MODELING SAND TRANSPORT UNDER BREAKING WAVES

Protection of coastal areas against erosion and sedimentation is important and it is continuously required for the safety behind dunes. The effects of interventions in the coastal zone are often predicted with morphological models. The SANTOSS model is a sediment transport formula developed by among others the University of Twente (van der A et al., 2013) within such a morphological model. The SANTOSS model calculates the near-bed sediment transport for regular non-breaking waves. The objective of this master thesis is to improve the prediction of sediment transport under plunging breaking waves with the SANTOSS formula within Delft3D by adding physically based wave breaking effects to the SANTOSS formula. This is done stepwise through (i) modeling recent series of wave flume experiments involving breaking waves (van der Zanden et al., 2015) in Delft3D; (ii) improving modeled transport in the breaking region by adding wave-breaking effects; (iii) validating the improved transport model using a separate dataset.

Many of the existing parameterizations within Delft3D were developed for irregular wave conditions. In order to correctly reproduce the measured wave heights and set-up/down for regular waves, the formulations for wave dissipation due to wave breaking were adapted. The modeled velocities are close to reality, although the magnitude of the undertow is underestimated in the breaking region and the orbital amplitudes and acceleration skewness are underpredicted all along the test section.

Especially the mismatch between the measured and the modeled undertow has a large effect on the errors in modeled sediment transport. The underestimation of the net currents at the onshore side of the breaker causes an underestimation of the current-related offshore directed suspension transport at the offshore side of the breaker bar and an underestimation of the onshore directed near-bed transport modeled by SANTOSS without wave breaking. Both underestimations cancel each other out. Still, the magnitude of the total sediment transport is underestimated, whereas the direction of the sediment transport is modeled correctly.

Adding turbulence to the Shields parameter (a. J. H. M. Reniers et al., 2013) during the crest period with a calibration factor for the importance of the turbulence is a wave breaking effect that works well for this test case (See Figure 1). Finally, this physically based improvement for the SANTOSS formula was implemented in Delft3D and validated on a separate dataset (Lip Experiments; Reniers & Roelvink, 1995). It was shown that especially for the accretive case, the adapted model improved predictions of bed-load transport rates.

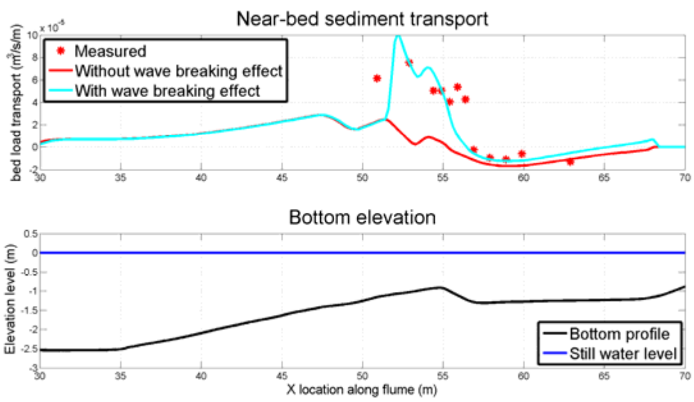

Figure 1: Bed load transport without and with wave breaking effects in a Delft3D model for the CIEM wave flume experiments

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