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Influence of nonlinear waves on sandbar migrations using Monte Carlo simulations

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Coastal systems typically involve a variety of natural processes working together. Understanding the interaction between waves and currents and its influence on long-term geomorphological evolution of coastlines and sandbar features is of great importance for coastal managers and policy makers. Our knowledge and understanding of these processes has undergone significant developments in the last decades but this issue still remains a challenge to researchers.

The modelling of the sea bed topography changes in the coastal zone can be obtained from numerical simulation of hydrodynamic and sediment transport processes. In the present work, one adopts a morphodynamic model that considers an intra-wave approach. The sediment transport processes are resolved for each individual wave cycle in conjunction with a sediment continuity equation, enabling to calculate morphological changes through time.

In this work, we investigate the performance of the morphodynamic model to simulate sandbar migration. The numerical results are compared against the observed beach profile evolutions obtained during the European project "Large Installations Plan" (LIP) (Arcilla et al., 1994). The LIP 1B case is investigated, corresponding to an erosive case, typical of storm events, where a breaker bar in the surf zone migrates offshore. The large-scale laboratory experiments were performed in the Delta flume of Deltares, resulting into a two-dimensional analysis (2D). Consequently, this work contributes to the cross-shore transport problem, particularly, for the modelling of nearshore sandbars.

The ability of practical sediment transport models, recognized to capture the interaction between non-linear waves and undertow currents, is assessed (e.g., Hoefel and Elgar, 2003; Silva et al., 2006; Nielsen, 2006; Abreu et al., 2013). Local values for the non-linear parameters (wave asymmetry and skewness) are computed in the model according to Ruessink et al. (2012). In particular, this study investigates the influence of the variations of such parameters in the sandbar evolution using Monte Carlo simulations and compares it with the variability induced by with other ill-defined parameters (e.g., sediment grain size). This methodology allows to observe the influence of such parameters in model predictions, improving our knowledge on such mechanisms, as well as of the capacities and weaknesses of the present (empirical) practical transport models.

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