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Comparison of modelled seismic loss against historical damage information

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The increasing loss of human life and property due to earthquakes in past years have increased the demand for seismic risk analysis for people to be better prepared for a potential threat. With the centralization and increase of population near urban centres and megacities, earthquakes occur in these places will cause much more damage than in the past. Therefore, the quantification of seismic risk is extremely important. Seismic risk modelling results provide the spatial distribution of expected damage and loss to exposed elements in an earthquake of different magnitudes. Therefore, seismic risk model can play a key role in the following aspects: (i) to assess the potential seismic hazard and loss for a target area from both deterministic and probabilistic view; (ii) to support the long-term plan for seismic risk mitigation and preparedness; (iii) to prioritize decision making in emergency response and disaster management; and (iv) to optimize retrofitting strategies.

The modelling of seismic risk is typically composed of three modules, namely hazard, exposure and vulnerability. Different researchers have applied different assumptions in modelled the seismic hazard, exposed stock value and their vulnerability. Therefore, uncertainty exists in every step of the loss modelling chain. Thus, it is quite essential to evaluate the reasonability of the loss modelling results. One way to check the reasonability of modelled seismic loss is by comparison with real losses derived from post-earthquake surveys. China has a long history of recording historical devastating natural disasters including major losses during earthquakes and associated secondary events, which can be dating back to 1831 B.C. (Gu, 1989). Based on this bunch of damage information, Daniell (2014) developed an empirical loss function for mainland China during his PhD study. The advantage of this loss function compared with others is its normalization of historical loss with the socio-economic indicator (e.g. Human Development Index) and its calibration of damage functions of previous events to relate to the present conditions. Therefore, the loss estimated based on the empirical loss function developed in Daniell (2014) (tagged as “empirical loss”) will be used to evaluate losses estimated purely from modelled parameters (tagged as “analytical loss”).

Our results indicate that for both deterministic and probabilistic hazard scenarios, the empirical loss and analytical loss are within two times' difference (i.e. the empirical loss is generally larger than analytical loss, but it is lower than two times of the analytical loss). When the building vulnerability change is scaled in the empirical loss function of Daniell (2014) by using HDI and the soil amplification effect is integrated into the analytical loss modelling process, the difference between "empirical loss" and "analytical loss" will further decrease. This congruence verifies the reliability of the parameters we use in modelling seismic loss.