balt adapt

Baltic Sea Region
Climate Change Adaptation Strategy

Climate Change Impacts on River Discharge

BALTADAPT CLIMATE INFO # 11

Objectives, methods and location

Discharge of fresh water from rivers into the Baltic Sea has a profound influence on both the chemical and physical status of the water, and thereby also the ecological state in the sea. Therefore, projections of the future discharge under certain conditions are valuable tools in planning and managing adaptation measures in the Baltic Sea Region.

The river discharge data cover all major river basins and aggregations of the small coastal basins around the Baltic Sea. These data have been modelled with Balt-HYPE which is an application of the HYPE (HYdrological Predictions for the Environment) model for the entire Baltic Sea runoff basin. Calculations are made in sub basins with a median size of 350 km^2. Regulation of reservoirs within the model domain has not been simulated by this model, so the discharge data delivered represents the flow as if the reservoir had a natural spillway.

The data used for running the model, such as temperature, precipitation, topography, land use, soil characteristics etc. were taken from publically and readily available data bases. To calculate future climate data, several of IPCC's future emission scenarios were used. These were combined with a number of scenarios on demographic changes, land use management and technological progress in waste water treatment and agricultural changes to calculate river discharge up to year 2100.

The Torne river discharges into the Baltic Sea at the northernmost part of the Gulf of Bothnia.

Part-financed by the European Union
(European Regional Development Fund)

