RANS MODELLING OF SEDIMENT TRANSPORT AND MORPHODYNAMICS OF A NOURISHED SHOREFACE

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INTRODUCTION

A common technique employed to limit beach erosion is to nourish the coast by adding additional sediment on or close to the beach. The cross-shore redistribution of the nourished sand is an important factor for determining the efficiency of the nourishment. To help design nourishments, models that can accurately predict the cross-shore transport surfzone can be a valuable tool. In this study, we aim to demonstrate the validity of using a CFD tool for understanding the morphodynamics of a nourishment. Furthermore, we aim to investigate transport patterns responsible for redistributing sediment from the nourishments.

METHODOLOGY

Accurately predicting the cross-shore transport of sediment has been shown to be difficult for many practical, process-based models (Van Rijn et al., 2011). For this reason, we use a 2DV wave-resolving approach in order to capture important processes that govern sediment transport by waves. This model has previously been used to investigate breaker bar morphodynamics (Jacobsen et al., 2014) and swash zone sediment transport (Kranenborg, 2023). The hydrodynamics are captured by the Reynolds Averaged Navier Stokes equations, coupled with a VOF method to model the movement of the surface interface and a $k-\omega$ turbulence model. Sediment transport is modelled as bedload and suspended load separately. The transport of sediment is then used to calculate the bed level change.

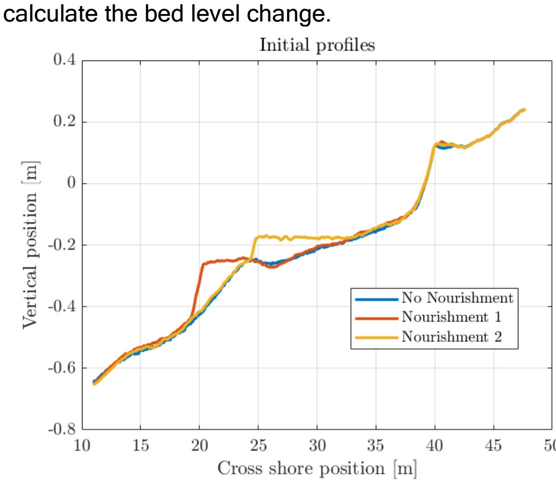

Figure 1 - The three initial profiles of the Walstra et al., (2011) experiments used in this study.

We use the experiments by Walstra et al., (2011) as a starting point. They measured the profile evolution of for two different waves and three different profiles: an unnourished profile, and two profiles with nourishments onshore and offshore of the breaker bar respectively (see Figure 1). The two irregular wave conditions were an erosive condition ($H = 0.17$ m and $T_s = 2.3$ s) and an accretive condition($H = 0.10$ m and $T_s = 3.1$ s). The sediment bed consisted of sand with $D_{50} = 0.134$ mm.

The experiments showed a reduction of the erosion volume for the nourished scenarios compared with the scenario without nourishment. Furthermore, Walstra et al (20011) report that this happens in conjunction with a change in return flow and wave skewness. The CFD model, shown in Figure 2, is particularly suitable to investigate such processes, as it can model the important vertical nonuniformities in sediment concentration and flow velocity (Kranenborg 2023).

CONCLUSION

At the conference we will present how CFD can be used to investigate nearshore sediment transport. In particular, we demonstrate how the different nourishment scenarios affect the sediment transport patterns. Of special interest is the how the changes vertical profile in flow velocity and sediment concentration affects the dynamics of a nourished foreshore.

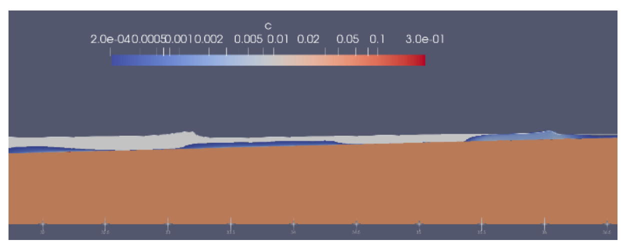

Figure 2 - Predicted free surface and sediment concentration by the CFD model for the scenario without a nourishment and erosive waves. The brown area is the sediment bed, white is water and grey is air. The suspended sediment concentration is shown in a blue (low concentration) to red (high concentration) scale.

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