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Significance of vegetation restoration in gully beds on reducing erosion and sediment transfer in highly degraded Andean environments

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Vegetation control on slope processes is critical in badlands, as their low vegetation cover and reduced soil development often result in rapid generation of overland flow on the gully slopes, which is transported efficiently downslope through a dense network of active gullies leading to a rapid and sharp hydrological response. Experimental results by e.g. Rey (2003, 2004) highlighted the ability of vegetation barriers established in steep gully beds to reduce the sediment and water transport efficiency of active gully systems. However, little is known about the importance of gully bed vegetation over a longer time span, and this in comparison with other controlling factors such as topography and lithology.

The aim of this study is to gain new insights in the effectiveness of gully bed vegetation in trapping and retaining eroded sediment in highly degraded 'badland' environments, that can improve process-based understanding of the influence of vegetation on gully bed sediment deposition in comparison with other factors such as local slope gradient and drainage area. Field measurements from 138 steep gully segments with strong variations in vegetation cover show that gully bed vegetation is the most important factor in promoting short-term sediment deposition and gully stabilization. Topographical variables only have a secondary effect on sediment transport capacity and sediment deposition rates in steep vegetated gully systems. In the absence of any ground vegetation cover, bare steep gullies become very efficient pathways of sediment transport; and sediment deposition only occurs when the sediment transport capacity drops significantly by a strong decrease in local gully slope.

Our data indicate that the establishment of herbaceous and shrubby vegetation in gully beds gives rise to the formation of vegetated buffer zones, which enhance sediment trapping in active gully systems in mountainous environments. Vegetated buffer zones are shown to modify the connectivity of sediment fluxes, as they reduce the transport efficiency of gully systems which then evolve from sediment sources to sediment sinks.