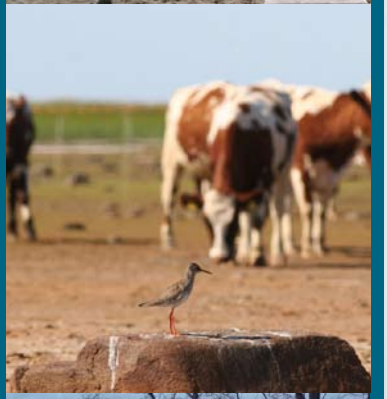


Project part-financed by the European Union (European Regional Development Fund) within the BSR INTERREG III B programme

Towards Climate Change Adaptation in the Baltic Sea Region

Results of the Case Studies

www.astra-project.org

AstrA

Developing Policies and Adaptation Strategies to Climate Change in the Baltic Sea Region

Developing Policies and Adaptation Strategies to Climate Change in the Baltic Sea Region

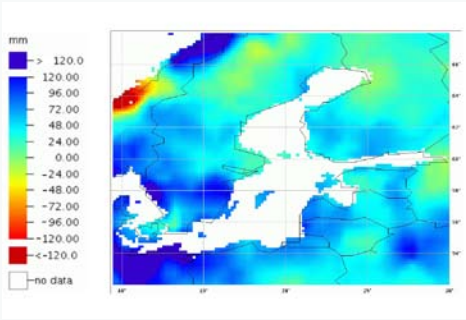
It is established scientific knowledge that the climate is already changing and an increase in the average global surface temperature can be observed. There is wide agreement that this trend of global warming is continuing, mainly due to human influence. Early adaptation to climate change greatly reduces the financial and humanitarian risks potentially involved. Planned adaptation can also increase our everyday quality of life. This underlines the need for societal responses.

Focusing on the Baltic Sea Region (BSR), the ASTRA project assessed the regional impacts of the ongoing and future global change in climate. Its aim is to develop adequate climate change adaptation strategies and policy recommendations together with the relevant stakeholders, such as planners and decision makers. ASTRA's partners comprise various research institutes and regional and local planning offices around the Baltic Sea Region. Lead partner of the project is the Geological Survey of Finland.

The ASTRA project used climate change models and climate impact research to develop regional and local impact scenarios. In this context, it concentrated on risk awareness and the formulation of policy recommendations. The main focus was on practical applications; stakeholders became directly involved in the project's activities.

From June 2005 to December 2007, the ASTRA project has been co-financed by the Baltic Sea Region's INTERREG III B Programme of the European Union, with a project budget of EUR 2.2 million.

On the following pages, the results of the ASTRA project will be presented in a nutshell. The detailed project results can be downloaded from www.astra-project.org.



Seasonal changes in precipitation from 2000 und 2100. Left: winter season (December to February); right: summer season (June to August), SRES A2 scenario, HadCM3

Towards Climate Change Adaptation Strategies in the Baltic Sea Region

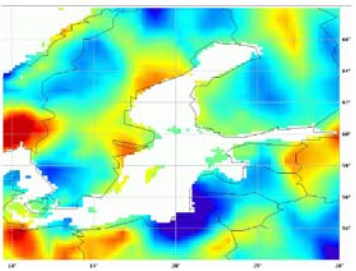
Adaptation to climate change impacts is rather new on the political agenda of the Baltic Sea Region as well as that of the European Union. According to the latest expectations for the ongoing change in the climate, adaptation should become an integral part of policies, ensuring sustainable future development. Public authorities responsible for policy making on behalf of public welfare play a key role when addressing climate change issues. Their decisions can benefit sustainability in territorial development.

Climate change in the Baltic Sea Region

Scientific studies have shown a general trend of rising average temperatures and changes in precipitation patterns for the Baltic Sea Region (BSR). The BSR faces different regional and seasonal challenges in the light of the changing climate. Questions raised include what level of coastal protection will be needed in the future, and how to cope with severe flooding events or water shortages.

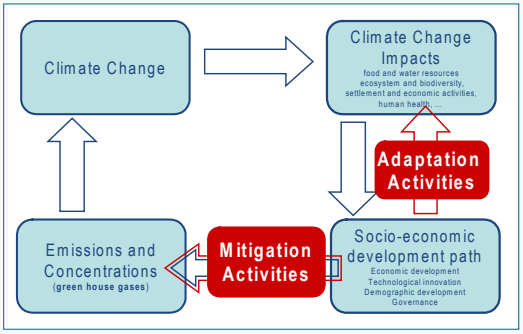
Adaptation to climate change impacts

The concepts of adaptation and mitigation tackle climate change in two different ways, as shown in the illustration on this page. Adaptation seeks to moderate the negative effects or exploit the beneficial opportunities of climate change. Mitigation includes measures and strategies to reduce CO_2 and other greenhouse gas emissions. Both approaches should be regarded as complementary: the more successfully they are both followed, the lower the risks for society will become due to climate change impacts.



ASTRA publication "Towards Climate Change Adaptation Strategies in the Baltic Sea Region"

As guidance for decision-makers, the ASTRA book "Towards Climate Change Adaptation Strategies in the Baltic Sea Region" comprises the main findings of the ASTRA project and presents information and recommendations on how to develop adequate adaptation strategies for climate change impacts. This publication provides definitions of key concepts concerning adaptation, reasons why adaptation strategies are needed and the main challenges when coping with climate change issues. Climate change in the Baltic Sea Region and main affected sectors are also described, including an overview of the current institutional preparedness regarding adaptation to climate change impacts. Furthermore, the book provides an overview of existing adaptation strategies in the BSR. Approaches and examples of good practice are highlighted and recommendations that can be drawn from the ASTRA project findings are finally presented.



