Geophysical Research Abstracts, Vol. 7, 01195, 2005
SRef-ID: 1607-7962/gra/EGU05-A-01195

Effects of large Rockslide Dams on Sediment Budgets – Evidence from the Himalaya, the Tien Shan, and the New Zealand Southern Alps

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We study the morphodynamic impacts of large (10^6 to 10^9 m^3) rockslides and rock avalanches on mountain rivers and their subsequent fluvial recovery. We compare case studies from the Himalaya, the Tien Shan, and the Southern Alps of New Zealand. These mountain belts are all tectonically very active, and their relief characteristics provide ideal triggering conditions for large rockslide and rock-avalanche dams. Differing climatic and lithologic conditions allow us to consider various environmental constraints on the effects of rockslide dams on sediment budgets.

We investigate breached rockslide dams, and use geomorphometric techniques on dated deposits to estimate average sediment discharge and aggradation at selected sites. Where available data on hydrologic catchment parameters, or water and sediment discharge permit, we also estimate the longevity of river damming, deriving lake infill rates from contemporary sediment yield data. We further test earlier notions that large rock-slope failures are major sources of debris to mountain rivers.

Our data show that average sediment discharge from rockslide and rock-avalanche dams ranges between 10^4 and 10^6 m^3/yr, with corresponding mean specific sediment yields of 10^2 to 10^4 t/km^2/yr. These rates however correlate negatively with deposit age. Moreover, the additional contribution of upstream fluvial sediment yield often cannot be differentiated. Historic case studies further show that most of the debris is being eroded from dams soon after breaching, possibly during outburst events, giving rise to short-term yields of up to 80,000 t/km^2/yr (e.g. Mt Adams, Poerua River). In the western Southern Alps of New Zealand, the volumes of individual rockslide deposits

equate up to 10^2 yr of total debris production from shallow basin-wide landsliding and, in some cases, several decades of contemporary regional sediment yield from the mountain belt. In the Tien Shan, backwater aggradation behind infilled rockslide dams may attain up to 10^{10} m^3 (e.g. Beshkiol, Naryn River). Corresponding infill times are on the 10^3-yr scale, based on contemporary fluvial sediment yield. However, some the oldest still existing rockslide-dammed lakes occur in the Himalaya, where they may be as old as 10^4 yr (e.g. Ringmo, Suli Gad).

The preservation of both breached and intact rockslide-dam deposits in these erosional mountain landscapes attests to their geomorphic importance in locally and temporarily storing sediment. Therefore, massive rock-slope failures may be agents of both sediment delivery and sediment retention in tectonically active mountain belts.