Flooding, erosion and coastal structures hazards on the Spanish coast

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Coastal flooding, beach erosion and coastal structures can be affected by long-term changes in sea level and in the storminess. Each beach or construction requires a specific study for a proper estimation of coastal hazards. However, high resolution regional studies are useful to decision-makers to focus in the most endangered areas. The aim of this work is to provide an overview of coastal risks along the Spanish coast.

Four different databases providing hourly data have been used to study 423 local sites along the Spanish coastline (around 10 Km spatial resolution). 1- The mean sea level was estimated from satellite and tide-gauges based on Church et al. (2004). 2- The astronomical tide was assessed from the Spanish tide-gauge network interpolating 68 tidal constituents to obtain a tide series for each local site. 3- The coastal surge data come from a numerical reanalysis (GOS) with 1/8 degree spatial resolution performed by using the 2-D barotropic Regional Ocean Modeling System (ROMS) model. 4- Nearshore wave time series (at 15-25 m water depth) are provided from a reanalysis obtained from a hybrid downscaling along the Spanish coast (Camus et al., 2013).

Flooding can be considered as the combined result of mean sea level, tidal level, surge level and run-up. Run-up has been assessed by the Stockdon et al. (2006) formulation from the wave time series. We reconstructed hourly flood level time series from their components in the selected locations during 60 years (from 1950 to 2009). A time-dependent extreme value model based on Pareto and Poisson probability distributions has been developed for magnitude and frequency respectively. Long-term trends and their statistical significance, and future changes on flooding return levels (e.g. 20 year return level) have been estimated.

Two main causes of beach erosion have been analyzed. The shoreline retreat induced by sea level rise has been quantified by using Bruun's rule, and the erosion due to changes in the orientation of the beaches has been assessed as the response to changes in mean energy flux direction.

Changes on reliability and functionality of coastal structures are associated to changes on dynamics. In order to quantify the effects, different indicators have been developed. Number of hours with significant wave height larger than 3 meters (breakdowns), changes in weight of blocks for a representative breakwater (stability) and overtopping for a given breakwater (operability).

Results show significant positive trends in flooding and erosion along the entire Spanish coastline. Coastal structures are expected to be under more severe conditions (reduction of functionality and reliability) in most of the analyzed locations.