5 Support and instruments for reduced vulnerability

5.1 Mapping of floods, landslides and erosion

There are areas in Sweden which, because of their location and topography and the nature of the soil represent risk areas for landslides and flooding. Natural disasters of this kind entail high costs for society as well as risks to human life, but can be prevented to a reasonable degree. The Swedish Parliament (Riksdag) in 1986 passed a government bill on preventive measures against landslides and other natural disasters (1985/86:150). The Swedish Rescue Services Agency was given responsibility for general stability mapping and for sharing out government grants between preventive measures in developed areas. Since 1998 the Swedish Rescue Services Agency has also carried out general flood mapping along parts of the larger Swedish watercourses in accordance with tasks identified for it in the Agency's appropriation directions.

5.1.1 Existing flood and stability mapping and inventory of shore erosion

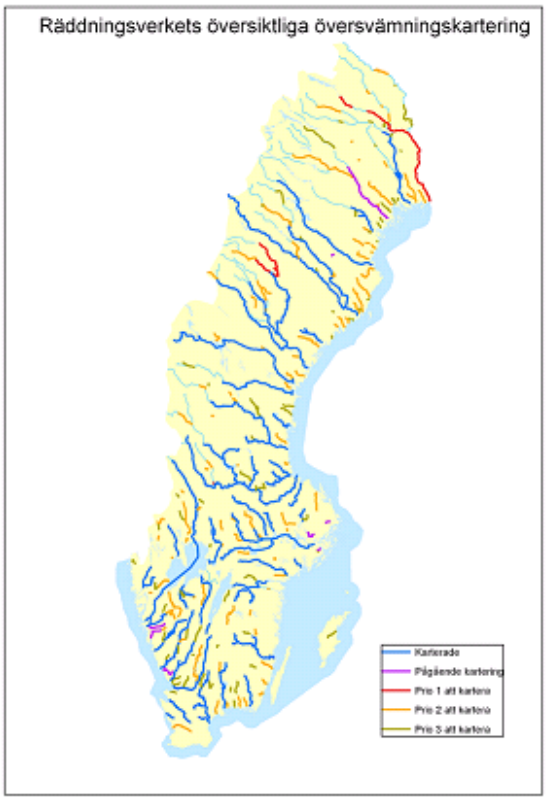
Surveying areas at risk of floods, landslides and erosion entails work in several stages – general mapping, detailed mapping, where necessary in-depth mapping of stability and preventive measures. The general mapping carried out by the Swedish Rescue Services Agency identifies areas that do not have satisfactory safety and where detailed investigations should be carried out. The detailed investigations may show that conditions are satisfactory or provide the basis for continued investigation or planning of preventive measures and applications for government grants. Detailed investi-

gations at present are the responsibility of the municipality or property owner.

Flood mapping

The purpose of general flood mapping is to broadly identify areas at risk of flooding along watercourses. The maps provide support in the operational planning and action plans of the rescue services and serve as a basis for the municipality's overall planning. They are used in the county administrative board's review of the municipalities' public planning. Around 10 per cent of Swedish watercourses have been prioritised by the Swedish Rescue Services Agency for general mapping, which is equivalent to 10 000 kilometres. To date around 8000 kilometres have been mapped in 56 watercourses in 154 municipalities, see Figure 5.1.

Figure 5.1 Watercourses with general mapping (2007)



Source: Swedish Rescue Services Agency, 2007.

Swedish Rescue Services Agency general flood mapping

Mapped
Mapping in progress
Phase 1 to be mapped
Phase 2 to be mapped
Phase 3 to be mapped

The mapping is done for the estimated 100-year flow and design flow. The 100-year flow is estimated on the basis of statistical analysis of observed water discharge series and occurs with a risk of 1 in 100 for each year during a 100-year period. The probability of the flow occurring during a 100-year period is 63 per cent. The design flow is calculated on the basis of the guidelines of the

Design Flood Committee for the dimensional design of risk category I dams, when the most unfavourable conditions are combined, see section 4.2.2.

The watercourse is described using dam and bridge drawings, the characteristics of the watercourse and the surrounding topography. The water level is calculated in two sections across the watercourse using a hydraulic model and is interpolated forward along the watercourse. The area of flooding is calculated with the aid of the digital elevation database of the National Land Survey of Sweden. GIS (geographical information system) is used for mapping.

More detailed calculations of water levels and a more accurate description of topography are required in the detailed planning of building development. The elevation database of the National Land Survey of Sweden is based on elevation data every 50 metres and a mean error in elevation of 2.5 metres. The deviation may be positive or negative. The database is intended for overall planning. More detailed elevation data are required for more accurate calculations and mapping.

The mapping is passed by the Swedish Rescue Services Agency to the affected municipalities and county administrative boards in report and digital form. The digital map layers can be linked to other suitable maps which show flood risks for instance for building construction and roads. The map layers can also be linked to various coordinate registers which indicate risk areas for landslides, environmentally hazardous activity etc. The municipalities are advised by the Swedish Rescue Services Agency if necessary to draw up an action plan stating which areas should be the subject of detailed investigation and any preventive measures.

Stability mapping

In support of the work of municipalities and county administrative boards on risk management, the Swedish Rescue Service Agency has been responsible since 1987 for carrying out general mapping of the stability conditions of the ground in areas with building development on clay and silt slopes. The aim is to identify areas which by the general mapping method cannot be regarded as stable and to provide a basis on which to decide where detailed investigations should be carried out. Stability mapping was performed in

151 municipalities in 2006. Three municipalities had already been mapped with respect to ravines and slopes in moraine and coarse sedimentary deposits. Completed stability mapping is handed over to affected municipalities and county administrative boards in both map format and in digital form as map layers.

General stability mapping is carried out in two stages – a preliminary study and a main study. The preliminary study is performed very broadly in consultation with the municipality with the aim of defining areas to be dealt with in the main study. The main study is carried out in two stages and is an ongoing nationwide activity which is gradually being performed one municipality at a time. The first stage entails distinguishing special areas with and without the necessary conditions for landslides on the basis of soil type, topography, proximity to watercourses and places where groundwater emerges. The second stage involves distinguishing areas on the basis of field studies and calculations that cannot be classified as satisfactorily stable or where the stability conditions cannot be clarified. A detailed geotechnical investigation should be carried out for these areas. The main study does not provide precise answers on the risk of landslides. Prior to the adoption of detailed development plans and building permits there is a need for at least a detailed geotechnical investigation to establish the stability of the ground. Figure 5.2 shows which municipalities have been the subject of stability mapping and what stages of mapping have been carried out.

Figure 5.2 **Total number of municipalities subject to stability mapping in preliminary study/main study (2007). Some form of preliminary study/main study has been carried out in the municipalities shown in colour**

Source: Swedish Rescue Services Agency, 2007b.

Inventory of shore erosion

The Swedish Geotechnical Institute (SGI) is conducting an inventory of the extent of shore erosion in Swedish in collaboration with affected municipalities. The purpose of the inventory is to obtain an overview of where shore erosion occurs along the country's coasts and on the shores and banks of lakes and watercourses. The inventory to date has been carried out for all coastal stretches including adjoining large and small islands and the larger lakes. Watercourses will be the subject of a subsequent inventory. The inventory may form the basis for a first overall assessment of the extent of shore erosion. Supplementary studies are needed to determine risk areas, the need for reinforcement measures and as a basis for physical planning.

Known erosion conditions and the factors predisposing to erosion are reported for each municipality. Known erosion areas

are based on data from the municipalities with a description of geological conditions, erosion status and the extent and type of any protection against erosion. In addition to this, the inventory includes a survey of factors predisposing to shore erosion on the basis of geological conditions. The inventory is being gradually published on the SGI website.

5.1.2 Use of mapping in the municipal planning process

Under the commission of inquiry we have arranged for a survey of ways in which municipalities take account of floods and landslides in the municipal planning process, how they deal with the Swedish Rescue Services Agency's general mapping and to what extent they do their own mapping. The questionnaire has been sent to all municipalities, in other words both to those which have been mapped by the Swedish Rescue Services Agency and those which have not. The questionnaire was returned by 136 municipalities. More than half the respondents have suffered damage as a result of flooding, almost half as a consequence of landslips/landslides and around a quarter as a result of both. The results are briefly described below; see also Annex B15.

Flooding

Of the 136 respondents, around 80 per cent have taken account of flooding risks in their planning, particularly in detailed development plans but also in the comprehensive land-use plan. More than half have not done any mapping of their own. The reason for this has been adequate knowledge of local conditions and circumstances, no development taking place in areas at risk, lack of resources, inadequate data etc.

Fifty-eight municipalities state there is general flood mapping from the Swedish Rescue Services Agency, which should be regarded as a low number as the SRSA had mapped watercourses affecting 154 municipalities in 2006. Of these, 45 have made use of the mapping and considered it to be of assistance to them. The mapping has been used in particular in work on comprehensive land-use and detailed development planning, and to a far lesser extent in infrastructure projects. Around two-thirds of those who

have used the mapping state that it has influenced the municipality's decisions, that the mapping is easy to understand but also too imprecise. A third of those who have used the mapping regard the information as reliable. Two-thirds have entered the mapping into the municipality's GIS system. Only nine municipalities keep the mapping up to date, the reasons given being lack of resources, insufficient experience and having their own material. Half have followed up the mapping with their own analyses such as maximum flows and in-depth mapping. Seven have applied for grants for preventive measures. Just over half the 136 respondents, principally those municipalities which have suffered flood damage, state that they need external support. The support relates to detailed mapping, clear climate scenarios concerning sea levels, flows and independent expert assistance.

Landslides

Sixty per cent of the 136 respondents have taken account of stability risks, principally in detailed development planning. Most of the others state that they do not have such risks, but shortage of resources and lack of data are also given as reasons. Fifty-four municipalities have carried out their own mapping. The respondents principally attribute not having carried out mapping to the lack of risks and shortage of resources.

Only 29 municipalities state that they have access to general mapping from the SRSA. The SRSA had carried out stability mapping in 151 municipalities in 2006. The survey shows that a relatively large proportion of the municipalities, 40 per cent, are not aware of the mapping at all. Virtually all the municipalities that have been aware of the mapping have used it and consider it to have assisted them in their comprehensive land-use and detailed development planning and in in-depth analysis, but also in infrastructure projects. Nineteen municipalities consider the mapping to have influenced their decisions and that it is endorsed in the municipality, is easy to understand and is, largely reliable, but is too imprecise. Several administrative bodies use it, but the emergency services rarely do so. Few municipalities have entered the mapping into their GIS systems and kept it up to date. Reasons given include the mapping being regarded as too imprecise, shortage of resources, the mapping not influencing the municipality's decisions

on planning and the mapping previously having existed in digital form. Most of the respondents have followed up the mapping with their own in-depth analyses. Fourteen have applied to the SRSA for grants for preventive measures.

Almost half the 136 respondents state that they need external assistance with their planning for landslides, and a relatively large proportion state that they do not have any knowledge of the area. The assistance comprises mapping, updating of existing map material, in-depth analyses, interpretation of mapping, expertise and financial assistance.

Taking account of climate change

Just over 40 municipalities have taken account of climate change in some way. Of these many have taken expected higher water levels in watercourses and seas into account in their comprehensive land-use plans. The measure most commonly taken has been to raise the minimum level for foundations. New rules in the planning of wastewater systems is another measure mentioned. Several respondents state that safety has been enhanced by taking greater account of flooding, but without written rules. Two-thirds have not taken account of climate change. Reasons given are not having identified the risks, inadequate data, shortage of resources and expertise and lack of signals from government agencies, politicians and experts.

Almost 75 per cent of municipalities state that they will plan for changes in the future, for instance safety regulations and safety margins for floods and landslides. However, many of them are unsure and consider it to be too early to take any decisions. Many are waiting for clearer material on which to base decisions from government agencies and others.

The municipalities' wishes for improvements and needs for assistance

The municipalities have made suggestions in the survey for improvements to SRSA's general flood mapping. Wishes are expressed concerning better elevation data, increased level of detail, increased use of municipalities' primary databases owing to

deficiencies in the National Land Survey of Sweden database, increased clarity regarding the elevation system of the digital layer and expanded and explanatory information in connection with the mapping activity.

There is also an expressed wish on the part of the municipalities for increased assistance with the planning process in relation to provisions on how flooding risks are to be managed, clearer climate scenarios, assistance with analysis and skills, advice from independent experts, increased collaboration between municipalities and government agencies and resources for mapping. There is also a wish for more detailed mapping in areas where there is a great risk of damage.

With regard to stability mapping there is a wish for greater depth in order to enhance credibility, increased coverage and more detailed information. There is a wish to have high-risk areas surveyed with regard to stability in conjunction with flooding risks and areas at risk outside conurbations, as well as detailed inventories along major watercourses. Financial assistance and technical assistance from experts and government agencies are also mentioned as being crucial.

5.1.3 Mapping in a changed climate, considerations and proposals

The SRSA should continue to be made responsible for general mapping of flood areas and stability conditions in areas of building development, see also sections 4.3.1 and 4.3.2. It is vital that mapping continues to take account of changes in the climate. The need for a review of areas already mapped with respect to climate change should be clarified. Supplementary mapping should then be carried out where needed. Our view is that the maps should be generally available, free of charge, and be in digital form. We consider that the detailed mapping/investigation should continue to be the responsibility of municipalities and property owners. The cost of converting the flood mapping of 100-year flow is estimated at around SEK 10.5 million.

It is essential that a review of existing mapping in relation to a changed climate focuses primarily on the areas at greatest risk. The flow picture across the country will change in nature. In some watercourses the 100-year flow is expected to have a substantially

shorter recurrence interval, while in others the opposite is expected. In some areas the risk of landslides will increase, while in others it is expected to be unchanged or even decrease. New areas at risk may also be added in non-mapped watercourses.

SGI has carried out a national general survey of coastal areas in which the factors predisposing to shore erosion exist. Greater depth should be given to the analysis of risks of shore erosion in areas of building development so that it can meet the need for more detailed investigations and reinforcement measures, see also section 4.3.3. Account should be taken of climate change and changes in sea level. The costs of mapping shore erosion in areas of building development along the cost are estimated by SGI to total SEK 2 million per year over a five-year period. In addition there is a cost of SEK 1 million for the development of models. It is also important to take account of areas of great natural and recreational amenity, but this should be a secondary concern. Our aim is to combine responsibility for all general mapping. SRSA, in cooperation with SGI, should be given responsibility for mapping shore erosion in areas of building development.

There is a need to add depth to the analysis of geographical areas with factors predisposing to landslides against the backdrop of climate change (Fallsvik et al, 2007). There is likewise a need for a general national map database of factors predisposing to landslides in areas of building development and areas with development potential. These proposals are discussed more fully in section 5.2.

It is apparent from the municipal survey that the municipalities would like to see more detailed mapping and more detailed elevation data. The elevation database of the National Land Survey of Sweden is intended for general planning. The database cannot be regarded as adequate with the increased risk scenario brought about by a changed climate. There is a need for a new national elevation database with greater accuracy than the present-day one, see also section 5.2.

The municipalities would like to receive technical assistance from government agencies and experts, as well more information in connection with mapping. The county administrative board is responsible for providing material for the municipalities' public planning. This responsibility should be further clarified, see also section 5.10 on responsibilities and 5.8 on information and technical assistance. There is also a need for expert agencies such as the

Swedish Meteorological and Hydrological Institute (SMHI) and SGI to assist with the planning activities of the municipalities, as discussed in sections 5.5, 5.8 and 5.10.

The municipal survey reveals clear deficiencies in the municipalities' knowledge of how general mapping has been carried out. Our view is that the municipalities should revise their routines for the use and maintenance of mapping. We also consider that SRSA should improve the clarity of information supplied to the municipalities in mapping activity.

Proposals

- The SRSA should continue to be tasked with general mapping of flooding risks and stability conditions in relation to landslides in areas of building development and in consideration of climate change. The SRSA should also clarify the need for a revision of mapping already carried out in view of changes to the climate, as well as carrying out such supplements. The SRSA should also be tasked with mapping risks of shore erosion in areas of building development, in cooperation with SGI. The maps should be generally available, free of charge, and in digital form.

5.2 Databases and knowledge resources

A very important element in efforts to adapt society to a changed climate is access to and availability of knowledge. As well as establishing new knowledge, there is a great need to clarify what knowledge and information exist and to make it readily available. Extensive material relevant to risk analyses, planning and adaptation measures currently exists at county administrative boards, other authorities, municipalities, organisations and research institutions. Climate change will affect all sectors of society but to differing degrees, and it is vital that everyone is given an opportunity to acquire the material that exists and is required for the adaptation of their own area of activity in a simple way. In the following section we identify a number of databases that are important for many players in adapting to a changed climate and that should be made more readily accessible or improved.

5.2.1 Need for a better national elevation database

The use of digital geographical information has increased substantially in recent years. The technology, knowledge and opportunities relating to digital methods of analysis have been developed and made new areas of use possible for geographical information. There is a reliance on good-quality topographical information in many analyses. The elevation database, GSD-Höjddata, which the National Land Survey of Sweden completed in the early 1990s, does not have sufficient resolution and accuracy for many of the analyses that need to be carried out today. The elevation database today is supplied as a grid with a spacing of 50 metres and with a mean error in elevation of 2.5 metres. In the case of some projects, the stakeholders themselves have chosen to carry out their own measurements in order to obtain more detailed elevation data. The relatively poor resolution of the elevation database makes it difficult to use as a basis even for general mapping. Various users have also criticised the high cost of using the national elevation database. It cannot really be considered efficient and cost-effective for different elevation databases to be created and for uncertainties also to arise as to which elevation systems have been used.

The National Land Survey of Sweden is now working to develop the basis for a new Swedish elevation model, and certain tests have been done. No decision has yet been taken on the elevation model. The model will ideally be supplied as a grid with a spacing of 2.5 metres and with a mean error of 0.5 metres. The whole of Sweden would be included in such a model. Particular areas might possibly be given higher priority, depending on funding and level of interest. The cost of constructing such a database is estimated at around SEK 200 million. This cost includes maintenance during the actual phase of construction. In addition there is the cost of updating the database.

We consider it essential that the National Land Survey of Sweden is given resources and the task of creating a new national elevation database with denser and more precise elevation data than the present-day one, largely in accordance with the proposal now being drawn up by the National Land Survey of Sweden. We also consider it important that such an elevation database is supplemented by another two contours along the coast at the 1 and 2 metre level to facilitate planning with a rising sea level. A database of this kind should be made generally available, free of charge,

to public-sector players such as municipalities and government agencies.

Proposals

- The National Land Survey of Sweden should be given the resources for a new national elevation database with denser and more precise elevation data than the present-day one. The database should be generally available, free of charge, to municipalities and government agencies and in digital form.
- It should be made clear in the instructions to the National Land Survey of Sweden that the agency is given responsibility for adaptation to a changed climate in its area of responsibility, see section 5.10.2.

5.2.2 National database of factors predisposing to landslides

A climate with greater and also more intensive precipitation and increased runoff in large parts of the country is expected to have significant consequences for the suitability of land for building development and for the safety and damage scenario in infrastructure and building construction. The general analysis in section 4.3.2 points out that areas which today are judged to have acceptable stability may become unstable in the event of increased precipitation, which may lead to landslides. The tendency towards erosion and the formation of ravines is also expected to increase in parts of the country.

SGI, in cooperation with the Geological Survey of Sweden (SGU), the National Land Survey of Sweden and the SRSA, has previously presented a model for a national general map database of factors predisposing to landslides in areas of clay and silt. The intention was for the map database to form the basis for general planning, so that slope stability could be managed more safely through the planning and construction process. It was proposed that the database should be produced in areas with a high or moderate frequency of landslides, which was estimated to represent 200–300 map sheets for the whole country. The cost of the production and administration of 200 map sheets was estimated at

SEK 47 million in 2001. (SGI, 2001) This cost is estimated by SGI to have increased.

As well as municipalities and county administrative boards, there is likely to be interest in the database in the National Road Administration, Banverket (the National Rail Administration), the SRSA, the construction industry, insurance companies and so on.

We consider it essential to set up a national map database of factors predisposing to landslides. There is also a need for broad assessments of factors predisposing to landslides outside the areas with existing building development, as there is a risk of infrastructure, for instance, being affected by landslides to a greater extent than at present. The databases should take account of climate change and cover both areas with building development and potential areas for development. It is intended that it will be possible for factors predisposing to landslides to be assessed on the basis of a GIS analysis based on soil types and topography. To assist in prioritising areas to be included in the database, an in-depth analysis should be performed of geographical areas with factors predisposing to landslides. The in-depth analysis should suitably be based on the work on general maps of the changed stability of soil types undertaken as part of the commission of inquiry (Fallsvik et al, 2007). The database should be made generally available and be free of charge and in digital form.

The intention is for the map database to supplement the SRSA's general mapping. It should also be possible for it to be coordinated with mapping of other types of natural disasters, for examples floods.

Proposals

- SGI, in cooperation with SGU, the National Land Survey of Sweden and the SRSA, should be commissioned to compile a national map database of factors predisposing to landslides in areas with building development and potential areas for development. The map data should take account of climate change. In order to prioritise areas to be included, an in-depth analysis of geographical areas with factors predisposing to landslides and landslides should be performed. Analyses performed under the work of the commission of inquiry should

form the basis for the in-depth analysis. The maps should be generally available, free of charge, and in digital form.

5.2.3 Meteorological, hydrological and oceanographic data and comparisons with climate models

Availability of reliable and usable meteorological and hydrological data is essential for planning and decision-making in a number of different areas of society. A wish is often expressed for access to information on the form a changed climate might take in terms of different climate parameters in a particular place and in comparison with historical observation data. Observational data cannot, however, always be easily compared with the data produced using climate models, as the latter represent a geographical area rather than a point. There is, however, a strong wish for it to be more readily possible to compare these two data types.

The Swedish Meteorological and Hydrological Institute (SMHI) today is a network of meteorological, hydrological and oceanographic measuring stations, where data are collected on a point-by-point basis. In addition, data are gathered for instance by radar and satellite and are exchanged with the meteorological services of other countries. Some of SMHI's stations report in real-time, while data from others are gathered and processed more frequently, for example monthly. A quite small number of these stations have long observation series which extend over periods of time and are of climatological interest. Many stations only have shorter observation series, and some historical observation data are not digitised. For some climate factors, for example the presence and depth of ground frost, as well as certain oceanographic parameters, the observation network is sparse. Observation data are made available to the general public to a certain extent through the media and the Internet. SMHI also provides data for all non-commercial use at a cost equivalent to the work of extraction/distribution. In 2005 SMHI supplied data free of charge equivalent in value to SEK 55 million for non-commercial research and environmental activity. Commercial users, including SMHI's own business operations, are charged a licence fee (SMHI, 2007b).

The observation network is not in all cases sufficiently fine-mesh, and its availability in not such that all the needs and wishes of society for data can be met. Private-sector players, for example

the National Road Administration, water-regulation enterprises and municipal wastewater treatment plants, therefore have their own measuring stations with a varying degree of detail.

Various players have expressed a wish for more information and data under the inquiry, often site-specific, for instance relating to precipitation and flows. This applies for example to players in stormwater management, who want higher-resolution precipitation data for the dimensional design of stormwater systems, and follow-up of high flows which can be related to calculated flood risks and design flows of significance for dams.

A build-up of knowledge on how climatic factors and extreme weather events affect different sectors of society also generally requires access to digitised, detailed and geographically precise observation data. Internationally, partly as a result of agreements in GCOS *(Global Climate Observing System)* and GEO *(Group on Earth Observation)*, the trend is moving in the direction of increased availability of observation data.

We consider it important to increase the availability of observation data through re-analysis and digitisation. SMHI should be tasked with making proposals on how this should be done. SMHI should also be commissioned to describe how a denser observation network, or other measures, can contribute to an improvement in access to climatological parameters with higher geographical resolution. The consequences of making such material available generally and free of charge, and ways in which it can be made easier to compare historical observation data and data from climate models should also be elucidated.

Proposals

- SMHI should be asked to make proposals on how increased availability of data through re-analysis and digitisation can be brought about.
- SMHI should be commissioned to describe how access to climatological parameters with higher geographical resolution can be improved through a denser observation network, or other measures. The consequences of making the material available generally and free of charge should be elucidated.

5.2.4 The Adaptation Portal

The consequences of climate change make it necessary for society to enhance its knowledge of vulnerability and adaptation needs. Cooperation has been under way since 2005 in a network of government agencies to create a joint portal containing combined knowledge on vulnerability and climate adaptation, known as the Adaptation Portal. The National Board of Housing, Building and Planning, the SRSA, SGI, SMHI and the Swedish Environmental Protection Agency collate knowledge and information on climate adaptation to assist municipalities, county administrative boards and other local/regional players.

This work has led to the development of a web-based aid which is on the SMHI website (*www.smhi.se/klimatanpassning*) and which is available generally and free of charge. The aspiration is for the portal to be updated as knowledge increases and the number of practical solutions multiplies. See also section 5.8.

5.2.5 National platform for collaboration on natural disasters and database of naturals disasters that have occurred

Extensive UN activity is in progress to prevent natural disasters and minimise their effects. All member states of the UN have, for instance, undertaken to follow the Hyogo Declaration and the Hyogo Framework for Action and establish a 'national platform' for work on natural disasters by 2015. In Sweden the SRSA has been commissioned by the Government to establish such a platform for natural disasters in collaboration with affected agencies and organisations. The task is to take measures to improve the coordination of efforts towards preventing and mitigating the effects of natural disasters.

The SRSA was tasked in 2005 with building up a database of statistics that provides a combined picture of natural disasters in Sweden within the Swedish Centre for Lessons Learned from Incidents and Accidents (NCO), and in collaboration with the government agencies affected. The background to the assignment is that at present there is no collated information in Sweden on natural disasters, their consequences or experiences and lessons learned by various players. In connection with major accidents or accidents and incidents from which substantial experience can be

drawn, the SRSA acts as a national and international observer to learn both from operations and from how cooperation and preventive measures have worked. The contents of the data will be based on the agencies' feedback of experience. The natural disasters included are extreme precipitation, earthquakes, avalanches, forest fires, landslides, storms, shore erosion and flooding.

We consider it important that information on the database is disseminated and that it is used for the purposes of prevention, damage remediation and reconstruction. The database should be available generally and free of charge and should be continuously updated. This database can be regarded as part of the SRSA's task of starting on the establishment of the national platform in collaboration with affected government agencies and organisations.

The insurance industry has extensive statistics on extreme weather events that have occurred. It would be valuable to link relevant parts of these statistics to the database.

5.2.6 The Planning Portal

Climate change makes new demands on the location and planning of building development and infrastructure. Vulnerability can be reduced by adapting planning to a changed climate and taking preventive measures.

The Planning Portal is an ongoing project run by the National Board for Housing, Building and Planning to create a web service to assist with physical planning, regional development planning, infrastructure planning, urban and rural development and with the locating and permit approval of buildings and installations. Companies, municipalities, government agencies, organisations and individuals are to be able to search for and retrieve geographical information that is relevant to community planning and general planning via the Portal.

5.2.7 Databases in different sectors and geographical areas of responsibility

County administration boards and municipalities

Information and data of value to planning and decision-making in urgent situations may be dispersed between different administrative bodies in a municipality or government agency. We consider that municipalities and government agencies should make an inventory of and collate such information, for example on land and water conditions within their areas of activity, so that it becomes readily available to users. This can be achieved by collecting the information in digital databases that are integrated into the GIS systems of municipalities and government agencies.