Mitigation and adaptation as complementary approaches in climate change policy (adopted from IPCC 2001: Climate Change 2007: Mitigation to climate change – Summary for policy makers.)

The book is freely available at www.astra-project.org.

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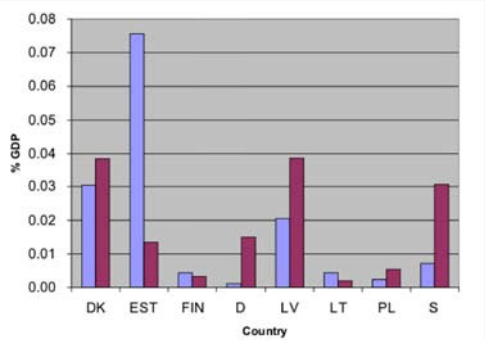
Hilpert, K., Mannke, F., Schmidt-Thomé, P. (eds.), 2007: Towards Climate Change Adaptation Strategies in the Baltic Sea Region, Geological Survey of Finland, Espoo.

Adaptation to Sea Level Rise

The sea level is an important issue for future coastal safety. Although in his last report the IPCC (2007) published lower estimates for sea-level rise induced by global warming, recent literature, satellite measurements and observations imply that these could be underestimated (WBGU 2006). Thus, integrated assessments are important in this context. Although some parts of the Baltic Sea are affected by isostatic land uplift, several coasts are still at risk. If CO_2 emissions remain undamped the increase will be greatest in the southern Baltic Sea (approx. up to 95 cm), while in the northern parts it will range between 15-45 cm by 2100. The questions raised include what level of coastal protection will be needed in the future, how to cope with severe sea and river flood events, and especially how much coastal protection will cost. What will actually happen mainly depends on the future development of greenhouse gas emissions, as well as on demographic and technological developments, i.e. on future human behaviour. This example is based on a scenario associated with at least a tripling of atmospheric CO_2, providing an idea of what could happen if anthropogenic CO_2 emissions continue to rise in a business-as-usual way.



Difference of the cumulative costs (2000-21000) for adaptation (blue) and for the residual damage costs (red) in % of GDP (2006). Cost assessments like this depend on the valued assets. Therefore the residual damage costs are quite different for the Baltic countries. But if countries are only a little protected yet, like Estonia or Lithuania, the necessary investments in coastal protection exceed the expected and possibly saved damage costs.

The benefits of adapting to sea level rise are computed by comparing adaptation costs (incurred by dike construction and maintenance) and the residual damage costs (expected costs of extreme floods inducing dike breaches) for the case where dike heights are not changed (non-adaptation) with those for the case where they are adjusted to a 100-year flood return level (normative protection (adaptation) target). The graphic on this page illustrates that most countries will benefit from adaptation. Denmark, Latvia, Sweden and Germany are in particularly prone to risk and can achieve a positive benefit. The opposite holds for Estonia, Finland and Lithuania. Here, the costs are negative, implying that the selected adaptation target might be too large. For these countries the 100-year protection level is not beneficial from a cost-benefit-analysis viewpoint (e.g. without considering natural/cultural values). The reason for this is that it makes less sense to build dikes protecting only low-lying lands where few economic assets are situated. This makes it clear that such analyses provide only a comparative snapshot. Further climate impacts need more detailed studies on risk propagation and the threatened infrastructure, although the above-presented results were already improved by additional GIS analysis. The multiplicity of exposed sectors is a real challenge in the development of adaptation policies. Considerable scientific progress has been made during recent years, but a qualitative survey among decision makers in the BSR revealed that current knowledge about the sectors at risk and about potential adaptation measures is in its infancy. Here, a new philosophy of science-stakeholder interaction must be established.

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IPCC (2007): Climate change 2007: The Physical Science Basis. WG I of the Intergovernmental Panel on Climate Change (IPCC). Cambridge: Cambridge University Press.

WBGU (2006): The future of the ocean: to warm, to high, to sour. Special Report of the German Advisory Council on Global Change to the Federal Government. Berlin.

Today's Weather Events are a Window to the Future

In January 2005 the Baltic Sea Region was hit by a fierce winter storm. Strong winds and floodwaters caused a wide array of damage in all countries of the region, totalling some 1.5 billion euros in insured losses alone. Coastal floods and erosion, power cuts, and forest and property damage were only a few of the effects felt. Hardly any sector of the societies in the region was left untouched.

Although it was a single event, a study carried out under ASTRA on the January 2005 storm clearly revealed how complex the direct and mediate impacts related to extreme events can be. Individual areas and exposure units in the Baltic Sea Region are affected in very different ways, although the basic nature of extreme events remains similar across the whole region.

This offers possibilities for learning. Individual events experienced both personally and through case-studies, such as the winter storm study carried out in the ASTRA project, are valuable in raising awareness of the possible effects of climate change. Through learning about the impacts seen in the various parts of the Baltic Sea Region, we can anticipate the extent and the nature of extreme weather events and the effects that we will possibly face in the future.

Especially in planned adaptation through spatial planning, much can be learned by comparing different ways of dealing with both human and natural challenges that are similar to all, fitting functional land use guidance and planning practices into individual geographic and socio-economic settings. Apart from setting new standards for safe construction and safety levels of various societal functions, learning from extreme weather events can be a key to the kind of individual expertise that handling complex issues such as climate change demands.

