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Single-Path Sigma from a Huge Dataset in Taiwan

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Ground-motion variability, which was used in the probabilistic seismic hazard analysis (PSHA) in computing annual exceedence probability, is composed of random variability (aleatory uncertainty) and model uncertainty (epistemic uncertainty). Finding random variability of ground motions has become an important issue in PSHA, and only the random variability can be used in deriving the annual exceedence probability of ground-motion. Epistemic uncertainty will be put in the logic tree to estimate the total uncertainty of ground-motion.

In the present study, we used about 18,859 records from 158 shallow earthquakes ($M_w > 3.0$, focal depth $\leq$ 35 km, each station has at least 20 records) form the Taiwan Strong-Motion Instrumentation Program (TSMIP) network to analyse the random variability of ground-motion. First, a new ground-motion attenuation model was established by using this huge data set. Second, the residuals from the median attenuation were analysed by direct observation on inter-event variability and site-specific variability. Finally, the single-path variability was found by a moving-window method on either single-earthquake residuals or single-station residuals. A variogram method was also used to find minimum variability for intra-event residuals and inter-event residuals, respectively.

Results reveal that 90% of the single-path sigma σ_{SP} are ranging from 0.219 to 0.254 (ln unit) and are 58% to 64% smaller than the total sigma (σ_T =0.601). The single-site sigma (σ_{SS}) are also 39%–43% smaller. If we use only random variability (single-path sigma) in PSHA, then the resultant hazard level would be 28% and 25% lower than the traditional one (using total sigma) in 475-year and in 2475-year return period, respectively, in Taipei.