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Climate Change Assessment for the Baltic Sea Basin

The Fourth Assessment Report of the Intergovernmental Panel on Climate Change [*IPCC*, 2007] has had a big impact on the public perception and acknowledgment of global climate change. However, regional climate change assessments are urgently needed to complement the big picture with regional results and scenarios of higher resolution, which local decision makers and stakeholders can use [*Visbeck*, 2008; *von Storch and Meinke*, 2008].

An outstanding example of a regional assessment is the BALTEX (Baltic Sea Experiment) Assessment of Climate Change for the Baltic Sea Basin (BACC; http://www.baltex-research.eu/BACC/), which was compiled by a consortium of 84 scientists from 13 countries around the Baltic Sea [*BACC Author Team*, 2008]. The assessment covers various disciplines related to climate research and related impacts.

The Baltic Sea is a major intracontinental shelf sea in northern Europe. Its catchment basin, covering almost 20% of the European continent, spans different climate and population zones, from a temperate, highly populated and industrialized south with intensive agriculture to a boreal and rural north. The Baltic Sea basin encompasses most of the Scandinavian peninsula in the west; most of Finland and parts of Russia, Belarus, and the Baltic states in the east; and Poland and small parts of Germany and Denmark in the south.

The region represents an old cultural landscape, and the Baltic Sea itself is among the most studied sea areas of the world. Thus, there is a wealth of information, in thousands of publications, concerning past climate conditions in the region. A large part of the information is not in English and also had not been available for western researchers, as the eastern part of the Baltic Sea basin had been behind the iron curtain until the early 1990s. The challenge was to install a writing team that could do "paper mining" in their home countries and compile the material into a comprehensive, well-written assessment book. Besides looking at past and current climate change, the BACC report presents climate projections until the year 2100 using the most sophisticated regional climate models available, and an assessment of climate change impacts on terrestrial, freshwater, and marine ecosystems of the Baltic Sea basin.

The work was organized in four chapters (past and current climate change, projections of future anthropogenic climate change, climate-related change in terrestrial and freshwater ecosystems, and climate-related marine ecosystem change); a number of annexes that provide relevant background information; and an introductory chapter that places the initiative in context, clarifies key analytical and modeling concepts, and provides a summary of the assessment. An international steering committee (chaired by BACC initiator Hans von Storch of GKSS Research Centre Geesthacht, Germany, a coauthor of this article) was responsible for the selection of lead authors, who then installed a team of contributing authors for their respective chapters. The chapter and annex manuscripts were anonymously reviewed by external experts under the independent supervision of former World Climate Research Programme director Hartmut Grassl.

Main Results of the Assessment

Air temperatures in the Baltic Sea basin already have risen over the past century (time series since 1871), increasing by approximately 1°C in the northern areas of the Baltic Sea basin and by around 0.7°C in the southern areas. Consequently, the warming in the Baltic Sea basin is slightly stronger than the global mean temperature increase of 0.75°C reported by *IPCC* [2007].

Climate scenarios for the period leading up to the year 2100 suggest that air temperatures could rise by 4°–6°C in northern areas such as Sweden, Finland, and western Russia and by 3°–5°C in southern areas such as Poland and northern Germany. Water surface temperatures in the Baltic Sea could increase by 2°–4°C. Higher water temperatures and decreased salinity would have a great impact on the Baltic Sea's flora and fauna, affecting the different organisms in the aquatic ecosystem in various ways, including creating altered growth conditions for bacteria and plankton (e.g., leading possibly to increased nuisance cyanobacterial blooms) and changed survival rates of commercially important fish species such as cod. Ecosystems on land—including managed forests—could benefit from an extended growing season, but land ecosystems may also become increasingly vulnerable to damage by insect and fungal pests as well as other stresses.

While the northern parts of the Baltic Sea are usually mostly ice covered in today's winters, a milder climate could by 2100 reduce the ice cover by 50–80%. While these conditions would be beneficial for shipping in the Baltic Sea, they would threaten populations of the Baltic ringed seal, an endemic species that is dependent on ice surfaces in order to reproduce.

Precipitation is expected to change as well, with possible increases of 20–75% during the winter season over the entire basin. During summer, the northern areas would experience a slight increase (–5% to +35%), while a strong decrease of up to 45% is expected for the southern areas. The combination of reduced summer season rainfall and increased temperatures in summer could threaten water supplies, food production, and forestry in the countries along the southern coast of the Baltic Sea. Another possibility is that increased overall precipitation and freshwater inflow, especially in the winter season, could lead to a decrease in the Baltic Sea's mean salinity and possibly also to intensified eutrophication and algal blooms.

Storm activity in the past has shown decadal-scale variability, and the regional assessment detected no recent trends toward more or less storminess. Also, the various scenarios for future wind conditions differ considerably so that no robust outlook can be given at this time, but very strong changes are unlikely.

According to *IPCC* [2007], global sea levels are expected to rise by 20–60 centimeters by the end of the century. As the Baltic Sea is connected to the world ocean, a similar sea level rise can be expected here. Still, no consensual perspectives for regional sea levels are available for the Baltic Sea. However, a postglacial local land uplift (in the north) and lowering (in the south) are well documented for the Baltic Sea basin. This means that the northern coasts will be less affected by global sea level rise, as they also rise due to postglacial land uplift, while the southern coasts may be more vulnerable to flooding in the future.

