20. **SWEDEN**

This country fiche provides a comprehensive overview and assessment of climate change adaptation in Sweden. After detailing the vulnerability of Sweden’s coastal zones, the responsibility and financing for coastal protection is explained. Next, the fiche presents the relevant research activities, the coastal defence, risk reduction and adaptation plans available in Sweden as well as the current and future protection and adaptation expenditure. The persons contacted and sources of information used are listed at the end.

20.1. **VULNERABILITY OF SWEDEN’S COASTAL ZONES TO CLIMATE CHANGE**

Sweden is located on the Baltic Sea and has a coastline of more than 13,500 km long. The country is divided into 21 counties. The coastal counties which will be discussed in the remainder of the text are illustrated in *Figure 20-1* together with an overview of the main physical and socio-economic indicators of the coastal zones.
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The following paragraphs discuss the main climate change risks for the Swedish coastal zones. Marine eco-systems along the Baltic Sea are expected to be most affected by rising temperatures and changes in precipitation\(^1\). In addition, coastal erosion and rising sea levels may threaten southern areas. Few studies are yet made on the western coasts Although there might be considerable consequences for freshwater supply in the long-run, especially with regard to the water quality, Sweden will be affected far less than other European countries.

\(a/\) Flooding and erosion

Rising sea levels are expected to aggravate coastal erosion problems in southern Sweden and increase flood risk along the western and southern coasts. Rocky northern Sweden is less prone to flooding and erosion as a rise in sea level will be counteracted by a land lift-up.

Examples of areas most affected by increased flood risk are the municipalities located in Skåne county and Göteborg located in Västra Götaland. The counties most at risk to coastal erosion are Skåne, Blekinge and Halland.

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\(1\) Precipitation will increase in winter and autumn and summers are expected to be warmer and drier, particularly in southern Sweden (cf. Swedish Commission on Climate and Vulnerability, 2007, *Sweden facing climate change – threats and opportunities*).
b/ **Freshwater shortage**

Sweden is favoured in its access to freshwater supply. Up to now, it has been relatively easy to find good quality water resources. Half of Sweden’s local water supply comes from surface water, mainly lakes and watercourses, the other half from groundwater. Furthermore, the good quality of raw water makes purification techniques relatively simple in Sweden. Although climate change might influence the conditions of water supply, e.g. an increased risk of humus or chemical pollutants entering water sources due to flooding or flash storms, drinking water is expected to remain sufficiently available.

c/ **Loss of marine eco-systems**

The Baltic Sea is a semi-enclosed sea with many river inflows and limited water refreshment from the ocean. The salinity level is low, decreasing from south to north. This is not a problem per se. The Baltic Sea has a rather unique eco-system adapted to low salinity levels but rising temperature and increased precipitation may further reduce the salt level of the water and put additional pressure on marine eco-systems.

In 2007 the countries surrounding the Baltic Sea (Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden) agreed on the Baltic Sea Action Plan. This programme aims to restore the good ecological status of the Baltic marine environment by 2021. The strategy is seen as a crucial starting point for wider and more efficient actions to combat the continuing deterioration of the marine environment resulting in the first instance from human activities. The main objectives are:

- To intensify measures that ensure a water quality sufficient to maintain or recover the functioning of the marine eco-systems;
- To reduce emissions from maritime transport and to prevent ballast water releases;
- To enhance the protection of marine and coastal landscapes and habitats and, particularly, the conservation of native Baltic species.

The Baltic Sea Action Plan was initiated by HELCOM, the governing body of the Helsinki Convention. With the Action Plan, HELCOM aims to improve the capacity of the Baltic marine environment to cope with the stress of climate change.
20.2. RESPONSIBILITY AND FINANCING FOR COASTAL PROTECTION AND CLIMATE ADAPTATION

In Sweden, coastal zone management is mainly a sub-national matter. National authorities have only a limited role in coastal defence since spatial planning falls under the responsibilities of the respective municipalities² and coastal protection works need to be initiated and financed by landowners³.

In practice, when the property of a private landowner is at risk of a natural disaster, the municipality can verify which other surrounding landowners are affected and may act as the coordinator of the coastal protection works. Municipalities might bear (part of) the costs⁴ and can apply for financial support from the Swedish Civil Contingencies Agency (MSB). With the exception of erosion, this agency may grant co-financing for all preventive measures against flooding and other natural disasters up to 80%. MSB grants are only available for existing built-up zones. New development projects are expected to take certain safety margins into account. For the period 2007-2009, the MSB has an annual budget of about € 4.3 million, whereas yearly applications are in the range of € 10-12 million. Besides the MSB fund, municipalities can use local taxes⁵ to finance coastal protection works.

