balt adapt

Baltic Sea Region
Climate Change Adaptation Strategy

Climate Change in the Baltic Sea Region: Wind Waves

BALTADAPT CLIMATE INFO # 10

Waves under a changing climate

The Baltic Sea is nearly a closed basin, therefore its wave climate is controlled primarily by the local wind and is not strongly influenced by waves in the North Atlantic. Following variations in the large-scale atmospheric circulation in the past decades, both the wind speed and wind direction over the Baltic Sea have been changing (Lehmann et al, 2011).

The largest changes are to be expected in the extreme values in wind speed and wave height. The number of extremely high wind speed events and following storms is increasing in Northern Europe (Weisse & Günther, 2007). This will have impacts not only for ship routes and fisheries in the Baltic Sea Region but will also result in damages to the coastal line, causing erosion.

Wave climate model simulations

Long-term model simulations of the waves conditions allow us to follow pronounced tendencies in the wind and waves conditions over the Baltic Sea. We applied the wave model WAM (The WAMDI Group, 1988) to the Baltic Sea for the period from 1960 to 2002. WAM was forced by wind from a high-resolution regional atmospheric model (HIRHAM). First, we analysed the wind conditions over that period focusing on maximum wind speed.

Annual maximum wind speed increased from 15.7 m/s in 1960 to 20.2 m/s in 2002 (Figure 1, green area and red line). There was also an increase in the mean wind speed from 6.4 m/s in 1960 to 7.1 m/s in 2002 (Figure 1, orange line).

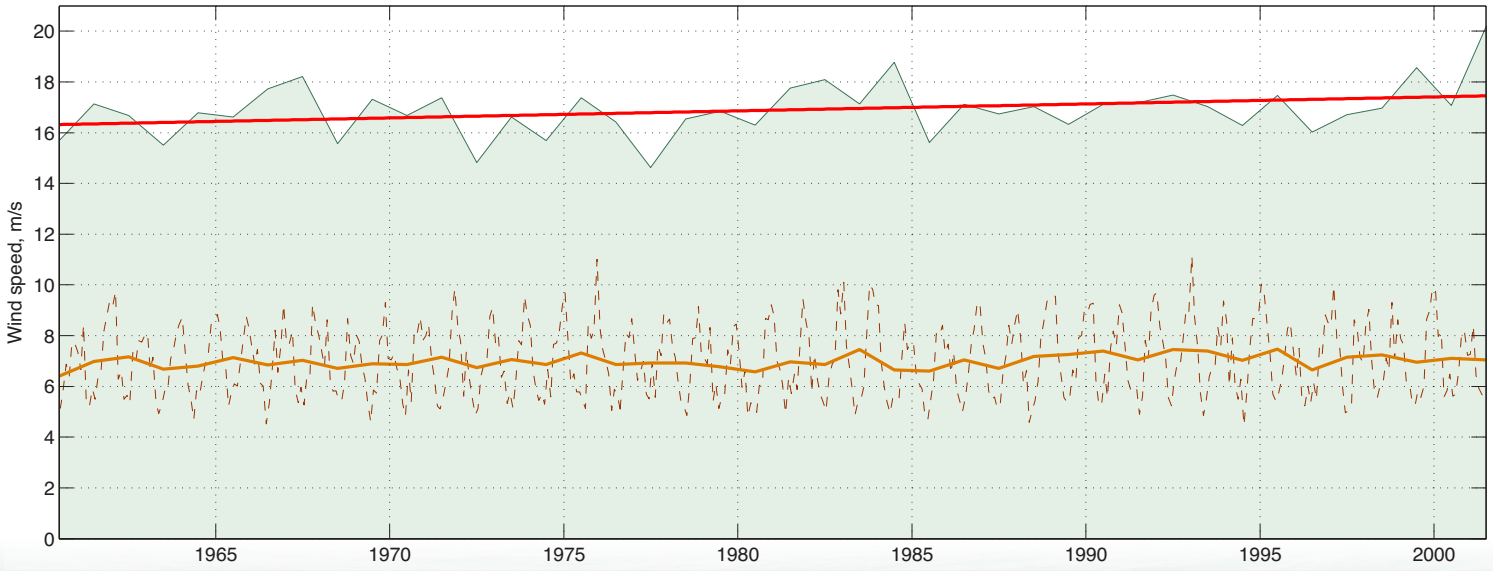

Figure 1: *Mean annual (orange solid line) and maximum (green area) wind speed (m/s) over the Baltic Sea and its monthly variations (orange dashed line). The red line represents the linear estimation of maximum wind speed.*