Effects of the winter storm and protection measures on the market place in Helsinki (photo: Samuli Lehtonen)

The January 2005 storm offered a valuable example of this. The record high sea-level raised by the storm had little effect in Helsinki, Finland, but caused some 9 million euros worth of damage in Pärnu, Estonia. Apart from the characteristics of the coastlines themselves, equally important factors were the long-term rules of lowest construction levels in effect in Helsinki and the preparedness and co-operation of various actors to lessen the damage during the storm. Both factors are based on knowledge of the vulnerable points of the area.

Early adaptation to future extreme events and learning from today's events pays off. It is expected that with climate change, extreme weather events will become more common in the future. In fact, some events seen as extreme today may be considered average within few decades. Adaptation is especially economical when planning new urban areas along the immediate coastline, reducing potential damage from day one.

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Climate Change and the Oder Estuary

The Oder River (German: Oder; Polish and Czech: Odra) is an outstanding example of the interrelations between river basin and coast and demonstrates the dependency of coastal management on river basin management. Agriculture, industries and cities cause loads of heavy metals, organic pollutants and especially high loads of the nutrients nitrogen and phosphorus. The quality of river water suffers from these loads, but the main consequences are visible in the coastal area. The lagoon can be regarded as a hypertrophic, degraded ecosystem. It largely lacks submersed vegetation, suffers from severe algae blooms, and the water transparency in summer is often below 50 cm. On sunny days without wind, anoxic conditions temporarily occur and cause fish kills as well as damage to the benthos. Due to regular dredging of the canal and denitrification processes, the lagoon still serves as a retention pond for nutrients and protects the Baltic Sea to a certain degree from pollution, but the poor water quality hampers bathing tourism and nature protection. Water quality will gain importance because most parts of the coastal zone became Natura 2000 sites and the EU-Water Framework Directive (WFD) demands good water quality. The WFD further asks for a river basin and coastal water management plan, while climate change is interfering with this river-basin-coast-chain and will increase problems with algae blooms. Furthermore, the on-going sea-level rise and a sinking coast as well as changes in precipitation in the catchment, with subsequent changes in river discharge, might increase the risk of flooding in the river basin and aong the coast. An increased risk of storms and storm surges along the Baltic Sea coast will have immediate negative effects on coastal erosion, protection measures and tourism infrastructure (leisure boat harbours, beaches, piers, promenades). A strong northerly wind can cause storm water levels on the Baltic Sea coast to rise by one metre or more (increasing with sea-level rise). During these situations, backwater in the Odra is observed far south of Szczecin, and a temporary intrusion of Baltic Sea water with a salinity of 6 $^{0}/_{00}$ into the lagoon is observed and causes a hazard. The region has to face danger from two sides, due to sea-level rise as well as due to increased floods. Therefore, integrated coastal and flood protection is needed.

Threats and opportunities of climate change: The Oder/Odra estuary region

These and other impacts have been, and still are discussed together with ministries, regional authorities and local associations within regional workshops and conferences as well as within the ongoing ICZM project IKZM-Oder (www.ikzm-oder.de).

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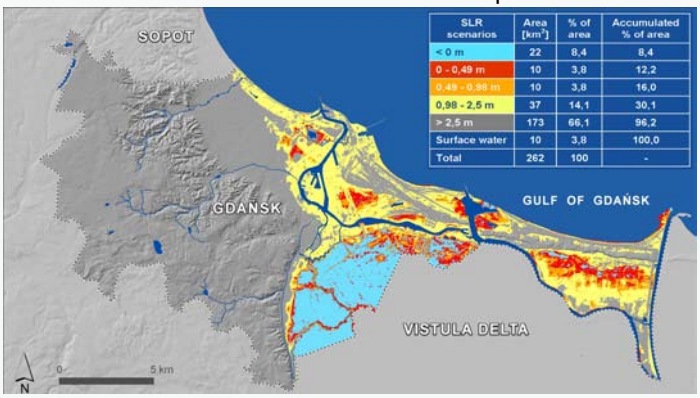
Climate is also Changing in Gdańsk – Are We Ready?

Due to its geographic location in the Vistula Delta, Gdańsk is extremely vulnerable to floods caused by intensive precipitation, high discharge of the Vistula River, storm surges and ice jams. In addition, parts of the city and its infrastructure are situated below sea-level.

Analysis based on the scenarios of the SEAREG and ASTRA projects for sea-level rise and changes in temperature and precipitation patterns with a 100 years perspective indicate that coastal erosion and flood risk in the Gdańsk region will increase. Assessment of climate change impacts on the urban area of Gdańsk and its vicinity revealed the strongest impacts on beaches (tourism), arable land and the production-service sector. Transport and communication as well as residential-service sectors would also be affected. Moreover, the problem concerns the water supply system, since groundwater intakes of high admissible resources and great importance for the city are located in low lying, potentially endangered areas.

Gdańsk is currently one of the best flood-protected cities in Poland: it has a network of flood protection structures, i.e. dikes, ditches, culverts, sluices, pumping stations and storage reservoirs. Recurring flood events with severe impacts (i.e. in 2001) have led to an analysis of existing flood protection policies as well as the technical condition and modernization of the infrastructure. A Polish law regulates principles for the determination of areas demanding flood protection. The potential influence of sea-level rise has been considered in coastal zone management. However climate change impacts have not so far been taken into account in an integrated approach to water and flood risk management. The project's results shall function as a tool for further analysis and support the integration of climate change impacts issues and flood protection aspects into planning and decision making in Gdańsk.

