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The Risk and Calculation of Extreme Storm Surges due to Climate Change

K. Sossidi, G. Gönnert, B. Gerkensmeier, and Th. Buß

Free and Hanseatic City of Hamburg, Agency of Roads, Bridges, and Waters, Hamburg, Germany
(Kristina.Sossidi@LSBG.Hamburg.de, fax +49 40 427949 164)

The North Sea coast is seriously threatened by storm surges. Climate change and resulting consequences as sea level rise and possible intensification of storm surges will have serious effects on the safety of people and economic values in coastal areas. The uncertainties of climate change necessitate new concepts of coastal protection.

The Project XtremRisK – Extreme Storm Surges at the North Sea Coast and in Estuaries, Risk Calculation and Risk Strategies, funded by the German Federal Government, will assist in facing this challenge. The „Source-Pathway-Receptor"-Concept will be used as a basis for risk analysis and development of new strategies. The project results will be exemplarily applied and further developed at two pilot sites, the island of Sylt and the city of Hamburg.

The objective of this paper is to determine the relevant extreme events. Within the XtremRisK project, methods will be developed to assess the extreme events under the conditions of today. Starting from there, extreme events will be assessed using conditions which reflect the climate change scenarios. The presentation will give an overview about methods and results of the calculated extreme events.

A couple of methods to calculate an extreme storm surge exist, which are often statistical methods. Here, a method will be used which takes the physics of storm surges into account. With this method, the three components of a storm surge, tide, wind surge and external surge, will be analysed and their development over the last 100 years will be assessed.

The paper focuses on analysing (i) the highest event of each component and (ii) the interaction between tide and surge and the interaction between surge and external surge. This detailed analysis is needed because the components do not interact linearly. The non-linear interaction between the components require the consideration of the hydrodynamics. With this knowledge, an extreme event based on the maximum components can be calculated. Investigation on the hydrodynamics and physics of storm surges show that the components have to be added non-linearly, which leads to a lower water level than in case of linear superposition. With this, a realistic extreme event under present climate conditions can be calculated.

A long consistent time series of water levels is very important for the characterisation of storm surges. Consequently the extreme storm surge for the city of Hamburg will be determined at tidal gauge Cuxhaven and its propagation upstream to Hamburg subsequently calculated by numerical modeling. The storm surge for Sylt will be determined at the tidal gauge Hörnum.

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