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Improving 1D Site Specific Velocity Profiles for the Kik-Net Network

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Ground motion predication equations (GMPEs) form the cornerstone of modern seismic hazard assessments. When produced to a high standard they provide reliable estimates of ground motion/spectral acceleration for a given site and earthquake scenario. This information is crucial for engineers to optimise design and for regulators who enforce legal minimum safe design capacities. Classically, GMPEs were built upon the assumption that variability around the median model could be treated as aleatory. As understanding improved, it was noted that the propagation could be segregated into the response of the average path from the source and the response of the site. This is because the heterogeneity of the near-surface lithology is significantly different from that of the bulk path. It was then suggested that the semi-ergodic approach could be taken if the site response could be determined, moving uncertainty away from aleatory to epistemic. The determination of reliable site-specific response models is therefore becoming increasingly critical for ground motion models used in engineering practice.

Today it is common practice to include proxies for site response within the scope of a GMPE, such as Vs30 or site classification, in an effort to reduce the overall uncertainty of the predication at a given site. However, these proxies are not always reliable enough to give confident ground motion estimates, due to the complexity of the near-surface. Other approaches of quantifying the response of the site include detailed numerical simulations (1/2/3D - linear, EQL, non-linear etc.). However, in order to be reliable, they require highly detailed and accurate velocity and, for non-linear analyses, material property models. It is possible to obtain this information through invasive methods, but is expensive, and not feasible for most projects.

Here we propose an alternative method to derive reliable velocity profiles (and their uncertainty), calibrated using almost 20 years of recorded data from the Kik-Net network. First, using a reliable subset of sites, the empirical surface to borehole (S/B) ratio is calculated in the frequency domain using all events recorded at that site. In a subsequent step, we use numerical simulation to produce 1D SH transfer function curves using a suite of stochastic velocity models. Comparing the resulting amplification with the empirical S/B ratio we find optimal 1D velocity models and their uncertainty. The method will be tested to determine the level of initial information required to obtain a reliable Vs profile (e.g., starting Vs model, only Vs30, site-class, H/V ratio etc.) and then applied and tested against data from other regions using site-to-reference or empirical spectral model amplification.