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Analysis of factors affecting the Spatial Distribution of co-seismic landslides triggered by the 2011 (Mw 6.9) Sikkim earthquake

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The Himalayan region is known as an earthquake-triggered landslides prone area. It is characterized by high seismicity, large relative relief, steep slopes, and dense precipitation. These seismically triggered landslides are likely to affect substantial societal impacts, including loss of life, damage to houses, public buildings, various lifeline structures like highways, railways tracks, etc. Further, they obstruct post-earthquake emergency response efforts. A past study by Martha et al. 2014 reported that an earthquake of Mw 6.9 in 2011 triggered 1196 landslides in Sikkim which is a part of the eastern Himalayas. The slope failure events are controlled by several factors, which can be grouped into four main classes: seismology, topography, lithology, and hydrology. Each class contains several sub-factors. Having in-depth knowledge of these factors and their influence on the density of landslide events in the affected area due to the 2011 Sikkim earthquake is essential to realize the level of threat of co-seismic landslide due to future earthquakes. Eight landslide controlling factors is considered in this analysis including peak ground acceleration (PGA), slope, aspect, elevation, curvature, lithology, distance from rivers, and topographic wetness index (TWI). Further, the frequency ratio model using the GIS framework is applied to evaluate the contribution of each landslide controlling factor to landslide occurrence. Scatter plots between the number of landslides per km^2 (LN) and percentage of landslide area (LA) and causative factors indicate that distance from the river, slope angle, and PGA are the dominant factors that control the landslides. The results of the above analysis showed that the majority of co-seismic landslides occurred at slope >30°, preferably in East, Southeast, and South directions and near river within a distance of 1500 m. The detailed study of interactions among these factors can improve the understanding of the mechanisms of co-seismic landslide occurrence in Sikkim and will be useful for producing a co-seismic landslide susceptibility map of the area.