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Evaluation of bedform predictors in tidal environments

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The seabed of coastal environments commonly exhibits a large range of complex mobile bedforms due to the interaction between hydrodynamics and sediment transport. Yet, no fundamental law has been identified which describes the initiation and development of these ubiquitous, flow and wave driven features. Thus, the prediction of bedform dimensions and dynamics is carried out using empirical relationships. In this study we evaluate some of these equations, based on a large data set consisting of high resolution multi-beam bathymetry, modelled hydrodynamics and sediment characteristics collected in the Jade Bay, and the Weser and the Elbe estuaries (German Bight, North Sea). More than 2000 individual bedforms were identified; they display a wide range of dimensions with heights ranging from 0.1 to 5 m and wavelengths between 10 and 300 m. They were used to test the classical relationships of Flemming (1988) and Francken et al. (2004) for the interdependency of length and height of individual bedforms. Taking into account all the data resulted in a large scatter, with weak correlations of averaged measured and predicted parameters (bedform height and length). However, applying a generalized extreme value method (which weights the Gaussian distribution of bedform height with the maximum frequency for every measured bedform length) in order to get the maximum density of bedform height, a strong dependency was identified ($r^2 = 0.76$). Furthermore predictor equations that relate equilibrium flow and sediment characteristics to bedform dimensions and hydraulic roughness were tested (e.g. Yalin, 1964; Van Rijn, 1984). Results showed a significant scatter and limited reliability. Statistical analyses were used to accurately quantify the influence of the physical environment (depth, current velocity, grain size) on bedform morphologies in order to enhance the bedform predictors.

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