Enhanced stress and changes to regional seismicity due to the 2015 M_w 7.8 Gorkha, Nepal, earthquake on the neighbouring segments of the Main Himalayan Thrust

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In this study we evaluate stress evolution and change in seismic hazard after the 2015 Gorkha earthquake sequence. We take a methodology usually used in areas with well-established seismic monitoring and apply it to an area with a sparse dataset and a limited time observation window. Our goal is to validate this approach as a rapid response tool for seismic forecasting after large earthquakes. We propose a long-term seismic forecasting model of the Main Himalayan Thrust using the historical earthquake catalogue and regional paleo-seismicity. Through application of the rate-and-state friction model, we evaluate short-term rate evolution after the Gorkha earthquake. The long elapsed time since the last megathrust event and the mainshock coseismic stress increase on the Main Himalayan Thrust suggest high seismic potential in the Lalitpur and Lamjung areas along the fault system. To infer rate evolution after the Gorkha earthquake, we modelled the coseismic Coulomb stress change on optimally oriented planes (OOPs). To determine regional OOPs, we used the GCMT mainshock focal mechanism to infer the regional stress orientation and assumed a low deviatoric stress for the regional stress state based on the stress estimation. As the coseismic stress impact away from the rupture patch becomes insignificant, the OOPs outside the coseismic slip patch keep the mechanism imposed by the regional stress. In contrast, the orientations of OOPs are diverse close to the rupture zone due to comparable stress magnitudes of the regional stress and the coseismic Coulomb stress change. Using the stress change on OOPs and the regional seismicity rate model through a smoothing kernel method and seismicity since 1921, we quantify the seismicity rate evolution in the region after the mainshock. The location of the consequent earthquakes coincides with areas of high background seismicity rate and areas where stress was enhanced by the M_w7.9 mainshock and M_w7.3 aftershock. We model the change of seismic rate over time and project a fast decrease, due to the short aftershock duration assumption we use.

Keywords: Coulomb stress change, earthquake forecasting, optimally oriented planes, the 2015 Gorkha earthquake

