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Can we fill the gap between on-site soil loss and off-site sediment yield in mountain landscapes?

Katrin Meusburger (1) and Christine Alewell (2)

(1) Swiss Federal Institute for Forest, Snow and Landscape Research WSL, CH-8903, Birmensdorf, Switzerland, (2) Environmental Geosciences, University of Basel, Switzerland

Worldwide mountain ranges are most severely affected by climate- and land use change, both of which are expected to alter the rate and pattern of soil degradation and soil loss. Owing to the distinct topography multiple erosion processes, triggered by different agents and risk factors, interact in mountain environments. Linking the on-site soil erosion risk to off-site impacts of sediments is often impeded by this inherent complexity. However, the increasing quality and availability of spatially explicit data in combination with novel soil and sediment tracing techniques hold great potential to improve our understanding of the relative importance of different erosion processes and their spatial and temporal pattern.
This contribution summarizes our experiences gained during several studies in mountain environments. We will present the suitability of fallout radionuclides and specifically of Plutonium-239+240 as quantitative soil redistribution tracer for in-situ soil erosion assessment. Further, we explored the novel technique of compound-specific stable isotopes (CSSI) as a tool to identify land use specific sediment sources in rivers and lakes in combination with modeling. One of the main outcomes of this confrontation between tracing and modelling is that forests according to commonly applied model concepts are an underestimated source of sediment. On alpine grasslands, we could further identify snow gliding and wet avalanches as one important soil erosion agent constituting at some sites up to 80% to total soil loss. In the snow-free season, grasslands with disturbed vegetation cover are most susceptible to soil loss, and soil erosion rates exceed soil formation rates. Therefore, the remote-sensing-based mapping and implementation of fractional vegetation cover into soil erosion risk models is crucial and was implemented for Swiss grasslands. In general, time series of remote sensing images indicate an increasing trend of soil erosion features and shallow landslides in alpine areas. Comparison of the landslide development in three different valleys exhibits that the development is driven by the combined effect of climate- and land use change.