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PERL: A multilevel strategy for liquefaction hazard assessment in complex stratigraphic successions

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In May and June 2012, Emilia region (Italy) was struck by a seismic crisis characterized by more than 2000 earthquakes with two main shocks (20 May and 29 May events with ML 5.9 and 5.8, respectively) and several earthquake-induced effects. Relevant liquefaction events were observed all over the area showing a maximum intensity at San Carlo and Mirabello, two main hamlets in the Terre del Reno Municipality. In this work, a methodology is proposed for assessing liquefaction susceptibility in wide areas characterized by complex geo-stratigraphic conditions through a multi-level approach based on simplified models. To this aim, extensive geological studies and more than one thousand geophysical and geotechnical surveys available from previous studies have been collected in a dedicated geographical information system. The database is structured to guarantee data and metadata harmonization and standardization, useful for the realization of an integrated and interoperable system progressively supplemented with new information. Preliminary 2D and 3D high resolution geological and geotechnical models are elaborated to reconstruct the complex subsoil setting of Terre del Reno area. This study forms the base for the 2D numerical modelling carried out with a finite difference code (FLAC) to identify the mechanism of pore pressure increase and of liquefaction triggering. The rationale behind this study concerns the definition of a simplified approach based on synthetic indicators. Specifically, starting from parametric analyses, the role of different variables on the triggering process is evaluated together with the definition of set of thresholds able to model the occurrence of liquefaction effects. The spatial variability of the soil properties, layering and mechanical characteristics is considered with a geo-statistical approach. A comparison between the liquefaction effects observed in 2012 and the results obtained from calculations is performed for demonstrating the reliability of the proposed approach in extensively simulating a liquefaction occurrence.