Central Railway Station in Gdańsk during flood caused by cloudburst in July, 2001 (photo: Wojtek Jakubowski /KFP)



SLR scenarios	Area [km²]	% of area	Accumulated % of area
< 0 m	22	8,4	8,4
0 - 0,49 m	10	3,8	12,2
0,49 - 0,98 m	10	3,8	16,0
0,98 - 2,5 m	37	14,1	30,1
> 2,5 m	173	66,1	96,2
Surface water	10	3,8	100,0
Total	262	100	-

Gdańsk – areas potentially affected by sea level rise (based on SEAREG SLR scenarios and high quality DTM)

To raise awareness of the need for adaptation to climate change, potential impacts were discussed with local and regional stakeholders during conferences, seminars, meetings and personal interviews. The stakeholders involved included: the Gdańsk Development Agency, the cities of Gdańsk, Sopot and Gdynia, Pruszcz Gdański Municipality, the Maritime Office, the Regional Board for Water Management, the Institute of Meteorology and Water Management, Pomorskie Voivodeship Office, and the Office of the Marshall of the Pomorskie Voivodeship.

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Climate Change Awareness in Rīga

Rīga, the capital city of Latvia, is of major importance for sustainable development of the country, it is the major centre of economic development and where most of the inhabitants of Latvia live. At the same time, Rīga is especially vulnerable to impacts of climate change due to its location in the vicinity of the Gulf of Rīga and at the mouth of three major rivers: Daugava, Gauja and Lielupe. Apart from high climate change impact risks and possible threats, the awareness of stakeholders and inhabitants could be considered as low. While at the national level the Climate Change Mitigation Program 2005-2010 is functioning well, adaptation approaches at both national and local levels are generally lacking.

The winter storm 2005 in Rīga (photo: Ivars Kruze)

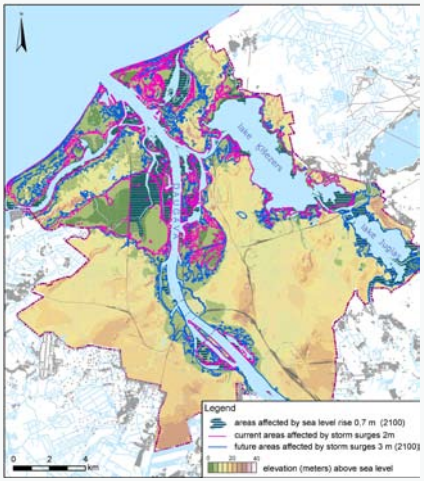
The most important climate change impacts in Rīga are likely to be:

- flooding
- storm damage
- groundwater level rise
- hydropower plant dam safety
- heat waves

In addition, other climate change risks can also significantly affect not only the welfare of inhabitants, but can be considered as a major threat to the development of Rīga, especially considering its high economic importance (major ports), recreational business and significance of climate change to the water supply systems.

To reduce climate change risks and support the development of adaptation strategies at the national level and in the municipality of Rīga within the ASTRA project:

- project participants and involved stakeholders have become acquainted with existing experiences ("success stories") in the Baltic Sea area. Participation in the project supported the intensification of climate change research in Latvia and involvement in research and stakeholder networking;



Scenario of sea level rise and storm surges in Rīga for 2100

- project experience has been used to support the start of work on the national climate change adaptation strategy;

- existing knowledge on climate change and its impacts has been summarised, discussed at the "Climate change and waters" conference in Rīga and published as a book "Climate change in Latvia";

- the impacts of the winter storm "Erwin" (2005, also known as "Gudrun") on the infrastructure of Rīga have been assessed and conclusions have been drawn for seperate sectors;

- a sea level rise map hase been created for the coastal zone of the City of Riga using sea level rise models (data of the Potsdam Institute for Climate Impact Research generated within the ASTRA project).

River Salaca: Climate Change and Nature Protection

The River Salaca Basin covers the major part of the North Vidzeme Biosphere Reserve. This territory can consequently serve to demonstrate to a wider society and researchers the impacts of climate change on biodiversity and territories with low human activity. River

Salaca is one of the least affected rivers, not only in Latvia but in the whole Baltic region, and the fourth most important salmon spawning area in the Baltic. It has high landscape diversity of such habitat types as aquatic ecosystems, raised bogs, coastal meadows and forests. The protection of biological diversity from possible threats caused by climate change is especially important in the River Salaca Basin.

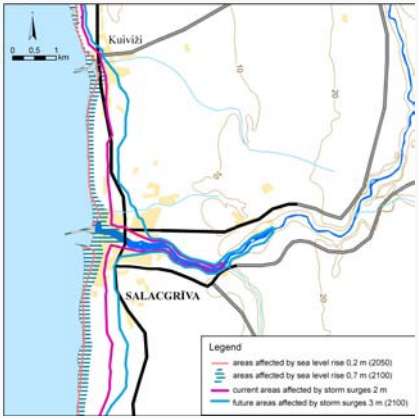
Long-term ecological observations have provided information on the possible ecosystem response to climate change processes in the studied areas of the river basin.

