

Coastal vulnerability assessment of the French Mediterranean coasts to storms flooding and erosion phenomena, and morphodynamic modeling under climate change projections

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INTRODUCTION

Storm events on sandy coastal environments already weakened by a sediment deficit can generate a strong erosion of the beach-dune system, accentuating the phenomena of marine flooding and damage to infrastructures. In order to assess this risk of coastal flooding under stormy conditions and taking into account climate change and the new IPCC projection (IPCC, 2021), modeling approaches nowadays provide a robust tool. In this study, a modeling chain is used to simulate present-day and future coastal hazards on the Mediterranean French coastline, taking into account the complex interaction of hydrodynamic and morphodynamic phenomena.

METHOD

In order to build a regional strategy for the evaluation of the coastal hazards under storm events, a methodology is proposed to evaluate the reality of a potential increase of coastal flooding following dune/beach erosion and to identify the concerned coastal regions for prioritizing regional coastal zone management actions.

First, a coastal-dune vulnerability index is built at a regional scale and a clustering analysis used to identify the most vulnerable sites. Then, two representative sites are used for being modelled for coastal flooding assessment, under climate change scenarios.

The vulnerability index which will be presented is based on an adaptation of the protocol proposed by García-Mora et al. (2000, 2001), Idier et al. (2013) and applied in Ciccarelli et al. (2017). Four groups of variables have been studied: geomorphological conditions of the dune system, marine influence, vegetation condition and the anthropic effects. This coastal vulnerability index is adapted to the specific peculiarities of the French Mediterranean Sea. In this study, 81 coastal sectors, based on geomorphic features are chosen and 17 variables, including both the quantitative and the qualitative parameters, are considered in the coastal dune vulnerability classification. A hierarchical clustering to create homogeneous sector groups from the similarity matrix of sector variables is applied.

The sites of Canet-en-Roussillon and Sète are chosen from the two main clusters for a numerical approach to analyse the effects of storm erosion on the magnitude of flooding, based on the coupling of SWAN and the Xbeach morphodynamic model, in its surfbeat mode. This implementation allowed a calibration phase using historical data available under storms events, a large sensitivity test to adjust physical and numerical parameters is performed. This approach allowed identifying the main processes leading to flooding. In a second step, the modeling chain is used to simulate extreme events scenarios with a 10 and 50-year return period (on wave heights), by including the sea level rise

contributions, in order to assess the coastal risks associated.

RESULTS

The amplitude of the erosion and flooding at both sites are in line with observations made during and after storms. Figure 1 shows the profile-based Xbeach performance at Canet-en-Roussillon. The vulnerability index with the clustering procedure will be further presented in the main paper, beside with the complete results and discussions analysis of the modeling chain including the IPCC projections scenarios.

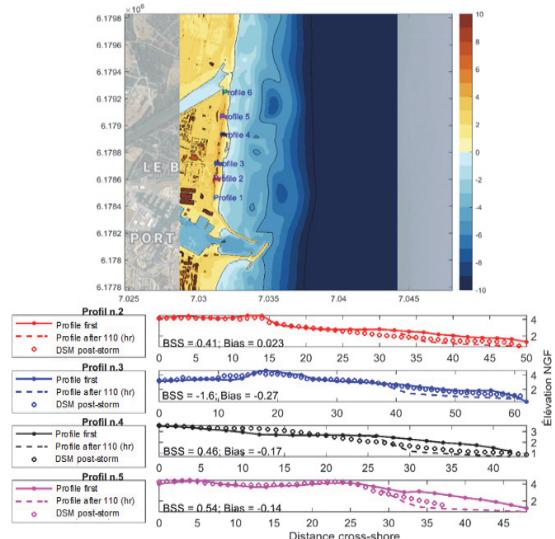


Figure 1. Canet-en-Roussillon (France) site, model boundary and bathymetry (top). Comparison between the XBeach calculated and measured beach profiles after storm. BSS performance and bias averaged over the profiles are shown (down).

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