Bedrock, soil types, groundwater, seabeds

There are several database in SGU that are freely accessible and are of value in planning construction, in studying soil stability and for water supply. This applies for instance to information on bedrock, soil types, groundwater and wells.

SGU has produced a map on behalf of SGI showing factors predisposing to erosion along coasts and watercourses. Shore erosion in principle constitutes a grey area between land and sea mapping and to date has not been taken into account to any great extent. The information on rock and soil types provided by SGU is of relevance to the assessment of the risk of erosion along Swedish shores. In conjunction with marine geology mapping, which now goes to a water depth of 3 metres (previously 6 metres), attempts are made to clarify the material dynamics on the seabed, which can be regarded indirectly as having an impact on coastal erosion.

However, there is generally a lack of detailed information on the height conditions of the seabed, its bathymetry and the change in it as a result of erosion and transport of sediment. The working groups under the commission of inquiry have indicated that this makes the work of assessing the development of coastal erosion and flooding of areas close to shorelines more difficult. The National Maritime Administration has material on marine measurements in a national depth database. The data are not generally available and are digital to a limited extent. Municipal ports may also have similar data locally. The Armed Forces also have access to depth

data, which at present are classified information, see also section 4.1.3. For sea areas alongside building development there is, however, often a lack of data on shallow areas of significance to coastal processes.

In order to create new ways of assessing coastal erosion in relation to climate change, the National Maritime Administration should be commissioned as far as possible to collate existing material and present it in digital form. This should be done in cooperation with SGU and the Armed Forces.

Register of bridges

The bridge management system of the National Road Administration includes a database containing data on bridges, see also section 4.1.1. The National Road Administration has proposed certain additions to the database, for example information on what bridges cross water and searchable data that identify the watercourses. It should be possible for data from this database to provide valuable material for the general flood mapping for which the SRSA is responsible. We consider it important that specific sector material to as great an extent as possible is made available to other sectors.

Geotechnical and geological information

There is information at present on geotechnical studies etc. dispersed among many players, such as SGI, SGU, the National Road Administration and municipalities. The view has been expressed during the work of the commission of inquiry that a compilation of this existing material would be valuable, so that it is readily accessible for other players. SGI presented a preliminary study in 2002 which describes a national database for geotechnical studies (Rydell, 2002). We consider that a national database of this kind would be of value for adaptation efforts in the future. It should be possible for it to be developed within the operations of the National Road Administration.

Proposals

- The National Maritime Administration should be commissioned, following consultation with SGU, the Armed Forces and other affected authorities, to compile and make available existing bathymetric map material for the Swedish coast in digital form.

5.3 Warning systems and operational support efforts

5.3.1 SMHI's forecasting and warning service

SMHI's forecasting department has a constant state of preparedness, with a duty meteorologist, a duty hydrologist and during daytime also a duty oceanographer. An extensive forecasting system provides the basis for the task of issuing warnings to prevent and limit injuries and damage to people, property and the environment. The warnings are distributed to county administrative boards, municipalities, government agencies, power companies and water-regulation enterprises and the mass media. The warnings are also on SMHI's website and are read out on the radio to inform the public.

Present-day weather warnings from SMHI are given in three categories, from certain risks to the public and disruption of community functions in category 1 to very extreme weather with great danger to the public and major disruption of important functions in category 3. The warnings apply to land, sea and mountains. In categories 2 and 3 the public is encouraged to follow the information on the Internet, radio and television. Warnings are issued for wind, snowfalls, ice, rain, frost, lightning and high flow rates. SMHI also issues a warning of the risk of fire on behalf of the SRSA.

With regard to water flow warnings, category 1 signifies high flow with a recurrence interval of 2–10 years, category 2 very high flow with an interval of 10–50 years, which entails flooding problems in exposed places. Category 3 entails extremely high flow with a recurrence interval of more than 50 years and a risk of severe flooding. The probability of the flow occurring is then more than 50 per cent.

On the 20th of every month hydrological information is provided on snow, soil water, groundwater, water level and water

discharge rate. General hydrological information is also provided in the event of unusually low flows, following major flow situations and when there is a risk of high flows for several days ahead.

In the event of very high flows, SMHI offers assistance to the municipalities' emergency rescue services and county administrative boards in the form of specially targeted forecasts and consultation, to a differing extent depending on whether there are prepared models or not. In severe flow situations, SMHI staff may be stationed at the affected location to assist the emergency rescue services and county administrative board. Quick local information is important for forecasting activity.

Experience shows that knowledge is needed to interpret the warnings. Firstly understanding of what the warning means meteorologically and hydrologically is needed, and secondly there is a need to understand what it actually means in terms of possible events and problems to be faced. Experience, feedback of experience, knowledge and training are needed for this purpose, see also section 5.8.

The warning and forecasting service at SMHI is of great significance in reducing the consequences of natural disasters. Our view is that the warning system would need to be further supplemented by risks of intensive local rainfall, drought, heat waves and storm-felling. Intensive rainfall causes flooding in built-up areas principally because of over-filled sewer systems. Long periods of low precipitation, also combined with heat, pose problems for land-based industries and groundwater supplies. High temperatures over prolonged periods affect the elderly and sick in particular, with a risk of deaths occurring. Storm-felling affects electricity, telephony and communications, with indirect consequences for the public and many sectors of society.

Proposals

- SMHI should be tasked, in consultation with the Swedish Board of Agriculture, SGU, the National Board of Forestry and the National Board of Health and Welfare, to investigate ways of expanding the warning systems for extreme weather and to introduce such systems where appropriate. The possibility of creating warning systems for heat waves, drought,

storm-felling and intensive rainfall, for instance, should be analysed, and if possible such systems should be developed.

5.3.2 Support and resources of the SRSA in the event of natural disasters

The SRSA has a duty officer who is a trained fire officer with experience of commanding operations in major incidents. The duty officer provides support to municipalities, government agencies and international bodies seeking assistance in connection with natural disasters. This person acts as intermediary for contacts with experts both within the SRSA and at other agencies. The duty officer also has contact with other agencies and ministries which may be affected when an assistance operation from central government is launched.

In the case of more extensive natural disasters, such as floods and forest fires, central government can assist the municipalities through the SRSA with expert support and special reinforcement resources. The SRSA has several depots with material resources for floods, forest fires, oil protection and environmental protection. The two flood depots for example have reinforcement materials such as sandbags, temporary flood defences and pump resources. Staff resources are at the various colleges.

The SRSA follows the development of high flows in the country's watercourses by gathering data on flow situations from the county administrative board concerned and from SMHI. The information comprises pictures of damage and damage predictions for the next week, actions carried out and planned and the need for and access to equipment and personnel. The information is collated and reported weekly to the Ministry of Defence. As a result of this gathering of information early signals are received indicating the need for equipment and other support resources in the event of high flows and flooding.

The SRSA has the watercourse models belonging to the flood mapping at its disposal. These are jointly administered by the SRSA and SMHI. The watercourse models are used to create general flood maps for the areas at risk of being flooded along watercourses. They are intended to be used in acute stages – the emergency rescue service stage and in warning of very high flows – to project the likely development of water levels and water

discharge rates during ongoing floods. The model is loaned to municipalities and other players wishing to perform local or detailed calculations and simulations. Updated models are returned to the SRSA for administration, so that more detailed calculations of water level can be made in new flood situations.

We consider it essential that this emergency planning continues.

5.3.3 The work of SGI in acute natural disasters

SGI has special responsibility for monitoring stability conditions in the valley of the Göta Älv river. Its remit comprises regular inspections, particularly with respect to landslides that have occurred and signs of imminent landslides, the status of erosion defences, measurements of soil movements, pore pressure etc.

SGI at present assists municipal rescue services and others affected when landslides have occurred or it is feared that these may occur, in order to eliminate risks and reduces harmful effects. Its operations normally consist in inspection, valuation of risks, assessment of necessary measures and advice in urgent situations. On the other hand, SGI does not at present maintain any formal duty activity for urgent operations when it feared that landslides and shore erosion may occur or have occurred. The agency's objective is that responsible staff at SGI can be reached, but immediate action cannot be guaranteed at present.

We do not consider there to be adequate duty activity at present to cope with future increased risks of landslides and erosion. The instructions for SGI should state that SGI has to maintain regulated duty activity, with special staff designated for events that occur suddenly or are feared to be imminent. The cost of such activity is estimated at SEK 0.5–1.5 million per year (SGI, 2006).

Proposals

- SGI should be given increased resources for scheduled duty activity relating to events that have occurred suddenly or are feared to be imminent.

5.3.4 The coordination group for information in the event of high flows

The River Safety Commission (SOU 1995:40) proposed that regional coordinating bodies should be set up to manage flood risks along Swedish watercourses. The SRSA was tasked with initiating the formation of these in 1997. These river groups, of which there are now 25, do not formally have any operational function, and are a forum for collaboration with the aim of disseminating knowledge about the watercourse as a whole and urging that preventive measures are taken against damage as a consequence of high flows and are coordinated along the watercourse, see also section 5.10.

In addition to these river groups two coordination groups for several river groups have been formed. One of these is the *Coordination Group for Information in High Flows*, which covers the large regulated rivers from the Dalälv in the south to the Umeälv in the north. This group includes county administrative boards, the emergency rescue services, SOS Alarm, the police, SMHI, the National Road Administration, Bankverket (the National Rail Administration) and the Armed Forces. The group acts operationally. Its task is to coordinate information when high flows occur and make proposals for measures to reduce the consequences of high flows. When dams burst or it is feared that they will do so, the group is to assist the rescue services commander with information as the basis for action.

The group normally meets in the spring and autumn. The aim is provide information from each river group, exchange information from flows that have occurred and make forecasts for spring and autumn floods. Teleconferencing takes place daily during high-flow periods within the group, with affected dam owners, municipalities and others as required. Information is also provided to the press. Following agreement in flow situations, the group meets at the Water Regulation Enterprises in Östersund. The county administrative board representative of the affected river works on home ground.

We do not make any proposal concerning the formation of new river coordination groups. We consider that the county administrative boards and other players should gradually examine the possibility of forming such groups which, where appropriate, can act operationally. Regarding the formation of river groups, see also section 5.10.

5.4 Permits for water activity

In our sub-report *Översvämningshot. Risker och åtgärder för Mälaren, Hjälmaren och Vänern (Flood threats. Risks and measures for Lakes Mälaren, Hjälmaren and Vänern)* (Climate and Vulnerability Commission, 2006) we have discussed measures to counter flood and the water rulings that apply to these three lakes. In this report we discuss, among other things, food risks, dam safety, increased hydropower potential and drainage issues. In connection with these questions permit issues for water activity and amendments of old water rulings are updated.

In section 3.2.2 we discuss floods that have occurred, in 4.2.1 electricity systems and hydropower potential, in 4.2.2 dams, in 4.3.1 flooding of areas of building development, in 4.4.2 drainage in agriculture, in 5.5.1 flood mapping and in section 5.10 river groups.

Rules for reviewing permits for water activity

All permits under water law can be reviewed regardless of whether they are based on the provisions of the Environmental Code or on other legislation that affects water law. The objective criteria for review are, in principle, also the same regardless of the age of the permit. Review takes place in accordance with the provisions of the Environmental Code, primarily the rules on consideration contained in Chapter 2.

There are, however, differences between permits of differing ages which affect the options for and circumstances of review. The differences apply to the time limit for review, the proportion of loss of water or head the permit holder has to tolerate and the possibility of review in consideration of conditions in the surroundings having changed substantially.

The time limits, that is to say the time that must have elapsed before a review can be requested, range between 10 and 30 years depending on when a ruling that has gained legal force or a currently valid ruling was notified.

The proportion of loss of water or head which the permit holder has to tolerate without compensation varies between 5 and 20 per cent, with the proportion being settled in the ruling. For power production a minimum of 5 per cent and a maximum of 20 per cent of the production value are tolerated.

The review may entail amending a provision on ”permitted production quantity or similar provision on extent of the activity” and ”amending or lifting conditions or other provisions or notifying new such conditions or provisions”. There are thus no restrictions with regard to the type of obligations that can be imposed on the operator in the review. The limitation on how far the review can go lies in the fact that the review is not allowed to result in such radical provisions that the activity can no longer be undertaken or that it is made substantially more difficult.

Limitations in the permit may be amended regulation provisions, reduced regulation amplitude or increased minimum water discharge. New conditions may apply to the duty to take damage-prevention measures, for example water-level dams or erosion defences.

The review takes place at the environmental courts. Applications for reviews may be made by the Swedish Environmental Protection Agency, the Legal, Financial and Administrative Services Agency and the county administrative board. In addition, the SRSA has a position as a party to the case and present its arguments directly. This also applies to municipalities which wish to plead environmental interests and other general interests in the municipality.

The applicant is obliged to ensure that the application contains the information required for it to be able to be used as the basis for the review. According to the provisions of the Environmental Code the permit holder is also obliged to provide the investigation on the activity needed for the review.

In application cases under water law other than review cases, the applicant has to pay the legal costs of all other parties. In review cases the permit holder, the Swedish Environmental Protection Agency, the Legal, Financial and Administrative Services Agency and the county administrative board have to bear their own costs. On the other hand, the applicant agency bears the legal costs of parties other than the opposing parties referred to above.

Processing time in general obviously depends on the extent of the issues the court has to consider in the case. An important factor is what attitude the permit-holder can be expected to have towards the applicant. If there is a ready-made agreement between the applicant and the permit-holder, the procedure is normally very straightforward. The time is also affected by whether there are other individual interests than those of the permit-holder that are

affected by the review, and by how complex the amendment applied for is from the technical and environmental point of view.

A processing time of 10–12 months must be anticipated for a normal review case relating to a single permit. Complex reviews with many interests represented may take considerably longer, often several years. (Naturvårdsverket 2007)

Assessments of the Environmental Code Committee

The Environmental Code Committee was commissioned through additional instructions in 2001 to assess whether the review of water rulings are sufficient to be able to improve the options for preventing and limiting the risks of flooding. This remit was partly given against the backdrop of the major floods in 2000. The conclusions were presented in 2002 in the report *Miljöbalken under utveckling, ett principbetänkande (The Environmental Code under development, a report in principle)* (SOU 2002:50). The conclusions in the report (p. 155) are as follows:

> We have not been able to find any systematic deficiencies in the current water rulings that increase the risks of floods in general. This is principally due to it not being possible to eliminate the risk of floods with drained, enlarged or new reservoirs. Although such measures might to some extent reduce the number of smaller floods, they entail great costs to society in the form of loss of electricity production and extensive impact on building development and the natural environment. It is thus not generally possible to reduce the problems of floods by reviewing rulings.
>
> The conclusion drawn instead is that in the future we will have to live with floods and thus anticipate them occurring again. We therefore do not propose any changes to the rules for review. On the other hand, there are no measures that appear more appropriate, for example expanding river and coordination groups and increased consideration of the risk of flooding in physical planning.
>
> We have not found there to be reason to increase the options for society to decide to depart from an applicable permit for water operation.
>
> Nor have we found there to be reason in this context to propose amendments to the rules on legal costs in such cases concerned with increasing safety in water operations.

In its reasons for drawing these conclusions, the Environmental Code Committee has argued as follows.

With regard to ways of preventing flooding through active damping in regulated watercourses, the Committee discusses three different methods. The first of these is to reduce levels in hydropower reservoirs ahead of high flows. This is dismissed because of the difficulty of forecasting high flows sufficiently far ahead to be effective. The second is to create new reservoirs that can capture and alleviate high flows. This is judged to be impossible in practice owing to the large masses of water involved. The third method is to increase the margins in the existing reservoirs by either building on the dams or altering the damming limits. A reduction in the damming limit would, in the view of the Committee, entail such high costs in the form of loss of electricity production that it is not justified. A weakness of all the methods is that they would still not entirely eliminate floods.

The Environmental Code Committee also discusses climate change and notes that the results of climate modelling indicate that the weather will be milder and wetter in the future, particularly in northern Sweden. It is felt that there continues to be great uncertainty, and that it is therefore difficult to know how to counteract this through water regulation. Finally it is noted that the climate issue and its significance for safety in Swedish rivers must, however, be closely monitored in future.

The Environmental Code Committee found a review of water rulings not to be an answer to the problem of floods. No actual investigation of the rules and regulations is consequently considered necessary. The Committee instead points to increased information and increased cooperation for instance through river and coordination groups. The need for increased enforcement resources is also highlighted.

Considerations

We share the assessment made by the Environmental Code Committee that a review of water rulings is not a general means of dealing with the whole problem of flooding. We consider, however, that changes in many of the present-day water rulings will be required in the future in view of climate change. We base this on expected increased levels of precipitation, increased flows and in particular changed inflow dynamics in our watercourses according to global and regional climate models and scenarios.

The uncertainty about climate change has diminished since the Environmental Code Committee made its assessment in 2002. Uncertainties remain for instance on changed patterns of precipitation, but there is substantially greater knowledge today. We are facing a change in 100-year flows and design flows. The 100-year flows are increasing particularly in western Götaland, western Svealand and parts of Norrland, see sections 3.5.3, 4.2.1 and 4.2.2. The present-day cycle of snow cover and intensive spring flood will probably be shifted in time and less accentuated in the future. Snowfalls will be largely replaced by rain in large parts of the country.

These conditions will affect the prospects of the power industry and alter the reasons for some of the present-day retaining and lowering limits. There will therefore be a need to revise these on the side of both industry and society.

We have also seen in the case of Lake Vänern that a changed regulating strategy can reduce the 100-year level by around 0.4 metres without major economic losses in lost electricity production. A changed tapping strategy of this kind would not in this case need to entail any change in either the minimum lowering limit or the maximum retention limit. The change may possibly take place through a voluntary undertaking from Vattenfall. We have also proposed that the Government appoint a negotiator for the funding of the measures in Lake Vänern. It has emerged in discussions with those affected that the Lake Vänern water ruling is old, extremely comprehensive and that a review would entail unreasonable commitment of resources, see our sub-report *Översvämningshot – Risker och åtgärder för Mälaren, Hjälmaren och Vänern* (SOU 2006:94).

The water ruling for Lake Vänern may be unique, but there are many water rulings that are complex and where the cost of review is a decisive obstacle. Financial considerations for review with compensation for other parties and restrictions on what the permit-holder has to bear represent other obstacles to reviews. These restrictions are sometimes unreasonable as changes are required to reduce flooding risks.

There are obviously aspects of legal certainty that need to be taken into account. Overall, however, we consider that Chapter 11 of the Environmental Code containing rules for water operation should be revised, principally in view of climate change and the requirements this may impose for altered permits for dams and

land drainage. The possibility of legislation for dams without permits and owners should also be discussed. Consideration should also be given to the question of whether the whole of Chapter 11 should be revised in view of the fact that the legislation is outdated on many points. When the Environmental Code was introduced in 1999 no thorough revision was made and the old Water Act was transposed into the Environmental Code largely unchanged as a combined chapter.

Inventory of dams without permits and owners

It has emerged in contacts with the county administrative boards that there are a large number of dams that do not have a permit and/or an owner. Against the backdrop of the changed risks of flooding, the county administrative boards as authorities responsible for enforcement should make an inventory of these dams and assess the magnitude of the problem. The issue should also be raised in the revision of water legislation which we propose.

Revision of legislation on land drainage

Measures for land drainage, changes to bunds or water extraction require changes to permits and sometimes new water rulings. Amending permits and water rulings can often be a complicated process. In a changed climate with increased precipitation and changed flows, the originally intended function which the permit or water ruling was once intended to ensure will in many cases not be possible to maintain. The legislation in the area therefore needs to be overhauled on the basis of expected climate change, with the aim of drainage companies and bunds being able to retain their function without an extensive legal process. Attention should be paid in the revision of the legislation to the importance of nature conservation concerns and the capture of nutrients, as an alternative on some low-lying land might be to establish wetlands, see also section 4.4.2.

Proposals

- An inquiry should be carried out to analyse the need for reviews of water rulings with climate change in mind. The commission of inquiry should review the whole of legislation on water activities and analyse the need for re-examinations with respect to flooding risks and drainage. The inquiry should also consider dams without permits and owners.
- The county administrative board should be tasked with making an inventory of dams without permits and owners and assessing the magnitude of the problem as a basis for the proposed revision of the legislation on water operations.

5.5 Physical planning

There is great interest in and pressure on building in shoreline areas today. Many of these areas are already liable to flooding. The situation will be exacerbated in many places in a changed climate. Flooding and landslides and coastal erosion may affect existing homes and other buildings and associated infrastructure to an increasing extent. It is both complicated and costly to prevent damage in existing building development, and it is therefore important to avoid building on areas of land and water where there is a risk of flooding or on land with poor stability. It is crucial to take greater account of these risks in the planning process and make statutory instruments and responsibilities clearer.

One of the commission's working groups has been tasked with analysing how changes to the climate affect the risk of flooding of shoreline building development, landslides and coastal erosion, as well as flooding of hardened surfaces. The focus in this work has been on physical planning and the location and elevation of building development, see *Overview vulnerability analysis of flooding, landslides and erosion in the built environment in a future climate*, Annex B 14, and *The impact of climate change on public wastewater systems – description of problem, costs and proposed measures*, Annex B 16. The following section is largely based on these annexes. See also sections 4.3.1–4.3.4.

5.5.1 Responsibilities and roles in the planning of building development

The municipality has overall responsibility for local community development and the planning of building development in its geographical area. Under the terms of the Planning and Building Act (1987:10), the municipality is responsible for physical planning, for instance by establishing general plans for the planning of land and water use. The plans are strategic and cover the whole surface area of the municipality. The detailed planning for new, changed or existing building development takes place in particular through detailed development plans and entails close examination of the suitability of land for building development and regulation of the built environment. The detailed plans are legally binding and form the basis for later building legislation. The municipality is also responsible for preventive and remedial measures under the Civil Protection Act and for the water and wastewater of the municipality.

Under the Tort Liability Act, the municipality has general responsibility to compensate for harm occasioned through error or neglect in exercise of the powers of an authority, for example in matters pertaining to planning and building permits. This responsibility applies for ten years from the harm-causing action, that is to say the incorrect or negligent planning or building permit decision.

The county administrative board supervises planning and building in the county and has to collaborate with the municipality in the planning process. The county administrative board has several roles in this activity: the coordinating role regarding different state interests, the role of authority, for instance in examining detailed development plans, the supervisory role of working for example for a good environment, and the advisory role of providing material, offering advice on application of the Planning and Building Act etc. The county administrative board has a duty under the Planning and Building Act to ensure that health and safety issues are respected in the municipality's building development planning and for re-examining plans with legal effect where these issues are not addressed. Under the county administrative board instructions, they have responsibility for ensuring that consideration is given to risk and emergency management in public planning.

The National Board of Housing, Building and Planning is the national authority for issues concerned with public planning and

urban and building development. The Board has the task of devising methods for and passing on knowledge of physical planning, including issues of risk consideration in planning. It has to follow developments, guide communities and others and inform government of needs for amendments to legislation. The instructions of the National Board of Housing, Building and Planning state that the Board has overall responsibility for issues that relate to physical planning, buildings and economic use of land and water in all the environmental quality objectives.

5.5.2 Problems and deficiencies in present-day planning and regulations

Location of building development

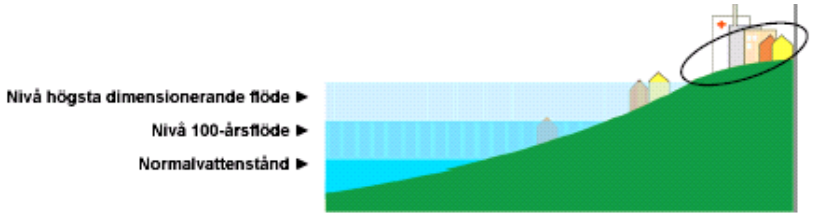
Waterside housing has become increasingly sought-after. An increasingly large proportion of construction is taking place in the coastal zone (5 km from the coast), in southern Sweden almost half. Just over 30 per cent of buildings in the country are located in the coastal zone. The proportion of buildings constructed within 100 of the shoreline more than doubled between the 1970s and the end of the 1990s, according to a report from the National Board of Housing, Building and Planning. This shoreline building development occupies around 30 per cent of the total coastline of Sweden, see also section 4.3.1. (National Board of Housing, Building and Planning, 2006; Bernes, 2005)

Under Chapter 2 Section 3 of the Planning and Building Act, building development has to be located on land which is suitable for the purpose in consideration among other things of soil, rock and water conditions. Health and the need for protection against accidents are matters of strong public interest addressed at several places in the Planning and Building Act. Under the Planning and Building Act, the general plan has to describe the environmental and risk factors that should be taken into account in decisions on the use of areas of land and water. The risk factors include flooding, landslides and erosion. In view of the greater risks of these natural disasters entailed by long-term climate change due to increased and more intensive precipitation, high flows and raised sea levels, see sections 4.3.1–4.3.4, it is very important that the legislation clearly emphasises the risks to be taken into account.

In the experience of the commission the planning basis and basis of knowledge that have underlie the municipalities' comprehensive land-use and detailed development planning are often too deficient and inaccessible for the municipalities to be able to take account of the risks of natural disasters in the present-day climate, as well as in a future climate. The municipal planners and technical administrations state that they are unsure about what levels to plan for. Difficulty is also seen in arguing against wishes for attractive waterside construction, even though the risks of flooding are known about in the municipalities.

The commission's sub-report Översvämningshot. Risker och åtgärder för Mälaren, Hjälmaren och Vänern (Flood Threat. Risks and measures for Lakes Mälaren, Hjälmaren and Vänern) (SOU 2006:94) focused on flood risks and options for tapping the big lakes. It was proposed in the sub-report that new construction should be avoided below the future design water level. It should, however, be possible for certain exceptions to be made for example for individual detached houses, holiday homes and roads with detour options. We proposed that only individual buildings, for example out-houses, ought to come into question below the 100-year level. The proposal is based on the recommendations presented by the county administrative boards in central Sweden in August 2006, Översvämningsrisker i fysisk planering. Rekommendationer för markanvändning vid nybebyggelse (Flood risks in physical planning. Recommendations for land use in new building development), see Figure 5.3.

Figure 5.3 Location of building development in relation to different flows according to recommendation of county administrative boards in Central Sweden



Key
Level of highest design flow
Level of 100-year flow
Normal water level

Source: County Administrative Boards in Central Sweden, 2006.

The role of the county administrative board in planning

Using a questionnaire-based survey, in the winter of 2005/2006 the commission made an inventory of the municipalities' management of floods and landslides in the municipal planning process based on the present-day situation and in planning for a changed climate, Annex B 15. The majority of respondents (the response rate was around 50 per cent) have taken account of flood risks in the planning and often in several stages, based on the SRSA mapping or their own analyses. Just over half have taken account of landslide risks. The equivalent figure with regard to the impact of climate change on the risks is just under a third. The survey points to the need for expanded and clearer support in the planning process from county administrative boards and other authorities, see section 5.1.

The advisory role of the county administrative board, that is to say compiling and supplying relevant planning data and knowhow ahead of planning and building legislation becomes more important still in a changed climate. The municipalities today have to plan not just for the present-day climate but also take account of the increased risks and uncertainties a future changed climate will entail.

With regard to the authority role of the county administrative board, we have found that there is a lack of experience on what room for manoeuvre the county administrative board has at

present for the ”review” according to Chapter 12 of the Planning and Building Act. The wording in the Act on unsuitability with respect to the need for protection against accidents or the term accident in itself is unclear. We consider there to be a need both to clarify and to strengthen the role of the county administrative board in the process.

