Geophysical Research Abstracts, Vol. 8, 09924, 2006
SRef-ID: 1607-7962/gra/EGU06-A-09924

Holocene climate change and its impact on the fluvial system in the Sutlej Valley, NW India

B. Bookhagen, (1), D. Fleitmann, (2), S. Niedermann (3), K. Nishiizumi (4), M.R. Strecker (1), R.C. Thiede, R.C. (1)

(1) Institut für Geowissenschaften, Universität Potsdam, Germany, (2) Geological and Environmental Sciences, Stanford University, USA, (3) GeoForschungZentrum Potsdam, Telegrafenberg, Germany, (4) Space Sciences Laboratory, University of California, Berkeley, USA

Along the Sutlej Valley in the NW Indian Himalaya, large tectonic and climatic gradients influence landscape evolution in different space and time domains. Here, we present new cosmogenic radionuclide age data from a transect perpendicular to the strike of the orogen. These samples include: (1) 30 new cosmogenic radionuclide ages (10Be, 21Ne, 26Al) from cut-and-fill terrace sequences that reveal a strong climatic influence on terrace formation and (2) river-sand samples to quantify basin-wide erosion rates across climatic gradients.

The Sutlej Valley region is heavily influenced by the Indian Summer Monsoon (ISM), which strongly interferes with topography resulting in a steep climatic gradient from S to N. Climate and landscape parameter analysis reveals three distinct zones in the orogen with typical topographic, climatic and surface-process characteristics: (1) the high-elevation, internal, presently arid regions (<0.2 m/yr rainfall) with steep hillslopes, (2) medium-elevation, presently wet areas (>2 m/yr) with steep hillslopes, and (3) low-elevation, outer, presently humid regions ($\sim$ 1 m/yr) with low to medium hillslopes. Our new cosmogenic nuclide basin-wide erosion rates integrate over the last $\sim$ 2 ka during which the ISM has been rather weak and within the limits of its present-day distribution. The erosion rates vary from a $\sim$ 0.1 mm/yr on the Tibetan Plateau to more than 1.5 mm/yr across the different climatic compartments. However, on longer timescales the boundaries between these zones have shifted significantly during intensified ISM phases. These periods lasted several thousand years and were accompanied by severe changes in surface processes.

For example, strengthened ISM periods from 27 to 23 ka and from $\sim$ 10 to 6 ka BP transported moisture into the presently arid high-elevation, interior sectors of the orogen, and led to a sudden increase in sediment flux. This overwhelmed fluvial transport capacity and resulted in aggradation in low-gradient regions of the Sutlej River longitudinal profile. Remnants of these up to 120-m-thick deposits are preserved in form of cut-and-fill terrace sequences. Interestingly, our data for the Holocene ISM reveal that sedimentation of the highest fluvial valley fill in the lower Sutlej Valley occurred almost instantaneously at the onset of the ISM at 9.7 ka. Furthermore, successive downcutting into these deposits during the following few millennia appears to have been controlled by sediment supply and moisture migration of the ISM. Thus, contrary to some common concepts linking fluvial incision of terrace systems to increased precipitation and runoff, we demonstrate that less moisture associated with centennial oscillations of the ISM system results in lower sediment supply, allowing flux-undersaturated rivers to incise episodically. Similarly, channels in the high-elevation regions were choked with sediments when a) more internal moisture migration increased erosion off hillslopes and b) localized bedrock landsliding resulted in the formation of intra-mountain lake basins. In conclusion, our new surface-age data spanning several climatic zones of the orogen allow us a) to identify an intimate link between pronounced monsoonal oscillations, erosion, and fluvial processes, and b) to quantify process and landscape-response times with respect to climatic perturbations.