Development of a Storm Surge Risk Index for the German Bight

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Widespread destruction and even loss of life were the devastating consequences of extreme storm surges in the German Bight, driven by strong north-westerly winds from intense extratropical cyclones. The consequent rise in sea levels poses threats like flooding, erosion and considerable infrastructure damage. Therefore, assessing storm surge risk is vital for ensuring public safety and preserving regional infrastructure.

A simple model is needed if future storm surge risk are to be assessed using climate projections. This model should be applicable to a multi-model ensemble of climate simulations with only limited variables available and rather coarse spatial resolution. However, most existing surge models are comparably complex and require numerous input variables for specific locations or regions. Therefore, they have been employed solely based on reanalysis. To fill this gap, we set up a statistical model using a multiple linear regression approach based only on the zonal and meridional component of the wind as predictors. In order to reduce model complexity and improve prediction accuracy, we apply regularization methods such as ridge, lasso and elastic net regression. We train the model using the skew surge, the difference between the observed and predicted high water within a tidal cycle, for the period 1959 – 2021. We evaluate the performance of the model in two ways: (1) the reconstruction of the skew surge over the entire period using cross-validation methods and (2) a classification evaluation using a contingency table and the F1 score. In a final step, we test the model based on reanalysis data.