Detailed development plan and building legislation

There are also difficulties and uncertainties regarding how measures to raise safety and prevent damage are to be ensured in the detailed development plan. This is therefore sometimes referred on for building permit examination. The commission’s working group states that there is often a lack of knowledge of how risk and safety issues are to be dealt with in the examination of building permits. We consider there to be a need to give clear conditions in the detailed development plan concerning protection and safety measures to ensure the suitability of land. Measures may also be required on property other than that which is under consideration for construction, to ensure that the land is suitable for its purpose, for example geotechnical reinforcement measures and flood defences.

It is stated that the elevation of land and the highest permitted level for water and wastewater are not always accorded the significance required for safe construction. Flood damage can arise both from prolonged precipitation with flooding of watercourses and lakes and raised sea levels and from very intensive precipitation over a short period of time. It is important that the management of water is addressed early in the planning process. In a safe built environment the planning process must be viewed as a complete entity and safety issues must be highlighted early in the physical planning, so that they can also be considered in interaction with any other measures that lie outside the scope of the Planning and Building Act.

5.5.3 The Planning and Building Act Committee (SOU 2005:77)

The current Planning and Building Act came into force in 1987. The aim was to bring about combined and clearly arranged planning and building legislation. The Act has been amended several times since it came into force. An extensive review of the Act is currently in progress. A parliamentary committee has being reviewing the Act over a period of three years and submitted its final report *Får jag lov? Om planering och byggande (May I may be permitted? On planning and construction)* (SOU 2005:77) in November 2005.

With regard to physical planning, both the strategic overall planning and the more implementation-oriented detailed development planning, the Planning and Building Act Commission established that the planning instruments under the Planning and Building Act are among the most important instruments at the municipalities' disposal. The Committee considered that the fundamental aims and structure of the Planning and Building Act stand up to scrutiny but that implementation of the Act needs to be improved. The Committee therefore made several proposals for amendments and additions to clarify and simplify implementation and make it more effective. The Commission emphasised the need for politicians to take greater responsibility for physical planning. As elected representatives they have to adopt a position on desirable development of land and water use in the municipality. At the same time, the Committee considers that central government should continue to play a strong role that necessitates and builds on dialogue between central and local government on increased community requirements to be satisfied in planning. The role of the county administrative board to represent and coordinate the interests of central government were considered by the Committee to be in need of development, as was the task of producing and contributing to collective regional planning material for different national objectives and interests. The Commission also proposed stricter requirements for the municipalities to collaborate with one another.

The risk of flooding and other natural disasters is discussed in the Commission's report. The Committee noted that in many respects there are deficiencies in the municipalities' management of risks, and considered that to a great extent this can be rectified by

an improved knowledge base and assistance towards better implementation of the Planning and Building Act. The Committee proposed that the specification that building development be located on land which is suitable for the purpose for instance with regard to the health of residents and soil, rock and water-related conditions be deleted. Instead, a more general reference is proposed to the characteristics of the physical environment and ways of avoiding and preventing risks to human health and safety, where safety and health have a broad meaning.

Regarding government interventions governed by Chapter 12 of the Planning and Building Act, the county administrative board is to examine the municipality's decision in a detailed development plan if there are fears that the decision means that issues concerning use of areas of land and water that relate to more than municipality have not been coordinated in a suitable manner. The Committee proposed that this requirement be abolished.

The report proposed that Chapter 5 Section 6 of the Planning and Building Act be amended so that it may be specified in a detailed development plan that building permits are not to be granted for measures that entail a substantial change in land use until a particular protective or safety measure has been taken to ensure that the land is suitable for building.

No other way of introducing conditions regarding the construction on a property that are of significance to another property is proposed in the Planning and Building Act Committee report.

5.5.4 A first step for a simpler Planning and Building Act (Government Bill 2006/07:122)

The Government's continued work to overhaul planning and building legislation has resulted in the Bill *Ett första steg för en enklare plan- och bygglag (A first step for a simpler Planning and Building Act)*, Bill (2006/07:122), which was presented to the Swedish Parliament in May 2007. This is the first stage in the Government's work to simplify and clarify the rules contained in the Planning and Building Act with the aim of making the planning and building process easier. The Bill proposes changes to the provisions on general interests to be considered, on general plans and detailed development plans, on building permits and on sanctions and appeals.

Clarifications are proposed to the fundamental provisions on the duties of municipalities. It is proposed that it be clarified in Chapter 2 Section 3 of the Building and Planning Act that building development has to be located on land suitable for the purpose in consideration not just of the health of the residents and others but also of their safety, with regard to the risk of accidents, floods and erosion. It is also stipulated in Chapter 4 Section 9 that it must be apparent from the county administrative board's statement on a comprehensive land-use plan whether the building development is unsuitable with respect to health, safety or to the risk of accidents, floods or erosion. Equivalent formulations are proposed in Chapter 12 concerning examination by the county administrative board of the municipality's decision to adopt, amend or repeal a detailed development plan or area provisions.

The Government justifies its proposals on the grounds that the municipalities need better support to manage the risks of various types of disruptions and accidents in their planning. The need is judged to be particularly great with regard to flooding, particularly with climate change in mind. The problems encountered by the county administrative board in examination under Section 12 are also mentioned as a reason for the amendments. The expressions "water conditions" and "civil protection" have not to date covered what has been desired with regard to flooding according to the Government.

The intention according to the Bill is to harmonise terminology in the Civil Protection Act (2003:778) and the Planning and Building Act. According to the preamble to the first of these acts, an accident signifies an event that occurs suddenly. This means that slow or constantly ongoing occurrences in nature are not classified as accidents. It is stated in the Bill that slow and constantly ongoing occurrences may, on the other hand, cause something that happens suddenly and that causes damage or injury, for example a building damaged by subsidence collapses or erosion causes a landslide. Such events, according to the Bill, can be regarded as accidents.

Under the Bill, flooding and erosion are not the result of an event that has occurred suddenly and are therefore not regarded as accidents under the Civil Protection Act. In order to bring about harmonised terminology in the two laws, the Government has therefore considered there to be a need for protection against floods and erosion to be expressed in the general provision,

Chapter 2 Section 3, on what is to be considered in planning and locating building development, as in the provisions on comprehensive land-use plans and government intervention. It is also proposed that the Swedish term ”olyckshändelse” (literally ”accidental event”) be replaced by ”olycka” (”accident”) to bring the terminology into line.

The proposed changes to the according to the Bill are also stated to need to be combined with skills development and advice.

5.5.5 Considerations and proposals

Greater account needs to be taken of the consequences of climate change in comprehensive land-use and detailed development planning as well as in the planning of infrastructure. Our view is that the requirements of the Planning and Building Act aimed at building development having to be located on land suitable for the purpose must be applied strictly. The county administrative boards have an important role here in reviewing the municipalities' plans and at the time of examination.

Our remit includes proposing measures to reduce vulnerability to long-term climate change and extreme weather events. The vulnerability of building development to floods, landslides and coastal erosion is an important part of this work. It is essential that great account is taken of these risks at an early stage in the planning process and that statutory instruments and responsibilities are clarified. As far as we have been able to assess, the proposals of the Planning and Building Act Committee in (SOU 2005:77) are not adequate. We have therefore emphasised our views on this in a letter to the Ministry of the Environment, see Annex A 5. This has applied in particular to the location of building development with respect to the risk of flooding, landslides, landslides and coastal erosion, the role of the county administrative board in the planning process and making preventive safety measures a condition in detailed development planning.

The proposals that the Government puts forward in the Bill (2006/07:122) are principally positive in order to reduce the risks of accidents and damage in building development as a consequence of flooding and erosion. If the proposals are implemented, they will provide increased clarity on what is to be considered in planning in the future. It is proposed that the proposals apply from 1 January

2008. However, there is a further need for clarification in the wording of the law to raise safety and simplify the planning process.

Landslides do not feature in the proposed statutory text. It can, however, be interpreted through the preamble that there has been an intention to also include landslides. It is apparent from the preamble that erosion can cause landslides. Landslides need not always be preceded by erosion, and can be set off for example by heavy rainfall, increased pore pressure, change in groundwater level and varying water levels in watercourses, and can then progress rapidly. Landslidess can also occur rapidly, for example due to large flows of water. These rapid events would probably fall within the definition of accident.

Another reason for not explicitly mentioning landslides in the wording of the statutory instrument is stated as being the lack of a definition of the terms in the statute. We consider it essential that both landslip and landslide are defined in the statutory instrument and explicitly mentioned alongside accidents, erosion and flooding, so that the meaning of the terms becomes clear, and to clarify that these risks also have to be considered in locating building development.

We also consider it important to assist municipalities and clarify how flooding, erosion and landslides due to climate change are to be taken into account in the municipal planning process. The National Board of Housing, Building and Planning, should therefore, with the support of other affected authorities, draw up guidelines for the planning, location and elevation of new building development, including wastewater systems, with respect to the risks of flooding, landslides and erosion. The National Board of Housing, Building and Planning should also, with the assistance of other affected authorities, draw up guidelines for planning and safeguarding measures to protect existing building development against the situations mentioned, as well as against penetration of water into sewer systems.

We consider there to be a continued need to state clearer requirements in detailed development plans for safety-raising and damage-preventing measures to prevent or reduce the risk of natural disasters. Function-based requirements in the detailed development plan are options that allow measures to be adapted to the specific case.

The duty of the county administrative board to provide material for the municipalities' physical planning should be strengthened and clarified in accordance with proposals in Bill 2006/07:122. See also sections 5.8 and 5.10.

SGI should be tasked with assisting municipalities and county administrative boards in managing risks related to the climate in the municipalities' planning matters, as it is not reasonable to presuppose that all county administrative boards and municipalities have the necessary skills on the relevant issues. This task should be written into the instructions detailing the agency's duties.

We see a need to include issues relating to climate change in the fundamental technical and public-planning training courses. Knowledge on the effects of climate change will be of great significance to the physical planning of building development and community infrastructure.

Proposals

- It should be apparent in the instructions detailing the duties of the National Board of Housing, Building and Planning that the agency is made responsible for adaptation to a changed climate in the area of physical planning, see section 5.10.2.
- The National Board of Housing, Building and Planning should therefore be commissioned, in collaboration with SMHI and other affected authorities, to draw up guidelines for the planning, location and elevation of new building development, including sewer systems, with respect to the risks of flooding, landslides and erosion in a changed climate.
- The National Board of Housing, Building and Planning should be commissioned, in collaboration with the Swedish Rescue Services Agency and other affected authorities, to draw up guidelines for the protection of existing building development against flooding, landslides and erosion and penetration of water into sewer systems.
- The Planning and Building Act should be supplemented by an explicit mention of landslides alongside accidents, flooding and erosion, so that it becomes clear that the risks of landslides have to be taken into account in locating building development. The terms landslip and landslide should be defined in

a statutory instrument, so that the meaning of the terms becomes clear.

- The Planning and Building Act should be supplemented so that it becomes possible to lay down requirements in the detailed development plan for safety-raising and damage-preventing measures to prevent or reduce the risk of floods, landslides and erosion, for example by applying function-based requirements.
- The Planning and Building Act should be also be supplemented so that municipalities are given the right to carry out measures on each others' land which are of a great significance in order to protect surrounding development.
- SGI should be given responsibility for assisting municipalities and county administrative boards in the municipal planning process on matters relating to landslides and erosion.

5.6 Grants for preventive measures

The climate scenarios for Sweden show that weather-related events such as floods, storms and landslides will increase over the next hundred years. Extreme weather events are already causing extreme weather events today, examples being the floods around Lake Vänern in the winter of 2000/01 and the winter storm Gudrun in 2005. We can anticipate an increase in damage of these kinds in the future. In many cases the harmful effects can be reduced by adapting society to the expected new circumstances, while in others it may be a better strategy to wait and deal with the damage when it occurs. The increased risk described in the impact assessments in this report raises questions on how this should be dealt with by the various sectors of society. A key issue is where the responsibility lies for preventing or dealing with any damage.

Since the 1980s the SRSA has had an appropriation of SEK 25 million to assist municipalities with preventive measures against natural disasters. The pressure on this appropriation has steadily risen. In 2002 the SRSA responded to a request to revise the grants system, and in 2005 petitioned for certain changes to the grant. The instructions for this commission of inquiry consequently included a separate remit to propose ways in which the system for preventive measures by government relating to floods and

landslides can be made for effective. In addition to the issue of the management of the appropriation, the more fundamental issue of principles of funding is raised - when and on what basis is it reasonable for government to provide support for municipalities and individuals? This is also closely linked to where the responsibility is to lie when damage does occur, and thus how responsibilities in society can be shared between central government, municipalities and individuals, and what incentive structures are created.

5.6.1 The Swedish Rescue Services Agency's appropriation for preventive measures against natural disasters

Many areas of Sweden are at risk of landslides as a result of the composition of soil types and topographical conditions. Floods too are a risk for many areas with building development, due to the location of the development next to lakes, watercourses and the coast. Several towns, which were established several hundred years ago, are partly sited on marshes and former seabeds.

Following the Tuve landslide in 1977 a decision was taken that central government would assist the municipalities in general mapping of areas prone to landslides. In 1983 a committee, the Rescue Services Committee, was appointed to submit proposals on government grants to the municipalities. The Government proposed, on the basis of the committee's proposal, that the municipalities should be given the right under a special law to enter a property to carry out detailed geotechnical studies. They were to be given the right to charge compensation for their expenses for preventive measures against landslides from the property owners to benefit from the measures, but to a maximum of 50 per cent of the costs. Municipalities which had particularly heavy costs would receive an extra tax equalisation grant under the rules that already applied to such grants, but to a maximum of 20 per cent of the assessed value. The criteria for such grants were applicable to municipalities with large areas at great risk of landslides and other natural disasters. The level of the grant was related to the municipality's tax-raising capacity.

In accordance with the *Landslides Bill 1986* (Bill 1985/86:150 Annex 3) an appropriation was instead introduced from which the municipalities could apply for money to take preventive measures "against unforeseeable and sudden events". The minister

responsible felt that the municipalities on the whole should be responsible for preventive measures themselves, but that in a fairly small number of municipalities there were larger areas at increased risk of landslides and other natural disasters. These municipalities at greater risk would then be able to apply for extra grants from an appropriation placed with the SRSA. Grant decisions were taken by the Government, until the SRSA acquired its own decision-making rights in the 1990s.

The Swedish Rescue Services Agency appropriation in its present form

The rules for appropriation 7.2 *Preventive measures against landslides and other natural disasters* are not contained in a statutory instrument. The SRSA has developed criteria for entitlement to grant based on the Landslides Bill and practice, as developed since the appropriation was introduced. SRSA decisions cannot be appealed. The appropriation applies to a “natural event which is not common or does not follow a slow non-dramatic course". Erosion is therefore not included.

Many measures are large in scale and take several years to implement. For measures that have not already been implemented, the municipalities receive half the granted appropriation when the project is launched and the remainder when it is completed. The application process generally takes about six months. The SRSA passes the documents to SGI and SMHI, which contributes with technical review and assessment of those applications that relate to their areas, that is to say geotechnics and hydrology. The agencies then contact the municipalities. The site relating to the applications which may be considered for receipt of grants is often visited. Supplementary information is requested in the event of incomplete applications. Processing of the applications takes around 75 per cent of a full-time post per year, including travel.

The appropriation applies to existing building development. Grants are thus not made for measures taken in connection with planning activity. The size of the grant is no longer related to the tax-raising capacity of the municipality but to the cost of the project. Funds are granted for up to 80 per cent of the cost. The SRSA has interpreted the meaning of developed areas in the text of the Bill to also cover certain access roads and infrastructure to the

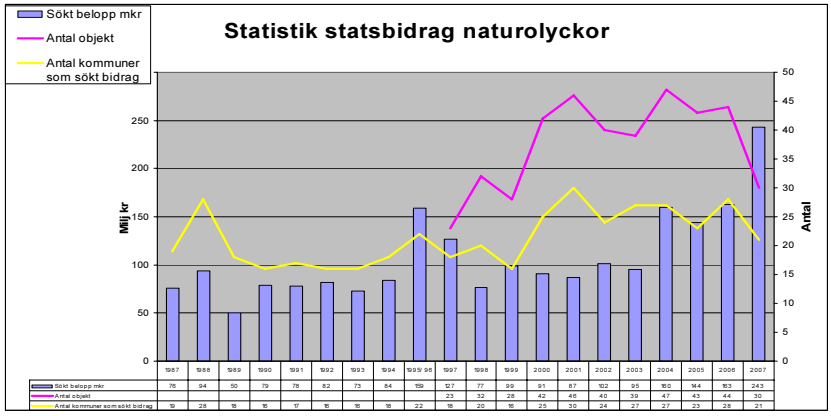
benefit of society. The SRSA emphasises that it is of the greatest importance that grants can be paid for this purpose as the safety aspect and accessibility are important in a rescue service stage.

The SRSA has drawn up a list of types of expenses entitled to payment of grant. The municipality or property owner has to pay for the detailed investigation to be attached to the application. If an in-depth investigation needs to be carried out, on the other hand, the municipality may receive a grant for it, as this generally results in optimised measures, which make good economic sense. This may also lead to the area being judged to have satisfactory safety, with the consequence that planned measures do not need to be implemented. Compensation is paid for restoring the area to its original standard, not for raising the standard, for example improvement of a section of road at the same time as the measures are taken. Compensation is not paid if the cost of the measures is greater tan the value of the object to be protected. If the value of a building is less than the cost of preventive measures, grants can be paid to purchase and demolish the property.

In some cases it may be difficult to draw the line. There has been discussion, for example, on whether grants are to be paid for the expenses of archaeological studies which the municipality is compelled to carry out. Measures which produce positive effects over and above the protection may also be difficult to assess. Bunding is one such example. The measures may be cost-effective for existing building development but also make possible waterside building development, which creates new revenue for the municipality.

The diagram below shows the trend between 1987 and 2007. The sum applied for has increased, as has the number of objects. The number of municipalities applying has increased somewhat, but has hovered around 25 for the last six to seven years.

Figure 5.4 **Applications for government grants for preventive measures against natural disasters over the period 1987–2007. The statistics cover both examined projects and non-examined projects (i.e. those not entitled to payment of grant)**



Source: Swedish Rescue Services Agency.

Statistics on government grants relating to natural disasters
Amount applied for, SEKm
Number of objects
Number of municipalities applying for grants

SEK million
Number

The number of applications for large-scale projects has increased in recent years, for example for bunds and protection of whole urban districts. As the appropriation only amounts to SEK 25 million per year, applications exceed the sum available many times over. Several municipalities therefore return with their applications year after year. In the budget for 2007, the Government decided to temporarily raise the appropriation to SEK 40 million for the period 2007-2009.

Views on the grant expressed by those affected

According to the SRSA, the appropriation has become more difficult to administer as pressure has increased. The applications increasingly often relate to large measures which go far beyond the appropriation, and which are difficult to assess as they also produce

positive effects for the municipalities. Resources have to be put into investigating a large number of projects, of which only a few can receive a grant.

In a communication to the Government in 2002 (Räddningsverket, 2002), the SRSA made the following proposals:

- that measures in accordance with binding rules or decisions of authorities required to implement the preventive measure should be eligible for compensation,
- that the preparation of documents, in addition to detailed study, for implementation of the measure should be an expense eligible for reimbursement,
- that preventive measures relating to coastal erosion that threaten building development should be eligible for reimbursement,
- that the costs of cleaning and dredging in watercourses to prevent flooding upstream should be eligible for reimbursement.

The SRSA again formulated a communication to the Government in 2005 (Räddningsverket, 2005) concerned with the problems relating to appropriation 7:2 (the grant for preventive measures) and also raised issues relating to appropriation 7:3 (compensation for rescue services). Greater uniformity in control of the use of the two appropriations was sought. Appropriation 7:2 was said to be far too small to meet the needs, which had increased firstly because of increased knowledge due to increasingly extensive mapping and secondly because of increased environmental awareness that entails more complex and costly measures, for example for stability problems and polluted soil. The SRSA warns that the risk of natural disasters will increase, as would the costs of damage, as many measures will not be taken.

The SRSA also considers there to be a need for clearer conditions to be specified regarding which measures carry entitlement to grant and how measures are to be prioritised. The SRSA goes on to write that

> The attention given to and interest in these matters is increasing and it appears essential to lay down clear requirements on how to proceed.

Another aspect is that if the grant is regulated in the same way as the rescue services appropriation, there is a risk of ending up in the

same situation, with appeals taking a great deal of time and causing great expense. The SRSA has also pointed out that there should be rules relating to what the various parties are responsible for and who is to bear the expense. This is important if the investigations are to be handled efficiently. (Swedish Rescue Services Agency 2007)

Experts from the Swedish Geotechnical Institute (SGI) consider the grant to be of very great benefit (SGI, 2007). The clear picture is that it would not be possible for the vast majority of the measures to be implemented if the grant did not exist, and that it would be necessary to wait for a situation requiring the rescue services to arise. SGI's view is that the appropriation should be retained in its present form, but that the infrastructure-based measures can be excluded from the appropriation and dealt with separately. SGI sees a need to extend risks for which there is a grant entitlement to erosion. This was also emphasised in the SRSA communication to the Government in 2002. The argument given is that, as in the case of landslides, certain municipalities are more at risk, and that erosion too can be a very rapid process. SGI has also stressed the importance of coordination between coastal municipalities for the measures to be effective. In these cases regional assessment is also needed.

Experts from SMHI have emphasised that both the fact that there are grants to apply for and the actual grant process itself mean that the municipality becomes aware of the risks and also takes account of them in its continued planning (SMHI, 2007). The application process also serves as knowledge transfer to the municipalities, in particular by officials involved in the municipality receiving material as a basis for discussions with decision-making politicians.

The Commission working group, on which the SRSA, SMHI and SGI sat, means that many measures would not be put into practice if the grant did not exist. Individual property owners find it difficult to pay for the necessary detailed studies and the actual measures-related projects, according to several municipal administrations and the authorities involved. In many cases measures must be implemented on the sites of several land-owners. In these cases it is not likely that the measures would be taken without the overarching role of the municipality. Another potentially problematic situation is when measures are needed on someone else's property. Soil-stabilising measures, for example, can be carried out

on land outside the threatened properties, for example buildings on top of a slope leading down to a river, where the slope does not form part of the plot of land. The property owners in these are not in a position to deal with the landslide risk. Another example is when land requiring remediation is located in more than one municipality, for example along a river. It is valuable for the applications to go to authorities that are in a position to take measures transcending municipal boundaries, which may be more cost-effective than if each municipality plans its own measures.

The Commission has been in contact with eight municipalities that have applied for grants from the SRSA (Umeå, Sollefteå, Bollnäs, Trosa, Arvika, Munkedal, Uddevalla and Kristianstad). The municipalities have received grants in some cases and rejections in others. The picture that emerges is that the grant process works very well. The municipalities feel that they receive good knowledge-based support from the authorities involved and that the application process works smoothly. Some municipal administrations consider it regrettable that the application process extends over several budget years, as it is difficult to budget not knowing whether a grant will be made or not. Several administrations also state that they find it difficult to extract money from the municipal budget for the detailed studies required, as they are very expensive.

Those municipalities that have had large landslides or have had problems with flooding over a long period often also work in the longer term on these issues and in several cases regularly earmark funds in their budgets for preventive measures.

Some municipalities have also cited the difficulties that can arise if a land-owner refuses access to its land. The municipality does not have any way of forcing anyone either to take action on their own land or to allow access in order to reach someone else's land. An individual person can therefore stop a project completely or make it much more expensive. This may be just one property owner out of ten who are affected. It is unclear who is responsible if something then happens.

Another difficulty is that the municipalities do not have any model for sharing cost with individuals. The municipality can sign an agreement with businesses. There is no such option with individuals. Some municipalities agree with individuals that each pays half of the insurance “excess”. There is also a desire to be able to share the cost of detailed investigations.

In the case of both these problems there is considered to a need for clearer legislation that clarifies responsibilities and the rights and obligations the various parties concerned have in relation to these issues.

Responsibilities

The Commission on Slope Stability in 1884 established the responsibilities in the event of natural damage quite clearly (Skredkommissionen, 1994). Responsibility for preventing and restoring damage due to extreme weather events does not differ from the responsibility for other risk management in society. The basic principle is that all concerned are responsible for their own property.

Central government is responsible for national infrastructure such as roads, railways and backbone networks for power transmission. Central government can also be said to have overarching responsibility for crisis management and protection against large-scale risks in the form of floods, storms, erosion, landslip and landslide risks and large-scale epidemics. Where large investments have been required, central government has in some cases shared in the financing for example of embankments, tunnels and channels. Municipalities and county councils have equivalent responsibility for more local risks of flooding and landslides. They are also responsible for crisis management, medical care, drinking water and physical planning of building development, municipal roads and railways.

The general mapping done by the SRSA identifies areas that appear to have inadequate safety, areas where the municipality should therefore go on to undertake detailed studies. The general flood mapping also provides a foundation for the municipalities' general planning and for the operational planning of the rescue services. The general maps are handed over to affected municipalities either in report form or digitally. The municipalities are advised by the SRSA to draw up a plan of action for areas that are to be the subject of detailed investigation and possible measures. See section 5.1.

A fundamental requirement in the Planning and Building Act is that land has to be suitable for building development from a general point of view. Suitability is assessed both in planning and in

the examination of building permits, for instance with respect to health and safety. The environmental and risks factors that should be taken into account in decisions in land and water areas are to be described in the municipality-wide comprehensive land-use plan. The risk factors include flooding, landslides and erosion A revision of the law is in progress. It is proposed in Bill 2006/07: that account should taken in examining the location of building development, among other things, of flooding and erosion risks (see section 5.5).

In examining building permits, the municipality has to take account of whether the land is suitable for building development in consideration of the health and safety of residents. The municipality is responsible for its decision for 10 years after granting a building permit application. Until the limitation period has expired, individuals can demand compensation from the municipality. If the municipality has conducted the necessary studies according to the knowledge that existed at the time when the building permit was granted, it is free of liability. The building client has principal responsibility for all building and construction works being carried out according to applicable plans and provisions. He also has to ensure that examination and inspection take place to a sufficient extent (Commission on Slope Stability section 1.5.2, and Chapter 9 Section 1 of the Planning and Building Act 1987).

It is not always clear where the dividing line between a risky but non-urgent situation and a situation requiring the rescue services lies. Responsibility under the Planning and Building Act is therefore to some extent linked to responsibility for rescue services, which is governed by the Civil Protection Act. Central government or the municipality have a duty to intervene if this is deemed necessary in view of 1) the need for rapid intervention, 2) the significance of the threatened interest, 3) the costs of the operation or 4) other circumstances. This duty can thus be interpreted quite broadly. The municipality receives reimbursement by central government if its expenses exceed a sum that amounts to 0.02 per cent of its tax-raising capacity (Chapter 7 Section 3 of the Civil Protection Act (2003:788)). There may therefore be a certain incentive for the municipality to stretch the concept of rescue services where there is a risk of natural damage.

Considerations

The studies carried out for this commission indicate that the risk of natural damage will increase as the climate changes. Some redistribution of public funds can be considered to be justified on the grounds that climate change affects different part of the country and sectors differently in Sweden. Some will be affected by increased costs, while others will encounter more favourable conditions or not be affected at all. Some municipalities have already been affected by recurrent floods, with consequent costs of urgent measures and repairs, as well as losses of income and loss of capital.

