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Control of Seismic Slip on Spatial Distribution of Earthquake-Triggered Landslides

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Current understanding of earthquake-induced landslide indicates that there are three main parameters that are important in the triggering of slope failures: ground motion induced by seismic shaking, slope properties and material properties. Each of these three parameters has many complicated and interrelated facets.

In this study, we focus on the influence of the earthquake kinematics on landslide triggering using six dip-slip earthquake-triggered landslide sequences: Mw 7.6 Chi-Chi (Taiwan), Mw 7.6 Kashmir (Pakistan), Mw 7.2 Fiordland (South Island, New Zealand), Mw 6.9 Loma Prieta (California, USA), Mw 6.6 Northridge (California, USA), and Mw 5.6 Rotoehu (North Island, New Zealand). We analyze the 1D spatial pattern of landslide distances to the fault which emerge from the cross-analysis of the six sequences.
In an attempt to minimize the role of specific site effects on the triggering, we restrict our analysis to the events located on the hanging wall of the seismic fault, solely. We compare the 1D spatial distributions of landslide distances to the seismic fault to their aftershock distribution counterparts. Because aftershocks would only respond to seismic source effects, the comparison between landslide and aftershock distributions allows separating the relative contribution of geomorphology and site effect, i.e. slope and material properties, and the one of earthquake mechanics, on landslide triggering. To further quantify the contribution of earthquake kinematics on landslide triggering, we tentatively collapse the landslide and aftershock spatial distributions by normalizing the distributions by the earthquake size notably.

We also test how the landslide and aftershock spatial distributions fit the Peak Ground Acceleration (PGA), Peak Ground Velocity (PGV) and Peak Ground Displacement (PGD) distributions, respectively.

Our results argue for the control of the seismic slip, i.e. earthquake faulting style, on the landslide distribution to be stronger than the one of ground motion, as estimated as correlations with either PGA, PGV, or PGD, when available. It implies key controls of the amplitude and orientation of the seismic slips, i.e. the earthquake focal mechanisms, and possibly the importance of buried versus surface faulting earthquakes, on spatial patterns of earthquake-triggered landslides.