Folkhälsomyndigheten
PUBLIC HEALTH AGENCY OF SWEDEN

Impact on health of climate change in Sweden

A risk and vulnerability analysis

Item number: 24209-1.

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About this publication

This publication contains a risk and vulnerability analysis of the impact of climate change on health in Sweden.

Knowledge of the health risks that could be presented by climate change provides an important foundation for the Public Health Agency of Sweden's overall mission: to promote health, prevent ill health and protect against threats to health. This publication also fulfils the requirements of Ordinance (2018:1428), which states that a climate and vulnerability analysis must form the basis for the direction and design of climate change adaptation actions among government agencies.

This risk and vulnerability analysis may also provide useful knowledge support for other national government agencies and county administrative boards affected by the Ordinance on government agencies' climate adaptation work (2018:1428). It may also provide support to regions and municipalities, and to decision-makers at national, regional and local levels, as well as the academic community, and the work of the Swedish Expert Council on Climate Adaptation.

The risk and vulnerability analysis should be viewed as an assessment of the impact of climate change on health, based on the current situation in respect of society's knowledge and management. It describes potential impacts and provides a foundation for developing preparedness, planning for, and preventing the risks associated with a changing climate. This means that confidence in this particular analysis will diminish as new knowledge emerges regarding impact on health, while adaptation measures implemented will alter the current scenario with regard to society's vulnerabilities and coping capacity. This is why the Public Health Agency of Sweden intends to update the risk and vulnerability analysis as new knowledge emerges, at least every five years as required by Ordinance (2018:1428).

The Unit for Environmental Health has been responsible for this work, with the assistance of external and internal experts.

Public Health Agency of Sweden

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Contents

Abbreviations

CCHF: Crimean-Congo Haemorrhagic Fever, a tick-borne viral disease

ECDC: European Centre for Disease Prevention and Control, a public health agency of the European Union (EU) that assesses risks and provides guidance to help countries prevent and respond to outbreaks and public health threats

EWRS: Early Warning and Response System, a web-based alert system for the European Commission, ECDC, and EU public health agencies responsible for cross-border health threats

IHR: International Health Regulations

IPCC: Intergovernmental Panel on Climate Change, the United Nations body for assessing the science related to climate change

PFAS: Per- and polyfluoroalkyl substances. Sometimes also known as highly fluorinated substances. This is a large group of substances found throughout the environment, and almost all people have PFASs in their bodies.

PM: Particulate Matter, airborne particles 10 or 2.5 micrometres (μm) in diameter

RASFF: Rapid Alert System for Food and Feed, the EU's rapid alert system for food that poses or could potentially pose a risk to human health

RCP: Representative Concentration Pathways (RCPs) describe how greenhouse gas concentrations change over time. Scenarios are named after the radiative forcing level reached by the year 2100, e.g. RCP 4.5 and RCP 8.5. The higher the number, the greater the climate change.

SSP: Shared Socioeconomic Pathways (SSP) describe socioeconomic scenarios. They include factors such as population, economic growth, education, urbanisation and technological development. A total of five different pathways are outlined for how the world might evolve on the basis of climate policy. The higher the SSP number, the higher the predicted level of emissions and climate change.

STAR: Strategic Tool for Assessing Risk, a risk assessment tool developed by WHO as part of its work on the International Health Regulations (IHR)

TBE: Tick-Borne Encephalitis

WHO: World Health Organization

WNV: West Nile Virus, a mosquito-borne viral disease

Glossary

Cyanobacteria: Microscopic organisms that, in many species and genera, can be found in lakes, seas, soil, and in symbiosis with plants. Mass occurrences of cyanobacteria are known as algal blooms. Some species can produce toxins with various effects. Some 30 to 50 per cent of cyanobacterial blooms are toxic.

Overflow discharge: A safety feature present in all municipal sewer networks. Overflow discharge involves a temporary release of untreated wastewater following heavy rainfall, for example.

Endemic: Commonly found in a particular geographical area or biotope.

Immunocompromised: People with compromised immune systems due to illness, immunosuppressive medication or radiotherapy.

Inversion: A layer in the atmosphere where the temperature increases with altitude, instead of decreasing in the normal way with increasing altitude above the Earth's surface.

Zero-degree crossing: When both above-zero and below-zero temperatures are recorded outdoors two metres above the ground during the same 24-hour period.

Neurodegenerative disease: A disease that slowly breaks down nerve cells in the nervous system, such as dementia and Alzheimer's disease.

Pathogen: An infectious agent or organism that causes disease, such as disease-causing bacteria, viruses, fungi, worms and arthropods.

Resilience: The ability of a system to withstand and manage change and continue to evolve; to cope with crises and disruptions while using the event to promote renewal.

Rhinitis: An inflammation of the nasal mucous membranes. Common symptoms include sneezing, itching, runny nose, nasal congestion and fatigue.

Raw water: Water intended to be used as drinking water.

Sensitisation: When the body develops a sensitivity to something by forming antibodies. These antibodies may result in an allergy in some people, while some people who are sensitised to a particular substance never develop allergies.

Thunderstorm asthma: A phenomenon characterised by a rapid increase in asthma cases in people, associated with high pollen counts and thunderstorms.

Vector: In biology and medicine, a vector is an organism that can carry a pathogen or parasite, propagate it and transmit it to other species. The vector itself is not affected by the course of the disease. Ticks and mosquitoes are common vectors.

Zoonosis: A disease or pathogen that can spread naturally between animals and humans. Epidemic nephropathy and tularaemia are examples of zoonoses.

Summary

Sweden's population, ecosystems and infrastructure are adapted to our current climate, but the climate change we are now seeing is impacting conditions for health and a good living environment. This report describes how climate change affects health in Sweden and highlights the health risks that societal actors need to be prepared for so that they can prioritise actions, increase preparedness and create better conditions for preventive measures.

The risk and vulnerability analysis is based on scientific evidence, agency reports, and expert assessments, and should be regarded as a snapshot of what is currently known about the impact of climate change on health in Sweden. The health risks assessed are those that exist or may arise within the borders of Sweden. They include both direct and indirect health effects that are important from a public health perspective. The analysis also includes an overview of society's vulnerability and coping capacity.

Health is affected by both extreme weather and changing ecosystems

Climate change entails risks of health effects due to extreme weather events such as heatwaves, droughts and flooding. It also entails risks of health effects from other types of ecosystem changes, such as altered precipitation patterns and growing seasons that may favour various pathogens and disease-transmitting vectors. The combination of an ageing population, urbanisation and high temperatures are factors that have collectively impacted health in Sweden already and are expected to increase.

The report lists 14 health risks according to risk level, in descending order. The following aspects are reported for each health risk:

- Impact on health: exposure levels, severity, risk areas and risk groups.
- Likelihood: how likely it is that health will be impacted in the near future.
- Vulnerability and coping capacity: a snapshot of Sweden's vulnerability and ability to manage health risks.

Heatwaves – the greatest risk to health

The results of the risk assessment show that heatwaves are the most significant health risk linked to a changing climate in Sweden. Heatwaves are assessed to have a critical impact on health, are highly likely to occur within 5 years, and the level of confidence in the assessment is high.

The assessment also shows a high risk of flooding, water-borne infections, pollen allergies, forest fires, air pollution, tick-borne diseases and landslides due to

climate change, with equally high likelihood of occurrence but moderate impact on health.

Food-borne infections and drought are at a medium-high risk level. These are assessed to have a minor impact on health but are highly likely to occur in the near future. At the same risk level are impacts on drinking water and warmer winters, albeit with a lower expected likelihood of occurrence but with slightly greater impact.

Mosquito- and rodent-borne diseases are at a low risk level. The likelihood of introduction of new pathogens is assessed to be low in the coming years and they are therefore not expected to have significant impact on health in the near future.

Introduction

Sweden's climate has already changed

The fact that temperature, precipitation and weather patterns have already changed over the last century is clearly evident from long series of global, national, and regional data (1, 2).

The average temperature in Sweden has increased by 1.9 degrees since the early industrialisation era, which is more than twice the global increase. All four seasons have become warmer, with the greatest temperature increase observed during winter in northern Sweden.

Annual precipitation has increased since the 1961–1990 period, with the greatest increase being seen in summer (3).

The growing season in Sweden as a whole is now three to four weeks longer than it was at the start of the 20th century. This period is extended by about five weeks in the south of Sweden (Götaland), and by about two weeks in the northern parts of the country (Norrland). Since the 1961–1990 period, the amount of time with snow cover has decreased by more than 20 days in the southern and central parts (Götaland and Svealand), about 15 days in southern Norrland and just under 5 days in northern Norrland (4, 5).

As average temperatures rise, the likelihood of extreme weather events such as droughts, heatwaves and torrential rain increases, which in turn increases the risk of flooding, landslides, slope failures and erosion.

- Torrential rain has affected the whole country, but is slightly more common in the south (6).
- To date, droughts have mainly affected eastern Götaland and Svealand (7).
- Heatwaves have become longer and more intense, especially in southern Götaland and eastern Svealand (8).
- The number of tropical nights, when the temperature does not drop below 20 degrees during the night, has increased over the last 30 years (8).

Future climate in Sweden

It is not possible to say exactly how great the climate change will be; nor is it possible to say exactly what the change will be in a particular place at a particular time. The ability to describe the future climate is limited by the fact that we do not know the extent of climate-affecting emissions, and hence warming. Greenhouse gas emissions are reliant on societal developments, factors such as population, technological development, emission restrictions and energy efficiency.

Regardless of the pace of warming, climate change will affect the climate in all parts of the world and all layers of society (9). Calculations from the IPCC and the Swedish Meteorological and Hydrological Institute (SMHI) show that the temperature increase will be greater at northern latitudes, and therefore in Sweden (10).

SMHI has produced climate scenarios and county-specific climate analyses for Sweden (11) that generally show an increase in average temperature and precipitation, but with greater differences between dry periods and periods with heavy precipitation. Temperatures are expected to increase in all seasons, but with regional differences. The greatest increase in temperatures is expected to occur in northern Sweden in winter, and the biggest changes will involve shorter and milder cold spells. The likelihood of more extreme weather events, such as heatwaves, droughts and flooding, is increasing.

Purpose

The purpose of this report is to describe how climate change affects the health of the Swedish population and to highlight the health risks that societal actors need to be aware of and plan for in the near future.

The key issues underlying this risk and vulnerability analysis are as follows:

- Which health outcomes impacted by climate change are relevant in the Swedish context?
- Which groups are particularly vulnerable to the health outcomes affected by climate change?
- What risks are expected to occur as a result of climate change, and what level of severity and impact on health can be anticipated?
- What are the vulnerabilities of society, and what capacity exists to respond to the health risks arising due to climate change?

Methodology

Updated literature review

A literature review of the impact on health of climate change in Sweden was conducted by the Public Health Agency of Sweden and Umeå University in the autumn of 2023. The literature review was based on a previous review (12), which was supplemented with relevant research published since 2019.

Choice of time horizon and climate scenario

Different scenarios and time horizons need to be selected depending on which societal actor is to undertake climate change adaptation (13).

The Public Health Agency of Sweden assesses that public health work on climate change adaptation should focus on a time horizon up to 2050, since the health sector's measures both can and need to be implemented in a relatively short time.

Climate scenarios can be used to draw conclusions about how human behaviour may influence the climate of the future. Greenhouse gas emissions are reliant on societal developments, factors such as population, technological development, emission restrictions, energy efficiency and human lifestyles. The literature includes a range of alternative scenarios regarding society's impact on climate.

The Paris Agreement sets the goal of limiting the rise in global average temperature to well below 2 degrees, but aiming for less than 1.5 degrees, compared to pre-industrial levels. However, actual emissions at present are likely to be too high to be compatible with limiting warming to that goal (9).

What can be deduced from the climate models is that all emission scenarios (RCP, SSP) indicate similar climate impacts over the next few decades due to uncertainties in the natural variability of the climate system (14). The risk assessment assumes that global warming will reach around 2 degrees by 2050, which would mean a significantly greater temperature change in northern latitudes, and hence also in Sweden.

Risk assessment

In December 2023, the Public Health Agency of Sweden held a workshop with 27 experts from national government agencies and the academic community to jointly analyse the impact of climate change on disease burden and health outcomes in Sweden.

The risk assessment used STAR, the Strategic Tool for Assessing Risk (15), which was developed by the World Health Organization (WHO) for use in the health sector for contingency planning for international health threats (IHR). The methodology advocates an approach that integrates contingency planning for all

types of disasters, whether caused by natural or human factors. The risk assessment is based on a snapshot of current knowledge and the existing capacity for risk management, and for each risk includes

- identifying the risk and its related health effects
- assessing the exposure of the population and risk groups to the risk
- analysing vulnerability and coping capacity for managing the risk
- assessing the likelihood of the risk occurring and its impact on health
- estimating confidence in the assessment of the risk.

Involving experts from various sectors in the risk assessment ensures that the various roles occupied by government agencies, other societal actors and civil society are taken into account in the work.

Identified risks

The health risks analysed during the workshop are limited to events occurring within the borders of Sweden.

Seven of the health risks identified are environmental factors that are directly affected by the impact of climate change on temperature and precipitation, leading to impact on health of varying severity. These include heatwaves, warmer winters, forest fires, air pollution, droughts, flooding and landslides. The health risk related to impact on drinking water is addressed separately as it is influenced by both various environmental factors and changes in ecosystems, which in turn are affected to varying degrees by climate change.

Six of the health risks represent health outcomes that can be linked to a combination of weather-related events and altered ecosystem parameters as a consequence of climate change. These are water- and food-borne infections, tick-, mosquito- and rodent-borne diseases and pollen allergies.

The effects of climate change in other countries may also affect health in Sweden. This applies in particular to effects that could become global risks through their impacts on migration flows and food security. It is important to address these effects in Sweden's preparedness work, but they require a different type of analysis and are presented in overview in the section titled Discussion.

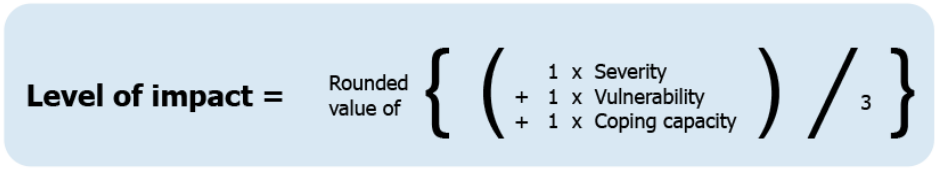
In the 2021 risk and vulnerability assessment, a literature review identified 17 different health outcomes that are both affected by climate change and significant from a public health perspective in Sweden (13). The current assessment analyses 14 health risks instead. Impacts on the indoor environment are linked to several of the other health risks and are now assessed in the context of these. Similarly, zero-degree crossings are included in the assessment of warmer winters. The risk of cold snaps has not been assessed at this time, as the phenomenon is not expected to increase in Sweden due to climate change.

Risk level calculation

The assessment is based on a number of steps for each health risk. The first step assesses severity – that is to say, the strength of the link between the health risk and expected climate change in Sweden by 2050 – and the seriousness of the impacts on health. The result gives a value on a scale of 1 to 5, where 1 is very low and 5 is very severe.

To determine the level of impact, the severity score is then viewed in relation to society's vulnerability and ability to manage the risk (Figure 1).

Figure 1. Calculation of the level of impact on health. The model is based on the assigned values for severity, vulnerability and coping capacity and produces a rounded score of 1 to 5.

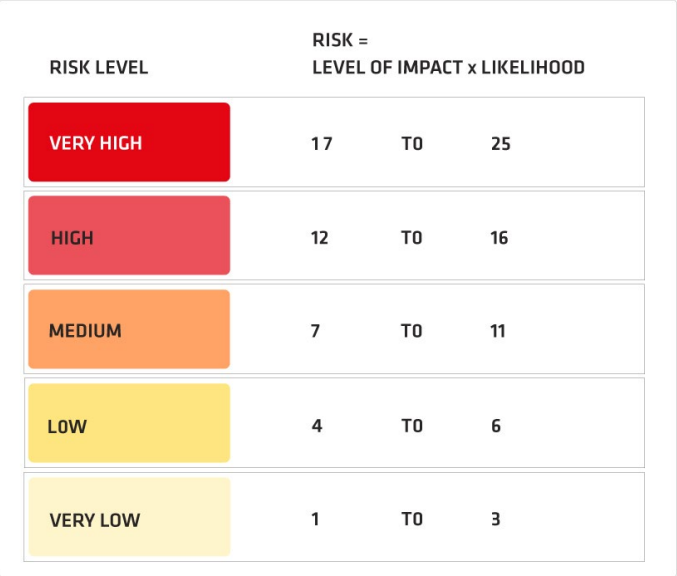


Source/calculation model: based on WHO STAR 2021 (15).

Likelihood is based on past events and frequency and is rated on a scale of 1 (very unlikely) to 5 (almost certain). The likelihood is evaluated on the basis of a five-year time horizon, as climate change adaptation work in Sweden is based on five-year cycles, and to allow for prioritisation of actions in the near future (16, 17).

To determine a risk level, the level of impact is multiplied by the likelihood score. The risk level is presented on a scale of 1 to 5, where 1 is very low and 5 is very high: see Figure 2.

Figure 2. Calculation of risk level. The model is based on the estimated level of health impact and the likelihood of the impact occurring within 5 years.



Source/calculation model: based on WHO STAR 2021 (15).

Confidence in the assessment

Confidence in the assessment of each risk is deemed to be good, sufficient or uncertain, and any uncertainties identified are reported under each risk described.

Results

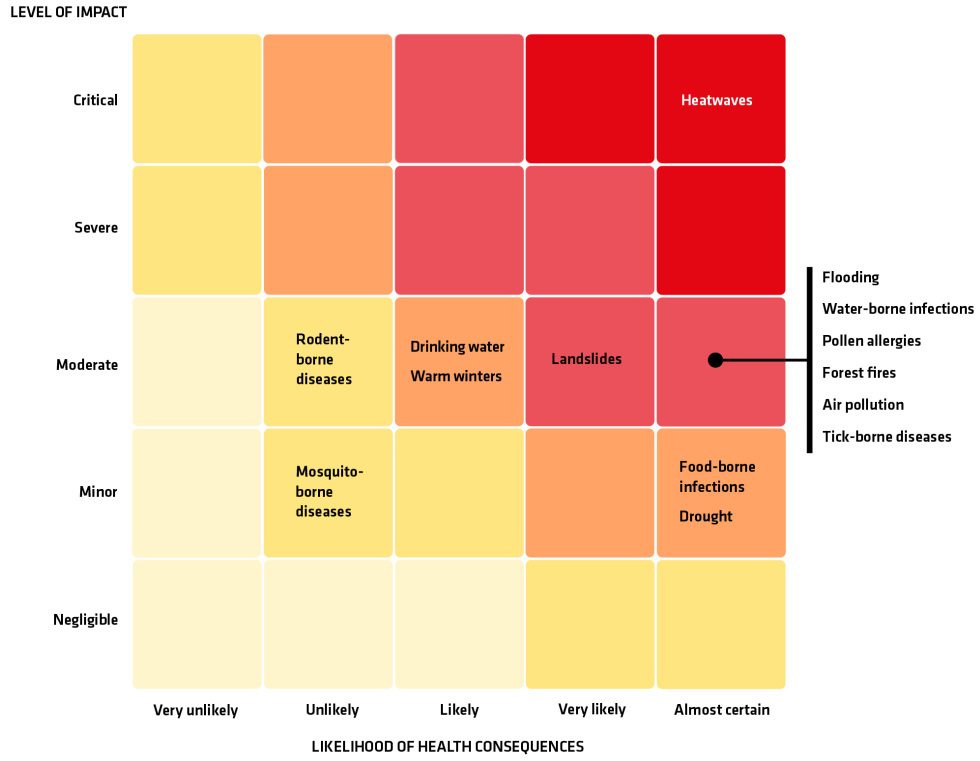
Heatwaves are the most significant health risk linked to a changing climate in Sweden. Heatwaves are assessed to carry a very high risk level (red), with critical impact on health and a high likelihood that the identified impact on health will occur (see Figure 3).

