

Recent satellite-based radar and optical monitoring of the activity of retrogressive slow-moving landslides in Nepal during monsoon

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Abstract:

The steep Himalayan slopes are highly exposed to landslides, primarily triggered by earthquakes and intense monsoon precipitation. Along the southern slopes of the Himalayas, a specific type of landslide affects old destabilized hillslopes, characterized by intense internal fracturing and prone to rapid retrogressive erosion through deep gully incision, ultimately leading to the catastrophic collapse of secondary landslides. Understanding these mechanisms requires establishing potential spatio-temporal relationships between landslide units and triggering factors, such as rainfall, increased groundwater pressure, or gully erosion, as well as their influence on displacement amplitude. In this study, high-resolution optical and radar satellite remote sensing data have been integrated to characterize the dynamics of three regressive slow-moving landslides located in the Marsyangdi and Khudi valleys in Nepal. The combination of DSM comparison and optical pixel tracking provides a comprehensive view of the three-dimensional surface displacement fields across the landslides, insights into their geometries, and highlights how gully downcutting drives landslide activity through basal destabilization. The high-temporal-resolution displacements derived from SAR amplitude images, along with their correlation with precipitation and groundwater table variations, reveal a non-linear response to the monsoon. This process begins with the destabilization of the basal panel, followed by large displacements in the main panel driven by fluctuations in the water table. This unique dataset highlights the influence of river erosion on hillslope dynamics and the relationship between the deformation of three slow-moving landslides and water table variations during the monsoon season.