Plinius Conference Abstracts,
Vol. 11, Plinius11-129, 2009
11th Plinius Conference on Mediterranean Storms

The responses of artificial embayed beaches to storm events

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The plan-view and the profile shape of sandy beaches largely depend on the incoming wave-energy (Wright and Short, 1984). In this sense, storm events are responsible for major changes in the configuration of sandy beaches and the cumulative effect of storms and fair-weather conditions determines the morphodynamic state of a certain beach. With increasing wave energy, the beach will change from the Reflective state to the Low Tide Terrace, Transverse Bar and Rip, Rhythmic Bar and Beach, Longshore Bar and Trough and finally to the Dissipative beach state. These morphodynamic states are also observed at artificial embayed beaches, although artificial groins limit alongshore sediment transport and protect sections of the beach from waves approaching from a range of directions (Short and Masselink, 1999).

This contribution focuses on the morphological changes of the shoreline and the submerged sandbars of artificial embayed (sandy) beaches due to the effect of high-wave conditions associated to storms. We characterize the morphological response of the emerged and submerged beach profile of two of the artificial embayed beaches of the Barcelona city coast (NW Mediterranean). The two embayed beaches under study are single-barred beaches subject to the same climatic conditions but with different morphological characteristics. The study comprises more than 4 years of data, from November 2001 to March 2006, obtained through an Argus video system (Holman and Stanley, 2007). The extraction of the shoreline and barline locations is accomplished using 10-minute time-exposure video images. Shorelines were extracted directly from oblique images (see Ojeda and Guillén, [2008] for a complete description) and rectified afterwards. Sandbars were inferred from the rectified time-exposure video images based on the preferential wave breaking over shallow areas, so they required a minimum significant wave height (Hs) which allowed the occurrence of a clear wave-breaking pattern. The barline extraction was accomplished through an automated alongshore tracking of the intensity maxima across each beach section (Van Enckevort and Ruessink, 2001).

The mean Hs during the study period was 0.71 m and the averaged peak period was 5.7 s. The wave height time series shows a cyclic behaviour, with storm periods (October-April) separated by periods of low storm activity (May-October). The two most energetic periods affecting the beaches were from October 2001 to May 2002 and from October 2003 to April 2004 (wave data were obtained from a WANA node [virtual buoy] and direct measurements of the Barcelona-Coastal buoy). Approximately 25 storm events have been identified during the study period (following Ojeda and Guillén [2008], significant storms were defined as those with Hs higher than 2.5 m during the peak of the storm and a minimum duration of 12 h with Hs greater than 1.5 m).

The morphological responses of the beach to the storm action determine the morphodynamic state. These responses were grouped into five categories: shoreline advance or retreat, beach rotation, sandbar migration, formation of megacusps, and changes in the sandbar configuration (linear or crescentic shape). The intensity and frequency of these modifications were different in both beaches. Regarding the changes in the morphodynamic state of the beaches, the bar at Bogatell switched more frequently among the four intermediate morphodynamic states during the study period than the bar at La Barceloneta. The bar at La Barceloneta only underwent the complete “reset” of the nearshore morphology (i.e., abrupt change of the plan-view shape of the beach towards a Longshore Bar and Trough state) once, associated with the high-energy wave event occurring on November 2001.

At this beach, the strongest storm events produced the offshore migration of the bar and a certain decrease in the bar sinuosity, but did not generate an alongshore parallel bar.

Similar storms caused different effects on the two adjacent beaches and, furthermore, the effect of storms of similar characteristics at the same beach, were also different. In the final paper, we will focus on these differential behaviours in an attempt to attain a certain predictability of the beach behaviour after a storm depending on the wave characteristics and the morphodynamic configuration of the beach prior to the storm.

ACKNOWLEDGMENTS
This work was funded by the Spanish Ministry of Science and Technology within the project SEDMET (CTM2006-06919). The work of E. Ojeda and F. Ribas was partially supported by the Spanish government through the FPU and Juan de la Cierva programs, correspondingly. The authors would like to thank Dr. Gerben Ruessink for providing the BLIM software and Puertos del Estado for the wave data.

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