Geophysical Research Abstracts
Vol. 16, EGU2014-5106, 2014
EGU General Assembly 2014

Influence of hillslope-channel coupling on two mountain headwater streams, Swiss National Park, Switzerland

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Sediment fluxes in mountain headwater streams are strongly conditioned by sediment supply from hillslopes and thus hillslope-channel coupling, defined as linkages connecting slopes and channels through sediment transport processes. Sediment supply from hillslopes can have major influences on channel characteristics. The main goal of my research is to achieve a better understanding of these influences on mountain headwater streams in two study areas. This is conducted through the investigation of "channel-reach morphology" according to MONTGOMERY AND BUFFINGTON (1997), morphometric and sedimentological characteristics of the channels and analysis of the slope-channel coupling system.
The study was conducted in two valleys in the Swiss National Park, i.e. Val dal Botsch (VdB) and Val Mueschauns (VMu). In both headwaters slopes and channel are coupled effectively due to the small spatial vicinity and frequent debris flow processes connecting the two system components. Both catchments were glaciated in the Pleistocene but show contrasting glacial imprints today. While VdB has a V-shaped morphometry that is dominated by unconsolidated sediments (mainly talus and moraine material), VMu is U-shaped in the upper valley segments and the surface is mainly covered with bedrock.
Several methods for data collection and analyses were used: (1) Channel-reach morphology classification, (2) DEM-based analysis of long profiles, ksn-values, slope-area plots and measurement of cross sections in the field, (3) investigation of sedimentological characteristics with pebble counts as well as (4) mapping of recent linkages between slopes and channel and determination of connectivity (effectivity of coupling) using a heuristic approach.
The results show that sediment input into both headwater streams is dominated by debris flows. The debris flow catchments, as parts of the slope system, have the highest connectivity to the channels. Channel changes are greatest where debris flows cause massive sediment input. Channel changes include an increase in sediment size and density of boulders, a decline in grain roundness and particle sorting as well as slope steepening and alterations of cross sections due to channel incision into the deposited debris flow material. Channel-reach morphology can be modified as well, e.g. from step pool to cascade. The intensity of the influence on channels varies among the investigated debris flows. A comparison of the larger debris flows reveals that debris flows with catchments dominated by bedrock and large areal extend (absolute and relative to main channel drainage area) have the strongest influence on channels. These results suggest that the variable influence on the channel is linked to differences in the Pleistocene glacial imprint of the two study areas. Geomorphic heritage plays a crucial role in recent alpine systems.

Reference:
MONTGOMERY, D. R. AND J. M. BUFFINGTON (1997): Channel-reach morphology in mountain drainage basins. Geol. Soc. Am. Bull. 109 (5), 596-611.