

Earthquake Risk: Including Uncertainties in the Ground Motion Calculation

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Project description

Earthquake risk assessment envelopes, within other modules, the evaluation of seismic hazard for the region under study. When stochastic catalogues of earthquakes are used, the ground-motions induced by each earthquake in the catalogue are calculated for a geographic mesh which may be as detailed as of 50m by 50m, and for an area that extends along 200km by 200km. Since a typical event catalogue contains up to 950,000 earthquakes, calculating the induced ground-motions clearly represents a significant computation effort. The ground motion intensities are obtained using equations named "Ground Motion Predictive Equations (GMPE)", which include a term defining the standard deviation from the estimated mean values. This standard deviation represents a measure of the uncertainties related to the calculation of mean ground motions. The GMPEs are not a full time-domain seismic wave propagation model but rather empirical ground-motion equations derived from regression analyses carried out on a database to fit a given functional form. Examples of these are those equations by Atkinson & Boore (2003) or Akkar & Bommer (2007).

Due to the extreme computational effort that would demand the inclusion of the entire distribution around the mean ground motions, at present this step is not included in the calculations. However, taking into account the uncertainties enveloped in the ground-motion estimation is a desirable step, currently hampered by the very high computational demand. This uncertainty is expressed as a standard deviation associated to a Log-normal distribution from the regression analyses done in the derivation of the GMPEs. These uncertainties include both epistemic (science is far away to fully understand and model seismic energy propagation) and aleatory uncertainties.

At the moment these uncertainties in the GMPEs are not included in any commercial model with worldwide business. Therefore, finding a mathematical way to incorporate the distribution around the mean ground-motions without increasing the already demanding computational effort is the scope of this proposal. A suitable solution would definitively represent a milestone in earthquake catastrophe modelling.

A more detailed explanation on how AIR models work and a deep inside view on the GMPEs will be presented and discussed with the study group.

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References

Akkar, S. & Bommer, J.J. (2007). Prediction of elastic displacement response spectra in Europe and the Middle East. *Earthquake Engineering and Structural Dynamics* **36**, 1275-1301.

Atkinson, G.M. & D.M. Boore (2003). Empirical Ground-Motion Relations for Subduction-Zone Earthquakes and Their Application to Cascadia and Other Regions. *Bulletin of the Seismological Society of America* **93**(4), 1703-1729