The most significant climate change impacts in the Salaca River Basin are changes in the water level regime (occurrence of spring floods, low water periods), in the temperature regime (increasing spring temperature), a decrease in the number of days with snow and ice cover, changes in the frequency of extreme weather events (winter storms in the coastal area), changes in vegetation in the river basin (e.g. overgrowth of aquatic vegetation in the River Salaca), fish habitat losses and a consequent decline in the recreational value of the River Salaca.

View on River Salaca (photo: Ivars Druvietis)

Several stakeholders are involved in tackling problems linked with climate change impacts, including administrators and scientists from the North Vidzeme Biosphere Reserve, state institutions and agencies in the region (the Regional Environmental Board and Agency, Fire and Rescue Service, the Road Administration and Rural Development Service), and spatial planners from Rīga and Vidzeme Planning Regions.

Within the ASTRA project the climate change impacts and adaptation measures relevant for highly-valued protected areas have been investigated and the development of adaptation measures has been promoted. A sea level rise map for the coastal zone has been created using sea level rise models (data of the Potsdam Institute for Climate Impact Research) generated within the ASTRA project. Draft proposals for spatial development policy have been elaborated with the aim of averting damage due to coastal erosion. It has been suggested that following measures have to be taken in the coastline tourism and environment protection zone:



Scenario of sea level rise and storm surges for 2100 at the River Salaca

- Construction of coastal defence structures at dense settlement sites;
- Control or prohibition of the expansion of settlement sites in vulnerable coastal areas;
- By-passing of the VIA Baltica motor way from the close proximity of the sea coast.

In the basin of River Salaca, activities such as the following are proposed in adapting to the expected climate change:

- Maintenance of the balanced overgrowth of river banks;
- Construction of hermetic toilets at camping sites in the coastal zone of the river;
- Construction of stairs and footbridges on steep slopes;
- Creation of improved swimming places;
- Limiting of the number of beavers in the River Basin.

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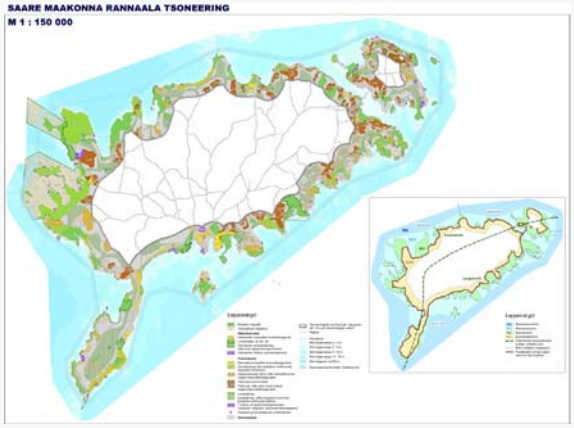
Saaremaa Case Study Area

Saaremaa, the biggest island of Estonia, is like a small model of Estonia due to its low-lying and flat topography and the existence of all major shore types characteristic of the coast of Estonia. Saaremaa is a popular tourist region of the country with a number of attractions and suitable recreation areas.



Saaremaa. Zonation of the Coast

The coastal zone of Saaremaa can be easily affected by global climate change and the concurrent sea-level rise. Increasing cyclonic activity due to warmer winters and more frequent and stronger storms with higher storm surges in ice-free sea conditions have already caused destruction to depositional shores, e.g. sandy beaches, and resulted in rapid changes in the shoreline position in many places. Continuation of the observed trends in climatic conditions (temperature rise in winter, frequent and strong westerly storms) will intensify the shore processes even more in the future.

A few local authorities in Saaremaa have managed to create a comprehensive land use plan for the municipalities and to establish regulations governing construction along the coast. Unfortunately, these measures have been undertaken more as a way to legally sanction growing coastal land use activities than to regulate future coastal development. Estonia's current patchwork of laws and regulations regulating its coastal zone – while still evolving – remains incomplete and subject to numerous loopholes and other abuses. The powerful storm Gudrun and subsequent flooding in January 2005 clearly showed that the local authorities were not prepared to avoid or mitigate the impact of such a catastrophic event. In order to better organize coastal zone protection and land use, a detailed coastal zone management plan for Saaremaa Island is still in progress and will be completed by the end of the ASTRA project. The analytical work of the management plan is based on the existing datasets as well as on measurement data from coastal geomorphic and hydrodynamic field investigations at coastal study sites and in the sea. The coastal zone management scheme will hopefully allow the stakeholders to determine the best way to manage this important resource and to protect the coastal zone against the negative effects of both global climate change and increasing encroachment by development.

The stakeholders involved in the current project are the authorities of all coastal municipalities of Saaremaa.

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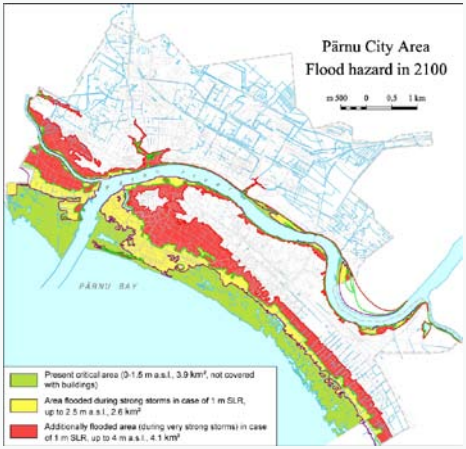
Pärnu: Climate Change and Storm Surges

Pärnu and the beach of Valgerand 4 km to the northwest are located on the coastal lowland of the Pärnu Bay. These areas are extremely vulnerable to floods caused by south-westerly storms. About 45% of the area is only up to 5 m above sea level (a.s.l).