The principle of own responsibility militates against financing by central government. To ensure that insurance cover is valid, the property owner has protect himself to the best of his ability against damage such as fire and water damage. Measures to limit fires, e.g. fire walls, are governed by law and today are a self-evident part of construction. There is no equivalent legislation today with regard to landslides, floods and erosion. A difference lies in the fact that the risks vary for different areas, and it is difficult for an individual property owner to assess them or acquire knowledge of them. As the risks increase with future climate change, areas that there were not previously at risk will also need to be protected. In cases where the risks did not exist or were not known when the land was built on and the costs are significant and difficult for the individual or the municipality to bear, it may be appropriate for central government to provide some assistance. At the same time it appears reasonable for the period of limitation for the liability of municipalities for detailed development plans and building permits to be extended. Such a measure clarifies the responsibility of the municipalities to include future change in their planning. Floods and landslides often occur at long intervals of time, which may lead to the risks being disregarded as a long period of time has elapsed since any natural disaster has occurred.

Several municipalities have expressed the view that current knowledge and information on climate change is inadequate, see Annex B 15). The SRSA nevertheless assists today with general mapping which is presented to the municipalities, both in writing and digitally. As knowledge of climate change increases, this too is included. We consider it appropriate for the limitation period to be extended from 10 to 20 years with regard to liability for compensation for floods, landslides and erosion. Account should be taken of

the information to which the municipalities have had access via the general mapping, as well as the requirements imposed on the municipalities to carry out additional detailed studies.

The grant process today appears to work well, both in driving preventive measures and as a tool for knowledge transfer and quality assurance of measures. In the last few years, particularly following the floods of 2000/2001, the pressure on the appropriation has become too great, however, as several municipalities have applied for funding for extensive measures, the costs of which far exceed the size of the appropriation. These measures, which often apply to the bunding of urban areas, also provide added value for the municipality, it is therefore often difficult to assess whether they ought to be eligible for grants. One option is to limit the grant to applying to minor measures. Support for such measures is justified by the fact that they often in practice provide support via the municipality for individuals for whom the complexity of investigation and measures may be too great and also exceed their ability to pay.

An alternative to the present-day system of grants is to restore the grant money to the municipal cost equalisation system from which it was originally taken, and to share it out according to some scale depending on how much at risk the municipalities are. It would then form part of the economic geographical model. This would be in line with the conclusion drawn by the Equalisation Committee that general grants are more effective than targeted grants with accompanying requirements (SOU 2003:88). However, it appears difficult to establish criteria for how large a pot should be available to different municipalities, as it is impossible with our present knowledge of climate change to establish how often municipalities are affected, and as the costs for the same type of measure vary widely with local circumstances. It is also difficult to establish at a general level how much at risk the municipalities are.

Given the positive experiences of the grant process at present, as well as the risk of measures not being taken at a sufficient rate, we consider it better to retain the grant in its current form. The criteria for the grant should, however, the clarified and written into the SRSA's appropriation directions. The criteria should be drawn up by the SRSA following consultation with SGI, SMHI and the municipalities through the Swedish Association of Local Authorities and Regions. In addition, responsibility for maintenance of the preventive facility should be clarified before the application is

approved. If the measures create added value for the municipality or property owner, the percentage of grant should be adjusted accordingly. In order to ensure uniform handling a template should be prepared for the calculation of gains for the municipality from building development being made possible. This should be included in the criteria for the grant.

We consider that measures against erosion should be included in the appropriation, in line with what the SRSA and SGI recommend. As in the case of flooding and landslides, building development or infrastructure have to be threatened for grants to come into consideration. The measures should be examined closely so that the risk of adverse effect in other parts of the watercourse or coast can be minimised. Knowledge is limited for measures against coastal erosion with regard to measures that may affect seabed conditions and material transport such as the construction of piers, groynes and extraction of sand. More research is needed in this area. Grants should therefore preferably be made to measures on the shore, such as groyning and measures to bind sand.

At present grants are paid up to 80 per cent of the cost of the measures. Our view is that the proportion of grant should be reduced. The municipality has primary responsibility for planning and building legislation and has decisive influence on the location of building development. It also has the best knowledge of local conditions. As such, the municipality is the most suitable body to take decisions on and deal with risks of natural disasters. As the measures are important in ensuring the safety of the population of the municipality, it should also fall within the municipality's responsibilities to take such action, and the municipality should therefore also bear part of the cost. Property owners should also take their share, in particular as the measures taken in many cases increase property values. We consider a suitable proportion of grant to be 60 per cent. The remaining 40 per cent would be shared between the municipality and the property owner. The distribution would have to decided on a case-by-case basis.

In addition, we consider that applications for large investment projects should be taken out of the appropriation and dealt with separately. Together with the decrease in proportion of grant, this means that more projects can receive grants each year. As pressure of applications will probably increase with climate change and increased awareness, we consider that, despite these changes, the appropriation should not return to its previous level but should in

future remain at the level established for the period 2007-2009, i.e. SEK 40 million per year. Proposals concerning the management of large investment projects are developed in section 5.6.2.

The grant at present applies to existing building development. It is unclear, however, where the limit lies for how newly constructed an area or building may be. If the risks of flooding were known when a residential area was built, is not reasonable for central government to pay to protect the area, and the cost should instead be borne by the municipality and property owner. The risks of landslides and floods are significantly better known now than previously. With improved map data and study methods, it is reasonable to require the municipalities to take account of these risks. Our view is that measures taken on properties or infrastructure which were built when the risks were known should not carry entitlement to payment of grant. To simplify the application procedure, consideration can be given to setting a time limit, so that measures carried out on buildings and infrastructure built after a certain number of years are not eligible for grants. We consider it reasonable to set the year 2007 as the limit.

Some municipalities have felt that giving grants to individual members of municipalities for preventive measures contravenes the principle of equality. The preamble to the Local Government Act (Government Bill 1990/91:117, p. 29) indicates that the principle of equality signifies that it is not permissible to treat certain members of municipalities or groups of members of municipalities differently on other than objective grounds. Rational reasons or objective considerations are required as a basis for members of municipalities to be treated differently. For special treatment to contravene the principle of equality, it must be a case of ”improper” special treatment. (p. 149) The municipalities and county councils have to be objective and fair in their treatment of members of the municipality. What constitutes an objective ground is decided by case law. As the measures to which the grant pertains are based on decisions on the risks to the threatened properties, the criteria of an objective ground ought to be fulfilled. This interpretation was also made in the Landslides Bill. The fact that municipalities have interpreted the Act differently suggests, however, that the possibility of the municipalities financing measures aimed at preventing natural disasters should be governed by a separate law, to clarify responsibilities and simplify the decision-making process.

We further consider that the municipalities should be given statutory support to carry out measures on the land of others, in case this is necessary in order to protect surrounding building development against the risks of natural disasters. The municipality should also have right of access to the land others where required to carry out measures on adjacent land. The provisions should be accompanied by requirements to restore damage and for adverse impact on the property to be minimised. Provisions on access to the land of others are contained both in the Planning and Building Act, Section 7, and in the Joint Facilities Act, see also section 5.5.5. These could be expanded in accordance with the above proposals.

Proposals

- The appropriation for preventive measures should be retained at the present level of SEK 40 million per year. The burden on the appropriation should be reduced by taking out large-scale measures, such as bunding of urban areas, and dealing with these separately. The percentage of grant should be changed from 80 per cent to 60 per cent of the cost of measures.
- The SRSA should be tasked, following consultation with SGI, SMHI and the Association of Swedish Local Authorities and Regions, with drawing up criteria for the appropriation to be written into the SRSA's appropriation directions. The following are should be included in the criteria:
  - Erosion should be included.
  - Government grants should not be paid for measures to protect buildings erected after 2007.
  - Before an application is granted, responsibility for maintenance of the facility to which the application relates should also be clarified.
  - A template for calculation of gains for the municipality if a new building development is made possible should be devised.
  - Account should be taken of climate change in assessing needs and formulating measures.
- The municipality's responsibility for detailed development plans and building permits should be extended to 20 years with regard to responsibility for payment of compensation for

flooding, landslides and erosion. The extended limitation period should not apply retroactively.

- The principle of equality should not pose an obstacle to municipalities funding measures on privately owned properties which are aimed at preventing natural disasters. To ensure that the issue is handled identically in all municipalities, this should be governed by a separate law.

5.6.2 A new appropriation for large investments to prevent natural disasters

Large-scale measures to prevent natural disasters that surpass the municipality or region's ability to pay, and that are judged to be of high priority from the point of view of vulnerability, should be eligible for government grants over and above the funds available in the SRSA's appropriation for preventive measures. This may apply to measures that apply to a large area that covers several municipalities or counties, protection of areas of national interest, or extensive measures such as bunding of whole areas of towns that represent a significant cost for the municipality. Examples of such measures are increasing the tapping capacity of Lakes Vänern and Mälaren. A special appropriation item should be created in the government budget for this purpose. The size of the grant may be adapted to the existing need.

The SRSA should, following consultation with affected authorities, comment on when a request for funds from this appropriation should be made and prepare the matter. The county administrative boards can usefully play a role in gathering together potential projects and passing on proposals to the SRSA. Applications for the 7:2 appropriation that exceed the appropriation and are judged to be crucial from the point of view of vulnerability may also come into consideration.

The measures should be jointly funded by central government and those who benefit from the measures, such as municipalities and firms. Responsibility for implementation should be borne by the appropriate authority, depending on the nature of the measures.

Increased options for tapping Lakes Vänern and Mälaren are crucial measures which should begin as soon as possible. It was

proposed in the Commission sub-report (SOU 2006:94) that the SRSA should be given coordinating responsibility for continued investigations on increased options for tapping water from Lake Vänern and for presenting a proposal for a long-term solution to the Government by 2012. It was proposed that SGI be tasked with conducting a geotechnical investigation of relief through the Göta Älv river. It was estimated that such an investigation would take around three years and cost between SEK 60 and 110 million. It was judged that other investigations could be carried out within the existing budget. We propose that a negotiator be appointed when a decision on a long-term solution has been taken. The task of the negotiator is to be to negotiate on distribution of costs of measures with the parties affected.

In order to increasing the tapping of Lake Mälaren measures were proposed to increase the spillway capacity through the Södertälje sluice and the sluice at Söderström in Stockholm. It was estimated that the measures would cost a total of around SEK 650 million, of which SEK 150 million for measures at the Södertälje sluice. The measures at Södertälje, which can be implemented relatively soon, should be prioritised so that there is no risk of flooding with major consequences in Stockholm. These therefore need to be financed over the next few years.

We propose that a negotiator be appointed with the aim of negotiating on the apportionment of costs for measures both at the Södertälje sluice and at the Söderström sluice. The costs should be shared between the municipalities around Lake Mälaren and central government. At the Södersluss sluice the measures should be carried out by the City of Stockholm as part of the planned reconstruction. At Södertälje the National Maritime Administration should also bear part of the costs as the responsible authority. The National Maritime Administration should also carry out the project in Södertälje. Spillway capacity at the Söderström sluice should be increased in conjunction with the reconstruction of the sluice planned by the City of Stockholm.

We estimate that the appropriation may need to be around SEK 100–300 million per year over the next ten-year period. It should be possible for the appropriation to be lower at the start of the period, however, as there will mainly be studies aimed at identifying suitable measures for Lake Vänern and measures at the Södertälje sluice.

Proposals

- An appropriation for investments aimed at preventing natural disasters should be instituted in the government budget. The SRSA should, following consultation with affected authorities, comment when such a request should be made and prepare the matter. The county administrative boards should collect potential projects together and pass on proposals to the SRSA. The size of the appropriation should be adapted to the existing need. The measures should be jointly funded by central government and those who benefit from the measures, such as municipalities and firms. The distribution of costs should be settled separately for each individual case. The basic principle should be that whoever obtains benefit from a measure also bears the greatest portion of the cost. Responsibility for implementation should be borne by the appropriate authority or other body, depending on the nature of the measures.
- The appropriation should apply to large-scale projects with costs that exceed the payment capacity of the municipality or region and which are judged to be of high priority from the point of view of vulnerability. There should be particular reasons for central government to contribute to financing the measures. Examples of criteria may be that the measures relate to
  - a large area that covers more than one municipality or county,
  - protection of areas of national interest,
  - extensive measures, for example bunding of whole urban areas, which exceed the payment capacity of the municipality within a reasonable period of time.
- A negotiator should be appointed to conduct negotiations on the financing of increased spillway capacity through the sluices at Södertälje and Söderström. Negotiation should take place with the municipalities located around Lake Mälaren. Revenue through public-private partnership can also be considered. Government funding should take place through the proposed appropriation for large-scale preventive measures. The National Maritime Administration should also come into consideration for the funding of measures at the Södertälje sluice. The

negotiator should propose a scheme under which the results of negotiation are ensured and implemented.

- When decisions have been taken on a long-term solution for increased tapping provisions in Lake Vänern, a negotiator should be appointed. Negotiations are to result in a proposal for the financing of the measures. The cost should be shared between central government and those who benefit from the measures, such municipalities around Lake Vänern and the Göta Älv river and holders of water rights. Revenue through public-private partnership can also be considered. The proposed appropriation should be considered for the central government part of funding. The negotiator should propose a scheme under which the results of negotiation are ensured and implemented.

5.7 Insurance cover

Several major storms and floods have occurred in Sweden over the last decade. Individuals, businesses and municipalities have been badly affected in several cases. On a number of occasions central government has covered the costs of those particularly severely affected. This has highlighted the issue of whether government support should be introduced for individuals and businesses affected by extreme weather events or whether the private insurance system is adequate. As storms, floods and landslides can all be expected to become more frequent in a changed climate, it is important that the insurance cover of society for such events functions. The Commission has therefore been tasked with presenting experience of insurance cover for the public, tenant-owner associations, non-profit associations, small businesses and agriculture, as well as assessing the need for measures to improve cover. We do not consider an analysis of the alternative of introducing a natural damage fund similar to that in Norway (see section 2.2.3) to come within the Commission's terms of reference. A review of the disaster protection of the municipalities is in progress in the Ministry of Defence commission of inquiry *Review of the disaster compensation scheme for the municipalities.*

Political initiatives on government support in extreme weather events

Members of parliament from all the parties in the centre-right coalition have repeatedly introduced motions to introduce some form of government support in extreme weather events. The form of government support advocated in the majority of cases is a natural damage fund. Interpellations on the establishment of a natural damage fund have also taken place on several occasions, for instance the records of the Riksdag 2005/2006:116.

The justification in most cases has been that it is not reasonable for individuals and municipalities to have to bear the entire cost themselves. Some parts of the country are more at risk than others, which means that some municipalities face high costs. The authors of motions have considered it fairer for the costs to be borne by the country as a whole. In motion 2000/01:Fö715 it is stated that large sums have been appropriated for affected municipalities and to restore road and rail networks. Individual citizens of municipalities have been referred to their property insurance policies. The proposer's view is that large insurance excesses jeopardise the finances of many families. It is also stated in Motion 2005/06:Fö215 that the excess is relatively high, and that in addition to this there is damage to outbuildings and plots which those affected have to pay for themselves.

The authors of the motions have also highlighted the issue of individual roads. Several motions state that individual road associations find it difficult to obtain grants for rebuilding their roads, and that in the countryside there are many private roads whose owners have difficulty funding restoration of the road, see for example Motion 2002/03:Fö 231 and interpellation 2000/01:291. It is pointed out in Motion 2002/03:Fö 206 that central government has allocated extra funds for the repair expenses of the National Road Administration and the National Rail Administration, whole damage to municipal amenities is paid by the municipalities themselves. The view of the authors of the motion is that this is not reasonable, and that it would be fairer to have a natural perils fund from which everyone affected could apply for funds.

Insurance cover against natural perils in Sweden

Insurance of property and economic activities has generally been left to the private insurance market in Sweden. Businesspeople are responsible for their own activities, in the same way that households are responsible for their property. When major disasters with severe harmful effects occur, as in the case of the winter storm Gudrun in 2005, it has, however, happened that central government has assisted forest owners and farmers, for instance. This procedure has been criticised on the grounds of reducing the incentive to insure property. Central government money cannot, however, be used in any way other than as determined by parliament. This means that there must be appropriation authorisation from the Riksdag that covers the purpose concerned.

Insurance for individuals, associations and businesses

The insurance companies cover damage caused by weather events such as flooding, landslides and storms for households with home insurance. No differentiation of risk is made at present with regard to different types of natural perils, as is done in several European countries. This means that the whole insured population shares the risk premium relating to natural perils, which generally makes insurance policies cheaper. In addition, expensive inspections for insurance policies are avoided, which also keeps premiums down. On the other hand, the insured population also has to bear costs that affect high-risk policy-holders.

Insurance policy for detached houses cover damage to the home and outbuildings. Damage to plots of land, fences etc. is generally not covered. It is possible to take out extended cover for buildings and land with some companies. Some indirect costs are also covered by the policy, such as food ruined as a result of power failures or additional costs of board and lodging. On the other hand, loss of income is not covered. Damage to vehicles caused by flying objects according to the Swedish Consumers Insurance Bureau is covered by the vehicle's own insurance (Swedish Consumer Insurance Bureau, 2007).

On 1 January 2006 provisions were introduced into the Electricity Act on compensation in the event of power failures. Customers who are affected by a continuous power failure that lasts

twelve hours or longer are entitled to outage compensation. Compensation is paid as a percentage of the annual electricity network cost. In January 2007 this was equivalent to around SEK 900 per day.

The damage that tenant-owner associations may suffer can be insured against in the same way as private homes. The cost of damage that occurs to land and access roads generally has to be borne by the landowners themselves, but as in the case of insurance policies for detached houses, some companies offer add-on policies.

The non-profit associations that need insurance cover against natural perils are principally road associations. The Swedish Private Roads Association (REV) offers a collective insurance solution for its members. This does not at present include damage to the road itself but principally cover for property (large road barriers, buildings etc.) as well as liability insurance. Private road associations often consist of a small number of households. The costs of repairing a section of road that has been washed away can be very significant. REV considers that it ought it be possible for private insurance to be developed to give the associations protection in such situations, and that it should be possible to design a good solution with a suitable level of excess and maximum payment. It is unclear, however, how high the premium would be and what willingness to pay there would be among the road associations. REV also considers that the municipalities should have the right to assist private road associations severely affected by extreme weather events (Swedish Private Roads Association, 2007).

Tables 5.1 and 5.2 list the insurance policies for landslides and floods for different players, according to responses to a questionnaire sent out by the Commission via the Swedish Insurance Federation. The five largest companies responded to the questionnaire.

Table 5.1 Insurance policies against landslides. 1 price base unit (PBB) = SEK 40 300 in 2007

	Covered by insurance	Particular excess	Restriction
Private policies Detached and holiday houses	YES	Minimum 10 000 Often linked to 10% cost of cost of claim	Age deduction in general. In some case deduction for water and wave erosion
Residential and office properties	YES	Minimum ½ PBB, up to 5 PBB. In one case linked to 10% of cost of claim	Between max SEK 3m and 350 PBB
Agriculture	YES	Basic excess In one case 1 PBB	Generally max 150 PBB
Small and medium-sized businesses	YES	Varies greatly from basic excess of ½ PBB to max 5 PBB	Between max SEK 3m and 350 PBB
Large business, central government, county council and municipally owned buildings and facilities and infrastructure	Varies	Varies	Varies

Source: Swedish Insurance Federation survey of insurance companies.

Table 5.2 Insurance policies against flood

	Covered by insurance	Particular excess	Restriction
Private policies Detached and holiday houses	YES	Minimum 10 000, but linked to 10% of cost of claim	Age deduction
Residential and office properties	YES	Minimum 10 000 or ½ PBB up to 5 PBB	Between max 4 000 and 350 PBB
Agriculture	YES	From ½ PBB up to 1 PBB	400 000 - – 150 PBB
Small and medium-sized businesses	YES	Minimum 10% of cost of claim Excess from ½ PBB and max 5 PBB	From 400 000 to max 350 PBB

Source: Swedish Insurance Federation survey of insurance companies.

The SRSA and SGI have emphasised that there is an uninsurable grey area with regard to landslides. This applies to buildings that have been cordoned off by the rescue services owing to an imminent risk of landslide. As the building has not been damaged the owners cannot make any claim on their insurance policy, but in practice they have been deprived of their home. This is a difficult issue, as insurance policies normally only cover the cost of damage that has occurred, not anticipated damage. The situation could be interpreted as being that damage has already occurred, as the house is uninhabitable.

Insurance solutions for companies may vary. Large companies usually have tailored policies, in which various types of risks are also insured separately, for example fire and flood. Small and medium-sized companies are generally referred to a combined insurance policy that contains all types of risks they wish to insure themselves against. These package solutions include cover for natural perils, for example damage caused by storm, hail, flood, landslip, avalanche, earthquake, volcano eruption and dam burst. The premiums are not set according to where the business is located and tend instead to be subject to standard calculation. Maximum payouts in the event of natural damage range from SEK 6 to 14 million, including outage compensation. There are restrictions on payouts for example in the case of dam failures and natural peril.

As cover for natural perils forms part of the package solution, there is no separate premium for this part alone. However, the Swedish Insurance Federation considers that in relation to the premiums for small business insurance a reasonable level of cover is obtained. The Swedish Insurance Federation considers that in the present situation it is difficult to answer the question of whether cover against natural perils is satisfactory. It is anticipated that there will be increased focus on this issue in the future (Swedish Insurance Federation, 2007).

Costs due to natural perils are not yet a major issue for many of those involved. Most of the stakeholder organisations and federations asked have reported that to date they have not had an opportunity to raise the issue of cover against natural damage.

Insurance cover for agriculture

Agriculture is prone to extreme weather events such as heavy rain, flooding and storms. There is no collective documentation on damage to harvests due to extreme weather events, only individual reports. It is also difficult to decide what is an extreme weather event. As harvests regularly vary with the weather, it is also difficult to decide what is regular harvest damage. The extent and frequency of previous damage is therefore not entirely known. Individual farmers are, however, sometimes hit hard. In several cases a complete year's harvest has been lost.

The insurance policies for agriculture indicated in Tables 5.1 and 5.2 relate to damage to buildings. Harvest damage and losses in the keeping of livestock are not included. The insurance cover available on the arable side is against hail damage and poor crop germination after sowing. On the other hand, it is not possible to insure for example against complete loss of a crop due to floods. Since 1988 central government has had some overarching responsibility in the case of harvest damage of the natural disaster type affecting large areas. General protection for harvest damage was phased out in 1994, but even after this date the Riksdag has stated on a number of occasions that central government has overarching responsibility in the event of natural disasters. In examining different claims for compensation arising from the floods in 2000, 2001 and 2003, the Government did not, however, consider the nature of damage to be such that any special central government responsibility existed (Government Bill 2004/05:1). A working group appointed by the Ministry of Agriculture in 2002 found in its report that it was not possible to quantify how much greater than previously the damage would have to be for central government responsibility to come into play, or to define whether the damage had been caused by "bad weather" or a natural disaster (Ministry of Agriculture, 2003). It was also found that that there is assistance for agriculture that is paid regardless of harvest yield, which reduces the need for special protection against harvest damage.

The working group considered two alternatives. One was to retain the present-day system, with the addition that central government also continues to have to apply payments of compensation for harvest damage as a consequence of natural disasters restrictively. The intention was to retain the incentive structures that exist in the market for farmers to take out separate insurance

policies and the possibility of insurance companies providing policies. The second alternative was based on the view that the responsibility of central government for agriculture should be the same in scope as for other entrepreneurs and industries, which the working party advocated and which the Government subsequently proposed in the 2004/05 budget bill.

The responses from those to whom the working group's report was sent for comment highlight several deficiencies in the forms of support available at present. Area payments, not linked to harvest yields, were not made at the time for table potatoes, fruit, berries, vegetables, sugar beet or peas for canning. However, these exceptions will be removed with effect from 2008.

The Ministry of Agriculture and many county administrative boards were in agreement with the working group's proposals and did not consider that central government should have any special responsibility for natural perils in agriculture. It was considered that there are great opportunities for the majority of farmers to guard against excessively severe consequences due to natural disasters, apart from agriculture with distinct specialisation. The Swedish Institute for Food and Agricultural Economics in the main supported the working group's proposals, but noted that major harvest damage affects large geographical areas at the same time, which makes it difficult for the insurance companies to handle insurance policies in the agricultural area. They also pointed out that the commercial supply of insurance solutions for agriculture is limited, which suggests a failure of the market. The low supply may, however, also be due to lack of demand, due to agricultural policy, as farmers now receive a single farm payment from the CAP regardless of crop yield.

In the framework of the inquiry, representatives of the Federation of Swedish Farmers (LRF) have pointed out that it is difficult to establish their own funds as profitability in the farming operation is low. Private insurance solutions for agriculture often demand high premiums, which means that many countries have government assistance of the natural peril fund type. There is therefore considered to be a need for some kind of collective solution, for example a pool system for subsidising insurance premiums. The LRF feels that the variability of the weather today already necessitates a natural perils system, and that a government disaster fund should be set up.

Livestock production is also susceptible to extreme weather events. Livestock husbandry, for example poultry flocks and dairy cows, is highly susceptible to power failures, problems with the transport sector and a deterioration in water supply (Annex B 34, Centre for Transdisciplinary Environmental Research, 2007). Storms and floods may therefore cause expensive damage. Livestock insurance for agriculture pays out if the animals die or fall ill or if they are so severely harmed that they have to be destroyed. There are also private insurance policies against diseases of livestock, such as salmonella. The extent of the insurance varies for different animals. Insurance policies for poultry may, for example, compensate for losses due to the flock having to be isolated. The policy covers loss of livestock value, clean-up costs and interruption of production.

Protection in preparation for outbreaks of infectious livestock diseases were analysed in the STUDS project. It was found that in international terms Sweden has uniquely generous regulations on compensation and that government costs in the event of a major outbreak may therefore be very high (Ministry of Agriculture 2003, section 8.5.3). STUDS recommended improved reporting routines in order not miss out on the co-financing from the EU which is available In addition to assistant in dealing with the infection, culling etc., central government pays compensation for loss of production.

The forestry sector

Forty per cent of forest owners affected by the winter storm Gudrun had forest insurance for storms. Compensation terms vary between the insurance companies. The risk of wind-felling can be reduced in some cases by a number of preventive measures, such as thinning methods and planning deciduous trees or coniferous trees other than spruce. However, the National Forestry Board found a deficiency in active risk management in forestry. Risks are not included in formal calculations for production and revenue routinely made in forestry, and wind-felling has historically had been a major problem. Despite the scale of the damage, the winter storm Gudrun does not appear to have significantly altered behaviour. (National Board of Forestry, 2006, p.132–35)

The National Forestry Board consider it principally to be the market that should guide processing, onward transport to industry and storage of timber after severe events have occurred. However, it is felt that initiatives on the part of central government are also required for the market to work well. The damaged timber after an extensive storm represents very high value for forest owners, the forestry industry and society. If most of the timber is not removed from the forest, there is additionally a risk of growing forest being affected by costly insect infestation. The National Forestry Board therefore considers good insurance against storm damage to be of great significance for the processing of wind-felled timber. The National Forestry Board additionally considers there to be a risk that too many forest owners throughout the country will continue not to take out storm insurance, often due to inadequate knowledge. It is therefore important that the forest owners receive good information on forest insurance issues (National Board of Forestry, 2006, p. 161).

