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Evaluating Rates of Water-driven Soil Erosion in a Degraded Landscape Using an Event-based Modelling Approach

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Abstract

The Mixteca Alta region in southeastern Mexico combines a complex geological history, a highly diverse topographical relief, and an intense precipitation regime. Some areas of this region present a serious and persistent soil erosion problem as a consequence of a dynamic interaction of these conditions coupled with a long history of anthropogenic influences. Santa Catarina Tayata municipality, located in the heart of Mixteca Alta is characterised by a low population density, smallholder land tenure (bienes comunales), and a diverse land use system (e.g., mature forest, grass-dominated areas, cultivated lands, eroded lands).

Aiming at evaluating current rates of water-driven soil erosion in a target area of this region, a watershed (Cuauhtemoc) of 2.5 km^2 was selected. Precipitation event sediment yield was measured using a sediment collection station at the outlet or downstream of different plots / micro catchments under different land cover (forest, monocrop maize cultivation, fallow, and eroded land) along with measured soil texture, bulk density, stone coverage, soil cover, vegetation height and derived surface roughness, overland Manning's roughness coefficient, hydraulic functions, cohesion, median particle diameter from May to September of 2017 together with a Digital Surface Model and 4-band images (Green, Red, Red-edge and NIR) used for land use classification derived from an Unmanned Aerial Vehicle (UAV). These parameters served as input to an event-based modelling approach using the physically based OpenLISEM model. The resulting plots/micro catchments validated parameters were used as input to the target watershed modelling to estimate the gross sediment production and sediment yield.

Measurements and preliminary modelling results show that the eroded land dominates by far the gross sediment production and the sediment yield followed decreasingly by maize, fallow and forest. We assume that the erosion in the eroded land is due to a combination of low cohesion, low infiltration, permanently exposed underlying material, steep local gradient, and lack of proper management. A series of recommendations to decrease / overcome erosion in the eroded land consist of implementing physical barriers (e.g., biological and/or mechanical barriers) along the rills / gullies in at specific distances.

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