Floods during strong storms in recent years (in January 2005 locally up to 310 cm due to wind speed and wave action) have caused considerable economic losses amounting to several tens of millions of euros. Calcula-

tions show that a sea-level rise of up to 1 m and storm surges of up to 4 m by the end of the 21st century will cause widespread flooding, if the processes accompanying climate change continue. Especially dangerous are the periods when floods are supplemented by abundant precipitation and higher discharge from the Pärnu River to the Pärnu Bay. In addition to floods, certain shore sections are intensely abraded during severe storms and the frequency of landslides of riverbanks may increase.



Up to 6.7 km² or 24% of residential area of Pärnu might be flooded

The results of the project were presented to the Pärnu City Government, the Audru Municipality and also discussed on national radio, television and in the county newspaper.

Tallinn and Sea Level Rise

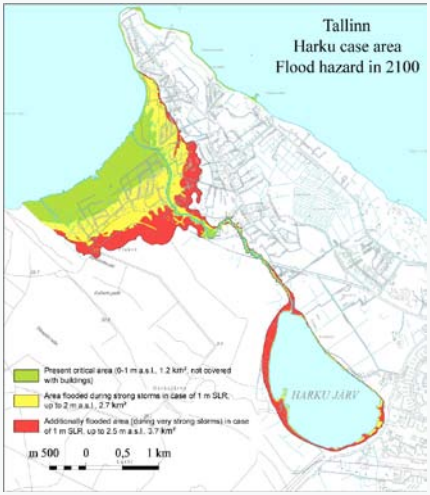
Tallinn, the capital of Estonia, covers an area of 158 km² and is located on the southern coast of the Gulf of Finland. Tallinn's shoreline is almost 70 km long and is divided into several peninsulas and minor bays at the mouths of ancient buried valleys. In the area of the buried valleys, 26 to 32 km² of the coastal land has a maximum elevation of 3 to 5 m a.s.l.. Commonly, these areas are densely populated or are subject to intense construction activity, and they are extremely vulnerable to storm surges. The buried valleys cut the Cambrian-Vendian aquifer, which is the main groundwater source for Tallinn and mainly feeds via the buried valleys. In the bays, intrusion of seawater into the groundwater occurs.

The water level of Lake Ülemiste in the southern part of Tallinn is 36.5–36.7 m a.s.l.; the Ancylus Lake dune system isolates it from the lower part of the town. During long-lasting severe rains Lake Ülemiste may overflow and endanger the centre of Tallinn.

Floods during strong storms of recent years have caused economic losses amounting to about one million euros. If climate change continues, by the end of the 21st century the sea level may rise in the Tallinn area by up to 80–100 cm, and during storms by up to 250 cm. This would cause widespread flooding in the new residential district of Harku and in many other similar areas (comprising up to 9 km² of the area of Tallinn). For Tallinn, long-lasting northwesterly winds and storms are the most unfavourable. Time series have shown an increase in their strength and duration. Sea-level rise will lead to the intensification of seawater intrusion into the Cambrian-Vendian aquifer, frequent landslides on scarp shores and intense abrasion.

The results of investigations were presented to the Tallinn Town Government in November 2007.

Recommendations for both Pärnu and Tallinn case study areas include cessation of the construction of long-lasting expensive buildings in low-lying areas until the rate of sea level rise has been determined more reliably.



Areas in Tallinn possibly prone to storm surges by the end of the 21st century.

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Adaptation Action in Espoo

In Espoo, the ASTRA project has been valuable in raising awareness of climate change. In addition, early results of the project and its discussions have been applied in concrete actions such as flood control. In 2005 the Gudrun storm swept over Finland resulting in the revision of detailed action plans. For instance, the city improved its preparedness for flooding. In the same year, parallel to the ASTRA project, the Board of Managers of the City of Espoo Technical and Environmental Services appointed a Flood Group to assess the flood risk in Espoo, to draw up flood maps, to conduct a survey of the liabilities and responsibilities and to propose measures to be adopted in preparation for floods.

A flood risk area under detailed planning (photo: City of Espoo)

In May 2007, Espoo organised a seminar that was co-financed by the ASTRA project. The seminar was entitled "Climate Change and Planning in Espoo" and was mainly targeted at planners. However, it offered a good platform to discuss the state of climate change issues in the city. The audience included participants from national and regional organisations, residents' associations and other cities, the media and also a large number of local politicians. Parallel to the seminar, a summary was compiled of the key impacts of climate change on urban planning based on the latest research results. The seminar provided a cross-section of the city's response to climate issues, and how mitigation and adaptation have been considered in one city.

In addition, many departments of the city have been participating in the project in various ways. This has offered an opportunity for a wide range of bodies and stakeholders inside the city to discuss and adopt climate change issues in their duties. It also has also prompted local actors to provide feedback on the project itself.

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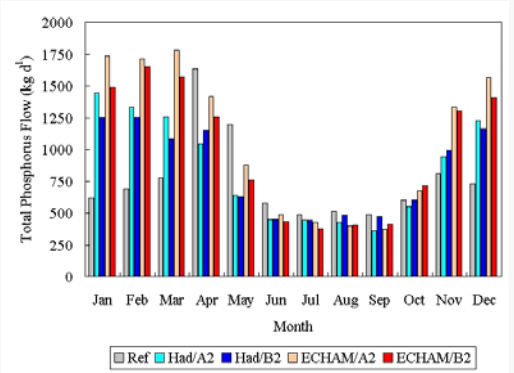
Climate Change: New Challenges to Water Protection

The most important activities of the Pirkanmaa Regional Environment Centre within the ASTRA project consisted of four regional seminars and a modelling case study in which the impacts of climate change on nutrient (phosphorus and nitrogen) transport from the Kokemäenjoki river basin were assessed.

