

SEDIMENT TRANSPORT IN GLACIER-FED RIVERS IN THE KARAKORAM

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Estimation of rates of contemporary processes of denudation in catchment areas in the Himalayan ranges is of considerable scientific and practical importance. Exceptionally large quantities of sediment are transferred downstream in the high specific discharges of Himalayan headwaters to the principal rivers of the Indian subcontinent. These sediment yields are of interest in view of possible anthropogenically-accelerated erosion of the lower slopes of the Himalaya which may accompany deforestation. Considerable accumulation of sediment occurs in existing reservoirs utilising runoff from mountain basins and will occur in those currently planned. Sedimentation and flooding problems also characterise the reaches of rivers downstream of the Himalaya. Glacierised basins in the high Himalaya have amongst the highest specific discharges and contribute large quantities of silt to meltwater runoff.

Rates of sediment transport in rivers draining from glacierised basins within the catchment of the upper Indus basin in the Karakoram mountains were measured during spring and summer months in the years 1986 through 1991. At Batura Glacier, samples of meltwater were collected by an Epic automatic liquid sampler at intervals of from 1 to 3 between April and October 1990 from the single channel draining from the glacier portal, about 0.75km from the glacier terminus before the confluence with the Hunza River. Meltwater samples were collected from the rivers draining from Barpu, Bualtar and Passu glaciers with similar frequency but for shorter periods in 1986, 1988, and 1989, at short distances downstream of the portals. Samples were filtered and sediment concentration was determined gravimetrically. Stages were recorded continuously and discharge obtained from measured stage-discharge rating relationships on each site. The sediment flux was obtained from these data. Since 90% of the discharge

occurs between April and October, annual total sediment delivery from Batura Glacier can be estimated from this information.

The total sediment flux in 1990 from the basin of Batura Glacier, of which 60% is glacierised, was 3.950 Mt, or $6.086 \text{ kt km}^{-2} \text{ yr}^{-1}$. Assuming all the sediment was derived from under the ice, specific yield from the glacier would be $10.144 \text{ kt km}^{-2} \text{ yr}^{-1}$. By comparison, sediment delivery to the Arabian Sea by the pre-dammed Indus would have been about 460 - 500 t $\text{Km}^{-2} \text{ yr}^{-1}$. Batura Glacier provides about 0.5% of the discharge of the Indus from 0.07% of the basin, But 0.87% of the sediment yield. The shorter periods measurements at other glaciers give an indication of the variability of sediment yield in the Karakoram, and allow an estimate of the total sediment yield from the Hunza basin, and from the glacierised area therein. 13.8% of the sediment flux at the mouth of the Indus is derived from the Hunza, 58% of that from the glacierised areas which make up 1.4% of the area.

These data show the importance of glacierised basins in the Karakoram to the sediment budget of the Indus, and demonstrate the high yields of sediment from high mountain areas of the Himalaya, which play a major role in world sediment delivery to the oceans as a whole.