ON THE INFLUENCE OF STORM PARAMETERS ON EXTREME SURGE EVENTS AT THE DUTCH COAST

A storm surge is the rise in water level due to a storm. Storm surges are a threat for low lying areas near coasts. In the Netherlands, storm surges are input for design conditions of coastal protection. The allowed change of failure per year is incorporated into law. For the densely populated Randstad region, represented by a measurement station by Hoek van Holland, this chance is $1 \cdot 10^{-4}$ year^{-1}. Associated water levels are determined by extrapolation of measurements. This method entails large uncertainty. A result of the currently used approach is lack of insight into the coupling between the storm and the storm surge. Next, little is known about the duration and course of extreme surges. These data are important for dune and dike design.

This thesis focuses on the properties of storms causing extreme surges at Hoek van Holland, by modelling surges with an idealized coupled meteorological-hydrodynamical model. Six storm characteristics (storm parameters) are used as model input. The meteorological part of the model is an analytical parametrical model, based on the Holland model. The hydrodynamical model is forced by the meteorological model and numerically solves the nonlinear depth-averaged shallow water equations in a one-dimensional domain. The model domain is a one-dimensional transect from the edge of the continental shelf between Scotland and Norway to Hoek van Holland. Output is given in water levels at Hoek van Holland.

The meteorological model is validated with rather good results, but some outliers are indicated. The coupled model is calibrated using data of 21 historical storms. Results of the calibrated model are good when focusing on peak surge levels. The surge duration however is underestimated but the model. Probability distributions for the six storm parameters, based on an earlier analysis of historical data, are used as input for Monte Carlo analysis. Return periods for each modelled surge are determined using the methodology of Gringorten.

The computed surge level (including tide) with a statistical return period of 10,000 years is 6 m, compared to 5.10 m according to the design conditions. For low return periods, calculated surges exceed observed surges (Figure 1). The average duration of computed surges with a return period of 10,000 year is more or less two hours larger than the design conditions (Figure 2). The storms causing extreme surges differ from average storms in a high radius to maximum winds and large atmospheric pressure gradients, represented by a pressure shape factor. To a lesser extent, these storms have lower central pressures and move more slowly than average storms.

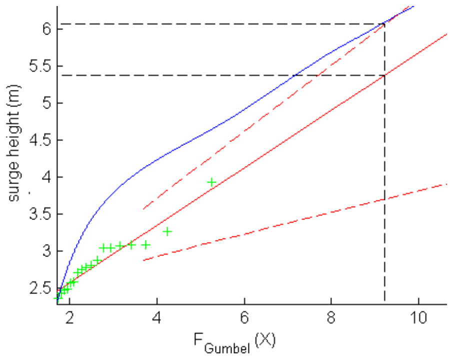

Figure 1: Gumbel plot of $1 \cdot 10^{-4}$ year^{-1} surges. Surge levels based on model output are denoted in blue and based on extrapolation of measurements in red.

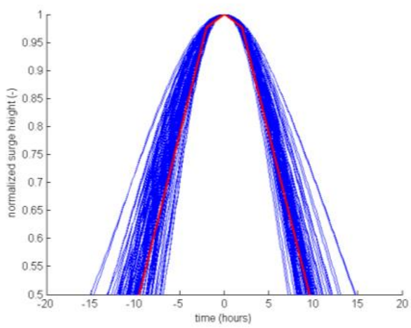

Figure 2: The courses of 100 normalized modeled surges are presented in blue. The surge course according to the hydraulic boundary conditions is shown in red. Only water levels above 0.5 are shown.

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