

[23] Energimarknadsinspektionen (2018) Tillsyn avseende leveranssäkerheten i elnäten. Ei R2018:09.

[24] Energiforsk (2021) Klimatförändringars inverkan på vattenkraften. Report 2021:743. English summary.

In the short and medium term, Swedish agriculture may benefit from larger harvests of certain crops and the cultivation of new crops. However, a changing climate represents greater risks. To reach a sustainable production of food, agriculture needs to adapt to meet the conditions of a changing climate.

Changes to water management, such as increased irrigation, improved drainage and ecosystem-based management of watersheds are important adaptation measures. Although only about 3 % of all water abstraction is used for irrigation, most irrigation in Sweden is concentrated to the southern province of Skåne. Water for irrigation is needed when water is already scarce in streams and rivers, increasing the stress on ecosystems. The need for irrigation is rapidly increasing as the vegetation period gets longer in a warming climate and as the occurrence of droughts and heatwaves increases.

Animal husbandry

Climate change increases the risk of outbreaks of infectious animal diseases, mainly due to ecosystem changes and an increased presence of ticks and insect vectors. Many vector-borne diseases are zoonotic and may spread between animals and humans. It is difficult to distinguish the impact of climate change on infectious diseases from the influence of other anthropogenic factors.

In a warmer climate, animal husbandry may benefit from an extended grazing season as well as from possibilities for new feed crops. However, drought may cause water scarcity and reduced harvests of feed crops. Farm animals housed indoors may suffer from heat stress, increasing the risks of mortality and disease. Stables in Sweden are in general built to protect animals from wind and low temperatures, not from heat.

Reindeer husbandry

Reindeer herding depends upon well-functioning ecosystems, which makes it vulnerable to climate change. Sudden weather changes, shifting seasons, changes in vegetation and increased unpredictability are among the effects of climate change, posing major challenges to the reindeer herding sector – both now and in the future.

Climate change will result in poorer winter grazing, a lack of cooling patches of snow in summer, and uncertainty regarding ice conditions when moving reindeer herds. Increasing occurrence of zero passages creates difficulties for grazing, resulting in reindeer herding requiring more substantial

supplementary resources[25]. A changing climate also has a social and economic impact on Sámi communities. Members of Sámi districts have an exclusive right to reindeer herding in Sweden. In addition, a reduction in reindeer grazing affects biological diversity in the mountain areas negatively, as previously bare mountain regions become covered in bush vegetation[26].

The combined impact of climate change and increased exploitation in northern Sweden makes adaptation measures for reindeer herding more difficult. Climate adaptation for this sector needs a holistic approach, since reindeer herding depends on a cohesive landscape and a functioning ecosystem. Protection of old-growth forests with hanging lichens, is beneficial to reindeer as lichens are an important feed source for reindeer.

Forestry

Climate change has a direct impact on forests and forestry. In a warmer climate, the growing season is extended, and forest growth will in general increase. However, the potential for abiotic and biotic damage to forests will also increase. Conditions will improve for certain insects, pests, and pathogenic fungi, facilitating their spread. Milder winters improve the survival of deer, leading to increased grazing of pine and broadleaf vegetation.

In a changing climate, the risk of forest fires will increase, especially in southern Sweden. When the snow-free and summer seasons lengthen, the fire season and periods with a high risk of wildfire are extended.

As the growing season is extended, more harvesting may occur during this season, increasing the risk of root rot. Storm damage may also increase in the future as water levels in the ground become higher during winter and ground frost is absent. High water levels also lead to an increase in soil erosion if heavy machinery is used in forestry operations, according to current practices. Regeneration during dry years will become more difficult.

Shorter periods with ground frost will increase the importance of logging systems well adapted to softer ground in order to minimize impacts on vulnerable soils.

[25] Adaptation actions for a changing Arctic: Perspectives from the Barents area (2017) AMAP.

[26] Tunón, H. & Sjaggo, B.S. (red.) (2012) Ájddo – reflektioner kring biologisk mångfald i renarnas spår. En kunskapssammanställning om renar och renbete. CBM:s skriftserie nr. 68.

Insurance markets

The Swedish insurance sector is one of the financial sectors most clearly affected by climate risks due to damage costs from flooding, storms, and drought. The insurance sector is already showing a statistically significant trend towards an increase in number of incidents due to extreme-weather events. Although a great proportion of this trend derives from increasing value of insured assets, climate change related damages are becoming more frequent.

In Sweden, almost all property owners and tenants have some form of insurance protection against natural disasters and damage. This is relatively unique in comparison to many other European countries where it is no longer possible to sign a private insurance with relevance to climate-related risks. However, insurance covers citizens and businesses against unpredictable events. If an event is no longer unpredictable, it does not qualify for insurance cover. This may apply to repeated flooding of a basement, for example. Home insurance in Sweden typically includes cover for flooding, but this practice may become difficult to maintain with repeated incidents and increasing costs.

When the risk of damage is deemed too high, it may become impossible to insure property. One national insurance company in Sweden has already stated that they no longer will offer insurance for new development in areas that the local County Adminstrative Board has considered unsuitable due to the risk of climate effects. According to Swedish legislation, the responsibility for safeguarding property is firstly the property-owner (individuals and businesses alike, as well as local and national authorities).

Especially in major cities, damage may go far beyond individual homeowners, as e.g. cloudbursts and flooding can impair important societal functions, including critical infrastructure or health care facilities, leading to escalating damage costs for society.

Railways and roads

In Sweden, milder winters will decrease the need for salting roads, and probably for clearing them of snow. There may be more zero crossings in the northern and central parts of the country, leading to increased risks of difficult driving conditions and damage to roads and other infrastructure. Long periods of warm weather affect railways negatively. Railway lines and various other components can expand in the heat, which may cause traffic disruptions.

Electronic communication

In Sweden, increased risk of storm damage to forests affects local overhead power lines, as well as communication masts. Continuously, work is underway to move power lines underground, making the power supply network less sensitive to weather extremes. However, overhead lines, and the risks connected to them, will remain for years.

During floods, entire areas are likely to lose power, compromising electronic communications. Many large fibre cables are incorporated into bridges and will be damaged if a bridge is flushed away. Work is underway to protect electronic communication, for example by increasing the robustness of systems and their resilience to precipitation, wind, lightning strikes, dampness, extreme temperatures, floods, landslides, and fire.

Shipping

Shipping in Swedish waters is not affected by climate change to a great degree. Increased water depth resulting from rising sea levels does not bring any negative effects for shipping but could mean problems in certain ports. Quays in the south of Sweden will need to be adjusted to higher water levels.

