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Italian Case Studies Modelling Complex Earthquake Sources In PSHA

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This study presents two examples of modelling complex seismic sources in Italy, done in the framework of regional probabilistic seismic hazard assessment (PSHA).

The first case study is for an area centred around Collalto Stoccaggio, a natural gas storage facility in Northern Italy, located within a system of potentially seismogenic thrust faults in the Venetian Plain. The storage exploits a depleted natural gas reservoir located within an actively growing anticline, which is likely driven by the Montello Fault, the underlying blind thrust. This fault has been well identified by microseismic activity (M<2) detected by a local seismometric network installed in 2012 (http://rete-collalto.crs.inogs.it/). At this time, no correlation can be identified between the gas storage activity and local seismicity, so we proceed with a PSHA that considers only natural seismicity, where the rates of earthquakes are assumed to be time-independent. The source model consists of faults and distributed seismicity to consider earthquakes that cannot be associated to specific structures. All potentially active faults within 50 km of the site are considered, and are modelled as 3D listric surfaces, consistent with the proposed geometry of the Montello Fault. Slip rates are constrained using available geological, geophysical and seismological information. We explore the sensitivity of the hazard results to various parameters affected by epistemic uncertainty, such as ground motions prediction equations with different rupture-to-site distance metrics, fault geometry, and maximum magnitude.

The second case is an innovative study, where we perform aftershock probabilistic seismic hazard assessment (APSHA) in Central Italy, following the Amatrice M6.1 earthquake of August 24th, 2016 (298 casualties) and the subsequent earthquakes of Oct 26th and 30th (M6.1 and M6.6 respectively, no deaths). The aftershock hazard is modelled using a fault source with complex geometry, based on literature data and field evidence associated with the August mainshock. Earthquake activity rates during the very first weeks after the deadly earthquake were used to calibrated an Omori-Utsu decay curve, and the magnitude distribution of aftershocks is assumed to follow a Gutenberg-Richter distribution. We apply uniform and non-uniform spatial distribution of the seismicity across the fault source, by modulating the rates as a decreasing function of distance from the mainshock. The hazard results are computed for short-exposure periods (1 month, before the occurrences of October earthquakes) and compared to the background hazard given by law (MPS04), and to observations at some reference sites. We also show the results of disaggregation computed for the city of Amatrice. Finally, we attempt to update the results in light of the new “main” events that occurred afterwards in the region.

All source modeling and hazard calculations are performed using the OpenQuake engine. We discuss the novelties of these works, and the benefits and limitations of both analyses, particularly in such different contexts of seismic hazard.