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Sensitivity of mountain ecosystems to human-accelerated soil erosion. Contrasting geomorphic response between tropical and semi-arid ecosystems.

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Human-induced land cover changes are causing important adverse effects on the ecological services rendered by mountain ecosystems, and the number of case-studies of the impact of humans on soil erosion and sediment yield has mounted rapidly. A modelling framework that is specifically adapted to mountain environments is currently lacking. Most studies make use of general river basin models that were originally parameterized and calibrated for temperate, low relief landscapes. Transposing these modelling concepts directly to steep environments with shallow and stony soils often leads to unrealistic model predictions, as model input parameters are rarely calibrated for the range of environmental conditions found in mountain regions.

Here, we present a conceptual model that evaluates erosion regulation as a function of human disturbances in vegetation cover. The basic idea behind this model is that soil erosion mechanisms are independent of human impact, but that the frequency-magnitude distributions of erosion rates change as a response to human disturbances. Pre-disturbance (or natural) erosion rates are derived from in-situ produced 10Be concentrations in river sediment, while post-disturbance (or modern) erosion rates are derived from sedimentation rates in small catchments. In its simplicity, the model uses vegetation cover change as a proxy of human disturbance in a given vegetation system. The model is then calibrated with field measurements from two mountainous sites with strongly different vegetation dynamics, climatic and geological settings: the Tropical Andes, and the Spanish Betic Cordillera.

Natural erosion processes are important in mountainous sites, and natural erosion benchmarks are primordial to assess human-induced changes in erosion rates. While the Spanish Betic Cordillera is commonly characterized as a degraded landscape, there is no significant change in erosion due to human disturbance for uncultivated sites. The opposite is true for the Tropical Andes where the share of natural erosion in the modern erosion rate is minimal for most disturbed sites. When pooling pre- and post-disturbance erosion data from both sites, it becomes evident that the human acceleration of erosion is significantly related to vegetation disturbance. It may therefore be expected that the potential for erosion regulation is larger in well-vegetated ecosystem where strong differences may exist in vegetation cover between human disturbed and undisturbed or restored sites.