There are seven health risks at a high risk level (orange), with a high likelihood of occurrence and moderate impact: flooding, water-borne infections, pollen allergies, forest fires, air pollution, tick-borne diseases and landslides.

Food-borne infections and drought are at a moderate risk level (light orange), with minor impact on health. Impact on drinking water and warmer winters are also at the same level of risk, albeit with a lower expected likelihood of significant impact on health within 5 years.

Mosquito- and rodent-borne diseases (yellow) are at a low risk level. The emergence of new pathogens is deemed unlikely in Sweden in the near future, and is not expected to have a significant impact on health.

Figure 3. Risk matrix of health risks related to climate change, based on an assessment of the level of impact and the likelihood of occurrence in Sweden within 5 years. The matrix presents a snapshot that includes an assessment of society's present ability to manage the risks. The colours, from red to yellow, indicate very high to very low risk levels.



Source/risk matrix: based on WHO STAR 2021 (15).

The following section presents the health risks in descending order according to the risk level identified. The following aspects are reported for each health risk:

- Impact on health: exposure, severity, risk areas and risk groups.
- Likelihood: how likely it is that health will be impacted within 5 years.
- Vulnerability and coping capacity: a snapshot of Sweden's vulnerability and ability to manage the health risk.

Heatwaves

Good confidence in the assessment.

Climate change is leading to higher temperatures, with longer and more intense heatwaves. There is no universally accepted international definition of a heatwave as conditions vary from country to country. In Sweden, SMHI defines a heatwave as a continuous period when the maximum daily temperature exceeds 25 degrees for at least five consecutive days (8). The Swedish warning system takes into account the health effects of high temperatures. An advisory or warning for high temperatures is issued when outdoor temperatures are expected to reach 26 degrees or higher for at least three consecutive days (18).

Impact on health

Prolonged periods of high temperatures can cause a range of health problems, from mild discomfort to premature death. The severity of the effects is dependent on both the intensity and the duration of the heat. In the summer of 2018, Sweden experienced prolonged high temperatures all over the country (19). Compiled data shows that mortality increased compared to previous summers, and overall excess mortality of about 700 deaths was observed for the whole summer (20). Heat-related symptoms and complaints were also reported in the population in connection with the prolonged heat (21).

Demonstrating the effects of heat on mortality is a complex task. Deaths on hot days in Sweden are often attributed to cardiovascular disease or heart failure, while heat stress is rarely noted as the cause of death. There are indications that the risk of dying from heat in Sweden has increased in recent decades (22–25).

Vulnerability to high temperatures can vary both among individuals and across different parts of the country. Studies conducted in Sweden have shown that the population in northern Sweden is affected more by high temperatures. This is reported to be due to the relative temperature change being greater in the north during heatwaves (26).

High temperatures occurring early in the summer have a greater impact on the risk of death compared to those occurring later in the season. One explanation for this may be that the population gradually adapts to higher temperatures. The most vulnerable people tend to die first, which is why there is also a link between high winter mortality and low heat-related mortality the following summer, and vice versa (27).

Risk groups

Certain groups are particularly vulnerable to heat, partly because heat and dehydration place additional strain on the heart and circulatory system. This includes people with chronic illnesses, older adults, individuals with physical or mental disabilities, young children, pregnant women, and people taking certain medications (27). Pregnant women are more likely to give birth prematurely, increasing the likelihood of complications and low birth weight.

For people suffering from depression, mental illness or substance abuse, the risk of death is significantly higher on hot days compared to days with lower temperatures (28). One contributing factor is the fact that serious side effects of medications increase under heat stress (29–31).

Certain occupational groups are at higher risk of exposure to harmful heat. These include people performing heavy physical labour and emergency service personnel wearing protective clothing (32). A report by the Swedish Civil Contingencies Agency (MSB) also noted that the risk of road accidents may increase. Violence, riots and public disorder are also likely to increase during prolonged heatwaves (33).

Likelihood

Given current international commitments to limit emissions, heat-related illness in Sweden could double by the end of the century compared to today (34–36).

Periods of high temperatures are expected to become more common in Sweden. Heatwaves, which have previously occurred once every twenty years on average, are projected to occur every three to five years by the end of the century (37, 38).

Vulnerability and coping capacity

The risk assessment identified the fact that society has very high vulnerability and low capacity to manage the health impacts of heatwaves (see the section titled Methodology).

Societal vulnerability during heatwaves

- Sweden has an ageing population. The proportion of people over the age of 65 is expected to increase from 20 to 23 per cent of the population by 2050 (39). This means that the number of particularly vulnerable individuals is expected to increase by around 600,000.
- As heatwaves typically occur during the height of summer, the strain on healthcare and social care services increases at a time when parts of the workforce are usually on holiday.
- According to the National Board of Health and Welfare, the number of hospital overcrowding incidents has risen during the summer months over the past decade (40).
- Existing buildings, including healthcare facilities, are not designed for heatwaves, and this may result in indoor temperatures exceeding comfortable limits (41).
- Urban heat islands mean that people living in cities are particularly vulnerable during heatwaves (41). At present, 88 per cent of Sweden's population lives in urban areas, and this share is expected to rise as the population grows (42).
- Living alone, lacking social interaction or not being able to leave one's home are risk factors during heatwaves. In Sweden, more than one in three people over the age of 60 lives alone (43).
- Depending on the design of medicine stores, care facilities, operating theatres and sterile storage, heatwaves may impact healthcare on account of medicine shortages, challenges relating to hygiene and cancelled surgeries, for example (44).
- Levels of air pollutants such as ground-level ozone and airborne particles also rise during heatwaves, further increasing the risk of death and ill health (41).
- Continued cuts to healthcare resources and staff shortages present challenges in maintaining adequate access to care (45).

Societal capacity in the event of heatwaves

- In 2022, SMHI introduced impact-based weather warnings, which are more adapted to regions and issued on the basis of the expected impact in specific areas (46).
- The Public Health Agency of Sweden has issued guidance on heatwave action plans which is aimed at municipalities, regions and private healthcare providers (47). Many societal actors have already developed action plans (44).
- The Public Health Agency of Sweden has issued a general recommendation (HSLF-FS 2024:10) concerning indoor temperatures, along with guidance that includes high-temperature situations (41, 44, 48).

Pollen allergies

Good confidence in the assessment.

Climate change brings about seasonal shifts and changes in the length of the seasons, with an earlier start to the growing season and a longer growing season. Outdoor allergens affected by this include pollen from trees and grasses, as well as mould spores (49, 50). Climate change influences both the production and concentration of pollen in the atmosphere, the duration of the pollen season and the allergenic potential of pollen (51).

Impact on health

In Sweden, a large proportion of the population, around 39 per cent, report symptoms, hypersensitivity or allergy to pollen, and this share has increased over time (52).

Health effects of pollen include asthma, eye infections, increased susceptibility to viral infections, respiratory diseases (53, 54), and worsening of cardiovascular disease.

Quality of life may be negatively affected during periods with high pollen counts. Sick leave is common among allergy sufferers, as are reduced productivity at work and school due to fatigue and exhaustion caused by both symptoms and the side effects of medication (55).

The effects of pollen are generally exacerbated in combination with air pollution, as pollen attaches to particulate matter and penetrates deeper into the lungs. In people with pollen allergies, exposure to air pollutants such as PM2.5 and ozone

can worsen symptoms (56, 57). During the pollen season, thunderstorms and heavy rain can trigger the release of tiny particles from pollen grains and increase the risk of thunderstorm asthma (58–61).

Risk groups

Risk groups include individuals with pollen allergy, asthma, and other respiratory-related allergic conditions.

Likelihood

Studies over the past thirty years have shown changes in the production, distribution and concentration of pollen and spores. Higher temperatures and changes in precipitation affect pollen and spore levels, and more long-range dispersal of pollen has been observed. Elevated carbon dioxide levels and warmer temperatures increase pollen production, particularly in urban environments, where plants also tend to flower earlier and produce more pollen (50, 62).

A warmer climate may lead to the introduction and establishment of new pollen-producing species. One example is common ragweed, which has not previously posed a major problem for allergy sufferers in Sweden as it blooms late and historically has not had time to seed and spread. Nowadays, it can spread northward in Europe, partly due to climate change (63–65).

As the climate changes, the frequency of intense thunderstorms is expected to increase across Europe, leading to a greater risk of thunderstorm asthma (66).

Vulnerability and coping capacity

The risk assessment identified the fact that society is partly vulnerable and has partial capacity to manage the health impacts of pollen allergies (see the section titled Methodology).

Societal vulnerability to pollen allergies

- The number of people with pollen allergies has increased in recent decades, partly due to climate change. Pollen counts are expected to increase significantly due to warming and higher carbon dioxide levels (62).
- All age groups are susceptible to pollen allergies.
- An increasing number of older people are suffering from pollen allergies.
- Inequalities in allergy care, such as access to allergy treatment, certified health care centres and a shortage of specialised allergists all over the country, mean that treatments available are not used to their full potential (67).
- At the national level, there is no clear responsibility for allergy care, including pollen.
- Access to immunotherapy can be limited and may sometimes involve long waiting times.

Societal capacity in the event of pollen allergies

- Pollen levels are monitored all over Sweden. Daily pollen measurements are taken to identify and analyse pollen counts and plant species during the pollen season.
- Pollen forecasts are available to the public.
- In general, Sweden has an effective healthcare system for treating asthma.

Tick-borne diseases

Good confidence in the assessment.

Ticks are potent vectors for transmitting various zoonoses; that is to say, diseases that spread between animals and humans. The survival and geographical distribution of ticks are strongly influenced by changes in climate and ecological conditions. In Sweden, ticks are now surviving further north. Shorter and milder winters, early warm springs and long, humid growing seasons with temperatures favourable to ticks are expanding their range both northwards and to higher altitudes (68, 69).

Impact on health

A number of different diseases can be transmitted to humans through tick bites. The most common tick-borne diseases in Sweden are Lyme disease and TBE.

Lyme disease is caused by bacteria and can result in a variety of symptoms, including skin redness, joint problems, and neurological symptoms such as meningitis, radiating pain, and facial paralysis. Heart involvement can occur, but is rare.

Tick-borne encephalitis, TBE, is caused by a virus. Infected individuals may be asymptomatic or experience mild symptoms, but about one-third of those who fall ill develop serious symptoms such as encephalitis with high fever, headache, confusion, seizures and paralysis. Most people recover, but around one-third may experience long-term effects such as fatigue and memory problems (70).

Other less common tick-borne diseases in Sweden that can affect humans include anaplasmosis, babesiosis and rickettsiosis.

Risk groups

People who spend a lot of time outdoors are at risk of being bitten by ticks. Vulnerable groups for these diseases include older people, immunocompromised people, and people who are not vaccinated against TBE.

Likelihood

The number of cases of Lyme disease and TBE has increased in Sweden, in line with the expanding range and population density of our common tick, Ixodes ricinus (71). This is believed to be due to the growing presence of the tick's host animals, and the fact that milder and shorter winters improve tick survival. Combined with a longer season, this increases opportunities for reproduction. As a result, the risk of contracting tick-borne diseases is rising in Sweden.

Climate change in Northern Europe has created a geographical zone where new tick species can establish themselves and introduce new tick-borne pathogens (69). The taiga tick (Ixodes persulcatus), for example, which is capable of transmitting a more severe form of TBE (72), has been found in Sweden in recent tick collections, and its spread is increasing due to climate change (69, 73, 74).

The serious viral disease Crimean-Congo haemorrhagic fever (CCHF) is primarily transmitted by a type of tick (Hyalomma spp.) that is not currently endemic in Sweden. However, these ticks are regularly found on migratory birds in Sweden and neighbouring countries. A hot summer could allow them to reproduce in Sweden within a relatively short time frame (75). In Europe and surrounding countries, only a few cases of CCHF are diagnosed annually (76). The risk of this disease becoming more widespread is currently highly uncertain, but is probably very low at present.

Vulnerability and coping capacity

The risk assessment identified the fact that society is partly vulnerable and has high capacity to manage the health effects of tick-borne diseases (see the section titled Methodology).

Societal vulnerability to tick-borne diseases

- TBE has historically spread westwards in Sweden. There has also been some spread northwards, although cases north of the Dalälven river are still rare, with the exception of the municipality of Gävle.
- The highest number of TBE cases ever reported in a single year was recorded in 2023. An upward trend in the number of cases has been observed, despite an increase in the number of vaccine doses sold. A decade ago, the incidence was less than half as high (70).
- A large proportion of the population is unlikely to be immune to TBE.
- There is a socioeconomic aspect to TBE vaccination, as it is not included in any national immunisation programme. This means that the cost must be covered by the individual in most regions. Maintaining full protection also requires repeated doses over time.
- There is currently no vaccine for Lyme disease on the market, and having had the disease does not provide immunity against future infection. However, a vaccine is under clinical trial (77).
- Recommendations on how to protect yourself from tick bites can be difficult to follow.
- Both TBE and Lyme disease are now becoming established in new areas, where awareness within the healthcare system may be more limited when it comes to diagnosing tick-borne infections.
- As Lyme disease is not a notifiable disease, it is difficult to observe patterns or track the spread of the disease.

Societal capacity in the event of tick-borne diseases

- An increasing number of regions are introducing free or subsidised TBE vaccination, primarily for children.
- More and more people are choosing to be vaccinated against TBE, as awareness of the disease is increasing through media coverage, advertising, and targeted information from healthcare providers and vaccine companies.
- Information about these diseases is available, and there is generally a high level of awareness about tick-borne diseases in areas where the population is familiar with ticks.
- The Public Health Agency of Sweden publishes maps highlighting municipalities with a higher incidence of TBE cases (78).
- The Swedish Veterinary Agency (SVA) and universities have conducted various projects involving tick collection to monitor the distribution of tick species in Sweden and to identify both new species and tick-borne pathogens.

Air pollution

Good confidence in the assessment.

Climate change can influence the impact of air pollution on health in several ways. It can directly influence the levels of pollutants, and it can influence the effects of exposure to those pollutants. The presence of air pollutants from forest fires, for example, and the formation of ground-level ozone and particulate matter (PM2.5 and PM10), for instance, are influenced by climate and weather, particularly temperature.

Impact on health

Air pollution appears to have an adverse impact on almost every organ in the body (79). Even low levels of air pollution cause significant health effects (80). Air pollution can cause both acute effects and chronic diseases, such as respiratory issues and asthma, lung cancer, cardiovascular disease, neurodegenerative diseases and diabetes, as well as impacting pregnancy outcomes and children's lung function (79–81).

In 2019, air pollution levels in Sweden are estimated to have resulted in more than 6,700 premature deaths (82). Increased levels of particulate matter from forest fire smoke in the summer of 2018 led to an increase in acute lower respiratory tract problems in the affected regions (83).

Ground-level ozone is primarily a problem in urban environments. One study shows that ground-level ozone causes 10 premature deaths per year on average in Stockholm (84). In another study that simultaneously included a number of

pollutants, ozone had a significantly greater effect on the risk of premature death in Stockholm (85).

The adverse health effects of air pollution are amplified at high temperatures, particularly in the case of ozone and PM10 (86). The fact that the negative effect of pollution increases during heatwaves may be due to factors such as increased respiratory rate and that dehydration affects blood viscosity and coagulation. In Stockholm, for example, the heat effect on cardiovascular mortality was higher at elevated nitrogen dioxide levels (87).

People with other respiratory diseases may be more sensitive to air pollution during the pollen season.

Risk groups

With short-term exposure (hours to days), older people, children and people with underlying diseases such as asthma and cardiovascular diseases have an increased sensitivity (88). When it comes to the effects of air pollution on the risk of developing diseases, socioeconomic conditions, lifestyle habits, access to healthcare, other exposure pathways (in the workplace, for example) and genetic factors may also contribute to increased vulnerability. Some effects may be particularly significant during specific life periods, such as during pregnancy or in early life.

Likelihood

Modelling indicates that climate change will not result in major changes to the air environment in northern Europe (89). Although trends and forecasts for Sweden generally show declining average levels of nitrogen dioxide and particulate matter (90) and ozone (91), heatwaves and forest fires in the future may still result in increased health problems on account of episodes involving high levels of particulate matter and ozone.

In the most favourable climate scenario, SSP 1–2.6 with sharply reduced emissions, Sweden is expected to see a 90 per cent reduction in ozone-related mortality by the middle of the century, while the other scenarios instead show an increase of between 1 and 80 per cent (92).

Vulnerability and coping capacity

The risk assessment identified the fact that society has high vulnerability and partial capacity to manage the health impacts of air pollution (see the section titled Methodology).

Societal vulnerability to air pollution

- An ageing population or a growing group of socioeconomically disadvantaged people may lead to increased health risks even if exposure to air pollution remains the same (88, 93).
- Levels of particulate matter and nitrogen dioxide are generally higher in the southern parts of Sweden, where population concentration and pollution emissions are greatest. Exposure can occasionally be high in northern Sweden as well, especially during cold seasons with frequent inversions, and in valleys where pollutants can become trapped (82).
- A large and growing proportion of the population lives in medium-sized and large cities, where environmental quality standards for air pollution are often exceeded (94). Levels of particulate matter and nitrogen dioxide from traffic are highest in cities or areas with high traffic intensity, while exposure to ground-level ozone can be higher in suburban and rural areas than in cities (82, 95).
- The Swedish air quality index is based on a relatively small number of monitoring stations, most of which are located in central parts of large and medium-sized cities (96). The lack of monitoring stations can reduce the effectiveness of informing and warning the population about air quality and tracking exposure level trends.

Societal capacity in the event of air pollution

- In general, Sweden has an effective healthcare system for treating the health effects that air pollution can cause.
- The Sweden Air Quality Index is available to the general public and provides valuable information on current air quality (96).
- WHO has defined new air quality guidelines (80). Within the EU, work is in progress on revising the air quality directives as set out under the *Green Deal* and the *Zero Pollution Action Plan*, which will lead to stricter limit values for particulate matter and nitrogen dioxide, for instance, and define requirements for reduced exposure to air pollution (97).

Forest fires

Good confidence in the assessment.

Forest fires are a naturally occurring phenomenon in all forest environments, but most forest fires are caused by human activities. Climate change increases the risk of more frequent and extensive forest fires on account of high temperatures, thunderstorms and prolonged periods of dry weather without rain (98–100).

Impact on health

Forest fires impact health directly due to fire and smoke, such as accidents, deaths, acute respiratory distress, asthma and the like, as well as increasing numbers of cases of respiratory and cardiovascular diseases. They also cause less commonly studied outcomes such as emergency visits for headaches (101) and sick leave (102). Moreover, forest fires can have long-term effects on mental health due to loss of forests, property and changes in economic conditions (103, 104). See the section on air pollution for more information on the health effects of particulate matter and ozone.