In the seminars, lectures on adaptation to and possibilities for mitigation of climate change were presented. Representatives of Finnish ministries and other authorities and prominent scientists were invited as speakers. The most important expected impacts of climate change in Pirkanmaa are increased floods, changes in agriculture and forestry, increased eutrophication of waters and changes in the recreational use of nature. Participants in the seminars were regional stakeholders, including local communities and the Regional Council of Pirkanmaa, regional governmental authorities, universities of the region as well as non-governmental organizations. In the final seminar, which was also open to the citizens of the region, information about the findings of ASTRA was distributed.

In the modelling case study, results of previous research projects could be utilized. Climate change will have impacts both on inland waters and on the Baltic Sea. The modelling system consisted of three parts: a runoff

model, a nutrient transport model and a river-lake model. The Rossby Centre coupled Regional Climate Model (RCAO) was used for the discharge simulations. The boundary conditions were taken from two global climate models from the Hadley Centre (HadAM3H) and the Max Planck Institut für Meteorologie (ECHAM4/OPYC3). The IPCC emission scenarios A2 and B2 were used. According to the modelling calculations, there will be a considerable change in the seasonal dynamics of nutrient loading. Annual loading will increase regardless of the climate model or the emission scenario used. Winter loading will be greater than at present, whereas the spring peak will be lower and will take place earlier than in the present climate.



Total phosphorus flow at the outlet of the river Kokemäenjoki catchment. Average monthly values (kg/d) with different models and scenarios. The grey bars (Ref) represent the present climatic situation.

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Kokkola – Rising or Sinking City?

The Kokkola case study focused on adaptation to climate change impacts and to some degree on mitigation actions in city planning. The study area was the Old Harbour Bay master plan area on the shallow coast of the Bothnian Bay. Several new residential areas have been planned near the shoreline, and there are also many existing vulnerable targets such as harbours, waste water treatment plants and nature reserves.

One of the predicted impacts of climate change is a rise in the sea level, which in Kokkola will be partly counteracted by the rapid land uplift amounting to 8-9 mm/year. Different sea level scenarios up until 2100 and flood risk maps were created based on height modelling (by the Geological Survey of Finland) of the shore areas and a sea level model (by the Swedish Meteorological and Hydrological Institute). Scenarios have been taken into account in city planning (e.g. building heights in new residential areas and in the building code, detailed project planning of the new waste water treatment plant, drainage, protection of the shoreline). Sea-level rise might also have some positive impacts, such as decreasing need for dredging.

The Technical Research Centre of Finland (VTT) calculated climate change scenarios for the years 2070 to 2100 in the Kokkola area based on a regional climate model and using the IPCC scenarios A2 and B2. The results give a good picture of the foreseeable changes in precipitation, short term precipitation maximums, as well as changes in mean, maximum and minimum temperatures, wind speeds, snow precipitation, duration of the snow and ice cover and melting-freezing cycles. These results are a good tool for city planners and are used as basic information for instance in master planning, architecture and the dimensioning of storm sewers.

The most important stakeholders during the ASTRA process have been city planners, boards in city administration, companies in the large-scale industrial area, waterworks of the city, citizens, NGO's, schools and the press. A good result has been a local increase in awareness of climate change impacts.

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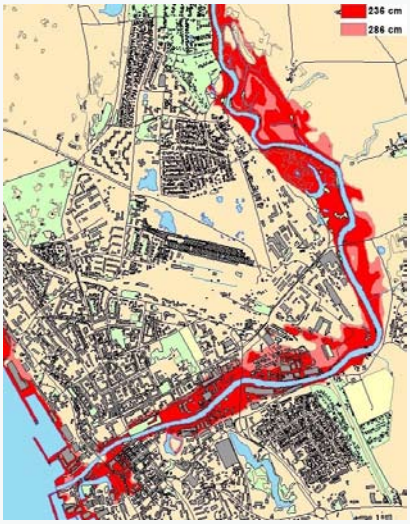
Klaipeda and the Curonian Spit

Klaipeda is the third largest city in Lithuania with 190 000 inhabitants, and is known as an important economic, cultural and scientific centre of Lithuania and an ice-free port. The Curonian Spit is a 98 km long and 0.4-4 km wide sand dune peninsula separating the Baltic Sea and the Curonian Lagoon. The Curonian Spit has 2400 inhabitants. 52 km of the peninsula is covered by the Curonian Spit National Park, with the highest moving dunes in Europe and rare plants. In 2000 the Curonian Spit was added to the UNESCO World Heritage List.



High risk zones of inundation in Klaipeda

In the framework of the ASTRA project, climate change impacts on the seashore and coastal ecosystem, dune deflation, surface erosion and changes in anthropogenic pressure were analysed and recommendations for adaptation provided.

More than half of the inhabitants of Klaipeda claim that they are more or less sensitive to meteorological conditions. A scheme for biometeorological forecasting and a public warning system was developed.

Flood risk, storm risk and increase of weather extremity were analysed in the infrastructure sector. Possible city inundation schemes and a special report for city planners indicating high risk zones were prepared.

