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Modelling of shear-wave velocity and soil amplification in the Po Plain sedimentary basin (Italy) to account for site-effects in regional PSHA

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As it is well known, the severity and frequency content of the ground shaking at a site are significantly dependent on the soil characteristics and local geomorphological features (e.g., Stone et al. 1987; Massa et al. 2014). It follows that neglecting site response may result in a severe underestimation of the local ground motion hazard. Therefore, probabilistic seismic hazard analysis (PSHA) based on the assumptions of level ground and exposed bedrock defines only a basic level for the definition of the expected ground motion. Besides studies for critical facilities, where the integration of site-effects into a PSHA has become a standard practice (e.g., Abrahamson et al. 2004; Rodriguez-Marek et al. 2014), detailed hazard mapping inclusive of site-effects is nowadays possible in many regions of the world where extensive seismic microzonation and/or scientific studies have been carrying out, leading to large-scale evaluations of seismic amplification effects.

With the aim of performing a soil hazard analysis in the Po Plain sedimentary basin (Italy), one of the deepest and widest alluvial basin worldwide where several cities and critical facilities are present, we present the results from pseudo-3-D modelling of soil amplification, computed using a new shear-wave velocity model for the study area. The proposed model characterizes the subsoil up to the seismic bedrock depth. Mascandola et al. (2018) identifies the seismic bedrock of the Po Plain in correspondence with a marked increase in the mechanical properties of the subsoil materials, which produces a measurable resonance effect at the surface in the medium-to-long-period range. This corresponds to a marked seismic impedance contrast where the shear-wave velocity approaches, or exceeds, 800 m/s.

The pseudo-3-D shear-wave velocity model is derived through the interpolation of several S-wave velocity profiles obtained from joint 1D inversion of H/V and array data. Locally, the model shows a good agreement with the existing shear-wave velocity profiles. To account for soil amplification in regional PSHA, the model was discretized into a grid. For each grid node, a 1D soil model is defined and a numerical ground response analysis is carried out to compute site amplification functions.

The regional soil hazard is computed by coupling the hazard curves on rock with the gridded amplification functions (e.g., Bazzurro and Cornell, 2004; Barani and Spallarossa, 2017). To avoid double counting of uncertainties related to site response, a partially nonergodic approach will be used (e.g., Rodriguez-Marek et al., 2014) and to propagate the epistemic uncertainty of Vs through the hazard, a multi-SAF approach (Barani and Spallarossa, 2017) will be adopted by random sampling of the soil column.

The results will be compared with conventional PSHA estimations that accounts for site effects through the application of frequency-independent soil factors derived from seismic codes (European Committee for Standardization, 2004; Ministero delle Infrastrutture e dei Trasporti, 2018), or by adopting ground motion prediction equations (GMPEs) for specific ground types.