Forest fires result in high levels of particulate matter in the air, not only affecting the local population but also having an impact at regional, national and global level, as particulate matter can be dispersed over long distances. In the summer of 2018, Sweden was hit by the most extensive forest fires in modern times. Forest owners were severely impacted by economic losses, and around a hundred people were evacuated from their homes. The emergency services and others involved in the firefighting effort were under severely strain, and one firefighter died (105). Large parts of the counties of Jämtland and Härjedalen were affected by high levels of smoke from the forest fires (106). The number of patients with acute asthma and

who sought medical care for lower respiratory diseases increased significantly in all of the counties' municipalities. At the same time, warm and dry conditions contributed to high levels of ground-level ozone in Sweden (107).

Risk groups

Particulate matter from smoke poses a health risk to both local residents and people fighting the fires, and can also affect people further away. Emergency services personnel and landowners involved in firefighting operations are exposed to high levels of particulate matter during forest fires. Certain groups of people, such as children, pregnant women, older people, people with cardiovascular and lung diseases, and people with asthma and chronic obstructive pulmonary disease, are particularly sensitive to smoke particles (103).

Likelihood

Climate change is expected to increase the risk of forest fires (108). However, climate change and changes in forest management are expected to increase the proportion of deciduous trees in Swedish forests, which could potentially reduce the risk of forest fires (109). The occurrence of forest fires in other countries also contributes to an increase in overall exposure to particulate matter in Sweden.

The risk of forest fires and vegetation fires varies by region in Sweden. Some parts of the country are more severely affected by drought than others, while differences in vegetation mean that fires behave in different ways. Up to the middle of this century, an increase in high-risk periods for forest fires is expected in southern Sweden and along the coast of Norrland. These high-risk periods will become longer and more frequent and extend over a longer season, while the level of fire risk will generally be higher (110).

Vulnerability and coping capacity

The risk assessment identified the fact that society has high vulnerability and partial capacity to manage the health impacts of forest fires (see the section titled Methodology).

Societal vulnerability to forest fires

- The forest landscape covers just over two-thirds of Sweden, which means that the country has large tracts of land that are vulnerable to forest fires (105).
- The emergency services needed support from many other societal actors to deal with the forest fires and the disruption caused by the fires of 2014 and 2018.
- Major fires occurred in sparsely populated municipalities in the summer of 2018. Depopulation, an ageing population, long distances and large areas of forest all pose increasing challenges (99).
- The forestry sector's field organisation is sparsely staffed, with few people involved, and the people responsible for work on the final extinction of fires have varying levels of expertise. Many are temporary or migrant workers, which can lead to language challenges (99).
- A lack of knowledge about forest fire suppression in firefighter training and a lack of coordination of the extensive voluntary aid have been identified (99).
- There is no comprehensive national fire database which includes mapping and information on forest fires for future risk assessment and planning (111).

Societal capacity in the event of forest fires

- Sweden's fire service has good capacity for effective firefighting operations through efficient international cooperation and other initiatives. This was evident during the forest fires of 2014 and 2018, when few people and homes were harmed and no essential societal functions were destroyed (99).
- The Swedish Civil Contingencies Agency (MSB) has reinforcement resources in the form of water-scooping aircraft and helicopters, as well as forest fire depots.
- The NORDRED agreement and the EU Civil Protection Mechanism enable cooperation and exchange of equipment and personnel within the Nordic countries and the EU.
- A number of proposals on how Sweden's preparedness for forest fires can be strengthened have been submitted in a government inquiry (105).
- The general public is able to keep track of the fire risk in forests and fields thanks to the fire risk forecast and the mobile application *Brandrisk ute* (112, 113).

Flooding

Sufficient confidence in the assessment.

Flooding is when water covers areas beyond the normal boundary of a lake, watercourse or sea. Flooding can also affect land areas that are not normally adjacent to water, but where water remains standing due to torrential rain (114). The risk of flooding is largely dependent on how watercourses are regulated, the preventive measures taken and the conditions of existing buildings and infrastructure and how these change (115).

As the climate changes, flooding is expected to become more frequent due to higher sea levels, more precipitation and more torrential rain. However, the risk varies between different parts of the country (115).

Impact on health

Torrential rain can cause deaths and injuries due to vehicles getting trapped in the water or buildings collapsing, for example, or with secondary effects from mudflows and landslides (116). Flooding can also disrupt electricity supplies for production of drinking water (117).

Following flooding, there is an increase in mental health problems (118, 119) and the risk of cardiovascular and respiratory mortality, which may be due to a combination of physical, psychological, and environmental impacts and poorer access to health services (120, 121).

Wells may become contaminated by saltwater during periods of coastal flooding, as many wells are located close to the coast and at low altitudes (122).

The risk of infectious diseases may increase after a flood due to the spread of pathogens to drinking water and bathing water, for example. There is also a risk of exposure to chemicals due to leakage from contaminated land. Flooding can also result in the spread of disease when sewer systems are overloaded and wastewater flows into reservoirs from which waterworks draw their water, or when contaminated water spreads into flooded homes.

Zoonotic diseases such as leptospirosis are spread through contact with infected rodents and rats or contaminated water. Flooding also increases the risk of post-flood mosquito outbreaks, which can cause discomfort and psychological distress due to numerous bites, with a risk of secondary infections (see the risk of mosquito-borne diseases).

The financial consequences have had the greatest impact (123) in the case of Sweden's floods. Examples include the torrential rain that fell in the town of Gävle in 2021, where an estimated 4,000 to 5,000 permanent homes were affected by the subsequent flooding (124). Financial loss can have a long-term impact on people's mental health.

Risk groups

People living near coastal areas and beaches, as well as people involved in rescue and clean-up operations, are particularly vulnerable to flood risks. Populations in urban areas are more vulnerable to torrential rain, as a high proportion of hardstanding increases runoff.

Certain groups, such as children, older people, pregnant women and people with chronic diseases, may be particularly vulnerable to physical or mental health risks associated with flooding (125–127).

Likelihood

As climate change progresses, flooding is expected to increase in severity, duration and frequency (128), particularly during July, August and September. Flooding due to extreme water flows is expected to become more common in large parts of Götaland, southern Svealand and the north-westernmost part of Norrland, while the risk is expected to be lower in northern Svealand and the rest of Norrland. Local differences are significant, however (115).

The risk of flooding along the coasts is influenced by factors such as sea level rise and land uplift. In the future, sea level rise is expected to be lower in the central and northern parts of Sweden where land uplift is greater, while southern Sweden is considered to be most vulnerable to sea level rise as land uplift there is very low (115, 129, 130).

Coastal flooding can also be caused by temporary sea level rises due to storms, particularly in autumn and winter.

There are many indications that torrential rain will become more intense and more frequent in the future. The atmosphere can hold more water vapour in a warmer climate, creating the conditions for heavier precipitation, but as in today's climate, there will also be a natural variation in the intensity of torrential rain (115).

Vulnerability and coping capacity

The risk assessment identified the fact that society has high vulnerability and partial capacity to manage the health impacts of flooding (see the section titled Methodology).

Societal vulnerability to flooding

- Climate change poses risks for Sweden's large lakes (Vänern, Vättern, Mälaren and Hjälmaren). One challenge for climate change adaptation around these lakes is that it is not clear who should take responsibility or bear the costs for climate change adaptation measures (131).
- Seven per cent of Sweden's population lives within 100 metres of water, and this group has a high proportion of older people (132), which increases vulnerability to flooding due to limited mobility and medical needs.
- It is common for coastal and shoreline areas to be developed despite the risk of flooding, as these areas are attractive residential environments or interesting areas for development.
- A drained landscape where a large proportion of wetlands have disappeared can lead to an increased risk of flooding and rapid progression of events during periods of heavy rainfall (133).
- Runoff processes are rapid in developed areas due to the fact that they have a large proportion of impervious runoff surfaces (134). Further urbanisation is increasing vulnerability to flooding. Major preventive measures are needed so that cities are better able to cope with extreme precipitation.

Societal capacity in the event of flooding

- MSB updates the review of flood risk every six years. This identifies areas at significant risk of flooding from both nearby watercourses and the coast, and torrential rain has also been included in the latest review (135).
- Guidance is available from the Swedish National Board of Housing, Building and Planning to support county administrative boards in their supervision of municipalities' detailed development plans regarding the risk of flooding (136, 137).
- The focus of coastal municipalities on adapting to future sea level rises has increased significantly over the past decade. Adaptation to higher sea levels has been highlighted clearly in municipal planning (138). In 2024, for instance, the municipality of Vellinge will begin extensive work to protect Falsterbonäset, the south-western part of the peninsula, from rising sea levels and storm surges (139).

Water-borne infections

Good confidence in the assessment.

Higher temperatures in the lakes and seas where people swim affect the occurrence of water-borne infectious diseases. This section focuses on pathogens spread via bathing water, but also on Legionella, which can grow in various water pipes and installations. Impact on drinking water is addressed in a separate section.

Impact on health

Pathogens that cause gastrointestinal infections, such as E. coli, norovirus and Cryptosporidium, can spread between people in bathing water. Private wastewater systems and overflow discharges can affect bathing water quality, but pathogens can also be introduced via runoff from agricultural land, for example, and from bathers themselves. More cases of gastrointestinal infections are expected with warmer surface waters as the occurrence of certain pathogens increases; but also due to changes in behaviour as people swim more, and for longer periods.

Higher water temperatures in summer increase the growth of naturally occurring Vibrio bacteria. These bacteria thrive in nutrient-rich warm waters, and the risk of infection increases when surface water temperatures exceed 20 degrees. The bacteria are usually transmitted to humans when swimming outdoors. This may lead to an infection of the ear canal and middle ear, or to an intestinal infection if water is swallowed or if fish or shellfish containing the bacteria are eaten. The bacteria can also cause blood poisoning if it enters the bloodstream via open wounds (140). Severe illness may be fatal if the correct diagnosis is not made and treatment is not started in time (141). Warming of seawater is linked to the

occurrence of more Vibrio infections in Sweden, often in connection with heatwaves (142–144). More cases of Vibrio infections were observed during the hot summers of 2014 and 2018, for example (145).

Cercarial dermatitis, also known as swimmer's itch, is harmless but can be very distressing due to the itching caused by cercariae, a larval stage of a parasitic flatworm. The larvae normally infect sea birds, with aquatic snails as intermediate hosts, but they can accidentally penetrate the skin of humans bathing in freshwater or brackish water. The larvae die off by themselves within a few days, but they cause an itchy rash and sometimes a mild fever. The number of cercariae increases with higher water temperatures (146).

Higher water temperatures in nutrient-rich waters also increase the risk of harmful algal blooms caused by cyanobacteria (146, 147). Cyanobacteria produce various toxins that can affect the liver, cause gastrointestinal symptoms or affect nerve impulses to the respiratory system. It is rare for adults to be poisoned. There is a risk of young children accidentally swallowing water and becoming ill. Skin irritation may occur after swimming in waters with heavy algal blooms, or among fishermen and other occupational groups exposed to lake water and seawater. The mechanisms behind harmful algal blooms are not fully understood, but climate change is believed to be one of the explanations on account of both higher water temperatures and greater runoff from agricultural land after torrential rain.

Legionella is a bacterium occurring naturally in soil and water bodies that grows at favourable temperatures around 20–45 degrees. Legionella mainly causes problems when it grows in various water pipe systems and installations (148). Infection occurs when the bacteria are inhaled through aerosols generated during showering, for example. Infection with Legionella bacteria may cause severe pneumonia (Legionnaires' disease) or a milder fever (Pontiac fever). Eight cases of Legionella were reported in northern Stockholm in August 2017, resulting in four deaths, as a result of infection from a cooling tower. There are usually between 100 and 200 cases of Legionella infections in Sweden each year (149).

Risk groups

People who engage in activities or outdoor sports that involve contact with open water in summer are more likely to be exposed to water-borne pathogens. This also applies to consumers of shellfish and professional or recreational fishermen. Risk groups mainly include older people, immunocompromised individuals and people with underlying conditions such as diabetes and kidney disease.

Likelihood

The risk of water-borne infections is expected to increase due to a combination of warmer water temperatures, more torrential rain and flooding, and more people living in coastal areas. These factors create the conditions for increased exposure to pathogens (150).

In a warmer climate, the temperatures of water systems are affected, thereby increasing the risk of Legionella growth.

Sea temperatures in the Baltic and North Seas are expected to continue rising in the future (151, 152), thereby promoting the growth of Vibrio bacteria.

Vulnerability and coping capacity

The risk assessment identified the fact that society has high vulnerability and, at the same time, high capacity to manage the health impacts of water-borne infections (see the section titled Methodology).

Societal vulnerability to water-borne infections

- Increased risk of heavy precipitation also increases the risk of overflow discharges of wastewater, which poses a significant risk to drinking water sources (131).
- Adaptation measures are challenging, as they primarily concern naturally occurring organisms that proliferate in warmer waters
- Toxins from cyanobacteria may be present in the water even when there is no visible algal bloom.
- Knowledge and awareness of Vibrio infections and algal blooms are not widespread, as cases have been rare in the past. This increases the risk that health and medical care services may overlook cases, and that the general public remains unaware of potential risks or how to prevent water-borne infections (150).

Societal capacity in the event of water-borne infections

- The information on how to avoid Vibrio infections is relatively clear and easy to communicate.
- The Swedish Agency for Marine and Water Management has regulations (HVMFS 2012:14) and general recommendations for municipalities regarding bathing water.
- Local experience with algal blooms in some municipalities is a valuable resource for spreading knowledge and providing information.
- The Bathing Water Directive (2006/7/EC) requires municipalities to monitor the microbiological quality of water and describe the bathing water profile for major bathing sites. Information is published on badplatsen.se to inform the general public about water quality, and possibly advise against bathing.
- Legionella infections, Vibrio infections and other notifiable diseases are monitored.
- The Drinking Water Directive includes Legionella.
- The Swedish National Board of Housing, Building and Planning has general recommendations (section 6:626 of BFS 2011:6) stating that the developer must carry out a risk assessment for Legionella, particularly in nursing homes, hotels, swimming pools, hospitals and multi-dwelling buildings, as well as in water installations that spread aerosols.
- The Public Health Agency of Sweden has produced an evidence review on Legionella in the environment which focuses on both preventive measures and how environmental investigations are conducted in order to identify and manage infection risks (153).
- The Government has decided to introduce a notification requirement for cooling towers to prevent the risk of Legionella spread, which means that operators will be required to notify cooling towers to the municipal environmental and health protection supervisory authority (154).

Landslides

Sufficient confidence in the assessment.

Landslides are rapid mass movements in the soil or bedrock. In a changing climate, changes in precipitation and groundwater levels as well as erosion can make the ground less stable (155). Many communities, individual properties, roads and railways are sited on clay soil, which is particularly vulnerable to the risk of landslides and slope failures (156). Human activities can also lead to the collapse of slopes in infrastructure and built-up areas (157).

Impact on health

An increasing trend of fatal landslides has been observed in Europe, particularly in recent years. These are mainly caused by extreme natural events such as storms, heavy rain and flooding (158). Landslides can cause problems ranging from personal injury to disruption of electricity and water supplies. A major mudslide occurred in Norway in December 2020, causing ten deaths and affecting more than 1,000 people. The cause of the landslide is believed to be linked to the fact that the residential area was built on a high-risk site (159), with rain during a wet autumn further contributing, but human activity may also have played a part in the landslide (160).

Over time, Västra Götaland has been affected by a number of landslides that have had a serious impact on key societal functions and infrastructure. It may also lead to consequences in terms of reduced accessibility for emergency services and medical transport that is necessary for people to maintain good health (161). One example of this is the major landslide at the Stenungsundsmotet motorway interchange in September 2023, which destroyed the E6 motorway in both

directions and could cost billions of Swedish kronor to rebuild (162). Another area at risk of landslides, and which becomes more vulnerable in the event of torrential rain, is Åre, where a major mudflow occurred in 2023. This had a major impact on the community, resulting in water damage to buildings and closure of roads (163). The valley along the Göta älv river has historically been particularly prone to landslides (164) and is considered to have the most serious risk profile, with complex challenges regarding both coastal and river flooding and conditions for landslides (165).

There is also a potential risk of exposure to chemicals or pathogens if industrial land and old landfills are exposed by landslides. Mental health problems are also common in the wake of major natural disasters.

Risk groups

People living in areas with unstable ground or working in areas previously affected by landslides are at higher risk. Communities located near the coast, particularly areas with terrain that is readily eroded by waves, flowing water or wind, may be vulnerable to erosion and landslides. People working in the emergency services and people living downstream of high-risk areas, where drinking water quality may be affected, are also potentially at risk. Everyone is vulnerable in the case of natural disasters, but young children, older people, people with disabilities and people with chronic illnesses who have limited mobility are particularly at risk (166).

Likelihood

Approximately one-quarter of the area of Sweden, consisting mainly of clay and silt soils, is deemed to be prone to landslides (156).

At present, landslide risks are increasing due to population growth and expansion into areas prone to landslides. Moreover, an increase in landslides linked to more intense precipitation is expected as a result of climate change (157). In a high emissions scenario, the number of landslides and slope failures per year in Sweden is expected to increase sixfold from current levels by 2100 (155). Total damage costs at national level are expected to increase tenfold, from around SEK 50 million per year at present to about SEK 500 million per year by 2100 as a result of a changing climate (157).

Future increases in risks of landslides are expected to be concentrated in areas where the risk is already high at present. This applies to the Vänern landscapes, the Göta älv river valley, eastern Svealand and almost the entire coast of Norrland. Local conditions determine where the risks will be greatest. The risk of mudflows is also increasing, particularly in mountainous areas and in hilly terrain with moraine soils (167). As precipitation can pose a risk to ground stability, the summer months and early autumn are also periods with a higher risk of landslides.

Vulnerability and coping capacity

The risk assessment identified the fact that society is partly vulnerable and has high capacity to manage the health effects of landslides. See the section titled Methodology.

Societal vulnerability to landslides

- Both landslides and slope failures can occur more or less without warning. There is currently no known way to measure or record ground signals that can predict landslides and slope failures in the Swedish geological environment with any degree of foresight (167).
- Landslides occur each year in Sweden, but they often go unnoticed as injuries are rare (168). There is inadequate documentation on the number of landslides and possible injuries, and the extent of the risks to Swedish society and health has not been studied in detail.

Societal capacity in the event of landslides

- Eight government agencies have jointly produced a guide to various map data on landslides, slope failures and erosion. The data are displayed in a web-based map viewing service and are described in the guidance and accompanying product sheets (169, 170).
- SGI is compiling information on landslides, slope failures, and erosion in a database (171). At the same time, SMHI is keeping statistics on warnings issued when weather developments are expected to pose risks to the general public or disrupt public services.
- SGI and MSB have identified proposals for measures to increase coping capacity, which includes the development of legal instruments, economic instruments and knowledge bases in order to create guidance. Additionally, competence-enhancing initiatives are proposed to improve the ability to assess climate-related risks and implement sustainable measures (165).

Food-borne infections

Sufficient confidence in the assessment.

Food-borne infections are usually categorised into two different groups: infection and poisoning. Infection occurs when food contains microorganisms that manage to pass through the stomach and attach themselves to the intestinal wall. Some pathogenic microorganisms may also penetrate and damage the lining of the gut, or spread throughout the body. Poisoning occurs when food is contaminated, primarily by bacteria that produce toxins in the food as they grow. Higher temperatures can increase bacterial growth. High humidity also increases the growth of mould fungi.

Impact on health

A number of studies have shown a link between higher air temperatures and more Salmonella infections (172).

Climate change may increase the risk of food-borne infections through increased risk of contaminated irrigation water, for both food produced in Sweden and imported food. Surface water is often used for irrigation, and fruit and vegetables may be contaminated if pathogens are present in the water. Outbreaks of food-borne infections caused by E. coli, Salmonella and Listeria, for example, have been reported in many countries in connection with the use of contaminated water for irrigation and washing of fruit and vegetables (173).

