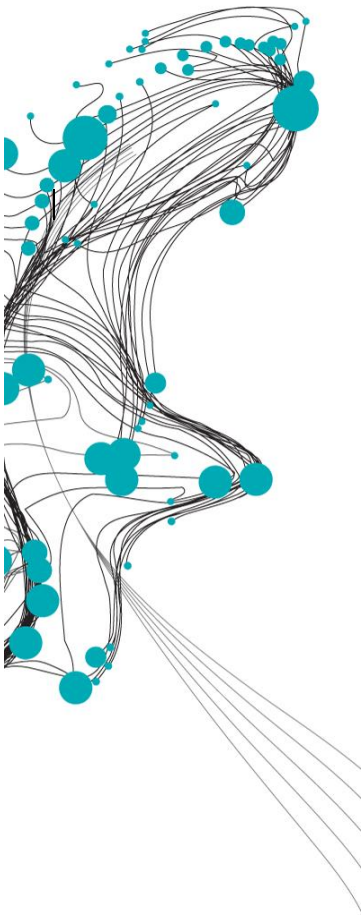
Improving Suspended Sediment Transport Models for Breaking Wave Conditions



In coastal regions the prediction of erosion or accretion of beaches is a critical issue to society. However, current models like Delft3D do not predict suspended sediment transport under breaking wave conditions very well. Generally, the current-related suspended sediment transport is largely influenced by the sediment mixing coefficient and reference concentration. In this project the reference concentration model in Delft3D was improved on the basis of measurements from the SINBAD wave flume experiment. Potential reference concentration models were firstly tested stand-alone with input of measured flow data using Matlab. Based on this, the reference concentration models of Hsu and Liu (2004) and Van der Zanden, et al. (2017)'s were selected to be implemented into the Delft3D model.

In order to ensure an accurate hydrodynamic input for the sediment models, the Delft3D hydrodynamic model of the SINBAD wave flume experiment was investigated and re-calibrated on the basis of a sensitivity analysis. It was found that wave height, undertow and turbulent kinetic energy cannot be predicted accurately at the same time. Additionally, an adaption was implemented in the Delft3D source code, which increases the turbulence injection depth and decreases the near-surface turbulence production. In this way the near-bed turbulent kinetic energy prediction was improved for the regular breaking wave conditions in the SINBAD experiment.

After this hydrodynamic re-calibration of Delft3D the sediment models of Hsu & Liu (2004) and Van der Zanden et al. (2017) were tested against the SINBAD sediment concentration measurements. Both models improve the reference concentration prediction in the outer breaking region. In terms of offshore-directed suspended sediment transport, these implemented models give better predictions at the breaker bar. However they still underestimate the offshore-directed suspended load transport at the bar trough due to underestimated undertow.

In order to test the newly implemented sediment models under irregular wave conditions as well, the two models were also applied for another wave flume experiment LIP 1B. Both implemented models generally improve the predictions, but still overestimate the reference concentration in the breaking region. Under this circumstance, the offshore-directed suspended sediment transport is overestimated as well.

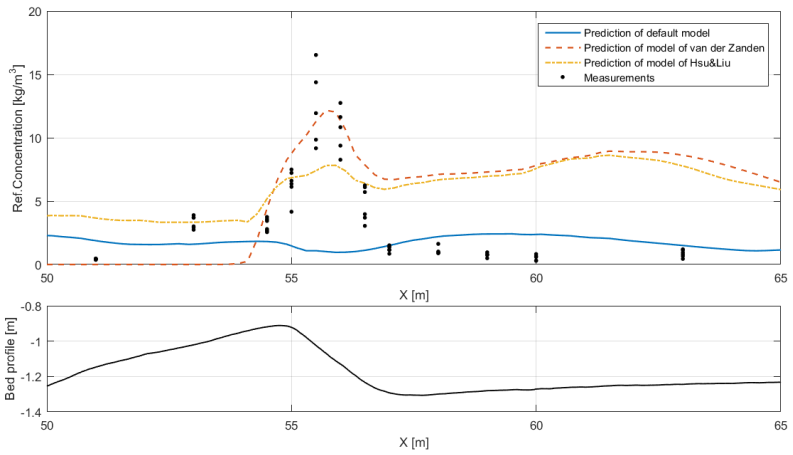


Figure 1: Reference concentrations in the surf zone along a breaker bar as predicted by the default model of Delft3D and by the two new models and compared to the measurements of the SINBAD wave flume experiment.

Van der Zanden, J. (2017a) 'Inclusion of Wave Breaking Turbulence in Reference Concentration Models', Coastal Dynamics, (188), p. 13.

Hsu, T. and Liu, P. L. F. (2004) 'Toward modeling turbulent suspension of sand in the nearshore', Journal of Geophysical Research C: Oceans, 109(6), pp. 1–14.

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