Increased water flows could cause problems through an increased risk of erosion and landslides in narrow passages, such as canals. The risk of landslides is high along Göta älv, which constitutes an important shipping route in western Sweden, and shipping there may be affected. An inventory has been carried out of the risks along the river due to a changing climate. Less ice cover and a shorter ice season are positive for shipping.

Aviation

Aviation in Sweden is not affected by climate change to a great degree. Changes in ground frost and groundwater could affect the buoyancy of airfields, and increased precipitation could put an increased strain on stormwater systems at airports. Heat may affect the surfacing of runways.

The need for de-icing may decrease in the south of Sweden but increase in the north, as winter days become less cold and increasingly damp. Action taken by airports may include continuous maintenance of the stormwater systems and a thicker layer of concrete to counteract the loss of buoyancy.

Cultural heritage

Many of the risks to cultural heritage posed by a changing climate can be seen in Sweden already today. Both material values, represented in buildings, ruins, museum collections, objects, archaeological sites, and physical landscapes, as well as immaterial values, such as traditional methods of

housebuilding and cultivation of land, need to be considered. The effects of climate change have a particular social and economic impact on Sámi communities and their cultural heritage, which is closely linked to the land and surrounding ecosystems

Climate change related risks can be both immediate and clearly visible, such as flooding and landslides, but also slow and difficult to identify, such as gradual sea level rise, or mould and overgrowth. The degradation processes for most materials are affected by temperature and humidity. With higher temperatures expected, chemical reactions and changes in materials can occur more quickly. Preventive measures such as risk analysis, surveillance and maintenance are essential to prevent and mitigate damage to cultural heritage.

Slow effects require systematic monitoring to be detected in time. Adaptation activities can also cause damage to cultural heritage sites, for example the construction of erosion protection close to archaeological sites.

Tourism

Both national and international tourism is expected to increase in Sweden, with big cities as a main tourist destination. Coastal areas are important both for tourists and for the recreation of the local population. Here, the most important resources are beaches, lakes and the sea. In the north of Sweden, winter tourism is also very important, as are hunting and fishing tourism. Ecotourism, including wildlife watching, is an emerging branch of tourism in Sweden.

Summer tourism can benefit from a changing climate with warmer summers, while conditions for winter tourism become more unfavorable. Decreasing snow cover during winter months are already affecting skiing facilities, which are becoming more dependent on producing snow in the winter season. At the same time, ski resorts have developed towards having activities all year round. In this way, companies and destinations can become less vulnerable to climate change related risks such as declining snow supply.

Impact of global climate change

Sweden is an extensively internationalised country. The impacts of climate change on infectious diseases, economic development, trade flows, inequality, security and conflict, geopolitics, and migration, as well as the linkages between them, are important. In both a national and a global context, key considerations include just adaptation, as well as concern for socio-economic and gender equality in climate change adaptation processes.

Climate-related developments in regions bordering Europe may have profound effects also in Sweden. The warming of the Arctic region and a retreat of sea ice, opens the region to trans-Arctic shipping. As a result, possibilities for both international competition and cooperation increase, as well as conflict risks. As global warming makes Africa, the Middle East and Central Asia less liveable regions, migration to Europe may increase further, bringing both substantial challenges and opportunities.

(c) National adaptation priorities, strategies, policies, plans, goals and actions

i. Domestic adaptation policies and strategies

The National Strategy for Climate Change Adaptation[27] brings a national focus to climate change adaptation. The strategy especially reflects on how to strengthen climate change adaptation work and its coordination in Sweden, including prioritization of actions and investments. The strategy sets out a national adaptation goal to develop a long-term sustainable and robust society that meets the challenges of climate change by reducing vulnerability and making the most of opportunities. This national adaptation goal together with the adaptation goals under the Paris agreement and according to Agenda 2030, is considered in politics, strategies, planning, and integrated into ordinary activities and responsibilities.

The National Adaptation Strategy (NAS) also identifies ten key principles aimed at guiding climate change adaptation work in Sweden and introduces a new adaptation policy including monitoring and evaluation. The strategy is designed to clarify the responsibilities for adaptation and for different stakeholders to better anticipate, manage and adapt to climate change. The strategy also includes focus of funding of certain adaptation measures and highlights the continued need for knowledge-increasing actions and research in several areas.

A new national adaptation strategy is planned to be presented in 2023.

A Swedish National Expert Council for Climate Adaptation evaluates ongoing adaptation and advices the Government on preparing for climate change. The Expert Council is tasked by the Government to submit an analysis report every five years outlining:

- Recommended focus areas for Sweden's work on climate change adaptation.
- A prioritization of adaptation measures based on an assessment of risk, costs, and benefits.
- A cross-sectoral assessment of the societal impacts of climate change.
- A follow-up and evaluation of national work related to climate change adaptation.

[27] Sveriges Riksdag (2018) Regeringens proposition 2017/18:63: Nationell strategi för klimatanpassning.

ii. Adaptation priorities

As the global temperature rises and other changes to the climate increase, Sweden will face more frequent and severe events, such as extreme weather, fires and floods, and slow-onset events, such as, changing rainfall patterns, and sea level rise. This will impact places, sectors, and communities in diverse ways, driving structural adjustments and innovation. Extensive adaptation of critical infrastructure, especially in the power sector, have generally already been implemented. The hydro power dams have been strengthened in preparation for increased precipitation and the nuclear reactors have been back-fitted to withstand very severe weather events. Continued adaptation measures are however needed within several sectors of society and geographic areas.

Based on the predicted consequences for society, the following areas are particularly important for ongoing Swedish adaptation work:

- Landslides, mudslides, and erosion that threaten communities, infrastructure, and businesses.
- Floods that threaten communities, infrastructure, and businesses
- High temperatures that involve risks to the health and wellbeing of people and animals.
- Water supply shortages for individuals, agriculture, and industry.
- Biological and ecological effects that affect sustainable development.
- Impacts on domestic and international food production and commerce.
- Increased incidence of pests, diseases and invasive non-native species that affect people, animals, and plants.

In particular, the strategy highlights the need for identifying specific risk areas in Sweden regarding landslides, flooding and erosion. An increase in the frequency of landslides and flooding is expected to affect long-term investments and have significant consequences for several sectors that are deemed vulnerable and socially important. This applies for example to investments in infrastructure, technical support systems, buildings, and structures, as well as within agriculture and forestry. It is therefore extremely important that the effects of a changed climate are taken into consideration in planning, maintaining and equipping existing buildings, facilities and systems, and when making new investments.

Since 2009, the Government allocates funding for prioritised preventive and knowledge building initiatives for adaptation focusing especially on landslides, flooding and erosion. Over the years an increasing part of the funding has been directed on common knowledge-enhancing initiatives on climate change impacts across all the prioritised areas and to enhance cross-cutting cooperation through development projects among stakeholders.