Extreme weather events such as torrential rain, flooding and droughts can increase the risk of crop contamination, as various harmful substances can be spread or carried during such events.

Risk groups

In general, everyone who consumes food is potentially exposed to the risk of food-borne contamination. The particularly vulnerable groups are mainly made up of immunocompromised people, children, older people and pregnant women.

Likelihood

In general, both gastrointestinal infections and food poisoning cases caused by toxins are expected to increase in connection with climate change. Contamination via irrigation water may increase due to increased precipitation and increased soil runoff, as pathogens from both domestic and wild animals may enter watercourses and subsequently be used for irrigation (174). Wastewater may also pollute surface water during torrential rainfall and potentially lead to crop contamination.

In summer, the risk of gastric flu increases due to pathogens in food. Although not all causes are established, a larger proportion of gastrointestinal infections occur during the summer months (175). Besides the fact that several pathogens thrive in warmer conditions, illness could result from improper food handling in hot weather. For instance, more people are having picnics and barbecues, and in such cases food handling – both refrigeration and hygiene – may be poorer. The longer and warmer summers that are expected may therefore result in more cases of illness than at present.

One study indicates a potential link between more Campylobacter infections in the Nordic countries and climate change (176). The study estimates that the number of Campylobacter cases could double by 2080.

Vulnerability and coping capacity

The risk assessment identified the fact that society is partly vulnerable and has high capacity to manage the health effects of food-borne infections (see the section titled Methodology).

Societal vulnerability to food-borne infections

- Higher incidence of food-borne infections during the summer months.
- Awareness of how food should be handled and stored is generally high, but advice and recommendations are not always followed.
- There is a great deal of dependency on multiple and lengthy cold chains within the food supply system, and a broken cold chain may lead to bacterial growth.

Societal capacity in the event of food-borne infections

- Information on food-related risks is available from the relevant government agencies, and is distributed through relevant channels in the run-up to summer.
- The municipalities and the Swedish National Food Agency are responsible for preventive work in the form of supervision and control of food-borne infections, while the healthcare services treat people who fall ill. The Public Health Agency of Sweden often coordinates investigations in cases of illness involving multiple regions in Sweden.
- As an EU Member State, Sweden has access to RASFF, the EU's Rapid Alert System for Food and Feed, as well as the EWRS and EpiPulse alert systems for outbreaks of communicable diseases or other health threats in European Member States.
- The inter-agency Zoonosis Collaboration Group (ZSG) is convened in the event of a zoonosis outbreak where there is a need for specific action, coordinated information, a common situational analysis or consultation between government agencies that form part of the group. The ZSG is made up of managers, experts and PR officers from the Swedish Work Environment Authority, the Public Health Agency of Sweden, the Swedish Board of Agriculture, the Swedish National Food Agency and the Swedish Veterinary Agency.
- The inter-agency working group for Campylobacter was relaunched in 2023. This group was initially set up after the 2016–2017 outbreaks to discuss aspects such as signals of an increase in cases and improved communication between government agencies.
- A comprehensive investigation of Salmonella infection in Swedish egg production was carried out in 2023, which strengthened Sweden's capacity to manage food-borne infections through international collaboration and dialogue with the European Food Safety Authority (EFSA) and the European Commission.

Drought

Uncertainty in the assessment.

Drought is when there is a shortage of water in nature, and for human activities. Drought may involve low precipitation, low soil moisture, low water flows, low water levels in lakes and low groundwater levels (177). The hydrological cycle is affected as a result of rising temperatures, which alters precipitation patterns and thereby creates a risk of drought.

Impact on health

Drought can lead to poorer drinking water quality with more gastrointestinal infections due to increased concentrations of contaminants in reservoirs, reduced water availability and use of alternative drinking water sources. Infections may also increase due to limited access to water for hygiene purposes, although this is rare in Sweden. As drought often occurs in conjunction with heatwaves, there is an increased risk of dehydration in humans when water is scarce, which can be a serious health condition.

Surrounding watercourses are at risk of acidification if the water table drops in areas with acid sulphate soils. The drying of acid sulphate soils leads to the leaching of metals, which can contaminate watercourses, wells and crops and lead to increased human exposure (178).

Drought affects conditions for drinking water supply due to water shortages and saltwater intrusion, which renders drinking water unfit for consumption. This may pose a potential threat to essential societal functions in areas such as health and medical care, care and social care and emergency services, but it may also pose a

threat to certain industrial production (179). Moreover, drought can also lead to increased stress and mental health problems.

Drought increases the risk of forest fires. Dry conditions may also lead to a decline in air quality due to the release of more particulate matter and dust, which can cause more respiratory symptoms.

Risk groups

Agricultural and forestry workers and people living in areas where there is a risk of limited access to drinking water are groups at risk of drought.

Likelihood

The incidence of drought is generally expected to decrease (180, 181), as is its frequency, severity and duration (181, 182). This is due to generally wetter conditions, with an increase in annual precipitation of around 10 to 20 per cent expected in Sweden.

Southern Sweden will be at greater risk of drought than northern Sweden. According to calculations by the Geological Survey of Sweden (SGU), groundwater levels are rising in most of Sweden, except in the south-eastern parts of the country, where levels are expected to fall. This may lead to water shortages, mainly in agricultural areas, especially on Öland, Gotland, Västgötaslätten and coastal areas in Skåne (183–185).

At the same time, seasonal differences in groundwater levels have increased in northern Sweden (186), which is expected to lead to an increased risk of drought there in spring.

Vulnerability and coping capacity

The risk assessment identified the fact that society has very low vulnerability and partial capacity to manage the health impacts of drought (see the section titled Methodology).

Societal vulnerability to drought

- Water shortages may become a significant societal issue in the future, affecting many societal functions, and may impact the availability of water for households, industries and agriculture, and also for firefighting.
- In the southern parts of the country, there are small water sources that can be rapidly impacted by drought. Around 1.2 million citizens currently have no access to municipal water; and in summer, this figure rises to 2.5 million.
- Drought affects agricultural production and leads to losses for farmers, as well as increasing the risk of food shortages. It can also impact food prices and availability. Extreme drought, such as in 2018 when harvests fell by 50–70 per cent, has long-term consequences (185).
- The dry summer of 2018 had a major impact on Swedish forests, with managed secondary forests being affected the most (187). Such extreme drought may continue to affect forest regeneration for a number of years (188).

Societal capacity in the event of drought

- To assist county administrative boards and municipalities, SMHI has been working in collaboration with SGU to expand the regular warning system to include the *Risk för vattenbrist* (risk of water shortage) service (189), which was launched in 2017.
- The Swedish National Food Agency has formed a national water emergency group, VAKA, to assist municipalities in the event of acute water shortages (190). VAKA is made up of representatives from drinking water producers, environmental agencies, emergency services and analytical experts.
- There is a national coordination group for drinking water led by the Swedish National Food Agency, which is able to coordinate information exchange between relevant government agencies and organisations in the event of water shortages (191).
- In 2022 and 2023, fewer irrigation bans were reported in Sweden's municipalities compared to the previous period from 2019 to 2021, which improves future coping capacity through continued investment in efficient delivery measures and sustainable water use (192).
- The Southern Baltic Sea River Basin District has a specific sub-programme of measures against drought and water shortages where identified actions are described that should be implemented on a local, regional and national level to prevent or reduce the risk of water shortages (193).

Impact on drinking water

Sufficient confidence in the assessment.

Changing precipitation patterns, increased frequency of extreme weather events and rising sea levels affect drinking water quality through aspects such as saltwater intrusion, wastewater overflow discharges and the release of contaminants from the soil, including pathogens. Higher water temperatures can promote the growth of microorganisms and algae (cyanobacteria) in water bodies and affect the treatment process and drinking water production.

Water shortages during periods of drought can impair groundwater quality and lead to the use of lower-quality water sources. Moreover, flooding and ground movements such as landslides and slope failures can disrupt water supply networks and affect water supplies. Changing frost patterns can damage infrastructure such as water and sewer systems, which may impact water quality and health in the long run.

Impact on health

Common gastrointestinal infections via water are caused by norovirus, Campylobacter, EHEC, Shigella and Salmonella (194). Parasites such as Giardia and Cryptosporidium can also be spread via drinking water. Cryptosporidium is highly resistant to chlorine and caused the two largest drinking water-borne outbreaks in Sweden in 2010 and 2011. Around 27,000 people in Östersund are estimated to have been infected with the parasite, and around 20,000 in Skellefteå. Residents were then required to boil their tap water for three and six months, respectively. Other substances that may be present in drinking water and affect health include naturally occurring substances and anthropogenic chemicals,

including pesticides and insecticides, some of which have endocrine-disrupting, neurotoxic and carcinogenic properties. Saltwater intrusion can also render drinking water unfit for consumption (195).

Few water-borne outbreaks have been reported in recent years, which may be partly due to increased precautionary measures such as the imposition of boil water advisories in the event of anomalies or suspected contamination. Moreover, treatment has been improved by introducing more disinfection steps at waterworks, such as UV light that kills parasites. PFAS contamination has led to the introduction of additional treatment steps in areas where water sources have been contaminated, which may also reduce the presence of other contaminants. Despite flooding in several parts of the country in the summer of 2023, no increase was observed in reports of cases of infectious diseases linked to drinking water. However, reports of cases of gastroenteritis and norovirus were reported in Dalarna, probably caused by flooded private wells (196).

Risk groups

Vulnerable groups include older people, immunocompromised people and children. For anyone with a weakened immune system, the symptoms of infection may be both severe and prolonged. Children, particularly infants, are more sensitive to high levels of several chemicals in drinking water.

Likelihood

Heat and extreme torrential rainfall are factors that increase the risk of water-borne disease (197). Norovirus, which causes winter vomiting disease, has caused outbreaks via both private wells and municipal drinking water supplies and, overall, is the pathogen responsible for the most water-borne outbreaks in Sweden over the last two decades (194).

The average occurrence and concentration of Cryptosporidium and Giardia in surface water samples is higher during or immediately after extreme weather events (198). The presence of Cryptosporidium has been linked to specific weather phenomena such as torrential rain (199, 200). The parasite is expected to cause increasing problems, with more cases of disease in the future (201, 202).

The expected increase in precipitation and extreme weather events due to climate change will result in further deterioration of water quality: this has been recognised as a challenge for drinking water producers (203).

Vulnerability and coping capacity

The risk assessment identified the fact that society has high vulnerability but, at the same time, high capacity to manage the health impacts of impact on drinking water (see the section titled Methodology).

Societal vulnerability to impact on drinking water

- Increased risk of heavy precipitation and high water levels can affect drinking water quality through overflow discharges and the transport of undesirable substances from the soil to water sources with the water (131).
- Individual municipalities may find it challenging to manage heavy precipitation, and it may be so extreme that the infrastructure is unable to maintain the production and quality of drinking water. Sewer systems, for example, may be overloaded during torrential rain and affect raw water.
- Around 10 per cent of households use a private water supply (204); and of these, just over half are permanent residences (205). Private wells generally have significantly less protection than municipal water, which means that water quality is more vulnerable to extreme situations such as drought and flooding (206).

Societal capacity in the event of impact on drinking water

- Sweden has a generally high level of resources, technical capabilities and knowledge when it comes to maintaining and monitoring drinking water quality.
- Awareness of the impact of droughts on groundwater availability and the potential for localised water shortages has increased at all levels of society. Society's understanding of the need for climate change adaptation planning is also increasing steadily (206).
- The new Drinking Water Directive, which has been partially implemented in Sweden through the Swedish National Food Agency's regulations (207), may raise awareness of the importance of access to and quality of drinking water.
- The Swedish National Food Agency's *Handbok för klimatanpassad försörjning av dricksvatten* (Handbook for climate-adapted drinking water supply) (208) and the related conferences held by the agency with most county administrative boards in Sweden, pave the way for municipalities to adapt to the changes that need to be made.
- Small municipalities sometimes face challenges due to limited resources, and both political and financial support is often needed to meet these challenges. The earlier inquiry *En tryggad dricksvattenförsörjning* (A secured drinking water supply) (SOU 2016:32) emphasised the importance of municipalities working together to effectively manage upcoming challenges in respect of drinking water.
- The national coordination group for drinking water brings together a number of key government agencies (191). Climate impact and climate change adaptation have been a priority for the working group for drinking water quality.
- Recommendations and tools from the Swedish National Food Agency relating to algal blooms are available to municipal drinking water producers (209).
- In the event of crises that affect drinking water, assistance for municipalities is available from the national water emergency group, VAKA, which is coordinated by the Swedish National Food Agency (190). VAKA is made up of representatives from drinking water producers, environmental agencies, emergency services and analytical experts.
- To manage chemical risks in drinking water, SamTox serves as a forum for identifying and addressing new potential chemical threats (210).
- The Swedish National Food Agency provides guidance and recommendations for people who have their own wells or other small drinking water facilities. In the case of major events in the surrounding environment, such as flooding or forest fires, the Swedish National Food Agency also provides information about the need for additional water samples and recommends being prepared to deal with water shortages, especially during droughts or power cuts (211).

Warmer winters

Uncertainty in the assessment.

In recent decades, winters in Sweden have become more than 2 degrees warmer (212). Shorter, warmer winters may have a significant impact on the landscape, ecosystem and infrastructure, which are primarily adapted to a colder climate. These changes are expected to affect health in the northern parts of Sweden in particular.

Impact on health

A shorter period of snow during the winter months can represent such a change to people's local environment that it adversely affects mental health (213, 214). In particular, climate change is affecting winters in northern Sweden, and disruption of traditional ways of life and connection to the environment may contribute to stress and mental health problems, particularly among the Sámi population and people whose livelihoods are reliant on a cold winter climate (215–217). In an interview study among Swedish reindeer herding Sámi, climate change was described as a potential ultimate threat to the survival of their livelihood and culture. They shared their concern for the future, expressing their fear of being the last generation able to continue herding reindeer (218).

With warmer winters and thinner ice on lakes and watercourses, the risk of drowning may increase among both recreational and professional users (219, 220). Changes in road conditions may impact road accidents. More zero-degree crossings in winter increase the risk of slipping. Reduced ground frost in combination with increased precipitation may also make trees less stable during winter storms, thereby increasing the risk of fallen trees and disruption to societal functions (221).

Warmer winters also have a significant impact on the permafrost and glaciers of the Arctic environment. In Sweden, permafrost still occurs in marshlands in northern Lapland. Thawing permafrost can lead to deterioration in the quality and quantity of drinking water and increases the risk of water-borne diseases (222). Another health effect linked to the thawing of permafrost is its impact on infrastructure, which may pose safety risks (223).

In the latest National Environmental Health Survey in 2023, 30 per cent of the population said they are always or often concerned about climate change. Women with a university education are the most concerned (46 per cent), while men with a basic education are the least concerned (17 per cent)

Risk groups

The most vulnerable are the Sámi population and the rest of the population in northern Sweden.

Likelihood

The number of zero-degree crossings in winter is expected to increase in central and northern Sweden (224). Since 1990, Sweden as a whole has seen a decrease in the number of days with snow cover, and this trend is expected to continue (225). Although the total amount of snow is declining, extreme weather events with heavy snowfall and significant snow depth are expected to become more frequent in the future.

Permafrost has decreased by 60 per cent in Sweden, Norway and Finland in recent decades (226), which may have a significant impact on ecosystems and potentially lead to changes in disease patterns.

Vulnerability and coping capacity

The risk assessment identified the fact that society is partly vulnerable and has partial capacity to manage the health impacts of warmer winters (see the section titled Methodology).

Societal vulnerability to warmer winters

- In particular, warmer winters will affect the health and living conditions of people whose livelihoods are dependent on cold winters, such as reindeer herding and mountain tourism.
- At present, not enough is known about the complex interactions between the warming Arctic environment and potential risks in other parts of Sweden.
- Funding for environmental monitoring is expected to decrease significantly in 2024–2026 (227), which will affect opportunities for systematic and long-term monitoring of any changes in ecological conditions in the Arctic.

Societal capacity in the event of warmer winters

- The Sámi Parliament has developed an action plan for climate change adaptation on the basis of the goal of working to preserve biodiversity and reduce vulnerability by increasing flexibility in Sámi use of land and water (228).

Rodent-borne diseases

Sufficient confidence in the assessment.

A changing climate may create conditions for larger rodent populations, and so there is a risk of increased transmission of disease between rodents and humans, primarily due to altered contact pathways.

Impact on health

Puumala hantavirus infection (Nephropathia epidemica) is a viral disease spread by the bank vole. It is most commonly spread by inhalation of dust contaminated with vole urine and faeces, or by direct contact with vole saliva, urine or faeces.

Tularaemia is caused by a bacterium found in various rodent species and can be transmitted to humans via mosquito bites. Patients with tularaemia become acutely ill, with high fever, headache and nausea (229). In the last decade, a few hundred cases of tularaemia have been reported each year in Sweden. Three major outbreaks of tularaemia occurred in Sweden in 2015, 2019 and 2023 (230).

Leptospirosis is caused by bacteria that are common in many mammalian species. The infection is usually either asymptomatic or causes flu-like symptoms, but the bacteria can also cause sepsis and complications such as liver and kidney damage, encephalitis or meningitis. The infection is mainly spread via the urine of infected animals, typically through direct contact or via water or moist soil contaminated with urine. The bacteria can enter through small wounds or scratches on the skin, but also through mucous membranes in the mouth and eyes, for instance.

Risk groups

Groups at increased risk of exposure are primarily people working with wastewater treatment, waste management, agriculture, forestry, and outdoor recreation.

Likelihood

There is no clear information on how rodent populations will be affected by climate change, as this is dependent on a number of interacting factors.

Most cases of Puumala hantavirus infection have been reported in the north of Sweden, but it also occurs in the south of the country (231). To date, Puumala hantavirus has mainly been transmitted during cleaning of holiday homes. Most cases are reported in winter and spring, and the risk increases when there are more rainy winter days. This is because the rain forms ice on the ground that blocks vole access to the space under the snow cover, where it usually seeks shelter in winter. Rodents are therefore more likely to seek shelter indoors, which can increase the risk of human infection (232).

Most cases of tularaemia have occurred during the summer and are associated with higher temperatures and longer outbreak periods (233). Regions with a high number of current tularaemia cases are expected to be affected differently by a changing climate. Cases are expected to increase in Jämtland, Dalarna, Norrbotten, Värmland and northern Gävleborg, while cases are expected to decrease in Örebro and southern Gävleborg (234).

Domestic Leptospira infection is very rare in Sweden. The risk of Leptospira infection is mainly associated with flooding, activities near watercourses and contact with animals. More flooding may contribute to an increased risk of infection.

Vulnerability and coping capacity

The risk assessment identified the fact that society has high vulnerability and partial capacity to manage the health impacts of rodent-borne diseases (see the section titled Methodology).

Societal vulnerability to rodent-borne diseases

- There are areas with large rodent populations in Sweden, and there is also a growing rodent population, mainly rats, in urban areas.
- Awareness of the prevalence of these diseases tends to decline if no cases have been seen in healthcare settings for a long time.
- Awareness of rodent-borne diseases is limited, including knowledge of appropriate preventive measures such as cleaning basements following a flood.
- There is no vaccination available for tularaemia.
- Investigations of tularaemia often rely on spontaneously reported cases or events, and so some cases may go unnoticed or unreported, making it difficult to get a complete profile of the spread of the disease.

