MODIFICATIONS TO SEISMIC HAZARD MODELLING FOR CHRISTCHURCH

In November, 2011, GNS Science convened an international expert panel to update the seismic hazard model for Canterbury. This update considered recent scientific understanding of the earthquake sequence and addressed responses to the GNS Science submission to the Royal Commission. The 12-person panel was made up of international and NZ-based scientists across a range of fields related to seismic hazard assessment. After presentations on various aspects of the hazard modelling for the Christchurch region, each panel member responded to 50 questions relating to the modelling. The process led to recommendations for weighted combinations of multiple seismicity models for each of the short-term, mid-term and long-term components of the model. Similar weightings were elicited for other aspects of the hazard modelling (e.g. source depth, minimum magnitude, stress-drop modification and inclusion of epistemic variability in the ground-motion prediction equations, GMPEs).

A second 5-person expert panel workshop was convened in March to decide on the weightings that should be accorded to two New Zealand specific GMPEs – that of McVerry (2006), which was used previously, and that of Bradley (2010). Bradley & Cubrinovski (2011) showed that the Bradley model developed before the Canterbury earthquakes provided a good match to the short-period motions (peak ground acceleration and 0.2s spectral acceleration) recorded in the 4 September 2010 Darfield and 22 February 2011 Christchurch earthquakes at all distances, and of 1.0s spectral accelerations except for under-prediction for a few sites at source-to-site distances less than 10km.

This process addressed several issues raised by reviewers of GNS Science's submissions to the Royal Commission by:

i. Allowing for the variation between different GMPEs (epistemic uncertainty) by increasing the variance of the McVerry et al. model, as well as adding the Bradley et al. model as a second GMPE that has been evaluated against New Zealand data.

ii. Allowing for different values (5.0, 5.25 and 5.5) of the minimum magnitude included in the hazard analysis.

iii. Allowing for different values of the maximum magnitude (M7.2, M7.5 and M8.0) included for the distributed-seismicity component of the seismicity modelling.

iv. Adopting a distribution of focal depths from 1 km to 30 km, and considering finite-source effects by placing the upper limit of the rupturing fault plane at a magnitude-dependent distance above the focus.

v. Considering estimates with and without stress-drop modifications.

Directivity effects have not been incorporated as yet, and will not be until the importance of directivity has been demonstrated through further research.

Revised seismicity rates from the EE model have recently been released, incorporating seismicity up to early January 2012. The short-term values are about two-thirds those estimated in June 2011, while the long-term values are about one-third of the earlier estimates (Figure 1). These were incorporated along with the other changes to hazard modelling, including addition of the Bradley GMPE, in late March 2012. The percentage changes in the ground motions are less than those in the seismicity rates. GNS Science has provided the Department of Building & Housing with estimates of deep soil peak ground accelerations for use in liquefaction assessment that are slightly lower than previously, 0.13g instead of 0.15g for an average annual exceedance rate of 1/25. Updates of the peak ground accelerations estimated for shallow soil sites in the Port Hills, and of acceleration response spectra for the Central Business District and elsewhere, are expected to be available by early May.

The reduced earthquake activity estimates will lead to a reduced hazard factor Z, compared to

the value of 0.34 calculated in September 2011; the finalised Z value in May 2012 is expected to be similar to the gazetted value from DBH of May 2011.

References

Bradley, B.A. 2010. NZ-specific pseudo-spectral acceleration ground motion prediction equations based on foreign models. *Report No. 2010-03*, Department of Civil and Natural Resources Engineering, University of Canterbury, Christchurch, New Zealand.

Bradley, B.A. and Cubrinovski. M. 2011 Near-source strong ground motions observed in the 22 February 2011 Christchurch earthquake, *Bulletin of the New Zealand Society for Earthquake Engineering*, 44(4): 181-194.

McVerry, G.H., Zhao, J.X., Abrahamson, N.A. and Somerville, P.G. 2006. New Zealand acceleration response spectrum attenuation relations for crustal and subduction zone earthquakes. *Bulletin of the New Zealand National Society for Earthquake Engineering*, 39(1): 1-58.