Baltic Sea Region
Programme 2007–2013

BSSS-BALTIC 21 LIGHTHOUSE PROJECT

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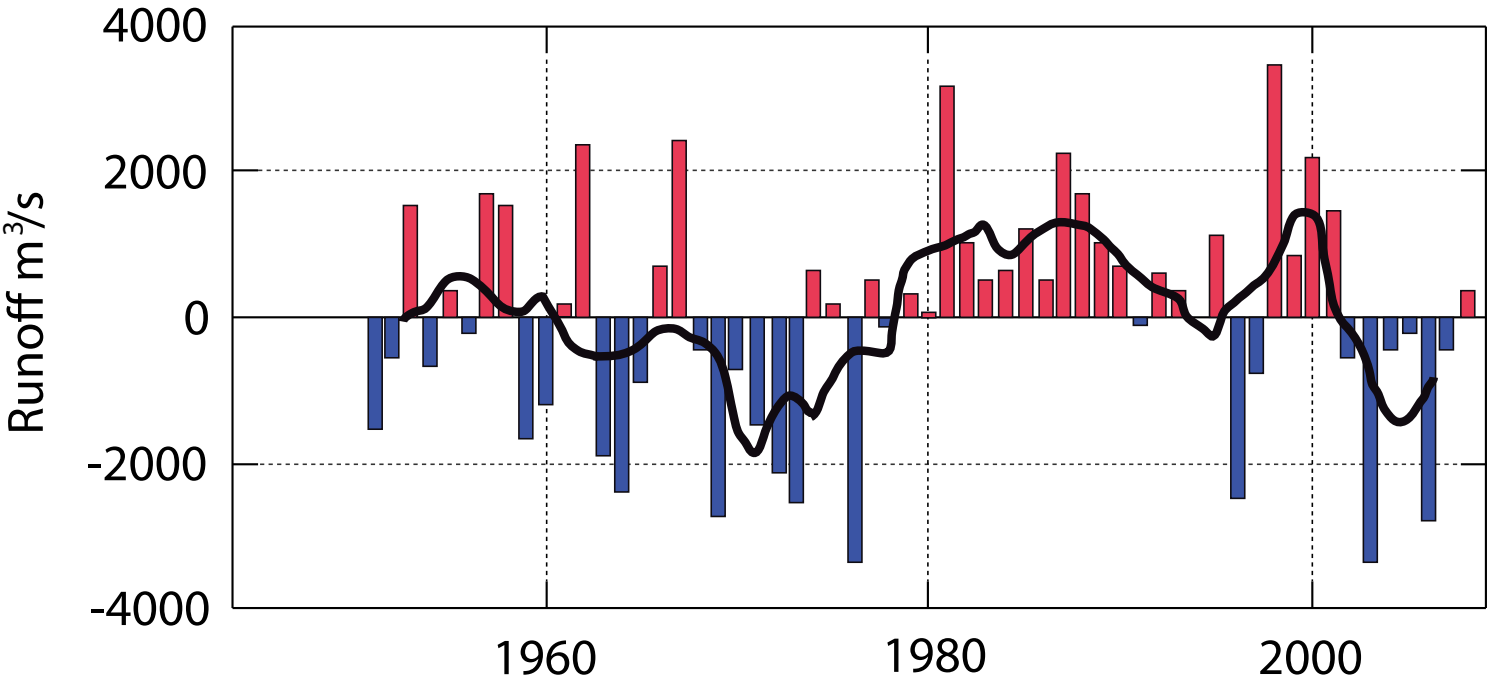
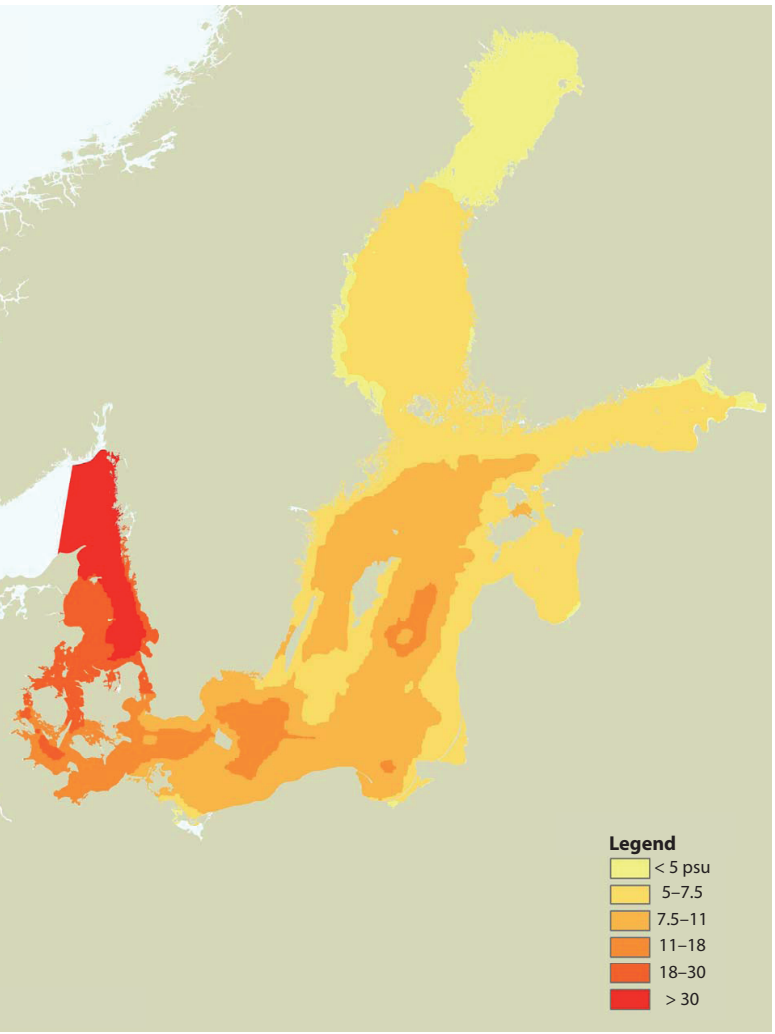


Figure 1: *Total discharge deviation during 1950 to 2008 to the Baltic Sea with bars displaying the year to year deviation from the average for this period. The black line is the running mean over 5 years. (Adapted from helcom.fi)*



Current situation

The average annual discharge to the Baltic Sea for the period 1921–1998 has been estimated to be 14 119 m^3/s or 445 km^3/year. The changes from year to year are however large; the wettest year, 1924, had an average annual discharge of 18 167 m^3/s and the driest, 1976, 10 553 m^3/s. It should be noted that no statistically significant trend can be found when analysing these time series.