Societal capacity in the event of rodent-borne diseases

- Awareness of rodent-borne diseases among healthcare workers is high in areas in which they are endemic.
- Clinical management is good once cases have been diagnosed.

Mosquito-borne diseases

Sufficient confidence in the assessment.

There are around fifty mosquito species in Sweden, and they occur all over the country. Changes in temperature, precipitation patterns such as torrential rain and drought, and human activities can affect the existing mosquito population and facilitate the emergence of new, potentially disease-transmitting mosquito species. Increased precipitation, torrential rain and flooding also increase the risk of post-flood mosquitoes.

Impact on health

Mosquito-borne diseases are caused by bacteria, viruses or parasites transmitted by biting mosquitoes, which act as vectors and can spread disease between humans, or from animals to humans. In Sweden, mosquito-borne diseases are rare, but disease-carrying mosquitoes do exist and both vectors and pathogens may be introduced and increase as the climate changes.

One of the diseases associated with biting mosquitoes is tularaemia. This is caused by a bacterium found in various rodents that can be transmitted from them to humans via mosquito bites and other means. Patients with tularaemia become acutely ill, with high fever, headache and nausea (229). In the last decade, a few hundred cases of tularaemia have been reported each year in Sweden. Three major outbreaks of tularaemia occurred in Sweden in 2015, 2019 and 2023 (230), and a large proportion of cases were believed to have been transmitted by mosquitoes.

Another mosquito-borne disease that occurs in some parts of Sweden is Pogosta disease. This is caused by a virus usually found in birds. Many infected individuals are asymptomatic, while others may experience joint pain and fever.

Post-flood mosquitoes are a group of biting mosquitoes that lay their eggs in areas that are regularly affected by flooding (235). When the water level rises during the warm part of the year, the eggs hatch and result in large numbers of biting mosquitoes, which can cause severe discomfort, psychological distress, and numerous bites with a risk of secondary infections (236).

Risk groups

Risk groups primarily include people who spend a lot of time outdoors in areas populated by many mosquitoes, such as farmers, foresters, hunters, and people indulging in outdoor pursuits. People who live or work near watercourses or water sources may also be more vulnerable to mosquito-borne diseases. Children are normally more vulnerable to mosquito bites than adults. Immunocompromised people are particularly susceptible to infections. People who are sensitive or allergic to mosquito bites are at risk during post-flood mosquito outbreaks.

Likelihood

Most cases of tularaemia have occurred during the summer and are associated with higher temperatures and longer outbreak periods (233). Regions with a high number of current tularaemia cases are expected to be affected differently by a changing climate. Cases are expected to increase in Jämtland, Dalarna, Norrbotten, Värmland and northern Gävleborg, while cases are expected to decrease in Örebro and southern Gävleborg (234).

The likelihood of post-flood mosquito outbreaks is high, as flood events are expected to increase (see the risk of flooding). Post-flood mosquito outbreaks already occur almost every year. At present, control measures are limited to the lower Dalälven river area and the Klarälven river in the municipality of Forshaga. However, these mosquitoes are widespread throughout the country, as demonstrated by the major mosquito outbreak in August–September 2023, when large parts of Sweden were affected by post-flood mosquitoes (237).

Another mosquito-borne disease that has spread northwards in the last decade is West Nile fever, which is caused by the West Nile virus (WNV) (238). WNV is currently endemic in Germany (239). Although no confirmed cases of WNV have been reported in Sweden as yet, it is likely that the virus may be introduced into the country via infected migratory birds, which could increase the risk of cases in humans. Usutu virus, which in many ways is similar to WNV but much rarer, has also spread northwards in Europe (240).

There are other mosquito-borne diseases that are unlikely to occur in the next few years, but the health risk is expected to increase as the climate becomes more favourable for both pathogens and vectors. Examples of such diseases include dengue fever, Zika fever, chikungunya and leishmaniasis. The first three are spread

in Europe by the Asian tiger mosquito, which thrives in densely populated areas (241). It is already established in Europe and is continuing to spread (242, 243).

Vulnerability and coping capacity

The risk assessment identified the fact that society has high vulnerability but, at the same time, high capacity to manage the health impacts of mosquito-borne diseases (see the section titled Methodology).

Societal vulnerability to mosquito-borne diseases

- Full-cover clothing, mosquito repellent, and mosquito nets are required to protect against mosquito bites. In practice, it is generally difficult to ensure complete protection against mosquitoes.
- Public awareness of mosquito-borne diseases in Sweden is low.
- Immunity is low for most mosquito-borne diseases.
- Knowledge of mosquito-borne diseases within the healthcare sector is low, mainly because Sweden has not experienced any widespread occurrence of mosquito-borne diseases.
- No vaccine is available for tularaemia.
- Investigations of tularaemia often rely on spontaneously reported cases or events, and so some cases may go unnoticed or unreported, making it difficult to get a complete profile of the spread of the disease.
- As Pogosta disease is not a notifiable disease, it is difficult to observe patterns or track the spread of the disease.
- Mosquito surveillance is relatively limited, and there is no systematic monitoring.
- Culex modestus, the mosquito that can spread WNV if it is carrying the virus, is present in Sweden and appears to be spreading geographically (244).

Societal capacity in the event of mosquito-borne diseases

- Testing and care for suspected imported cases of mosquito-borne diseases are good.
- Mosquito control is currently carried out in the lower Dalälven river area, where licences to control mosquito larvae have been issued in order to reduce the number of biting mosquitoes. However, this is based not on the potential spread of disease, but on more general nuisance for residents in areas with many biting mosquitoes (245).
- Several mosquito-borne diseases (including WNV) are notifiable, and monitoring of diagnosed cases is good.
- SVA monitors diseases in wild animals in Sweden, and has monitored the occurrence of WNV and Usutu virus as part of short-term research projects (240).
- SVA has conducted projects to create tools that can provide cost-effective mosquito monitoring and has run a number of mosquito initiatives where members of the general public have been asked to help catch and send in mosquitoes (246).
- SVA is also conducting projects that aim to investigate the establishment of invasive mosquito species in Sweden, which provides an opportunity to increase preparedness for potential new pathogens (247).

Discussion

Climate change is already affecting health

Protecting and promoting the health of current and future generations is one of the strongest arguments in favour of action to prevent climate change and promote climate change adaptation and sustainable development (248). Sweden's population is already being affected by the health effects of climate change, with heatwaves becoming more frequent, pollen allergies increasing, and TBE occurring in a growing geographical area. Stronger measures are needed in the healthcare sector – but also in other sectors that affect health, such as water, food, agriculture, energy and transport – to both prevent and manage negative health outcomes of climate change.

All health risks need to be considered in the long term

This risk and vulnerability analysis describes 14 risks, all of which involve potential impact on health in Sweden linked to a changing climate up to 2050. The analysis provides a current snapshot that needs to be updated as new knowledge is developed, climate change adaptation measures are implemented and our climate changes. This is particularly applicable to the impact of climate change on the health of vulnerable groups in the population.

The assessment of risk level and the likelihood of impact on health in the near future supports the prioritisation of relevant climate change adaptation measures, but all 14 health risks must be taken into account in long-term climate change adaptation in order to prevent ill health and address increasing health inequality.

Combined effects of climate change need to be addressed

Society must build capacity and resilience so that multiple climate-related risks can be addressed simultaneously. Climate change affects the entire ecosystem and often leads to simultaneous multiple effects. High temperatures, for instance, can increase the risk of drought, forest fires, air pollution, pollen allergies and vector-borne diseases. These combined effects have a greater impact on health than the effect of individual risks. Extreme weather events can also lead to chain reactions triggering other risks, such as when heavy rainfall may cause flooding and then erosion, landslides or slope failures.

The 14 health risks have been assessed individually in the risk and vulnerability analysis. The combined effects have been described and highlighted by means of cross-references between the different sections, but no combined assessment has been made. When developing the assessment tool further, it will be necessary to consider whether combined effects can be included in the actual risk assessment,

and if so how. Nevertheless, this needs to be taken into account in climate change adaptation work.

Global effects require in-depth analysis

The risk and vulnerability analysis is limited to climate change occurring within Sweden's borders, but the country is also affected by the effects of climate change in other countries. Risks related to transboundary mosquito-borne and tick-borne diseases and health risks linked to air pollution and forest fires have been analysed to a degree, but there has been no analysis of indirect effects such as access to food, migration, trade, finance and security policy (249–254). The most prominent risks and vulnerabilities include our dependence on other countries for food and strategic goods such as medications, medical equipment, and chemicals for treatment of drinking water, as well as our own capacity to supply such products in the event of various disruptions (254). Health is also affected by migration patterns, which may present both risks and opportunities for Sweden. Climate change in other countries may increase risks for Swedish companies and institutions, and thus impact economic stability and, in turn, human health (255).

More knowledge is needed about indirect climate effects on health, as well as specific research on how global climate change impacts local conditions and public health. This knowledge needs to be developed by the academic community and through analyses by relevant government agencies in order to fully assess potential risks and opportunities linked to transboundary effects of climate change. Strategies to address indirect climate effects on health should be developed and involve a broad group of societal actors from the public and private sectors (256). Measures to address and adapt to indirect climate effects need to be developed in parallel with climate initiatives aimed at reducing emissions (255).

Use health as a driving force for all climate initiatives

Health and well-being are both a prerequisite for and an investment in sustainable societies. Using health as a driving force involves recognising and raising awareness of how the health of the population is affected, both positively and negatively, by environmental and climate-related actions. The objective is to link such issues more closely with people's day-to-day lives and highlight the importance of prevention and health promotion initiatives.

Health can be used as a driving force both in reducing emissions that have an impact on climate and in adapting to a changing climate. Efforts to reach the goal of net zero emissions by 2045 are impacting the need for climate change adaptation, as reduced emissions lessen environmental impact, and thus health effects as well. Efforts to achieve net zero emissions also bring with them major health benefits by reducing air pollution emissions and increasing opportunities for a more physically active population with healthier eating habits. However, climate change adaptation must take place regardless of future reductions in emissions, as

inertia in the climate system means that emissions already released will affect our climate for decades to come, impacting nature, society and health in Sweden.

Highlight synergies for effective action

The Environmental Objectives Council will be working until 2026 on “Hälsa som drivkraft för miljömålen och hållbar utveckling” (Health as a driving force for the environmental objectives and sustainable development), with the Public Health Agency of Sweden as the lead agency (257). The overall aim of this programme area is to promote knowledge exchange, collaboration and coordination of actions and issues where health can be used as a driving force to accelerate the pace of work on the environmental objectives, an important element in Sweden’s climate initiatives. There are many mutual dependencies and potential synergies between climate action and health, as the causes and impacts of climate change are cross-sectoral. Using health as a driving force for sustainable development can broaden the scope of the work to engage more societal actors, promote collaboration between sectors and ensure that decision-making and actions help to promote a sustainable and healthy future for society as a whole.

References

1. SMHI. Klimatförändringen är tydlig redan idag. SMHI; 2023 [cited 7 June 2024]. Retrieved from: https://www.smhi.se/kunskapsbanken/klimat/klimatet-forandras/klimatforandringarna-marks-redan-idag-1.1510.
2. SMHI. Sveriges klimat har blivit varmare och blötare. SMHI; 2019 [cited 20 May 2020]. Retrieved from: https://www.smhi.se/kunskapsbanken/klimat/sveriges-klimat/sveriges-klimat-har-blivit-varmare-och-blotare-1.21614.
3. SMHI. Nederbörd. 2023 [cited 28 March 2024]. Retrieved from: https://klimatanpassning.se/hur-klimatet-forandras/klimateffekter/nederbord-1.21297.
4. SMHI. Vegetationsperiod. 2023 [cited 28 March 2024]. Retrieved from: https://klimatanpassning.se/hur-klimatet-forandras/klimateffekter/vegetationsperiod-1.21294.
5. SMHI. Snö. 2023 [cited 28 March 2024]. Retrieved from: https://klimatanpassning.se/hur-klimatet-forandras/klimateffekter/sno-1.34651.
6. SMHI. Extremregn i nuvarande och framtida klimat: Analyser av observationer och framtidsscenarier. 2017. Retrieved from: https://www.smhi.se/polopoly_fs/1.134304!/climatology_47_4.pdf.
7. SMHI. Torka. 2024 [cited 28 March 2024]. Retrieved from: https://klimatanpassning.se/hur-klimatet-forandras/klimateffekter/torka-1.21291.
8. SMHI. Värmebölja. 2023 [cited 15 April 2024]. Retrieved from: https://www.smhi.se/kunskapsbanken/meteorologi/temperatur/varmebolja-1.22372.
9. IPCC. Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Geneva, Switzerland; 2023.
10. SMHI. Starkast uppvärmning i norra och östra Sverige. SMHI; 2020 [cited 20 May 2020]. Retrieved from: https://www.smhi.se/nyhetsarkiv/starkast-uppvarmning-i-norra-och-ostra-sverige-1.159340
11. SMHI. Klimatscenarier. Om analysen. SMHI; 2024 [cited 7 June 2024]. Retrieved from: https://www.smhi.se/klimat/framtidens-klimat/klimatscenarier/info/haag.
12. Public Health Agency of Sweden. Hälsokonsekvenser av klimatförändring i Sverige: En risk- och sårbarhetsanalys 2021. 21268. Retrieved from: https://www.folkhalsomyndigheten.se/contentassets/d12dc30a4b6b47549b018b53adf2b11a/halsokonsekvenser-klimatforandring-sverige.pdf.
13. SMHI. Vägledning för användande av klimatscenarier. 2015. https://www.smhi.se/polopoly_fs/1.165111!/Klimatologi_11%20V%C3%A4gledning%20f%C3%B6r%20anv%C3%A4ndande%20av%20klimatscenarier.pdf.
14. SMHI. Klimatinformation som stöd för samhällets klimatanpassningsarbete 2022. Retrieved from: https://www.smhi.se/polopoly_fs/1.180219!/Climatology_64%20Climate%20information%20that%20supports%20the%20f%C3%B6d%20f%C3%B6r%20society's%20climate%20adaptation%20efforts.pdf.
15. WHO. Strategic toolkit for assessing risks: a comprehensive toolkit for all-hazards health emergency risk assessment. Geneva; 2021. Contract No.: CC BY-NC-SA 3.0 IGO. Retrieved from: https://www.who.int/publications/i/item/9789240036086.
16. Government Offices of Sweden. Nationell strategi och regeringens handlingsplan för klimatanpassning. 2024 [cited 16 April 2024]. Retrieved from: https://www.regeringen.se/rattsliga-dokument/skrivelse/2024/03/skr.-20232497.

17. Swedish Parliament. Ordinance on the climate adaptation work of government authorities (2018:1428). 2018 [cited 15 April 2024]. Retrieved from: https://www.riksdagen.se/sv/dokument-och-lagar/dokument/svensk-forfattningssamling/forordning-20181428-om-myndigheters_sfs-2018-1428/.

18. SMHI. Varning för höga temperaturer. 2022 [cited 28 February 2024]. Retrieved from: https://www.smhi.se/kunskapsbanken/meteorologi/varningar-och-meddelanden/varningstyper/varning-for-hoga-temperaturer-1.169218.

19. SMHI. Sommaren 2018 – Extremt varm och solig. 2018 [cited 5 March 2019]. Retrieved from: https://www.smhi.se/klimat/klimatet-da-och-nu/arets-vader/sommaren-2018-extremt-varm-och-solig-1.138134.

20. Åström CB, P.; Forsberg, B. Ovanligt många dödsfall i Sverige sommaren 2018. Läkartidningen. 2019.

21. Public Health Agency of Sweden. Resultat från Hälsorapports augustienkät om värmeböljor. Public Health Agency of Sweden; 2018 [cited 16 April 2024]. Retrieved from: https://halsorapport.se/sv/resultat/resultat-augusti-2018/.

22. Oudin Åström D, Schifano P, Asta F, Lallo A, Michelozzi P, Rocklöv J, et al. The effect of heat waves on mortality in susceptible groups: a cohort study of a mediterranean and a northern European City. Environ Health. 2015;14:30. DOI:10.1186/s12940-015-0012-0.

23. Rocklöv J, Forsberg B, Meister K. Winter mortality modifies the heat-mortality association the following summer. Eur Respir J. 2009;33(2):245-51. DOI:10.1183/09031936.00037808.

24. de' Donato FK, Leone M, Scortichini M, De Sario M, Katsouyanni K, Lanki T, et al. Changes in the Effect of Heat on Mortality in the Last 20 Years in Nine European Cities. Results from the PHASE Project. Int J Environ Res Public Health. 2015;12(12):15567-83. DOI:10.3390/ijerph121215006.

25. Oudin Åström D, Forsberg B, Ebi KL, Rocklöv J. Attributing mortality from extreme temperatures to climate change in Stockholm, Sweden. Nat Clim Change. 2013;3(12):1050-4. DOI:10.1038/nclimate2022.

26. Oudin Åström D, Åström C, Forsberg B, Vicedo-Cabrera AM, Gasparrini A, Oudin A, et al. Heat wave-related mortality in Sweden: A case-crossover study investigating effect modification by neighbourhood deprivation. Scand J Public Health. 2020;48(4):428-35. DOI:10.1177/1403494818801615.

27. Public Health Agency of Sweden. Hälsoeffekter av värmeböljor – En kunskapssammanställning. Solna; 2022. Retrieved from: https://www.folkhalsomyndigheten.se/publikationer-och-material/publikationsarkiv/h/halsoeffekter-av-varmeboljor/?pub=112090.

28. Stafoggia M, Forastiere F, Agostini D, Biggeri A, Bisanti L, Cadum E, et al. Vulnerability to heat-related mortality: a multicity, population-based, case-crossover analysis. Epidemiology. 2006;17(3):315-23. DOI:10.1097/01.ede.0000208477.36665.34.

29. Hajat S, O'Connor M, Kosatsky T. Health effects of hot weather: from awareness of risk factors to effective health protection. Lancet. 2010;375(9717):856-63. DOI:10.1016/S0140-6736(09)61711-6.

30. Page LA, Hajat S, Kovats RS, Howard LM. Temperature-related deaths in people with psychosis, dementia and substance misuse. Br J Psychiatry. 2012;200(6):485-90. DOI:10.1192/bjp.bp.111.100404.

31. Zanobetti A, O'Neill MS, Gronlund CJ, Schwartz JD. Susceptibility to mortality in weather extremes: effect modification by personal and small-area characteristics. Epidemiology. 2013;24(6):809-19. DOI:10.1097/01.ede.0000434432.06765.91.

32. Public Health Agency of Sweden. Värmestress i urbana inomhusmiljöer – förekomst och möjliga åtgärder i befintlig bebyggelse. Stockholm; 2018.

33. Swedish Civil Contingencies Agency. Värmeböljors påverkan på samhällets säkerhet. En kunskaps- och forskningsöversikt med fokus på Sverige och konsekvenser utanför hälsoområdet. 2012. ISBN 978-91-7383-204-5 Contract No.: MSB362.

34. United Nations Environment Programme. Nations Environment Programme. Emissions Gap Report 2023: Broken Record – Temperatures hit new highs, yet world fails to cut emissions (again). Nairobi. https://doi.org/10.59117/20.500.11822/43922; 2023. Retrieved from: https://wedocs.unep.org/handle/20.500.11822/43922;jsessionid=ABABEE4E9FCBD465651D12FA8F31F1A9.

35. Vicedo-Cabrera AM, Guo Y, Sera F, Huber V, Schleussner CF, Mitchell D, et al. Temperature-related mortality impacts under and beyond Paris Agreement climate change scenarios. Clim Change. 2018;150(3-4):391-402. DOI:10.1007/s10584-018-2274-3.