The Government also distributes specific assignments to state agencies related to various measures of concern. Most adaptation issues are multidisciplinary, meaning that the assignments are largely performed in cooperation between different actors and across sectors at the national, regional, and local levels.

iii. Adaptation action plans

In line with their responsibilities, all levels of government and many businesses have strategies and plans to adapt to climate change. State agencies, including the County Administrative Boards, develop adaptation action plans for their areas of responsibility, in accordance with the Adaptation Ordinance. There are presently about 45 adaptation action plans covering different sectors and business areas, at the national and regional level. The action plans together contribute to the implementation of the national strategy. Several other national strategies and action plans like the National Security Strategy and the National Food Strategy also include and recognizes the importance of adaptation thereby contributing to the national goal of adaptation.

About 90 % of the Swedish local authorities have identified the need to act on climate change adaptation, and around half of the municipalities have developed action plans meaning there are close to 150 local adaptation action plans in Sweden[28]. Coastal municipalities, larger cities and municipalities close to larger cities, as well as municipalities in the southern part of Sweden, have progressed further in the adaptation process than rural and northern municipalities.

[28] SMHI (2020) Kommunernas arbete med klimatanpassning 2019 – analys av statusrapportering till SMHI. Klimatologi Nr 55

(d) Implementation and support needs of, and provision of support to, developing country Parties

Swedish development cooperation is governed by bilateral, regional, and thematic strategies, based on the basic principles such as accountability, focus on results, transparency and partner countries' ownership of development cooperation, and decided upon by the Swedish Government. The partner countries' own needs, priorities and strategies are the foundation for the development of the Swedish development cooperation strategies and constitute a fundamental entry point in all the operations of the Swedish International Development Cooperation Agency (Sida).

Swedish development cooperation provided through Sida includes support to bilateral, regional, and global institutions and organisations (including multilateral support, so-called 'multi-bi' support). Sida has continued to strengthen the focus on adaptation to increasingly meet the growing demand and needs for adaptation support from developing country Parties (Table 1).

2017	Country	Disbursed (MSEK)	Disbursed (MUSD)
1	Tanzania	229	27
2	Kenya	180	21
3	Mozambique	142	17
4	Mali	127	15
5	Ethiopia	119	14
2018	Country	Disbursed (MSEK)	Disbursed (MUSD)
1	Tanzania	209	24
2	Mozambique	189	22
3	Somalia	185	21
4	Mali	155	18
5	Afghanistan	145	17
2019	Country	Disbursed (MSEK)	Disbursed (MUSD)
1	Mozambique	255	27
2	Burkina Faso	239	25
3	Somalia	167	18
4	Mali	140	15
5	Kenya	132	14
2020	Country	Disbursed (MSEK)	Disbursed (MUSD)
1	Mozambique	187	20
2	Somalia	175	19
3	Kenya	145	16
4	Burkina Faso	136	15
5	Bangladesh	88	10

Table 1. A summary of the top five countries receiving bilateral climate finance from Sweden during 2017–2020. Most of the countries are among Sweden's major bilateral development cooperation partners.

Sida provides resources which enable development initiatives focusing on the poorest and most vulnerable women, men, girls, and boys. Broad-based national and local ownership is key, contributing to the efficiency and long-term sustainability of the projects and programmes. In terms of distribution across sectors, the largest climate finance disbursements in 2017–2020 were made to initiatives within agriculture; energy; environmental policy and administration; and urban development, rural development and multisector.

Some examples of programmes with a focus on adaptation that Sida provides support to:

Example 1: One of the key aspects of Sida's work within climate adaptation is ensuring that climate finance reaches the local level, where it is most needed. Locally led climate adaptation initiatives provide local institutions with more direct access to climate finance, which in turn enables them to implement adaptive actions in relation to existing and emerging needs. Therefore, Sida provides support to the initiative Financing Locally-Led Climate Action (FLLoCA)[29] in Kenya, the first national scale model of devolved climate finance. The initiative incentivizes county governments and strengthens their capacity to work in partnership with communities to assess their climate risks and identify and prioritize local resilience investments. The program then finances the priority actions developed with this participatory process. Local access to climate finance is fundamental as finance is directed to local needs while also empowering local stakeholders to participate in decision-making processes that affect their livelihoods.

Example 2: Sida supports the Rwandan national climate and environment fund (FONERWA)[30]. The Fund has the objective to mobilise domestic and international climate finance, and secure sustainable financing to support projects that contribute to environmental sustainability, resilience to climate change and green growth. The Fund is open to line ministries and districts, civil society organisations, private entities, and research institutions. The support is expected to i) provide access to sustainable and equitable finance that enables public and private entities to address climate and environment priorities; ii) improve skills of national stakeholders and CSOs in the design of project proposals; iii) result in bankable projects approved for funding by

[29] World Bank (2021) https://www.worldbank.org/en/news/press-release/2021/10/26/new-us-150-million-program-to-strengthen-kenya-s-resilience-to-climate-change

[30] FONERWA (2022) http://fonerwa.org

the FONERWA board; and iv) enable implementation of projects and dissemination of lessons learned. These outcomes will be achieved by activities such as training of national CSOs by international NGOs in developing proposals and increased participation of national CSOs in addressing climate change and environmental challenges. The support from Sida specifically provides technical assistance to environmental CSOs, capacity building of FONERWA and tools for improved gender integration. The projects supported by FONERWA are often pilots, in which new innovative methods are applied, such as climate-smart production of vegetables or clean cooking.

(e) Implementation of adaptation actions and plans

i. Progress and results achieved

Progress towards the priority areas and adherence to the principles of adaptation according to the national strategy and adaptation action plans is monitored on an ongoing basis. The 2018 national strategy introduced a five-year policy cycle including adherence to the ordinance of adaptation with annual monitoring of adaptation actions and an evaluation every five year.

Sweden has made substantial progress in implementation of adaptation actions and plans, especially since 2018 when the national strategy for adaptation was introduced. Sweden has also completed a range of climate risk assessments of sectors and regions, and some examples are listed below. Introducing an ordinance on adaptation has clarified responsibilities for national and regional agencies, motivating increasing adaptation actions and knowledge-enhancing initiatives. A review of progress and results of adaptation since 2018 is found in the first assessment report of the National Expert Council for Adaptation[31]. The Expert Council was established as a result of the strategy.

The implementation of the strategy has brought on a more prominent role in providing planning and guiding documents for adaptation by introducing a coordinating role for the National Board of Housing, Building and Planning to support local governments on adaptation initiatives. The support is provided in cooperation with several other national agencies and the county administrative boards.

