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Three decades of landslide activity in western Nepal: New insights into trends and climate drivers

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Landslide activity in the Himalaya region is hypothesized to have increased over the last decades, as suggested by exiting landslide databases and disaster inventories. This trend has been linked to an enhancement of heavy rainfall events under warming climate, but also to anthropogenic factors that influences the slope stability as well as to an increase of exposed of people and infrastructures in prone areas. Yet, as recognized by the Intergovernmental Panel on Climate Change (IPCC), such positive trends are still unclear, mostly due to the lack of baseline data with enough spatio-temporal resolution. Focusing on Far-Western Nepal, we draw on remote sensing techniques to create a multi-temporal regional landslide inventory for the period 1992-2018 over an area covering 6,460 km2. To this end, we systematically interpret geomorphologically high-resolution satellite imagery from Google Earth. Besides, we analyze multispectral differences from Landsat images to interannual date the initiation or reactivation of the interpreted landslides. This massive effort includes the digitalization of 26,350 landslide events, of which 8,778 were dated at an annual scale. These events serve as a basis for the analyses of landslide frequency relationships and trends in relation to annual precipitation and temperature datasets, derived from ERA-5 climate reanalysis.

Our results show a strong correlation between the annual number of shallow landslides and the accumulated monsoon precipitation (r=0.74). Furthermore, warm and dry monsoons followed by especially rainy monsoons produce the highest incidence of shallow landslides (r=0.77). However, we find strong spatial variability in the strength of these relationships, which is linked to recent demographic development in the region. This highlights the role of anthropogenic drivers, and in particular, road cutting and land-use change, in amplifying the seasonal monsoon influence on slope stability. In parallel, the absence of any long-term trends in landslide activity, despite a widely reported increase in landslide disasters, points strongly to increasing exposure of people and infrastructure as the main driver of landslide disasters in this region of Nepal. Thus, our assessment could not determine evidence for any climate change signal related to landslide activity over this part of the Himalayas.