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Marine submersion is an increasing concern for coastal cities as urban development reinforces their vulnerabilities while climate change is likely to foster the frequency and magnitude of submersions. Characterising the coastal flooding hazard is therefore of paramount importance to ensure the security of people living in such places and for coastal planning.

A hazard is commonly defined as an adverse phenomenon, often represented by a magnitude of a variable of interest (e.g. flooded area), hereafter called response variable, associated with a probability of exceedance or, alternatively, a return period. Characterising the coastal flooding hazard consists in finding the correspondence between the magnitude and the return period. The difficulty lies in the fact that the assessment is usually performed using physical numerical models taking as inputs scenarios composed by multiple forcing conditions that are most of the time interdependent. Indeed, a time series of the response variable is usually not available so we have to deal instead with time series of forcing variables (e.g. water level, waves). Thus, the problem is twofold: first, the definition of scenarios is a multivariate matter; second, it is approximate to associate the resulting response, being the output of the physical numerical model, to the return period defined for the scenarios.

In this study, we illustrate the problem on the densely urbanised city of Leucate, located in the French Mediterranean coast, for two response variables (namely inundated areas and inland water volumes). A multivariate extreme value analysis of waves and water levels is performed offshore using a conditional extreme model, then two different methods are used to define and select 100-year scenarios of forcing variables: one based on joint exceedance probability contours, a method classically used in coastal risks studies, the other based on environmental contours, which are commonly used in the field of structural engineering. We show that, under the reasonable assumption that the failure region (i.e. the set of forcing conditions leading to a higher value of a given response variable) is convex, these two methods enable one to frame the true 100-year return value of the response variable. The selected scenarios are propagated to the shore through a high resolution flood modelling coupling overflowing and overtopping processes. Results in terms of inundated areas and inland water volumes are finally compared for the two methods, giving upper and lower bounds for the true 100-year return values of the response variables.