Many other agencies have also presented national guidelines for adaptation concerning their business areas. Examples are the national guidelines on nature-based solutions serving as a climate adaptation tool published by the Swedish Environmental Protection Agency[32] and the advice to be applied during heatwaves for staff in childcare published by the Public Health Agency of Sweden[33].

The national strategy includes a commitment to develop and deliver national assessments of climate impacts. According to the national adaptation priorities, assessments of the expected increase of landslides, erosion and flooding are mostly progressed. Many authorities consider risks connected

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[31] National Expert Council for Climate Adaptation (2022). Assessment Report Nr 1.

[32] Naturvårdsverket (2021), Naturbaserade lösningar– ett verktyg för klimatanpassning och andra samhällsutmaningar, Rapport 7016.

[33] Folkhälsomyndigheten (2022) Råd vid värmeböljor – till personal inom barnomsorg.

specially to flooding to be mostly important within their areas of responsibility, and this is also the area where most measures are being carried out or planned[34]. Risks identified within the areas of land-based industries, human and animal health, the natural environment and food supply are often more evolved. Identified opportunities because of climate change are few and often come with reservations.

Identified risk areas

Risk areas for landslides, mudslides, erosion, and flooding have been identified through a cooperative work of several national agencies[35]. Ten national risk areas are identified, where complex climate-related risks threaten human lives and health, ecosystems, infrastructure, housing, and cultural heritage (Figure 2). In the context of climate change, landslides, shore erosion and flooding can lead to major disruptions and significant costs for society. The direct costs of such events can be expected to rise to 20-50 billion Swedish crowns by the year 2100 if action is not taken. Many businesses and numerous other actors are likely to be affected.

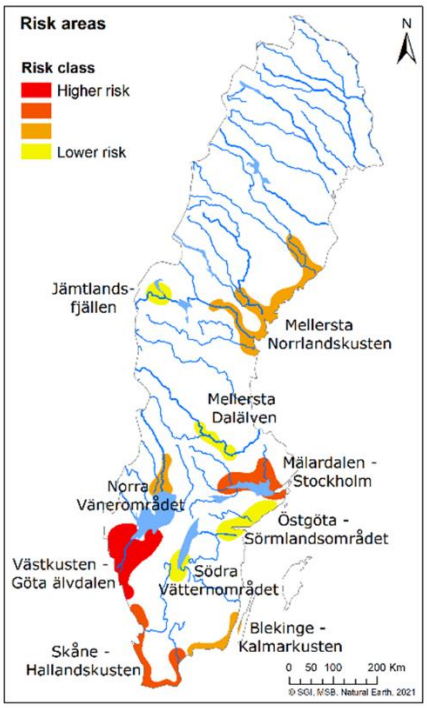

Figure 2. The ten geographical areas in Sweden most at risk from landslides, erosion and flooding.

The strategy highlights the prevention of landslides. In 2018, the Government introduced a specific initiative for co-financing landslide

[34] SMHI (2022) Myndigheters arbete med klimatanpassning 2021. Klimatologi Nr 66.

[35] SGI och MSB (2021) Nationella riskområden för ras, skred, erosion och översvämning.

mitigation measures along the Göta älv river in western Sweden. The risk of landslides along the river is identified as among the highest in Sweden already in today's climate. Change in precipitation patterns and increasing drainage can make the risk considerably higher in the future. A full cover of state funding is possible due to the high risks for human lives and socially important infrastructure. The funding is channeled through the local authorities that support property owners at risk in their adaptation measures. There is a special ordinance regulating the state funding along Göta älv[36]. Several actions to prevent landslides are underway. The Government has also invested in increased financing to prevent local flooding, landslides and erosion in other Swedish risk areas[37].

Implementation at the local level

Sweden's municipalities and regions are obliged to carry out risk and vulnerability assessments as a basis for coping with extraordinary events and crises[38]. Such analyses also cover events that will be affected by climate change.

Concrete adaptation measures have been initiated in many instances, above all in municipalities hit by extreme weather events. Regarding the nationally prioritized challenges, municipalities have mostly undertaken adaptation measures towards flooding, landslides and erosion, whereas few measures have been undertaken with regards to the effects on domestic and international food production and trade[39].

Most municipalities integrate climate change adaptation measures into spatial planning, especially concerning flooding, landslides and erosion. One fourth of municipalities consider heatwaves in their spatial planning, while one third have developed routines, checklists and action plans to counter extreme heat. Examples of physical measures introduced by municipalities include stabilizing and reinforcing measures to counter landslides, measures to manage stormwater through delay and retention of water flows, such as dams, reservoirs and rain gardens, as well as removal of impervious surfaces.

Implementation of action plans and measures by local authorities can be financially supported by several government grants such as the greener cities

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[36] Swedish Parliament (2018) Ordinance on Government grants for preventive measures against landslides at Göta älv.

[37] Swedish Parliament (2022) Ordinance on Government grants to municipalities for preventive measures against natural disasters.

[38] Swedish Parliament (2006) Lag (2006:544) om kommuners och regioners åtgärder inför och vid extraordinära händelser i fredstid och höjd beredskap.

[39] SMHI (2020) Kommunernas arbete med klimatanpassning 2019 – analys av statusrapportering till SMHI. Klimatologi 55

grant or the Local Nature Conservation Initiative (LONA). LONA is a specific government grants for nature-based solutions and is also open for applications from other local actors in the municipalities and for the county administrative boards. LONA funds measures for water retention and drought resistance such as river and wetland restoration. The Swedish Environmental Protection Agency also guides municipalities and county administrative boards in their applications for financing through the EU LIFE-programme for investments in environment and climate action.

ii. Cooperation on enhancing adaptation at the national, regional and international level

Sweden, like other Parties to the UNFCCC and the Paris Agreement, recognises that adaptation is a global challenge faced by all with local, subnational, national, regional, and international dimensions.

National level cooperation

To enhance national adaptation, several knowledge-raising bodies have been established at the national level. The Swedish National Knowledge Centre for Climate Change Adaptation is run at the Government's instruction at SMHI. The role of the Centre is to act as a hub for knowledge about climate change and to be a meeting place for actors involved in climate change adaptation. The Centre operates the online portal Klimatanpassning.se and arranges different types of training opportunities. Other important tasks include providing expert support to the Government offices.

Several agencies work together within a National Network for Adaptation. The aim is to strengthening society's ability to deal with the positive and negative effects of climate change. Among many other activities, the network cooperates in joint development projects, on the web portal Klimatanpassning.se and issues a newsletter.

