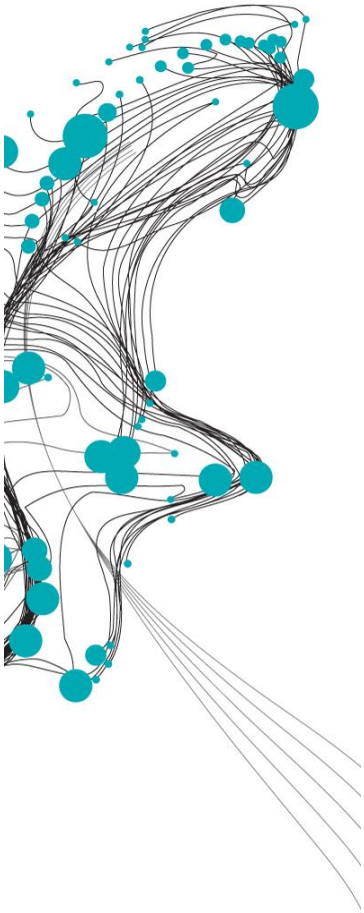

MODELLING THE MORPHODYNAMIC IMPACT AND THE EFFECT ON SIGNIFICANT WAVE HEIGHT DUE TO SAND EXTRACTIONS.

A MODEL STUDY FOR THE HOLLAND COAST AREA

Sand extractions are performed in the Dutch part of the North Sea in order to be able to maintain the coastal safety level of the Netherlands by means of sand nourishments. The pit that is left behind after an extraction is referred to as a sand pit. Due to the decrease of available sand and possible cost reductions, Rijkswaterstaat is interested in the effects of new sand extraction strategies, i.e. larger extractions in terms of depth as well as extractions closer to the shore than current regulation allows.

For the morphodynamic impact we built a process-based idealized sand pit model in MatLab, which is based on a previous sand pit model and considers the pit as a local perturbation of an otherwise flat seabed of uniform depth. We use the sand pit model for tidal flow, sediment transport and bed evolution. The effects are presented in terms of area of morphodynamic influence, pit deepening, morphodynamic radius of influence and pit migration. An example of pit evolution is presented in Fig. 1.

For the impact on the significant wave height we use the Delft3D-WAVE model with storm conditions of different recurrence periods (100, 1,000, and 10,000 years). Using a schematized seabed profile of the Holland coast as reference situation, we determine the change of the significant wave height due to a sand pit (see Fig. 2).

A sensitivity analysis for both models is carried out to analyse the effects of different pit geometries and pit locations on the model results.

From the model results in Fig. 1, we can see that sand pits trigger the formation of tidal sandbanks. It can be seen from Fig. 2 that refraction occurs near the sand pit, but that the effect is small in other areas.
In conclusion, according to this study the morphodynamic impact after 50 years is small as well as the change in significant wave height for deeper sand pits and pits closer to the shore.

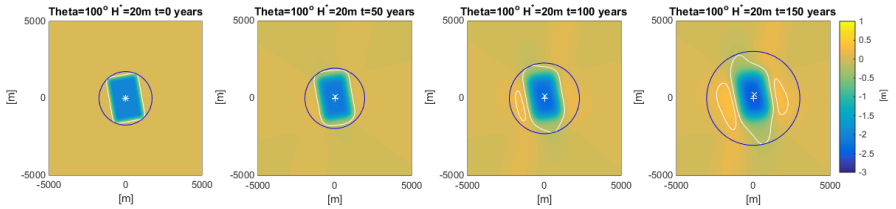

Figure 1: Evolution of the sand pit in time for a water depth of 20 m and initial pit depth of 2 m, orientation of 100° (c.c.w. w.r.t. east) Pit volume of 10 Mm³, and length to-width ratio of 1.5. The centre of the initial sand pit is marked with a plus sign (+). The pit's centre of 'mass' is marked with a cross sign (x). The white contour lines indicate the area of morphodynamic influence, and the blue circle indicated the radius of influence.

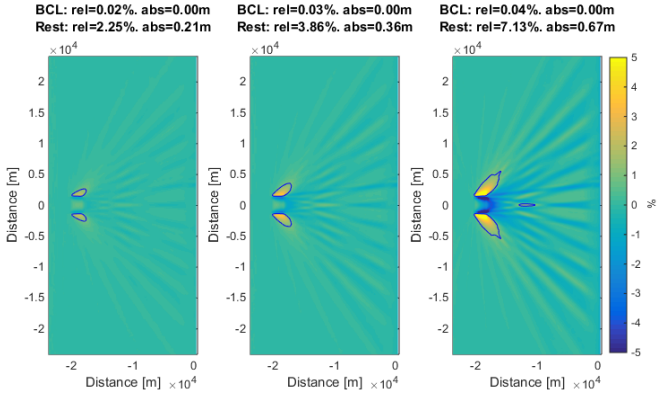

Figure 2: Relative change in significant wave height for a 1:10,000 year storm. The pit is positioned at -20 m NAP depth and has a volume of 10 Mm³, 20 Mm³, and 50 Mm³ (from left to right) with pit depths of 2 m, 4 m, and 10 m respectively. The blue contour lines indicate the 1% increase in significant wave height due to the sand pit. The x-direction is the cross shore direction with the coast on the right side and the y-direction is the alongshore direction. The BCL zone is the nearshore zone between -5 m NAP and +3 m NAP.

Benno Fakkert

Graduation Date:
8 January 2016

Graduation committee:
University of Twente
Prof. dr. S.J.M.H. Hulscher
Dr. ir. B.W. Borsje
Dr. ir. P.C. Roos

Rijkswaterstaat
R. Hoogland, MSc

UNIVERSITY OF TWENTE.