Geophysical Research Abstracts
Vol. 16, EGU2014-15458, 2014
EGU General Assembly 2014

Impacts of an "extreme" storm on a low-lying embayed sandy beach (Pals Bay, NW Mediterranean)

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The present study aims to assess the effects of an extreme storm in the medium-term evolution of a low-lying, low-tidal sandy coast based on airborne LIDAR (LIght Detection and Ranging) derived high-resolution topographic data. LIDAR data were acquired by the Institut Cartogràfic de Catalunya and analyzed in a Geographical Information System (GIS) environment in order to estimate the shoreline displacement (advance or retreat), volumetric changes of the emerged beach, dune erosion and overswash. LIDAR surveys were undertaken in October 2008 and August 2009 to evaluate the impact of an extreme storm that severely hit the north-west Mediterranean coast on 26 December 2008. During this storm, maximum significant wave heights of 7.5 m (with peaks of 14.4 m of maximum wave height) and maximum wave peak period of 12.8 s were recorded at the Palamós buoy, located at 90 m depth. In addition, several weak to moderate storms also occurred during the study period.

The Pals Bay in the northern of Catalonia (NW Mediterranean) has been chosen for this study because: (i) it is a low-lying coastal land, which makes the coastline highly susceptible to flooding by waves during storms; and (ii) it includes high natural value areas and urbanized ones that show different behavior under the impact of storms. It comprises three beaches: the Pals Bay beach that extends along 6840 m between L'Estartit and Begur promontories, and two pocket beaches located at the southern end of the Pals Bay, Cala Moreta and Sa Riera, which are only 185 m and 188 m long, respectively.

During the study period, shoreline position and volumetric changes in the large bay beach were not homogeneous. The coastline variations showed alongshore fluctuations up to 40 m, probably related to the development of rhythmic topographies in form of beach cups. Overall, the emerged beach experienced a net volumetric loss of -62 516 m3 (-9.14 m3/m). However, the loss of sediment was not uniform. In urbanized areas, sediment erosion occurred along the whole beach profile, whereas in natural areas foreshore erosion was accompanied by net accumulation of sediment in the backshore. This positive volumetric gain in the upper beach could be largely attributed to overwash processes during the extreme storm, which also caused dune erosion and overwash fan deposition. Nevertheless, the smaller pocked beaches behaved differently. In Cala Moreta, shoreline evolution presented an anti-clockwise rotation of the beach, with a small net loss of sediment of -265 m3 (-1.43 m3/m). Sa Riera showed a small retreat of the shoreline and an important accumulation of sediment in the backshore that resulted in a net positive volume balance in the emerged beach of +2515 m3 (+13.38 m3/m).