Spatial extreme value analyses for Schleswig-Holsteins coastline and Islands

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Rising sea levels along with changes in storminess and their impact on the likelihood of coastal flooding around the world are among the most debated issues of our time. A feature that is mainly due to the fact, that the occurrence of these events and the reliability of environmental datasets are highly uncertain. To efficiently plan and design coastal defence structures, an in-depth understanding of the stochastic behaviour of extreme events is required. Over the last decades, several approaches for estimating probabilities of extreme still water levels have been developed. Applying different statistical methods can yield different estimates of return water levels and even the use of the same model can produce huge discrepancies, caused by a subjective choice of the model setup. Here, the most common direct methods for estimating probabilities of extreme still water levels are tested for sensitivity against the chosen model setup. The results for the German Bight highlight, that the peaks over threshold method yields more reliable and more stable estimates of probabilities of extreme still water levels than the block maxima method. However, using peaks over threshold methods most often raises the question: which threshold should be used? In analysing a variety of threshold selection methods it is highlighted that the use of the 99.7th percentile leads to the most stable return water level estimates along the German North Sea coastline. Furthermore it is important to use a time series of tidal high waters of an appropriate length. In terms of the German Bight, it is shown that this is a time series starting in 1976 or earlier.

As no sufficient long records exist in the study area, a numerical tide-surge model hindcast of the entire North Sea was performed to overcome this data shortage. The model was run for the period from 1970 to 2009 to fulfil the criteria of using time series starting in 1976 or earlier. The coastline was redistributed to a mean distance of 1000 m between consecutive nodes. At each node along the coastline, water levels were extracted and probabilities of extreme still water levels were calculated. In Figure 1, return water level estimates for the one in a 1000 years event (exceedance probability PE = 0.001) are presented. The figure shows return water levels occurring in southern regions to be higher than in the northern parts of Schleswig-Holstein. In the area of the Halligen, return water levels increase in easterly directions, which is mainly a result of shallow water effects leading to tidal amplifications.



Figure 1. Left: North Sea, the blue rectangle shows the coastline of Schleswig-Holstein. Right: 1000-year return water levels along the entire coastline of Schleswig-Holstein.