Cooperation is promoted on all levels and between sectors and actors working with land use planning, risk management, natural disasters, and climate change adaptation, to reduce risks and enhance preparedness. Several coordination forums with relevance for adaptation currently exist in Sweden. Through these forums, sectoral agencies and other stakeholders can share experiences and plan key actions.

These forums include:

- Agency network for shore erosion

- Committee on dimensioned flows in hydroelectric dams in a changing climate
- Delegation for landslides
- National network for drinking water
- National network for climate change adaptation
- Regional networks for coastal cooperation

Regional (Nordic and European) level cooperation

Sweden supports and is actively involved in the development and implementation of regional strategies that involve several Scandinavian and European countries to integrate the consideration of climate change impacts and adaptation e.g. for the Baltic Sea Region and the Arctic Region.

The Nordic Council of Ministers is an official body for inter-governmental co-operation in the Nordic Region. It seeks Nordic solutions wherever and whenever the countries can achieve more together than by working on their own including adaptation actions. Sweden actively supports and participates in the cooperation.

Valuable cooperation and exchange of experience is also taking place within the Interest Group on 'Climate Change Adaptation' (IG CCA) of the Network of European Environmental Protection Agencies and the Working Group on Adaptation coordinated by European Commission's Directorate-General for Climate Action (DG Clima).

International level cooperation

Sweden is resolutely committed to the Paris Agreement — when it comes to mitigation, adaptation, and means of implementation. Most of the Swedish climate finance to low- and middle-income countries is channelled as bilateral official development assistance (ODA) through the Swedish International Development Cooperation Agency, Sida. Sida provides climate change support at several levels, including support to local and national institutions, bilateral support to multilateral organisations and support to other regional and global organisations. The support is provided to partner organisations both with climate change as a main objective ('principal objective' according to Development Assistance Committee (DAC) terminology), and as a secondary objective ('significant objective' according to DAC terminology), i.e., integrated in contributions that have other main objectives. This is done in cooperation with a variety of actors, including government institutions, multilateral organisations, research institutions, non-governmental organisations, the private sector, and Swedish authorities.

Sida has made efforts to focus on supporting countries in climate change adaptation since the Climate Change Initiative of the Swedish Government 2009–2013 and has continuously strengthen its focus on adaptation and increasingly meet the growing demand from national, regional, and international development cooperation partners. Sida´s interventions, relating to climate change adaptation constitutes 75 % of Sidas climate finance 2020 (Table 1).

	2017 (% of total)		2018 (% of total)		2019 (% of total)		2020 (% of total)	
	MSEK	**MUSD**	**MSEK**	**MUSD**	**MSEK**	**MUSD**	**MSEK**	**MUSD**
Adaptation	1329 (41%)	156 (41%)	2099 (48%)	242 (48%)	2041 (43%)	216 (43%)	1600 (39%)	174 (39%)
Cross-cutting	1206 (37%)	141 (37%)	1246 (29%)	143 (29%)	1523 (32%)	161 (32%)	1453 (36%)	158 (36%)
Mitigation	714 (22%)	83 (22%)	999 (23%)	114 (23%)	1147 (24%)	122 (24%)	999 (25%)	109 (25%)
Total	**3249**	**380**	**4343**	**500**	**4711**	**498**	**4052**	**440**

Table 2. Climate finance provided by Sida during 2017-2020.

The climate finance Sida disbursed in 2017–2020 was distributed among geographic regions and global organisations (Figure 3). The largest proportion of the financing was provided to local, national and regional actors in Africa. The large portfolio of climate change initiatives at the global level increased during the time period, as did to some extent the smaller portfolios in Latin America and Asia.

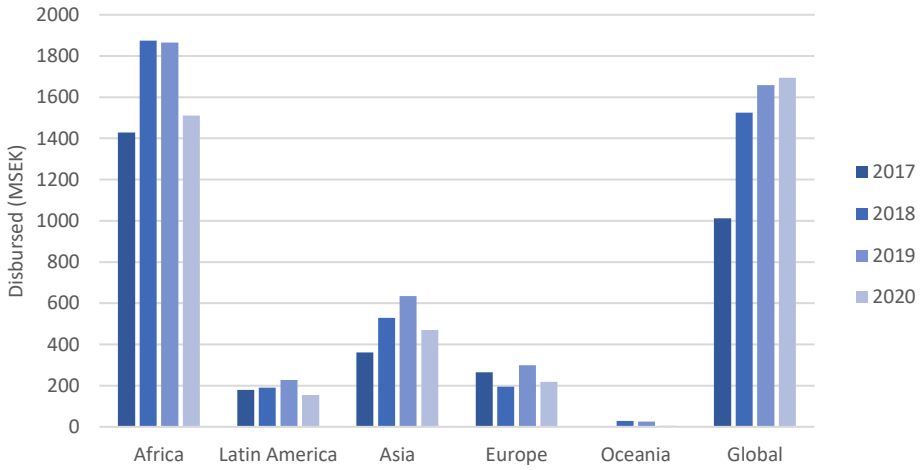

Figure 3. Sida's climate finance by geographic region and global organisations during 2017–2020.[40]

[40] The figures represent disbursements to Parties to the UNFCCC (non-party countries excluded) plus regional and global contributions for 2017–2020.

Swedish climate finance goes beyond what is channelled through Sida. Sweden provides significant support through various multilateral climate funds such as the Green Climate Fund, the Global Environmental Fund, to the Adaptation Fund, the Least developed country fund as well as the Nordic Development Fund. Significant amounts of climate financing are also channelled through the multilateral development banks.

Some examples of programmes with a focus on adaptation that Sida provides support to:

Example 1: Sida provides funding to ICIMOD, an intergovernmental organisation with eight member countries in the Hindu Kush Himalayan region. The overall objective of ICIMOD's work is that men, women, and children in the region enjoy improved well-being in a healthy mountain environment. The programme aims to contribute to reduced poverty, reduced physical and social vulnerability and improvement of ecosystem services. Activities and results include: development and dissemination of flood early warning systems; climate change adapted value chains; measurement, monitoring and management of air pollution; strengthening of women's capacity and leadership roles in agriculture and local decision making bodies; strengthening the regional cooperation through technical exchanges and management of transboundary natural resources; and increasing the global awareness of the importance of mountain areas for resilient living conditions and ecosystems. ICIMOD coordinated the HKH assessment, which was published in 2020 and yielded great interest. With more than 2 000 media mentions, 580k downloads, 715 native tweets and 82 citations, the publication has the widest reach of any ICIMOD publication in the institution's history. In 2020, ICIMOD was accredited by the Adaptation Fund, the only accredited regional organisation in Asia.