At the national level, the Swedish Environmental Protection Agency and the Swedish Housing Authority are mostly concerned with coastal protection. The Swedish Environmental Protection Agency is responsible for biodiversity and maritime preservation. In addition, the agency evaluates defence and protection works undertaken at the sub-national level and reports to the government. The Swedish Housing Authority is responsible to provide the municipalities with national guidelines concerning housing and spatial planning.

20.3. RESEARCH INTO SWEDEN’S VULNERABILITY AND TO CLIMATE CHANGE AND CLIMATE CHANGE SCENARIOS

Sweden has already performed profound research into the vulnerability of its coastal areas. Knowledge on how climate change will affect different sectors from an economic point of view and which adaptation measures should be taken is still limited. The research institutes most involved so far are the Swedish Meteorological and Hydrological Institute (SMHI) and the Swedish Geotechnical Institute (SGI). Both institutes supported the Swedish Commission on Climate and Vulnerability in developing the national report ‘Sweden facing climate change – Threats and opportunities’, published in autumn 2007.

² Sweden has 290 municipalities of which 82 are situated along the coast.
³ Landowners can be private proprietors or municipalities.
⁴ When granting building permits, the municipality has to examine the risks with respect to health and safety of the residents; the municipality is responsible for its decision up to 10 years after granting such permit.
⁵ Municipalities receive 20% of the income tax levied to their inhabitants.
The Swedish Meteorological and Hydrological Institute is a government agency under the Ministry of Environment. The agency develops information on weather, water and climate to provide public as well as private actors with an important foundation for decision-making. More specifically the SMHI, and especially its Rossby Centre research unit, undertakes research into climate models and scenarios. Overall, funding for climate change research at the SMHI is estimated at € 2.5 million per year.

The Swedish Geotechnical Institute has a coordinative role in reducing the risks of coastal erosion and damage caused by such erosion. SGI has in particular responsibility as a governmental expert body for safety issues relating to landslides and coastal erosion. The institute carries out inventories of the eroding coasts as well as the areas most vulnerable to erosion.

20.4. COASTAL DEFENCE, RISK REDUCTION AND ADAPTATION PLANS IN RELATION TO CLIMATE CHANGE

As coastal protection is the responsibility of the municipalities and landowners, no national coastal defence plan exists in Sweden. The Swedish government foresees in the publication of a national climate change adaptation strategy by 2009.

At present, the government supports the municipalities in their coastal defence activities providing general guidelines, laws and vulnerability studies such as the Nature and Conservation Act and the national study ‘Sweden facing climate change – threats and opportunities’.

a/ Initiatives at national level

As in most Scandinavian countries, coastal protection policy in Sweden is mainly focused on spatial planning. The Nature Conservation Act of 1974 defines that the first 100 m to 300 m of the coast needs to be free of exploitation. Spatial plans of the different municipalities need to comply with this Act. In addition, new development projects have to take a certain safety margin into account to protect against future erosion or higher water levels. In 2007, just over 40 municipalities (mainly inland) had taken account of climate change in one way or the other. Mostly the expected higher water levels in watercourses or the sea were incorporated in their land use plans.

In October 2007 the national study ‘Sweden facing climate change – Threats and opportunities’ was published. A special commission, the *Swedish Commission on Climate and Vulnerability*, was appointed by the Swedish national government to carry out this two-year investigation. This Commission has analysed how Sweden’s climate may develop over the next hundred years and has

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6 At present, the Swedish government heavily invests in climate and energy; for the period 2008-2010 further initiatives of more than € 100 million have been proposed including climate research, energy efficiency measures, pilot projects and networks; another € 45 million is reserved specifically for energy efficiency measures.
analysed the consequences for a number of sectors and areas. An important aspect that has been investigated is the vulnerability to flooding, landslides and erosion. The budget amounted to €2.14 million of which the Swedish national government funded 60%. The remaining part was financed by different authorities and organisations from their proper working budgets.

A few Sea Level Rise scenarios were studied. For example, based on a global SLR of 88 cm, the study estimates the affected coastal zones at 100 m, 65 m and 30 m inland, respectively moving from south to north. Without additional protection measures, the total cost of coastal erosion and coastal flooding between 2010 and 2100 approximates to €40 billion. The total cost of coastal protection until 2100 is estimated between €289-578 million.

