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A robust methodology for regional-scale analysis of storm-induced coastal hazards

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Coastal vulnerability to storms can be simply defined as the potential of a coastal stretch to be harmed by the impact of a storm. Its assessment includes accounting for the modification of the coastal substrate (morphodynamic response to storms, i.e. coastal hazards) and the affectation of socio-economic and environmental values. This will serve to managers to assess the expected magnitude of damages along the coast due to storm hazards to take (informed) decisions on mitigation/adaptation strategies. Its utility is clearly reflected in the Protocol on ICZM in the Mediterranean where countries are advised to undertake hazard assessments of coastal zones to address the effects of natural disasters.

Within this context, the main aim of this work is to develop a robust methodology to compare storm-induced hazards along the coast at regional scale. The method will be developed for and applied to the Catalan Coast.

In this work, we consider that main coastal responses (hazard) induced by the impact of a storm are large sediment transport rates, beach erosion and inundation. The magnitude of the response will be the integrated result of two contributions: the one associated with the forcing, i.e. determined by the storm properties and, the one associated with the receptor, which take into account the role of the coastal geomorphology in modulating the morphodynamic processes. The relative role of each of these components will control the hazard source along the coast and it will be bounded within two (idealized) situations: (i) the case of a geomorphic homogenous coast, where regional variations in hazard intensity will be driven by differences in storm properties along the coast and, (ii) the case of a spatial uniform storm climate, where regional differences in hazard intensity will be controlled by the spatial changes in coastal geomorphology.

Since, it is not likely that none of these two "pure" situations will occur, we have developed a methodology able to analyze the contribution of each factor (storm and geomorphology) to the overall hazard intensity. This will serve to compare the relative importance of each hazard source along the coast and, to provide managers with information on which should be the main factor to be modified if coastal hazards have to be managed.

The first step consists in building a data set characterising storms in the study area. In this case, we have used a 50-years long time series of wave conditions obtained by combining hindcasted and recorded wave data along the Catalan coast. This has been done for different locations along the coast in order to cover a total coast length of about 400 km. This data set consists in a series of storms (defined as events where the significant wave height exceeds a value of 2 m during a minimum period of 6 hours) covering the period from 1958 to 2008. Each storm is characterized by the significant wave height at the peak of the storm, associated peak wave period and direction (also at the peak of the storm) and duration.

Once storms were defined, the second step was to obtain time series of parameters characterizing storm-induced hazards. This was done in two ways: (i) by using a simplified version of hazard parameters where only the forcing contribution (wave parameters) was retained and, (ii) by using a full version where the contribution of coastal geomorphology is also accounted for. The first option is used to analyze the spatial variation in hazard's intensity due to storm properties (to analyze the climatic contribution) whereas the second serves to analyze the modulation in processes introduced by local factors (the geomorphic contribution).

These sets of parameters were fitted to an extreme function probability distribution resulting in different hazard intensity probability distributions along the coast. With this, we can compare the storm hazards along the coast by obtaining the intensity of considered hazard associated with a given probability in each location.

Obtained results show that, if we only consider the forcing contribution to the hazard, the Southern part of the Catalan coast is the most hazardous in terms of erosion and sediment transport potential, whereas the Northern part is the most hazardous in terms of inundation. If we also consider the receptor contribution, there is a change in the relative intensity of the hazards along the coast. Thus, the inundation and erosion potentials decrease at the S coast and increase at the N coast.

The full paper will present in detail the developed methodology and its application to analyze the spatial variations in storm-induced hazards intensity along the Catalan coast.