IMPACT OF A SANDY SHORE MORPHOLOGY ON OVERTOPPING

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ABSTRACT

To assess the exposure of coastal communities to marine flooding, process-based models rely on topo-bathymetric data in areas subject to morphological changes. To infer on the impact of ongoing changes at Cova-Gala, in central Portugal, a calibrated overtopping model was run with recent winter and summer morphologies. The model was forced with moderate and extreme swells. In both cases, the inundation probability increased with a lower concave beach profile or in the absence of a steep foredune.

Key words: Coastal flooding; Infragravity wave; Runup; XBeach; Portugal

1. INTRODUCTION

An objective of the project MOSAIC.pt is to develop an operational forecasting system for coastal flooding capable of accounting for storm driven morphodynamics. The developed system relies on the OPENCoastS architecture for downscaling North-Atlantic metocean conditions at any local beach or waterfront (Oliveira *et al*., 2021). The downscaled conditions then serve to force local applications of XBeach (Roelvink *et al*., 2018), in 2DH and using its surfbeat hydrodynamic solver. Based on hydro- and geomorphological data collected within the project (Freire *et al*., 2020), an application was setup and validated for the waterfront of Cova-Gala, south of the entrance to the Figueira da Foz harbour. The system runs for now with or without morphological evolution over 48-hour periods. So it is important to quantify the errors induced by geomorphological changes over longer timescales.

2. METHODS

In the present study, the focus was on the impact of shore and nearshore morphologies in the inundation-prone area south of the harbour's southern jetty. Two hindcasted swells were chosen. The first occurred on 21 February 2019. It had a moderate 3.25 m significant wave height (Hs), with a 17.6 s peak wave period and a 278ºN mean wave direction, and has been previously used for validating the overtopping model. The second is Storm Hercules' swell which occurred on 6 January 2014, with the latter wave characteristics reaching 7.03 m, 21.3 s and 287ºN at 15-m depth in front of the harbour entrance. These were combined with a steady mean sea level of 2.39 m ALTH38, corresponding to a total water level (storm surge plus tidal level) with a return period of 70 years. To account for the random phase model of XBeach, each combination was run 10 times, and identical series of simulations were run with topo-bathymetries from February and August 2019 and a third from July 2021. In 2019 morphologies, the shoreface was identical (surveyed in August) and the model bathymetry changed from the intertidal zone landward. In August, the beach was gently sloping until a sharp junction with a steeper foredune. In February, the beach was much lower, having the beach-foredune transition a concave upward shape with an unchanged dune height. In July 2021, the beach slope was the smoothest and ran as a ramp up to the top of dune, which was higher and had moved landward. Figure 1 shows the spatial probability (out of 10 simulations) of inundation for the six swell-morphology combinations.

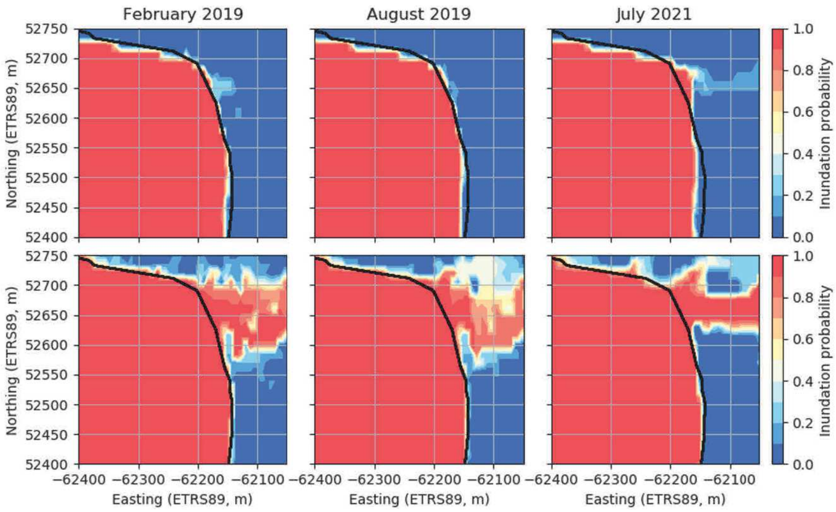

Figure 1. Top panels: Probability of inundation maps for winter 2019 (left) and summers of 2019 (center) and of 2021 (right) with February 2019's swell, the black line is the maximum spring tide reach. Lower panels: same as top, but for January 2014's swell.

3. MAIN RESULTS AND DISCUSSION

For both swells, the minimum probability of back dune inundation occurred with the August morphology (Figure 1). With the February morphology, the lower intertidal elevation increased the short-wave mean Hs towards the shoreline, forcing higher infragravity waves and leading to higher runup and more frequent overtopping. With the July morphology, changes along the shoreface profile did not impact the level of incident energy, but infragravity waves dissipated more smoothly across the gently sloping beach ramp, also leading to more frequent overtopping. Results, indicate that forecast systems at this location, accounting or not for morphodynamics, should be well constrained in terms of intertidal beach state. The assimilation of products derived from satellite imagery (*e.g.*, weekly waterlines) is sought as a means to achieve this.

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