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Investigating the landslide susceptibility of a glacial/periglacial landscape, Langtang Valley, Nepal

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Landslides in Nepal cause an average of 78 fatalities per year and have a significant negative impact on socio-economic development. In 2015, the devastating Gorkha earthquake triggered over 24,000 co-seismic failures across the country. Since then, research has focused on trying to understand the processes that control landslide occurrence across this geomorphologically complex region. However, it is apparent that much research has focused on the largely non-glacial Lesser Himalayas, despite the fact that approximately 41% of the Greater and Tethyan Himalayas are dominated by glacial and/or periglacial processes. This is problematic, as glacial processes commonly lead to the development of unstable to metastable landforms susceptible to failure; such as glacial debris-cones, alluvial-fans, moraine fields, and sediment-mantled slopes. Consequently, glacial and periglacial landscapes may have different controls on landslide susceptibility compared to non-glacial landscapes and so should be investigated separately.

Here, we present the results of a combined field-remote sensing investigation into the susceptibility of a glacial/periglacial landscape in the Greater Himalayas of Nepal. The study site is Langtang Valley, a 46% glaciated valley located 60 km north of Kathmandu near the Nepal-China border. This region is home to several rural developing communities who rely on tourism and subsistence farming to survive. Furthermore, it is a region that was severely impacted by the 2015 Gorkha earthquake that triggered over 250 landslides across the valley, including the devastating 'Langtang Avalanche', which buried the village of Langtang and killed over 350 people. The overall objective of this study is to assess the dominant control factors on landslide occurrence across Langtang Valley with a view to developing a high-resolution susceptibility map of the region. In October 2018, detailed fieldwork was carried out to map the typologies and morphologies of landslides across the valley, as well as lithological and structural variations.

In addition to providing new geological constraints on a previously poorly mapped region, these data were correlated with remotely sourced data relating to topography, land-use and climate using a log-linear regression model. This modelling showed that the most statistically dominant controls on landslide occurrence in Langtang Valley are elevation (linear predictor weighting of > 1) and land-use (linear predictor weightings of 0.4 – 0.6). Almost no landslides occurred at elevations greater than 5000 m with permanent snow/ice cover, whilst most landslides occurred at slightly lower elevations dominated by seasonal periglacial processes. In terms of susceptibility, the lower elevation western portion of the valley is found to be most susceptible to failure, followed by the south-facing slopes across the central portion of the valley. The least susceptible areas are the north-facing high elevation slopes in the central-eastern portion of the valley. These results suggest that elevation, rather than slope angle, is the dominant control on landslide occurrence in glacial regions of the Greater and Tethyan Himalayas. As such, this research highlights the importance of considering different landscape regions separately when investigating the controls on landslide occurrence across large areas.