Climate change impacts

There is a risk that increase in future river discharge to the Baltic Sea will dilute the slightly salty, brackish water. In the Baltic Sea the open surface waters of the central basin have salinity of 6 to 8 ‰ and at depths 40 to 70 m 10 and 15 ‰. Where the major freshwater inflows are situated, such as at the head of Finnish Gulf with the mouth of Neva and the Bothnian gulf where Lule, Tornio and Kemi rivers end, the salinity is much lower and it is higher near the Danish Straits, see Figure 2.

The salinity in the water means specific conditions for life in the Baltic Sea and many ecosystems and habitats that have evolved in the Baltic Sea would not survive a dramatic change in salinity. Also

Figure 2: *Modelled current salinity at the bottom of the Baltic Sea. From Zyad Al-Hamdani and Johnny Reker (eds.). 2007. Towards marine landscapes in Zyad Al-Hamdani and Johnny Reker (eds.). 2007. Towards marine landscapes in the Baltic Sea. BALANCE interim report #10.*
Available at http://balance-eu.org/

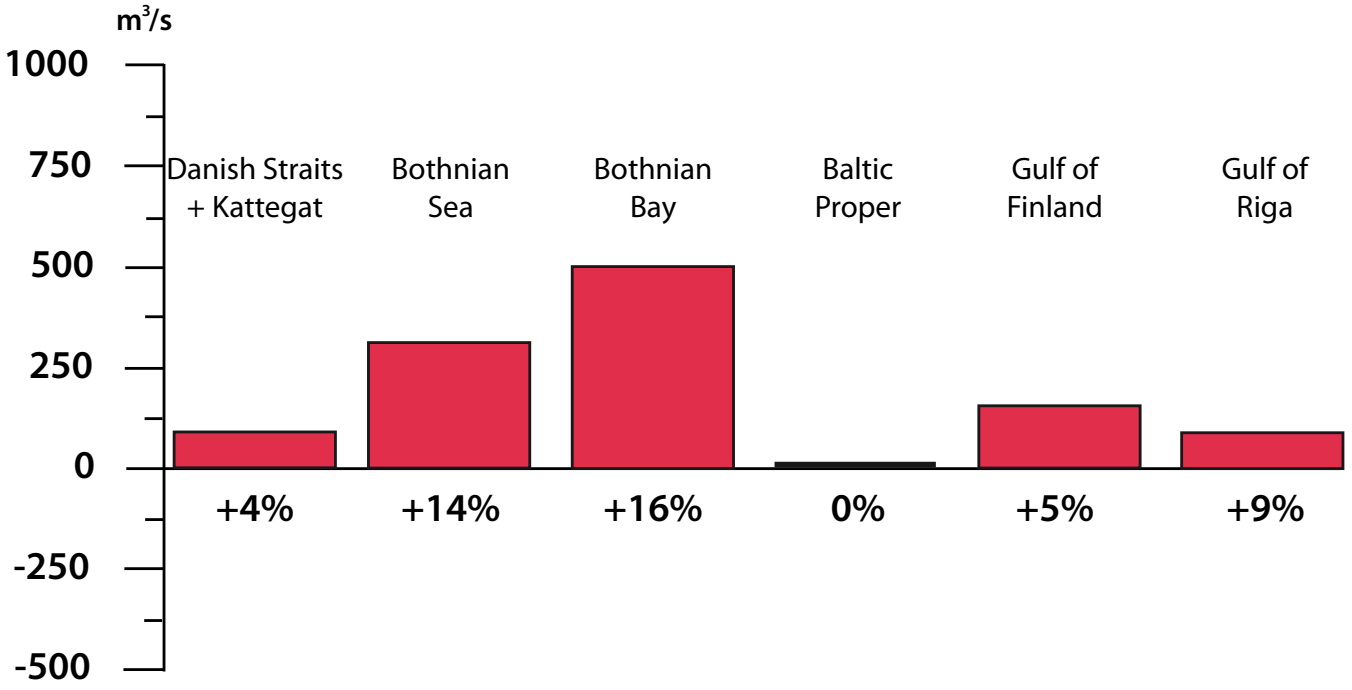


Figure 3: *Annual mean discharge changes in a future climate calculated by the hydrological model HYPE. The values show a mean of different climate scenarios calculated by different climate models up to the year 2100.*

the physical characteristics of the water change with salinity. In some cases this can lead to changed layering of the water and thus the conditions for mixing surface water with deep sea water. This in turn can lead to e. g. dead bottoms due to oxygen deficiency.

