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Constraining erosion and sediment flux from the upper Indus River, NW Himalaya

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In recent years many sediment budgets from large fluvial systems focus principally on characterizing the periodic storage and release of sediments, or sediment buffering, within lowland floodplains and deltas. Yet the recognition of large, dissected valley-fills within high mountain source regions offer unequivocal evidence that sediment buffering can operate throughout source-to-sink systems, with deposits potentially residing over 105-106 yr timescales even within headwater areas. This raises questions on how important such deposits are and if, and over what timescales, these deposits may introduce significant bias to large fluvial sediment budgets.

The Indus River of the western Himalaya is one such fluvial system where prolific sediment buffering is recognized to occur within its headwaters, through many wide (>5 km), overdeepened intermontane basins providing exceptional accommodation space. Valley-fills within the upper Indus basin reside on average over 103-104 yr in the wetter periphery of the Tibetan Plateau but may persist for >105 yr in the more arid interior Transhimalaya basins. Within plateau marginal catchments, periglacial and glacial processes drive sediment production, and monsoonal precipitation mediates sediment evacuation, in marked contrast to the arid Transhimalaya and monsoonal frontal Himalaya. Although Quaternary valley-fills in the upper Indus hold significant volumes of stored sediment ($\sim$177 km3), 21% of this volume is held in only $\sim$7% of the drainage area. Integrated datasets from bulk petrography, isotope geochemistry, detrital zircon U-Pb geochronology, and OSL chronology suggest that over wetter climatic intervals it may be catchments on the edge of the Tibetan Plateau, which both efficiently produce and evacuate sediment, regulate the overall compositions and volumes of exported sediment from the Himalayan rain shadow. However, poor connectivity of these valley-fills to the fluvial system prevents significant sediment recycling over the Holocene, with no more than 4.4 km3 contributing to the modern sediment export from even the largest upper Indus tributary. And although significant recycling occurs within the headwaters, this contribution to the total Holocene Indus sediment budget is negligible. These conclusions highlight the variable capacity for sediment buffering within headwater regions of large-scale sediment routing systems, and offer insight on the overall transfer of sedimentary signals from the high mountains.