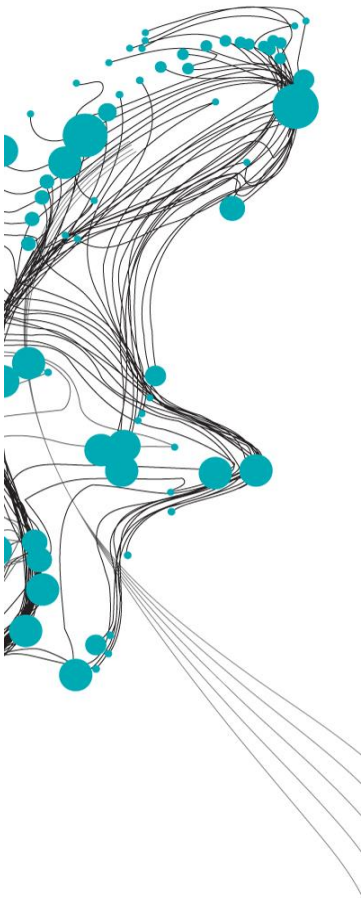
Modelling the transport of organic matter over tidal sand waves



The bed of shallow shelf seas such as the North Sea consists of sand waves and is a habitat for benthic organisms, as these two have an influence on each other. Sand waves are rhythmic bedforms of several meters high, have wavelengths of hundreds of meters and migrate several meters per year. A hydro-morphological model in Delft3D has been made to predict the behaviour of the sand waves. The presence of benthic organisms can also change the characteristics of the sediment and consequently the sediment transport. To understand how the benthic organisms affect the sand wave dynamics, it is necessary to first characterize the food-supply of these benthic organisms. A biogeochemical model using organic matter and flow velocity to determine where the organic matter will settle down was applied, in which the organic matter is used as a proxy for food for the benthic organisms. Thus the organic matter could provide a preliminary prediction on the distribution of the benthic organisms along the sand waves. Nevertheless, existing research about the connection between hydrodynamics and ecology is scarce. A one-way coupling between the models will give insight in the transport of organic matter over sand waves. Therefore, this research connected the hydro-morphological model with the biogeochemical model.

The coupling between the two models is a one-way coupling in which the hydrodynamics of the hydro-morphological model (e.g. horizontal and vertical flow velocity and vertical diffusivity) has been used as input in the biogeochemical model. The inputs from the hydro-morphological model differ in bathymetry and forcing conditions, i.e. tidal symmetry and residual currents. Together with the organic matter and several processes in the biogeochemical model (e.g. advection, dispersion, sinking and respiration), the one-way coupling is able to predict the distribution of the organic matter over the different sand waves. Tide-averaged organic matter concentration show an higher concentration just above the trough on both sides of a symmetrical sand wave and only on the lee side of an asymmetrical sand wave, see Figure 1. Furthermore, the results show two behaviours during one tidal cycle of twelve hours. Namely, an increase in organic matter concentration during flood and ebb tide just above the troughs and an uni-directional organic matter transport during slack tide. This research concludes that the highest organic matter concentration are found just above the trough and the one-way coupling of the two models generates a more accurate prediction of that.

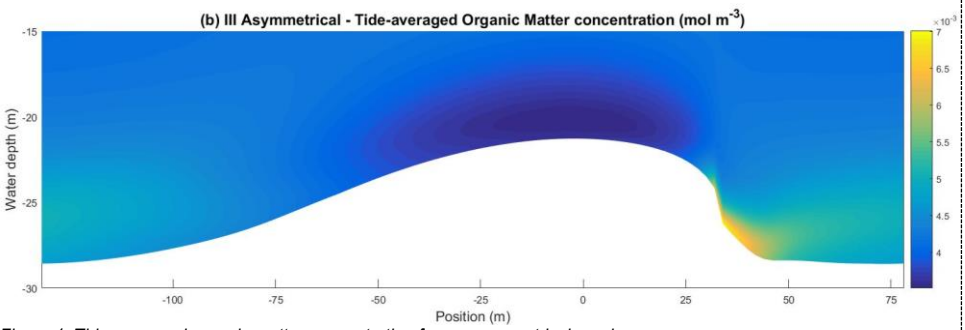


Figure 1: Tide-averaged organic matter concentration for an asymmetrical sand wave.

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