36. Gasparrini A, Guo Y, Sera F, Vicedo-Cabrera AM, Huber V, Tong S, et al. Projections of temperature-related excess mortality under climate change scenarios. Lancet Planet Health. 2017;1(9):e360-e7. DOI:10.1016/S2542-5196(17)30156-0.

37. SMHI. Värmeböljor i Sverige. [Fact sheet]. SMHI; 2011. No. 49. Retrieved from: http://www.smhi.se/polopoly_fs/1.16889!/webFactSheet_49.pdf.

38. SMHI. Blir det fler värmeböljor i framtiden? 2023 [cited 20 May 2024]. Retrieved from: https://www.smhi.se/forskning/forskningsenheter/meteorologi/varme-och-luftmiljo-i-stader/blir-det-fler-varmeboljor-i-framtiden-1.160054.

39. Statistics Sweden. Sveriges framtida befolkning 2023–2070. 2023. Retrieved from: https://www.scb.se/contentassets/e99a33e517a343488cd1fd73362167c8/be0401_2023i70_br_be51br2302.pdf.

40. National Board of Health and Welfare. Riktvärden för beläggningsgrad och vårdplatser, samt fortsatt arbete. https://www.socialstyrelsen.se/om-socialstyrelsen/pressrum/press/nytt-riktvarde-visar-behov-av-ytterligare-2300-vardplatser/; 2023.

41. Public Health Agency of Sweden. Värme och människa i bebyggd miljö. Kunskapsstöd för åtgärder som minskar hälsoskadlig värme. Stockholm: Public Health Agency of Sweden; 2019. Retrieved from: https://www.folkhalsomyndigheten.se/contentassets/da3f008f2fbc4d9f8424a3eb73f0d1a5/varme-manniska-bebyggd-miljo.pdf.

42. Statistics Sweden. Tätorter i Sverige. SCB; 2022 [cited 28 February 2024]. Retrieved from: https://www.scb.se/hitta-statistik/statistik-efter-amne/miljo/markanvandning/tatorter/pong/statistiknyhet/befolkning-i-tatorter-2018-preliminar-statistik/.

43. Statistics Sweden. Efter 60. En beskrivning av äldre i Sverige i Demografiska rapporter. 2022. Retrieved from: https://www.scb.se/contentassets/c4ac9fb5ad10451aab0885b7160de9b0/be0701_2022a01_br_be51br2202.pdf.

44. Public Health Agency of Sweden. Folkhälsomyndighetens återrapportering av regeringsuppdrag om kunskapsstöd angående värmeböljor: Ref no 02846-2018-1.1.1. Stockholm: Public Health Agency of Sweden; 2019.

45. Ström M. Stora neddragningar väntar 2024 trots kärva minusbudgetar. Läkartidningen. 2024.

46. SMHI. Nationell vägledning för vädervarningar – samhällsaktörernas arbete. https://www.smhi.se/polopoly_fs/1.170192!/Nationell%20v%C3%A4gledning%20f%C3%B6r%20v%C3%A4dervarningar%202022%20Upplaga%203.pdf; 2022. Upplaga 3.

47. Public Health Agency of Sweden. Att hantera hälsoeffekter av värmeböljor. Vägledning till handlingsplaner. Solna: Public Health Agency of Sweden; 2022. Retrieved from:

https://www.folkhalsomyndigheten.se/contentassets/ea328afcc93f4ad6a37693176fbb3158/hantera-halsoeffekter-varmeboljor.pdf.

48. Public Health Agency of Sweden. Kartläggning av bebyggelse med risk för höga temperaturer – Metodbeskrivning av GIS-verktyg utifrån marktäckning. 2019. Retrieved from: https://www.folkhalsomyndigheten.se/contentassets/ab816ad103404967a558acf879c4d50c/kartlaggning-bebyggelse-risk-hoga-temperaturer.pdf.

49. Kinney PL. Climate change, air quality, and human health. Am J Prev Med. 2008;35(5):459-67. DOI:10.1016/j.amepre.2008.08.025.

50. Demain JG. Climate Change and the Impact on Respiratory and Allergic Disease: 2018. Curr Allergy Asthma Rep. 2018;18(4):22. DOI:10.1007/s11882-018-0777-7.

51. Barnes CS. Impact of Climate Change on Pollen and Respiratory Disease. Current Allergy and Asthma Reports. 2018;18(11). DOI:10.1007/s11882-018-0813-7.

52. Public Health Agency of Sweden. Allt fler störs av buller och dålig inomhusmiljö. 2024. Retrieved from: https://www.folkhalsomyndigheten.se/nyheter-och-press/nyhetsarkiv/2024/april/allt-fler-stors-av-buller-och-dalig-inomhusmiljo/.

53. Damialis A, Gilles S, Sofiev M, Sofieva V, Kolek F, Bayr D, et al. Higher airborne pollen concentrations correlated with increased SARS-CoV-2 infection rates, as evidenced from 31 countries across the globe. P Natl Acad Sci USA. 2021;118(12). DOI:10.1073/pnas.2019034118.

54. Gilles S, Blume C, Wimmer M, Damialis A, Meulenbroek L, Gökkaya M, et al. Pollen exposure weakens innate defense against respiratory viruses. Allergy. 2020;75(3):576-87. DOI:10.1111/all.14047.

55. Kiotseridis H, Cilio CM, Bjermer L, Tunsäter A, Jacobsson H, Dahl Å. Grass pollen allergy in children and adolescents – symptoms, health related quality of life and the value of pollen prognosis. Clinical and translational allergy. 2013;3:1-12.

56. Berger M, Bastl K, Bastl M, Dirr L, Hutter HP, Moshammer H, et al. Impact of air pollution on symptom severity during the birch, grass and ragweed pollen period in Vienna, Austria: Importance of O-3 in 2010-2018. Environ Pollut. 2020;263. DOI:10.1016/j.envpol.2020.114526.

57. Carlsen HK, Haga SL, Olsson D, Behndig AF, Modig L, Meister K, et al. Birch pollen, air pollution and their interactive effects on airway symptoms and peak expiratory flow in allergic asthma during pollen season – a panel study in Northern and Southern Sweden. Environ Health-Glob. 2022;21(1). DOI:10.1186/s12940-022-00871-x.

58. D'Amato G, Annesi-Maesano I, Cecchi L, D'Amato M. Latest news on relationship between thunderstorms and respiratory allergy, severe asthma, and deaths for asthma. Allergy. 2019;74(1):9-11. DOI:10.1111/all.13616.

59. Agache I, Sampath V, Aguilera J, Akdis C, Akdis M, Barry M, et al. Climate change and global health: A call to more research and more action. Allergy. 2022;77(5):1389-407. DOI:10.1111/all.15229.

60. Price D, Hughes KM, Thien F, Suphioglu C. Epidemic Thunderstorm Asthma: Lessons Learned from the Storm Down-Under. J Aller Cl Imm-Pract. 2021;9(4):1510-5. DOI:10.1016/j.jaip.2020.10.022.

61. Lohmus M, Lind T, MacLachlan L, Ekebom A, Gedda B, Östensson P, et al. Combined Exposure to Birch Pollen and Thunderstorms Affects Respiratory Health in Stockholm, Sweden-A Time Series Analysis. Int J Env Res Pub He. 2022;19(10). DOI:10.3390/ijerph19105852.

62. Zhang YX, Steiner AL. Projected climate-driven changes in pollen emission season length and magnitude over the continental United States. Nat Commun. 2022;13(1). DOI:10.1038/s41467-022-28764-0.

63. Chapman DS, Scalone R, Stefanic E, Bullock JM. Mechanistic species distribution modeling reveals a niche shift during invasion. Ecology. 2017;98(6):1671-80. DOI:10.1002/ecy.1835.

64. Scalone R, Lemke A, Stefanic E, Kolseth AK, Rasic S, Andersson L. Phenological Variation in Ambrosia artemisiifolia L. Facilitates Near Future Establishment at Northern Latitudes. Plos One. 2016;11(11). DOI:10.1371/journal.pone.0166510.

65. Swedish University of Agricultural Sciences. The wormwood ambrosia needs to be fought – it can be a pest for pollen allergy sufferers. 2016 [cited 20 May 2020]. Retrieved from: https://www.slu.se/ew-nyheter/2016/11/malortsambrosian-maste-bekampas--kan-bli-en-varsting-for-pollenallergiker/.

66. Luschkova D, Traidl-Hoffmann C, Ludwig A. Climate change and allergies. Allergo J. 2022;31(4):44-53. DOI:10.1007/s40629-022-00212-x.

67. Swedish Asthma and Allergy Association. Astma- och Allergirapporten – om vår tids vanligaste kroniska folksjukdomar. 2022. Retrieved from: https://astmaoallergiforbundet.se/content/uploads/2022/05/Astma-och-Allergirapporten_2022-05-03-komprimerad_1.pdf.

68. SVA. Fästingar i ett förändrat klimat. 2023 [cited 29 February 2024]. Retrieved from: https://www.sva.se/amnesomraden/klimatforandring/en-omvarld-i-forandring/smittor-och-smittbarare/fastingar-i-ett-forandrat-klimat/.

69. Omazic A, Han SE, Albihn A, Ullman K, Choklikitumnuey P, Perissinotto D, et al. Ixodid tick species found in northern Sweden – Data from a frontier area. Ticks Tick-Borne Dis. 2023;14(6). DOI:10.1016/j.ttbdis.2023.102244.

70. Public Health Agency of Sweden. Sjukdomsinformation om TBE (Tick borne encephalitis). 2024 [cited 1 March 2024]. Retrieved from: https://www.folkhalsomyndigheten.se/smittskydd-beredskap/smittsamma-sjukdomar/tick-borne-encephalitis-tbe/.

71. ECDC. Ixodes ricinus – current known distribution: February 2023. 2023 [cited 1 March 2024]. Retrieved from: https://www.ecdc.europa.eu/en/publications-data/ixodes-ricinus-current-known-distribution-february-2023.

72. Ruzek D, Avšič Županc T, Borde J, Chrdle A, Eyer L, Karganova G, et al. Tick-borne encephalitis in Europe and Russia: Review of pathogenesis, clinical features, therapy, and vaccines. Antiviral Research. 2019;164:23-51. DOI: https://doi.org/10.1016/j.antiviral.2019.01.014.

73. SVA. Preliminära analysresultat för insamlingen av fästingar norr om Dalälven. 2019 [cited 30 January 2021]. Retrieved from: https://www.sva.se/djurhalsa/smittlage/insamlingar-och-medborgarforskning/insamling-av-fastingar/insamling-av-fastingar-i-norr-vilka-fastingarter-och-vilka-smittamnen-bar-fastingarna-pa/.

74. SVA. Fynd av tajgafästing leder till ny insamling. 2019 [cited 1 March 2024]. Retrieved from: https://www.sva.se/aktuellt/pressmeddelanden/fynd-av-tajgafasting-leder-till-ny-insamling/.

75. Grandi G, Chitimia-Dobler L, Choklikitumnuey P, Strube C, Springer A, Albihn A, et al. First records of adult Hyalomma marginatum and H. rufipes ticks (Acari: Ixodidae) in Sweden. Ticks Tick-Borne Dis. 2020;11(3). DOI:10.1016/j.ttbdis.2020.101403.

76. ECDC. Cases of Crimean–Congo haemorrhagic fever in the EU/EEA, 2013–present. 2024 [cited 1 March 2024]. Retrieved from: https://www.ecdc.europa.eu/en/crimean-congo-haemorrhagic-fever/surveillance/cases-eu-since-2013.

77. Blekinge Institute of Technology. Nu testas första vaccinet mot borrelia. forskningse. 2023.

78. Public Health Agency of Sweden. Områden med förhöjd förekomst av TBE. 2023 [cited 1 March 2024]. Retrieved from: https://www.folkhalsomyndigheten.se/smittskydd-beredskap/smittsamma-sjukdomar/tick-borne-encephalitis-tbe/omraden-med-forhojd-forekomst-av-tbe/.

79. Thurston GD, Kipen H, Annesi-Maesano I, Balmes J, Brook RD, Cromar K, et al. A joint ERS/ATS policy statement: what constitutes an adverse health effect of air pollution? An analytical framework. Eur Respir J. 2017;49(1):1600419. DOI:10.1183/13993003.00419-2016.

80. WHO. WHO Global Air Quality Guidelines. 2021 [cited 1 March 2024]. Retrieved from: https://www.who.int/news-room/questions-and-answers/item/who-global-air-quality-guidelines.

81. Yu ZB, Merid SK, Bellander T, Bergström A, Eneroth K, Georgelis A, et al. Associations of improved air quality with lung function growth from childhood to adulthood: the BAMSE study. Eur Respir J. 2023;61(5). DOI:10.1183/13993003.01783-2022.

82. Gustafsson M, Lindén J, Forsberg B, Åström S, Johansson EMM. Quantification of population exposure to NO2, PM2.5 and PM10 and estimated health impacts. 2022. 2446.0. Retrieved from: https://www.ivl.se/english/ivl/publications/publications/quantification-of-population-exposure-to-no2-pm10-and-pm2.5-and-estimated-health-impacts-2019.html.

83. Tornevi A, Andersson C, Carvalho AC, Langner J, Robertson L, Forsberg B. Effekter på luft och hälsa i områden utsatta för rök från skogsbränder – med fokus på Jämtland Härjedalen 2018. Umeå; 2021.

84. Vicedo-Cabrera AM, Sera F, Liu C, Armstrong B, Milojevic A, Guo YM, et al. Short term association between ozone and mortality: global two stage time series study in 406 locations in 20 countries. Bmj-Brit Med J. 2020;368. DOI:10.1136/bmj.m108.

85. Olstrup H, Johansson C, Forsberg B, Åström C. Association between Mortality and Short-Term Exposure to Particles, Ozone and Nitrogen Dioxide in Stockholm, Sweden. Int J Env Res Pub He. 2019;16(6). DOI:10.3390/ijerph16061028.

86. Anenberg SC, Haines S, Wang E, Nassikas N, Kinney PL. Synergistic health effects of air pollution, temperature, and pollen exposure: a systematic review of epidemiological evidence. Environ Health-Glob. 2020;19(1). DOI:10.1186/s12940-020-00681-z.

87. Rai M, Stafoggia M, de'Donato F, Scortichini M, Zafeiratou S, Fernandez LV, et al. Heat-related cardiorespiratory mortality: Effect modification by air pollution across 482 cities from 24 countries. Environ Int. 2023;174. DOI:10.1016/j.envint.2023.107825.

88. Hooper LG, Kaufman JD. Ambient Air Pollution and Clinical Implications for Susceptible Populations. Ann Am Thorac Soc. 2018;15:S64-S8. DOI:10.1513/AnnalsATS.201707-574MG.

89. SMHI. Luftmiljö i ett framtida klimat. SMHI; 2022 [cited 18 March 2024]. Retrieved from: https://www.smhi.se/forskning/forskningsenheter/meteorologi/luftmiljo-i-ett-framtida-klimat-1.621.

90. Wylde HA, Asker C, Bennet C, Forsberg B, Segersson D. Quantification of population exposure to PM10, PM2.5 and NO2 and estimated health impacts for 2019 and 2030 – A study based on high resolution dispersion modelling 2023. Retrieved from: https://www.smhi.se/polopoly_fs/1.191851!/RMK_119%20Quantification%20of%20population%20exposure%20to%20PM10%2C%20PM2.5%20and%20NO2%20and%20estimated%20health%20impacts%20for%202019%20and%202030.pdf.

91. Orru H, Åström C, Andersson C, Tamm T, Ebi KL, Forsberg B. Ozone and heat-related mortality in Europe in 2050 significantly affected by changes in climate, population and greenhouse gas emission. Environ Res Lett. 2019;14(7). DOI:10.1088/1748-9326/ab1cd9.

92. Domingo NG, Fiore AM, Lamarque J-F, Kinney PL, Jiang L, Gasparrini A, et al. Ozone-related acute excess mortality projected to increase in the absence of climate and air quality controls consistent with the Paris Agreement. One Earth. 2024;7(2):325-35.

93. Chen K, Vicedo-Cabrera AM, Dubrow R. Projections of Ambient Temperature- and Air Pollution-Related Mortality Burden Under Combined Climate Change and Population Aging Scenarios: a Review. Curr Env Hlth Rep. 2020;7(3):243-55. DOI:10.1007/s40572-020-00281-6.

94. Swedish Environmental Protection Agency. Miljömålen – Årlig uppföljning av Sveriges nationella miljömål 2019 – Med fokus på statliga insatser. Stockholm: Swedish Environmental Protection Agency; 2019. 6890.

95. Paoletti E, De Marco A, Beddows DCS, Harrison RM, Manning WJ. Ozone levels in European and USA cities are increasing more than at rural sites, while peak values are decreasing. Environ Pollut. 2014;192:295-9. DOI:10.1016/j.envpol.2014.04.040.

96. SMHI. Luftwebb. 2024 [cited 2 March 2024]. Retrieved from: https://www.smhi.se/data/miljo/luftwebb/.

97. Swedish Environmental Protection Agency. Utsläpp av luftföroreningar. 2024 [cited 1 March 2024]. Retrieved from: https://www.naturvardsverket.se/amnesomraden/luft/statistik--utslapp-och-halter/utslapp-av-luftfororeningar/.

98. Swedish Civil Contingencies Agency. Droughts and wildfires in Sweden: past variation and future projection. University of Gothenburg; 2017. MSB1112.

99. Swedish University of Agricultural Sciences. Risk för ännu en brandhärjad sommar i skogen. 2023 [cited 2 March 2024]. Retrieved from: https://www.slu.se/forskning/kunskapsbank/a2023/risk-for-annu-en-brandharjad-sommar-i-skogen/.

100. SMHI. Brandrisker idag och i framtiden. 2023 [cited 3 March 2024]. Retrieved from: https://www.smhi.se/kunskapsbanken/klimat/klimateffekter/brandrisker-idag-och-imorgon-1.87501.

101. Elser H, Rowland ST, Marek MS, Kiang MV, Shea B, Do V, et al. Wildfire smoke exposure and emergency department visits for headache: A case-crossover analysis in California, 2006-2020. Headache. 2023;63(1):94-103. DOI:10.1111/head.14442.

102. Meng YY, Yu Y, Al-Hamdan MZ, Marlier ME, Wilkins JL, Garcia-Gonzales D, et al. Short-Term total and wildfire fine particulate matter exposure and work loss in California. Environ Int. 2023;178. DOI:10.1016/j.envint.2023.108045.

103. WHO. Wildfires. 2024 [cited 8 October 2020]. Retrieved from: https://www.who.int/health-topics/wildfires#tab=tab_1.

104. Gao Y, Huang WZ, Yu P, Xu RB, Yang ZY, Gasevic D, et al. Long-term impacts of non-occupational wildfire exposure on human health: A systematic review. Environ Pollut. 2023;320. DOI:10.1016/j.envpol.2023.121041.

105. Swedish Government Official Report SOU 2019:7. Skogsbränderna sommaren 2018. Stockholm: Swedish Government Official Reports; 2019.

106. Tornevi A, Andersson C, Carvalho AC, Langner J, Stenfors N, Forsberg B. Respiratory Health Effects of Wildfire Smoke during Summer of 2018 in the Jamtland Harjedalen Region, Sweden. Int J Env Res Pub He. 2021;18(13). DOI:10.3390/ijerph18136987.

107. Johansson JM, Watne ÅK, Karlsson PE, Karlsson GP, Danielsson H, Andersson C, et al. The European heat wave of 2018 and its promotion of the ozone climate penalty in southwest Sweden. Boreal Environ Res. 2020;25:39-50. <Go to ISI>://WOS:000529241400003.