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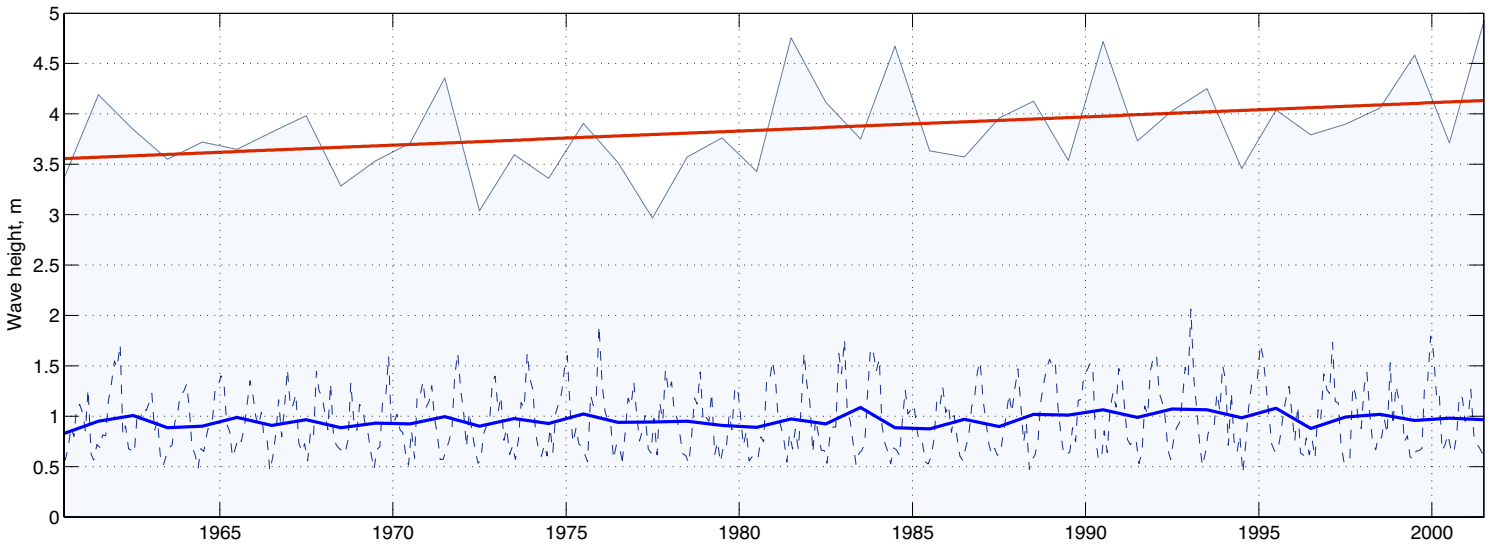

Figure 2: *Mean annual (blue solid line) and maximum (blue area) wave height (m) in the Baltic Sea and its monthly variations (blue dashed line). The red line represents the linear estimation of maximum wave height.*

In line with the increase in wind speed, the annual maximum wave height grew from 3.35 m in 1960 to 4.92 m in 2002 (Figure 2, blue area and red line). The annual mean wave height increased insignificantly during that period from 0.82 m to 0.96 m (Figure 2, blue line).

To quantify the number of extreme events, we compared the anomalies of hourly wave heights to their double standard deviation (2STD). We define extreme events as those anomalies exceeding 2STD and the frequency in percent of time. For the modeled period, the frequency of extreme events increased from 2.23 % of time to 5.41 % (Figure 3, green line).

The impact of waves on the seabed and the coastal line is directly related to the frequency and intensity of extreme events. As an indicator of wave impact on the coastal line, we calculated the shear stress produced by waves as a major factor causing erosion of the seabed in the shallow areas and on the coastal line. Comparing shear stress velocity to a threshold value for erosion (Dobrynin et al, 2010) in the shallow areas of the Baltic Sea where the depth is less that 20 m, we calculated the part of the model domain where erosion occurs (Figure 4, green and red line). The shallow part of the Baltic Sea affected by erosion was 1.52 % in 1960 and 1.85 % in 2002. The local effects of erosion in the different parts of the Baltic Sea should be studied in detail.

