A sensitivity study with three beach morphodynamic numerical models

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Introduction: Beach-dune systems are the best natural coastal defense in the sea-land interface. The objective of this study was to improve the evaluation and prediction of the vulnerability/resilience of beach-dune systems against wave action and surge during maritime storms, characterized by strong winds and low atmospheric pressure.

Methods: Three morphodynamic numerical models were applied, tested, evaluated and compared: the XBeach model (versions 18 and 19) [1], the Duner model [2, 3] and the Delft3D model (version 5.00.10.1983) [4]. The case study was a case of beach-dune profile erosion performed in a large scale flume laboratory experiment. Besides the comparison of the similarity between the numerical and the experimental results of the profile evolution, impact and error indicators were used to evaluate the performance of the models. The impact indicators were the erosion volume and the profile retreat at certain reference vertical levels. The error indicator was the Brier Skill Score (BSS) [5].

Results: The XBeach model (versions 18 and 19) was the one which presented the best similarity between the numerical and the experimental results, followed by the Duner model and finally by the Delft3D model (version 5.00.10.1983) (Figure 1).
The XBeach model (version 19) was the one which presented the best performance (highest BSS), excellent, either applied with the default parameters or calibrated. It should be pointed out that the version 19 of the XBeach model with the default parameters presented a higher performance than the version 18 of the XBeach model calibrated, which was also excellent and much higher than the version 18 with the default parameters, which performance was only good.
The Duner model presented a good performance, similar to the performance of the XBeach model (version 18) with the default parameters.
The Delft3D model (version 5.00.10.1983) presented a weak performance after calibration and a bad performance when applied with the default parameters.

Discussion: The XBeach model has the highest number of calibration parameters and therefore is the most complex of the three models to calibrate. For this case study, the improvements achieved with the version 19 of the XBeach model, relatively to the version 18, were due to the changes introduced in the process of avalanching for multiple sediment fractions. The Duner model is a simple and reliable tool to simulate dune erosion despite its limitation to simulate the submerged bar. The Delft3D model (version 5.00.10.1983) does not reproduce the dune erosion because it does not consider infragravity waves.

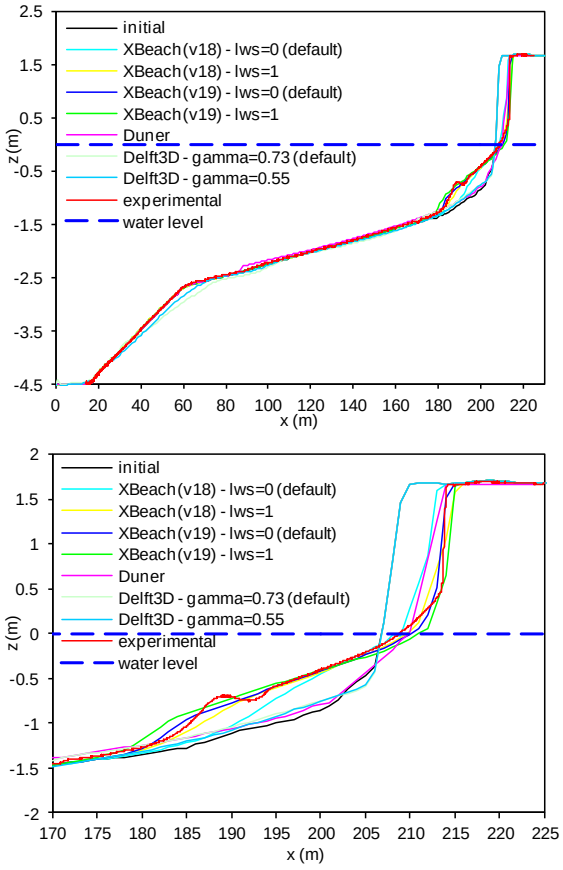

Fig. 1: Results of the morphodynamic models XBeach (versions 18 and 19), Duner and Delft3D (version 5.00.10.1983), at the laboratory scale, after 6 hours: complete profile (above) and detail (below).

References: [1] Roelvink et al. (2009) *Coastal Engineering* **56**:1133-1152; [2] Oliveira, F.S.B.F. (2012) *MEFTE 2012*; [3] Oliveira, F.S.B.F. (2012) *2as Jornadas de Engenharia Hidrográfica*: 315-318; [4] Deltares (2011) *Delft3D-Flow. User Manual*; [5] Van Rijn et al. (2003) *Coastal Engineering* **47**:295-327.