The insurance industry is currently planning and introducing new products intended to be better suited to the circumstances of various forest owners than the products offered to date. The changes to the policies are in large part a direct effect of the winter storm Gudrun. Several areas with inadequate insurance protection were identified. Damage to small areas was not covered, for example, despite the total damaged area affecting a forest owner possibly being quite extensive. Some forest tracks and forest ditches were destroyed. Many forest owners also faced the expense of regenerating the forest earlier than they had planned.

Examples of changes made to forestry insurance policies are that the minimum damaged area for which compensation is paid is 0.5 hectares, rather than 1 hectare as previously. Compensation can be paid for regeneration costs, timber losses and increased costs of harvesting in growing forest if damage occurs. Compensation can also be paid for the costs of restoring forest roads or forest ditches. The extension of cover has, however, led to a hike in premiums. The amount paid out per hectare also remains fairly low, SEK 20–25,000 per hectare, while the value of forest per hectare may be more times greater. Furthermore, the limit for maximum compensation payable has been lowered.

An alternative in order to obtain a better spread of risk and lower premiums is to combine various types of risk in a single policy. One insurance company has merged its forest damage

policies for fire and storm, which has resulted in a far higher level of policy take-up for storm cover among policy-holders than previously.

Insurance solutions in other countries

The nature of the insurance market and the form of government assistance available in the event of natural perils differs widely from one country to another. An account of this can be found in section 2.2.3 and Annex B 35. According to an analysis by CEA *(Committé Européen des Assurances)*, six out of fourteen countries have some form of government protection, see Table 2.1. What this protection covers varies widely. Norway has a government disaster fund and a pool system for the private insurance companies, where the private pool system accounts for the majority of payments made. Finland has government harvest damage protection against exceptional weather events. Denmark has a market-based insurance system for extreme weather events, and central government does not intervene. There is, however, a storm damage fund, which is funded through an annual charge of DKK 20, levied on all fire insurance policies. In France too there is a solution by which a mandatory 12 % surcharge on home insurance finances protection against natural disasters. However, there are no specific criteria dictating whether an extreme weather event is to be classified as a natural disaster and the decision rests instead with the government. The United Kingdom and Germany allow the private insurance market to deal with all settlement of claims. The same applies to Italy, Greece, the Netherlands, Turkey and Austria.

Considerations

There are several areas in which the insurance solutions available are not sufficient to entirely protect the individual from economic harm. This applies for instance to private roads, harvest damage and storm insurance for forests. In these there are, however, no specific impediments to private insurance solutions. The extreme weather events concerned are heavy rain, exceptionally high flows in watercourses and storms in particular. All these events are by nature sudden and unpredictable, which means that in principle

they can be handled by an insurance system. We therefore cannot find there to be any strong reasons for introducing central government solutions to deal with natural perils.

Extreme weather events, such as storms and heavy precipitation, may lead to severe strains on society. In addition, they have the characteristic feature of affecting many people at the same time. The consequences of natural perils are therefore often more visible than for events that affect individual owners at different times. The insurance companies' payments in claims for weather-related floods, for example, are small in comparison with floods due to burst water pipes or similar occurrences. The excess for the individual is the same regardless of cause. There does not appear to be any reason for central government to provide assistance in one situation but not the other.

In the forestry section there are certain deficiencies today in insurance protection against storm damage. The principal deficiencies are that claim payments are relatively low for timber-rich stands and that the policy does not cover widespread damage in an area smaller than 0.5 hectares. The forest owner should, however, be able to bear some risk. The risk of damage is of a type which in principle can be dealt with by the private insurance market. It is doubtful whether it possible to create policy that provide full compensation in return for reasonable premiums. An alternative that can be considered is to introduce a mandatory addition to existing fire insurance polices in the forestry sector according to the same model as is applied in Denmark and France, with a fixed premium supplement. This would lead to a good spread of risk and thus lower premiums and excesses.

In addition, we have not found sufficient reason to introduce government harvest damage protection. We therefore come to a similar conclusion to that drawn by the Ministry of Agriculture in its commission of inquiry (Ministry of Agriculture, 2003). It is difficult to say how climate change will affect agriculture, as it is uncertain how much harvest damage will increase in relation to the increase in yields. As the Ministry of Agriculture pointed out, it is very difficult to define what harvest damage would be eligible for compensation. Nor are there are any comprehensive statistics to measure against in the present-day situation. There is some protection in the agricultural sector through the single farm payment scheme, which is not linked to the production of crops. There have previously been insurance policies against harvest damage, but the

insurance companies state that demand for them was not sufficiently high. The Swedish Federation of Farmers (LRF) considers the premiums to be too high. As in the case of forestry, a supplement to existing damage policies, with a fixed surcharge on the premium, might be a possible insurance solution.

If the situation for agriculture changes, for example the single farm payment scheme being reduced, abolished or harvest damage becoming more extensive than we can predict at present, these conclusions may need to be revised. We propose that a system for the documentation of the extent of harvest damage due to extreme weather events be established so that developments can be monitored, see section 4.4.2.

A problem not addressed by the insurance system at present is the situation that arises when a building has been cordoned off due to an acute risk of landslide. It should be possible for this to be covered by private insurance policies, by defining such a situation as damage that has occurred where the cost of returning the building to usable condition is eligible for compensation.

Damage to roads at present is not insurable. We consider it essential that such insurance solutions are developed. This is particularly crucial for private roads, where the economic situation is precarious as the road associations often consist of a small number of households.

The insurance companies consider a large part of the explanation for why certain damage cannot be insured against to be the fact that there has not been any demand. In some cases products have been developed but have then been closed down because the level of demand has been too low. In cases which the Commission has been able to identify the risk has been perceived as low, the premium has been considered to be too high and/or the insurance policy has been covered a sufficiently large part of the damage to be of interest. In many cases farmers, forest owners and road associations, for example, regard the premium as being too high in relation to the risk of a damage. Historically the level of damage due to storms and floods in Sweden has been quite low. This mean that the risk is perceived as being so low that it not worthwhile insuring against it. However, with the many natural perils of recent years in connection with floods and landslides, awareness of the risks, and consequently the level of demand for new types of insurance products, is likely to have increased.

Circumstances may, however, change for the insurance system in the future. Increased knowledge of risks of flood, landslip, landslide and erosion, together with initiatives for improved mapping, mean that these risks are becoming increasingly well known. If the risks of damage change, it is conceivable that the insurance companies will introduce differentiated premiums and excesses, with the consequence that properties in areas with a proven high risk of a particular natural peril will be subject to sharply increased insurance costs or will quite simply no longer be insurable. The alternative of government re-insurance may then need to be examined. It is important, however, not to create a system that deters those concerned from taking preventive measures that would cost-effective. Private terms of insurance include reasonable protective measures having to be taken for compensation to be payable. Many government bodies (government agencies, county administrative boards and ministries) which have taken part in the work of the Commission have emphasised the importance of placing responsibility for the location and design of building development and infrastructure with those responsible. Several proposals in this direction are made in the sector analyses in this report.

Conclusions

We consider there to be certain deficiencies at present in insurance protection against natural disasters. The deficiencies in insurance protection do not, however, justify special government assistance to deal with natural perils. The gaps that exist in relation to insurance against natural perils are judged to be of such a nature that they can be dealt with by private insurance companies.

Private insurance protection should, however, be developed, with regard to damage due to natural disasters. We consider it important to develop property insurance so that a building which is cordoned off due to an acute risk of landslide is defined as an insurance claim. We additionally judge there to be a strong need for the insurance companies, together with suitable representatives of policy-holders, to develop existing insurance policies for forestry and agriculture and develop new policies for private roads.

5.8 Information and training

Knowledge on how different parts of society are affected by climate change will gradually increase. It is necessary to know how vulnerable different areas are and how society can reduce its vulnerability make important systems robust.

Knowledge on how society can adapt to future climate change is crucial, but it is just as important that the knowledge reaches out to those who need it. For a large part of society, access to relevant information is a vital prerequisite for vulnerability to be reduced and adaptation to a changed climate to be brought about. The long-term spreading of knowledge is additionally dependent on society being able to integrate new knowledge on climate adaptation into education and training.

5.8.1 Information

Dissemination of information

Information on climate change and adaptation should first of all be goal-oriented and differentiated. Different groups in society need different types of information. It is important that technical personnel in a municipality, for example, can receive the information required ahead of investments and choices of equipment and to identify any future problems. Politicians who have to decide on future planning need a different type of information. The dissemination of information must be adapted with respect to the structural differences that exist between purchases in different sectors. In some areas mostly internal dissemination of information within affected authorities may be sufficient. Far more active, externally oriented and outreaching information initiatives are needed for sectors and industries with great needs to adapt which are dominated by small players with relatively meagre resources. Examples of these are farmers, with around 65,000 enterprises, often one-man businesses, tourism, which is also dominated by small businesses, and 354,000 private forest owners, for whom forestry is often a secondary occupation.

Secondly the information must be interactive, and there is a need for scope for exchange of information, feedback and dialogue. There must be channels between local, regional and central level, between the public sector and the private sector, between

businesses and industry associations and between research and practice.

Thirdly, established channels and forms of dissemination of information should be used as far as possible. Sector authorities, county administrative boards, municipalities, industry organisations and research institutions all have important roles to play.

What is to be conveyed?

The media are by far the most important way of reaching the public. It is essential that research results on climate change can be made more readily available to the media and consequently disseminated to broad groups. The wide attention that climate issues have attracted in recent times has probably already contributed to raising the general level of knowledge.

It is important to disseminate knowledge of changed circumstances for different activities and the risk of extreme weather events and natural disasters. It may be a matter of needing to amend non-statutory standards, safety margins and methods in different industries. Risk assessments affected by changes to the climate should be gradually updated. This relates for example to safety against storms, floods and landslides or risks of the spread of infection.

Who is to be responsible for the dissemination of information?

Institutions involved in climate research should in general disseminate readily available information on the results. Knowledge of climate change and its consequences should be continuously updated.

We propose that SMHI be given special responsible for collating and disseminating information on climate change through a supplement to its instructions. In particular, SMHI should develop and collate knowledge on regional and local climate change in support of municipalities, county administrative boards, sector authorities and others concerned.

We also support the initiative taken the Swedish Environmental Protection Agency, SMHI, the Swedish Rescue Services Agency, the Swedish Geotechnical Institute and the National Board of

Housing, Building and Planning to establish a web portal, the Adaptation Portal. This web portal will bring together climate information and information on adaptation issues targeted primarily at the municipalities, but in the longer term should be able to include information animated at other players in society, see section 5.2.4.

It would be of great value to coordinate the various web portals that have been established and that are linked to climate adaptation, in particular the National Board of Housing, Building and Planning's planning portal and the SRSA's information on natural disasters and extreme weather events. The authorities should consider forming a coordination group for web-based information.

We consider that the changes we propose to the instructions of the sector authorities should be interpreted such that their remit also includes compiling knowledge on the consequences of climate change in the sector in their respective areas of responsibility and identifying what measures should be taken to reduce vulnerability. Educational initiatives should also be taken to disseminate in-depth knowledge in their own sectors.

Sector organisations and other cooperative organisations should play an important role in passing on information for instance to the business community, for example in the energy, wastewater and district-heating sectors.

The county administrative boards have a key role to play in disseminating knowledge on climate change and how vulnerability can be reduced. Under our proposal, the county administrative boards are to coordinate efforts aimed at municipalities, the business community and regional authorities in different sectors. An important role in this work will be to coordinate the supply of knowledge. The county administrative board and the climate panel attached to the county administrative board should, on the basis of information from SMHI, sector authorities etc., adapt the information to regional circumstances, for example by creating a website with links for different types of information, for example different databases.

The municipalities should pass on and adapt the information from the county administrative board to relevant groups and the general public. Above all, knowledge and information should be disseminated within the administration and to entrepreneurs. The Swedish Association of Local Authorities and Regions should also develop a role for support to and passing-on of knowledge between

municipalities. A manual could, for example, be produced in support of the preventive efforts of municipalities in relation to floods, landslides and erosion.

Examples of crucial information initiatives

There are a number of areas where more information is needed on climate change and adaptation measures. Our proposals for expanded responsibility for county administrative boards and central authorities includes strengthening information to different groups such as municipalities and the business community. We have also identified the role of the municipalities and sector organisations in the dissemination of information. We present a number of examples below of areas in which we see particularly great needs to strengthen efforts in relation to broad groups.

- A broad information campaign on climate change and effects of a changed climate on forestry should be implemented by the National Board of Forestry in cooperation with the Federation of Swedish Farmers, associations of forest owners and other forestry players. Particular importance should be attached to information on the need for the spreading of risk, environmentally friendly operation, better forest roads and preventive measures against pests.
- Information initiatives should also be taken by the Swedish Board of Agriculture in cooperation with the Federation of Swedish Farmers, the Rural Economy and Agricultural Societies etc. on climate change and effects of a changed climate, for instance on crop selection, autumn/spring sowing, drainage systems, irrigation, pests, fertiliser application/nutrient leaching including effective catch crops, development cultivation systems and use of pesticides. Guidance on long-term investments should be included in particular.
- Climate change and increased global mobility lead to an increased risk of the spread of infection. Because the global spread of many infectious diseases will change in the future, risk information, vaccination recommendations etc. will need to be updated continuously.

- The National Food Administration, the National Board of Health and Welfare and the Geological Survey of Sweden (SGU) should inform permanent and summer residents with private water sources of the risk of poorer water quality and access to water in areas in which there is a risk of substantially changed water flows. There are 2 million people in Sweden today who take their water from private water sources.
- Municipalities and the Swedish Water and Wastewater Association (Svenskt Vatten) should inform private property owners of the risk of increased precipitation and downpours entailed by climate change. Proposals for measures should be highlighted, for the example the installation of non-return valves in wastewater pipes.

Proposals

We propose that clearer responsibility for climate adaptation should be introduced into the instructions of government agencies and the county administrative boards, see 10.2. Such responsibility should include providing information on the issue.

5.8.2 Training

Climate change will affect conditions in a number of areas. Basic growing conditions for agriculture and forestry will change. Dispersal routes and spread of infectious diseases will be affected. Dimensional design conditions, safety margins etc. in a number of technical areas will also be affected. These are examples of areas in which proven experience will not apply in the future as climatic conditions change. In many cases continuing professional development that updates knowledge among personnel who work in the industries concerned is required. An increased element of teaching on climate effects and measures to reduce vulnerability and adapt the care and maintenance of different systems to a changed climate are also required in basic training.

Some examples of essential training initiatives are as follows.

- Extended continuing professional development of staff in the healthcare sector and of veterinary personnel on infectious

diseases in view of increasing pressure of infection globally and the risk that completely new infectious diseases may become established in the country in the event of climate change.

- Inclusion of the topic of climate change and its effects on forestry and agricultural production in forestry training and agricultural training programmes.
- Inclusion of the topic climate change and its effects on physical planning, geotechnics and dimensional design of technical infrastructure in technical university study programmes. Continuing professional development of personnel who work in these areas should also be arranged.
- Training of personnel in municipalities, for example the rescue services, and various industries on how SMHI weather warnings are to be interpreted, what the warning means meteorologically and hydrologically but also how the warning is converted to a local place in the form of possible events and programme. Experience, feedback of experience, knowledge and training are all required for this purpose.

5.9 Research on climate change and adaptation measures

The descriptions of future climate change are still relatively imprecise. Knowledge on how climate change will affect different parts of society and what measures should be taken to adapt remains limited. The conclusions we draw on vulnerability, adaptation needs and costs in different parts of society in many cases rest on a relatively unstable foundation. Build-up of knowledge and research have a significant role to play in many of the areas the Commission has studied.

Descriptions of the climate change-ecosystems-land-based industries/health chain are still fairly rudimentary. Extensive research efforts are required to increase understanding of the effects of climate change on ecosystems and health and to enable the land-based industries to utilise the advantages climate change brings with it.

Applied research on links between society infrastructure, technical systems and the effects of climate change is largely lacking. There is a great need for a build-up of knowledge and research efforts in these areas so that appropriate measures to adapt can be taken.

5.9.1 Ongoing research in the area of climate change and adaptation

A number of research programmes and projects relating to climate change and adaptation measures are in progress with finance from various research funders.

Formas

Formas (the Swedish Research Council for Environment, Agricultural Science and Spatial Planning) finances a number of climate-related research projects. Some of these are concerned with adaptation (e.g. local capacity building, flood calculations, local politics, biosphere research). However, Formas does not finance any programmes in the area. Formas has also been commissioned to initiate collaboration on climate research, see Government Bill (2000/01:03).

Mistra

Mistra (the Foundation for Strategic Environmental Research) has recently launched significant initiatives on climate change and adaptation. The *Stockholm Resilience Centre* is a newly formed international interdisciplinary research centre at Stockholm University which will be conducting research on the mutual dependence between the development of society and vital ecosystems. Questions on the organisation of societies to cope with future climate change are included in the programme. *Swedish Research Programme on Climate, Impacts and Adaptation (SWECIA)* has also been launched in 2007 with the aim of creating a new common framework and model system for studies and feedback in and between the climate system and society, along the whole chain

from socio-economic development to land use and back to climate effects. The programme is due to last four years in its first phase.

Authorities

SMHI undertakes applied research on climate models at the Rossby Centre and provides other actors with data, scenarios and tools. Climatological research based on measured data today is also dominated by ongoing climate change and includes the development of knowledge support for society. Research on some climate effects on water, air and the environment forms part of the activities. SMHI's climate-related research is partially funded via the appropriation and partly from external funds.

The Swedish Environmental Protection Agency has been financing the Climatools programme since the autumn of 2006. The aim is to develop tools for use in vulnerability analysis and adaptation measures in sectors and social systems that may need strategies for adaptation.

The Swedish Geotechnical Institute (SGI) is undertaking its own research and funding projects in the area of geotechnics, some of which are linked to climate change.

The Swedish Rescue Services Agency funds a number of research projects with a bearing on climate change in the 2003–2006 research programme *Forskning för ett säkrare samhälle (Research for a Safer Society)*.

Universities

Universities and other higher education institutions undertake some research linked to the need for adaptation to climate change both in Sweden and in other countries.

5.9.2 Reinforcement and coordination of research in support of climate adaptation

The great upheavals faced by society necessitate strong action to reduce vulnerability and adapt different activities to a gradually changing climate. Increased knowledge and increased support in

many areas are required to deal with this. A combined resource for knowledge development and for passing on knowledge is essential.

The research area of climate change and adaptation is new. Some research linked to climate and adaptation measures has been initiated in a number of institutions, organisations and authorities, see section 5.9.1. These efforts will be of benefit to adaptation activities in various sectors of society.

The nature of many of the research issues raised by the Commission's work is such that they cannot easily be financed in the current organisation of research funding. This applies for example to the building-up, maintenance and analysis of long observation series, mapping work of various kinds, the compilation and summing-up of existing research results, certain long-term trials, development of methods of analysis and applied research on technical systems.

We judge it difficult within the framework of existing systems of research funding to bring about the coordination we regard as necessary.

This applies in particular to ways of implementing combined applied research for decision-making support for initiatives relating to the infrastructure of society.

Broad research efforts are required to support decisions on adaptation measures. Many questions are interdisciplinary and include both theoretically oriented and applied research. In several areas coordinated or collective research efforts are essential if it is to be possible for appropriate adaptation measures to be taken. In other areas such research efforts can contribute to the development of adaptation efforts so that future costs can be reduced and opportunities to utilise the advantages climate change brings with it can be enhanced. A more precise research-based survey of possible adaptation measures and costs is also important in making it possible to analyse the social effects and marginal benefit of measures. Vigorous coordination of research efforts is thus essential. We also take the view that there should be a significant boost to resources.

Investigate how a new institute for climate research and adaptation can be created

We consider that a new institute focused on climate research and climate adaptation should be created to provide the necessary basis for the harnessing of forces we would like to see.

The approach adopted by such an institute should be interdisciplinary, and the initiatives taken should cover research on climate as well as more applied research with development aspects. The work of the institute should include:

- continued development of climate models,
- adaptation of the technical systems of society with the focus on high flows, floods, storms, landslides and erosion,
- soil ecosystems, water resources (freshwater and drinking water), and effects on land-based industries and the environment,
- marine ecosystems, particularly in the Baltic Sea, as well as effects on ecosystem services, tourism and fisheries,
- impact of changes in climate and ecosystems on the spread of infection.

The framework for an institute could be provided by the geotechnical research and commissioned activity undertaken at SGI together with climate research, the hydrological and oceanographic and commissioned work carried out at SMHI and parts of IVL Swedish Environmental Research Institute Ltd. The extensive research in land-based industries which is today undertaken at the Swedish University of Agricultural Sciences (SLU) and possibly other parts of the operations of the National Veterinary Institute and the Swedish Institute for Infectious Disease Control should also be attached to its activities. As well as the funds currently at the disposal of the transferred activities, such an institute should be given a further sum of SEK 100 million per year.

The forms which the institute is to take should be investigated. One option is to create a ”network institute” along the lines of the *Tyndall Centre* in the United Kingdom. Another option is to take existing activities away from the agencies and institutions concerned completely in order to create a physically/geographically entirely new organisation. This would, however, bring certain problems with it. There is often no clear dividing line between research and other activity at the authorities. At SMHI models for weather,

climate and environment, for example, are largely common or closely related to those used for the more climate-oriented work. This means that there are common needs for computer infrastructure, databases, networks and development efforts.

The proposed increased resources and the broader expertise would provide such an institute with greater combined skills and should mean broader opportunities for international impact and collaboration.

5.9.3 Six areas with needs for extended and combined research efforts

In Chapter 4 we present the research needs we have identified in separate sections. We attempt below to summarise these research needs in six different areas. We do not consider that the last area, Climate change in Sweden and the world around, socio-economic effects, adaptation measures and impact on the national economy should be included in the proposal for a new institute.

Development of climate models

There a general need for continued development of spatial resolution, scaling-down at local/ecosystem level and with respect to the processes included in the climate models. The methods initially need methods to be developed by which to compare observation data with model data. Specific sector-wise climate indices and combinations of indices also need to be developed to a greater extent. In particular there is found to be a need for:

- Expanded understanding of links between climate, vegetation and land use comprising the carbon cycle (including methane) and greenhouse gas balances, particle effects, cloud processes and links between atmosphere and sea and between snow, ice and atmosphere.
- Development of parts of global system models in which the description also covers vegetation and biogeochemistry.
- Development of methods for translation between point data and the grid data of the models. Regional models at present use 25–50 km resolution while historical data are given for a particular observation point. Continued refinement of the

resolution in the models and development of methods for the interpretation of information at grid scale from scenarios on the basis of local effects and extremes is needed.
- Commitment to the development of high-resolution gridded climate data both for scenarios and for the historical climate on the basis of advanced geographical and temporal data analysis that combines model calculations and measurements.
- Continued development of hydrological methods to calculate flows in a changed climate and methods for interpreting and using the results.

Technical systems of society and physical planning

Research is needed for the adaptation of the technical systems in society to a changed climate in particular on the risks and consequences associated with high flows, floods, landslides, erosion and storms. Research on these areas and how they affect building development, transport infrastructure and technical supply systems, including water sources, is essential. There is also a need for technical development to facilitate measures for adaptation to a changed climate. There is more specifically a need for research on:

- Changes in the sea with respect to water level, currents, bathymetry, changes in extremes linked to floods and coastal erosion and the development of protection against erosion.
- Production potential and effects in the energy area, changes for hydropower, wind power, thermal power (coolant), solar energy, district-heating and district-cooling distribution.
- Risk of flooding of stormwater systems, changes in local intensive rainfall, interpretation of grid data for local conditions.
- Flooding in watercourses with consequences for various systems, need for changes in water regulation, in-depth analyses in areas particularly at risk, combination risks and risk of the dispersal of pollutants.
- Risks of erosion and landslides in a changed climate, local forecasting methods to assess relationships between groundwater pressure and pore pressure, methods for surveying and mapping earth movements, development of warning systems.
- Changes in the availability and quality of surface water and groundwater with consequences for the supply of drinking

water including the development and adaptation of more advanced treatment technology in the case of increasing humus levels, risks of the spread of infection etc.
- Dam safety in a changed climate, changed return periods for high flows, changed inflow dynamics and the significance of this for dam safety and risks of floods.
- Storms, extreme winds, low-pressure movements and effects on overhead power lines, shipping aviation.
- Icing, salt deposits and acid precipitation with respect to effects on masts, overhead power lines and wind power generators.
- Changes in the risk of lightning, with regard to both frequency and intensity, principally for systems with overhead power lines and masts.

Research on soil ecosystems, environmental effects and land-based industries

Despite growing realisation that ecosystems will be greatly affected in a changed climate, there is in general a great lack of knowledge on how different ecosystems will change, what role land use will play and how circumstances for land use will change. It is difficult, with present-day knowledge, to describe how protection of the natural environment and biodiversity should be amended in view of climate change. Climate change also plays a great role in other respects in determining how well the environmental objectives can be attained in the longer term, and more research is required. This also applies to freshwater systems and water quality, where it is particularly important to develop integrated models. The land-based industries, agriculture, forestry and reindeer herding, are based on the utilisation of soil ecosystems. Research on how ecosystems change, the impact this has on environmental effects and conditions for the land-based industries is an important basis for development in the area. In order to be able to safeguard valuable natural environments and biodiversity, both existing and new, it is essential to view ecosystems and the land-based industries as an integrated system. An important research task is to develop views on what such a system should look like in a changed climate. More specifically there are the following tasks:

- Scaling-down of climate models at ecosystem level on the basis of circumstances and processes that are of decisive significance for land-based industries and biodiversity.
- Development of methods for spreading risk, including mapping of land and geographical areas and their suitability for different types of trees/provenances/bred material in a changed climate.
- Build-up of knowledge on optimum care of mixed stands, deciduous stands and continuity forests including set-aside options for instance through long-term trials.
- Development/adaptation of general consideration measures for practical forestry that can offset adverse effects of climate change on biodiversity in the forest.
- Research on pests such as spruce bark beetle, pine weevil etc., diseases of deciduous trees and countermeasures around the food choice of wildlife, population dynamics, effects of a changed climate and forest condition.
- Development of tools for stand planning and planning of harvesting including modelling and minimisation of windfelling, development of new tools for timber capture and to minimise damage in connection with logging on damp, unfrozen ground.
- Consequences relating to the intensity, spread, extent and course of forest fires in a changed climate with changed forest condition including link to climate strategies for fire-risk models.
- Consequences for the environment and biodiversity of adaptation measures primarily in land-based industries.
- Modelling and field trials for studies of the impact of climate on growth, quality, pests and weds and how developed cultivation systems, plant breeding and biological pesticides can reduce pest problems and the need for pesticides.
- Research on nutrient leaching in a changed climate depending on soil type, crop, fertiliser application regime, processing measures and changes in growth and on the impact of nutrient metabolism on other environmental objectives, such as biological diversity and methods of minimising adverse impact.
- Research animal health, feedstuff production and methods for guiding livestock husbandry for maximum environmental benefit.

