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Hillslope-glacier coupling: from debris cover to landscape evolution

D. Scherler (1), B. Bookhagen (2), and M.R. Strecker (3)

(1) Earth and Environmental Science, University of Potsdam, Potsdam, Germany (dirk@geo.uni-potsdam.de), (2) Department of Geography, University California Santa Barbara, Santa Barbara, USA (bodo@eri.ucsb.edu), (3) Earth and Environmental Science, University of Potsdam, Potsdam, Germany (strecker@geo.uni-potsdam.de)

Glaciers are important landscape-shaping agents in many orogens worldwide, but their interaction with adjacent periglacial hillslopes is not well studied. In this contribution, and in analogy to hillslope-channel coupling in fluvial systems, we consider the processes relevant for hillslope-glacier coupling and their linkages to topography. In particular, we focus on the role of glaciers as conveyer belts of hillslope-derived debris, which affects surface-melt rates and thus glacial mass balances. We present examples for strong and weak couplings between glaciers and hillslopes from different regions in the Himalaya and discuss implications for glacial landscape development on continental plateaus. We find that supraglacial debris covers increase with topographic relief and the steepness of snow-accumulation areas, which results in greater ice extents but lower accumulation-area ratios. As accumulation areas get steeper and hillslope-debris fluxes increase, the longitudinal distribution of flow velocities and thus glacial erosion potential is progressively shifted upglacier.

We present preliminary results from a numerical model in which we couple the formation of debris covers on glaciers to the production and supply of debris from adjacent hillslopes. Model results reproduce observed glacier-surface velocity patterns and allow us to contrast the behavior of debris-covered versus clean-ice glaciers.