Redefining the zoning of active and capable faults in urban areas: the case of the Mt. Marine fault across the Barete and Pizzoli towns (Central Apennines, Italy)

F. Iezzi[1], P. Boncio[2], A. Pizzi[2], T. Piacentini[2,4], B. Pace[2], M. Francescone[2], F. Morelli[2], I. Puliti[2], N. Salvatore[2], A. Blumetti[3], P. Di Manna[3], F. Papasodaro[3], M. Moro[4], E. Falcucci[4], S. Gori[4], M. Saroli[4], I. Nicolosi[4], F. D'Ajello Caracciolo[4], M. Chiappini[4], V. Sapia[4], V. Materni[4], S. Urbini[4], M. Caciagli[4], G. Di Giulio[4], M. Vassallo[4], G. Milana[4], L. Minarelli[4], M. Pischiutta[4], F. Cara[4], V. Sepe[4], C. Doglioni[4].

[1] Dipartimento di Scienze della Terra, dell'Ambiente e delle Risorse, University "Federico II" of Naples, Italy.

[2] Dipartimento di Ingegneria e Geologia, University "G. D'Annunzio" of Chieti-Pescara, Italy.

[3] Istituto Superiore per la Protezione e la Ricerca Ambientale, Rome, Italy.

[4] Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy.

In October 2020, a project has been setup in order to perform detailed studies of the locally-distributed seismic hazard due to coseismic surface faulting (i.e. hazard from active and capable faults) in the areas damaged by the 2016-2017 Central Italy earthquakes. The project was funded by the Italian Government (Commissioner structure for post-earthquake reconstruction), it has been coordinated by INGV, and it has been realized by several Universities (Chieti, L'Aquila, Camerino, Insubria) and Research institutions (CNR, ISPRA, INGV) (https://sisma2016data.it/faglie-attive-e-capaci/). The final aim of the project is to orient the post-earthquake reconstruction and future land development, taking into account the local fault displacement hazard imposed by active faults which have not been not re-activated by the recent sequence, but are expected to produce surface-rupturing earthquakes in the future. The project has also a particular methodological meaning, as it is the first time in Italy that an intensive, systematic and coordinated investigation is performed for zoning active and capable faults in urban areas. The methodological procedure followed the Italian guidelines for land use in areas affected by active and capable faults (Technical Commission on Seismic Microzonation, 2015).

In this work we present preliminary results from the Barete and Pizzoli towns, located nearly 10 km NW of the city of L'Aquila and crossed by the Mt. Marine active normal fault (Central Apennines, Italy). We started from the existing 400 m-wide Attention Zone, shaped around the trace of the Mt. Marine fault during the post-event microzonation studies on the basis of bibliographic data. We moved upon this, firstly constraining the geometry and the activity rates of the multiple fault splays occurring in the area, and subsequently building Susceptibility and Setback Zones around the trace of defined active and capable faults.

We have investigated the several fault segments belonging to the Mt. Marine fault through: (i) multi-temporal analysis of aerial photographs, which contributed to the investigation of the local geomorphology, helping in the identification of potential fault scarps; (ii) detailed morphotectonic analysis of 1m-resolution LiDAR, aimed at investigating fault scarps and quantifying their heights, contributing therefore to discern between scarps of tectonic and anthropogenic origin; (iii) structural-geological fieldwork, aimed at mapping the several fault traces both on limestone bedrock and on continental sediments and to corroborate the tectonic nature of scarps identified during the remote sensing analysis.

Given the intense anthropogenic modifications that lasted for millennia in the area, the identification of the fault traces and of their lateral continuity is not straightforward, especially in proximity of the town of Pizzoli, where the fault is highly segmented. To improve our fault mapping, we have conducted a geophysical campaign in order to (i) verify the presence of potential active and capable faults in key locations highlighted by our field mapping, and to (ii) systematically investigate the existing Attention Zone in proximity of the urban areas. Specifically, we performed 19 electrical resistivity tomography (ERT), 9 Ohm Mapper investigations, and 12 ground penetrating radar (GPR) investigations for a variety of length and investigation depths, aimed at verifying the presence of capable faults in different geological contexts.

To verify the tectonic nature of mapped scarps, and to corroborate the nature of discontinuities in the stratigraphic record shown by geophysical investigations that could resemble faulting evidence, we have performed 6 paleoseismological trenches of variable length, 1 in the town of Barete and 5 in the town of Pizzoli. These trenches have highlighted the presence of multiple fault splays in proximity of the town of Pizzoli, with multiple surface-rupturing earthquakes occurring through time and a maximum vertical coseismic offset up to 80 cm.

Overall, this work allowed us to produce a highly-detailed fault map, where faults have been distinguished for the degree of certainty in the location of the fault trace. This fault map has been then used to build Susceptibility and Respect Zones. Specifically, where the location of the fault trace is certain, we built asymmetric Setback zones 30 m wide around the fault trace (narrower in the footwall and larger in the hangingwall). Where the fault trace is uncertain, or uncertainties persist on the location of the fault after investigation, we built Susceptibility zones the width of which depends on the degree of uncertainty in the location of the fault trace. In general, as for the Setback zones, also the Susceptibility zones are shaped asymmetrically, being wider in the hanging wall.

In conclusion, we want to highlight the importance of applying a multidisciplinary approach, including geological and geophysical methodologies, for investigating active and capable faults exhibiting a large structural complexity. This is an important methodological and procedural step forward for improving geological actions aimed at mitigating fault displacement hazard in urban areas.

References:

Technical Commission on Seismic Microzonation, 2015. Land Use Guidelines for Areas with Active and Capable Faults (ACF), Conference of the Italian Regions and Autonomous Provinces – Civil Protection Department, Rome, 2015.