

Summary

In August 2018, the Swedish Government tasked the Swedish National Expert Council for Climate Adaptation (hereinafter referred to as the Expert Council) with evaluating climate change adaptation work in Sweden and submitting proposals for ongoing work. This remit includes preparing a report for the Government every five years, containing:

1. proposals for the focus of the national climate change adaptation work,
2. a prioritisation of adaptation measures based on an assessment of risk, cost and benefit,
3. an overall analysis of the effects of climate change on society, and
4. monitoring and evaluation of the national climate change adaptation work.

The Expert Council consists of members who, together, have broad expertise. It is linked to the Swedish Meteorological and Hydrological Institute (SMHI), where its secretariat is based. The Expert Council has independent responsibility for its decisions. This report is the Expert Council's first report to the Government.

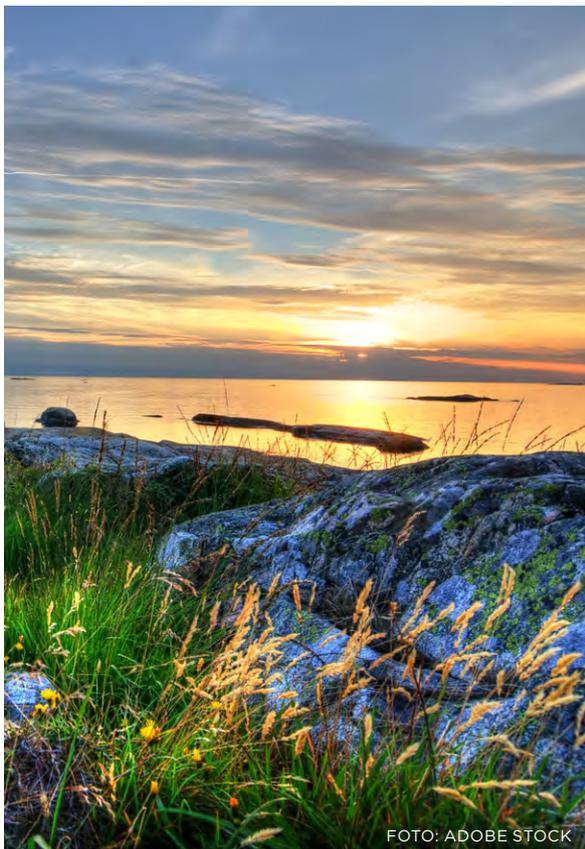


FOTO: ADOBE STOCK

THE EXPERT COUNCIL'S MAIN MESSAGE

- *Concerted efforts are needed in order to seriously ensure that our society is transformed in a climate-proof direction. The focus needs to be shifted from problems to solutions, and from planning to implementation. The initiatives that have been carried out to date have been unable to create the necessary societal changes.*
- *The work to reduce climate impact and adapt society in line with a changing climate is mutually dependent, and should be coordinated as far as possible.*
- *The current distribution of responsibilities, organisation and policy instruments create insufficient incentives for ensuring that the necessary adaptation measures are carried out. Broad agreements are required to allow for long-term planning and decisions.*
- *Measures cannot be postponed. Without climate change adaptation, ongoing societal development may lead to increased vulnerability in society, involving high future costs.*
- *Climate change adaptation is essential within all sectors of society. To make synergies possible and to avoid conflicting goals, both cross-sectoral integration and an overall view of geographic and administrative boundaries are needed. We also need stronger public-private partnerships.*
- *Climate change brings significant risks in terms of civil security. Climate change adaptation is therefore a security issue, with a bearing on aspects such as financial systems and civil defence. Physical security and land use, water security and food security are three significant risk areas.*
- *The Expert Council proposes a number of prioritised measures at both overall and risk area-specific levels. All in all, the prioritised measures allow for stronger incentives for both the continued preparatory adaptation work and the implementation of concrete adaptation measures.*

1. Carrying out the assignment

Strategic considerations have been made, supported by dialogue with various actors within society and a review of written documentation on climate change adaptation such as plans and strategies, as well as current research. The ambition has been to capture the breadth of the climate change adaptation issue.

Prioritisations of measures, as well as recommendations, focus on what the Government can influence. Overall prioritisations and proposals for the focus of the national climate change adaptation work are presented in an overview chapter. The Expert Council also presents prioritised challenges which span several different areas. Documentation chapters present proposed measures within each individual area. The Expert Council's report should thus be seen as data for decisions that the Government can make. The Expert Council believes that the proposals form an important basis for the forthcoming national strategy at an overall level and within various areas. The presented prioritised challenges show the great breadth of climate change adaptation, and thus the importance of climate change adaptation in relation to many societal functions.

A large number of national agencies, county administrative boards, industry organisations and other sources of expertise have contributed by commenting on and proposing additions to draft versions of texts. This has been based on voluntary contributions, as opposed to a formal round of referrals. In September 2020, the Expert Council arranged a dialogue seminar to share information about the work and to obtain opinions. Documentation reports have been commissioned with a focus on the issues where the Expert Council has identified a need for synthesised knowledge. Through this process, the report has gained broad support and has also been quality reviewed. However, it is the Expert Council that is responsible for the content of the report.

Future scenarios have also been drawn up, with documentation produced at workshops, illustrating how a society that has been affected by climate change and other changes – but where we have succeeded with climate change adaptation – may appear 30 to 50 years from now. The aim has been to facilitate communication and to encourage discussions on what the climate-adapted society we are striving for might look like (Appendix 3).

2. The Expert Council's conclusions

Below is a summary from the Expert Council's report on the four components that its report to the Government should include. Section 2.1 presents proposals in connection with the national climate change adaptation work (with a focus on the national strategy for climate change adaptation), based on the Expert Council's prioritisations of overall measures (chapter 18) and measures within prioritised challenges or major risk areas (chapter 19). Proposals are also presented in section 2.2. The prioritisation of adaptation measures is based on chapters 18 and 19. Section 2.3 pro-

vides a summary analysis of the effects of climate change on society, based on most of the chapters in the report. Section 2.4 presents monitoring and evaluation of the national climate change adaptation work, which is based on a summary of all sector-related chapters, as well as chapters on access to and the need for climate information and other data. A summary of all prioritisations from this chapter can be found in Appendix 2.

2.1 Proposals for the focus of the national climate change adaptation work

The focus of this section is on proposals for the forthcoming revision of the national strategy for climate change adaptation.

The Expert Council proposes that the forthcoming national strategy for climate change adaptation should adopt a transformative perspective that concretely strengthens the incentives for both the continued preparatory adaptation work and the implementation of concrete adaptation measures.

The national climate change adaptation work in Sweden has thus far been guided by the general assignment in the national climate change adaptation strategy. This work has related to the prioritised challenges described therein, and to the changes that have taken place in the wider world, for example a sharper focus on climate change adaptation in relation to the goals of the Paris Agreement, on climate resilience and on crisis management.

The Expert Council believes that Sweden's positions on climate change adaptation need to be moved forward. The focus needs to be shifted from problems to solutions, and from planning to implementation. The initiatives that have been carried out to date have been unable to create the necessary societal changes. The Expert Council's report clearly indicates that the distribution of responsibilities, organisation and existing policy instruments creates insufficient incentives for ensuring that the necessary adaptation measures are carried out in Sweden. With adaptation measures, ongoing urban development and infrastructure investments may lead to greater vulnerability, with significant costs for society and individual business owners. This places great demands on the forthcoming national climate change adaptation strategy, which needs to be given a clear transformative perspective.

Concerted efforts are required in order to seriously ensure that our society is transformed in a climate-proof direction. We have seen a number of good examples that can guide such a more transformative change, including in relation to multifunctional solutions in coastal areas or close to cities. Here, approaches and land use patterns have been directed towards nature-based and flexible solutions, but these need to progress from individual good examples to become standard practice. The conditions need to be strengthened in order to allow for a societal development that is able to address the

consequences of a changed climate in a robust and far-sighted manner. Such a more transformative approach is in line with European policy developments within the field of adaptation.

