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Fault- and Area-Based PSHA in Nepal using OpenQuake: New Insights from the 2015 M7.8 Gorkha-Nepal Earthquake

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The 2015 Gorkha-Nepal M7.8 earthquake (hereafter known simply as the Gorkha earthquake) highlights the seismic risk in Nepal, allows better characterization of the geometry of the Main Himalayan Thrust (MHT), and enables comparison of recorded ground-motions with predicted ground-motions. These new data, together with recent paleoseismic studies and geodetic-based coupling models, allow for good parameterization of the fault characteristics. Other faults in Nepal remain less well studied. Unlike previous PSHA studies in Nepal that are exclusively area-based, we use a mix of faults and areas to describe six seismic sources in Nepal. For each source, the Gutenberg-Richter a and b values are found, and the maximum magnitude earthquake estimated, using a combination of earthquake catalogs, moment conservation principals and similarities to other tectonic regions. The MHT and Karakoram fault are described as fault sources, whereas four other sources - normal faulting in N-S trending grabens of northern Nepal, strike-slip faulting in both eastern and western Nepal, and background seismicity - are described as area sources.

We use OpenQuake (http://openquake.org/) to carry out the analysis, and peak ground acceleration (PGA) at 2 and 10% chance in 50 years is found for Nepal, along with hazard curves at various locations. We compare this PSHA model with previous area-based models of Nepal. The Main Himalayan Thrust is the principal seismic hazard in Nepal so we study the effects of changing several parameters associated with this fault. We compare ground shaking predicted from various fault geometries suggested from the Gorkha earthquake with each other, and with a simple model of a flat fault. We also show the results from incorporating a coupling model based on geodetic data and microseismicity, which limits the down-dip extent of rupture.

There have been no ground-motion prediction equations (GMPEs) developed specifically for Nepal, so we compare the results of standard GMPEs used together with an earthquake-scenario representing that of the Gorkha earthquake, with actual data from the Gorkha earthquake itself.

The Gorkha earthquake also highlighted the importance of basin-, topographic- and directivity-effects, and the location of high-frequency sources, on influencing ground motion. Future study aims at incorporating the above, together with consideration of the fault-rupture history and its influence on the location and timing of future earthquakes.