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Probabilistic estimation of earthquake-induced tsunami occurrences in the Adriatic and northern Ionian seas

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In the framework of the EU-funded project TRANSFER (Tsunami Risk ANd Strategies For the European Region we faced the problem of assessing quantitatively the tsunami hazard in the Adriatic and north Ionian Seas. Tsunami catalogues indicate that the Ionian Sea coasts has been hit by several large historical tsunamis, some of which of local nature (especially along eastern Sicily, eastern Calabria and the Greek Ionian Islands), while others had trans-basin relevance, like those generated in correspondence with the western Hellenic Trench. In the Adriatic Sea the historical tsunami activity is indeed lower, but not negligible: the most exposed regions on the western side of the basin are Romagna-Marche, Gargano and southern Apulia, while in the eastern side the Dalmatian and Albanian coastlines show the largest tsunami exposure.

To quantitatively assess the exposure of the selected coastlines to tsunamis we used a hybrid statistical-deterministic approach, already applied in the recent past to the southern Tyrrhenian and Ionian coasts of Italy. The general idea is to base the tsunami hazard analyses on the computation of the probability of occurrence of tsunamigenic earthquakes, which is appropriate in basins where the number of known historical tsunamis is too scarce to be used in reliable statistical analyses, and the largest part of the tsunamis had tectonic origin. The approach is based on the combination of two steps of different nature. The first step consists in the creation of a single homogeneous earthquake catalogue starting from suitably selected catalogues pertaining to each of the main regions facing the Adriatic and north Ionian basins (Italy, Croatia, Montenegro, Greece). The final catalogue contains 6619 earthquakes with moment magnitude ranging from 4.5 to 8.3 and focal depth lower than 50 km. The limitations in magnitude and depth are based on the assumption that earthquakes of magnitude lower than 4.5 and depth greater than 50 km have no significant tsunamigenic potential. A proper statistical analysis of the catalogue allowed to retrieve the earthquake occurrence rate both at a regional scale and, most importantly, in each of the 30'x30' cells in which the studied geographical domain has been divided into. The final result of the statistical analysis is the computation for each cell of the a- and b-values of a truncated Gutenberg-Richter law. The second step is of more deterministic nature and consists in the tsunamigenic potential determination by using suitable relationships between the earthquake magnitude and the initial disturbance of the sea in each cell. To maximize the coseismic displacement and hence the tsunami initial conditions, only vertical faults have been taken into account. Moreover, each cell has been assigned a typical characteristic focal mechanism (strike-slip or dip-slip) based on the available regional focal mechanism databases and on basic tectonic information. For each magnitude and hence for each initial condition offshore, the tsunami height at the coast is computed through simple empirical amplification formulas. The output of this second step is given by the spatial distribution of the minimum magnitude needed to produce tsunami heights at the coast larger than a given threshold. By combining the results coming from the two steps, we finally determine the number and distribution of tsunamigenic earthquakes expected to occur over a given time interval and to produce tsunami heights larger than a given threshold along any stretch of coast of the selected domain. We will present maps relative to different tsunami height thresholds over a time interval of 10,000 years and discuss the compatibility with the information retrievable from the TRANSFER European tsunami catalogue on one side, and on the other the expected strong relation between the distribution of the parent seismicity and of the resulting tsunami effects, including the importance of doubtful or disputable epicentral determinations for historical earthquakes of moderate to large magnitude.