The forthcoming national strategy should be characterised by the system-wide approaches that are a feature of international developments. This includes promoting multifunctionality, in which climate change adaptation interacts with climate goals and has beneficial effects on public health, biodiversity and other environmental and society objectives. It also includes the integration of issues where there is a need for planning across administrative and geographic boundaries.

The need for stronger wording. The wording in the current climate change adaptation strategy, that climate change adaptation goals “should be taken into consideration in policies, strategies and planning at national level, and should be integrated into ordinary operations and responsibilities”, is too vague, and gives the adaptation issue an unnecessarily uncertain status. The forthcoming national strategy should clearly state that *The national objective for climate change adaptation will be taken into consideration in policies, strategies and planning at different administrative levels and be integrated into ordinary operations and areas of responsibility.* In this way, the expectation that climate change adaptation will be included at all levels of society in the wording of the goals will be clarified. Additional wording should also be added to the strategy, explaining that *The responsibility for society's climate change adaptation lies with both the public and private sectors to avoid any unclarity about the role of private sector actors, such as property owners.* Finally, additional wording is proposed to clarify the expectation of action, since the previous wording primarily refers to policies, strategies and planning. It is therefore proposed that the goal formulation should end with *In the event of significant risks, it is incumbent on the responsible party to take preventive adaptation measures.*

The need to integrate prioritised challenges into overall prioritised risk areas. With regard to the prioritised challenges in the national strategy, the Expert Council is of the opinion that these are central, but that they should be integrated into larger overall prioritised risk areas. The Expert Council's report therefore highlights three such

prioritised challenges (or risk areas): (1) Physical security and land use, (2) Water security, and (3) Food security.

The need for manageable principles with a stronger status. The Expert Council sees the ten principles in the current national climate change adaptation strategy – which should guide climate change adaptation work – as a strength, but wishes to see two changes. First, there is a need to clarify the principles and how they support various aspects of the adaptation work. This is necessary because the principles are different in nature and affect different parts of the climate change adaptation work. There is a need to make the principles more manageable and usable in practice. This applies to both the preparatory work and the implementation of the measures. Second, the status of the principles needs to be strengthened. In the current strategy, these principles are not binding and are almost invisible in the ongoing climate change adaptation work. The Expert Council proposes that the revised principles for climate change adaptation are explicitly included in the actual goal formulation for climate change adaptation, and with a clear expectation that the principles will characterise the concrete adaptation work. For the implementation of the adaptation measures, principles in the form of hierarchies should be developed and applied, in order to guide the practical decision-making and ensure effective and desirable solutions. The adaptation principles should also be included as a clear component of the regular monitoring of the climate change adaptation work.

The need for a national action plan. The conditions for strengthened climate change adaptation increase considerably with a national action plan that combines the agencies' own action plans with clarified national expectations on focus and progression within various focus areas. The opportunities thereby increase for issues being addressed with a cross-sectoral focus, with regard to synergy effects and conflicting goals between different

sectors. A national action plan clarifies and concretises national expectations, and prioritisations are concretised through time-bound, monitorable goals. As part of the work process, a cross-ministry working party or preparatory group for society's climate change adaptation is proposed. National strategic work is required in connection with issues such as climate change adaptation of transport infrastructure, integrated water and landscape planning, coastal issues and security aspects.

Integrate climate change adaptation into the climate policy framework. In accordance with the EU's policy focus, clearer integration of the climate change adaptation issue into Sweden's existing climate policy framework is required. In the event of a future review/revision of the Swedish Climate Act, climate change adaptation should therefore be included. The Prime Minister's Ministerial Working Group on Climate Policy should also include climate change adaptation. The policy cycle for the climate change adaptation strategy should be harmonised with the four-year cycle for the climate action plan, including in relation to the budget process. There should also be a review of how the six-year cycle for implementing the Water Framework Directive and the Floods Directive can be integrated with the climate change adaptation strategy's cycle. A combined climate perspective is required regarding a review of the financial policy framework, risk analysis of the sustainability of public finances, and the ongoing reworking of the Riksbank Act (i.e. the Swedish central bank) and presentation of climate reporting at the same grant-wide level as the financial plan.

Close attention to transnational climate effects in national strategies. Closer attention should be paid to transnational effects of climate change in the next national security strategy. The distribution of responsibilities for security issues linked to climate change should be strengthened in the national climate change adaptation strategy and the food strategy, and should be included as an element within total defence.

2.2 Prioritisation of adaptation measures based on an assessment of risk, cost and benefit

Conditions for implementing prioritisations

The Expert Council's assessment is that the conditions are not currently in place for carrying out a traditional cost/benefit analysis of climate adaptation measures at national level. However, the Expert Council's report contains yellow example boxes in the various sub-chapters, providing examples of the size of costs for risks and measures.

A cost/benefit analysis requires being able to calculate socioeconomic profitability for multiple measures with the same aim, and that these measures can also be ranked based on monetary units. The costs of different measures, as well as benefits from a future perspective, are very hard to quantify at national level, and will include very great uncertainties. The cost may end up with one actor and the benefit with another, including future generations. The value of multifunctionality is not currently something that can be included in cost calculations and data for implementing measures, which is problematic, and it is difficult to put monetary costs on many losses which are seen as unacceptable.

Measuring the benefit of measures requires national monitoring of indicators. Attention needs to be paid to the fact that risks and adaptation needs differ both geographically and for different groups within society. For example, regional very large needs in one part of the country, or for one part of Sweden's population, may need to be prioritised equally with needs that give a higher cost nationally.

The Expert Council's starting points for prioritisations

The Expert Council's summary proposal for prioritisations focuses on overall prioritised measures (chapter 18) and measures linked to risk area-specific prioritised challenges (chapter 19) in which increased governance is required to promote Sweden's climate change adaptation.

Risks have also been prioritised in various sub-chapters for each sector (chapters 10–14), from an overall perspective for transnational

dependences (chapter 15), in relation to both overall access to climate information and other decision-making data (chapters 4 and 9), and cross-sector access (chapter 16).

The proposed prioritised measures relate to areas where the decision-making mandate lies at national level. However, the measures in turn support climate change adaptation at local, regional, national and transnational levels. They mainly focus on issues that need to be initiated and carried out during the coming period which is affected by the next national climate change adaptation strategy.

The proposed prioritised measures will create the right conditions for the required concerted efforts on climate change adaptation to be carried out during the coming five-year period. However, the Expert Council cannot overemphasise the importance of stronger national work on both limited climate impact and climate change adaptation. These are the yin and yang of climate policy. It matters what we do in connection with each individual area, and how they link to each other. A sharper focus on how synergies between the two aspects of climate work can be strengthened is much needed.

The Expert Council's overall prioritisations

Stronger knowledge building. Ensuring that planning data from different sources is uniform and compatible, for example by using the same data on future climate change/scenarios as a basis. This requires clear national advisory guidelines for how dimensioning values are drawn up in order to contribute to uniform and transparent decisions, which in turn requires relevant climate information with high spatial and time-related resolution to be produced and made available for the whole of Sweden. Resources need to be ensured for modelling and environmental monitoring of the effects of climate change on biodiversity, about land's bearing capacity and groundwater conditions, and for establishing a national monitoring system for climate-related infectious diseases. Knowledge building is required in connection with

nature-based measures, synergies and conflicts between climate change adaptation and other sustainability goals, including taking transnational climate effects into consideration. Integrated, cost-free services should be developed that contribute relevant planning data based on coordinated, uniform climate information, combined with expert advice and support for both public-sector and private-sector actors. Continued development is required on communication and response functions for consequence-based weather warnings.

Overall analyses of financing needs. Initiate overall and long-term regional analyses on the financing need for climate change adaptation, with a focus on socioeconomic profitability where possible. A broad spectrum of sectors should be included, with regard to synergies and goal conflicts. The main aim is to support county-wide planning and prioritisation of adaptation measures that take into account monetary and non-monetary values, as well as social justice.