The Commission’s recommendations to reduce the vulnerability of Sweden’s coasts and adapt society to long-term climate change and extreme weather events include:

− Spatial planning should be considered as the most important tool to protect against violence from the sea;
− Investigation of risks of coastal erosion in built-up areas, compilation and evaluation of bathymetric information and expansion of extreme weather warning systems;
− Compensation and subsidy systems for preventive measures for coastal erosion in built-up areas;
− Areas of the coastal zones without private or public interests should not be protected but given back to the sea;
− Sweden should press for measures at EU level that reduce the vulnerability of the Baltic Sea in a changed climate.

Based on the recommendations of the climate change study, Sweden is developing a national climate change adaptation strategy, expected to be published in the course of 2009.

b/ Climate change adaptation from a sub-national perspective

Sweden has 290 municipalities, of which 82 are situated along the coast. Three coastal municipalities very vulnerable to climate change in terms of flooding, erosion and extreme weather events, have been selected as case in point.

Kristianstad

The municipality of Kristianstad is situated on the south coast of Sweden in the Skåne county. Kristianstad is at risk of both flooding and erosion. Most parts of the municipality are situated only a

7 The Rossby Centre calculated that a global Sea Level Rise of 88 cm would result in around 80 cm SLR in southern Sweden, 50 cm SLR in the central region and 20 cm SLR in northern Sweden.
8 Bathymetry is the measurement of the depth of oceans, seas or other large bodies of water.
few metres above sea level. Large parts of the city itself, situated 20 km from the coast, are situated below sea level.

In autumn 2008, the municipality began with the development of a master plan for adaptation to climate change. The plan is expected to be finalised by mid 2009. Input is mainly drawn from dedicated seminars.

Up to now, Kristianstad has dealt with coastal protection through spatial planning and the use of ad-hoc measures. Building restrictions, based on a series of measurements and investigations, exist for certain areas along the coast. A SLR of 0.77 cm by 2100 is taken into account in spatial planning.

In addition, new protective dikes (over a length of about 10 km) and six water pumping stations are planned at a total cost of about € 20 million. After a close call in early 2002, the construction started in 2003 and will continue until 2012. Additionally there is a small pilot project ongoing to protect the sand dunes by utilising nets made of coconut fibres.

Kristianstad has a flood warning system called Flood Watch Kristianstad. The system was initiated in the mid 1990s and came into operation in the beginning of 2007. The total cost is estimated at € 75 000 and ongoing system improvements are valued at € 20 000. The annual operational cost will be around € 5 000.

**Ystad**

The Ystad municipality located in the Skåne county has been actively fighting against coastal erosion since the 1980s. Information and knowledge have been acquired through research, pilot projects and investigations and many different protection measures have been taken since then. Four different areas within the municipality are severely affected. These areas are protected with groins, small scale beach nourishments, revetments, breakwaters and transplanted vegetation. In some of them land use is restricted.

Besides erosion also flood-risk and increased groundwater levels are expected to aggravate in the future. To address this, the local government agreed on a *Policy for the management and protection of the coast* in September 2008.

The main objectives of the plan are to protect against the loss of valuable land and infrastructure, to protect areas adjacent to the coast from flooding and to preserve the extent and width of the beach. As the basic position of Ystad is to safeguard the natural dynamics of the coast, the implementation of the plan should respect the following principles:

- **Coastal protective measures or projects will be subject to risk, cost-benefit, and environmental impact assessments:** in areas where existing built-up zones or infrastructures are threatened by coastal erosion, relocation shall be evaluated based on socio-economic assessments, soft measures
The economics of climate change adaptation in EU coastal areas

will be evaluated as second option and new hard coastal protection measures shall only be considered after other alternatives have been evaluated and found less appropriate;

- Physical planning shall anticipate climate change: exploitation shall be avoided in vulnerable areas, areas where erosion may be accepted will be identified and in the planning of new and existing settlements, considerations shall be taken with respect to the climate effects on groundwater levels.

To serve as an effective guidance tool, the Policy for the management and protection of the coast will be regularly updated on the basis of research and studies. An action and maintenance plan with a ten-year perspective will be established and reviewed every two years. The first plans, together with a specific budget, are expected for Spring 2009. Ystad will try to engage the national authorities to take over part of the financing.

