DEPTH-RESOLVED MODELLING OF SEDIMENT FLUXES UNDER BICHROMATIC WAVES IN THE SWASH ZONE

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INTRODUCTION

Traditionally, many numerical studies of sediment transport or morphodynamics in the swash zone use depth-averaged approach. This is relatively computationally cheap, however, the assumptions it makes on vertical structures of the flow velocity and suspended sediment concentration are not always fully met. Depth-resolving models, albeit more computationally expensive, offer the ability to investigate sediment transport without imposing assumptions on vertical structures. Therefore, these models are a great tool for investigating processes related to sediment transport in the swash zone. In this study, will look at the behavior of suspended sediment in the swash zone, and the role vertical structures therein.

METHODOLOGY

The model solves the Reynolds-Averaged Navier-Stokes (RANS) equations coupled with a $k-\omega$ turbulence model and a Volume Of Fluid (VOF) approach for determining the air/water interface. The sediment transport model is based on the model by Jacobsen et al., (2014) and uses an advection diffusion model for suspended sediment transport with a reference concentration at the bed boundary. For details about the model validation, we refer to Kranenborg et al., (2022).

The model is forced using the wave and beach conditions according to the bichromatic experiments conducted by van der Zanden et al., (2019). These experiments feature a maximum wave height of $H = 0.64$ m and a 1:15 beach consisting of sand with a grain size of $D_{50} = 0.25$ mm.

RESULTS

Figure 1 shows model results in the surf and swash zones over two wave groups of simulation time. Looking at the surface elevation, the individual wave groups are clearly visible (Fig. 1a). Also, we see different types of wave-swash interactions. For instance, at roughly $t = 160$ s, $x = 75$ m, the backwash collides with an incoming wave, whereas just after $t = 180$ s, at $x = 75$ m, the uprush is overtaken by a new, stronger bore. Figure 1b shows that sediment transport occurs mainly in two regions, namely around wave-breaking ($x = 65$ m) and higher up in the swash ($x = 80$ m). Overall, the model predicts offshore transport higher up in the swash zone. At the conference we will present the behavior of suspended sediment transport and demonstrate the significance of vertical structures.

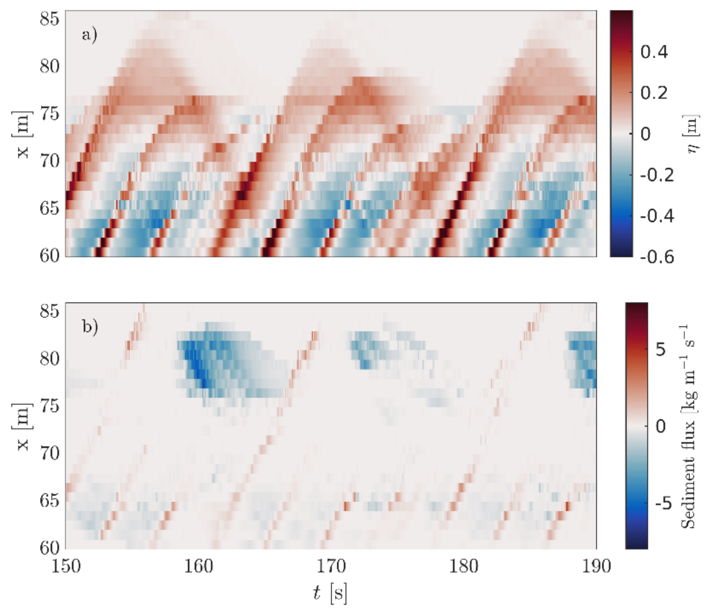

Figure 1 - Modelled surface elevations relative to the initial surface elevation at that location (top) and depth-integrated suspended sediment fluxes (bottom) at different cross-shore positions x and different times t.

ACKNOWLEDGEMENTS

This work is part of the Shaping The Beach project. Shaping The Beach (2018-2023) is an NWO-TTW funded research project (no. 16130), with in-kind support by Deltares. This work was carried out on the Dutch national e-infrastructure with the support of SURF Cooperative.

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