Stronger climate change adaptation in financial frameworks and analyses. To take advantage of the momentum and the window of opportunity that has opened up with the recovery following the Covid-19 pandemic, the Climate Policy Council proposes a number of measures that aim to introduce the climate issue into several key policy and subject areas, and thereby increase the pace of the climate transition. The Expert Council sees a need for the climate change adaptation issue, together with emissions reductions, to be included in this proposal. This involves bringing forward the review of the financial policy framework, risk analyses of the sustainability of public finances, reworking the Riksbank Act and climate reporting being expanded to also include climate change adaptation.

Stronger incentives for climate change adaptation linked to financial operations. Ensure that businesses within the financial economy integrate climate-related physical risks and climate change adaptation into their operations and submit reliable information about this in their sustainability reporting. This will improve the conditions for financial resources being steered away from climate vulnerable operations towards climate robust operations. There is also a need to map and deal with financial flows that undermine the climate change adaptation work in Sweden, as well as in developing countries that receive Swedish aid.

Clarify responsibilities. Responsibilities and costs need to be seen from an owner's perspective. However, there is great uncertainty among the actors who need to carry out measures regarding responsibility, obligations and financing. The responsibility for financing climate adaptation measures should therefore be clarified, and incentives such as climate change adaptation declarations and shared liability for damages between construction project planners and municipalities should be introduced,

with a 25-year time horizon. Increased information is also required on responsibilities and obligations linked to the ownership principle. Initiatives carried out by public sector actors and by industry organisations and insurance companies need to be coordinated. A national public-private partnership platform should therefore be set up. The municipalities should be given responsibility for coordinating climate adaptation measures relating to the built environment within their geographic area.

Draw up county-wide plans for climate change adaptation. Climate effects are not restricted by administrative boundaries, and climate change adaptation may require cooperation and cross-border measures. There is thus a need for the county administrative boards to draw up county-wide plans. The aim of these plans is to draw up goals and courses of action to achieve county-wide integrated climate change adaptation, based on overall regional analyses of socioeconomic profitability with regard to synergies and goal conflicts for various stakeholders. The Expert Council initially sees these county-wide climate change adaptation plans as providing guidance for the climate change adaptation work carried out by municipalities, county administrative boards and private actors, but they may come to play a more steering role in the future.

Place similar demands on municipalities and regions as on agencies. This involves initiating, supporting and following up on the climate change adaptation work, and driving this work forward with a clear progression. It is proposed that the national expectations for the municipalities' adaptation work should be clarified through requirements for goals and action plans. The municipal adaptation work that links directly to the structure plan should be evaluated to ensure that it is based on current analyses of the municipality's climate change adaptation needs. The county administrative board should be given a clearer mandate via the Ordinance (2018:1428) on Agencies' Climate Change Adaptation Work to identify, support and monitor needs and opportunities for coordination, whereby the municipalities should be encouraged to cooperate with other municipalities, for example from a drainage perspective.

Secure financing. Various forms of economic initiatives are required in order to increase the pace of climate change adaptation. The municipalities need to be compensated financially for costs that arise through increased state management of the climate change adaptation work. The existing grant for climate adaptation measures administered by the Swedish Civil Contingencies Agency (MSB) needs to be broadened and expanded – powerfully, and in the long term – to allow for continuity and planning. A climate change adaptation boost, with a focus on multifunctional solutions, should be introduced for part-financing innovative investments with significant climate change adaptation benefits. Co-financing solutions between actors in the public

and private sectors should be investigated and introduced, with both individuals and public interests benefiting from initiatives. Targeted state issues of green bonds for large-scale adaptation projects – in which the state is expected to have a role as a co-funder – should be part of this.

Review the legislation. Stronger legal incentives are required in several areas, in order for the implementation of concrete climate adaptation measures to occur. An addition should be made to the Swedish Planning and Building Act (PBL), making it clear that all climate-related risks should be taken into consideration in the municipalities' structure plans. It needs to be clarified how the application of the PBL provisions on climate adaptation measures can be strengthened and particularly favourable measures can be promoted. An inquiry is needed to review the legislation and regulations that govern climate change adaptation, with the aim of creating the right conditions for facilitating the implementation of adaptation measures in different sectors. This includes mapping possible synergies and goal conflicts between sections of legislation, and how sections of legislation can work together. Guidance for the application of legislation also needs to be reviewed.

The Expert Council's three overall prioritised challenges linked to civil security

Due to the integrated nature of climate change adaptation, larger and more far-reaching challenges need to be identified, in addition to more specific proposed measures. The Expert Council has therefore defined three overall challenges or risk areas in relation to civil security. These include a broad range of aspects, described on the basis of different actors' viewpoints, linked to the needs of both society and the natural environment.

The three prioritised areas integrate the seven prioritised challenges that are included in the current national climate change adaptation strategy. The aim of integrating these into the national strategy's prioritised challenges in larger areas is to clarify the need to see how different sectors' needs and opportunities for adaptation interact, and what synergies and conflicts with other goals exist.

The Expert Council proposes that climate change adaptation needs to be seen based on a fundamental security perspective, with a focus on: (1) Physical security and land use, (2) Water security in accordance with the UN definition, and (3) Food security in accordance with the UN definition. The focus on food security and food supply is an important component in the rebuilding of civil defence. Sweden is affected in many ways by food supply issues, including through our dependence on the world around us. Supply security involves both access to and use of resources. Both of these aspects need to be dealt with in order to create supply security.

The focus on civil security demonstrates the importance of strategic prioritisation within these areas. Climate change adaptation is thus a broader concept than the way the term may traditionally be used, having a bearing on issues such as financial systems and civil defence.

Prioritised challenge: Physical security and land use

Climate-secure green urban planning with a landscape perspective. Cities need to change towards meeting their own needs for energy, food, transport and heat to a greater extent. Urban planning therefore needs to be carried out on the basis of strategic prioritisations based on a security mindset. Climate-proof urban planning needs to be ensured by imposing requirements on climate change adaptation in relation to construction. Risks relating to flooding, high temperatures and health need to be addressed. Increased vegetation in urban environments can support temperature control and torrential rain management. The need for temperature control in indoor environments will increase. This may come into conflict with zero emissions requirements, with their demands for limited energy consumption. Measures are therefore required to facilitate temperature control without using energy, or with limited energy use. Nature-based solutions can sometimes have the greatest benefit if they are located upstream of densely populated areas. Diverting water can cause problems downstream, both in urban environments and in surrounding areas. The risks of flooding outside cities are often not evaluated and analysed. However, it is important to have an overview of damage to communities, infrastructure and ecosystems in the countryside.

Manage land use and coastal zones in change.

In the forest landscape, effective green infrastructure is needed in order to ensure biodiversity, including through fragmentation of species' habitats. The climate change adaptation perspective needs to be integrated with measures that reduce the impact of climate change in protected forest areas, combat overgrowth in prioritised environments, and lead to more effective management of problems in connection with stocks of hoofed game increasing due to climate change. The boundary between the responsibility of the individual and the state when it comes to forestry climate change adaptation also needs to be clarified. The need for payment levels for agriculture following extensive damage needs to be investigated. Flexible land use and planning includes climate adaptation measures which can be expanded and restructured over time. This is important not least in coastal areas, since we do not know how much the sea is rising or at what rate. We cannot yet start building protection, or move existing settlements, to prepare for a situation that will arise in 100–200 years. This must be done in different stages, in line with rising sea levels. An overall national strategy for the climate change

adaptation of Sweden's coasts and monitoring of the coastal zone's change are required as data for identifying particularly vulnerable areas and making decisions on suitable measures. There is also a need to investigate financing, resourcefulness, mandates and a distribution of responsibilities for carrying out measures at the coast, taking flexible land use as a starting point.

