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The geosciences perspective on seismic response assessment and application to risk mitigation - Guest Editorial

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Abstract

Earthquake effects cause dramatic social damage in terms of deaths, injuries and homeless, as well as economic losses when they impact human activities and infrastructures. During the last four decades, the number of people living in areas potentially exposed to earthquakes has almost doubled, as about 2.7 billion people presently reside in seismically active regions. In the period 2001-2020, earthquakes (and tsunamis) were responsible for an average (per year) of 38,000 killed people, more than 6.2 million affected people, and economic losses of about 35 billion US$ (CRED's

Emergency Events Database, 2021; https:// www.cred.be/publications). Not only the most destructive events (e.g., Sumatra 2004, Haiti 2010, Fukushima 2011), but also minor worldwide distributed earthquakes (about 15,000 per year events with magnitude between 7.0 and 4.0) are continuously revealing the essential role of prevention activities devoted to the assessment, management, and mitigation of seismic risk in urban settlements. This is the case of Italy, one of the Mediterranean regions more prone to seismic activity where even earthquakes of moderate magnitude produced dramatic scenarios of devastated villages and loss of lives. The last earthquakes in northern-central Italy (the 2009 Mw=6.1 L'Aquila event, the 2012 ML=5.9. Emilia event, the 2016-2017 up to Mw 6.5 Amatrice-Norcia sequence) severely damaged many residential and strategic infrastructures, and hundreds of people died after the collapses of structures and unreinforced masonry buildings. For these seismic sequences, several technical and scientific activities were carried out in the emergency and post-emergency phases (i) to collect information related the nature and the source of the seismic event (e.g., Lavecchia et al., 2012; Chiaraluce et al., 2017; Wilkinson et al., 2017; Pezzo et al., 2018), (ii) to identify the extent and evaluation of local site effects in comparison to the building damage pattern (e.g., Tertulliani et al., 2012; Douglas et al., 2015), and (iii) to support reconstruction in the damaged settlements (e.g., Moscatelli et al., 2020; Vessia et al., 2021). We learnt from these emergency and post-emergency activities that a strategy for seismic hazard assessment and risk mitigation requires the combination of multidisciplinary and multiscale approaches to manage heterogeneous datasets and procedures, which would provide limited knowledge and ambiguous results if taken separately. A geosciences perspective should aim to overcome these difficulties by integrating specific case histories and methodological approaches to properly investigate the seismogenic process and the site response. Geological, geotechnical, and geophysical data collected during field activities contribute to the formulation of a reliable conceptual model of the subsoil, with a representation of the geological features and the physical and mechanical behaviour of the geomaterials. Based on field data and model results, geoscientists are required (i) to evaluate the ground shaking level at a target site including the soil amplification phenomena due to local geological conditions (Donati et al., 1998; Calderoni et al. 2010; Sarris et al., 2010; Leyton et al., 2013; Fabbrocino et al., 2015; Papadopoulos et al., 2017; Giallini et al., 2020), (ii) to provide map of active faults and their traces at the surface or imaging buried structures (e.g., Ben-Zion et al., 2003; Galli et al., 2014; Tarabusi & Caputo, 2017; Villani et al., 2018), (iii) to assess the liquefaction susceptibility in saturated sandy soils (Wotherspoon et al., 2012; Papathanassiou et al., 2015; Lai et al., 2019), and (iv) to investigate the phenomena related to slope instabilities (Jibson 2007; Terrier et al., 2014; Nowicki et al, 2014; Allstadt et al., 2018; Martino et al., 2020). A geosciences perspective provides the required link between regional-to-local-scale applications and normative/guidelines devoted to the seismic response assessment and risk mitigation, taking advantage of the upgraded competencies in Earth Science disciplines, and connected with the development of new and improved technological instruments for environmental monitoring and laboratory and in-situ testing.

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