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SENSITIVITY OF HAZARD ASSESSMENT TO THE SELECTION OF ATTENUATION RELATIONS AND LOGIC-TREE WEIGHTS

Attenuation relationships for estimating the values of particular ground-motion parameters for future earthquake scenarios constitute a basic tool for Probabilistic Seismic Hazard Assessment (PSHA). The recognition of epistemic uncertainty in ground motion prediction equations has led to it now being common practice not to base probabilistic seismic hazard assessments on a single equation, even if derived specifically for the region in question, but rather to combine two or more applicable equations in a logic-tree (Frankel et al., 2000).

The logic tree (Reiter, 1990) is set up so that for each of the steps in which there is epistemic uncertainty, separate branches are added for each of the choices that the analysts considers feasible. To each of these a normalized weight is assigned that reflects the analyst’s confidence that this is the most correct model. The hazard calculations are then performed following all the possible branches through the logic tree, each analysis producing a single hazard curve showing ground motion against annual frequency of exceedance. The weighting of each hazard curve is determined by multiplying the weights along all of the component branches. The results allow the definition of a mean and a median hazard curve, as well as similar curves for different confidence intervals.

Fig. 1 - Hazard curves for the site of Rosarno and the different attenuation relations considered (each including its own standard deviation).

Due to the expansion of strong-motion networks, the number of proposed attenuation relationships has been strongly increasing in the last decade. A recent comprehensive review (Douglas, 2003) summarizes over 120 studies that have
derived equations for the estimation of PGA and 80 studies that derived equations for the estimation of response spectral ordinates. From among them we decided to select 9 of the most recent and commonly used attenuation models to be used in our sensitivity analyses referring to three ground motion parameters: PGA, spectral acceleration, for 5% critical damping, at 10 Hz and spectral acceleration at 1 Hz.

As different relations use different definitions of independent variables (distance, magnitude, site conditions, style-of-faulting, selection of the horizontal component of ground motion), to ensure a basic consistency and to make different attenuations suitable to be used together in a PSHA logic tree, we adopted simplified empirical adjustments of the independent variables (Bommer et al., 2003).

To check the PSHA sensitivity we selected three sites characterized by low, intermediate, and high seismicity and located respectively in northern (Forlì), central (Nocera Umbra), and southern Italy (Rosarno). Fig. 1 shows an example of the hazard curves obtained for Rosarno with the nine attenuation models selected.

For each site and for each ground motion parameter considered, we investigated the distribution of the hazard curves (mean, median, several percentiles) with different approaches for the selection of the weights assigned to each attenuation model: equal weights, random weights and weights assigned on the basis of an expert judgment. The results emphasize the strong influence of the attenuation on PSHA particularly at long return periods and for high percentiles.

REFERENCES


