



Sporadic, rainfall triggered landslides and debris flows in the monsoon, Nepal Himalaya

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Small river catchments play a major role in the overall denudation of the Himalayas, because they may generate extreme, geomorphic events. We characterize their potential impacts on the morphology and functioning of trunk rivers, and indirectly on infrastructure and settlements located along the valley floor. Our study case, the Ghatte Khola, is an intermittent tributary of the Kali Gandaki (Western Nepal) affected by occasional debris flow events. The cause of the debris flows is a persistent planar slide zone (dip slope) that is reactivated by pre- or monsoon heavy rainfall on the upper, forested catchment. As a result, the narrow valley of the upstream part of the tributary is temporary clogged by slide masses, until sudden, landslide outburst floods occur. Downstream, where the channel is entrenched across a 5-8 m thick debris fan, the functioning of successive debris flows cause bank erosion and stream channel widening. At the junction with the Kali Gandaki, the flows may aggrade debris volumes large enough to dam the Kali Gandaki for a few hours and cause the level of this major river to rise more than 5 m upstream. During the last 40 years, pulsed aggradations transferred erosion point to the opposite (left bank) side of the Kali Gandaki. This ephemeral, yet threatening behaviour of the stream, occurs every two or three years, according to field investigations (geomorphic mapping, sediment analysis) and interviews of villagers. We present various scenarios simulated using the SAGA-GIS cellular automata combined with a Digital Elevation Model. We discuss the available rainfall intensity-duration thresholds susceptible to trigger Himalayan landslides. Our study suggests that such high-magnitude/low-frequency events are very efficient to foster sediment fluxes and create temporary sediment storages in Himalayan valleys, a fact that is to be considered prior to any new settlement and road design in a country where infrastructures are rapidly developing.