UNDERSTANDING THE MORPHOLOGICAL IMPACT OF THE OESTERDAM NOURISHMENT

The construction of the storm surge barrier in 1986 has led to a strong decrease of flow velocities and in sediment transport in the Dutch Eastern Scheldt basin, while the magnitude of locally-generated erosive wind waves has not changed. Therefore, the intertidal areas in the basin receive less sediment and experience net erosion, see Figure 1. Intertidal areas damp waves and erosion of those areas leads to reduction of coastal safety, as the wave attack on the dams in the basin increases. The height of the tidal flat near the Oesterdam has decreased by 25 to 50 cm since 1986. A nourishment, placed in front of the dam in November 2013, should mitigate erosion of the flat and extend the life span of the dam and surrounding levees with 25 to 30 years.

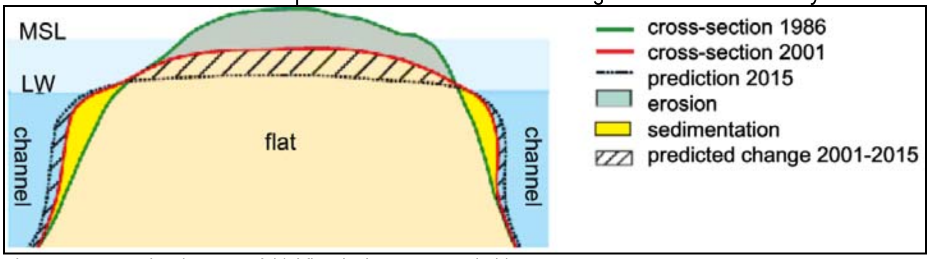

Figure 1: Present development of tidal flats in the Eastern Scheldt.

The effect of the nourishment on currents and waves is poorly understood and it is not clear which processes drive sediment transport. Data retrieved during a monitoring campaign are used in the present work to set-up a numerical model (Delft3D) in depth-averaged mode that is able to simulate the evolution of the nourishment. Wave behaviour is simulated using the SWAN-model. The goal is to identify the mechanisms that control the morphodynamic impact of the nourishment on the intertidal area. This thesis reveals the accuracy of the model, the effect of the nourishment on hydro- and morphodynamics and the drivers of morphological changes near the nourishment.

Two models that simulate flow, wave behaviour, sediment transport and morphological changes are set-up. The simulation of flow and waves is coupled, as they interact with each other. A large-scale model of the Eastern Scheldt model (Scaloost) generates the hydraulic boundary conditions for a model covering the back of the basin (Oesterdam). It was concluded, after calibration and validation, that the model is capable of simulating the evolution of the nourishment. It should be noted that although the simulation of wave heights in deeper parts like near the Marollegat station is correct, an overestimation of 20 to 40 cm near the tidal flat is observed. A calculation using the Brettschneider method showed that the model results are more plausible than the observed values. The quality of the measurements is thus questionable. Also, the model cannot be used for assessing the durability of the nourishment, because bed level changes are overestimated.

Analysis of model results showed that tidal currents are the main drivers of sediment transport towards the tidal flat and waves form the erosive forces of the tidal flat. A long-term simulation showed that the tidal flat would continue to erode if the nourishment was not performed. Hydrodynamics are significantly affected by the nourishment: a zone of flow convergence is observed east of the nourishment and increased energy dissipation by the breaking of waves on the nourishment leads to more wave damping. Also, sediment transport rates increased on top of the nourishment and decreased in the sheltered area behind the hook. The elevated nourishment is from a morphological point of view the most active zone, while the sheltered area shows hardly any morphological changes. In general, sediment is eroded from the top of the nourishment and deposited near its edges. Suspended sediment transport was dominant on the flat, but became subordinate to bed load transport on the elevated parts of the coarser grained nourishment.

The morphodynamics are mainly controlled by waves and indirectly by wind as correlations between wind and wave conditions were found. Breaking of waves on top of the nourishment causes sediment stirring, which leads to sediment transport. Wind-driven and to a lesser extent wave-induced currents transport the sand towards the edges of the nourishment, where sediment accretes. The impact of tidal currents is limited, although they are responsible for the development of a channel east of the nourishment hook. Eventually, the Delft3D-model proved its value as it allowed for area-wide analyses of the different phenomena. Finally, it was recommended to focus on the quality of wave measurements in future monitoring campaigns and investigate the accuracy of wave simulations using SWAN.

Michiel Pezij

Graduation Date:
August 28 2015

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

Deltares
Drs.ir. J.J. van der Werf
Ir. P.L.M. de Vet

UNIVERSITY OF TWENTE.