ABSTRACT

In this study, we address several GMMs that have been proposed in the literature for the application of earthquake hazard assessment in Iceland. We show that they are dramatically inconsistent with the existing strong-motion data which brings their suitability for application in hazard analyses in Iceland in question. However, their different functional forms may have useful applications, and therefore we recalibrate the models to the Icelandic dataset. A Bayesian random effects model that uses a Markov Chain Monte Carlo algorithm for inference is presented to account for uneven sampling of the different earthquakes and correlations of the recorded ground-motion from a single event by partitioning the aleatory variability into inter-event and intra-event components. The results reveal that the recalibrated models seem to fit the recorded data very well in the magnitude and distance range where data is available.

RESIDUALS

Figure 2 shows the residuals plots (in log-10 units) versus distance and magnitude for the original and recalibrated Am05 model. For the sake of space only the residuals for model Am05 are shown but their behavior is quite representative of the overall residual behavior of the other models considered in this study.

GROUND-MOTION VARIABILITY

The model-to-model variability in the median predictions is obtained for estimating the minimum epistemic uncertainty (Atik and Youngs, 2014). The variability among the median ground-motion estimates of the original and recalibrated models for different magnitudes at two site classes is compared and shown in Fig 3. The thick line and the gray shaded area represent the mean and the standard deviation, respectively. The red solid line shows the epistemic uncertainty proposed by Atkinson and Adams (2013).

Hazard maps using a Monte Carlo PSA

A Monte Carlo basis approach is used to provide probabilistic seismic hazard maps for North Iceland. The seismic source zones and associated seismicity parameters proposed in the simplified source model of Sigbjörnsson and Snæbjörnsson (2007) are used to illustrate the hazard variability. To show how the GMM variability manifests as uncertainty of the earthquake hazard, the standard deviation and coefficient of variation of PGA for two hazard levels based on the original and recalibrated GMMs have been calculated over a dense grid over North Iceland.

residuals versus distance and magnitude for the original and recalibrated Am05 model. The solid line is the least-squares linear regression line and the dashed lines are the 95% confidence limits.

Conclusions

• Many of the GMMs in previous PSA studies for Iceland may not necessarily be appropriate. Therefore, the GMMs have been recalibrated to Icelandic strong-motion data.
• The residuals versus magnitude and distance have been centered on zero throughout the range of fitted values which indicate the recalibrated GMMs are unbiased over the magnitude and distance range of the data.
• The spatial variation of hazard uncertainty and coefficient of variance shows how the epistemic uncertainty of the GMMs is translated into the hazard, especially at near- and far-fault regions where data is sparse.
• The case-study for North Iceland shows how, and to what extent, important assumptions of the selected GMMs affect the hazard levels and its uncertainty, and directly also affects our level of confidence in the final result.
• The findings have direct implications on the reassessment of the earthquake hazard in Iceland which is the basis of earthquake resistant design in the country.

Acknowledgements

This study was funded by Grant of Excellence (No. 141261-051/052/053) from the Icelandic Centre for Research, and partly by the Icelandic Catastrophe Insurance. The support is gratefully acknowledged.