Modelled losses of the 2021 Mansfield earthquake and comparison with other Australian earthquakes

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Abstract

On 22 September 2021, a magnitude 5.9 earthquake occurred southeast of Mansfield in the Eastern Highlands of Victoria, approximately 130 km northeast of Melbourne. We ran 100 stochastic simulations of the Mansfield event using earthquake loss modelling software (QuakeAUS) and calculated the resulting losses for a market industry portfolio of buildings. The median Peak Ground Acceleration (PGA) out of the 100 simulations at each ground shaking calculation grid cell (referred to as 'local median value') is a fairly good match for the PGA stations estimates of the Mansfield earthquake (derived from intensity measurements) provided by the USGS. We then chose the losses calculated from the median hazard as the best estimate of the event losses from the Mansfield earthquake. Almost all of the losses occur in the greater Melbourne region, especially where there are soft soils.

We then compared these losses with the losses generated by QuakeAUS from a 50,000 year stochastic catalogue of events in Australia, choosing events from the region around Melbourne. We found that the losses for our best estimate of the ground shaking of the Mansfield event lie near the lower bound of the losses from this event set; earthquakes occurring at closer distances or with larger magnitudes generate larger losses.

We have also compared the Mansfield earthquake with large or damaging earthquakes that have previously occurred in Australia. We prepared a list of large or damaging Australian earthquakes ranked by magnitude, using the preferred magnitudes from Allen et al. (2018). The list also includes deaths, serious injuries and losses derived from PerilAUS (Risk Frontiers' database of natural hazard losses in Australia), ICA (2021) normalised losses (which are derived by Risk Frontiers), and Daniell and Love (2010). The normalised insurance sector losses, which are designed to estimate the costs if historical events were to impact current societal conditions, were estimated using the method of Crompton and McAneney (2008).

Among all eight of the Australian earthquakes having magnitudes larger than 5.9 (the magnitude of the Mansfield earthquake) that are not located far offshore, six occurred in remote, rural or offshore locations and produced no significant damage; the same is true of the next five largest earthquakes smaller than the Mansfield earthquake, which lie in the magnitude range of 5.7 to 5.9. Of the 14 largest Australian earthquakes, the only two that are known to have caused significant damage, the 1968 Meckering and 1979 Cadoux earthquakes, both occurred in populated regions.

In contrast, apart from these two earthquakes and the Mansfield earthquake, all of the earthquakes that have caused damage in Australia have had magnitudes less than 5.7, in the range of 4.7 to 5.6, except for the M 4.16 2010 Kalgoorlie-Boulder earthquake. These smaller earthquakes have historically caused more damage in Australia than larger earthquakes because they are more numerous, and they have occurred in populated areas. Just two small earthquakes, the 1989 Mw 5.42 Newcastle and the neighbouring 1994 Mw 4.71 Ellalong earthquake, have caused about 90% of all earthquake losses in Australia.

The strong influence of proximity to the earthquake on damage, which is clearly evident in Australia , was also demonstrated in Christchurch, New Zealand during the 2010-2011 Canterbury earthquake sequence. The 4 September 2010 Mw 7.1 Darfield earthquake, which was located on the western outskirts of the city, caused the kinds of damage that New Zealand earthquake engineers expected for an event of that size.

However, the much smaller 22 February Mw 6.2 Christchurch earthquake occurred on a previously unidentified fault directly below the CBD, causing insured losses three times as large as those of the Darfield earthquake.

Keywords: Stochastic earthquake loss modelling, historical earthquake losses.

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