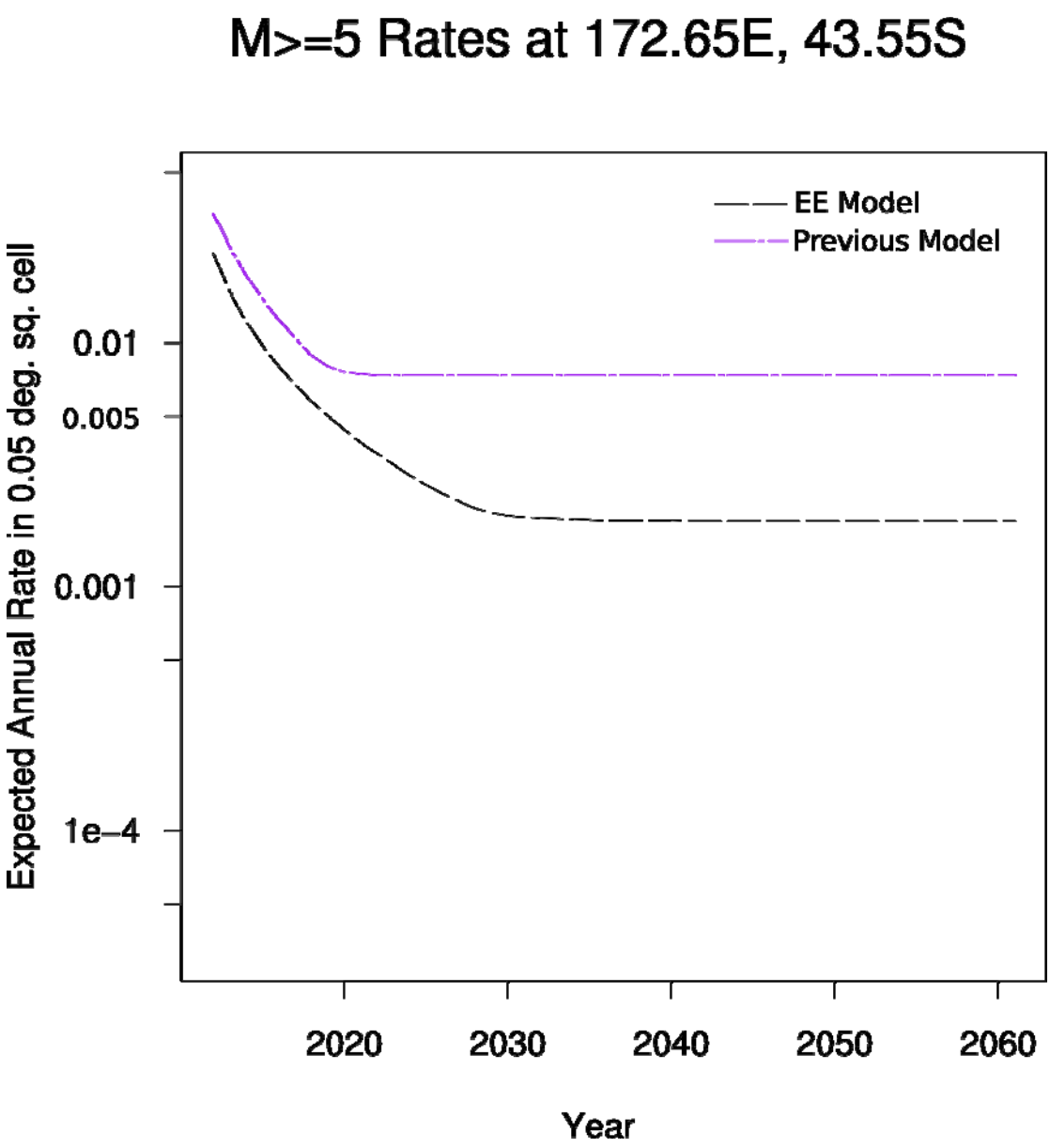

Figure 1 The reduction in estimated seismicity rates from the June 2011 model (upper curve) to the current model (lower curve).