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Restoration of badlands through applying bio-engineering techniques in active gully systems: Evidence from the Ecuadorian Andes

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A better insight in the processes controlling sediment generation, transport and deposition in badlands is necessary to enhance restoration of degraded soils through eco-engineering techniques. In this study, we evaluate the effect of different bio-engineering measures on soil and slope stability. Five micro-catchments (of 0.2 to 5 ha) were selected within a 3 km^2 area in the lower part of the Loreto catchment (Southern Ecuadorian Andes). The micro-catchments differ only by land cover and degree of implementation of soil and water conservation measures. Bio-engineering techniques were used to construct dikes made of fascines of wooden sticks and earth-filled tires in active gully beds, where they are most efficient to reduce water and sediment transport.

The experimental design consists of three micro-catchments within highly degraded lands: (DI) micro-catchment with bio-engineering measures concentrated in the active gully beds, (DF) with reforestation of Eucalyptus trees, and (DT) reference situation without any conservation measures. Two micro-catchments were monitored in agricultural lands with (AI) and without (AT) bio-engineering measures in the active gully beds. All catchments were equipped with San Dimas flumes to measure water flow, and sediment traps to monitor sediment export. In the (active) gully beds, various parameters related to gully stability (soil water content, bed elevation, vegetation cover, sedimentation/erosion) were monitored at weekly intervals.

First results show that bio-engineering techniques are efficient to stabilize active gully beds through a reduction of the rapid concentration of excess rainfall and the sediment production and transfer. Fascines made of wooden sticks are far more efficient than earth-filled tires. Sediment deposition behind dikes is strongly dependent on precedent rainfall events, and the slope and vegetation cover of the gully floor. The sediment deposited facilitates colonization of the gully floor by native grass and shrub species. Analyses of soil samples indicates that the soil moisture is significantly higher (and the bulk density lower) in the deposition zones within restored gullies compared to the reference situation. During rainfall events, the infiltration in the deposition zones becomes important. The increase in water availability in the gully floor permits grass seeds to germinate and shoot rapidly, which strongly enhances gully stabilization.