Example 2: The Global Facility for Disaster Reduction and Recovery (GFDRR) is a global partnership that helps developing countries better understand and reduce their vulnerability to natural hazards and climate change. GFDRR is a grant-funding mechanism, managed by the World Bank and engaging over 400 local, national, regional, and international partners. GFDRR provides knowledge, funding, and technical assistance in order to build capacity and to help vulnerable nations improve resilience and reduce risk. In 2020, more than 130 countries were supported for improved government institutional capacity in disaster and climate risk–informed policy design and analysis. The contribution is considered to have climate

change adaptation as principal objective, hence Sida's total disbursement in 2020 of approximately 25 MSEK is identified as climate finance.

iii. Barriers, challenges and gaps related to the implementation of adaptation

There are still several barriers to overcome to address capacity issues, increase the pace of climate change adaptation, and ensure that prevention measures are sufficiently flexible and robust. Analysis from several agencies and the national Expert Council for adaptation concludes that Sweden's capacity for climate change adaptation needs to grow further, in terms of preventive action, planning and interagency coordination together with cooperation to prevent identified climate risks.

There is a pronounced need among municipalities for continued support in the work with adaptation. This includes decision support and guidance in preventing climate risks in planning, that is they call for further knowledge-enhancing initiatives. Besides a lack of knowledge and resources, local authorities also identify that current legislation may in some cases hinder adaptation, and that a review of the legislative landscape is required.

Barriers identified here include a lack of resources, time and knowledge, as well as short-term planning horizons (in particular at the municipal level) and lack of tools and support for planning. In addition, the report identifies that current legislation may in some cases hinder adaptation, and that a review of the legislative landscape is required.

The national Expert Council finds that research on adaptation has advanced significantly, but that several knowledge gaps remain, for example regarding transnational climate risks and dependencies, just adaptation, and transformation[41]. Also, awareness and understanding of certain risk areas and their sensitivity to climate change must continue to be developed, and how sustainable measures are implemented need also be further understood. The effects of climate change can be prevented and reduced if the pace of adaptation is increased.

[41] National Expert Council for Climate Adaptation (2022). Assessment Report Nr 1.

Good practices, lessons learned and information-sharing

The Swedish National Knowledge Centre for Climate Change Adaptation gathers case studies on adaptation work in Sweden. The purpose of these case studies is to provide inspiration and to share experiences of different types of adaptation work. The knowledge centre has gathered and described more than 75 case studies on adaptation, including more than 65 cases translated into English. The case studies are all available at the Swedish portal for climate change adaptation. Several of the cases also contribute to mitigation efforts.

The Swedish Portal is a hub for adaptation knowledge and contains information on all aspects of adaptation. This includes how the climate is changing, the effects of different parts of society, tools for adaptation, educational materials, news and events, information about financing and much more. The portal is run by SMHI in collaboration with other national and regional agencies.

Some examples of adaptation actions and their outcomes:

More examples are available at the Swedish Portal for Climate Change Adaptation.

The climate adaptation of a park in Malmö

In 2014, the city of Malmö experienced extreme precipitation, causing widespread damage and financial losses. Such events are expected to occur more frequently as a result of climate change. The design of the new city park in Hyllie is an example of how the City of Malmö has incorporated the consideration of climate issues into its planning and implementation work.

Read more about the Hyllie park

Cloudburst mapping identifies vulnerable locations

Flooding because of a cloudburst event can have a major impact on important functions and structures in society. It can also result in major costs, due to damage to properties and buildings. In Botkyrka, a climate vulnerability analysis was conducted, revealing a need to carry out a detailed mapping of the town's vulnerability in the event of heavy rain, for existing and planned buildings. A cloudburst mapping was carried out, identifying places that required further analyses. These in turn could indicate a need for preventive measures, preparedness plans or greater consideration given to adaptation of new constructions.

Read more about the Botkyrka cloudburst mapping

Adaptive management for resilient forestry

Over half of Sweden's total land surface is productive forest land and constitutes together with the forest related industry, one of the most important Swedish industry sectors. While climate change will bring on a higher average growth rate for forests, it will also involve an increased risk of damage. In forestry, the adaptation process differs from that in other industries as it operates on longer time scales. The greatest challenge, therefore, is putting measures in place to deal with situations a long way in the future. Some of the adaptive actions now being taken have high initial costs but in the long run they will generate greater dividends for the owners and a better adapted forest. Forest management companies are now undertaking various pieces of work to spread the risks of damage to the forests in the future, including changes in how the thinning of forest stands is carried out, diversifying tree species and adapting felling plans.

Read more about adaptive-based forestry

Networking at the municipal level reinforces local climate change adaptation

Officials working on climate change adaptation in local municipalities often work alone. This makes it important to identify forms of cooperation between municipalities. Forming local climate change adaptation networks facilitates learning from each other and supporting each other in day-to-day adaptation work. One such adaptation network has been established in the Gothenburg region. The thirteen network municipalities meet four times a year, allowing members to share experiences and learn from each other, creating a common knowledge base. An expert group, participating once a year, is associated with the network. This group includes researchers from four universities, a landscape architect, and representatives from the National Board of Housing, Building and Planning and the Swedish Meteorological and Hydrological Institute (SMHI).

Read more about the network

Reindeer herding action plans identify vulnerabilities and adaptation measures

To improve the picture of how a warming climate affects reindeer husbandry, and how impacts can be addressed, the Sámi Parliament and the County Administrative Boards in northern Sweden initiated a pilot project, where four Sámi districts carried out climate and vulnerability analyses and developed action plans. The Sámi districts concluded that climate impacts are becoming increasingly evident, affecting reindeer husbandry in many

ways. For example, due to landscape fragmentation, many reindeer herding districts lack large contiguous grazing lands to spread their herds on when the pasture freezes. Competitive land use, such as forestry, mining and hydropower, reduces the area of grazing land and makes it more difficult for reindeer to move. Proposed measures include identifying alternative winter grazing land, as forests with hanging lichens, an important feed source for reindeer, have largely disappeared in recent decades due to intensive industrial forestry, including clear-cutting of old growth forests.

Read more about adaptation in Ängeså Sámi district

v. Monitoring and evaluation framework

Sweden views robust monitoring and evaluation as essential for assessing the performance and progress of adaptation, including investments, managing risk, supporting learning, and informing continual improvement in implementation. The Swedish ordinance for the work of Sweden's authorities on adaptation to climate change requires a yearly follow-up of the adaptation work by the authorities covered by the regulation. An on-line service has been developed specifically for the purpose. The results from the national and regional authorities are analysed and compiled in annual reports. To date, three reports are available, for 2019[42], 2020[43] and 2021[44].

