THE EFFECT OF WIND AND WAVES ON THE HYDRODYNAMIC AND MORPHODYNAMIC PROPERTIES OF SAND WAVES

The seabed of shallow continental shelf consists of rhythmic bed patterns of varying spatial and temporal scales. Among them lies the intermediate dynamic bed forms, sand waves. They are formed when bottom perturbations are subjected to tidal flow. They may migrate up to several tens of meters per year and grow up to one-third of the local water depth. These physical features may severely influence offshore human activities, such as navigation, construction of wind farms, and dredging. Therefore, it is essential to understand the physical processes that affect sand wave morphology.

In general, the effect of several physical processes and factors has already been studied. This research work studies the effect of wind and waves on sand wave properties by including these non-linear effects of several physical processes when compared to previous works. It will add more insight and improve the previous findings. Thus, this study presents a 2DV process-based model using Delft3D that includes advancements in physical processes such as variable eddy viscosity, non-linear wave-current interaction, and suspended load. The study examines both hydrodynamic and morphodynamic properties.

The hydrodynamic results show an increase in average viscosity and turbulence with the addition of wind and waves. It causes near-bed wind-driven residual in wind direction, including a small reverse drift above it opposite to the wind direction in tidally average horizontal flow. The morphodynamics results show that waves alone cause flattening of the crest but do not induce any significant migration. However, together with wind, waves intensify the migration, reduce sand wave height and increase wavelength. Our work also identifies that suspended load increases during storm conditions that intensifies height reduction. The change in hydrodynamic properties is reflected in morphodynamic properties as well. A steeply reducing migration rate is observed at 30 m or greater depth due to reverse drift observed in tidally average flow. The above results concern steady-state complete duration storm conditions. In actuality, storms are intermittent, and in their presence, sand wave fields show a migration rate of 0.5 – 1 m/year. The storm conditions cause a height reduction of 33% when present for the complete duration and 5% – 8% when present intermittent, compared to no storm conditions. The results of this research study related to the sand wave properties are comparable to field data. For future, it is recommended to conduct the same study with periodic boundaries to check the suitability of Riemann boundaries used in present study.

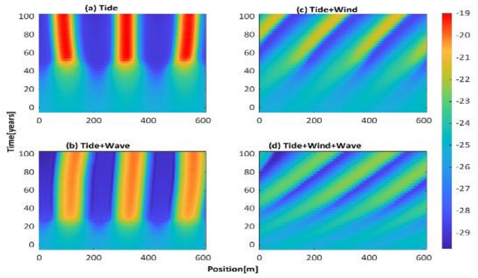

Figure1: Sand wave profile development in the presence of tide (a), tide +wave (b), tide+ wind (c) and tide+ wind + wave (d) over 0.25 m symmetrical initial bed for 100 years. The vertical colour bar shows the bed level (m).

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