Bedrock landslides, river blockage, and barrier-lake outburst as general geomorphic processes in high-relief mountainous landscape: an example from the Marshyangdi River, central Nepal

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This study demonstrates generality of large-scale bedrock landslides, river blockage by the slid mass, and debris flow by the barrier-lake outburst in landscape evolution of high-relief mountainous watersheds. We focused on the Marshyangdi River, south-eastern range of the Annapurna massif, central Nepal, to conduct ground-based surveys and geo-spatial analyses. Geology along the river consists mainly of Paleozoic and Mesozoic sedimentary rocks, gneiss, phyllite, schist, and shale from the upper to lower reach. Deeply-incised gorge develops in the area of massive gneiss, while fill terraces occupy the wide area of valley floor downstream from the Main Central Thrust. The lower- to mid-level terraces exhibit characteristic morphology with hummocky mounds with gneiss boulders settled on the surface, indicating their origin that may be relevant to large scale debris flow events by deep-seated bedrock landslide and subsequent barrier lake breach. Exposure ages of the boulders ranges from 2 to 4 ka, indicating repeated occurrence of such events under the Holocene climate. On the upstream area, several sets of lacustrine deposits remain along the main channel. The sequence and distribution indicate that the paleo landslide-dammed lakes expanded few-kilometers in length and few hundreds meters in depth before breaching. The debris flow ran through the river for tens of kilometers, spreading out over the downstream valley. Results of evidence mapping and topographic analysis indicate that these kind of large-scale sequential phenomena play a general function in landscape evolution of a high-relief steep mountainous watershed in tectonically-active settings. Disaster mitigation for such possible event requires enhancement of preparedness through prediction and risk assessment for conceivable hillslope and/or fluvial processes.

Keywords: Mountain geography, Disaster mitigation, Landslide-dammed lake, Debris flow, Climate change