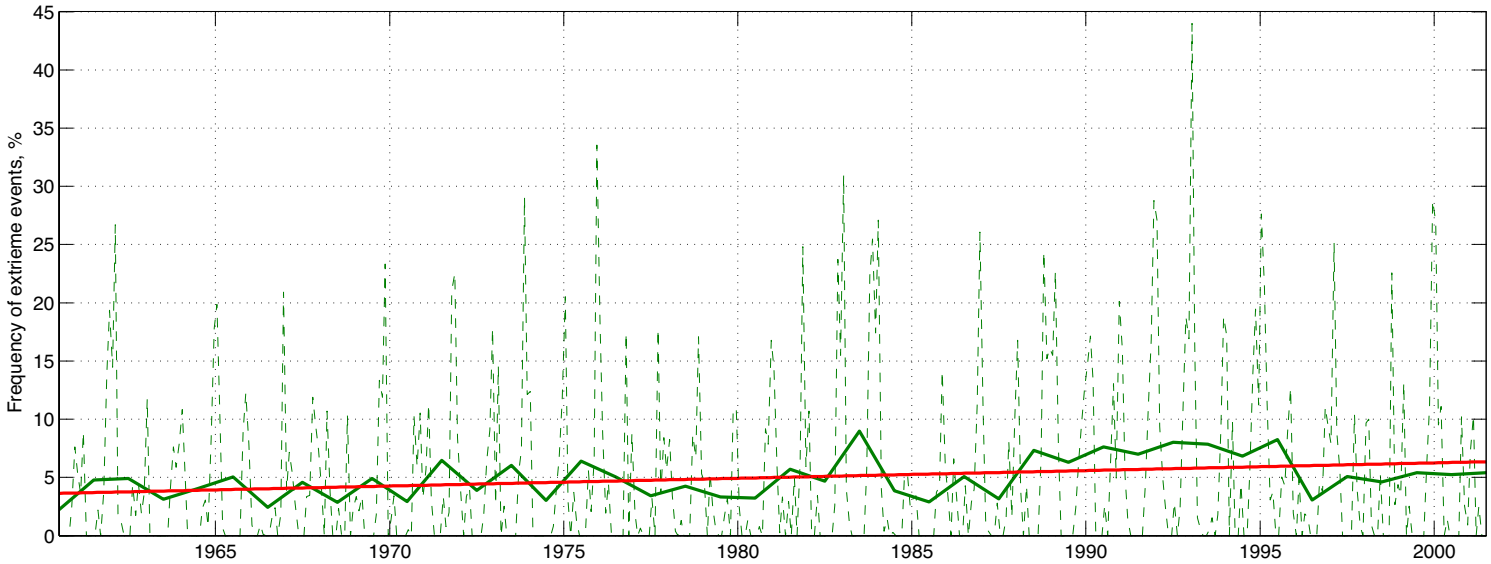

Figure 3: *Mean annual frequency of extreme events (% of time) (green solid line) and monthly variations (green dash line). The red line represents the linear estimation of mean annual frequencies.*

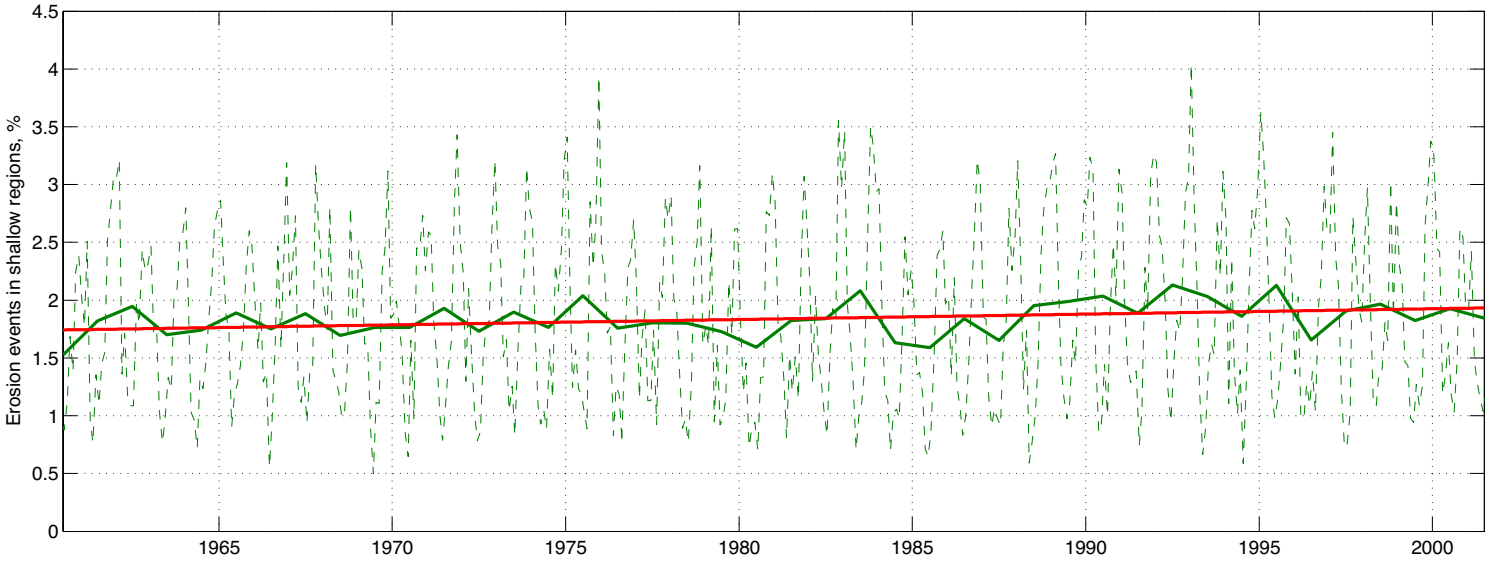

Figure 4: *Mean annual erosion coverage (%) (green solid line) and its monthly variations (green dash line) in the shallow part of the model domain (depth <20m). The red line represents linear estimation of the mean annual coverage.*

Outlook

The wave climate in the Baltic Sea is changing as a result of large-scale atmospheric circulation. Model simulations in the Baltic Sea show an increase in maximal wind speed and frequency of extreme events.

Following these changes in wind conditions, the wave height and frequency of highest waves is also increasing. As a consequence, the number of erosion events in the shallow areas is increasing as well. Additional studies are needed to understand the local effects of changes in wave conditions in the Baltic Sea now and in the future.

Time to adapt to a changing climate: Wind speeds and wave heights are expected to rise in the Baltic Sea Region.

References

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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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