108. Lund MT, Nordling K, Gjelsvik AB, Samset BH. The influence of variability on fire weather conditions in high latitude regions under present and future global warming. Environ Res Commun. 2023;5(6). DOI:10.1088/2515-7620/acdfad.

109. Astrup R, Bernier PY, Genet H, Lutz DA, Bright RM. A sensible climate solution for the boreal forest. Nat Clim Change. 2018;8(1):11-2. DOI:10.1038/s41558-017-0043-3.

110. Swedish Civil Contingencies Agency. Framtida brandrisk – förändringar i perioder av hög brandrisk enligt FWI-modellen. 2024. Contract No.: MSB2301 – March 2024. Retrieved from: https://rib.msb.se/filer/pdf/30619.pdf.

111. Granström A. En samlad svensk databas för bränder i skog och mark – aktörer, informationskällor och möjlig framtida samverkan. SLU; 2023. Retrieved from: https://www.slu.se/globalassets/ew/org/andra-enh/s/forskning/rapportserie/rapport-2023-1-granstrom-web.pdf.

112. SMHI. Brandriskprognoser. 2024 [cited 3 March 2024]. Retrieved from: https://www.smhi.se/vader/varningar-och-brandrisk/brandrisk.

113. Swedish Civil Contingencies Agency. Brandrisk Ute. 2024 [cited 3 March 2024]. Retrieved from: https://www.msb.se/sv/om-msb/informationskanaler/appar/brandrisk-ute/.

114. Swedish Civil Contingencies Agency. Flooding. 2024 [cited 5 March 2024]. Retrieved from: https://www.msb.se/sv/amnesomraden/skydd-mot-olyckor-och-farliga-amnen/naturolyckor-och-klimat/oversvamning/.

115. SMHI. Flooding. 2023 [cited 5 March 2024]. Retrieved from: https://www.klimatanpassning.se/hur-klimatet-forandras/klimateffekter/oversvamning-1.21324.

116. Swedish Civil Contingencies Agency. Nationell risk och sårbarhetsbedömning (NRSB) 2023. 2023. Retrieved from: https://www.msb.se/contentassets/e1e46c8ec261465984a510eb5275c0cc/nationell-risk-och-sarbarhetsbedomning-nrsb-2023.pdf.

117. Swedish Civil Contingencies Agency. Konsekvenser av en översvämning i Mälaren: Redovisning av regeringsuppdrag Fö2010/560/SSK. 2012. Retrieved from: https://rib.msb.se/filer/pdf/26230.pdf.

118. Speis PD, Andreadakis E, Diakakis M, Daidassi E, Sarigiannis G. Psychosocial vulnerability and demographic characteristics in extreme flash floods: The case of Mandra 2017 flood in Greece. Int J Disast Risk Re. 2019;41. DOI:10.1016/j.ijdrr.2019.101285.

119. Paranjothy S, Gallacher J, Amlot R, Rubin GJ, Page L, Baxter T, et al. Psychosocial impact of the summer 2007 floods in England. BMC Public Health. 2011;11(1):145. DOI:10.1186/1471-2458-11-145.

120. Yang Z, Huang W, McKenzie JE, Xu R, Yu P, Ye T, et al. Mortality risks associated with floods in 761 communities worldwide: time series study. BMJ. 2023;383:e075081. DOI:10.1136/bmj-2023-075081.

121. Paterson DL, Wright H, Harris PNA. Health Risks of Flood Disasters. Clin Infect Dis. 2018;67(9):1450-4. DOI:10.1093/cid/ciy227.

122. Eriksson M, Ebert K, Jarsjö J. Well Salinization Risk and Effects of Baltic Sea Level Rise on the Groundwater-Dependent Island of Öland, Sweden. Water-Sui. 2018;10(2). DOI:10.3390/w10020141.

123. Swedish Civil Contingencies Agency. En översiktlig sammanställning av data från genomförda utredningar av översvämningar. 2022. Retrieved from: https://rib.msb.se/filer/pdf/30072.pdf.

124. County Administrative Board. Utredning av skyfall och översvämningar i Gävleborgs län, augusti 2021. 2022. Retrieved from: https://www.lansstyrelsen.se/download/18.74b418a31817ff11b11152a4/1656404563637/Utredning%20av%20skyfall%20och%20%C3%B6versv%C3%A4mningar%20i%20G%C3%A4vleborgs%20l%C3%A4n,%20augusti%202021.pdf.

125. Bei B, Bryant C, Gilson KM, Koh J, Gibson P, Komiti A, et al. A prospective study of the impact of floods on the mental and physical health of older adults. Aging Ment Health. 2013;17(8):992-1002. DOI:10.1080/13607863.2013.799119.

126. Norris FH, Friedman MJ, Watson PJ, Byrne CM, Diaz E, Kaniasty K. 60,000 disaster victims speak: Part I. An empirical review of the empirical literature, 1981–2001. Psychiatry. 2002;65(3):207-39. DOI:10.1521/psyc.65.3.207.20173.

127. Xiong X, Harville EW, Mattison DR, Elkind-Hirsch K, Pridjian G, Buekens P. Hurricane Katrina experience and the risk of post-traumatic stress disorder and depression among pregnant women. Am J Disaster Med. 2010;5(3):181-7. DOI:10.5055/ajdm.2010.0020.

128. Tellman B, Sullivan JA, Kuhn C, Kettner AJ, Doyle CS, Brakenridge GR, et al. Satellite imaging reveals increased proportion of population exposed to floods. Nature. 2021;596(7870):80-6. DOI:10.1038/s41586-021-03695-w.

129. Hieronymus M, Kalén O. Should Swedish sea level planners worry more about mean sea level rise or sea level extremes? Ambio. 2022;51(11):2325-32. DOI:10.1007/s13280-022-01748-6.

130. Hieronymus M, Kalén O. Sea-level rise projections for Sweden based on the new IPCC special report: The ocean and cryosphere in a changing climate. Ambio. 2020;49(10):1587-600. DOI:10.1007/s13280-019-01313-8.

131. SMHI. Sveriges stora sjöar idag och i framtiden: Klimatets påverkan på Vänern, Vättern, Mälaren och Hjälmaren. Kunskapssammanställning februari 2018.; 2018. Retrieved from: https://www.smhi.se/polopoly_fs/1.165086!/Climatology_49%20Sweden's%20large%20lake%C3%B6ar%20today%20and%20in%20the%20future.%20Klimatets%20p%C3%A5verkan%20p%C3%A5%20V%C3%A4nern%2C%20V%C3%A4ttern%2C%20M%C3%A4laren%20och%20Hj%C3%A4lmaren.%20Kunskapssammanst%C3%A4llning%20februari%202018..pdf.

132. Statistics Sweden. Det strandnära Sverige: Statistik om strandnära markanvändning 2020. 2020. Retrieved from: https://www.scb.se/contentassets/7edbcfbb3a87470387d8c95868ecaf04/mi0812_2020a01_br_mi50sm2301.pdf.

133. Skåne County Administative Board. Angående dammsäkerhetsåtgärder för Vombsjön. 2024. Contract No.: 2828–2024.

134. Swedish Civil Contingencies Agency. Pluviala översvämningar. Konsekvenser vid skyfall över tätorter. En kunskapsöversikt. Karlstad: MSB; 2013.

135. MSB har identifierat 26 områden med betydande risk för översvämning [press release]. 2024.

136. Swedish National Board of Building, Planning and Housing. Översvämningsrisk vid planläggning. 2022 [cited 6 March 2024]. Retrieved from: https://www.boverket.se/sv/PBL-kunskapsbanken/planering/detaljplan/lansstyrelsens-tillsyn/tillsynsvagledning_naturolyckor/tillsynsvagledning-oversvamning/.

137. Swedish National Board of Building, Planning and Housing. Klimatrisker i översiktsplanering. 2024 [cited 7 June 2024]. Retrieved from: https://www.boverket.se/sv/PBL-kunskapsbanken/planering/oversiktsplan/allmanna-intressen/hansyn/miljo_klimat/klimatrisker/.

138. Segge S, Mauerhofer V. Progress in local climate change adaptation against sea level rise: A comparison of management planning between 2013 and 2022 of Swedish municipalities. Urban Clim. 2023;49. DOI:10.1016/j.uclim.2023.101555.

139. Municipality of Vellinge. Skyddsvallarna. Vellinge kommun; 2024 [cited 6 March 2024]. Retrieved from: https://vellinge.se/planer-och-projekt-i-Vellinge-kommun/aktuella-byggprojekt/trafik-och-infrastruktur/skydd-mot-hoga-havsnivaer/.

140. Public Health Agency of Sweden. Sjukdomsinformation om vibrioinfektion och badsårsfeber. 2017 [cited 6 March 2024]. Retrieved from: https://www.folkhalsomyndigheten.se/smittskydd-beredskap/smittsamma-sjukdomar/vibrioinfektioner/.

141. Daniels NA. Vibrio vulnificus oysters: pearls and perils. Clin Infect Dis. 2011;52(6):788-92. DOI:10.1093/cid/ciq251.

142. Semenza JC, Trinanes J, Lohr W, Sudre B, Lofdahl M, Martinez-Urtaza J, et al. Environmental Suitability of Vibrio Infections in a Warming Climate: An Early Warning System. Environ Health Perspect. 2017;125(10):107004. DOI:10.1289/EHP2198.

143. Baker-Austin C, Trinanes JA, Taylor NGH, Hartnell R, Siitonen A, Martinez-Urtaza J. Emerging risk at high latitudes in response to ocean warming. Nat Clim Change. 2013;3(1):73-7. DOI:10.1038/Nclimate1628.

144. Baker-Austin C, Trinanes JA, Salmenlinna S, Löfdahl M, Siitonen A, Taylor NGH, et al. Heat Wave-Associated Vibriosis, Sweden and Finland, 2014. Emerg Infect Dis. 2016;22(7):1216-20. DOI:10.32032/eid2207.151996.

145. Public Health Agency of Sweden. Sjukdomsinformation om vibrioinfektion. 2024 [cited 19 March 2024]. Retrieved from: https://www.folkhalsomyndigheten.se/smittskydd-beredskap/smittsamma-sjukdomar/vibrioinfektioner/.

146. Lindgren E, Ahlbin A, Andersson Y. Hälsoeffekter av en klimatförändring i Sverige – En nationell utvärdering av hälsokonsekvenser hos människa och djur. Risker, anpassningsbehov och kostnader. [B: 34 Underlagsrapport utarbetad för Klimat- och sårbarhetsutredningen, SOU 2007:60]. 2007.

147. Silva M, Pratheepa VK, Botana LM, Vasconcelos V. Emergent toxins in North Atlantic temperate waters: a challenge for monitoring programs and legislation. Toxins. 2015;7(3):859-85. DOI:10.3390/toxins7030859.

148. Public Health Agency of Sweden. Sjukdomsinformation om legionellainfektion. 2024 [cited 7 March 2024]. Retrieved from: https://www.folkhalsomyndigheten.se/smittskydd-beredskap/smittsamma-sjukdomar/legionellainfektion-och-pontiacfeber/.

149. Public Health Agency of Sweden. Legionellainfektion – sjukdomsstatistik. 2024 [cited 7 March 2024]. Retrieved from: https://www.folkhalsomyndigheten.se/folkhalsorapportering-statistik/statistik-a-o/sjukdomsstatistik/legionellainfektion/.

150. Froelich BA, Daines DA. In hot water: effects of climate change on Vibrio–human interactions. Environmental Microbiology. 2020;22(10):4101-11. DOI: https://doi.org/10.1111/1462-2920.14967.

151. EEA. European sea surface temperature. 2023 [cited 7 March 2024]. Retrieved from: https://www.eea.europa.eu/en/analysis/indicators/european-sea-surface-temperature.

152. SMHI. Fördjupad klimatscenariotjänst - Yttemperatur. 2024 [cited 7 March 2024]. Retrieved from: https://www.smhi.se/klimat/framtidens-klimat/fordjupade-klimatscenarier/oce/-/temperature/rcp45/2071-2100/summer/reference.

153. Public Health Agency of Sweden. Legionella i miljön – en kunskapssammanställning om hantering av smittrisker. 2022 [cited 7 March 2024]. Retrieved from: https://www.folkhalsomyndigheten.se/smittskydd-beredskap/smittsamma-sjukdomar/legionellainfektion-och-pontiacfeber/legionella-i-miljon--en-kunskapssammanstallning-om-hantering-av-smittrisker/.

154. Government Offices of Sweden. Anmälningsplikt för kyltorn för att förebygga legionellautbrott. 2023 [cited 7 March 2024]. Retrieved from: https://www.regeringen.se/pressmeddelanden/2023/12/legionella/.

155. Swedish Geotechnical Institute. Framtida kostnader till följd av ras, skred och erosion. Fördjupning av klimateffekter. Linköping; 2022. Retrieved from: https://swedgeo.diva-portal.org/smash/record.jsf?pid=diva2%3A1790718&dswid=9445.

156. Geological Survey of Sweden. Skred och ras. 2023 [cited 8 March 2024]. Retrieved from: https://www.sgu.se/samhallsplanering/risker/skred-och-ras/.

157. European Soil Data Centre. Landslides. 2024 [cited 9 March 2024]. Retrieved from: https://esdac.jrc.ec.europa.eu/themes/landslides.

158. Haque U, Blum P, da Silva PF, Andersen P, Pilz J, Chalov SR, et al. Fatal landslides in Europe. Landslides. 2016;13(6):1545-54. DOI:10.1007/s10346-016-0689-3.

159. Kraemer Mv. Varför rasar marken just i Norge? Olycksplatsen i Gjerdrum var klassificerad som högriskområde. yle. 2020.

160. Regjeringen.no. Årsakene til kvikkleireskredet i Gjerdrum 2020. 2021. Retrieved from: https://www.regjeringen.no/contentassets/3dadc8f7fad94608861163fa524023c0/no/pdfs/arsakene-til-kvikkleireskredet-i-gjerdrum-2020.pdf.

161. Swedish Geotechnical Institute and Swedish Civil Contingencies Agency. Storymap: Riskområden för ras, skred, erosion och översvämning. 2024 [cited 9 March 2024]. Retrieved from: https://storymaps.arcgis.com/collections/e842517ce39045a4a7603dba84281208?item=2.

162. Svenska Dagbladet. Expert: Återuppbyggnad kan kosta någon miljard. Svenska Dagbladet. 2023.

163. Becher GP. Observationer i samband med slamströmmen i Mörviksån, Åre, 7–8 augusti 2023. 2023. Contract No.: 2023:11. Retrieved from: https://resource.sgu.se/dokument/publikation/sgurapport/sgurapport202311rapport/s2311-rapport.pdf.

164. Geological Survey of Sweden. Stora skred i Sverige 2024 [cited 8 March 2024]. Retrieved from: https://www.sgu.se/samhallsplanering/risker/skred-och-ras/stora-skred-i-sverige/.

165. SGI and MSB. Riskområden för ras, skred, erosion och översvämning. 2021. Retrieved from: https://www.msb.se/siteassets/dokument/om-msb/vart-uppdrag/regeringsuppdrag/2021/ru-riskomraden.pdf.

166. Swedish Government Official Report SOU 2007:60. Sverige inför klimatförändringarna – hot och möjligheter. Stockholm: Government of Sweden; 2007.

167. Swedish Government Official Report SOU 2017:42. Vem har ansvaret? Betänkande av Klimatanpassningsutredningen. Stockholm: Swedish Government Official Reports; 2017.

168. Swedish Geotechnical Institute. Säkra bergslänter. Kunskapsläget och fallstudier. 2018 [cited 26 March 2020]. Retrieved from: http://www.swedgeo.se/globalassets/publikationer/sgi-publikation/sgi-p44.pdf.

169. Swedish Geotechnical Institute S, Swedish Civil Contingencies Agency, SMHI and Lantmäteriet, cartographer Webbaserad kartvisning om ras, skred och erosion 2024.

170. Swedish Geotechnical Institute. Kartunderlag om ras, skred och erosion, SGI Vägledning 1, utgåva 5. Linköping; 2023. Retrieved from: https://swedgeo.diva-portal.org/smash/get/diva2:1300126/FULLTEXT02.pdf.

171. SGI, cartographer Skred- och erosionsdatabas2023.

172. Swedish National Food Agency. Mikrobiologiska faror i livsmedel vid ett förändrat klimat. 2021. Retrieved from: https://www.livsmedelsverket.se/globalassets/publikationsdatabas/rapporter/2021/l-2021-nr-19-mikrobiologiska-faror-i-livsmedel-vid-ett-forandrat-klimat.pdf.

173. Markland SM, Ingram D, Kniel KE, Sharma M. Water for Agriculture: the Convergence of Sustainability and Safety. Microbiol Spectr. 2017;5(3). DOI:10.1128/microbiolspec.PFS-0014-2016.

174. Lindgren E, Albihn A, Andersson Y, Forsberg B, Olsson G, Rocklöv J. Ändrat klimat får konsekvenser för hälsoläget i Sverige: Värmeböljor och smittspridning oroar mest. Läkartidningen. 2008;105(28-29):2018-23. https://www.scopus.com/inward/record.uri?eid=2-s2.0-47349123727&partnerID=40&md5=b99f544d352a98332788dd0805119192.

175. Public Health Agency of Sweden. Sommaren är högsäsong för magsjuka. 2018 [cited 16 March 2020]. Retrieved from: https://www.folkhalsomyndigheten.se/nyheter-och-press/nyhetsarkiv/2018/juni/sommaren-ar-hogsasong-for-magsjuka/.

176. Kuhn KG, Nygård KM, Guzman-Herrador B, Sunde LS, Rimhanen-Finne R, Trönnberg L, et al. Campylobacter infections expected to increase due to climate change in Northern Europe. Sci Rep-Uk. 2020;10(1). DOI:10.1038/s41598-020-70593-y.

177. SMHI. Torka. SMHI; 2023 [cited 03 March 2024]. Retrieved from: https://www.smhi.se/kunskapsbanken/hydrologi/torka-1.111075.

178. Ljung K, Maley F, Cook A, Weinstein P. Acid sulfate soils and human health--a Millennium Ecosystem Assessment. Environ Int. 2009;35(8):1234-42. DOI:10.1016/j.envint.2009.07.002.

179. Swedish Government Official Report SOU 2016:32. En trygg dricksvattenförsörjning – bakgrund, överväganden och förslag. Slutbetänkande av Dricksvattensutredningen Regeringskansliet; 2016.

180. EEA. Climate change, impacts and vulnerability in Europe 2016: An indicator-based report. Copenhagen: European Environment Agency. 2017.

181. Spinoni J, Naumann G, Vogt JV. Pan-European seasonal trends and recent changes of drought frequency and severity. Global Planet Change. 2017;148:113-30. DOI:10.1016/j.gloplacha.2016.11.013.

182. Salvador C, Nieto R, Vicente-Serrano SM, García-Herrera R, Gimeno L, Vicedo-Cabrera AM. Public Health Implications of Drought in a Climate Change Context: A Critical Review. Annu Rev Publ Health. 2023;44:213-32. DOI:10.1146/annurev-publhealth-071421-051636.

183. Chen DL, Zhang P, Seftigen K, Ou TH, Giese M, Barthel R. Hydroclimate changes over Sweden in the twentieth and twenty-first centuries: a millennium perspective. Geogr Ann A. 2021;103(2):103-31. DOI:10.1080/04353676.2020.1841410.

