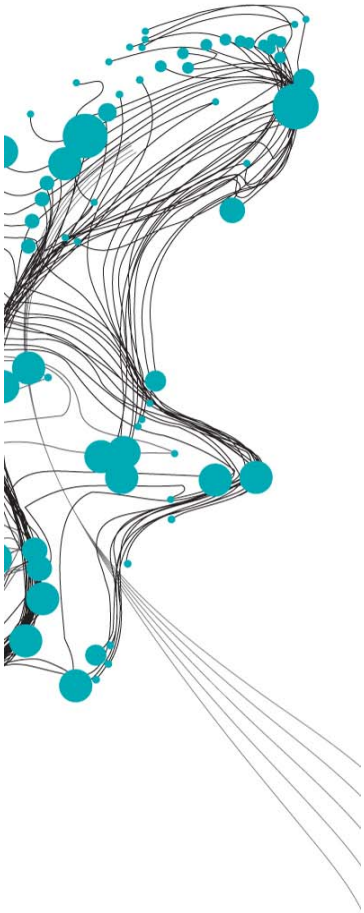
Including the effect of Non Water retaining Objects in the probabilistic modelling of dune safety



An important function of dunes in the Netherlands is to protect the hinterland against flooding. The land behind the dunes is the most densely populated and economically valuable area of the country. Therefore, dune safety is extremely important for the country. The safety of dunes as flood protection is tested every twelve years. The statutory safety assessment model DUROS+ is based on a sand balance with many simplifying assumptions.

One of the assumptions in DUROS+ is that hard elements are absent, which is not valid at many locations along the Dutch coast. When these hard elements have no water retaining function, these elements are called 'Non Water retraining Objects (Abbreviated as NWO)'. An example of a NWO is the Palace hotel in Zandvoort (figure 1.1). The presence of NWO's in dunes affect the sediment availability from the dunes. This is because a soft erodible part of the dune is replaced with a hard non-erodible part.

1.1 Example of a NWO in a dune: The Palace Hotel in Zandvoort

The current statutory safety assessment model is a semi-probabilistic model, which means that the actual safety test is performed with a deterministic model, but the hydraulic input parameters are based on probabilistic calculations. The impact of NWO's on dune erosion is not taken into account in these probabilistic calculations.

Both a semi-probabilistic and a probabilistic dune erosion model were developed to analyze how the impact of NWO's on dune erosion affect the assessment of dune safety. The probabilistic model was also used to analyze whether the determination of the hydraulic boundary conditions – needed as input for the safety assessment with the semi-probabilistic model – was significantly influenced by the incorporation of NWO's in the probabilistic calculations.

The probabilistic model is a combination between DUROS+ and the First Order Reliability Method, because this probabilistic method is very efficient for very low failure probabilities. However, this method was not always applicable. When this method was not applicable, Monte Carlo with Importance Sampling was a good alternative.

The main difference between the semi-probabilistic and the probabilistic dune erosion calculations is that the semi-probabilistic model overestimates the cross-shore location of the erosion point with a 10^{-5} failure probability compared to the probabilistic model results. Another difference is that the probabilistic dune erosion model provides insight in differences in dune failure probabilities across the dune while the semi-probabilistic model only shows the binary failure/non failure as result.

The values of the hydraulic boundary conditions determined by the probabilistic dune erosion model with the NWO's incorporated, did not significantly deviate from the values that were determined without the NWO's. Therefore, the semi-probabilistic model can still use the existing hydraulic boundary conditions to test dune safety. However, when the dune is 'just safe' or 'just unsafe' a more accurate calculation is required. The probabilistic model should be used in these cases for a more accurate calculation and to provide insight in failure probabilities.

Thijs Raaben

Graduation Date:
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Graduation committee:
University of Twente
dr. ir. J.S. Ribberink
dr. K.M. Wijnberg

Deltares
dr. ir. M.Boers
ir. J.P. den Bieman

UNIVERSITY OF TWENTE.