- Research on how changes in ecosystems affect reindeer grazing and the food choices and grazing patterns of reindeer.
- Research on the tendency of species to spread, access to dispersal routes and the ability of species to become established, the degree of "invasiveness" of new species in different ecosystems and the sensitivity of existing species, changes to the patterns of migrating species, risks of and needs for strategies for the active moving of species.
- Studies of the significance of climate change and extremes for population changes and key species versus, and in interaction with, the role of humans/land use.
- Extended environmental monitoring, for instance in the mountains, as well as support for relevant research infrastructure, for example research stations in the mountains.
- Studies of the significance of land uplift and ice for shore ecosystems, the prospects of management methods contributing to maintaining ecosystem amenity.
- Research on effects of biofuel production, including regional impact and significance of alternative production methods for biodiversity and their economic conditions.
- Studies of the effects of changed land use such as intensified tourism, infrastructure building, changes in the intensity of reindeer grazing.
- Field studies, for example in areas with low-lying forest and agricultural land with the aim of describing what types of wetland forest is formed in the case of free development in a wetter climate.
- Build-up of knowledge on the impact of climate change on eutrophication, acidification, turnover of environmental toxins and biodiversity.
- Research on processes and consequence of increased water coloration and increased humus levels.

Research on ecosystems in seas, effects on ecosystem services, tourism and fisheries

Research into how climate change will affect the seas and interactions with the nutrient burden, biogeochemical processes and the change in ecosystems is also essential as understanding of what changes in the seas can be expected from climate change is still very

limited. The Baltic is at risk of irreversible and rapid changes in salt levels, nutrient input, temperature and marine ecosystems. Collaboration between different disciplines and the development of integrated models are essential. Changes in the marine environment have a great impact on and are affected for instance by the fishing and tourist industries. The needs for research include the following:

- Impact on the biochemistry and ecosystems of the Baltic of changes regarding physical conditions such as salt level, temperature, inflows, currents etc.
- Changes in nutrient load on Swedish coasts and the total inflow to the sea.
- The effectiveness of measures against eutrophication in a future climate.
- Changed turnover of nutrients in the Baltic and the Kattegat and Skagerak.
- Biological effects of climate-induced changes including the presence of surface accumulations of algae.
- Changes to ecosystems resulting from cessation of land uplift, changed ice conditions, changed salt level etc. including effects on fisheries.
- Development of species-specific models for fish in relation to bioenergetics and growth, recruitment, energy allocation, population and community models. Verification of models against effects in and from, for example, natural inter-year variations in temperatures, north-south gradients in temperature and effects in bodies of water receiving coolant.

Research on the spread of infection and health

Knowledge on the risk of spread of diseases in a changed climate is largely fragmentary. A major survey of changes in the spread of vectors of infections and infective agents is needed. Research efforts are required on the conditions for the dispersal and survival of potential infective agents, including water-borne infection. There is a need for instance for:

- Research on the significance of the climate for the presence of vectors of particular infectious diseases and spread across the

country, current situation and changes and vector-borne infective agents such as *West Nile virus* and *Borrelia.*
- Studies of new methods for animal feedstuff production, handling and storage of foods in a warmer and damper climate.
- Studies of the survival infective agents in soil (*salmonella, VTEC* etc.) or pollutants in connection with floods.
- Establishment of networks internationally for R&D on the connection with climate for current infectious diseases in animals and zoonoses.
- Research on changes in allergies, dispersal of pollen and possible countermeasures.

Climate change in Sweden and the rest of the world, socio-economic effects, adaptation measures and impact on the national economy

The effects of climate change in Sweden can be expected to be significant. On a global scale, however, the situation looks even more serious, with the risk of large agricultural areas being wiped out, flooding of coastal areas and migrations of populations. Climate change will also have direct effects and socio-economic effects in other countries, regions and sectors. These effects will have repercussions for development in Sweden and for the need for adaptation in the country. Tools and data with which to analyse such effects at present are inadequate. There is also increased knowledge of impact between sectors and regions. International coordination of the research in this area should be aimed for. Examples of questions which should raised in the different areas are:

- Linking of national models to the global climate-related economic models in order to be able to produce nationally adapted socio-economic scenarios over longer periods of time.
- Knowledge of the interaction between climate change and socio-economic changes and their impact for example on refugee flows and tourist flows including effects in Sweden and on the Swedish economy.
- Development of tools such as a vulnerability index on diffeent scales in order to assess effects and needs for adaptation in the third world.

- Existing long time series should be maintained, as well as work to process existing historical material and make it available.

These questions border on the research initiative recently taken by the Foundation for Strategic Environmental Research (Mistra), for instance with the creation of the Stockholm Resilience Centre and the research programme Swecia. We assume that the continued research effects under this initiative will cover a large proportion of the questions we judge relevant to tackle in this area.

Proposals

- A new institute for climate research and adaptation should be established. The forms which the institute takes should be studied more closely.
- SEK 100 million per year should be provided for the research brought together in the new institute.

5.10 Issues of organisation and responsibility

A changed climate will require adaptation of society in a very large number of areas. A large proportion of these measures will be spread out over a long period and may be implemented continously as new investments are made, extensions, planned upgrades and refurbishments are carried out, standards are revised etc. Adjustments will therefore to a large extent take place gradually, provided sufficient information on climate change is available and used. This will probably apply to a large part of the adaptation of industry and commerce and certain parts of the infrastructure where the pace of technical transformation is high.

For a number of areas the investments required are of a long-term nature, and active efforts are therefore required to already adapt activities to a future climate today. The protection of human life and human health, environmental and natural amenity and cultural amenity are also areas where society should actively plan for climate change. Unless active efforts are made, there is a risk of increased costs and in some cases loss of human life and irreversible environmental effects. Society should identify such areas, and a clear structure of responsibility should be established.

A key point for the Commission is to review the responsibilities of individuals, different authorities and organisations for work on climate adaptation.

5.10.1 Present-day structure of responsibility

Responsibility for adaptation to a changed climate is shared in particular between individuals, the business community, municipalities and central government. Each fundamentally has responsibility for their property and their own activities. The municipality is responsible for the social functions at local level, while central government holds this responsibility at regional and national level. For a more detailed examination, see Annex B 14.

The responsibility of the individual

Responsibility for the protection of property rests primarily with the individual. The responsibilities of the individual are described in a number of statutory instruments. The preamble to the Civil Protection Act (Government Bill 2002/03:119), for example, states:

> *The principle of the primary responsibility of the individual*
>
> The purpose of current legislation on the rescue services is not to exempt the individual from responsibility for and the costs of intervention in the event of accidents and transfer responsibility and costs to the community. It is clearly apparent from the preamble that the purpose of the law instead is for the community to maintain an organisation that can intervene when the individual alone or with the assistance of another is unable to control an accident situation.

Responsibilities of the municipality

There are 290 municipalities in Sweden which are responsible for their citizens in relation to social care, care of children and the elderly, schools, physical planning and building development, health protection, waste and wastewater, refuse management and rescue services.

With regard to climate issues and the link with natural disasters in relation to planning and development the municipalities have responsibility for the planning of land and water use within their area under the Planning and Building Act. The municipality is responsible for physical planning, and pursuant to the Planning and Building Act planning takes place by the municipalities drawing up comprehensive land-use plans for the overall planning of land and water use. These plans cover the entire land area of the municipality and are politically strategic for the development of the municipality. The detailed planning for new, changed or existing development is done through detailed development plans which also form the basis for the granting of building permits, see section 5.5.

The municipality is the responsible authority for streets and public places in most of the country's major conurbations. This responsibility also applies to water and wastewater, rescue services and prevention and remedial measures under the Civil Protection Act. The municipality has ultimate responsibility for those who are resident in the municipality receiving the support and assistance they need.

Role of the county administrative board

The county administrative board has geographical area responsibility as the extended arm of central governments at regional level, with several tasks. The county administrative board has to coordinate the activities of several sectors in the county and therefore takes part in public planning and regional development.

The duties of the county administrative board are governed in part by the county administrative boards' instructions. To simplify, they can be said consist of three tasks:

- to develop the county,

- to push for national political objectives to be implemented in the county,
- to act as an administrative authority.

The county administrative board has responsibility for instance for monitoring that aspects of risk and emergency planning are taken into account in public planning. Under the county administrative board instructions, the county administrative board also has to ensure the necessary coordination in times of crisis.

The county administrative board supervises the planning and building process in the county and has to collaborate with the municipalities in their planning. The roles of the county administrative board in this context are:

1. Coordinating role – as the representative of central government safeguarding, coordinating and weighing up different central government interests, for instance in consultation on municipal planning proposals.
2. Authority role – examining detailed development plans and removal of shore protection, deciding on appealed plans and building permits.
3. Supervisory role – promoting a good residential environment and sustainable development of society, ensuring that laws are complied with. Intervening in the event of contraventions of the shore defences provisions.
4. Advisory role – providing planning material and required knowledge, advising on application of the Planning and Building Act, implementing Riksdag decisions and the goals of the Government, providing a regional overview.

The authority role includes the county administrative board having to safeguard and coordinate state sector interests in public planning.

Under the Planning and Building Act, the county administrative board has a duty to monitor that health and safety issues are satisfactorily considered in municipal development planning and to re-examine plans where they are not. This means that the county administrative boards have clear responsibility for preventing damage by ensuring that risks of flood, landslide and erosion, for example are addressed in the municipal plans.

Central government agencies

A large number of central government agencies are affected by climate change. Knowledge on climate change and adaptation measures is often developed on a sector-by-sector or area-by-area basis in interdisciplinary functions. In the vast majority of cases the central government agencies have a responsibility to monitor developments in their area and pass on this knowledge. There is often also responsibility for ensuring that new knowledge emerges and is disseminated.

The river groups

The 1995 River Safety Commission (SOU 1995:40) proposed that regional coordinating bodies should be set up for the management of flood risks along Swedish watercourses. The Swedish Rescue Services was then tasked in 1997 with initiating the formation of these.

The River Safety Commission described suitable tasks for the river groups as follows:

- To assess the need for planning material with respect to floods.
- To consult dam owners on dam safety issues over and above the regular inspection and to carry out or add to studies of tidal waves or potential dam failures or carry out other analyses.
- To assist in the coordination of the planning of the rescue services, including obtain data on flows with both dam failures and natural high flows in mind.
- To analyse the need for, value of and options for flow reduction and early tapping, harmonise the municipal interests and consult the dam owners on the principles of such measures, including compensation issues.
- To assess where restrictions should apply to building development in view of the possibility of high flows occurring.
- To make that that the information is planned and shared between SMHI, the dam owners, county administrative boards, rescue services, the municipalities in general and other affected bodies, firstly with regard to mutual tasks and secondly tasks for the public and mass media.

The river groups are based on the drainage basis of the river or watercourse, and its members consist of different stakeholders and players in the drainage basis. The river groups are a forum for collaboration and do not take over any responsibility held by any of the players or stakeholders in the group. The river groups do not act operationally, but there are two river coordination groups in the country with this task, see section 5.3.4.

The purpose of the river groups is to disseminate knowledge on the watercourse as a whole among the participants and create a network to facilitate cooperation ahead of future high-flow situations. Another important task is to work towards preventive measures against damage due to high flows being taken and these measures being coordinated along the watercourse so that no further damage occurs either upstream or downstream of the measures.

Today there are 25 river groups in the country from north to south. At present there are no river groups in the south-eastern part of the country. The county administrative boards usually convene and chair these groups under their regional coordinating responsibility.

5.10.2 Need for changes and clarifications in the structure of responsibility

Climate change will affect the underlying conditions in a large number of activities. Adaptation to a changed climate should therefore permeate virtually the whole of society. Practical efforts will be largely implemented at local level, by individuals, companies and municipalities.

The role of the municipality should be strengthened

The municipality has a key role in being responsible for public planning, emergency planning and the rescue services, as well as being the responsible entity for important parts of the technical supplies. Implementation of adaptation measures is largely the responsibility of the municipalities. This applies for instance to preventive protection against floods, landslides and erosion. In order to be able to implement measures in the municipality, both

politicians and officials are required to have access to sufficient information on climate change.

Risk assessments for floods, landslides and erosion are particularly important. Central information in the form of general mapping and altitude data is essential for municipal decisions for instance on development planning and preventive protection measures. It is important that the municipalities take greater account of floods and landslides in line with the proposals presented in the revision of the Planning and Building Act, see section 5.5. Technical facilities, particularly stormwater management and water supply, are vulnerable for example to heavy downpours and other floods. The municipality also needs data and an exchange of experience on what measures are effective. In their risk and vulnerability analyses to the Government, the municipalities should report in particularly on the work of reducing vulnerability to climate change.

The municipalities in general ask for support in order to strengthen their expertise in understanding and handling meteorological, hydrological and geotechnical data, in part on the basis of the extension to warning systems which we propose. Our view is that the coordination of different parts of municipal operations should be improved. Changes to the climate will increase the requirements for coordination. The new demands that climate change makes on the design of technical systems should be taken into account early on in the planning process. This may relate for example to the design of stormwater systems in new developments. Collaboration between the planning function and the rescue services should also be strengthened. This applies in particular in the planning of construction of areas threatened by floods and susceptible to landslides.

The role of the industry organisations

Industry organisations should be able to play a large role in adaptation to a changed climate. This applies both to industry and to other parts of private business, and areas where municipalities and county councils are responsible authorities. Climate change will in many cases alter the conditions on which industry standards and standardisation work are based. Sector research should also

actively support climate adaptation and pass on know-how for instance on adaptation techniques to the member companies.

Mention may be made by way of example of water supply and wastewater management, where the Swedish Water and Wastewater Association (Svenskt Vatten) plays an active role, as well as energy supply with the Swedish District Heating Association (Svensk Fjärrvärme), Swedenergy (Svensk Energi) and Elforsk.

Expanded responsibility for county administrative boards

The county administrative boards deal with a number of issues that are affected by climate change. The various roles of the county administrative board, in particular the coordinating role and the advisory role in relation to the municipalities, lead us to consider the county administrative board to be the most suitable body for coordinating the work of adapting to a changed climate.

Climate change appears differently in different parts of the country. The geographical differences make it important for regional climate data to be produced. In order to be effective the adaptation work in most cases needs to be implemented sector by sector. The sector-wide coordination which is also needed should, in our view, take place principally at regional level.

We propose that the county administrative boards be given a key role in work aimed at adapting to a changed climate. The aim would be to support the implementation of adaptation measures by municipalities and others players. This should partly take place through information. Passing on and compiling material from sector authorities is an important part of the information. The interpretation of material on climate change in the county and local adaptation of meteorological data and warnings are important aspects of this work.

The county administrative boards should also initiate and implement regional analyses. The long-term water supply should be analysed together with the water authorities. Other regional analyses may apply to the impact of climate on environmental and nature conservation, infrastructure, building development and subject areas that transcend municipal boundaries.

The efforts of a large number of players, as well as municipalities businesses, organisations and the regional bodies of government agencies, such as the regions of the road and rail administra-

tions and the regional bodies of the National Board of Forestry, need to be coordinated. It is appropriate to make the county administrative board responsible for this.

Important areas for the coordinating activity of the county administrative board will be to direct development of common strategies for the region in order to reduce vulnerability to floods and landslides through preventive measures.

The river groups play an important role in many places. The participants inform one another and facilitate coordination in high-flow situations. In one area river groups are, however, lacking. Our view is that the work of the river groups should be expanded and strengthened. We propose that the county administrative boards be given responsibility for initiating the formation of and supporting the work of the river groups.

We propose that a climate panel be set up at each county administrative board to support the coordinating and proactive role of the county administrative board on climate adaptation. This should include municipalities, businesses, government agencies, organisations and others that may be suitable.

We also propose that the county administrative boards be given increased resources to coordinate climate adaptation operations and for the activities of the climate panels.

The role of central government agencies

Those authorities which are to be regarded as sector authorities or have responsibility for a specific area should be given clear responsibility for climate adaptation in this area. This means that the authority has to promote adaptation to continuous long-term climate change. It also means reducing vulnerability to extreme weather events where the risks may increase in the event of climate change.

The authorities are to initiate the work of climate adaptation and support the various players in the area of activity. This entails the authority analysing the situation and the risks, following the work of various players and taking the initiative where required.

The authorities should also be responsible for supplying know-how and ensuring that information is disseminated to key groups in the area. This may apply both to specific information about the consequences of climate change and to technical measures.

The authorities are to assist the county administrative boards in this work, firstly with analytical material and information and secondly through collaboration on prioritised issues.

We propose that the relevant central government agencies be given clear responsibility for climate adaptation in their instructions. This activity should be reported to the Government. It should also be reported to the Swedish Environmental Protection Agency in line with the proposal for overall responsibility for follow-up which we propose should rest with the Swedish Environmental Protection Agency. We propose that the following government agencies should be given this clarifying responsibility, and it should be possible for additions to be made to the list. See proposals for amendments to the instructions in Chapter 1.

National Road Administration
National Rail Administration
National Maritime Administration
Swedish Civil Aviation Authority
Luftfartsverket (LFV)
Swedish National Post and Telecom Agency
Swedish Energy Agency.
Swedish National Grid
National Food Administration
National Board of Housing, Building and Planning
National Survey of Sweden
Swedish Geotechnical Institute
Geological Survey of Sweden
National Board of Forestry
Swedish Board of Agriculture
National Veterinary Institute
National Board of Fisheries
Swedish Agency for Economic and Regional Growth (Nutek)
National Board of Health and Welfare
Swedish Institute for Infectious Disease Control
Swedish Meteorological and Hydrological Institute (SMHI)
Swedish Rescue Services Agency
Swedish Emergency Management Agency
Swedish Environmental Protection Agency
National Institute of Public Health
National Heritage Board
Financial Supervisory Authority

Central coordination

It is difficult to find an authority that can naturally take responsibility for follow-up and coordination of the whole endeavour to reduce the vulnerability of and adapt society to a changed climate.

The Swedish Rescue Services Agency (SRSA) has a key role to play to in reducing vulnerability to extreme natural events such as floods, landslides and storms. The agency is already working on these issues, and it is therefore natural to include climate change in risk analyses and preventive efforts. On the other hand, it is not so natural for the SRSA to coordinate and follow up the longterm adaptation of agriculture and forestry, for example.

An overhaul of activities at the SRSA, the Swedish Emergency Management Agency and the Board for Psychological Defence is currently in progress, *Alltid redo! En ny myndighet mot olyckor och kriser (Always prepared! A new government agency against accidents and crises)* (2007:31), see section 2.3. In the sub-report, the chair of the commission proposes that the SRSA and the Swedish Emergency Management Agency, among others, be merged. The new agency would, under the proposal, have at its disposal appropriation 7:2 *Preventive measures against landslides and other natural disasters*. Our view is that if a decision is taken on a merger, the new agency should take over the duties which our report proposes should be placed with the SRSA.

The Swedish EPA is responsible for the environmental quality objective of *Reduced Climate Impact*. This objective is concerned with restrictions of emissions and efforts to reduce emissions of greenhouse gases and increase sinks. One option would be to include climate adaptation as part of the climate objective. The Swedish Environmental Protection Agency would then also assume responsibility for follow-up and coordination of adaptation to a changed climate. It would also be followed up and evaluated by the Environmental Objectives Council. Adaptation activity is, however, by nature local and dispersed between virtually all sectors. This entails changed circumstances in many activities. An important aspect of the work is to reduce vulnerability to extreme natural events, for which the SRSA at present has overall responsibility. Complete responsibility for operational implementation of adaptation to a changed climate therefore does not naturally rest with the Swedish Environmental Protection Agency.

Responsibility for international follow-up and reporting of climate-related activity, including adaptation, is currently held by the Swedish Environmental Protection Agency. It is therefore appropriate for the agency to also take responsibility for the national follow-up of adaptation. Follow-up responsibility should entail reporting how the work is progressing and, in consultation with the SRSA and SMHI, proposing further efforts that may be needed.

SMHI is responsible for weather forecasts in Sweden and undertakes climate research. SMHI also has operations in hydrology and oceanography. Weather forecasts and information about these are financed by appropriations. SMHI also disseminates information on climate change. Our view is that SMHI should expand the supply of knowledge and information, particularly towards municipalities, sector agencies and county administrative boards, see section 5.2.4. On the other hand, we do not feel that total responsibility for follow-up and coordination for adaptation to a changed climate should rest with SMHI. This would demand a different orientation and other expertise than SMHI has today. We co not consider this to be appropriate.

To summarise, we feel that the coordination of adaptation to a changed climate in the county concerned should be the responsibility of the county administrative boards. In the present case responsibility should be borne by regional self-governing bodies. National coordination should be shared between several authorities. The SRSA should, as at present, play a key role in reducing vulnerability to extreme natural events. The Swedish Environmental Protection Agency should take responsibility for following up climate adaptation and international reporting. SMHI should take responsibility for the supply of know-how of climate change and an expanded information function.

Proposals

- The county administrative boards should be given a key role in adaptation to climate change and coordinate the work in relation to municipalities, businesses and regional sector authorities. Regional analyses should be performed in the counties as a basis for planning, for instance the long-term water supply should be analysed together with the water

authorities. A special climate adaptation committee should be established in each county with the task of supporting the efforts of the municipalities, contributing to the supply of knowledge, summarising, providing, interpreting and forwarding information and coordinating, instigating and following up the work. This includes initiating the formation and supporting the work of river groups.

- SMHI should be given responsibility for the supply of knowledge on climate change and should create a reinforced information function in relation to different groups, in particular municipalities, sector authorities and county administrative boards.
- The Swedish Environmental Protection Agency should be given responsibility for collective national and international follow-up and reporting of climate adaptation efforts.
- Sector agencies concerned should be given clear responsibility for adaptation to a changed climate in their own areas of responsibility. This responsibility covers the risk of both extreme events and continuous climate change. The requirement that the agency will initiate, support and follow up work on adaptation to climate change in its own area of responsibility should be introduced into the instructions for each government agency. The Swedish Rescue Services Agency, the Swedish Meteorological and Hydrological Institute (SMHI), the Swedish Environmental Protection Agency, the Swedish Geotechnical Institute (SGI), the National Board of Housing, Building and Planning and the National Food Administration should additionally be given explicit responsibility to assist the county administrative boards in their work on climate adaptation. See also proposals for statutory text in Chapter 1.

5.11 Proposals for measures at EU level

Adaptation to a changed climate will need to take place throughout the world. International cooperation on methodology for adaptation and exchange of experience can facilitate work on adaptation.

What type of adaptation is required and how extensive it needs to be is largely governed by the way systems and structures are

designed in different countries and regions. What is a suitable adaptation measure in one country or one region may not necessarily be so in another. Some measures, such as flood defences along a large river, may require international cooperation.

Cooperation at EU level on adaptation should therefore primarily supplement national, regional and local adaptation efforts. Joint measures may be of great benefit in some cases.

Integration of climate and adaptation into EU legislation and financing mechanisms

There is a very large number of legislative acts in the EU. There are European Community directives and regulations in a large number of areas of policy. In the EU green paper on adaptation, COM(2007)354, a systematic review of EU legislation is proposed with suggestions for how existing legislation should be amended to take account of climate change. Our view is that Sweden should support such a review, with the aim of ensuring that EU legislative acts do not impede adaptation measures and, where possible, promote such adaptation measures.

Integration of climate adaptation into the EU's structural funds and other financing mechanisms is a possible development of EU policy. We consider that assessments of what adaptation measures may be necessary for an infrastructure project, for example, to cope with temperature, precipitation and water levels in a changed climate should form a natural part of the material on which decisions are based for EU funds for such projects. Sweden should press for an overhaul of the rules for EU financing instruments on this basis.

The EU green paper on adapting to climate change also mentions the possibility of creating new financial systems to support adaptation in public planning. The system of support to the municipalities for preventive efforts against flooding and landslides already exists in Sweden. We propose certain changes to this system, see section 5.7. Our view is that a system at EU level may be justified but that if so there should be options for national considerations. Supplementary systems, similar to our system for preventive measures, should be allowed to exist in parallel.

Initiatives for support for the Baltic Sea and other sensitive ecosystems

The Baltic Sea, its ecosystems and the ecosystem services this sea offers are at risk of being severely affected by climate change. There is increasing understanding that measures that affect the drainage basin of the whole of the Baltic Sea must be taken to strengthen the prospects of the Baltic again becoming the rich inland sea it once was. According to the climate scenarios and the analyses of biogeochemical processes and marine ecology we have studied, increasing eutrophication combined with climate-driven reductions in salt levels and temperature rises pose the greatest threats to the Baltic. While there are few reasonable adaptation measures that prevent warning and reduced salt levels, there are many ways of influencing the input of nutrients. These are measures to reduce point emissions, for instance from industrial plants and water treatment plants, measures to reduce emissions from households and not least measures in agriculture.

The EU has a clear role to play in the reducing the input of nutrients to the Baltic Sea. The EU's marine strategy and the EC directive linked to the strategy to some extent improve the prospects of initiatives in support of the Baltic. A common *Baltic Sea Action Plan* which is now under discussion (autumn of 2007) can make a further contribution to create the necessary basis for extended efforts. Measures at EU level should continue to be given high priority, and Sweden should be a driving force at EU level.

The EU's Common Agricultural Policy has been developed in the direction of more environmental support to the detriment of pure price support and similar direct subsidies. This development should continue in the forthcoming revision. It is particularly important in minimising the input of nutrients that incentives are created to preserve wetlands and create new ones and to develop cultivation systems with less leaching of nutrients. It should be possible for payment of support to be conditional on low losses of nutrients etc. More wetlands may also be significant factors in the preservation of biodiversity. Sweden should also press in other ways for policy to be formulated so that the environmental objective of a varied agricultural landscape can also be attained in a changed climate.

Measures to reduce diffuse emissions of nutrients from households etc. should also be taken. Bans on phosphates in detergents are an example of a measure with this purpose.

Fisheries in the Baltic, as in other seas adjoining EU territory, are governed by a quota system decided on at EU level. EU marine strategy is also a basis for measures in fisheries administration. Climate change and its effects should continue to be an important factor underlying fisheries administration and for initiatives at EU level in the marine area. The need to reduce present-day overfishing is becoming even greater.

Several infrastructure initiatives, particularly in the member states that joined the Union at the time of the last enlargement, are partly financed by EU funds. Initiatives of this kind may affect the environment in the Baltic Sea, but also other sensitive ecosystems, building development and infrastructure. Climate change may in part alter the conditions underlying infrastructure initiatives. The rules governing the EU's structural funds should be developed so that account is taken of climate.

Measures to adapt to a changed climate should be formulated so that they do not increase, and preferably contribute towards reducing, the input of nutrients to the Baltic Sea. Joint or coordinated adaptation measures to flood defences along the rivers and aquatic systems that discharge into the Baltic are an example of measures where such account should be taken.

Efforts to preserve biodiversity

Climate change entails rapid shifts in vegetation zones and ecosystems in a northerly direction. Threatened species which do not have a great ability to compete are at risk of being eliminated when more competitive species to an increased extent evade the climatic stress they are exposed to today. There will be a great need for retreat routes northwards for many species.

In a changed climate certain types of nature will be lost regardless of what efforts are made to protect them.

Climate change is mentioned as a threat to biodiversity in the EU action plan *Halting the loss of biodiversity by 2010 – and beyond, COM(2006)216 final.* There are no concrete proposals on how biodiversity can be protected better in a changed climate other than adding to the Natura 2000 network.

Our view is that an overhaul of EU nature conservation policy is required in order to fully take account of the fact that certain climate changes are unavoidable and to prioritise efforts aimed at protecting ecosystems and species so that retreat routes northwards are created. The Habitats Directive (92/43/EEC), which governs work on the EU's conservation programme Natura 2000, should be revised. This directive is based on the protection of sites where habitat types and species are to be found. There should be increased emphasis on creating environments that can function as retreat corridors for species retreating northwards. The need for active moving of species should also be investigated.

