Geophysical Research Abstracts
Vol. 21, EGU2019-10717, 2019
EGU General Assembly 2019

The complex landslide system at Khingar/Jharkot (Nepal) revisited - delineation, recent dynamics and human impact

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The Indo-Eurasian plate collision not only caused the uplift of the Himalayas and the Tibetan Plateau due to compressional tectonics, but also created rift valleys through extensional tectonics and local collapses of the plateau. One major rift valley, the Thakkhola half-graben, extends from the plateau in the North to the Dhaulagiri and Annapurna massifs in the South. Bounded by the steep Dangardzong fault in the West and the less pronounced Muktinath fault in the East, the half-graben is nowadays filled with up to 3 km thick Plio- and Pleistocene sediments. Underlying clay shales of the Jurassic Spiti Formation are strongly water swellable and prone to landslides.

In the Muktinath Valley, an eastern tributary basin of the Kali Gandaki (Mustang, Nepal), these conditions led to a complex landslide system with massive impacts on the local population. Multiple interacting slope movement processes (toppling, falling, sliding, sagging, slumping, flowing) can be observed in the area, that are mainly driven by rare precipitation events during the summer monsoon in this semi-arid (c. 350 mm/a) mountain setting and artificial irrigation. The local population lives in a 'symbiotic' relationship with the landslide system using the tops of the sliding blocks as farmland and irrigating them via pipelines and open channels with water from different sources, incl. precipitation, meltwater, spring intakes (also from a neighboring catchment) and spring water originating from the landslide's active shearing planes. Since such activities are supposed to further boost the system and even trigger new sliding processes in temporary stable areas, the analysis of cause-and-effect relationships between land use and the natural environment are highly relevant.

We present first results of the research project mukslide that aims i) to better understand the landslide system (drivers and controls, cause and effect), ii) to identify hotspots and quantify rates of (sub-) recent movement, and finally iii) to provide recommendations for mitigation. Here, we provide first results and introduce a geomorphological map of the catchment. Special emphasis is placed on mass movement related forms and processes, indicators of recent landslide activity (e.g. cracks and fissures, stretched roots, active shear planes, damaged infrastructure), hydrological characteristics, and the distribution of Spiti shale outcrops. Landslide dynamics are reconstructed using multi-temporal satellite scenes (Worldview, Pleiades), UAV/SfM based high-resolution DEMs, and photo comparisons. First data on recent movement indicate a complex pattern and highly variables rates of up to 0.5 m/a in large areas and up to 15 m/a in the recently most active part of the landslide. This highly active earthflow area enlarged strongly in the recent past and several signs point to a further growth in the near future.