Modelling barrier beaches under storms with XBEACH: The case of the Trabucador bar.

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Extreme events are responsible for some of the major changes that occur in the coast. This is especially evident in areas like barrier beaches. Ideally, the election of the most sustainable strategy for these fragile systems requires detailed information of not only the forcing conditions but also the associated morphology changes. However, this type of data set is rare and if exist they are mainly qualitative. This is the situation of the Trabucador bar (figure 1) a 5 km sandy barrier beach located at the southern part of the Ebro delta, which is typically overtopped during big storms in combination with high water levels.

The main objective of this work is to explore the functionality of a morphological model as a tool for having advanced warnings of coastal morphodynamics related to high energetic episodes. The analysis focuses on the morphodynamic response of the Trabucador bar under extreme events and evaluates the role of the main driving forces, waves and water levels, controlling the barrier.

The morphodynamic response of the barrier has been analyzed using XBEACH (Roelvink et al. 2009) a two-dimensional open source model for wave propagation, long waves and mean flow, sediment transport and morphological changes of beaches during storms. XBEACH has been introduced as part of a pre-operational morphodynamic system, PREMOS, and validated for different storm events that have produced the breaching of the barrier.

PREMOS is based on 3 main open source models: the meteorological unit, the hydrodynamic unit and the morphodynamic unit. The meteorological inputs correspond to the operational predictions of the Meteorological Office (SMC) obtained for the northwestern Mediterranean. Wave processes (generation and propagation) have been simulated with SWAN (Booj et al. 1996) a third-generation phase averaged wave model for deep and intermediate depths. The obtained conditions are finally used as the boundary forcings in XBEACH.

Figure 2 shows the simulated times series of the significant wave height obtained by SWAN using the wind field predicted by MASS (Kaplan et al., 1982) and the data recorded by a directional buoy moored in the area (at 50 m depth) for the episode of October 2003, an extreme event that causes important damages along the Catalan coast and breached the Trabucador barrier. It can be seen that SWAN is able to reproduce the general pattern of the storm although a non homogeneous bias is detected when is compared with the measurements. However, the observed deviations are in agreement with the results obtained by Bolaños et al. (2004) for the same area and must be considered as the present state of the art of wave predictability for the NW Mediterranean with a grid of 18 km x18 km.

The predicted evolution of the Trabucador bar during the storm is shown in figure 3. Results indicate that XBEACH is able to reproduce the reported breaching episode and this takes place in a relatively short time (less than 8 hours). The breach of the barrier starts with the development of narrow channels crossing the barrier, the number and width of which increase with an increase of the energy conditions. The model also presents, as expected, an accumulation of sand at the back side (bay). Both morphological effects (channels and wash over deposits) have been reported as the main signatures for other extreme events in the area (figure 1).

The paper will describe in detail the results obtained for the storm of 2003 and also other breaching episodes of the barrier. These results will be used to evaluate the functionality of such of models as a tool for barrier beach assessment.

References

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Figure 1. Breaching of the Trabucador bar after the storm of November 2001.

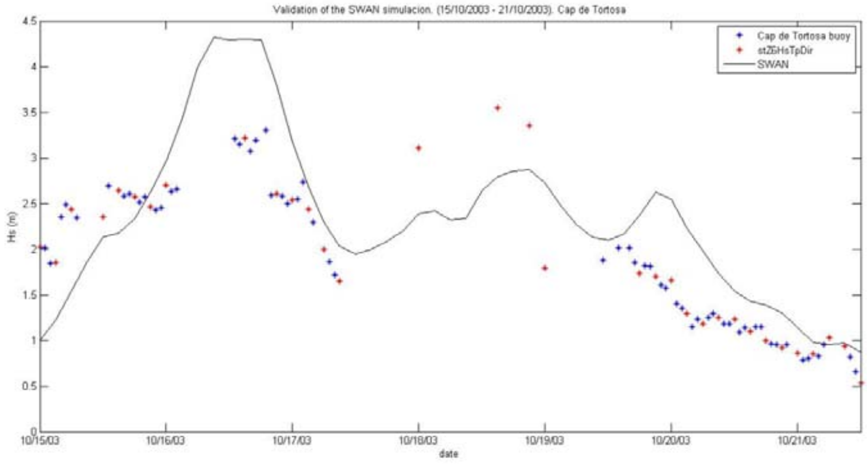

Figure 2. Measured vs modeled significant wave height at 50 m depth.

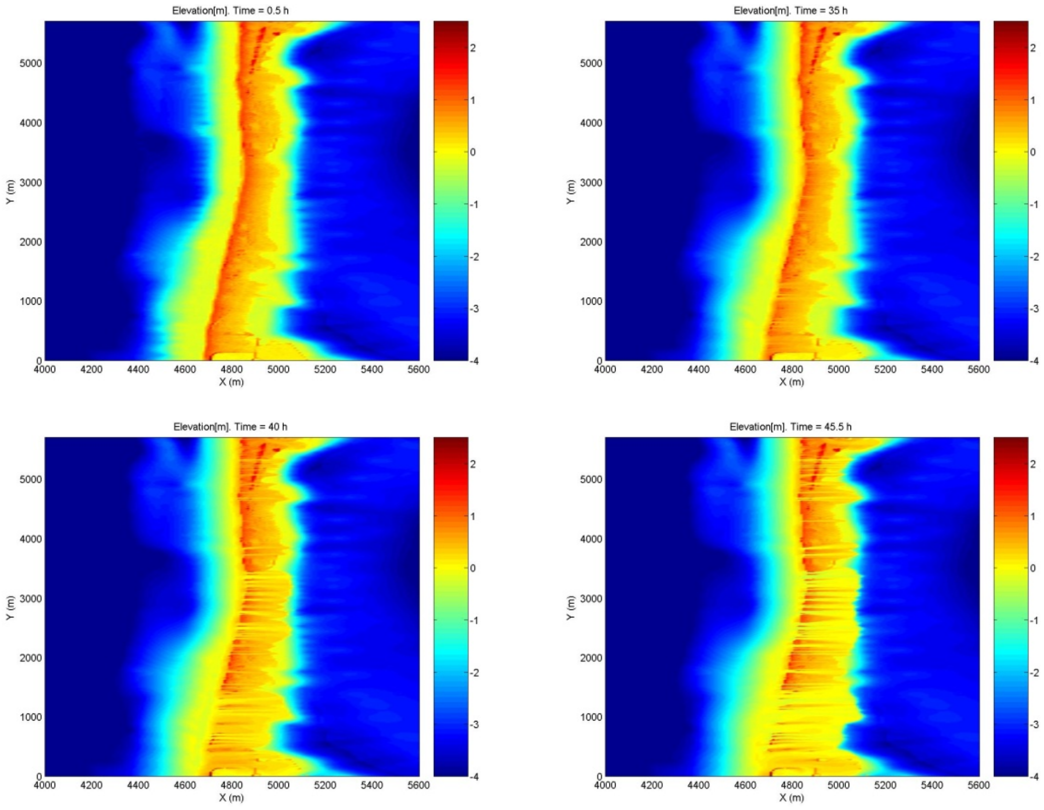

Figure 3. Initial topo-bathymetry (upper left) of the Trabucador bar and predicted bottom topography after 35, 40 and 45 hours (units in meters, open sea on the left side).