Initiatives in EU external policy

Adaptation measures implemented well at the European level with visible, positive results can also set an example for other countries and regions and reinforce the Union's credibility. Cooperation with other countries and regions, both bilaterally in international forums such as the UN Framework Convention on Climate Change may consequently be strengthened. This applies in particular to adaptation measures that benefit the EU's neighbouring countries. The European Commission largely comes to the same conclusions in its green paper on adapting to climate change.

The EU should also continue to take the lead in international work, principally under the Convention on Climate Change, and contribute actively to implementation of the five-year programme of work from 2006 and towards continued development of efforts in relation to adaptation issues under the Convention on Climate Change.

Adaptation issues should be given a prominent role in the EU's development assistance budget. Climate change and its impact on recipient countries, the projects and programmes which the Union intends to support should be an important factor in deciding what initiatives the Union should take.

Initiatives for research and build-up of knowledge

Research and build-up of knowledge on adaptation may to some extent gain from coordination. Many issues relating to adaptation are specific to the country or area in question, but more trans-boundary issues sometimes arise,

Initiatives at EU level in research on climate and adaptation may be particularly suitable where effects of climate change are similar across the Union. One such area is the impact on health, for example from high temperatures combined with increased levels of particles and ozone or from vector-borne diseases. Another area where the EU level may play an important role is evaluations and knowledge follow-ups. These areas are also mentioned in the EU green paper.

The Green Paper also mentions initiatives aimed at obtaining a better understanding of the effects of climate change in different areas. Better understanding of changes in a number of sea areas is highlighted in particular. However, the Baltic Sea is not mentioned. Our view is that research on changes in the Baltic Sea should be one of the key areas for EU-wide build-up of knowledge, particularly in view of the fact that the Baltic, with is unique environment, is largely surrounded by eight EU member states.

Proposals

- Sweden should press for an overhaul of all EU legislative acts so that they firstly do not impede adaptation measures and secondly, where possible, promote such measures.
- Sweden should press for measures at EU level that reduce the vulnerability of the Baltic Sea in a changed climate, including:
  - prohibition of phosphates in detergents throughout the EU,
  - increased treatment of point sources,
  - integration of climate considerations in fisheries administra tion,
  - taking account of the problems of nutrients in EU-financed infrastructure projects and adaptation measures.
- Sweden should press in particular for greater focus on the problem of nutrients and their impact on the Baltic Sea in future revisions of EU agricultural policy.

- Sweden should press for an overhaul of EU nature conservation policy with the aim of increasing focus on the effects of climate change in the protection of ecosystems and species.
- Sweden should press for climate considerations to be integrated into EU financing instruments, including the structural funds.
- Sweden should press for the EU to continue to be active in international negotiations on adaptation issues, in order to implement adaptation projects that also provide benefit for the Union's neighbouring countries and to give climate and adaptation a prominent place in EU development assistance activity.
- Sweden should press for the EU's research funding to include research on adaptation to climate change, including compilations of knowledge and follow-ups.

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6 Conclusions and proposals

6.1 Conclusions

Climate change – what do we know, and what is still uncertain?

The UN's climate panel, the IPCC, has reached the conclusion that global warming up until now has been around 0.7°C over the last 100 years. Warming has occurred almost twice as fast during the last 50 years compared with the 100-year period as a whole, and it is extremely likely that this has mostly been caused by human activity.

It is very likely that, compared with 1990, the average global temperature will increase by a further 1.8–4.0°C by the end of this century. In the international future scenarios produced by the IPCC, emissions are driven by forces such as population growth, economic growth, technological developments, etc. No assumptions on agreed reductions in emissions have been taken into account. The interval of uncertainty is growing wider since natural carbon dioxide sinks are affected by climate change, and could contribute between 1.1°C and 6.4°C to global warming. With agreed reductions in emissions, temperature increases may be restricted in the long term. However, a degree of continued temperature increase is unavoidable. In calculating this, the IPCC has shown that if it is assumed that atmospheric greenhouse gas concentrations were frozen at the level for the year 2000, which would require a complete cessation in emissions, the temperature would still increase by roughly another 0.6°C.

There is relatively widespread agreement between a large number of models that the temperature in Sweden and Scandinavia will rise by more than the global average. The precipitation patterns will also change, with increased precipitation in Scandinavia, but there is a greater degree of uncertainty here. There is also greater

uncertainty about how trends relating to winds and storms will change in our part of the world.

According to the IPCC's latest report, sea levels will rise globally by 0.2–0.6 metres over the coming 100 years, and considerably more in the North Sea and the Baltic. Sea levels will then continue to rise for many centuries. The uncertain additional rise in sea levels relating to deglaciation in Greenland and Antarctica has not been included.

- All in all, the scientific results clearly show that Sweden will be seriously affected by climate change. This can be stated with sufficient certainty to conclude that far-reaching adaptation measures will be required.
- There is a considerable degree of uncertainty in the scenarios which we have produced to show how the climate will change in Scandinavia in the future. However, the underlying factors in the scenarios are robust enough that they can be used for the planning involved in beginning to carry out climate adaptation within Swedish society.

Consequences for Sweden

The scenarios we have analysed indicate dramatic changes in Sweden's climate at the end of the century. The winter climate in much of Sweden will be similar to that which is currently found in northern France. Precipitation in much of the country will increase in the autumn, winter and spring. In the summer, we will experience a warmer, drier climate, particularly in southern Sweden. Torrential rain will become more intensive. Analyses carried out based on the scenarios we have studied show consequences including the following:

- The flooding risk for lakes and watercourses will increase, mainly in western Götaland and western Svealand and in parts of Norrland. Buildings and technical infrastructure, particularly roads, railways and drainage systems, will be affected. Vulnerable areas include the Lake Vänern area. The cost of the increased flooding of buildings over the coming 100 years has been estimated at between SEK 50 billion and SEK 100 billion.
- Higher flows and changes in catchment patterns involve the risk of reduced dam safety, particularly for smaller dams.

- The increase in sea levels leads to a greater risk of flooding at high water in coastal areas, particularly in Götaland, with areas including Gothenburg and Falsterbonäset being vulnerable. In the coastal areas which are close to beaches, there is the risk of significant coastal erosion, for example on the south coast of Skåne.
- The increase in intensive precipitation across much of the country affects the drainage systems. There is therefore a risk of increased cellar flooding due to overburdened sewerage systems.
- The risk of landslides increases in much of the country, due to increased precipitation, more intensive precipitation and increased flows. Buildings and infrastructure in western Götaland, eastern Svealand and coastal Norrland are particularly vulnerable. Resulting consequences include an increased risk of loss of human life and financial losses.
- The increase in precipitation results in better conditions for increased hydroelectric power production – particularly in the north of the country – by an estimated 15–20 percent.
- The temperature changes result in a reduced need for heating. Calculations indicate a reduction of around 30 percent. At the same time, the need for cooling becomes around five times as great.
- The vegetation season grows longer and the temperature increases. This favours forest growth, which increases by 20–40 percent. Agricultural conditions also improve. However, the risk of damage due to insect infestations also increases.
- The increased forest growth, combined with wetter ground and fewer frosts, leads to increased storm-felling of trees, affecting systems with overhead power lines, regardless of the intensity and frequency of the storms.
- The reindeer herding conditions change. Longer vegetation seasons and more pasture barely make up for the worsened winter pasture conditions.
- The tourism industry may benefit, but winter tourism will struggle in the long term due to reduced access to snow.
- The different length and climate of the seasons changes the conditions for soil ecosystems, with a northwards shift in ecosystems and species. Bushes start to grow on bare mountain regions above the tree line. Biodiversity and the local presence of plant and animal species – including insects – are affected. New species will gain a foothold in Sweden.

- The eutrophication of lakes and watercourses increases. Fish are seriously affected through changes in species composition and a shift towards warm-water species. Foreign species will also spread out further. Overall fish catches may increase, particularly in certain lakes. There is a risk of cod disappearing completely from the Baltic.
- The production of drinking water will be adversely affected, with increased levels of humus in the water and a greater risk of both chemical and microbial pollution of water catchment in the event of flooding.
- A greater risk of higher average winds and increased precipitation reduces the salinity of the Baltic, leading to a dramatic ecological change. The biology of the Baltic proper will then be similar to that of the Gulf of Bothnia today. Biodiversity will decline with many marine species disappearing, including cod. Even in the event of less dramatic changes in salinity, temperature, nutritive salt balance and ecosystems will be significantly affected.
- Extremely high temperatures become increasingly common, leading to a higher mortality rate for vulnerable groups such as the sick and the elderly. An increased frequency of flooding increases the risk of the spread of infection, including through water washing over pasture land and sewage overflow. A warmer climate also means an increased risk of new and existing diseases spreading.
- Climate change will continue beyond the year 2100. For example, sea levels will continue to rise for many centuries. In the long term, large coastal areas will be threatened.

Increased cost of damage, but increased income too

The overall cost of damage of the coming climate changes, which we have calculated based on sectoral area analyses, amounts to around SEK 1,100–1,900 billion over the coming 100 years, according to the assumptions detailed in section 4.8.3. This is, of course, a considerable sum. However, spread over 100 years and viewed in the context of assumed economic growth, this cost will not have any significant impact on the Swedish economy. Nevertheless, in certain sectors or areas the impact on the economy will be such that it could have consequences for the survival of

industries or result in their structure being radically changed. Examples include winter tourism and reindeer herding. Individuals may also be badly affected.

We believe that there are currently shortcomings in insurance protection against natural disasters. These do not, however, justify special state support for such disasters. The shortcomings which do exist are deemed to be of such a nature that they can be dealt with by private insurance companies. However, private insurance cover needs to evolve to take into account damage to land due to natural disasters.

It should also be pointed out that the calculated cost of damage has probably been underestimated. This may pertain to the cost of damage in terms of railways, dams, torrential rain and storms. We can also expect consequences for a number of areas which have not actually been included. Nor has the indirect cost to society been included.

Over the coming 100 years, the income potential as a result of climate change will increase by something in the order of SEK 1,200–1,700 billion, primarily due to reduced heating costs, increased hydroelectric power production, forest growth and improved harvests. However, the latter three will require adaptation measures and a degree of investment if their potential is to be realised. Tourism is another area where there is significant potential for expansion, even though some winter tourism is threatened. See also section 4.8.3.

Comparing costs and income is difficult, due to the considerable degree of uncertainty. Furthermore, the uncertainties in the cost calculations are much greater than those in the income calculations. An overall conclusion is that the cost and income items are largely similar in size if climate change is within the framework of the scenarios we have used. However, income and costs cannot be offset against each other, since they tend to occur in different sectors and affect different players.

Climate change over and above these scenarios, such as sudden or unexpected effects, may throw these conclusions into disarray. For example, a dramatic deglaciation in Greenland could lead to higher sea levels as early as this century. Similarly, the assessments of future storm frequencies and intensities are highly uncertain. If storms which are more powerful than Gudrun start to occur, storm costs will probably be considerably higher.

More far-reaching economic consequences are possible as a result of serious events abroad. Economic disruption as a result of hurricanes, widespread flooding, etc. could result in serious consequences for countries other than those affected. If areas become uninhabitable due to e.g. drought and loss of agricultural production capacity, this could result in conflict and climate refugees, which could have an indirect effect on Sweden.

Other consequences

In terms of economic consequences, climate change also threatens human life and natural and cultural values.

In many cases, the effect on ecosystems may be dramatic. Bushes will probably start to grow on bare mountain regions above the tree line, except in the high alpine areas of northern Norrland. Forests and other natural environments will change – in some cases, dramatically. There is a risk of a shift in the Baltic towards completely new ecosystems, if salinity levels fall. Reindeer herding, and hence also Sami culture, is also under threat.

The increase in the risk of landslides and the increase in certain areas of the risk of flooding may threaten human life and living environments. High temperatures and increased spread of diseases affect human health. These values cannot be calculated in purely economic terms.

Adaptation measures

A changed climate will require social adaptation in many areas. The total cost of these measures will be considerable for certain structures, initiatives and sectors. Many of these measures will, however, be spread over a long period of time, and may be introduced gradually in different areas in line with new investment, improvements, expansion, the revision of standards, etc. The socio-economic cost of adaptation measures will probably not therefore be large in comparison with the cost of damage.

One requirement in order for adaptation to be possible without state investment is that sufficient information and knowledge about climate change and effective technology must be made available and used. This applies, for example, to much of the

adaptation required for business. Research and development, training and information are thus key areas.

Questions of responsibility and integrating climate adaptation within various sectors are important steps in order for vulnerable areas to be adapted in line with a changed climate. In the proposals, we have therefore placed considerable emphasis on the authorities' roles and tasks.

The investments are long-term investments in certain areas, and active initiatives are required in order for today's operations to be adapted in line with the climate of the future. Otherwise, we risk additional costs and even loss of human life. Examples of such areas include roads, railways, buildings and dams. Significant investments will also be required before facilities are written off.

We have data from some sectors where the cost of preventive action is compared with the cost of damage. In these cases, the cost of action is less that the cost of damage. The cost of damage for the national road network has been estimated at SEK 5–14 billion up until 2100. The cost of damage-prevention action to eliminate 75 percent of the cost of damage is SEK 2–3.5 billion.

One of the most serious consequences that we have been able to identify is the increased risks of landslides and flooding. We have proposed a number of measures to reduce the risks and to prevent serious consequences. We believe that the conditions are good for reducing vulnerability to acceptable levels.

The agricultural industries require active adaptation. Due to the long throughput times, early action is particularly important in forestry. In farming, adaptation is dependent on the world market and future EU regulations. Both forestry and farming will be affected more by damage. Reindeer herding requires regulatory changes in order to deal with changed climatic conditions which lead to changes in reindeer pasture, as well as changes in migration times and new migration routes.

The ecosystem changes will probably be the most visible signs of climate changes. A changed climate means different nature and a changed environment. Many of the environmental objectives will probably be more difficult or even impossible to achieve. The environmental objectives therefore need to be reviewed, along with the related environmental strategies.

Overall assessment

There is no doubt that climate change is a global threat which will probably lead to a number of major famines due to droughts, floods, failed harvests, water shortages, etc. The economic consequences will be considerable. Nor is there any doubt that the consequences in Sweden will also be significant, albeit not on the same scale as in other countries. Active initiatives will be needed in order to deal with climate adaptation. We believe that Sweden has the resources and the right conditions to carry out the adjustments and adaptations necessary. In many poor countries which are affected, such resources are largely lacking.

Active adaptation measures are also required in order to take advantage of the significant potential for increased income, primarily from hydroelectric power and agriculture and forestry. Particular importance should be placed on environmental issues, Sami culture and flooding risks when implementing these adaptation measures.

6.2 Proposals

Climate change justifies adaptation measures within many different areas. Our primary proposals are for changes to state authority instructions, a number of specific tasks, strengthening the role of the county administrative boards, and new support functions for the work of the municipalities. We also propose a number of legislative changes, as well as initiatives at EU level. Finally, research proposals are given.

Changes in responsibility

The responsibility for adapting to a changed climate is shared between individuals, municipalities and the state. We propose that the county administrative boards should be given a driving role, and the task of coordinating the climate adaptation work within their respective counties. The Swedish Environmental Protection Agency should be given responsibility for monitoring the adaptation work and reporting. SMHI should be given responsibility for providing knowledge on climate change. We also propose additional responsibility for the Swedish National Post and Telecom

Agency, the Energy Markets Inspectorate, the Swedish Geotechnical Institute and the National Food Administration. Finally, we propose that many sector authorities should be given clearer responsibility for climate adaptation within their areas of responsibility.

1. The county administrative boards should be given a central role in adapting to climate change, and should coordinate the work in relation to municipalities, industry and regional sector authorities. Regional analyses should be carried out within the counties, in order to provide basic data for planning. For example, long-term water supply should be analysed in association with the water authorities. A specific climate adaptation delegation should be set up in each county with the task of supporting the work of the municipalities, contributing towards providing knowledge, summarising, providing, interpreting and disseminating information, and coordinating, driving forward and monitoring the work. This includes initiating the formation of river groups and supporting their work.
2. SMHI should be given the responsibility for providing knowledge on climate change, and should thus create a reinforced informationfunction for various groups, particularly municipalities, sectoral authorities and county administrative boards.
3. The Swedish Environmental Protection Agency should be given the responsibility for combined national and international monitoring and reporting on the climate adaptation work.
4. The Swedish National Post and Telecom Agency should be given clearer responsibility for ensuring that the telecommunications network is robust enough to cope with climate change and extreme weather conditions, either through agreements with the operators or by other means.
5. The Energy Markets Inspectorate should be given clearer responsibility for ensuring that regional and local electricity grids are robust enough to cope with climate change and extreme weather conditions.
6. The National Food Administration should be given coordination responsibility for drinking water issues at a national

level. This includes informationinitiatives, as well as identifying research and development needs, the need for raw water control, etc.

7. The Swedish Geotechnical Institute (SGI) should be given responsibility for supporting municipalities and county administrative boards in the municipal planning process for issues relating to landslides and erosion. SGI should be given responsibility for keeping regulated journals of serious incidents which occur or feared incidents. SGI should be given additional resources for these tasks.

8. All the relevant sectoral authorities should be given clear responsibility for adapting to a changed climate within their own area of responsibility. This responsibility should cover both the risk of extreme events and ongoing climate change. The mandate to each authority should instruct the authority to initiate, support and monitor the adaptation work for climate change within its area of operations. The Swedish Rescue Services Agency, SMHI, the Swedish Environmental Protection Agency, SGI and the National Board of Housing, Building and Planning should also be given the explicit responsibility of supporting the county administrative boards in their climate adaptation work. The mandate for the following authorities should be changed:

   The Swedish Road Administration
   The Swedish Rail Administration
   The Swedish Maritime Administration
   The Swedish Civil Aviation Authority
   The Swedish Civil Aviation Administration (LFV)
   The Swedish National Post and Telecom Agency
   The Swedish Energy Agency
   Svenska Kraftnät
   The National Food Administration
   The National Land Survey of Sweden
   The National Board of Housing, Building and Planning
   SGI
   The Geological Survey of Sweden
   The Swedish Forest Agency
   The Swedish Board of Agriculture
   The National Veterinary Institute
   The Swedish Board of Fisheries

The Swedish Agency for Economic and Regional Growth (Nutek)
The National Board of Health and Welfare
The Swedish Institute for Infectious Disease Control
SMHI
The Swedish Rescue Services Agency
The Swedish Emergency Management Agency
The Swedish Environmental Protection Agency
The Swedish National Institute of Public Health
The National Heritage Board
The Swedish Financial Supervisory Authority

Authority tasks

Much of the adaptation work can, and should, be carried out by sector. Sweden's social structure, with authorities acting as policy implementers, makes it appropriate to assign specific climate adaptation tasks to the relevant authorities. Examples of tasks which need to be carried out by the relevant responsible authority include investigations, changes to plans and strategies, and drawing up general advice. We have therefore proposed a large number of tasks for the relevant authorities. Municipalities and country administrative boards also have a real need for mapping and data documentation. We therefore propose tasks for a number of expert authorities in order to improve access to such materials.

9. The Swedish Road Administration and the Swedish Rail Administration should be tasked with mapping and, if necessary, rectifying risks of landslides, washout, flooding, erosion due to changes in precipitation and increased flows which could affect the road and railway networks. The task should include reviewing dimensioning norms for flows and heights, as well as developing models for support work and risk work. A plan should be put forward as the basis for the next transportpolicy decision.
10. The Swedish Rail Administration should be tasked with carrying out a review of the standard for dimensioning overhead power line equipment and the additional measures which may be required in order to improve robustness, particularly in terms of high winds.

11. The Swedish Civil Aviation Authority should be tasked with carrying out a vulnerability analysis of the changed bearing capacity of runways resulting from different conditions in terms of groundfrost and groundwater, as well as mapping the need for bringing forward the renovation of airports' drainage systems based on future increased precipitation.
12. The Swedish Maritime Administration should be tasked with studying the risk of harbours closing as a result of higher water levels and possibly increased winds, as well as proposing measures if necessary.
13. The Swedish Maritime Administration should be tasked, following consultations with the Geological Survey of Sweden, the Swedish Armed Forces and other relevant authorities, with compiling and making available existing bathymetric chart data for the Swedish coast in digital form.
14. The Swedish National Post and Telecom Agency should be tasked with analysing the vulnerability of the telecommunications sector in relation to future extreme weather conditions such as storms, floods, landslides, and with proposing measures. Particular attention should be paid to third-party disruption.
15. The Swedish Energy Agency should be tasked, following consultations with Svenska Kraftnät, with analysing the vulnerability of the energy sector in relation to future extreme weather conditions such as storms, floods, landslides, and with proposing measures. Particular attention should be paid to third-party disruption.
16. Svenska Kraftnät should be tasked with:
    - working with the power industry to analyse how changed catchment patterns due to climate changes and the operation of hydroelectric power systems might affect dam safety and the risk of flooding,
    - developing methods for mapping the vulnerability of risk class I and II dams in relation to climate change, as well as carrying out this mapping,
    - working with SMHI to develop calculation methods for, and to calculate, the flows and significance of risk class I and II dams in a changed climate,

- working with the mining industry to carry out an analysis of mining dams in relation to long-term climate changes.

17. The Swedish Forest Agency should be tasked with:
    - carrying out, in consultation with the relevant authorities and organisations, a review of the Swedish Forestry Act and the Swedish Forest Agency's related regulations and general advice, bearing in mind that climate change involves a gradual change in conditions,
    - developing, in consultation with the Swedish University of Agricultural Sciences, a system for reporting, monitoring and evaluating damage caused by wild animals, storms, insects, etc., including the economic effects of damage, as well as setting up experimental plots with different cultivation methods and tree varieties,
    - evaluating and assessing the degree to which the possibility of achieving the *Sustainable Forests* environmental objective is affected by climate change, both within the time periods to which the objectives apply and in the longer term, as well as the degree to which the objective and the intermediate objectives are relevant in a changed climate. If necessary, the Swedish Forest Agency should propose changes in the formulation of the objectives and action programmes,
    - carrying out a general information campaign aimed at forest owners, in association with the Federation of Swedish Farmers, forest owner associations and other forestry players, on climate change and the effect of a changed climate on forestry; the Swedish Forest Agency should be given a grant of SEK 10 million over three years for this purpose,
    - proposing, in consultation with the Sami Parliament of Sweden, additional measures – including changes to the applicable regulations – in order that the forestry industry should pay greater attention to reindeer breeding, and should identify essential winter pasture areas where e.g. careful ground preparation should be carried out,
    - developing, in consultation with the Swedish Board of Agriculture, cultivation advice and forms of support for combining biofuel production with environmental protection.

18. The Swedish Board of Agriculture should be tasked with:
    - mapping, in consultation with the relevant authorities and organisations, the need for future irrigation and drainage, as well as existing drainage systems, and the status of embankments and the need for action. This mapping should be followed up with proposals for measures, including costs and any support systems,
    - proposing, in consultation with the Swedish Environmental Protection Agency, a well-developed system for supporting wetlands, encouraging their effectiveness at capturing nutrients and their function for combined purposes such as biodiversity and creating irrigation reservoirs,
    - reviewing animal protection regulations, including building standards and recommendations for animal housing, particularly for pigs and poultry, in view of the risk of increased heat stress and opportunities for increased outdoor free-range grazing,
    - developing, in consultation with SMHI and the Swedish University of Agricultural Sciences, a system for monitoring crop damage, whereby the weather conditions at the time of damage and the economic damage are documented, and evaluating and assessing the degree to which the possibility of achieving the *A Varied Agricultural Landscape* environmental objective is affected by climate change, both within the time periods to which the objectives apply and in the longer term, as well as the degree to which the objective and the intermediate objectives are relevant in a changed climate. If necessary, the Swedish Board of Agriculture should propose changes in the formulation of the objectives and action programmes,
    - carrying out, together with agricultural organisations, wider-reaching information initiatives for farmers relating to climate change and its effects on agriculture and the environment.

19. The National Veterinary Institute should, together with the Swedish Institute for Infectious Disease Control, be tasked with:
    - monitoring epidemiological developments within new and known infections as a result of climate change and, if

necessary, taking initiatives for measures to maintain a high level of protection against infection,
- taking the initiative for researching and producing reference documentation for educating veterinary staff in infectious diseases.

20. The Swedish Board of Fisheries should be tasked, in consultation with the Swedish Environmental Protection Agency, with identifying prioritised measures for increasing fish transfer, e.g. removing obstacles in order to maintain/create new fish stocks, and freshwater fishing in a changed climate.

21. The Swedish Board of Fisheries should be tasked with investigating the effects on the Swedish fishing industry if cod were to stop reproducing in the Baltic.

22. Nutek should be tasked with drawing up a strategy for disseminating information and transferring knowledge to those involved in winter-based tourism about climate change and adaptation options.

23. Nutek, the Swedish Environmental Protection Agency, the Swedish Board of Agriculture, the Geological Survey of Sweden and the relevant county administrative boards should be tasked with identifying areas where increased competition may arise for e.g. water resources, particularly along the southern coasts of Sweden, as well as identifying national interest in tourism, environmental protection and outdoor activities within their areas of operation.

24. Nutek, the Swedish Environmental Protection Agency, the Sami Parliament of Sweden and the relevant county administrative boards should be tasked with identifying areas where increased competition for land may arise in mountain areas, as well as identifying national interest in environmental protection, tourism, reindeer herding and outdoor activities within their areas of operation.

25. The county administrative boards in Dalarna, Jämtland, Norrbotten, Västerbotten and Västernorrland should be tasked, together with Nutek and the Sami Parliament of Sweden, with developing dialogue methods between reindeer herding and tourism, as well as other activities relating to reindeer pasture.

26. The Swedish Environmental Protection Agency should be tasked with:
    - evaluating and assessing the degree to which the possibility of achieving the environmental objectives for which the agency is responsible is affected by climate change, both within the time periods to which the objectives apply and in the longer term, as well as the degree to which the environmental objectives and the intermediate objectives are relevant in a changed climate. If necessary, the Swedish Environmental Protection Agency should propose changes in the formulation of the objectives and action programmes.
    - mapping, in consultation with the Swedish University of Agricultural Sciences, the sensitivity of various ecosystems/species to a changed climate, taking into consideration land use, and thus identifying highly climate-dependent species, species with specific living environment requirements, keystone species, threatened species regionally in Sweden and species of special Swedish responsibility, and proposing measures for the protection of these, including any changes in the Habitats Directive.
    - working together with the Swedish Forest Agency and taking the sensitivity of various ecosystems/species to climate as a starting point, to evaluate the effectiveness of today's protection systems in creating transfer corridors for ecosystems/species in a changed climate, and to propose changes to regulations, guidelines and support systems, e.g. the possibility of introducing greater protection within production forests, developed forest protection agreements, and upgrading landscape strategies to regional, national or international levels.

27. The National Food Administration should be tasked with:
    - working together with the relevant authorities to review protection and control procedures throughout the entire drinking water production chain, from the protection of raw-water intakes through to purification and distribution,
    - working together with the relevant authorities to provide information on risks and preventive measures for individual springs,
    - reviewing regulations and guidelines for food handling, in view of increased summer temperatures and the increased

risk of periods with extremely high temperatures; the administration should also keep the public informed of food handling risks and precautions.

28. The National Board of Health and Welfare should be tasked with:
   - compiling information to prepare municipalities and county administrative boards for heatwaves. This should include proposed measures for cooling premises, and for identifying and reaching vulnerable groups,
   - monitoring epidemiological developments within new and known infections as a result of climate change and, if necessary, taking the initiative on measures to maintain a high level of protection against infection,
   - compiling information which can be used for improved education of healthcare staff in infectious diseases.

