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Bridging the gap between small and large scale sediment budgets? – A scaling challenge in the Upper Rhone Basin, Switzerland

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A large number of sediment budgets have been compiled on different temporal and spatial scales in alpine regions. Detailed sediment budgets based on the quantification of a number of sediment storages (e.g. talus cones, moraine deposits) exist only for a few small scale drainage basins (up to 10^2 km^2). In contrast, large scale sediment budgets (> 10^3 km^2) consider only long term sediment sinks such as valley fills and lakes. Until now, these studies often neglect small scale sediment storages in the headwaters. However, the significance of these sediment storages have been reported. A quantitative verification whether headwaters function as sediment source regions is lacking. Despite substantial transport energy in mountain environments due to steep gradients and high relief, sediment flux in large river systems is frequently disconnected from alpine headwaters. This leads to significant storage of coarse-grained sediment along the flow path from rockwall source regions to large sedimentary sinks in major alpine valleys.

To improve the knowledge on sediment budgets in large scale alpine catchments and to bridge the gap between small and large scale sediment budgets, we apply a multi-method approach comprising investigations on different spatial scales in the Upper Rhone Basin (URB). The URB is the largest inneralpine basin in the European Alps with a size of > 5400 km^2. It is a closed system with Lake Geneva acting as an ultimate sediment sink for suspended and clastic sediment. We examine the spatial pattern and volumes of sediment storages as well as the morphometry on the local and catchment-wide scale.

We mapped sediment storages and bedrock in five sub-regions of the study area (Goms, Lötschen valley, Val d'Illiez, Vallée de la Liène, Turtmann valley) in the field and from high-resolution remote sensing imagery to investigate the spatial distribution of different sediment storage types (e.g. talus deposits, debris flow cones, alluvial fans). These sub-regions cover all three litho-tectonic units of the URB (Helvetic nappes, Penninic nappes, External massifs) and different catchment sizes to capture the inherent variability. Different parameters characterizing topography, surface characteristics, and vegetation cover are analyzed for each storage type. The data is then used in geostatistical models (PCA, stepwise logistic regression) to predict the spatial distribution of sediment storage for the whole URB. We further conduct morphometric analyses of the URB to gain information on the varying degree of glacial imprint and postglacial landscape evolution and their control on the spatial distribution of sediment storage in a large scale drainage basin.

Geophysical methods (ground penetrating radar and electrical resistivity tomography) are applied on different sediment storage types on the local scale to estimate mean thicknesses. Additional data from published studies are used to complement our dataset. We integrate the local data in the statistical model on the spatial distribution of sediment storages for the whole URB. Hence, we can extrapolate the stored sediment volumes to the regional scale in order to bridge the gap between small and large scale studies.