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Book of Abstracts

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Tidal sand waves and benthic organisms: observations and modelling of bio-physical interactions

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Introduction

The sandy seabed of shallow coastal shelf seas (e.g. North Sea) displays fascinating morphological features of various dimensions. At the same time, the seabed also harbours a rich ecosystem. It is well established that benthic community composition is related to various abiotic variables, such as sediment grain size and bed shear stress. However, less is known about how macrobenthic species relate to morphological bed patterns, and in particular to tidal sand waves. Increasing pressure from offshore human activities makes it necessary to further study the drivers of benthic community distributions over sand waves. Moreover, a greater understanding of the effects of benthic organisms on hydrodynamics and sediment transport processes over sand waves may improve morphological model predictions. In this contribution, we will present a combination of field observations and process-based modelling techniques that are used to determine and understand the effects of the feedbacks between benthic organisms and sand waves.

Methods

First, camera transects were carried out in a sand wave field off the coast of Texel and the footage was analysed to determine crest/trough differences in benthic assemblages. Second, a linear stability analysis (LSA) was performed to study the two-way coupled feedbacks between organisms and small-amplitude sand waves. Third, the numerical model Delft3D was applied to study these two-way coupled feedbacks for finite-amplitude sand waves, in particular for the tube-building worm *L. conchilega.*

Results

The camera footage revealed that organisms living on top of the seabed and within (using seabed holes as a proxy) are significantly more present in the troughs of sand waves, compared to the crests (see Figure 1). These observations generally agree with the results from the two process-based models. In the LSA it was shown that biomass maxima tend to concentrate in the region around the trough and lee side slope of sand waves, whereas the Delft3D model related the highest patch densities of worms to the sand wave troughs. Furthermore, regarding sand wave morphology, the LSA demonstrated that a local disturbance (either to the bed or to the biomass) may trigger the combined growth of sand waves and spatially varying biomass patterns. Moreover, the model results revealed that the autonomous growth of organisms significantly influences the growth rate of sand waves. The Delft3D model showed that small biogenic mounds, created by the tube-building worms, induce (and accelerate) the growth of sand waves with a similar spatial scale as the biogenic mounds itself (tens of meters wide). Initially this leads to shorter sand waves than they would be in an abiotic environment. However, near equilibrium the wavelengths tend towards their abiotic counterparts again, suggesting that the equilibrium sand wave stage is mainly determined by morphological processes alone.

Figure 1 Crest (left) and trough (right) of a sand wave off the coast of Texel, showing clear differences in environment.