Close attention has to be paid in the case study area to protection against forest fires. After assessing different indexes that are in use in other countries the most suitable one was identified. It provided a basis for improvement of the forest fire awareness system, mainly due to the greater accuracy of the forecast. Lithuanian scientists have also prepared recommendations for city planners and foresters to reduce the impact of increased storms, to improve forest fire prevention and protection, and to reduce the impact of diseases and insects on trees, in order to avoid degradation and increase forest productivity.

Communication with local stakeholders in Lithuania was carried out in the form of four regional seminars organized in Klaipeda. Further information on climate change issues was provided to the general public in articles published in regional newspapers.


Discussion of project results with local stakeholders

More than 50 local stakeholders (environmentalists, spatial planners, meteorology and climatology specialists, landscape architects, strategic planners and monitoring specialists, regional development specialists, persons working in the field of education, as well as politicians) were involved in the process. Local stakeholders represented local and regional authorities, research and education institutions, industry and the business sector, institutions under the Lithuanian Ministry of Environment, non-governmental organizations and the media.

A number of possible adaptation measures that resulted from the ASTRA project has been presented in a draft of the National Implementation Strategy of the Climate Change Convention.

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Climate Change Adaptation Calls for Awareness, not only Information

Institutional preparedness for an increasing incidence of extreme weather events, such as storms and droughts, and for other anticipated effects of climate change is one crucial aspect of adaptation. In short, this means how society has locally prepared itself for the (currently) unexpected by either planned or reactive means. When the system at hand fails to anticipate the future or is incapable of adapting despite better knowledge, we talk about institutional vulnerability.

The Winter Storm Study carried out under the ASTRA project provided first insights into institutional vulnerabilities in the Baltic Sea Region. While similar effects were felt throughout the region, some areas seemed to have coped better with the storm than others. It was seen that part of the damages could be attributed to local maladaption towards extreme weather events. Aside from impacts on human well-being, institutional vulnerability can have serious economic consequences.

Overall, institutional vulnerability covers the issues of awareness of the effects of climate change, long-term institutional preparedness and possibilities for adaptation and co-operation, and dissemination structures. Adapting to climate change not only calls for information sharing, but also for working structures through which actors can implement adaptive measures. It additionally calls for co-operation, both between different levels and sectors of society and interested individuals.

A study was carried out on the institutional vulnerability of the spatial planning systems in the countries of the Baltic Sea Region, with respect to their vulnerability against the effects of climate change. Based on two linked studies involving both national focal points on climate issues and local and regional planners, an insight into the current state of awareness of the problem as well as the agency and association of the actors involved was obtained. These were seen as crucial elements to effect the most important action, namly adaptation.

Based on the studies, climate change adaptation is still an emerging issue in most of the BSR countries. In many of the countries, such as Sweden, Denmark, Germany and Latvia adaptation strategies are being drafted on the national level or by individual sectors. Finland completed a national adaptation strategy in 2005. Attitudes on adaptive action on the national level have a marked impact on the lower levels. It is important to note, however, that information alone does not lead to awareness of the issue, let alone to action.

Spatial planners in the Baltic Sea Region are interested in and largely aware of the climate change issue and see that the tools to tackle the problem exist. However, a clear understanding of the precise impacts and responsibilities when dealing with them is lacking. Other issues related to spatial development easily override adaptation. As one key point, it was noted that adaptation issues should be addressed in legislation guiding spatial planning on all levels in order for the issue to be given the value it deserves in the spatial development process.

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Developing Policies & Adaptation Strategies to Climate Change in the Baltic Sea Region (ASTRA)

Focussing on the Baltic Sea Region (BSR), the project "Developing Policies & Adaptation Strategies to Climate Change in the Baltic Sea Region" (ASTRA) assesses regional impacts of the ongoing global change in the climate. Its aim is to foster the development of adequate climate change adaptation strategies and policies together with relevant stakeholders, such as planners and decision-makers.

Background

Climate change will have potential long-term effects on the living environment. The impact of climate change, along with the socio-economic impacts of natural hazards, plays an important role in the spatial and economic development of regions. For example, the economical losses caused by natural hazards are continuously rising. Positive responses towards these impacts on regional development involve mid- to long-term strategies supported by decision makers and other stakeholders, including regional and local planners.

Finland

- Geological Survey of Finland (GTK, Lead Partner)
- Centre for Urban and Regional Studies (YTK)
- City of Espoo
- Pirkanmaa Regional Environment Centre
- The Association of Finnish Local and Regional Authorities
- City of Kokkola
- City of Helsinki
- City of Loviisa
- Regional Council of Itä Uusimaa
- Regional Council of Uusimaa
- The Association of Finnish Energy Industries

Estonia

- Tallinn University
- Geological Survey of Estonia (EGK)
- City of Pärnu
- City of Tallinn

Lithuania

- Environmental Centre for Administration and Technology (ECAT)
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- City of Klaipeda

Latvia

- University of Latvia
- Riga City Council
- Infosab Ltd.

Poland

- Polish Geological Institute (PGI) Gdansk
- Voivodship Inspectorate of Environmental Protection Szczecin
- City of Gdansk
- City of Sopot
- Regional Board of Water Management in Gdansk

Germany

- TuTech Innovation GmbH
- Potsdam Institute for Climate Impact Research (PIK)
- Baltic Sea Research Institute Warnemuende (IOW)
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