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Timescales of transient on- and off-site Effects of large Rock-slope Failures on Bedrock River Long Profiles

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The geomorphic interaction between incision in bedrock rivers and hillslope processes is of prime importance for understanding concepts of landscape evolution. Most approaches in the field of tectonic geomorphology have addressed this interaction from a one-sided perspective, in which fluvial bedrock incision triggers passive hillslope response and adjustment. This study conversely explores the transient geomorphic effects of large ($>10^6$ m^3) rock-slope failures on long profiles of rivers in selected tectonically active mountain belts around the world.

Regression of channel slope S versus drainage basin area A is used as an objective method to highlight knickpoints that separate steep incised from low-gradient and aggraded reaches, despite of high variations in the range of drainage basin size, uplift rates, climatic parameters, rock types, land cover, and sediment flux. These knickpoints often correspond to emplacement sites of large rockslides and rock avalanches. For a fixed reference concavity index, θ = 0.45, the highest values of the steepness index, k_s, and Erosion Index, ž, along a given profile spatially coincide with breach channels cut into formerly river-damming rockslide debris of up to 10^4 yr in age.

Assuming that these knickpoints do not predate rock-slope failure, it is argued that high profile steepness and inferred specific stream power are not always the cause, but rather a result, of large river-blocking rock-slope failure in many mountain basins. Moreover, where large rock-slope failure had blocked rivers and formerly impounded large lakes, smaller tributary streams show significant profile steepening where they had entered the lake. These fluvial hanging valleys are interpreted to reflect delayed profile adjustment to rapid base-level lowering following catastrophic lake drainage, and hence indicate the possibility of transient off-site effects of large rock-slope fail-

ures on bedrock river profiles.

Omitting “rockslide-affected” data points from slope-area plots lowers k_s, while increasing θ on average, yet only in few cases more than one standard deviation. These effects should be accounted for, when using channel steepness and concavity for inferring tectonic or climatic forcing. This seems appropriate, given the difficulty of distinguishing with certainty between seismic or climatic triggers for most prehistoric rock-slope failures.