29. The Swedish Institute for Infectious Disease Control should be tasked, together with the National Veterinary Institute, with:
   - monitoring and analysing epidemiological developments within new and known infections as a result of climate change and, if necessary, taking the initiative on new research within relevant areas due to climate change,
   - compiling and disseminating information on the increased risk of spreading infection and new diseases as a result of climate change, and analysing possible counter-measures and reporting these to other relevant authorities.

30. The National Board of Housing, Building and Planning should be tasked with:
   - carrying out a review of the board's Building Regulations (BBR) and advice on alterations (BÄR), and adapting these in line with a changed climate,
   - working with SMHI and other relevant authorities to draw up general advice for the planning, location and elevation of new buildings, including plumbing systems, with regard to increased risks of flooding, landslides and erosion in a changed climate,
   - working with the Swedish Rescue Services Agency and other relevant authorities to draw up general advice on measures for protecting existing buildings from flooding,

landslides and erosion, as well as water penetrating sewerage systems.

31. SMHI should be tasked with:
    - together with the Swedish Board of Agriculture, the Geological Survey of Sweden, the Swedish Forest Agency and the National Board of Health and Welfare, investigating the possibility of expanding the extreme weather warning systems and introducing such systems where appropriate. This should include analysing the possibility of creating warning systems for heatwaves, droughts, storm-felling and intensive rain and, if possible, such systems should be developed,
    - proposing how increased access to data through reanalysis and digitalisation could be achieved,
    - describing how access to climatological parameters at a higher geographical resolution can be improved through a closer observation network or through other measures. The consequences of making the materials generally available free of charge should also be investigated.
32. The county administrative boards should be tasked with inventorying permitted and unowned dams, and assessing the size of the problem as a basis for the proposed review of legislation in relation to water operations – see point 41.
33. The National Land Survey of Sweden should be given resources for creating a new national elevation database with more detailed, more accurate elevation data than the current database. The new database should be made generally available free of charge to municipalities and authorities in digital form.
34. The Swedish Rescue Services Agency should continue to be tasked with the general mapping of flood risk and rockslide and landslide stability conditions in built-up areas and with regard to climate change. The agency should also clarify the need for reviewing existing mapping in view of climate changes, and should make appropriate amendments. The agency should also be tasked, together with SGI, with mapping beach-erosion risks in built-up areas. The maps should be made generally available free of charge in digital form.

35. SGI should be tasked, together with Geological Survey of Sweden, National Land Survey of Sweden and the Swedish Rescue Services Agency, with producing a national map database of landslide conditions in built-up areas and potential development areas. The map database should take climate change into consideration. An in-depth analysis of geographical areas with rockslide and landslide conditions should be carried out for prioritising the areas to be included. Within the study, surveys carried out should form the basis for the in-depth analysis. The database should be made generally available free of charge in digital form.

Legislation changes

We believe that the municipalities have a major responsibility for adapting spatial planning so that risks of natural disasters are reduced, both with the current climate and with regard to future climate changes. In order to facilitate preventive measures and to clarify responsibilities, we have proposed certain legislation changes.

In order to increase the municipalities' economic responsibility for the consequences of flawed planning with regard to the risks of flooding, landslides and erosion, we propose an extension of the limitation period from 10 years to 20 years. We also propose that the municipalities' rights in connection with support for privately-owned properties should be clarified in law.

We also propose that the requirements in terms of forestry use for reindeer breeding should be expanded in view of the strain that reindeer herding may place on a changed climate, and the importance of forestry use for reindeer herding.

A review of the Swedish Planning and Building Act is currently underway. A bill has been presented containing proposals which address many of the shortcomings we have identified. This places a greater emphasis on flood and erosion risks, and landslides caused by erosion, and gives the county administrative boards a clearer mandate for their pronouncements on survey plans and reviewing detailed development plans. We propose that the act should be added to further, making it clear that rockslide and landslide risks should be taken into consideration when locating buildings, regardless of the reason, that the possibility should be introduced

of stipulating requirements in detailed development plans for measures to enhance security and prevent damage before planning consent is granted, and that the municipalities should be given the right to implement measures on land belonging to others where this is important in order to protect surrounding buildings from natural disasters.

36. The municipalities' responsibility for detailed development planning and planning permission should be increased to 20 years in terms of liability for damage from flooding, landslides and erosion. The increased limitation period should not apply retroactively – see chapter 1.

37. The principle of equality should not present a barrier to municipalities in terms of financing measures for privately-owned properties which aim to prevent natural disasters. In order to ensure that the issue is dealt with in the same way in all municipalities, this should be governed by a specific law – see chapter 1.

38. § 20 of the Swedish Forestry Act (1979:429) should be amended so that the obligation for consultation prior to felling is expanded to cover the entire reindeer pasture area – see chapter 1.

39. An explicit mention of landslides in terms of accidents, flooding and erosion should be added to the Swedish Planning and Building Act, so that it is clear that the risk of landslides should be taken into consideration when locating buildings. The term "landslides" should also be defined in the wording of the statute, so that the meaning of the term is clear.

40. The Swedish Planning and Building Act should be added to, making it possible to stipulate requirements in the detailed development plan on measures to enhance security and prevent damage in order to prevent or minimise the risk of flooding, landslides and erosion, for example through the use of function-based requirements.

41. The Swedish Planning and Building Act should also be added to so that the municipality is given the right to implement measures on land belonging to others where this is important in order to protect surrounding buildings.

Investigations into legislation changes

Within some areas which we have not had the opportunity to investigate in depth, we feel that there may be a need to make legislation changes. Here, we propose that specific investigations should be carried out.

We have found re-examining water permits to be complicated; older permits in particular can be highly complex. Changed climate conditions mean a greater need for re-examining water permits. We propose that an investigation be launched to review the Swedish Water Act with the aim of updating it.

Climate changes will involve changed conditions for high flows and dam safety. We, therefore, believe that the reasons for the Swedish National Audit Office's proposed review of dam safety are even stronger.

42. An investigation should be carried out in order to analyse the need for re-examining water permits in the light of climate change. The investigation should review the legislation in relation to water operations as a whole, and should propose in particular changes to facilitate re-examination in view of flooding risks and drainage. The investigation should also deal with permitted and unowned dams.

43. A review should be carried out of dam safety to see whether the current system meets society's current requirements. The review should examine society's need for the clearer regulation of dam owners' self-regulation, the scope of the supervision guidance and the supervision, competence requirements and how the supervision should be financed. This review is urgent in view of the current climate and climate changes.

State financing of investments

Adapting the transport infrastructure will require long-term investment. We believe that climate adaptation should be included in the transportpolicy objectives. Ongoing adaptation to a changed climate should take place when expanding and operating the transport infrastructure. Specific funds for climate adaptation should be earmarked in forthcoming transport infrastructure policy decisions.

We also propose that a new subsidy should be introduced for major state investment which aims to reduce vulnerability in a changed climate. We believe that this subsidy will be needed on an ongoing basis in future, but that the size should be adapted in line with needs. For current projects, government negotiators should be appointed.

We believe that the Swedish Rescue Services Agency's subsidy 7:2, *Preventive measures against landslides and other natural disasters*, plays an important role in initiating preventive measures in municipalities, and acts as a tool for transferring knowledge and for the quality assurance of the measures. We therefore propose that the subsidy should be kept in its current form and at the current level, but that certain changes should be made to the way in which the support criteria are formed and that the level of support should be reduced.

Future snow conditions will probably place new requirements in terms of winter pasture land for reindeer herding. The pressure on pasture land without appointed reindeer pasture rights will then increase. It should therefore be possible to use subsidy 45:1 in order to sign reindeer pasture agreements, whereby the landowner receives compensation. Subsidy 45:1 should therefore also be increased.

The risk of larger and more intense forest fires will increase in the future. Rapid discovery and extinguishing will become even more urgent, since major fires can require significant resources and have high costs. Continued state financing of fire monitoring is therefore justified.

44. Adapting the transport infrastructure in line with a changed climate should be included in the transport policy objectives. Funding should be earmarked for transport infrastructure climate adaptation each year.

45. A subsidy should be instituted in the state budget for investment to prevent natural disasters. The Swedish Rescue Services Agency should, following consultation with the relevant authorities, take a position on when such a request should be made, and should prepare the matter. The county administrative boards should act as collecting bodies for potential projects and should convey proposals to the Swedish Rescue Services Agency. The size of the subsidy should be adapted according to the need which exists. The measures should be

financed jointly by the state and the parties which benefit from the measures, such as municipalities and businesses. The distribution of the costs should be decided on according to a specific method in each individual case. The underlying principle should then be that those who benefit the most from a measure should also bear the majority of the cost. The responsibility for implementation should lie with a suitable authority or other body, depending on the nature of the measures.

The subsidy should apply to large-scale projects with costs which exceed the municipality or region's ability to pay, and which are deemed to be of a high priority in terms of vulnerability. There should be specific reasons why the state should contribute towards financing the measure. Examples of criteria may include that the measure relates to:

- a large area which covers several municipalities or counties,
- protecting areas of national interest,
- large-scale measures, e.g. banking up around the entire town area, which the municipality cannot afford within a reasonable time period.

46. A government negotiator should be appointed to carry out negotiations in relation to financing a larger spillway through Södertälje sluice and the sluice at Söderström. Negotiation should take place with the municipalities around Lake Mälaren. Income from public-private partnership could also be considered. State financing should be via the proposed subsidy for large-scale preventive measures. In terms of financing measures at Södertälje sluice, the Swedish Maritime Administration should also be involved. The government negotiator should propose a plan for how the outcome of the negotiation should be guaranteed and implemented.

47. Once a decision has been made on a long-term solution for increased water discharge options in Lake Vänern, a government negotiator should be appointed. The negotiation should result in a proposal for financing measures. The cost should be divided between the state and those benefiting from the measures, such as municipalities around Lake Vänern and the Göta Älv river, as well as the holders of water rights. Income through public-private partnership can also be considered. For the state's share of the financing, the proposed subsidy may be

appropriate. The government negotiator should propose a plan for how the outcome of the negotiation should be guaranteed and implemented.

48. Subsidy 7:2, *Preventive measures against landslides and other natural disasters*, should be kept at the current level of SEK 40 million per year. The burden on the subsidy should be reduced through large-scale measures, such as banking up around towns, being removed from the scope and dealt with separately. The contribution percentage should be changed from 80 percent to 60 percent of the cost of the measure.

49. The Swedish Rescue Services Agency should be tasked, following consultation with SGI, SMHI and the Swedish Association of Local Authorities and Regions, with drawing up criteria for the subsidy to be included in the agency's official letter of appropriations. The criteria should include the following:
    - Erosion should be included.
    - State subsidies should not go towards measures to protect buildings built after 2007.
    - Before the application is granted, the responsibility for maintenance of the facility to which the application relates should be explained.
    - A template for calculating the benefit to the municipality of permitting new building should be drawn up.
    - Climate change should be taken into consideration when assessing the need for measures and deciding on the measures.

50. In the future, it should also be possible to use the Sami Parliament of Sweden's subsidy 45:1, *Promotion of reindeer herding, etc.*, for expenses arising as a result of agreements entered into with land owners on winter pasturing. Subsidy 45:1 should henceforth be SEK 60 million per year.

51. Continued state financing of fire monitoring and airborne monitoring in connection with widespread damage should be provided.

EU and internationally

The EU's regulations and forms of support affect many areas. It is important that the EU regulations do not prevent or hinder adaptation measures. On the contrary, the regulations should be drawn up so that they support climate adaptation.

The need to reduce eutrophication and the introduction of nitrogen and phosphorus, particularly in the Baltic, will be greater in a changed climate.

Reforming the EU's agricultural policy will be particularly important.

The conditions for the environmental protection policy will change as the climate changes, and adapting regulations and strategies should be considered.

The EU's external policies will be increasingly important. The need to adapt in line with a changed climate should be integrated with e.g. aid policy.

The EU devotes considerable resources to research. Climate change and adaptation should be given prominence.

52. Sweden should work to review all the EU's acts so that they do not hinder adaptation measures and, as far as possible, promote such measures.

53. Sweden should work to ensure that climate awareness is integrated into the EU's financing instruments, including the structural funds.

54. Sweden should promote measures at EU level which reduce the vulnerability of the Baltic in a changed climate, including:
    - banning phosphates in washing detergents throughout the EU
    - additional purification of point sources
    - integrating climate awareness into fishery management
    - taking the problem of nutrients into consideration when dealing with EU-financed infrastructure projects and adaptation measures

55. Sweden should particularly work to ensure an increased focus on the problem of nutrients and the impact on the Baltic in forthcoming reviews of the EU's agricultural policy.

56. Sweden should work to review the EU's environmental protection policy in order to increase the focus on the effects of climate change in the protection of ecosystems and species.

57. Sweden should work to ensure that the EU continues to be active in international negotiations on adaptation measures, in order to implement adaptation projects which also benefit the EU's border states, and this adaptation should be given prominence in the EU's support work.

58. Sweden should work to ensure that the EU's research funding includes research into adapting to climate change, including reviewing and monitoring.

Research and knowledge development

There is a real need for research and knowledge development relating to a changed climate, effects and adaptation measures. We believe that it is necessary to boost current research funding within the area, and to coordinate efforts further. We also believe that there is a real need for information initiatives – see sections 5.8 and 5.9. The responsibility for climate change and adaptation which we propose should be allocated to various authorities should also include initiatives to provide information on the subject.

59. We propose that a new institute should be founded to focus on climate research and climate adaptation. The form which the institute should take should be investigated. We propose that, as well as the funding currently available to the operations transferred, the institute should be granted an additional SEK 100 million per year.

6.3 Impact assessments

One of the most important elements of our proposals is that a number of authorities should be assigned new or additional tasks. The cost of the tasks and the additional responsibility which we propose for state authorities can, in most cases, be included in existing subsidies to the authorities in question. We believe that these tasks are of a sufficient size that they can be paid for through reprioritising the authorities' tasks. Where we have deemed that

the tasks are particularly wide-reaching, we have proposed budgetary increases – see table 6.1 in section 6.4.

The authorities' climate adaptation work aims to prevent future damage, and thus also to reduce future costs. The nature and geographical distribution of the measures means that they should also contribute towards additional employment and regional development.

The responsibility of the municipalities to take climate change and the risk of natural disasters into account in their spatial planning is highlighted by extending the limitation period. This means greater economic responsibility. The opportunity for municipalities and property owners to receive funding to take preventive action against natural disasters is also reduced somewhat in that the proportion of the cost which qualifies for subsidies is reduced. We have also proposed legislation whereby, under certain conditions, the municipalities will be entitled to contribute towards financing preventive measures against natural disasters for individual properties. The proposal only requires clarification of current legislation in order to avoid such assessments differing between different municipalities.

These proposals may potentially involve a degree of increased cost for the municipalities. At the same time, we propose that the municipalities and regions which will have to bear greater costs due to the risk of natural disasters should be able to obtain support from a new subsidy which aims to prevent natural disasters. We believe that this prioritisation is reasonable, and will give a better distribution of responsibility.

We also propose that the data required for spatial planning should be improved and made freely available to municipalities and authorities. This is important for many small municipalities, due to the considerable cost of elevation data, additional mapping and analysing the risk of flooding and landslides. We also propose increased support to the municipalities from SMHI, SGI and the county administrative boards. Overall, this involves substantial new resources for supporting municipal planning and preventive measures. We also propose additional information initiatives to support the municipalities. Overall, we believe that the support proposed for the municipalities will mean that the municipalities are in a significantly better position to plan buildings and operations so that future costs resulting from climate change and extreme weather conditions will be kept down. Hence, in the long

term, our proposals will probably involve considerable savings for the municipalities.

We propose that the Swedish Forestry Act should be amended so that the obligation for consultation prior to felling is increased to include the entire reindeer pasture area. This may involve longer lead times for decisions in the areas affected. However, there is already a requirement to give notice of final felling no later than six weeks before such measures begin. The extra time which consultation might take can be deemed to be a reasonable restriction, and should be viewed in relation to the improvements which can be achieved. We also propose that subsidy 45:1, *Promotion of reindeer herding, etc.*, should be increased. We believe that this should result in wide-ranging, costly legal processes due to land disputes being avoided. This would mean cost savings for the state, which would fully or partly compensate for the increased costs.

It is proposed that those proposals which require additional funding should be funded through tax increases or public-private partnership – see section 6.4. Taxes generally have two effects: they reduce disposable income, and they steer behaviour so that consumption of the taxed item reduces.

Two of the alternatives discussed are environmental taxes on greenhouse gases and on environmentally-harmful input goods. The aim of such taxes is primarily that they should steer, i.e. that behaviour should be affected so that the use of the environmentally-harmful substance reduces, and thus so does the tax base. The reduced consumption is therefore a desirable effect. However, it can have negative consequences for the individuals and companies involved. Increased fuel tax affects households and small businesses with high levels of energy consumption, such as households in sparsely-populated areas and transport companies. However, the tax rate increases required in order to finance our proposals are extremely low per individual. A normal driver emits around 3 tonnes of carbon dioxide each year, and over the course of a year a long-distance lorry can produce 150 tonnes of carbon dioxide (The Swedish Road Administration, 2007). A 1 percent increase in carbon dioxide tax, i.e. an increase of SEK 0.01, thus corresponds to an increase of around SEK 30 per year for a normal driver and SEK 1,500 per year for an articulated lorry.

A specific property tax on the land value of hydroelectric power stations means taxing the profits which rising electricity prices mean for existing power stations. The opportunities for the power

companies to pass such a tax on to the consumer through higher electricity prices are extremely limited, as long as Nordic electricity prices are determined through marginal cost pricing. Households and companies will not therefore be affected by increased costs as a result of the tax.

We do not believe that our proposals will have negative consequences for the environment, employment or public services, gender equality, the integration policy objectives, personal integrity, crime or municipal autonomy. Any consequences which our proposals may have for individuals, industry and small businesses have been described above.

6.4 Financing the proposals

Costs

The majority of the proposals detailed in section 6.1 do not involve increased state costs, but can be financed through existing budgets. Some of the proposals involve significant new tasks or considerable increases in fees. In certain cases, we therefore see the need for the authorities involved to be given additional funding. This applies to providing and building up an elevation database, a geographical analysis of conditions for landslides, etc., landslide mapping with a database, a coordination function for the county administrative boards, increased responsibility within the planning process and recordkeeping by SGI, a dedicated information resource from SMHI, additional subsidies for reindeer herding and an information campaign for forest owners. It is also proposed that there should be funding for research into climate change and climate adaptation. The estimated costs for these measures are given in table 6.1.

Table 6.1 Cost to authorities of proposed tasks

Task	Cost	Comments
The National Land Survey of Sweden: Create and maintain improved elevation database.	SEK 200 million	One-off cost, paid over five years. Cost calculation: The National Land Survey of Sweden.
The Swedish Rescue Services Agency: Additional flooding mapping of watercourses, taking climate change into consideration.	SEK 10 million	One-off cost, paid over five years. Cost calculation: The Swedish Rescue Services Agency.
The Swedish Forest Agency: Information campaign for forest owners.	SEK 10 million	One-off cost, paid over three years.
SGI: Additional rockslide mapping.	SEK 47 million	One-off cost, paid over five years. Cost calculation: SGI (2001).
SGI: Additional analyses of those areas with rockslide and landslide conditions.	SEK 700,000	Cost calculation: SGI (2006).
SGI: Mapping beach erosion.	SEK 11 million	SEK 1 million for developing models and inventorying, then SEK 2 million per year over a five-year period. SGI assessment.
SGI: Support for municipalities and county councils, and recordkeeping for serious incidents.	SEK 8 million per year	Cost calculation: SGI (2006).
SMHI: Increased information service.	SEK 4 million per year	
Reinforcing the county administrative boards.	SEK 30 million per year	
Increased subsidy 45:1, Promotion of reindeer herding, etc.	SEK 13.3 million per year	
Research funding	SEK 100 million per year	

The total cost of the above proposals is around SEK 210 million per year for the first five years, and SEK 155 million per year thereafter.

In addition to these tasks, we propose a new subsidy for investments to protect against natural disasters. Those measures which would be financed by the new investment subsidy are primarily measures to prevent flooding from Lake Vänern and Lake Mälaren. In order to be able to assess the cost of measures for Lake Vänern, further studies are required which themselves are expected to cost around SEK 100 million. It is estimated that constructing a new tunnel would cost SEK 3.5–4.5 billion, whilst the additional cost of safeguarding the Göta Älv valley against landslides in the event of increased water discharge can only be estimated at between SEK 1.7 and 7.5 billion. The cost of enlarging the spillway from Lake Mälaren would be around SEK 650 million (for a more detailed account of the measures and costs involved in enlarging the spillway from Lake Vänern and Lake Mälaren, see the interim report from the study, SOU 2006:94). Other measures which may qualify for funding from such a subsidy include banking up around towns which are threatened by flooding.

For all these measures, the costs should be split between the state and those benefiting from the measures. It cannot generally be determined how much the state should contribute in individual cases. Uncertainty over costs and how much the state should contribute means that it is difficult to determine the size of the subsidy for a number of years to come. We do not propose consolidation, since this ties up state funding unnecessarily. The amount of money that needs to be earmarked for this type of measure will vary, and it is therefore appropriate that the size of the subsidy should be set annually as part of budgeting work.

The Göta Älv valley should be mapped in order to investigate the conditions for a larger spillway from Lake Vänern. This would involve a cost of SEK 60–110 million over a period of around three years, i.e. SEK 20–35 million each year. Together with the additional funding for mapping, databases, information and research, the total needed is around SEK 240 million each year for the next five years. Financing additional measures can be discussed once their cost is better known. However, we believe that at least SEK 100 million per year will need to be earmarked for these. Together with the cost of the authority tasks detailed above, this means that at least SEK 260 million per year must be made available after the initial five-year period.

Financing options

We believe that there are four possible financing options for the increased cost of the measures proposed. The first is that the polluters should pay, i.e. that the climate adaptation measures should be paid for by taxing the emissions which cause climate change. The second option is to use income from climate change to finance the cost of these changes, which would require a redistribution between those who profit and those who have to meet the costs. The third option is to reduce the need for climate adaptation measures which are environmentally harmful by increasing taxation, e.g. on certain input goods. Finally, the fourth option is co-financing between the public and private sectors. For the first three options, we have provided some calculation examples which attempt to show the amount of tax increase which would be required. A combination of the various financing methods is, of course, also possible.

1) The polluters pay

A tax on the dominant greenhouse gas, carbon dioxide (CO_2), achieves two aims at the same time. Not only does it cover the climate change costs for those activities which cause climate change, the tax's steering effect also reduces future emissions. CO_2 tax revenue was almost SEK 27 billion in 2004 (Statistics Sweden, Statistical database). A 1 percent increase in the general CO_2 tax would thus mean SEK 270 million in additional annual revenue for the state for the next five years, excluding adaptation effects.

The steering effect of fuel taxes varies with different fuels and usage. The majority of CO_2 tax revenue comes from tax on petrol, diesel and fuel oil. Calculated based on the consumption for 2007, a 1 percent increase in taxation (i.e. just over SEK 0.02) on these fuels alone would generate around SEK 270 million in additional revenue. In the long term, it has been estimated that the price elasticity of petrol is around -0.7 to -0.8 (The Swedish Environmental Protection Agency, 2006). This means that if the price increases by 1 percent, consumption will fall by 0.8 percent. In the short term, since replacing fleets, etc. has not happened, with adaptation instead being mostly via reduced mileage, price elasticity has been calculated at just -0.2 to -0.3.

Price elasticity for diesel consumption is considerably lower than for petrol, and can be estimated at around 0.2 in the long term

(Swedish Institute for Transport and Communications Analysis, 2004). For fuel oil, price elasticity is estimated to be around 0.5 (Environmental Advisory Council, 2004).

Calculated to include these steering effects, an increase in CO_2 tax of SEK 0.02 would give increased tax revenue of around SEK 210 million and a reduction in CO_2 emissions of around 30 tonnes per year – see the calculations in Appendix A 7. In the short term, there would be less of a decrease in fuel consumption. It has been estimated that revenue from petrol tax could fall by SEK 10 million annually in the short term, and by SEK 40 million in the long term on account of the higher rate of taxation.

If petrol tax were to be increased by SEK 0.10, annual revenue would be SEK 550 million, excluding adaptation effects. Adaptation effects would reduce revenue to SEK 500 million each year in the short term, and SEK 360 million in the long term.

2) Those benefiting from climate change should help to finance the costs for those who are worse off

It has been estimated that a milder climate and increased precipitation will mean growth for forestry and agriculture, as well as increasing the potential for hydroelectric power. For forestry and agriculture, there will also be a greater risk of damage. For hydroelectric power, the cost of measures which may be needed, such as reinforcing dams, does not compare to the increase in income. Increasing taxation on hydroelectric power would mean that the state would benefit from the increased natural resources resulting from climate change, and would use this to improve conditions in those areas where climate change has a negative impact.

The calculations for increased hydroelectric power potential due to climate change show an increase of between 7 percent and 32 percent. On average, hydroelectric power has provided 66 TWh per year over the last ten years. In extremely wet years, such as 2000 and 2001, production reached 78 TWh. In 2005, which also featured considerable precipitation, 72 TWh was produced.

If the average supply were to rise to 72 TWh, i.e. an increase of 6 TWh (approximately 8 percent) per year, this would correspond to an increase in income of SEK 2.4 billion per year at an electricity price of SEK 0.40 per kWh. This example does not include any measures for increasing capacity, which would increase income

even further, but which would also involve investment costs. The increase in income would not be immediate, but would be a gradual increase over the course of this century. However, the example does assume that precipitation will increase significantly as early as the period up to 2020 in at least one of the climate scenarios – see section 3.5. In accordance with the proposals of earlier investigations, such a tax would be in the form of a specific property tax on the land value of hydroelectric power stations. The FlexMex2 study (SOU 2003:120) estimated that an additional property tax of around 1 percent of the land value would generate a net income of around SEK 500 million.[1]

3) Taxation to counter undesirable climate change adaptation measures

A third alternative is to tax negative indirect effects of climate change, such as adaptation measures which are environmentally harmful. This would create an incentive to find other, less harmful solutions, whilst also generating a degree of income until these new solutions have been developed. If price elasticity is high, the steering effect of the tax will be good, resulting in a reduction in the tax base. If the aim of the tax is thus achieved after a period of time, new sources of financing may be sought.

Examples of negative adaptation measures include the increased use of pesticides and fertiliser. Increased taxes on these input goods would, however, need to be supplemented with another form of financing. Approximately SEK 600 million worth of pesticides and approximately SEK 1,700 million worth of fertiliser are currently used in Sweden each year (Swedish Board of Agriculture, 2006). These tax bases are therefore small in comparison to the need for financing.

4) Public-private partnership (PPP)

If the financing of climate adaptation measures can be spread over a longer period of time and shared between a number of different players, the economic burden for each individual player will be less. One alternative for financing climate adaptation measures is to create the right conditions for achieving a solution through public-

[1]The study followed *Calculation conventions for 2005* (Ministry of Finance) in making its calculations. Net income is income taking into account indirect effects of corporation tax income.

private partnership, PPP. PPP is a form of private financing of public infrastructure. Such financing could be achieved through the state or private lenders issuing long-term loans in the form of obligations to the municipalities, county councils and businesses taking part in this partnership. This would also allow for more rapid implementation than traditional financing would.

However, this financing model is not suitable for the ongoing financing of authorities' operations.

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