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Using faults for PSHA in a volcanic context: the Etna case (Southern Italy)

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At Mt. Etna volcano (Southern Italy), recurrent volcano-tectonic earthquakes affect the urbanised areas, with an overall population of about 400,000 and with important infrastructures and lifelines. For this reason, seismic hazard analyses have been undertaken in the last decade focusing on the capability of local faults to generate damaging earthquakes especially in the short-term (30-5 yrs); these results have to be intended as complementary to the regulatory seismic hazard maps, and devoted to establish priority in the seismic retrofitting of the exposed municipalities. Starting from past experience, in the framework of the V3 Project funded by the Italian Department of Civil Defense we performed a fully probabilistic seismic hazard assessment by using an original definition of seismic sources and ground-motion prediction equations specifically derived for this volcanic area; calculations are referred to a new brand topographic surface (Mt. Etna reaches more than 3,000 m in elevation, in less than 20 km from the coast), and to both Poissonian and time-dependent occurrence models.

We present at first the process of defining seismic sources that includes individual faults, seismic zones and gridded seismicity; they are obtained by integrating geological field data with long-term (the historical macroseismic catalogue) and short-term earthquake data (the instrumental catalogue). The analysis of the Frequency Magnitude Distribution identifies areas in the volcanic complex, with a- and b-values of the Gutenberg-Richter relationship representative of different dynamic processes. Then, we discuss the variability of the mean occurrence times of major earthquakes along the main Etnean faults estimated by using a purely geologic approach. This analysis has been carried out through the software code FISH, a Matlab® tool developed to turn fault data representative of the seismogenic process into hazard models. The utilization of a magnitude-size scaling relationship specific for volcanic areas is a key element: the FiSH code may thus calculate the most probable values of characteristic expected magnitude (Mchar) with the associated standard deviation σ, the corresponding mean recurrence times (Tmean) and the aperiodicity factor [U+F061] for each fault.

Finally, we show some results obtained by the OpenQuake-engine by considering a conceptual logic tree model organised in several branches (zone and zoneless, historical and geological rates, Poisson and time-dependent assumptions). Maps are referred to various exposure periods (10% exceeding probability in 30-5 years) and different spectral accelerations.

The volcanic region of Mt. Etna represents a perfect lab for fault-based PSHA; the large dataset of input parameters used in the calculations allows testing different methodological approaches and validating some conceptual procedures.