Working in an integrated manner on infrastructure planning. Effective climate change adaptation requires coordination between different actors (state and municipal infrastructure owners, regions, land owners, etc.), since infrastructure facilities engage with each other. Close dialogue between those responsible is thus of the utmost importance when planning a new facility, in order to achieve as good an overall solution as possible. The transport policy goal of transport provision that is sustainable in the long term cannot be achieved unless infrastructure and transport are adapted to withstand the effects of a changed climate. The robustness of an electrified transport system therefore needs to be investigated, taking into account climate change – not least in relation to transnational climate effects. Risk scenarios for Sweden's future energy system need to be drawn up in collaboration between relevant agencies. There is a need for a national strategy for the climate change adaptation of transport infrastructure and transport systems. The transition to a fossil-free Sweden, alongside other development factors, means that there is a changing energy system which needs to be adapted in line with climate change. Here, a national strategy is required for energy establishment/location and robustness of energy delivery with regard to climate change, including extreme weather. There is also a need to clarify what is/would be required to carry out climate change adaptation measures that lie outside an individual actor's influence. The transport policy goals need to be supplemented with climate change adaptation of the transport sector and infrastructure.

Prioritised challenge: Water security

Water management with an overall perspective and with regard to the effects of a changed climate. Water is a central component of virtually all the chapters of this report. When planning measures, a drainage area perspective is required since the measures or restrictions needed to resolve a problem may have to be made in locations other than where the benefit is. Responsibility, control and the implementation of measures also require cross-sector collaboration. At ministry level, a cross-ministry preparatory function for water issues should be set up. At municipal level, plans should be drawn up for water supply with long-term security in view of climate change and societal development. Inland surface water is closely linked to coastal water and marine environments, and here too planning with an overall perspective is required. The three marine plans should pro-

vide guidance for detailed development plans at municipal level. Resources for water management and marine environment programmes of measures should also be increased, so that the programmes can contribute towards water security through greater resilience to climate change. The link to fishery management should be regulated. The rules for what is permitted in areas with marine area protection, with regard to climate change, need to be tightened up. Establishing nature protection or refuges for climate change adaptation should also be made possible.

The need for financing and data on the effects of water shortages and drought. In order to be able to value and weigh up the costs and benefits of measures to counteract the effects of drought from an integrated drainage area perspective, knowledge is required about all the affected components. The effects of water shortages on society are usually known, but this is less often true for the effects on the natural environment. Knowledge needs to be produced that makes it possible to assess the effects of water shortages and drought for both the natural environment and ecosystem services. Here, an analysis of how the needs of the natural environment and ecosystem services are met – in competition with other water extraction needs – should be included. Sustainable water use needs to be ensured in legislation with regard to a changed climate. This includes the establishment, review and revision of water protection areas, improved water security and back-up options in the event of drought, including for agriculture. Mapping and analysis of access, demand and extraction of raw water are required for both surface water and groundwater. A Swedish water budget needs to be drawn up, in which the extraction of raw water should be reported, water extraction fees are charged for certain use, and an order of priority in the event of water shortages is established.

Need for increased flexibility regarding water extract permits and how climate change should be described in permit applications. Many of the current water extract permits are not adapted in line with variations in the natural systems, either seasonally or for long-term climate change. In order to be better able to adapt water judgments to a changed climate, there is a need for several new water extract permits and reconsidering older water judgments. Fixed-term water extract permits may also be needed from a climate perspective. Another alternative is to apply flexible terms to a greater extent, with the permitted extraction quantity varying with regional access. Such a course of action could bring relief for several operators – not least within agriculture. There may be a need for fixed-term water extract permits. Another alternative is to apply flexible terms to a greater extent, with the permitted extraction quantity varying with regional access. Since there is a clear link between water quality and water quantity, the option of introducing an environmental quality norm for quantitative surface water sta-

tus should be considered. If plans for water supply continue to be developed, all water use – as well as nature's/the ecosystem's water requirements – needs to be included, taking a changed climate into consideration. The starting point when reviewing permit applications within highlighted particularly sensitive areas should be that water extraction must not have a negative impact on ecosystems. Opportunities to impose demands on environmentally hazardous operations being adapted and protected with regard to a changed climate should be investigated.

Prioritised challenge: Food security

Food supply as a strategic resource in the rebuilding of civil defence. Not only is domestic production important for Sweden's food security; so too is food production, handling and transportation of imported foods, as well as changes in global resources and in the international market. Sweden's food security is also dependent on access to input goods that are essential to agriculture. Questions about climate change should be included in emergency preparedness and in continuity work. This includes external monitoring of transnational climate effects and clarifying the distribution of responsibilities for security issues linked to climate change in relevant strategies. It should be investigated how changes in legislation and measures in planning systems, construction,

standards, support systems, redistribution and similar areas can protect valuable agricultural land against other development. Multifunction solutions, which simultaneously benefit productive agricultural land and biodiversity, should be striven for.

Managing long food and input goods chains with regard to climate change.

In order to understand Sweden's vulnerability in a changed climate, we need to look at both changes in domestic food production and how the climate affects food supply and demand globally. Existing long food and input goods chains need to be reviewed with regard to climate change. Issues relating to strategic decisions for addressing transnational climate effects require cross-ministry cooperation. Opportunities for increased preparedness for climate-related disruption to food security and supply need to be reviewed. Warning systems for disruption to production and transportation should be developed at all levels and combined with action plans. As part of Sweden's aid work with capacity building to reduce the consequences of climate change in other countries, initiatives for food producers in developing countries are also required. Aid financing should, for example, be targeted at supporting building and implementing warning systems at regional/local level to make proactive measures possible, and at digital marketplaces for small-scale farmers.



FOTO: ADOBE STOCK

2.3 Summary analysis of the effects of climate change on society

A changing climate

Climate change is already happening, and Sweden faces continued changes with major societal effects.

A comparison between 1860–1900 and 1991–2019 shows a 17°C higher average temperature in Sweden. This is around twice as high as the corresponding increase in the global average temperature. More recently, a comparison between 1961–1990 and 1991–2020 shows that the vegetation period has risen on average by around two weeks in southern Sweden and ten days in the north. During the same period, the snow season in Svealand and Götaland has become almost a month shorter. The largest extent of sea ice in the Baltic Sea has reduced to around two thirds. Precipitation has risen by around 8 percent. South of a line roughly between Gothenburg in the west and Norrköping in the east, the rise in sea level is higher than the land uplift. Extreme high temperatures have also risen, as well as high flows in watercourses where the flow is not dominated by snow melting.

The size of the continued warming and other effects on the climate will depend on the time horizon, the degree of human climate impact, the sensitivity of the climate system and natural variability. Effective precipitation (in other words, precipitation minus evaporation) is expected to increase, particularly in northern Sweden and in the winter. In the summer and particularly in southern Sweden, however, it may fall in the event of high warming levels. Contrasts between wet and dry years and the occurrence of extreme precipitation are also expected to increase. Due to the deep uncertainty surrounding future sea level changes, it cannot be ruled out that land uplift will no longer be enough to compensate for rising sea levels somewhere along Sweden's coasts.

Effects on the natural environment and natural resources

Biodiversity is affected directly by climate change and indirectly through changed use of land and water. Losses of natural assets threaten our livelihoods, health and wellbeing, and ultimately society's vitality. Reduced biodiversity and changed ecosystems also create conditions for pests and vector species to invade new areas. By the end of the current century, the period of growth is expected – depending on the scenario – to be up to three months longer compared with 1971–2000, and the growing zones will have continued to shift north.

The effects of climate change on the natural environment, as well as on society, often have a connection to water. Access to water is controlled by changed precipitation patterns and increased evaporation, but also by water quality which, in turn, is affected by water shortages and other effects of climate change. The conditions for life in wetlands, lakes and watercourses are changing as a result of climate change, but the challenges are different around the country. Ongoing acidification, environmental toxins, physical impacts and eutrophication mean that the ecosystem is already under stress.

Prioritised risks for terrestrial ecosystems include long lasting drought, which for example increases the vulnerability of species in wetlands and small watercourses, and can lead to water shortages for land-dwelling creatures. Extreme weather can cause rapid changes to biodiversity, shrinking, growing and shifting habitats, and changed competition between species.

