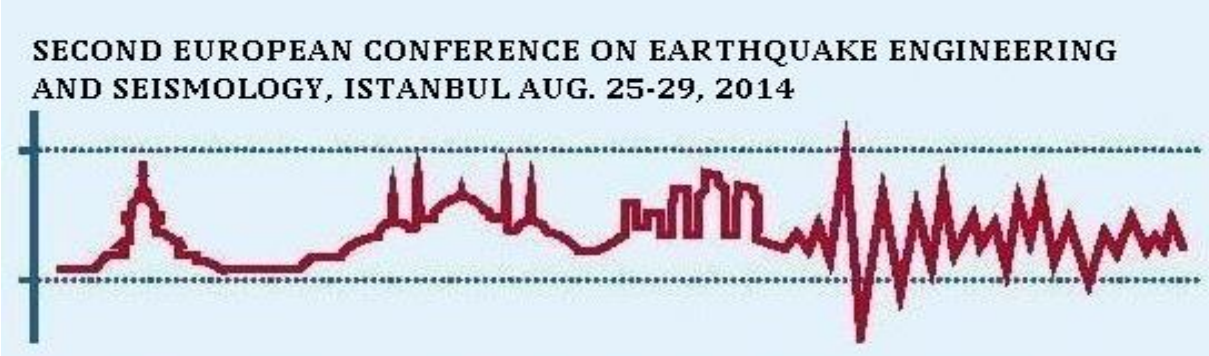

PROBABILISTIC SEISMIC HAZARD ASSESSMENT IN THE MT. ETNA REGION (ITALY): APPLICATION TO LOCAL VOLCANO-TECTONIC EARTHQUAKES

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Earthquakes are, by far, the most relevant source of hazard for the densely urbanised areas of Mt. Etna region. Local communities living in the eastern and southern flanks of the volcano continuously suffer social and economic losses due to the very high occurrence of damaging earthquakes, which produce intensities up to degree X EMS despite of low energy (M < 5.0). Seismic hazard in the Mt. Etna region is controlled by two distinct types of earthquakes, namely regional and local events, which have different magnitudes and frequencies (Azzaro et al., 2008). In particular, hazard deriving from local volcano-tectonic events can be relevant if short exposure times (30 years) are considered, since the reference intensity (I_{ref}) calculated at the exceeding probability of 10% reaches, in some localities, the IX degree (Azzaro et al., 2008; Azzaro et al., 2013).

In the framework of the UPStrat-MAFA project, the seismic hazard was performed following the probabilistic approach (PSHA) based on historical macroseismic data, by using the SASHA code (D'Amico and Albarello, 2008; Albarello and D'Amico, 2013) which has been implemented in the project itself. This approach uses intensity site observations to compute the seismic history for each investigated locality; results are obtained in terms of maximum expected intensity with an exceedance probability ≥ 10% for a given exposure time. In this study we produced PSHA maps referred to local volcano-tectonic seismicity.

The input dataset - earthquake parameters and intensity database - is the historical macroseismic catalogue of Mt. Etna earthquakes (CMTE, 2009), originally covering the period of 1832-2008 but now extended as far back as 1600 and up to 2013 (Azzaro and Castelli, 2014; Azzaro et al., 2014). To improve the completeness of the site seismic histories, the dataset of the observed intensities is integrated with 'virtual' values, calculated according to attenuation laws, starting from the earthquake parameters (epicentre and epicentral intensity). We applied the attenuation model based on Bayesian statistics specifically performed for the Etna region (Azzaro et al., 2013), which provides the probabilistic distribution of the intensity at a given site (Zonno et al., 2009), so that it is possible to quantify the intrinsic uncertainty of the decay process (Magri et al., 1994; Albarello and D'Amico, 2004). In this study we used the new parameters of the inverse power function calculated in the framework of the UPStrat-MAFA project, which modified the attenuation models previously determined by Azzaro et al. (2013).

The hazard maps are calculated using a grid with nodes spaced 1 km apart both in longitude and latitude. In this configuration, SASHA reconstructs the seismic history at each grid node using, for each earthquake, the greater value of the intensity observed (I_{site}) inside a search radius of 1 km from the node centre. If the I_{site} data are missing, the 'virtual' intensity is computed by the attenuation relationships described above. The probability distribution of the expected intensities at a given site is calculated for exposure times of 50, 30 and 10 years. The reference intensity (I_{ref}) is computed as the higher intensity with an exceedance probability ≥ 10%. PSHA maps are shown in Figure 1.