Göteborg

Göteborg, located in the Västra Götaland county, recognised the need to adapt to climate change for the first time in September 2003 when the City Council adopted a local water plan. Different departments as well as NGO’s worked together to propose measures on how to:

- Sustain groundwater levels;
- Reduce discharge of pollutants to water sources;
- Increase conditions for biodiversity;
- Preserve and create water environments for activities and recreation;
- Reduce the risk of flooding in residential areas.

With regard to climate change, the plan included a proposal to raise the lowest level for buildings by 50 cm in order to be prepared for SLR. Furthermore a study on the effect of increased precipitation on the sewage system as well as a storm water management plan has been recommended.

As a follow-up, Göteborg created a risk map of the low-lying areas which need to be carefully observed with regard to SLR. The minimum expected foundation levels have been raised and a crisis and disaster coordination group has been set-up to investigate all water levels across the municipality but SLR is not yet monitored. The municipality does not protect the coast with any other specific hard or soft defence measures and does not attribute a specific budget to climate change adaptation.

By the end of 2008 Göteborg aims to adopt a comprehensive city development plan. With this plan, the city aims to establish safe building regulations and provide clean drinking water as well as a reliable traffic system while minimising the impact on the environment. Göteborg commits to take climate change into account in future territorial developments.
20.5. PAST, PRESENT AND FUTURE EXPENDITURE

In Sweden, no specific budget has been attributed at national or sub-national level to adapt the coastal zones to climate change. The main adaptation measure in Sweden is a revision of the spatial planning policy and the incorporation of safety margins in land use plans. Other measures undertaken at national and sub-national level to protect against the effects of climate change, mainly flooding, erosion and extreme weather related events, amount to about € 9.5 million in 2008. Table 20-1 provides an overview of the expenditure as well as a forecast budget for the protection against flooding, erosion and extreme weather in Sweden for the period 1998-2015. Over this period Sweden will have invested about € 127 million in coastal protection and climate adaptation.

The main financing at national level occurs through the National Swedish Rescue Service Agency Fund. For the period 2007-2009, the yearly fund of € 2.68 million was exceptionally doubled. It has to be noted however that this fund is used to protect the entire country from natural catastrophe and not only the coastal areas. In preparation of a national adaptation strategy, a national climate change study was executed between 2005 and 2007 for a total budget of € 2.14 million in preparation of a national adaptation strategy. The Swedish Meteorological and Hydrological Institute undertakes climate change research for about € 2.5 million per year.

At sub-national level, municipalities mainly adapt their land use plans. Ad-hoc measures to protect against flooding and erosion are mainly taken in Ystad for approximately € 0.55 million per year since 2006.
Table 20-1: Expenditure to protect against coastal flooding and erosion (in € million)

<table>
<thead>
<tr>
<th>Year</th>
<th>MAINTENANCE EXPENDITURE</th>
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<th>INDIRECT EXPENDITURE</th>
<th>TOTAL</th>
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<td></td>
<td>Flood warning system Kristianstad*</td>
<td>National Swedish Rescue Service Agency Fund**</td>
<td>Specific investments on erosion measures Ystad***</td>
<td>New protective dikes and water pumping stations Kristianstad*</td>
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<tr>
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<tr>
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<td>33.04</td>
<td>3.99</td>
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* Proxy provided by the municipality of Kristianstad; besides building new protective dikes and water pumping stations also a pilot project with beach nourishments will be executed in 2009 for an amount of € 0.022 million and during the period 2008-2009 an additional € 0.050 million is available for measures against coastal erosion

** Proxy provided by Swedish Geotechnical Institute

*** Proxy provided by the municipality of Ystad

**** Swedish Meteorological and Hydrological Institute (Rossby Centre) spends on average 2.5 million per year to climate research; the national climate change study accounted for about € 2.14 million over the period 2005-2007 (exchange rate used: 1€=9.13SEK)
20.6. PERSONS CONTACTED AND SOURCES OF INFORMATION USED

20.6.1. PERSONS CONTACTED

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<tr>
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<td>Hedlund, Tom</td>
<td>Environmental Protection Agency</td>
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<td>County Administrative Board in Skåne</td>
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<td>Moback, Ulf</td>
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<td>Office of Regional planning and urban transportation, Stockholm County Council</td>
</tr>
</tbody>
</table>

20.6.2. SOURCES OF INFORMATION USED

- City of Göteborg, 2008, Proposal for a comprehensive plan for Göteborg
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