Competition for water in southeast Sweden is expected to increase, with a risk of water shortages during dry summers. Water shortages affect large sections of society, and the effects are particularly great within agriculture. An increased risk of flooding and torrential rain can lead to significant economic damage for agricultural companies. A changed climate is also expected to bring bigger problems with plant pests, and a heightened risk of diseases spreading among agricultural animals. Access to input goods for the agricultural sector may be affected by frequent and serious disrupt-

tion to production, product offering, distribution, transport networks, etc. and by growing price fluctuations.

Combined with factors such as a changed security policy situation, climate change will affect the conditions for maintaining food security and a secure food supply. Food companies operate to a high degree in an international market, and the effects of climate change in other parts of the world may affect Swedish companies. Today, we import half of all the food consumed in Sweden. This figure would be even higher when including imported input goods for agriculture and food production, such as artificial fertilisers, diesel and spare parts. The domestic food sector may need to satisfy a larger proportion of domestic consumption, while at the same time contributing more to global supplies via increased exports.

Climate change is a challenge for forestry. Even though climate changes can increase the opportunities for forestry through potential impacts on both growth and demand, many risks also increase which can result in rising costs for forestry, particularly if climate change adaptation is not carried out. These risks include root rot, European spruce bark beetle attacks and storm damage. There is also a risk of reduced growth in certain years and in certain regions due to water deficits. The risk of damage as a result of drought or reduced access to water is greatest in southeast Sweden and in inland Norrland. Both storms and forest fires can have major national effects even in today's climate, while damage from European spruce bark beetle is currently deemed to be at a medium level. By around 2100, European spruce bark beetle damage is expected to be very significant, with socioeconomic effects that make themselves felt at national level. In terms of storm damage and fires, the effects are expected to be very great as early as the middle of the century.

Temperatures are rising faster in northern Sweden than in the south. Reindeer pastures and changes in the landscape are controlled by changes in the weather, making the work of reindeer herders extremely weather-dependent. The effects of a changed climate already present challenges for reindeer herding, and are very likely to result in greater challenges in the future. Reindeer herding will be affected by an increased frequency of ice-locked winter pastures, reduced access to ground lichen, increased problems due to insects and changed presence of vector-borne diseases. This in turn can lead to additional psychosocial ill-health among reindeer herders.

Rising sea levels mean that some of today's shore areas will eventually end up under water. The effects of higher sea levels can already be seen today, and may affect the whole of Sweden's coastline. When the sea rises, natural environments, settlements and infrastructure are affected. Ground stability and groundwater quality can also be affected. Rising

seas can cause issues such as saltwater intrusion, which can lead to problems with access to drinking water, agriculture and ecosystems.

As part of the cumulative burden, climate change contributes towards marine ecosystems becoming weaker, reducing their resilience for dealing with existing burdens such as eutrophication. A changed distribution of various fish species can have negative consequences for commercial fishing. It is also possible that species that are currently found further south in Europe will become established in the North Sea, bringing new opportunities for the fishing industry.

Effects on infrastructure

In the future, infrastructure will be affected by aspects such as changes in precipitation, water levels, water pressure, water flows, groundwater levels and groundwater pressure. This can lead to increased damage and a greater need for road and rail structure maintenance, as well as to traffic disruption.

The climate-related risks that will affect infrastructure and the transport system most in the future are deemed to be linked to a greater number of more extreme cases of torrential rain, flooding, rising sea levels and changed groundwater levels, as well as heatwaves and changes to ground frost conditions and zero-crossings. Examples of the consequences include poorer access as a result of flooding and damage to physical structures. Other consequences may include a greater risk of accidents and increased maintenance requirements.

In the future, aviation may also be affected by extreme weather events (heat/cold, storms/lightning), changed wind conditions, increased water flows and flooding, changes in the number of zero-crossings, and more, larger birds around airports.

A changed climate will affect Swedish shipping, including through a changed need for ice breaking, poorer accessibility in lakes and watercourses due to lower water levels as a result of evaporation and drought, changed biofouling on hulls, flooding of harbours and shipyards, and reduced headroom.

Climate change will affect the conditions for the supply of drinking water. Access to raw water is expected to be reduced periodically, and society's need for water is changing. This can lead to changes to both the quality and quantity of raw water, but also to the production and distribution of drinking water. There is also a risk that problems may arise due to increased competition for water combined with greater water shortages.

The energy sector is doubly affected by climate change. This is partly due to steering away from fossil fuels, and partly due to future energy systems having to be sustainable in a changed climate. Sweden's future energy mix will thus influence how climate change affects the energy sector as a whole.

Effects on built environment, physical planning and human health

Climate change adaptation of the built environment is complex, and requires us to take a position on and deal with many contradictory objectives and interests in our cities and societies. Climate change adaptation of the built environment includes ensuring that new construction is adapted in line with the climate risks we will see in the future, as well as protecting and adapting the existing built environment. The latter in particular places demands on public-private partnership. Smart, effective solutions will be required in order to deal with climate-related risks and challenges, for example extensive torrential rain, rising sea levels and extreme heatwaves with drought and water shortages, following in the wake of a changed climate. This presents a major challenge, but also good opportunities to see the emergence of innovative new urban districts and pioneering architecture.

Climate change affects the whole of Sweden, but there are considerable differences in terms of how municipalities in different parts of the country are affected. In some municipalities the biggest problem is rising sea levels, while others have to deal with issues such as the risk of landslides, water shortages or shorter tourism seasons. The majority of municipalities believe that they have already been affected by climate change or extreme weather events. Cultural heritage can also be damaged by sudden events such as flooding, landslides and fire, as well as by slower changes such as higher moisture levels, which can lead to materials breaking down more quickly.

There are also risks associated with, for example, ground stability due to varying groundwater levels, high temperatures in outdoor environments, forest and grass fires near to settlements, the spread of pollutants, changes in the number of zero-crossings which can lead to frost erosion in buildings, moisture and mould, and high indoor temperatures where the need for cooling can in turn lead to goal conflicts with energy-efficiency measures.

Changes in the climate and length of the seasons makes it easier for ticks and various insects, infectious agents and host species to survive and propagate in new geographical areas. There is also an increased risk of new infectious diseases appearing in Sweden, which could include tropical diseases in future. Extreme weather causes deaths and other health effects, such as mental ill-health, either at the time of or in the wake of extreme weather. Flooding and landslides can also produce health effects due to toxic substances and infectious agents getting into drinking water. Significant burdens on health-care services or states of emergency can arise if essential social services such as electricity, communications, water, sewage or transport are knocked out. Climate change also affects the origin and distribution patterns of air pollution, extends the growing

season for various pollen-producing plants, and can increase air humidity and water ingress in buildings, resulting in damage due to damp and mould.

Effects on finance and insurance

A changed climate brings new conditions for the finance industry, including the insurance industry, since it involves higher costs of damage and affects investment decisions.

In recent years, the global financial system has been exposed to several shocks, including the 2008 financial crisis and the Covid-19 pandemic which broke out in 2020. The resilience of national and global financial systems against disruption is high on the agenda of many institutions, including the Riksbank (i.e. the Swedish central bank). The danger with climate-related risks is that they can cause extensive consequences within many different sectors at the same time. Climate change is therefore a systematic risk for the entire finance industry.

The significance of climate-related risks for the finance industry is becoming every clearer, and is attracting greater national and international attention from central banks, investors, lenders and businesses. Physical financial risks can involve acute risks for production facilities and value chains which arise in the case of extreme weather conditions such as storms, flooding, fire and heatwaves. There are also financial risks that arise through long-term changes to the climate, such as rising sea levels, which can affect the value of coastal communities. There are also transition risks, which are risks associated with uncertainties in connection with the transition to a low-carbon economy. If financial actors suspect that the future will be riskier, this can lead to rising capital costs. Increased flooding risk for homes, for example, can result in the security for the loan falling in value and the lender having to place greater emphasis on the borrower's ability to make repayments.

