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Estimating the consequences of a high impact event at the Ems estuary, Germany

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Storm induced water level elevations (i.e. surge) superimposing on high tides are among the most severe natural hazards along the German North Sea coast. Extreme water levels of several meters have been observed over the last centuries but different research studies already suggest that these events have not yet been the worst physically possible combinations of tide and surge in this region. In the ongoing research project EXTREMENESS*, we investigate the effect of different meteorological and astronomical conditions and how they could amplify water levels under predictable but yet unobserved combinations. As a case study, we focus on the Ems estuary and the region around the city of Emden, Germany with a resulting water level amplification of 140 cm under present-day sea level conditions. This scenario can be roughly rated as a 1,400-year return period event for the harbor of Emden.

In order to estimate potential consequences, we use the extreme storm surge scenario as well as an observed reference storm surge of 2006 (i.e. the event with the largest water levels on record in our study region) as inputs of a two-dimensional hydrodynamic-numerical model. We assume a failure of coastal protection structures at different locations and simulate the resulting flooding for both the scenario and the reference. An assessment of flood consequences is then conducted at each assumed failure location. We finally compare these flood consequences to evaluate the increase in damage potential associated with the extreme but physically possible water level amplification.

The comparison with our reference event yields a simple but comprehensible description of the extreme scenario in addition to the rather theoretical, statistically based estimate as a "1,400-year event". The results also highlight most vulnerable sections of coastal protection in case of a failure during a storm surge. In a next step we aim at integrating critical infrastructures in our flood assessment to also include potentially affected regions outside of the flood prone areas. This will allow an estimation of totally affected people and assist local authorities by providing an overview of relevant infrastructure linkages. Furthermore our results are intended to increase disaster awareness and preparedness in regions which are not directly vulnerable to flooding but to consequences of critical infrastructure failures including cascading effects.

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