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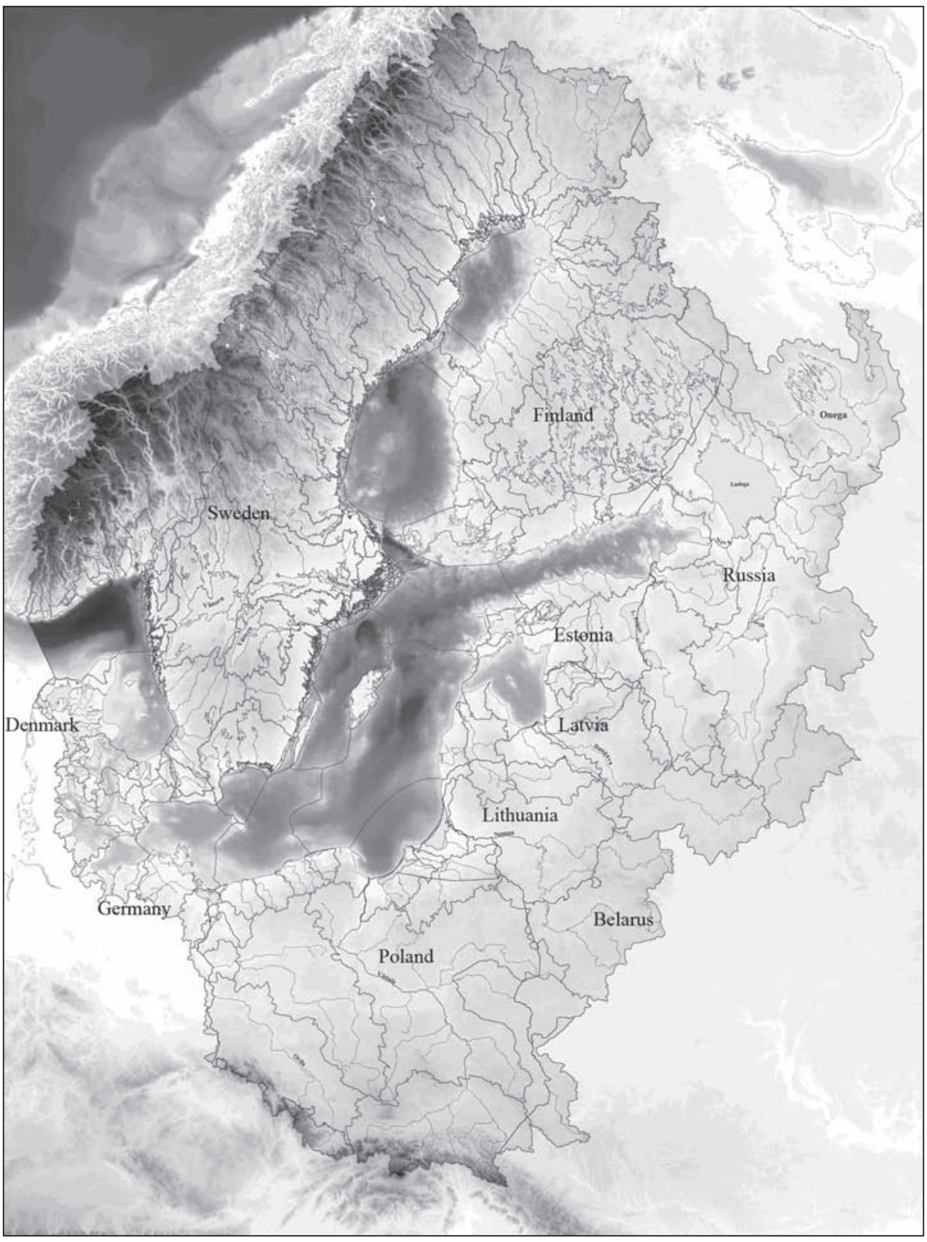

Fig. 1. The Baltic Sea basin. Courtesy of Swedish Meteorological and Hydrological Institute.

An Example for Other Regional Assessments

The BACC assessment report is unique in combining evidence about climate change and related impacts on terrestrial, freshwater, and marine ecosystems in the Baltic Sea basin. Also, stakeholder involvement is an important aspect of the report. The intergovernmental Baltic Marine Environment Protection Commission (Helsinki Commission, HELCOM; http://www.helcom.fi) used the BACC report as the basis for the HELCOM Thematic Assessment 2007 on Climate Change in the Baltic Sea Area (HELCOM Baltic Sea Environment Proceedings No. 111, 2007), which was officially adopted by representatives of Baltic Sea riparian states in March 2007.

The results of the BACC assessment process were not biased by political or economic interest groups, and the report relies exclusively on published scientific evidence. The BACC report aims to bring together consolidated knowledge that has broad consensus in the scientific community. At times, though, this consensus takes the form of "consensus on dissensus": For certain points, contrary opinions could not be resolved, as, for instance, in case of the degree of the past warming of Baltic Sea surface waters.

BACC is an ongoing project within the BALTEX program (http://www.baltex-research.eu). BALTEX is a regional hydroclimate project of the Global Energy and Water Experiment (GEWEX; http://www.gewex.org) of the World Climate Research Programme (WCRP; http://www.wmo.ch/pages/prog/wcrp/). The BACC assessment report has led to the launch of other, similar initiatives, including, for example, climate reports for the greater Hamburg area in Germany, for China's Yellow Sea, and for the Laptev Sea north of Russia. A second BACC climate report is due in 2012.

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