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Spatio-temporal stream power pattern in the Kosi River basin, Central Himalaya using SWAT model: a proxy for sediment erosion and dynamics

Rahul Kaushal (1), Ankita Sarkar (1), Kanchan Mishra (2), Rajiv Sinha (2), Santosh Nepal (3), and Vikrant Jain (1)

(1) Indian Institute of Technology Gandhinagar,Gandhinagar, India (rahul.kaushal@iitgn.ac.in), (2) Indian Institute of Technology Kanpur, Kanpur, India (kanchanm@iitk.ac.in), (3) International Centre for Integrated Mountain Development (ICIMOD), Kathmandu, Nepal (Santosh.Nepal@icimod.org)

The landscape development in the Kosi River basin in the central Himalaya is strongly influenced by large tectonic and climatic gradients. Dynamic behaviour of the Kosi River in the alluvial part has been well-documented and is strongly linked to high sediment supply from the upstream hinterland area. Hence, reach scale erosion mapping in the hinterland area is a major issue, which can be tackled by highlighting sediment generating areas within the Kosi River basin. Sediments generated through hinterland erosion are routed downstream and spatially distributed in lower reaches of the Kosi River. The spatial distribution of energy available for sediment transport is governed by stream power (function of discharge and slope). This sediment transport competency approach has been applied in this paper to unravel erosion at basin/reach scale using spatial distribution pattern of specific stream power (SSP). A physically-based semi-distributed hydrological model, Soil and Water Assessment Tool (SWAT) has been used to simulate the reach scale stream power variability through estimation of channel slope and discharge. Stream power distribution pattern for different months was extracted at reach scale, through SWAT model by utilizing basic inputs such as precipitation, temperature, elevation, land use land cover and soil data. We observed that stream power is higher in channel reaches of the Sun Kosi and Arun. Downstream variation in SSP plot shows that mid-channel reaches in the Higher Himalaya have higher stream power in the Kosi River basin. The results also highlight a significant role of channel slope on stream power distribution pattern. Spatial distribution of slope data shows higher channel slope in western and main channel of the Kosi River that also results in higher stream power. This increased fluvial incision event is manifested in the spatial distribution of sediment yield. Further, since the estimation of SSP incorporates spatial variation in channel width, the peaks in specific stream power shift downstream in comparison to stream power distribution due to spatial variability in channel width. The reaches of high specific stream power and stream power therefore represent the major erosional zones, and therefore this approach can be used as a proxy for sediment erosion to understand sediment dynamics in the Kosi River basin.