If both the amount of discharged water and the temperature of it changes water temperature in the sea could change on more local scale, such as areas around river mouths. Such a change could have an impact, both ecologically and physically.

To predict future river discharge is a complicated process with a lot of uncertainties attached to it. Climate change, changed water management and water consumption patterns etc. should be taken into account, which has been done to the best of knowledge in the hydrological modelling within Baltadapt. Despite that several studies have been carried out to estimate future river discharge applying the different emission scenarios from the Intergovernmental Panel on Climate Change (IPCC) in different model set ups. A synthesis of these studies shows that, over the whole basin, the summer season discharge could drop by 22 % while the winter season discharge could increase as much as 54 % in the year 2100.

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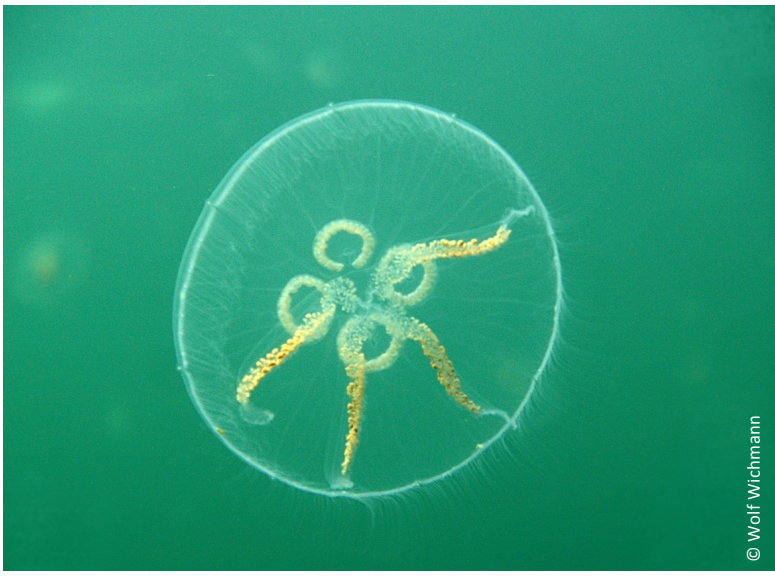
Conclusion

Most research points in the direction of a changed river discharge to the Baltic Sea in the future. The seasonal variations will be more pronounced than the annual average values. This means that we probably will have more discharge in the winter seasons compared to the current situation, but less in summers.

The discharge influences the salinity, the concentration of salt, in the sea water. Many of the ecosystems in the Baltic Sea are adapted to the salinity range in which they have evolved and cannot survive too large deviations from this. On a local scale changed river discharge and also changed water temperature can have an impact on ecosystems and physical characteristics of the water.



Changed river discharge can have an impact on the Baltic Sea's ecosystems.

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Editing and layout:
Project Coordination Office
s.Pro – sustainable projects GmbH
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1st edition – October 2011

The Baltadapt project in a nutshell

The Baltic Sea and its coastlines face challenges due to climate change …
Climate change will influence precipitation amounts and patterns, and lead to an increase in terrestrial and sea temperatures and a rise in sea level. The resulting changes will jeopardize the integrity of the ecosystem and increase risks caused by natural disasters.

… it is time to adapt now!
Adaptation strategies are needed to cope with the inevitable consequences of climate change. This is also highlighted in the EU Baltic Sea Region Strategy. Baltadapt is developing a transnational climate change adaptation strategy for the Baltic Sea Region, which focuses on the sea and the coastline.
Baltadapt can't stop climate change but it will help to adapt to its impacts. The project facilitates a knowledge-brokerage process on climate change adaptation between research and policy, thus contributing to improved institutional capacity. This will help decision makers in the Baltic Sea Region to tackle the consequences of climate change.
The project was approved under the Baltic Sea Region Programme 2007–2013 and has a total budget of € 2.86 m. Its partner consortium is led by the Danish Meteorological Institute. Baltadapt is a flagship project under the EU Strategy for the Baltic Sea Region and has been awarded the Baltic 21 Lighthouse Project quality label.

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