EGU22-13333
https://doi.org/10.5194/egusphere-egu22-13333
EGU General Assembly 2022

Complex hydrodynamics over tidal sand waves: the role of flow separation

Johan H. Damveld[1], Alice Lefebvre[2], Bas W. Borsje[1], and Suzanne J. M. H. Hulscher[1]
[1]University of Twente, Netherlands
[2]MARUM, University of Bremen, Germany

The global transition towards cleaner energy sources has triggered a tremendous shift of wind energy exploitation to the coastal seas. This threatens the environmental health of the ecosystem in these environments, with (potentially negative) impacts on the ecosystem services they provide. Large parts of the sandy bed of these shallow coastal seas, such as the North Sea, are covered by tidal sand waves. Their large dimensions and dynamic behaviour make them a threat for offshore engineering activities, as, for instance, cables to offshore wind farms can be exposed due to sand wave migration. At the same time, sand waves have been shown to serve as a habitat for large numbers of benthic organisms (Damveld et al, 2018), and should therefore be protected from anthropogenic disturbances. These conflicting interests require an integrated approach in marine spatial planning. To support decision making, process-based models can be applied to gain insight in the processes and mechanisms which control both the morphodynamics of sand waves and the habitat characteristics of the organisms living within, and the interaction between those.

Field evidence shows that the region around the steep slope and the sand wave trough are favourable for benthic organisms. The highest concentrations of organic matter, which serve as an important food source, are also found there. It is hypothesized that organic matter deposits accumulate near the trough and steep slope of sand waves due to the more sheltered hydrodynamic conditions there. The possible presence of a flow separation zone during periods of the tidal cycle may significantly contribute to the sedimentation of organic matter in this region. Unfortunately, current state-of-the-art sand wave models (e.g., van Gerwen et al., 2018) are mainly focused on explaining large-scale hydro- and morphodynamic behaviour. They are not set-up to resolve complex hydrodynamics (e.g., turbulence) which are needed to study small-scale processes near the steep slope of sand waves.

In this work we aim to develop a non-hydrostatic sand wave model in Delft3D, combining earlier work by Lefebvre et al. (2014) and van Gerwen et al. (2018). Using this model, we will systematically investigate the factors that contribute to the possible emergence of a flow separation zone. We are specifically interested in its spatial and temporal extent during a tidal cycle. We expect sand wave shape (e.g., lee slope angle, sharpness of the crest) and tidal current strength to be key parameters for the possible presence of flow separation.

Damveld, J.H., van der Reijden, K.J., Cheng, C., Koop, L., Haaksma, L.R., Walsh, C.A.J., et al. (2018).

Video transects reveal that tidal sand waves affect the spatial distribution of benthic organisms and sand ripples. *Geophysical Research Letters 45.*

Lefebvre, A., Paarlberg, A.J., Ernstsen, V.B., & Winter, C. (2014). Flow separation and roughness lengths over large bedforms in a tidal environment: A numerical investigation. *Continental Shelf Research 91.*

Van Gerwen, W., Borsje, B.W., Damveld, J.H., & Hulscher, S.J.M.H. (2018). Modelling the effect of suspended load transport and tidal asymmetry on the equilibrium tidal sand wave height. *Coastal Engineering 136.*