Globally, there is a growing trend of insured damage, caused by water-related incidents. This is primarily due to increased vulnerability through urbanisation, population growth and economic growth, with a large amount of new construction concentrated in areas that are exposed to risk, such as along the coast. Rising sea levels and the increased incidence and intensity of extreme weather events also contribute towards greater exposure and greater damage. There are also risks linked to new developments taking place in areas with a high risk of flooding, in the belief that the properties will be insurable. When climate change leads to increased compensation payments, this can lead to insurers deciding to make policies more expensive or unavailable. Individuals and business may then choose or be forced not to insure their assets. More limited insurance protection can have serious socioeconomic consequences and reduce the ability of individuals and business to adapt.

Effects on transnational dependence

Sweden has a great dependence on other countries, since it is a small player in geopolitical terms and in the global market. The welfare and functionality of our society requires secure, free flows of goods, services and communications. Sweden is dependent on exports and imports, and its level of self-sufficiency is low for a number of products. Drought, heatwaves and rising sea levels can trigger economic downturns, conflicts and migration in certain regions, and can affect Sweden's need for imports and exports of agricultural products, for example.

However, global trade does not only bring risks; it can also be an important buffer against changes and shocks in the domestic system, and Sweden can contribute exports to other regions that may have growing needs. The financial crisis and the food price crisis of 2007–2008 provide examples of how global trade can act as a buffer against local and regional shocks. However, this buffer only works as long as only limited geographic areas and systems are affected, and as long as free trade is not restricted by national regulations and does not lead to cascade effects that break trade chains.

Transnational consequences of climate change may be at least as great as those that directly affect Sweden. These increase the risks of war, conflict and poverty, and exacerbate shortages of water and food in regions that are already vulnerable. Climate change that changes conditions in other countries can affect the security policy situation, and can thus also affect Sweden in different ways. The combination of shortages of resources and population growth destabilises societies and fuels or intensifies conflicts, with people often being forced to flee as a consequence. Higher sea levels and severe storms threaten lives, property and infrastructure in coastal regions around the world. Global climate-related disruption to supplier chains involves a risk to domestic food security, input goods for agriculture and drinking water production, and to other manufacturing including supplies of healthcare equipment and pharma-

ceuticals in Sweden, bringing significant health threats and security risks.

The Arctic faces new opportunities, but also serious challenges. Indigenous people are particularly vulnerable. Climate change has helped to increase the economic importance of the Arctic. One of the most important changes is that the region is opening up to shipping. This allows for shorter trade links between Europe and Asia, for example, with changed trade routes and reduce costs for exporting and importing goods. These increasingly accessible shipping channels are expected to have geostrategic consequences for the Arctic, and thus also for Sweden's neighbouring areas in the north and northwest. Greater accessibility as the ice melts means increased competition for natural resources on the land, in the sea and on the seabed.

Climate change has – and will probably continue to have – a disproportionately large effect on developing countries, which may lead to increased inequality. Most of the countries to which Sweden provides aid are extremely vulnerable to climate change, and run a great risk of being affected by climate-related disasters.

Growing political and economic opposition in parts of the Middle East, Africa and Asia – combined with long rain-free periods, with drought as a consequence – may involve primarily increased migration streams within countries and in neighbouring regions, and also to the EU and thus Sweden. There is no clear evidence from research that large numbers of directly climate-driven migrants will come to Sweden, but Sweden still needs to prepare for climate change affecting the risk of conflicts, and thus indirectly leading to increased migration. As a member of the EU, Sweden is also affected by the mobility of people within Europe. Climate effects in southern Europe, combined with economic crises, may affect migration patterns within the EU if people are forced to flee as a result of a changed climate or to support themselves.

2.4 Monitoring and evaluation of the national climate change adaptation work

The Expert Council's monitoring is based on a qualitative identification of what is being done and what is required in order to address the risks identified and summarised in previous sections.

Implementing SMHI's proposed monitoring systems may eventually bring opportunities for more quantitative monitoring for indicators of risks and measures.

Monitoring and evaluation of access to and need for climate information, other planning data, guidance and warning systems

Access to reliable spatial information as planning data is a requirement in order to be able to analyse climate-related risks and make decisions on suitable adaptation measures. Sweden's municipalities have made different amounts of progress and have different needs in the climate change adaptation work, and these needs vary between different municipalities.

Several national agencies and county administrative boards contribute data, and a wealth of information has been gathered. In many cases, the municipalities are dependent on knowledge bases drawn up by other actors, but they sometimes find it hard to assimilate this information. A lack of resources, time and knowledge are real barriers, as are short planning horizons.

Planning data for climate change adaptation from different sources is neither uniform nor compatible, and can be hard to combine. For example, much of this data is based on different assumptions about future climate change/scenarios. There also tends to be a lack of data showing the cumulative risks, and it can therefore be hard to get an overview of the combined effects. However, it is not simply a matter of access to planning data. There is also a need for communication on the availability and applicability of existing data, both between national agencies and communications/municipalities, and between county administrative boards and municipalities.

The next generation of regional climate models is much better at simulating rain showers and torrential rain, and has shown a more significant increase in the intensity of torrential rain compared with previous results. Other processes for which these models are expected to bring added value include lightning, hail and extreme wind. However, the need for calculation is considerably greater and there is therefore a significant need for reinforced calculation resources and storage.

Work to produce guidance and guidelines based on available planning data needs to be carried out alongside drawing up harmonised, uniform data with a relevant level of resolution. The available guidance and guidelines have a relatively sharp focus on flooding, landslides and erosion. Some data is also available for phenomena such as heat-waves. For other areas, including water shortages, forest fires and storms, the data in the form of guidance and guidelines is more inadequate.

The Expert Council questions the introduction of national governing guidelines on dimensioning levels, etc. Sustainable decisions should be based on local risk analyses, but greater support is required from regional and national agencies on how decisions based on local conditions should take into account the changing climate. Guidelines are thus required for how these dimensioning values should be drawn up. These guidelines should not be steering, but should contribute towards uniform, transparent decisions.

Consequence-based warning systems bring better opportunities to act proactively in connection with climate-related events, and are central to disaster risk reduction and are thus also of great importance for climate change adaptation work. Warning systems need to focus on who and what is in the risk zone within all relevant sectors of society.

Monitoring and evaluation of access and need for measures – The natural environment and natural resources

There is a need for awareness-raising measures to increase understanding of how climate change

affects terrestrial ecosystems and green infrastructure. Otherwise, the need for climate change adaptation risks focusing primarily on issues relating to the built environment and infrastructure, with insufficient interaction with the departments within a county administrative board or a municipality, for example, that deal with the natural environment. This can lead to synergies not being taken into account, and can even create goal conflicts. By integrating climate change adaptation into plans for green infrastructure, resilience to climate change increases. The work with green infrastructure must therefore not be hampered by climate change, but must take climate change into account.

An overview is required in order to ensure that existing carbon sinks from land use are preserved and developed at the same time, with regard both to climate change adaptation and the reduction of greenhouse gas emissions, and to other components of sustainable development. Integrated landscape planning is required in order to ensure synergies and avoid goal conflicts. Greater knowledge is needed about which nature-based solutions for climate change adaptation promote and hinder carbon absorption, with regard to design and location-specific conditions. Advice directed at agriculture needs to be based on a holistic view of production, carbon sinks/reduced greenhouse gas emissions and biodiversity to ensure that contradictory messages are avoided.

Many measures linked to forestry are nature-based, and can involve synergies with several goals. One example is that planting mixed forest can make forests less vulnerable to storms and forest fires. Landowners can therefore secure their property, while at the same time increasing biodiversity. However, this may require a transition within the forest industry which, under current conditions, may involve an economic risk for both individual forest owners and the industry as a whole. The need for coordination and cooperation between different actors linked to forests and forestry will grow. Measures need to be carried out from a landscape perspective, taking into consideration the many ecosystem services of forests. This applies to the need to implement measures with regard to a landscape perspective, since forests have many ecosystem services, because measures can create both synergies and goal conflicts between different services.

