A suggestion related to communicating the uncertainties present in probabilistic seismic hazard analysis

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The seismic hazard curve is the elemental product of a probabilistic seismic hazard analysis. A basic assumption is the existence of a correct answer: the true or data-generating hazard curve that would be measured if one could observe the complete history of ground motions at a single site over a time interval greater than 10^4 years. Since this is not observable, and accepting that our best estimates of the hazard curve will be used to make important engineering and financial decisions, the pragmatic path forward is to trust the basic statistical equations used to generate the curve, to test and improve the components of the input, to be sure that the full range of scientific uncertainties is considered in the input, and to make full use of any available constraint on the final curve. The approach to dealing with epistemic uncertainties, through the use of logic trees, is perhaps the most problematic, and will be the primary focus of this paper. Each branch of the logic tree is used to generate a possible hazard curve. The cloud of consequent possible hazard curves displays the range of scientific uncertainty about the true hazard. Ideally, branches of the logic tree should be mutually exclusive and collectively exhaustive (MECE). If these criteria are met, then one curve within the set of possible hazard curves should be the true hazard curve.
I have investigated a logic tree for a single dominant fault in western Nevada, specifically the Mount Rose fault. This is a normal fault that dips beneath Reno, the major city in western Nevada. The spread in the logic trees shows which uncertainties contribute most to the overall uncertainty in the hazard. The weights assigned to logic trees are not probabilities, but under the MECE assumption the tools of probability theory can be used to determine analogous properties of the set of hazard curves. The weights for the branches of the logic tree determine the mean, which is contoured to make hazard maps, and which many users consider to be the best estimate of the hazard. Since, at fixed annual exceedance rate, the spread of hazard estimates is approximately lognormally distributed in this study, the log standard deviation is a fair estimate of the width of the uncertainty in the hazard. Another property, the uncertainty in the mean, was estimated by considering the distribution of mean hazards obtained as the result of randomizing the logic tree weights. Like the mean hazard, these statistical properties depend on the location of the station relative to the fault. Maps can thus be generated contouring these three additional properties. These or similar products should be provided as a part of every PSHA.
The western Nevada study reveals several general directions that are needed to improve PSHA results in this area. In brief, data are essential for reducing the large epistemic uncertainties. Needed data include geological and geodetic studies to characteize the behavior of active faults, detailed microearthquake locations to define subsurface fault geometry, geophysical methods to define basin structures and fault geometry, broadband seismograms in urban areas to reduce uncertainty in site effects, strong motion stations especially on the hanging wall of dipping faults to reduce uncertainty in ground motion models, and characterization of fragile geological structures well enough to recognize untenable branches of the logic tree at low exceedance rates.

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