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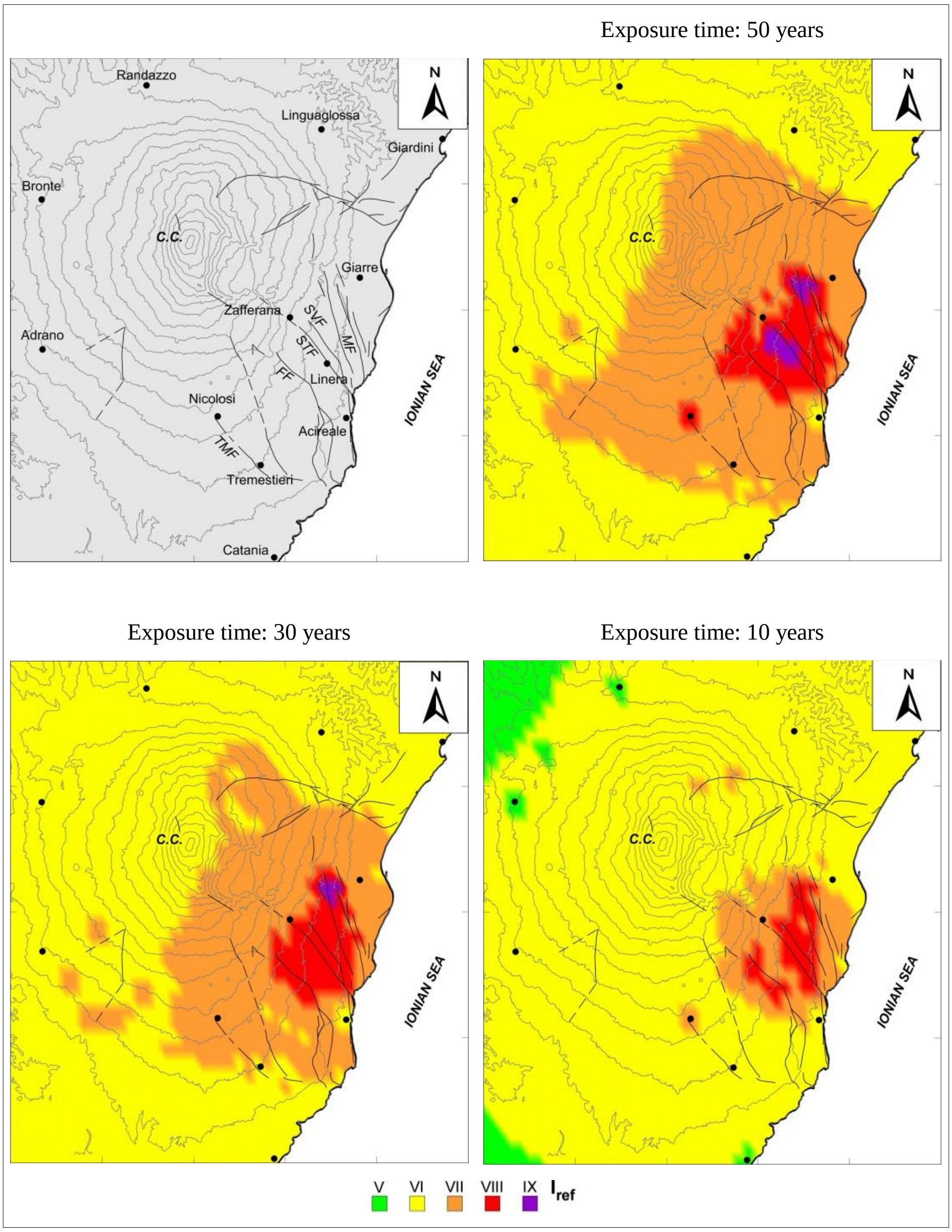

Figure 1. Seismic hazard maps (I_{ref}) with a probability of exceedance $\geq 10\%$, calculated for exposure times of 50, 30 and 10 years. Upper left, localities and faults described in the text; MF, Moscarello Fault; SVF, S. Venerina Fault; STF, S. Tecla Fault; FF, Fiandaca fault; TMF, Tremestieri Fault.

The map for 50 years of exposure time shows that the highest level of hazard affects the eastern flank, with values of I_{ref} VIII on a part of this sector, and two spots of I_{ref} IX along the Moscarello Fault and the S. Tecla Fault. Another area exposed to severe damage (I_{ref} VIII) is the village of Nicolosi, which is located just at the northern tip of the Tremestieri Fault on the southern flank of the volcano. Most of the Mt. Etna region shows a background value of I_{ref} VII, while the periphery of Etna including the city of Catania and the towns of Bronte and Randazzo, is exposed to slight damage (I_{ref} VI). The PSHA map calculated for 30 years is quite similar, confirming the high level of hazard in the eastern flank especially along the Moscarello fault also in the mid-term assessment.

Finally, the map calculated for 10 years of exposure times confirms the above results: a maximum value of I_{ref} VIII affects a narrow area crossed by the seismogenic faults with the highest seismic potential, namely the S. Tecla-S. Venerina-Moscarello Faults. A small spot of I_{ref} VIII also appears south of Zafferana, along the northern segment of the Fiandaca Fault.

As a final point, we also performed a deaggregation analysis (Albarello, 2012) in order to determine the earthquakes more important for the hazard of some localities in the eastern flank. The probability values of I_{ref} are binned into classes of epicentral distances (2 km each) and magnitude (0.5 units each); the highest probability values for each earthquake were summed up in the relevant distance / magnitude bin, and normalized to provide a sort of 'disaggregation' map.

The results are also used in other tasks of the UPStrat-MAFA project, in order to produce seismic scenarios and evaluate seismic risk (application of the Desruption Index).

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