As part of the national adaptation policy cycle, the National Expert Council for Climate Adaptation also monitors and evaluates the adaptation work. The Government is informed ahead of updating the NAS every five years. The first evaluation report was published in 2022 (summary in English).

Sweden reports on its adaptation work on adaptation according to Article 12 in the Climate Convention and Article 13 in the Paris Agreement. The first mandatory reporting under Article 19 and Part 1 of Annex VIII of the Governance Regulation and Annex 1 of the Implementing Act to the European Commission was completed in March 2021 and is available at the European Climate Adaptation Platform Climate-ADAPT.

[42] SMHI (2020) Myndigheters arbete med klimatanpassning 2019. Klimatologi Nr 54.

[43] SMHI (2021) Myndigheters arbete med klimatanpassning 2020. Klimatologi Nr 62.

[44] SMHI (2022) Myndigheters arbete med klimatanpassning 2021. Klimatologi Nr 66.

(f) Adaptation actions and/or economic diversification plans, including those that result in mitigation co-benefits

Progress and outcomes of adaptation actions

Sweden is facing climate risks such as sea level rise, flooding, landslides, erosion, storm damage, drinking water contamination, heatwaves, drought, forest fires, spread of diseases and challenges for reindeer herding. Climate change adaptation initiatives in Sweden have advanced significantly in recent years to address such current and future threats.

Municipalities play a particularly important role in enabling adaptation to climate change, since they are responsible for the implementation of many climate change adaptation measures in practice. A positive trend can be seen in stepping up to this responsibility, with 90 percent of municipalities having identified a need to act with regards to climate change adaptation. However, the progress of different municipalities varies widely. Few have evaluated whether measures taken to adapt to a changing climate have made the municipality less vulnerable. Coastal municipalities, larger cities and municipalities close to larger cities, as well as municipalities in the southern part of Sweden have come further in climate change adaptation work than rural and northern municipalities.

The adaptation work of state agencies have progressed and most agencies have carried out climate and vulnerability analyses, set goals and are implementinged action plans[45]. Adaptation is commonly mainstreamed into the organisations.

Many of the actions that the authorities have identified are analytical, for example climate and vulnerability analyses, strategic work and mappings of different kinds. Many are also informative, for example training courses, information, or awareness raising. Organisational actions include guidance, clarification of responsibilities and collaborations. Examples of technical actions include landslide prevention, recreation of wetlands and damming of ditches to which the authorities allocate funds.

Swedish forestry have undertaken several actions according to the national adaptation action plan for forest and forestry[46]. Examples of measures include a more accurate choise of tree species with respect to local site conditions, investment in using an increased diversity of tree species and a larger variety in the forest landscape as well as adapted silvicultural measures.

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[45] SMHI (2022) Myndigheters arbete med klimatanpassning 2021. Klimatologi Nr 66.

[46] Skogsstyrelsen (2019) Klimatanpassning av skogen och skogsbruket – mål och förslag på åtgärder.

Stump treatment against root in conjunction with harvesting activiteis is an important measure as well as avoiding thinning of stands higher than 20 meters, which decreases the risk of storm felling. Also, Swedish plant breeding programmes have addressed possible future climate conditions, thus creating preparedness ahead future planting.

Protection of forests and other natural areas supporting the protection of biological diversity is also an ongoing important adaptation measure, creating conditions for more resilient forestry and ecosystems. At the same time, these areas act as a carbon sink, giving important mitigation co-benefits. Special attention has been given to the restauration of wetlands, an adaptation measure that also brings mitigation benefits.

The Swedish Food Strategy for increased and sustainable food production is an example of an economic diversification plan that is being implemented based on several action plans. The goal of the food strategy is a competitive food chain where total food production increases, while relevant national environmental and climate goals are reached and sustainable growth and employment are created throughout the country. The strategy was adopted in 2017 by the Swedish Riksdag (Parliament) and extends until the year 2030. This year's follow-up report[47], shows that profitability has increased in the three sectors of the food chain but it is also clear that profitability is dependent on external circumstances (for example, the drought year 2018). To increase resource efficiency, further reduce greenhouse gas emissions and preserve and increase biodiversity in a changing climate, for instance new production and management methods adapted to climate change are still needed.

Progress and outcomes of the national adaptation work is further described in the first report of the National Expert Council for Climate Adaptation[48].

[47] Jordbruksverket (2022) Utvärdering och uppföljning av livsmedelsstrategin – årsrapport år 2022. Rapport 2022:2. English summary.

[48] National Expert Council for Climate Adaptation (2022). Assessment Report Nr 1.

(g) How adaptation actions contribute to other international frameworks and/or conventions

Sweden supports international goals for adaptation. The Sustainable development goals (SDGs) and the Paris Agreement, together with the final document from the conference on financing sustainable development (the Addis Ababa Action Agenda) and the Sendai Framework for Disaster Risk Reduction 2015-2030, form a global framework for long-term sustainable development.

Adaptation and climate resilient development is one of the main aims of the Paris Agreement. Agenda 2030 includes adaptation as an aspect in several of the 17 goals. One of the most important is goal 13: Take urgent action to combat climate change and its impacts. Adaptation is also part of Goal 11: Sustainable cities and communities, which involves adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and developing and implementing, in line with the Sendai Framework for Disaster Risk Reduction 2015–2030, holistic disaster risk management at all levels.

The Government's adaptation work is carried out in line with the goals of Agenda 2030. The national strategy integrates the goals of Agenda 2030 and the Sendai Framework through the definition of guiding principles of adaptation; sustainable development, mutuality, a scientific basis, the precautionary principle, integration of adaptation measures, flexibility, dealing with uncertainty and risk factors, a time perspective and transparency.

Within the framework of the Convention on Biological Diversity, guidance has been drawn up for the parties' work with adaptation. It is also important to highlight the opportunities in nature-based solutions that can help to preserve and make sustainable use of biodiversity and ecosystem services, and to reduce the effects of climate change. Sweden has made active contributions to the work with the voluntary guidelines and will continue to work to find ways for achieving increased cooperation between the work for biodiversity and the climate.

As part of the EU's Baltic Sea Strategy, which was adopted during Sweden's Presidency of the EU in 2009, a proposed climate change adaptation strategy for the Baltic Sea Region has been drawn up within the BaltAdapt flagship project. Sweden was responsible for compiling the strategy via SMHI. Shared knowledge databases, cooperation on funding and cooperation within research and industry are some of the proposals presented by BaltAdapt.