184. Stensen K, Krunegård AR, K. Matti, B., Hjerdt N. Sveriges vattentillgång utifrån perspektivet vattenbrist och torka – Delrapport 1 i regeringsuppdrag om åtgärder för att motverka vattenbrist i ytvattentäkter. 2019. Retrieved from: https://www.smhi.se/publikationer/sveriges-vattentillgang-utifran-perspektivet-vattenbrist-och-torka-delrapport-1-i-regeringsuppdrag-om-atgarder-for-att-motverka-vattenbrist-i-ytvattentakter-1.152540.

185. Barron J. Så påverkar torkan svenskt lantbruk. Ur SLU:s kunskapsbank: SLU; 2023 [updated 15 June 2023; cited 20 December 2023]. Retrieved from: https://www.slu.se/forskning/kunskapsbank/mark-miljo/sa-paverkar-torkan-svenskt-lantbruk/.

186. Swedish Civil Contingencies Agency. Långsamma kontinuerliga risker från klimatförändringar i Sverige 2050. 2021. Retrieved from: https://www.su.se/polopoly_fs/1.629301.1664533609!/menu/standard/file/Final%20report%20MSB%2004-29_SV.pdf.

187. Wolf J, Asch J, Tian F, Georgiou K, Ahlström A. Canopy responses of Swedish primary and secondary forests to the 2018 drought. Environ Res Lett. 2023;18(6). DOI:10.1088/1748-9326/acd6a8.

188. Swedish Forest Agency. Torkan 2018 påverkar fortfarande återväxten i skogen. 2023 [cited 3 March 2024]. Retrieved from: https://www.skogsstyrelsen.se/nyhetslista/torkan-2018-paverkar-fortfarande-atervaxten-i-skogen/.

189. Geological Survey of Sweden. Risk för vattenbrist. 2024 [cited 3 March 2024]. Retrieved from: https://www.sgu.se/grundvatten/grundvattennivaer/risk-for-vattenbrist/.

190. Swedish National Food Agency. VAKA – nationell vattenkatastrofgrupp. 2024 [cited 3 March 2024]. Retrieved from: https://www.livsmedelsverket.se/beredskap/beredskap-inom-dricksvattenforsorjning/vaka-nationell-vattenkatastrofgrupp.

191. Swedish National Food Agency. Nationella samordningsgruppen för dricksvatten. 2024 [cited 3 March 2024]. Retrieved from: https://www.livsmedelsverket.se/om-oss/samarbeten-och-projekt/nationell-samordningrupp-for-dricksvatten.

192. Swedish Water & Wastewater Association. Vattenbrist. 2023 [cited 3 March 2024]. Retrieved from: https://www.svensktvatten.se/fakta-om-vatten/vattenutmaningar/vattenbrist/.

193. Southern Baltic Water Authority. Delåtgärdsprogram mot torka och vattenbrist 2022–2027: Södra Östersjöns vattendistrikt. 2022. Contract No.: 537-6637-2022. Retrieved from: https://www.vattenmyndigheterna.se/download/18.47dc7e74182e92fe269baec/1662097861637/Del%C3%A5tg%C3%A4rdsprogram%20mot%20torka%20och%20vattenbrist%202022-2027%20S%C3%B6dra%20%C3%96stersj%C3%B6n.pdf.

194. Public Health Agency of Sweden. Sjukdomsinformation om vattenburna infektioner och utbrott. 2016 [cited 7 March 2024]. Retrieved from: https://www.folkhalsomyndigheten.se/smittskydd-beredskap/smittsamma-sjukdomar/vattenburen-smitta/.

195. Aastrup M, Thunholm B, Sundén G, Dahné J. Klimatets påverkan på koncentrationer av kemiska ämnen i grundvatten. 2012. 2012:27. Retrieved from: http://resource.sgu.se/produkter/sgurapp/s1227-rapport.pdf.

196. SVT Nyheter. Dricksvattenledning flöt upp i Nås. 2023 [cited 7 March 2024]. Retrieved from: https://www.svt.se/nyheter/lokalt/dalarna/regnovadret-i-dalarna-senaste-nytt--0mfjx2?inlagg=7c66640e5c90388bb785d242a9db6112.

197. Thomas KM, Charron DF, Waltner-Toews D, Schuster C, Maarouf AR, Holt JD. A role of high impact weather events in waterborne disease outbreaks in Canada, 1975–2001. Int J Environ Health Res. 2006;16(3):167-80. DOI:10.1080/09603120600641326.

198. Young I, Smith BA, Fazil A. A systematic review and meta-analysis of the effects of extreme weather events and other weather-related variables on Cryptosporidium and Giardia in fresh surface waters. J Water Health. 2015;13(1):1-17. DOI:10.2166/wh.2014.079.

199. Semenza JC, Houser C, Herbst S, Rechenburg A, Suk JE, Frechen T, et al. Knowledge Mapping for Climate Change and Food- and Waterborne Diseases. Crit Rev Environ Sci Technol. 2012;42(4):378-411. DOI:10.1080/10643389.2010.518520.

200. Semenza JC, Herbst S, Rechenburg A, Suk JE, Hoser C, Schreiber C, et al. Climate Change Impact Assessment of Food- and Waterborne Diseases. Crit Rev Environ Sci Technol. 2012;42(8):857-90. DOI:10.1080/10643389.2010.534706.

201. Public Health Agency of Sweden. Sjukdomsutbrott orsakade av dricksvatten. Utbrott i Sverige år 1992–2011. 2011 [cited 30 January 2021]. Retrieved from: https://www.folkhalsomyndigheten.se/contentassets/4d50365bbfa749cabeada3c11f9c786b/sjukdomsutbrott-vatten-1992-2011.pdf.

202. SMI, National Board of Health and Welfare, SVA. Smittsamma sjukdomar i ett förändrat klimat. Redovisning av ett myndighetsgemensamt regeringsuppdrag. 2011. 01 April 2011.

203. Tornevi A, Bergstedt O, Forsberg B. Precipitation effects on microbial pollution in a river: lag structures and seasonal effect modification. PLoS One. 2014;9(5):e98546. DOI:10.1371/journal.pone.0098546.

204. Swedish Water & Wastewater Association. Resultatrapport för VASS Drift 2022. 2023. Retrieved from: https://www.svensktvatten.se/globalassets/organisation-och-juridik/vass/drift/vass_drift-2022_nya.pdf.

205. Geological Survey of Sweden. Vattenkvalitet enskilda brunnar – dataunderlag. 2021. Contract No.: 2021:10. Retrieved from: https://resource.sgu.se/dokument/publikation/sgurapport/sgurapport202110rapport/s2110-rapport.pdf.

206. Geological Survey of Sweden. Fördjupad utvärdering av grundvatten av god kvalitet 2023. 2022. 39-1426/2021 Contract No.: 2022:13. Retrieved from: https://resource.sgu.se/dokument/publikation/sgurapport/sgurapport202213rapport/s2213-rapport.pdf.

207. Swedish National Food Agency. Frågor och svar om nya dricksvattenföreskrifter. 2024 [cited 8 March 2024]. Retrieved from: https://www.livsmedelsverket.se/foretagande-regler-kontroll/dricksvattenproduktion/regler-om-dricksvatten/fragor-och-svar-om-nya-dricksvattenforeskrifterna.

208. Swedish National Food Agency. Handbok för klimatanpassad dricksvattenförsörjning. 2019. Retrieved from: https://www.livsmedelsverket.se/globalassets/publikationsdatabas/handbocker-verktyg/handbok-for-klimatanpassad-dricksvattenforsorjning-2019.pdf.

209. Swedish National Food Agency. Handbok dricksvattenrisker. Cyanotoxiner i dricksvatten. 2018.

210. KEMI – Swedish Chemicals Agency. Samordningsgruppen för nya potentiella kemikaliehot – SamTox. 2024 [cited 8 March 2024]. Retrieved from: https://www.kemi.se/om-kemikalieinspektionen/organisation/samordningsgruppen-for-nya-potentiella-kemikaliehot---samtox.

211. Swedish National Food Agency. Egen brunn eller annan liten dricksvattenanläggning för privat bruk. 2023 [cited 8 March 2024]. Retrieved from: https://www.livsmedelsverket.se/livsmedel-och-innehall/dricksvatten/egen-brunn2.

212. SMHI. Observerad klimatförändring i Sverige 1860–2021. 2022. Retrieved from: https://www.smhi.se/publikationer/publikationer/observerad-klimatforandring-i-sverige-1860-2021-1.189738.

213. Warsini S, Mills J, Usher K. Solastalgia: living with the environmental damage caused by natural disasters. Prehosp Disaster Med. 2014;29(1):87-90. DOI:10.1017/S1049023X13009266.

214. Varutti M. Claiming ecological grief: Why are we not mourning (more and more publicly) for ecological destruction? Ambio. 2023;53(4):552-64. DOI:10.1007/s13280-023-01962-w.

215. Cianconi P, Betro S, Janiri L. The Impact of Climate Change on Mental Health: A Systematic Descriptive Review. Front Psychiatry. 2020;11:74. DOI:10.3389/fpsyt.2020.00074.

216. Cunsolo Willox A, Stephenson E, Allen J, Bourque F, Drossos A, Elgarøy S, et al. Examining relationships between climate change and mental health in the Circumpolar North. Reg Environ Change. 2014;15(1):169-82. DOI:10.1007/s10113-014-0630-z.

217. Lebel L, Paquin V, Kenny TA, Fletcher C, Nadeau L, Chachamovich E, et al. Climate change and Indigenous mental health in the Circumpolar North: A systematic review to inform clinical practice. Transcult Psychiatry. 2022;59(3):312-36. DOI:10.1177/13634615211066698.

218. Furberg M. Towards the limits – climate change aspects of life and health in Northern Sweden: studies of tularemia and regional experiences of changes in the environment [doctoral thesis]. Umeå: Umeå University; 2016 http://www.diva-portal.org/smash/get/diva2:1039580/FULLTEXT01.pdf.

219. Tyréns. County of Västerbotten Konsekvenser av klimatförändringar. . [Final report]. 2014. 249190.

220. WHO. Protecting health in Europe from climate change: 2017 update. WHO; 2017.

221. Swedish Transport Administration. Regeringsuppdrag om Trafikverkets klimatanpassningsarbete. 2018. Retrieved from: https://trafikverket.diva-portal.org/smash/get/diva2:1364649/FULLTEXT01.pdf.

222. Constable AJ, Harper S, Dawson J, Holsman K, Mustonen T, Piepenburg D, et al. Cross-chapter paper 6: Polar regions. IPCC AR WGII: Cambridge University Press; 2022.

223. Hjort J, Streletskiy D, Doré G, Wu QB, Bjella K, Luoto M. Impacts of permafrost degradation on infrastructure. Nat Rev Earth Env. 2022;3(1):24-38. DOI:10.1038/s43017-021-00247-8.

224. SMHI. Fördjupad klimatscenariotjänst - Nollgenomgångar. 2024 [cited 6 March 2024]. Retrieved from: https://www.smhi.se/klimat/framtidens-klimat/fordjupade-klimatscenarier/met/sverige/zerocross/rcp45/2041-2070/winter/anom.

225. SMHI. Klimatindikator – snö. 2022 [cited 6 March 2024]. Retrieved from: https://www.smhi.se/klimat/klimatet-da-och-nu/klimatindikatorer/klimatindikator-sno-1.91052.

226. Gisnås K, Etzelmüller B, Lussana C, Hjort J, Sannel ABK, Isaksen K, et al. Permafrost Map for Norway, Sweden and Finland. Permafrost Periglac. 2017;28(2):359-78. DOI:10.1002/ppp.1922.

227. Swedish Parliament. Miljö- och jordbruksutskottets betänkande 2023/24:MJU1. 2023 [cited 6 March 2024]. Retrieved from: https://data.riksdagen.se/fil/8B884D47-9EE6-496D-93FA-73CC6C9A7D9F.

228. Sameting, the Sámi Parliament. Handlingsplan för klimatanpassning. 2023 [cited 11 April 2024]. Retrieved from: https://www.sametinget.se/klimatanpassning_handlingsplan.

229. Public Health Agency of Sweden. Harpest. 2024 [cited 29 February 2024]. Retrieved from: https://www.folkhalsomyndigheten.se/folkhalsorapportering-statistik/statistik-a-o/sjukdomsstatistik/harpest/?p=24398.

230. Public Health Agency of Sweden. Harpest (tularemi) (Sverige augusti–november 2023). 2023 [cited 5 March 2024]. Retrieved from: https://www.folkhalsomyndigheten.se/smittskydd-beredskap/utbrott/utbrottsarkiv/harpest-tularemi-sverige-augusti-2023/.

231. Uppsala University. Sorkfeber allt längre söderut. 2024 [cited 2 May 2024]. Retrieved from: https://www.uu.se/press/pressmeddelanden/2024/2024-03-21-sorkfeber-allt-langre-soderut.

232. Khalil H, Olsson G, Ecke F, Evander M, Hjertqvist M, Magnusson M, et al. The importance of bank vole density and rainy winters in predicting nephropathia epidemica incidence in Northern Sweden. PLoS One. 2014;9(11):e111663. DOI:10.1371/journal.pone.0111663.

233. Rydén P, Sjöstedt A, Johansson A. Effects of climate change on tularaemia disease activity in Sweden. Global Health Action. 2009;2:91-7. DOI:10.3402/gha.v2i0.2063.

234. Ma Y, Vigouroux G, Kalantari Z, Goldenberg R, Destouni G. Implications of Projected Hydroclimatic Change for Tularemia Outbreaks in High-Risk Areas across Sweden. Int J Env Res Pub He. 2020;17(18). DOI:10.3390/ijerph17186786.

235. Lindström AE, D. Stickmyggor i Nordeuropa – en fälthandbok2022.

236. Ojala ML, R. Mygg och människor vid sjön Björken: Upplevelser av myggsituationen och attityder till bekämpningsåtgärder. Gävleborg County Administrative Board; 2013. Retrieved from: https://diva-portal.org/smash/record.jsf?pid=diva2%3A676847&dswid=-7723.

237. Waak J. Invasion av aggressiva myggor – Forskaren: ”Biter direkt”. SVT Nyheter. 2023.

238. Bakonyi T, Haussig JM. West Nile virus keeps on moving up in Europe. Eurosurveillance. 2020;25(46). DOI:10.2807/1560-7917.Es.2020.25.46.2001938.

239. ECDC. Epidemiological update: West Nile virus transmission season in Europe, 2023. 2024 [cited 4 March 2024]. Retrieved from: https://www.ecdc.europa.eu/en/news-events/epidemiological-update-west-nile-virus-transmission-season-europe-2023-0.

240. SVA. Övervakning av West Nile-virus och Usutu-virus. 2024 [cited 5 March 2024]. Retrieved from: https://www.sva.se/amnesomraden/smittlage/overvakning-av-west-nile-virus-och-usutu-virus/.

241. Musso D, Cao-Lormeau VM, Gubler DJ. Zika virus: following the path of dengue and chikungunya? Lancet. 2015;386(9990):243-4. DOI:10.1016/S0140-6736(15)61273-9.

242. ECDC. Aedes albopictus – current known distribution: February 2023. 2024 [cited 4 March 2024]. Retrieved from: https://www.ecdc.europa.eu/en/publications-data/aedes-albopictus-current-known-distribution-february-2023.

243. ECDC. Aedes aegypti – Factsheet for experts. 2024 [cited 4 March 2024]. Retrieved from: https://www.ecdc.europa.eu/en/disease-vectors/facts/mosquito-factsheets/aedes-aegypti.

244. SVA. Nilfebersmyggan upptäckt i Skåne. 2016 [cited 17 April 2024]. Retrieved from: https://www.sva.se/aktuellt/pressmeddelanden/nilfebersmyggan-upptackt-i-skane/.

245. Swedish Environmental Protection Agency. Myggbekämpning vid Nedre Dalälven 2023–2025. 2024 [cited 5 March 2024]. Retrieved from: https://www.naturvardsverket.se/lagar-och-regler/beslut/myggbekampning/myggbekampning-vid-nedre-dalalven-2023-2025.

246. SVA. Fånga myggan! 2017 [cited 5 March 2024]. Retrieved from: https://www.sva.se/aktuellt/pressmeddelanden/fanga-myggan/.

247. SVA. Övervakning av invasiva myggarter. 2023 [cited 6 March 2024]. Retrieved from: https://www.sva.se/amnesomraden/smittlage/insamlingar/overvakning-av-invasiva-myggarter/.

248. WHO. ZERO REGRETS: Scaling up action on climate change mitigation and adaptation for health in the WHO European Region. 2023. Contract No.: WHO/EURO:2023-3198-42956-69520.

249. Myers SS, Smith MR, Guth S, Golden CD, Vaitla B, Mueller ND, et al. Climate Change and Global Food Systems: Potential Impacts on Food Security and Undernutrition. Annu Rev Publ Health. 2017;38:259-77. DOI:10.1146/annurev-publhealth-031816-044356.

250. Watts N, Adger WN, Ayeb-Karlsson S, Bai Y, Byass P, Campbell-Lendrum D, et al. The Lancet Countdown: tracking progress on health and climate change. Lancet. 2017;389(10074):1151-64. DOI:10.1016/S0140-6736(16)32124-9.

251. Defrance D, Ramstein G, Charbit S, Vrac M, Famien AM, Sultan B, et al. Consequences of rapid ice sheet melting on the Sahelian population vulnerability. Proc Natl Acad Sci U S A. 2017;114(25):6533-8. DOI:10.1073/pnas.1619358114.

252. Burrows K, Kinney PL. Exploring the Climate Change, Migration and Conflict Nexus. Int J Environ Res Public Health. 2016;13(4):443. DOI:10.3390/ijerph13040443.

253. Andreoni V, Miola A. Climate Vulnerability of the Supply-Chain: Literature and Methodological review. Luxembourg: European Commission: Joint Research Centre: Institute for Environment and Sustainability; 2014. JRC93420. EUR 26994. Retrieved from: http://publications.jrc.ec.europa.eu/repository/bitstream/JRC93420/lb-na-26994-en-n%20.pdf.

254. Matschke Ekbom H, Doherty H. Konsekvenser för Sverige av klimatförändringar i andra länder. Stockholm; 2020. C 542

255. PwC Sweden. Konsekvenser för Sverige av klimatförändringar i andra länder. 2019.

256. Nordic Council of Ministers. Nordic Perspectives on Transboundary Climate Risk: current knowledge and pathways for action. 2022. Contract No.: 2022:531. Retrieved from: https://pub.norden.org/temanord2022-531/.

257. Public Health Agency of Sweden. Health as a driving force for sustainable development. 2022 [cited 22 April 2024].

This report contains a risk and vulnerability analysis of the impact of climate change on health in Sweden. The report provides a summarised profile of what is known about the health effects of a changing climate, as well as a snapshot of the vulnerability and coping capacity of society. The report is based on scientific evidence, reports from government agencies and expert assessments.

Climate change entails a risk of health effects due to extreme weather events such as heatwaves, droughts and flooding. It also entails a risk of health effects from ecosystem changes, such as changes in precipitation patterns and growing seasons that may favour various pathogens and disease-transmitting vectors.

Knowledge of health risks in a changing climate provides an important foundation for the work of the Public Health Agency of Sweden on improving public health, and in its work under the Ordinance on the climate adaptation work of government agencies (2018:1428). The risk and vulnerability analysis may also provide useful knowledge support for other national, regional and local actors.

The Public Health Agency of Sweden is a national expert agency working to improve public health by developing and supporting society's efforts to promote health, prevent ill health and protect against health threats. Our goal is to achieve public health that strengthens the development of society

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