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Relaxing the ergodic assumption in Europe and Middle East: from ground motion regional attributes to site-specific hazard curves

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The current practice for computing the seismic hazard is based on an ergodic assumption, where the aleatory variability, i.e. the standard deviation sigma of ground motion prediction equation (GMPE) includes the regional differences in ground motion. With the recently published datasets (e.g., NGA2 and RESORCE) it became possible to introduce statistically well-constrained regional adjustments to a GMPE, thus partially mitigating the a-priori assumption of regional ergodicity. Considering a European (RESORCE) strong motion data set, we quantify the regional differences in the apparent attenuation of high frequency ground motion with distance and in linear site amplification with Vs30, between Italy, Turkey, and rest of the Europe- Middle-East region. With respect to a GMPE without regional adjustments, we obtain up to 10% reduction in the aleatory variability sigma, primarily contributed by a 20% reduction in the between-station variability.
The large number of recordings available in RESORCE are also used to develop a framework for computing site specific PSHA, where the standard approach of Rodriguez-Marek et al (2013) is replaced by the analysis of different random effects distributions obtained through a mixed effect regression (Stafford, 2014). In particular, site-specific amplification factors, along with their uncertainties, are computed for more than 300 stations in Europe and, in turn, used to derive partially-ergodic and site-specific hazard curves. Finally, the comparison between the hazard curves obtained using the standard ergodic approach and the partially ergodic proposed in this study is presented for selected sites in Europe.