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Evaluation of the uncertainties introduced by the use of Vs30 proxies in evaluating GMPEs applicability through residual analysis.

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The ground motion prediction equations (GPMEs) are known to be key factors in controlling the seismic hazard levels at specific locations. They have also been highlighted as one of the major sources of uncertainty in seismic hazard assessment studies (e.g., Vilanova and Fonseca, 2007). The amplitude of earthquake ground motion at a specific location is primarily a function of the source characteristics (e.g., magnitude, focal mechanism), the location of the site relatively to the source (distance, azimuth to the fault), and the effect of the near-surface soil characteristics.

During the last decade, the GMPES have evolved from relatively simple equations characterized by a couple of variables to the complex and sophisticated functions embodied by the models developed in the context of the Next Generation Attenuation project of the Pacific Earthquake Engineering Research Center. The modeling of site effects in GMPEs was traditionally performed by using a scaling parameter based on generic site classification (e.g., soft-soil, stiff-soil, rock). Boore et al. (1997) pioneered the explicit use of a quantitative variable – the time-averaged shear-wave velocity in the upper 30 meters (Vs30) – to model the effects of near surface geology in the GMPEs. The Vs30 prevails as the most used single parameter to represent site effects in recent GMPES. However, since shear-wave velocity profiles are seldom available for ground-motion recording stations several proxies have been proposed to estimate Vs30 from more extensively available data. Correlations between Vs30 with the surface geology (e.g., Wills et al., 2006) are the most used for this purpose, although correlations with topographic slope (e.g., Wald et al., 2009) may also be employed.

In the absence of substantial datasets of ground motion data pertaining to earthquakes of engineering interest, the characterization of ground motion for seismic hazard assessment in regions of moderate tectonic activity often relies on GMPES derived for other regions. The evaluation of the degree to which a GMPE obtained for one region may represent the characteristics of ground motion in a different region (target region) has been addressed using weak-motion data together residual analysis (e.g., Scherbaum, Delavaud et al., Vilanova et al., 2012), although the reliability of this approach in still under debate.

The residual analysis performed by Vilanova et al. (2012) to constrain the GMPEs for SW Iberia relied on approaches based on surface geology to estimate the Vs30 parameter at the recording stations. In the context of project SCENE, funded by the Portuguese Science Foundation, shear-wave refraction profiles have been acquired at the sites refraction profiles at sites were permanent seismic stations are deployed. Using the improved metadata the extent of the bias introduced in the residual analysis due to the uncertainties associated with the estimation of the Vs30 parameter when no site-specific measurements are available is evaluated. Insights into the order of magnitude of the uncertainties associated with the acquired shear wave profiles (and corresponding Vs30) are also given by analyzing the impact using a different methodology – the multichannel analysis of surface waves (MASW) – at selected sites.