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Site-specific seismic probabilistic tsunami hazard analysis: performances and potential applications

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Seismic Probabilistic Tsunami Hazard Analysis (SPTHA) provides probabilities to exceed different thresholds of tsunami hazard intensity, at a specific site or region and in a given time span, for tsunamis caused by seismic sources. Results obtained by SPTHA (i.e. probabilistic hazard curves and inundation maps) represent a very important input to risk analyses and land use planning. However, the large variability of source parameters implies the definition of a huge number of potential tsunami scenarios, whose omission could lead to a biased analysis. Moreover, tsunami propagation from source to target requires the use of very expensive numerical simulations. At regional scale, the computational cost can be reduced using assumptions on the tsunami modeling (i.e. neglecting non-linear effects, using coarse topo-bathymetric meshes, empirically extrapolating maximum wave heights on the coast). On the other hand, moving to local scale, a much higher resolution is required and such assumptions drop out, since detailed inundation maps require significantly greater computational resources.

In this work we apply a multi-step method to perform a site-specific SPTHA which can be summarized in the following steps: i) to perform a regional hazard assessment to account for both the aleatory and epistemic uncertainties of the seismic source, by combining the use of an event tree and an ensemble modeling technique; ii) to apply a filtering procedure which use a cluster analysis to define a significantly reduced number of representative scenarios contributing to the hazard of a specific target site; iii) to perform high resolution numerical simulations only for these representative scenarios and for a subset of near field sources placed in very shallow waters and/or whose coseismic displacements induce ground uplift or subsidence at the target.

The method is applied to three target areas in the Mediterranean located around the cities of Milazzo (Italy), Thessaloniki (Greece) and Siracusa (Italy). The latter target analysis is enriched by the use of local observed tsunami data, both geological and historical. Indeed, tsunami data-sets available for Siracusa are particularly rich with respect to the scarce and heterogeneous data-sets usually available elsewhere. Therefore, they can represent a further valuable source of information to benchmark and strengthen the results of such kind of studies.

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