Within reindeer herding, people are used to adapting to major environmental and weather-related variations, and have historically had a good ability to adapt. However, current and future climate change mean that reindeer herding will be less able to adapt. One identified key to successful climate change adaptation for reindeer herding is to reduce vulnerability through increased flexibility. This can lead to conflict with other land use interests. There is a need for increased knowledge in general and sharing knowledge between reindeer herding and other actors

in order to reduce the conflict potential and find solutions together.

Sweden's agriculture and food industry face major challenges. Climate change brings new types of threat, and strategies at national level are needed in order to tackle them. Large-scale operations and the homogenisation of agriculture, combined with climate change, mean increased vulnerability to plant pests and infections, for example. Food production needs to become more resilient to crises and extreme events. Resilient agriculture needs to be competitive. Just like measures within other areas, the majority of climate change adaptation is taking place through measures with a broader purpose. A newly built stable is easier to adapt to a future climate than an older one. Newly laid drainage can be dimensioned for a future climate, and so on. Investments, management and initiatives are also needed in order to benefit from the possible advantages of a warmer climate for Sweden's agriculture, such as a longer growing season.

Sustainable water management is central to climate change adaptation, and requires clear integration between urban planning and land planning, and between land and sea, where many of the sea-related problems need to be resolved on land. Both environmental aspects and supply aspects need to be included in this work.

Currently, problems linked to water and the natural environment are often not taken into account sufficiently. In a water shortage situation, it is often the needs of the natural environment that have to take a back seat. However, there are good opportunities for preventing future problems with well thought-out planning that meets both the various needs for water in society and the natural environment's needs.

Remedial efforts connected to the aquatic environment are currently underway in several different respects. Within water management, overall mapping is being carried out and administrative measures are being drawn up. These policy instruments are based on an identified need for the physical measures required in order to comply with environmental quality norms. However, remedial work is also carried out for different purposes. Measures to recreate physical impact on the natural environment are being carried out within restoration, and eutrophication and climate effects are being addressed within other areas. There is a need for financed coordination and cooperation that allows for long-term planning at drainage area level. The link to climate change adaptation should be a common theme running through this work. However, there are very real conflicts of interest that need to be dealt with. Difficult questions about issues such as ownership and purchasing operations also need to be addressed.

A number of factors influence the water balance in an area, including water extraction, water reg-

ulation and a changed climate. In order to understand and be able to deal with the effects of these influencing factors, better understanding and greater knowledge about the overall effect in a drainage area are needed. This is true not least in connection with water quantity and water quality. A great deal of data is lacking. Monitoring levels and seasonal variation everywhere is, however, probably unrealistic. Particularly sensitive areas therefore need to be singled out.

Strategic use of the coastal zone with regard to climate change reduces the need for adaptation measures in the future. Flexible land use and flexible planning are required in order to create climate adaptation measures that can be amended and restructured over time. This is important, since we do not know how much the sea is rising or at what rate. We cannot yet build protection for a situation which will arise in 100–200 years; this must be done in stages. The need for relocation will not arise on a specific occasion, but will be a continuous process that needs to take place alongside the climate adaptation of existing buildings and infrastructure, as far as this is possible and economically defensible. In parallel, new building and other establishment should be avoided in areas that are expected to be affected by changed sea levels within a time perspective corresponding to the anticipated lifetime of the buildings. There is a need for new supporting legislation to allow for flexible planning and land use in the coastal zone.

Climate change adaptation is required to ensure robust marine ecosystems with great diversity. Measures are needed to reduce the burden from land, to protect areas and populations so that they can withstand invasive species and have the chance to adapt genetically, and to restore habitat. Climate refuges, in other words places that are less affected by climate change than surrounding areas, can help to preserve species and biodiversity, and thus also increase the resilience of surrounding areas. As a consequence of a changed climate, there is a growing need for different management plans to be better coordinated and for relevant regulations to be reviewed for improved coordination and to identify major goal conflicts. There is a need to integrate climate change adaptation for marine environments and fishing in the work involving structure plans and detailed development plans at municipal level, regional plans, marine plans and programmes of measures for water and marine environment management. Environmental monitoring also needs to contribute information as data for climate adaptation measures.

The climate and climate effects are not currently mentioned in the open summary of the remit to build up food preparedness, despite the fact that domestic food production is vulnerable to both national and transnational climate-related disruption and thus requires greater emergency preparedness. Infrastructure that may be affected includes access to fuel, input goods, mobile net-

works, accessible roads and cooling. Continuity plans linked to aspects such as reserve water, reserve power, fuel stocks, evacuation plans and food supply are therefore needed. Additionally, national risk assessments of transnational climate risks are inadequate. These effects may become a major challenge for Swedish food security.

Monitoring and evaluation of access and need for measures – Infrastructure

Climate change adaptation of infrastructure and the transport system will require more highly developed cooperation between agencies, municipalities and other actors. There is a mutual dependence between the Swedish Transport Administration and the municipalities, for example, when planning infrastructure in relation to other land use.

There is a real need to identify and prioritise stretches of road and rail that are particularly vulnerable. An extensive, better and faster information system is required in order to have better preparedness and to reduce vulnerability to variations and extreme weather in a future climate. An increasingly electrified transport infrastructure may require specific climate adaptation measures.

A relatively large number of actors are involved in different parts of the aviation sector. The divided responsibility between multiple aviation actors has led to a degree of uncertainty about what influence different actors have on issues requiring measures that affect the entire industry. This divided responsibility, and sometimes unclear defining boundaries, may be one reason why climate change adaptation work has not yet gathered pace within the aviation sector.

When planning new shipping lanes or changing existing ones, climate change is not currently considered to any great extent. Data on climate-related risks is also needed in order to adapt harbours in vulnerable areas.

Despite the clear need for climate change adaptation linked to the transport sector, there is currently no link between the transport policy goals and the Government's overall goal of creating a society that is sustainable and robust in the long term, and is adapted in line with a changing climate.

Many drinking water producers have started working to adapt their water supply in line with climate change. Major work is also being carried out by several agencies to secure the future water supply. Despite this, much remains to be done in terms of adapting Sweden's drinking water supply in line with climate change. In order to make access to drinking water climate safe, knowledge is needed about which surface water and groundwater resources are available, and how these are affected by climate change, and an overview is needed of the water balance in a drainage area. Greater knowledge is need-

ed about today's water extraction and access to water, and about resources that may be of interest to use in the future, for example as reserve water sources. Prioritisation is also needed between different stakeholders for those occasions when there is little access. Not enough is currently known about Sweden's water extraction to allocate water between different users. Such knowledge is also needed when dealing with water extraction permit applications.

The transition to a fossil-free Sweden, alongside other development factors, means that there is a changing energy system which needs to be adapted in line with climate change. The energy sector is doubly affected by climate change. This is partly due to steering away from fossil fuels, and partly due to future energy systems having to be sustainable in a changed climate. Transition and adaptation are mutually dependent, and need to be coordinated. New sources of wind or solar power should not be established in risk zones for issues such as rising sea, landslides or flooding. If we build in the right places today with the support of better knowledge bases, we can avoid costs for moving energy production facilities or making them climate-safe in the future. However, the many different future scenarios produced by agencies and other actors offer different decision-making data, leading to a lack of clarity and creating confusion about which measures need to be taken to make the energy system climate-safe. To get a more cohesive picture for prioritising measures, cooperation is required on which scenarios for the future energy system should be drawn up and used.

Monitoring and evaluation of access and need for measures – Built environment, physical planning and human health

Sweden's municipalities will be affected to different extents and in different ways by climate change, and they have different conditions for working with climate change adaptation. The progress made by the municipalities in their climate change adaptation work varies. Those who have made the most progress have often already been affected by extreme weather events. Progress made with climate change adaptation work is also related to aspects such as the size of the municipality, political will, internal support, resources and geographic location.

Nature-based solutions can be used to slow down climate change and to deal with the negative effects of a changed climate, while at the same time promoting biodiversity and other societal benefits. Clearer support in legislation would increase the number of nature-based solutions.

