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Parameter estimation in Probabilistic Seismic Hazard Analysis: current problems and some solutions

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A typical Probabilistic Seismic Hazard Analysis (PSHA) comprises identification of seismic source zones, determination of hazard parameters for these zones, selection of an appropriate ground motion prediction equation (GMPE), and integration over probabilities according the Cornell-McGuire procedure. Determination of hazard parameters often does not receive the attention it deserves, and, therefore, problems therein are often overlooked. Here, many of these problems are identified, and some of them addressed. The parameters that need to be identified are those associated with the frequency-magnitude law, those associated with earthquake recurrence law in time, and the parameters controlling the GMPE. This study is concerned with the frequency-magnitude law and temporal distribution of earthquakes, and not with GMPEs. TheGutenberg-Richter frequency-magnitude law is usually adopted for the frequency-magnitude law, and a Poisson process for earthquake recurrence in time. Accordingly, the parameters that need to be determined are the slope parameter of the Gutenberg-Richter frequency-magnitude law, i.e. the b-value, the maximum value at which the Gutenberg-Richter law applies mmax, and the mean recurrence frequency,λ, of earthquakes. If, instead of the Cornell-McGuire, the "Parametric-Historic procedure" is used, these parameters do not have to be known before the PSHA computations, they are estimated directly during the PSHA computation. The resulting relation for the frequency of ground motion vibration parameters has an analogous functional form to the frequency-magnitude law, which is described by parameters γ (analogous to the b¬-value of the Gutenberg-Richter law) and the maximum possible ground motion amax (analogous to mmax). Originally, the approach was possible to apply only to the simple GMPE, however, recently a method was extended to incorporate more complex forms of GMPE's.
With regards to the parameter mmax, there are numerous methods of estimation, none of which is accepted as the standard one. There is also much controversy surrounding this parameter.
In practice, when estimating the above mentioned parameters from seismic catalogue, the magnitude, mmin, from which a seismic catalogue is complete becomes important.Thus, the parameter mmin is also considered as a parameter to be estimated in practice. Several methods are discussed in the literature, and no specific method is preferred. Methods usually aim at identifying the point where a frequency-magnitude plot starts to deviate from linearity due to data loss.
Parameter estimation is clearly a rich field which deserves much attention and, possibly standardization, of methods. These methods should be the sound and efficient, and a query into which methods are to be used - and for that matter which ones are not to be used - is in order.