



Effects of climate change on storm surges in the Elbe Estuary – A sensitivity study

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Due to changing climatic conditions several parameters influencing water levels during storm surges along the German Bight are expected to change. Also the Elbe estuary including the waterway from the North Sea to the second largest container harbour of Europe, the congested area of Hamburg, and valuable tidal flats may be affected. In order to develop adequate adaptation strategies for flood protection, shipping infrastructure and environment, a detailed understanding of the present hydrodynamic situation along the waterway as well as the analysis of future situations under the influence of climate change is required.

The study presents a concept for investigating possible changes of water levels during storm surges under the influence of a changing climate. Additionally, the presented method enables the analysis of various scenarios so that shortcomings in input data and modelling techniques can be covered. The investigation is embedded in the scientific joint venture programmes KLIWAS and KLIMZUG-Nord.

Generally speaking, the development and intensity of a storm surge in the Elbe estuary is determined by the water level at the boundary to the North Sea, the river runoff into the estuary and the wind field over the estuary. A hydrodynamical numerical model (UNTRIM, V. Casulli and R. A. Walters (2000)) is used to calculate water levels and currents in the Elbe while a meteorological model (MKW, H. Schmidt and J. Paetsch (1992)) provides the local wind field over the Elbe. Two historical storm surges with different characteristics are the basis of the sensitivity study:

- the storm surge of January 3rd 1976 which caused the highest observed water levels along the Elbe estuary, and
- the storm surge of January 28th 1994 which had a high fresh water discharge.

Using historical storm surges as reference, probable future storm surge scenarios are simulated and analysed by systematic variation of the key parameters mentioned above according to the current knowledge about expected changes in a future climate. Thus, the influences of

- sea level changes in the North Sea,
 - increase / decrease of river runoff into the estuary, and
 - increase / decrease of the local wind over the estuary
- on the highest water level along the Elbe estuary during storm surge are analysed and revealed.

The aim of this investigation is to gain understanding of the probable changes of water levels during storm surges along the Elbe estuary depending on parameters that might change in a future climate. The results may help to identify exposed areas and vulnerabilities of e.g. the shore protection along the Elbe estuary and give us a chance to work on adaptation and risk mitigation necessitated under possible climate change.

References:

- Casulli, V. and Walters, R. A. (2000). An unstructured, three dimensional model based on the shallow water equations. *International Journal for Numerical Methods in Fluids*, 32, S.331 - 348.
- Schmidt, H. and Paetsch, J. (1992). Meteorologische Messungen auf Norderney und Modellrechnungen. *Die Kueste*, 54, S. 131 - 142.