Geophysical Research Abstracts,
Vol. 11, EGU2009-2537-1, 2009
EGU General Assembly 2009

Does the source of the 28 December 1908 Messina Straits tsunami coincide with the earthquake source? Hints from tsunami numerical modelling

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Together with eastern Sicily and Calabria, the Messina Straits is the region with the highest tsunamigenic occurrence rate in Italy. Tsunami catalogues indicate that the tsunami hazard in the Messina Straits is related to both local and remote sources, where remote refers to sources placed just outside the Straits (i.e. southern Tyrrhenian and eastern Sicily), and also to sources found at great distances, like the Western Hellenic Arc. Moreover, the Straits has historically been impacted by tsunamis generated by earthquakes as well as by landslides. The most recent and probably most famous event of catastrophic dimensions is the 28 December 1908 tsunami which followed a M=7.1-7.2 earthquake that razed to the ground the cities of Messina and Reggio Calabria, placed on the two opposite sides of the Straits. The effects of the tsunami are described in a large number of contemporary reports and have been recently revised by different authors to produce a set of data comprising run-up measurements, time delays between the earthquake occurrence and the first tsunami arrival, and first tsunami polarities in several coastal places located inside and outside the Straits. Similarly to other historical tsunamis contained in the Italian tsunami catalogue and following large earthquakes, the source for the 1908 event is debated, both as regards the earthquake and the tsunami. Several fault models have been proposed through the years based on the inversion or analysis of different kind of data. But usually the fault models retrieved by inverting macroseismic, seismological or geodetic data do not reproduce satisfactorily the tsunami observations. Recently it has been proposed (Billi et al., 2008) that a submarine landslide and not the earthquake was the responsible for the tsunami generation. In the framework of the EU-funded project TRANSFER (Tsunami Risk and Strategies For the European Region), coordinated by the Department of Physics of the University of Bologna, Italy, and of the Italian DPC-INGV-S1 project, we simulate numerically the generation, propagation and impact of the tsunami waves generated by earthquake and landslide sources taken from the available literature, with the goal of understanding which of the hypotheses proposed so far best reproduces the tsunami first arrival polarities, the first arrival timings and the run-up heights. From the modelling point of view, the initial condition for earthquake-generated tsunamis is taken to coincide with the vertical coseismic displacement and is computed through the analytical formulas by Okada (1992). The generation by landslides is simulated by means of the Lagrangian numerical model UBO-BLOCK2, developed and maintained by the Tsunami Research Team at the University of Bologna, Italy. The finite difference model UBO-TSUFD, developed by the same research group, is used to compute the tsunami propagation and impact.