In recent years, the Arctic Monitoring and Assessment Programme (AMAP) working group has worked with adaptation and resilience. To meet the need for an overall perspective on the Arctic, Sweden initiated the Arctic Resilience Report, completed in 2016. The aim has been to integrate a resilience perspective into the Arctic Council's work. A decision on a framework was taken at the meeting of foreign affairs ministers in May 2017.

(h) Gender-responsive adaptation action and traditional knowledge, knowledge of indigenous peoples and local knowledge systems related to adaptation

Sweden advocates the importance of just transition and that human rights are considered in all adaptation measures. The traditional knowledge of indigenous peoples is essential and should be included to improve conditions for sustainable adaptation measures.

In Sweden, just adaptation has been identified as a key area for development. Several actions to ensure that adaptation is carried out in a just manner have taken place. For example, in 2021 a new decree on financial support for projects aiming to enhance urban greenery in socially and economically disadvantaged neighbourhoods was issued[49]. The risks of unjust adaptation to public health are considered in the Adaptation action plan of the Public Health Agency of Sweden[50].

The National Knowledge Centre for climate adaptation has given special focus to just adaptation, completing a mapping study in 2020 and working to increase knowledge and understanding. In 2020, the County Administrative Board in Norrbotten produced a report on how gender and intersectionality could be addressed in the region's adaptation work[51]. Similarly, the County administrative Board of Uppsala has initiated the development of intersectional analysis in their climate adaptation work, that will focus on the difference in vulnerability between groups.

Further, Sweden's innovation agency, Vinnova, issues calls for research applications for adaptation projects, and includes gender equality as one of the prerequisites for granting funding. There are also several examples of research projects that focus on gender and just adaptation.

To strengthen the work with gender mainstreaming and ensure that government agencies provide the same conditions and service to all, irrespective of gender, the Government issued a development programme, starting in 2013. Today, the programme includes 54 agencies.

In 2014, Sweden became the first country in the world to launch a feminist foreign policy. This means applying a systematic gender equality perspective throughout the whole foreign policy agenda. Special focus is given to the continued promotion of economic and social conditions of women and girls, initiatives for sexual and reproductive health and rights, and strengthened work for the agenda of women, peace and security (WPS)[52].

Equality between women and men is a prerequisite for sustainability and for achieving the goals of UNFCCC and the Paris Agreement. Sida is committed

to integrating the gender equality perspective throughout its operations. The level of gender integration in Sida's climate finance 2017-2020 is presented in Figure 4 below. The overall level of gender integration is around 85 %. Sweden has also been a champion for gender integration in the multilateral climate funds, including the promotion of separate gender policies and action plans. Improved integration of gender issues contributes to the efficiency and long-term sustainability of projects and programs funded by multilateral climate funds.

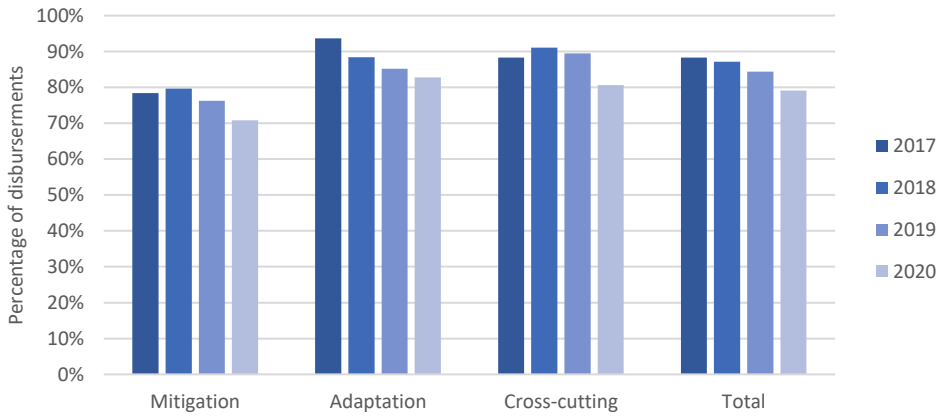

Figure 4. Level of gender gender mainstreaming in Sida's climate finance during 2017–2020.[53]

The Sámi Parliament of Sweden (the Sámediggi) is a body elected by the Sámi people to safeguard and promote Sámi rights, culture, livelihoods and languages. It is also a national administrative authority with an expert mandate on reindeer husbandry.

Indigenous people and local knowledge systems related to adaptation

The Sámi Parliament has been mandated by an ordinance, together with 31 national authorities and the 21 County Administrative Boards, to initiate, support and follow up on adaptation within its area of responsibility, including to develop action plans. Even before the ordinance, the Sámi Parliament had voluntarily developed an action plan with support of national funds. The plan includes how changes in the climate affect the conditions for reindeer husbandry and Sámi culture, and identifies specific problems

[49] Sveriges Riksdag (2020) Förordning (2020:1202) om stöd för gröna och trygga samhällen.

[50] Folkhälsomyndigheten, 2021. Folkhälsa i ett förändrat klimat – Folkhälsomyndighetens mål och handlingsplan för klimatanpassning 2021–2024.

[51] Länsstyrelsen Norrbotten (2019) Idéskrift och underlag för jämställd klimatanpassning.

[52] Regeringskansliet (2021) Utrikesförvaltningens handlingsplan för feministisk utrikespolitik 2019-2022 med inriktning och åtgärder för år 2022.

[53] The figures represent disbursements to Parties to the UNFCCC (non-party countries excluded) plus regional and global contributions for 2017–2020.

and proposes possible climate adaptation measures. One of the measures in the plan is that each Sámi reindeer herding community (sameby) is to produce its own climate and vulnerability analysis as well as its own action plan for climate adaptation. In 2018, four herding communities (samebyar) participated in a pilot project and developed climate and vulnerability analyses and action plans for climate adaptation.

The Sámi Parliament is also part of the National network for adaptation, previously mentioned. In addition, the Sámi Parliament adopted a Climate Strategy in 2019 and a revised environmental program aimed at inspiring the preservation of a sound living environment.

It is crucial that formalized procedures are established which give indigenous peoples the opportunity to participate and the ability to genuinely influence decision-making in issues that concern them. Procedures for consultations are a step towards strengthening opportunities for the Sámi to influence and participate in matters concerning the Sámi. In 2022 the Government adopted a law entitled "Consultation on Matters Concerning the Sami People"[54]. The law entails that the government, government agencies, regions and municipalities have the duty to consult the Sámi people before decisions are made that are affecting them. From a Sámi perspective, this would entail consultations on issues relating to the national implementation of the Paris Agreement as Sápmi (the Sámi homeland) and the Sámi people – being part of the Arctic – are heavily affected by the impacts of climate change.

[54] Swedish Parliament (2022) Lag (2022:66) om konsultation i frågor som rör det samiska folket.