Financing climate adaptation measures in the built environment is a key issue for many actors. The

issue needs to be dealt with differently for climate change adaptation on a small scale and when it comes to measures that affect larger geographic areas (such as across municipal boundaries) and large-scale climate adaptation measures.

Many climate-related risks need to be addressed from a broader perspective than within an individual municipality. Municipalities with limited resources for climate change adaptation can also benefit from using joint resources and joint expertise via inter-municipal networks.

Clear legislation is needed in order to determine the costs of necessary climate adaptation measures and who is responsible for these costs. When this is uncertain, there is a risk that measures will not be taken. There are also deficiencies in the application of existing provisions.

Despite the fact that strategies and guidelines are being drawn up for stricter planning and construction rules in coastal areas, planning for coastal settlements is continuing.

Amendments made to the Swedish Planning and Building Act in 2018 have allowed municipalities to specify provisions in their detailed development plans that aim to improve preparedness through sustainable surface water management. Despite this, the implementation of such procedures is going slowly.

In many cases, municipalities have no influence over land where climate adaptation measures need to be taken. Municipal responsibility for coordination would increase the opportunities for climate change adaptation of the built environment.

Many municipalities find that construction project planners do not make the necessary investments in climate adaptation measures. The incentives for actors within the construction industry to make climate change adaptations to properties need to be strengthened.

In order to protect public health, it is important to take measures to counteract high temperatures, both outdoors and indoors. Active measures such as air conditioning are an effective way to lower indoor temperatures, but they are energy-intensive and thereby risk contributing towards additional climate impact. These measures should therefore be prioritised in those environments where they are needed the most, in other words where vulnerable groups need to be protected. In other cases, less energy-intensive cooling measures, such as climate screening/shading, ventilation, etc., should be chosen instead if possible.

In order to quickly detect and rectify new infection risks, a national monitoring system is needed for both domestic climate-related infectious diseases and the threat of new diseases emerging. There must be cooperation between healthcare and

veterinary medicine, and data needs to be held in shared registers. This applies not only to data on the number of humans and animals who fall ill, but also to data on changes in the geographic extent of infection-spreading wild/domestic animals, disease-spreading species (such as ticks) and different types of infectious agents. Cooperation across sectoral boundaries is required in connection with knowledge and monitoring, in order to be able to deal with complex new challenges. The responsibility of regions, municipalities and private actors also needs to be clarified.

Monitoring and evaluation of access and need for measures – Business and industry

Regardless of size, industry and degree of internationalisation, an initial condition for building a climate-adapted industry is an awareness that climate change affects companies' operations, as well as the working environment; in other words, that the climate issue is bigger than simply companies' own climate impact. After awareness comes knowledge acquisition and application of this knowledge, as well as communication of risks to external stakeholders such as investors, customers, lenders and insurance companies.

Around a million small and medium-sized businesses in Sweden need information and knowledge in order to make climate change adaptations to their operations. Companies are emerging that offer climate change adaptation solutions. However, there is still a lack of structures and context for cooperation, advice and dialogue with municipalities, regions and agencies, and there is no common industry designation for these companies.

The need for climate change adaptation is often missing from existing regional development strategies, which may be due in part to the need for climate change adaptation not being clarified in Ordinance 2017:538 on regional growth work. Several of the European Regional Development Fund's regional programmes for the 2021-2027 programme period will be able to include support for the promotional system for regional industry, which in turn strengthens companies' capacity for climate change adaptation.

The dry summers in recent years have been a wake-up call for several industries. Companies have not had any plans or strategies for a secure water supply with regard to quality, access and emergency preparedness. A company's water supply strategy should include engaging in preventive dialogue with its water supplier. It is no longer possible to only rely on other actors for water delivery. More and more initiatives are being developed in relation to water efficiency, including in proposals for programmes of sub-measures in the southern Baltic Sea's water district.

There is currently insufficient knowledge about how much water is used by industry, in other sections of society, and in nature. In the long term, an order of priority between different water users in the event of water shortages will need to be drawn up and brought into use. Access to information on extraction is an initial step in this process.

Sweden is the only country in the EU that does not have a cost for water extraction. According to the Water Framework Directive, Member States should observe the principle of cost recovery for water services. An economic value of all water would not only mean new funding for climate adaptation measures, for example, but would also create driving forces in terms of how society's actors view water. A water extraction fee can thus be used to achieve cost-effective solutions and encourage technological development.

Even large, international companies have low awareness of physical climate risks in their international value chains, and are thus vulnerable to transnational risks. The greatest risks for Swedish companies are in the parts of the supplier chain that are furthest away, often in developing countries. This is despite the fact that there is considerable exposure to climate-related risks, particularly within the manufacturing industry and textiles.

Monitoring and evaluation of access and need for measures – Finance and insurance

There are currently no overall calculations or even estimates of the need for investment for climate change adaptation in Sweden. Nor are any conditions currently in place for carrying out a traditional cost/benefit analysis of climate adaptation measures at national level. However, it is clear that the costs will be very large. The need for investment in adaptation may even affect state finances, for example through the negative impact of climate effects on GDP and via effects for commercial state companies.

Better access to information about physical climate risks is needed in order to steer investments towards making operations more resilient. Assessing the consequences of climate risks for the actual economy, for example a business's delivery chains or production and the financial effects thereof, is a relatively new area. If the climate-related risks are to be measured, priced and dealt with, better reporting of these is needed from both financial and non-financial businesses. An important aspect of this work is therefore developing methods that make it possible to quantify climate-related risks and investment opportunities.

Insurance policyholders' exposure and vulnerability to climate change is increasing continuously. A clarification is needed for insurers, policyholders, municipalities and the Government on responsibility

for disaster risk reduction and climate change adaptation. Reduced access to and higher prices for insurance may lead to fewer parties being insured, meaning less ability to adapt to the effects of climate change. Sweden has a market-based system for property insurance, with little state involvement. One of the lessons learned from the Covid-19 pandemic is that major crises require solutions that involve both the state and the insurance industry. Public-private disaster buffers can help when dealing with events where the level of disaster damage is beyond the capacity of the insurance industry. However, state intervention with the aim of increasing insurance protection must not be an incentive not to insure where this is possible, or not to take adaptation measures.

Monitoring and evaluation of access and need for measures – Transnational dependence

Transnational consequences of climate change may be at least as great for Sweden as those that are due to climate change in Sweden. However, climate change adaptation with regard to transnational dependence within areas such as trade, food supply, infrastructure, finance, aid, international disaster preparedness and security policy is still on the starting blocks. Here, there is a need for knowledge building and strategic external analyses. Transnational climate-related dependence needs to be included in the rebuilding of civil defence, taking the coordination of different agencies' work as a starting point.

One example of geopolitical impact that needs to be taken into account is when the Northeast Passage opens due to Arctic ice melting. This is an example of how even new opportunities that arise due to climate change can lead to competition and conflicts in the absence of effective cooperation that resolves conflicts.

Climate change adaptation is an area that has gradually gained a greater focus in the Paris Agreement. By taking a more active and prominent role in adaptation issues, Sweden and the Nordic region can contribute towards the negotiations bridging the confidence gap between poor and wealthy nations. Justice-related aspects with support for vulnerable regions in countries with inadequate infrastructure need to be integrated into this work. Sweden often imports from these countries. Together with insurance systems that make risk-taking possible and a fairer trading system, opportunities for the private sector in developing countries can expand, and this in turn will lead to greater opportunities for climate change adaptation.

Greater opportunities for the expansion of the private sector in developing countries contribute to the opportunity for climate change adaptation by providing an expanded, diversified research base. There is therefore a need to increase knowledge among Swedish investors on the conditions for investment in developing countries. The deteriorated security situation increases the need to contribute towards training police and military officers, and this is an area where Sweden has experience. This may be a fundamental necessity in order for international investors to invest in a region.

Support for climate change adaptation in developing countries can, for example, contribute to the development of warning systems at national, regional and local levels linked to climate-related events such as drought and flooding. Warning systems that allow for proactive measures, together with for example the development of digital marketplaces, can support both small-scale producers and consumers when parts of a region are affected by drought or flooding.