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Temporal and spatial variations in erosion rate in the Sikkim Himalaya as a function of climate and tectonics

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The Tista River is a major tributary of the Brahmaputra drainage system (Eastern Himalaya). Its headwaters are located in the glaciated northernmost parts of the Sikkim and its catchment area amounts to more than 12,000 km2 including a depositional megafan (extending mostly in Bangladesh and West Bengal-India). The Tista has recently incised its megafan at the topographic front of the mountain range by about 30 meters. Neither the timing of deposition/incision of the megafan sediments, nor the erosion rates of the source areas as well as their potential relationships, have been investigated in detail. Comparing these data is essential to distinguish between a climatic and/or tectonic control of the evolution of the Sikkim Himalaya and piedmont.

To constrain erosion rates in the hinterland at different temporal scales (respectively millenial and geological timescales), we report cosmogenic nuclide (10Be) and thermochronological (apatite fission-tracks) data on modern river sands. Results were mapped to evidence spatial variations of erosion/exhumation rates in the Tista catchment. Cosmogenic nuclides were also used to date the onset of incision of the megafan and relate it to potential changes in hinterland erosion.

In addition, isotope geochemistry (εNd and 87Sr/86Sr) performed on modern river sands and Late-Quaternary megafan sediments allows characterizing the isotopic signature of the different source areas and constraining variations in provenance of the Tista megafan deposits through time in response to changing climatic conditions. Results show that the Tista fan deposits are mainly sourced from the High Himalayan Crystalline domain with excursions more influenced by the Lesser Himalaya domain.

These data provide a new comprehensive view on modern erosion and long-term exhumation of the Sikkim Himalaya. This study of a “closed system” will help our knowledge and understanding of erosional processes and sediment fluxes in mountainous environments as a function of climate and tectonics.