INFLUENCE OF TIDAL SAND WAVE FIELDS ON WIND WAVE PROPAGATION

Tidal sand waves are large-scale rhythmic bed forms commonly observed in tide-dominated shallow seas with a sandy seabed. Sand waves typically occur in fields as for example observed in the Southern Bight of the North Sea. They are here characterized by wavelengths between 100 and 1250 *m*, heights of 1 to 15 *m* and crests perpendicular to the principal direction of the tidal current. Due to morphological processes, sand waves grow and migrate which, in combination with the relatively small water depth of the North Sea, might result in interference with ship navigation, dredging activities and pipelines. Via near-bed orbital velocities, wind-generated surface gravity waves (i.e. wind waves) are able to interact with sand wave dynamics. The influence of a wavy bathymetry due to sand waves on the propagation of wind waves is not yet understood.

In this study the influence of sand wave fields on wind wave propagation is investigated. Therefore a model is described based on the elliptic form of the Mild-Slope Equation by Berkhoff (1976). This theory assumes an irrotational and inviscid fluid, linear harmonic waves, no energy dissipation and describes shoaling and refraction effects. Also, the model assumes the absence of currents. Furthermore, the model is characterized by a square domain where monochromatic wind waves incident from one of the boundaries and where the other boundaries describe non-reflective boundary conditions based on the Sommerfeld Radiation Condition. In the middle of the domain a patch of sand waves is located surrounded by a flat-bed configuration such that the boundaries are located far away from the sand wave field. A finite difference approximation is used to discretize the model. The resulting system of linear equations is subsequently solved by a direct solution method. The model is verified with an analytical solution which exists in case of a flat-bed configuration.

The sand wave field is described by a function that allows for variation in sand wave height, sand wave length, orientation with respect to the incident wind wave and asymmetry between the steep and mild slope. The patch-like structure is created by applying a 2D spatial tapering function.

The results show that the orientation of the sand wave crests with respect to the incident wind wave fronts has a major influence on the propagation of wind waves. Maximum influence is found when the sand wave crests are orientated perpendicular to the wind wave crests. The influence of the mean water depth, sand wave length, sand wave height and asymmetry becomes stronger when the orientation of the sand wave crests approaches perpendicularity. Furthermore, the influence of the mean water depth, sand wave height and sand wave length is relatively strong whereas the influence of asymmetry is relatively small. For regular patterns, amplifications up to three times the wind wave amplitude and three times the near-bed orbital flow velocity are found (see example in Figure 1 and Figure 2). Moreover, under certain parameter conditions local maxima were found indicating the presence of Bragg Resonance. In case of observed, irregular sand wave fields, wind waves also show amplification in amplitude and near-bed flow velocity. Furthermore, the zones of amplification were not always in union with the change of bed elevation.

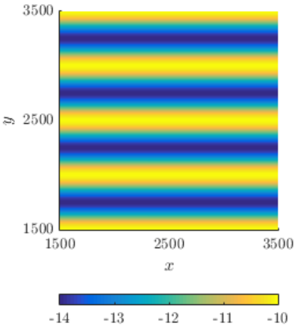

Figure 1: Top view of a regular sand wave field.

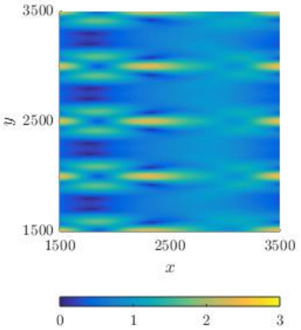

Figure 2: Change in wind wave amplitude due to presence of the sand wave field as given in Figure 1.

Berkhoff, J.C.W. (1976). Mathematical Models for Simple Harmonic Linear Water Waves: Wave Diffraction and Refraction. PHD Thesis, Technical University of Delft, 1976.

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