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Minor soil erosion contribution to denudation in Central Nepal Himalaya.

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In order to decipher river sediments provenance in terms of erosion processes, we characterized geochemical compositions of hillslope material coming from soils, glaciers and landslide, and compared them to rivers sediments. We focused our study on two South flank Himalayan catchments: (1) Khudi khola, as an example of small High Himalayan catchment (150 km2), undergoing severe precipitation, and rapid erosion $\approx$ 3.5 mm/yr [A] and (2) the Narayani-Gandak Transhimalayan basin (52000 km2) that drains the whole central Nepal.
To assess the question, systematic samplings were conducted on hillslope material from different erosion processes in the basins. River sediment include daily sampling during the 2010 monsoon at two stations, and banks samples in different parts of the basins.

Source rocks, soil and landslide samples, are compared to river sediment mobile to immobile element ratios, completed by hydration degree H_2O+ analysis[2]. Data show that soils are clearly depleted in mobile elements Na, K, Ca, and highly hydrated compared to source rocks and other erosion products. In the Khudi basin, the contrast between soil and river sediment signatures allow to estimate that soil erosion represents less than 5% of the total sediment exported by the river. Most of the river sediment therefore derives from landslides inputs and to a lesser extent by barren high elevation sub-basins. This is further consistent with direct observation that, during monsoon, significant tributaries of the Khudi river do not export sediments. Considering that active landslide zones represent less than 0.5% of the total watershed area, it implies that erosion distribution is highly heterogeneous. Landslide erosion rate could reach more than 50 cm/yr in the landslide area.

Sediments of the Narayani river are not significantly different from those of the Khudi in spite of more diverse geomorphology and larger area of the basin. Only H_2O+ and Total Organic Carbon concentrations normalised to Al/Si ratios show distinctly higher values. This suggests that contribution of soil erosion is higher than in the Khudi basin. Nevertheless, soil erosion remains a minor source of sediments implying that more physical processes such as landslide and glaciers dominate the erosional flux. In spite of high deforestation and agricultural land-use [B], soil erosion does not represent an important source of sediments in Nepal Himalaya.

[A] Gabet et al. (2008) Earth and Planetary Science Letters 267, 482–494.
[B] Gardner et al. (2003) Applied Geography 23, 23-45.