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Hillslope erosion and landslide dynamics in the central Himalayas

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Slope failures and landslides are the most important processes of hillslope erosion in non-glaciated active orogens. Beside tectonic activity, climate forcing, in particular daily and cumulated rainfall, have been pointed out as critical for triggering landslides, but large questions remain open relative to slope dynamics and climate influence. To address the question of hillslope erosion in active orogens, we are currently implementing different methodological approaches to measure erosion rates and document erosion processes in the central Himalaya. We present a focused study on the Khudi Khola valley (southern Annapurnas region in Nepal). This 136km2-wide catchment has previously been monitored in 1999-2004 to document climatic dynamics [Putkonen, 2004] and fluxes of suspended sediment. Those fluxes indicate an average modern erosion rate of 2-3mm/yr, well above erosion rates in surrounding High Himalayan catchments [Gabet et al., 2007].

From field study and aerial photos, a zone of large landslides in the upper part of the valley was identified as a major potential source for those sediments. On the long-range, comparison of satellite images from 1974 to 2010 indicates indeed that the landslide has been very active, his scar moving up by 400m, providing the source for the very high sediment production observed by Gabet et al. [2007]. To better document the short-term behaviour of this landslide, a specific study has been carried out during 2010 and 2011 monsoons on the landslide and on the Khudi watershed.

Ten kilometres downstream from the landslide, suspended sediment concentration was measured every day and sediment samples were analyzed. Major elements data showed constant values during monsoon and a geochemical signature similar to the landslide samples, which is consistent with a predominant contribution of the landslide to the final sediment exported by the river all over the monsoon.

In parallel, in order to follow the motions at the heart of the landslide, cameras were installed on the edges of the scar, taking one picture every thirty minutes during daytime. From these pictures, we were able to measure displacement vectors, using the iterative PIV plug-in for ImageJ software. Preliminary results show continuous displacements from the end of June to November within the landslide. In addition, we observe a good temporal correlation between major slope creeping and geomorphic activity and daily rainfall peaks. Nevertheless, further downstream, we only observe high sediment concentration values during the first weeks of the monsoon, although the rainfall and the landslide activity are still important until the middle of September. On-going work is focused on answering such apparent paradox.