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Natural infrastructure interventions and their effect on soil erosion mitigation in the Andes

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The Andes region is prone to soil erosion because of its steep topographic relief, high spatio-temporal variability in precipitation and heterogeneity in lithological strength. Soil erosion by water is affecting natural and anthropogenic environments through its impacts on water quality and availability, loss of soil nutrients, flood risk, sedimentation in rivers and streams, and damage to civil infrastructure. Sustainable land and water management, referred here as natural infrastructure interventions, aims to avoid, reduce and reverse soil erosion and can provide multiple benefits for the environment, population and livelihoods. In this study, we present a systematic review of peer-reviewed and grey literature involving more than 120 local case-studies from the Andes. Three major categories of natural infrastructure interventions were considered: protective vegetation, soil and water conservation measures, and adaptation measures that regulate the flow and transport of water. The analysis was designed to answer the following research questions: (1) Which soil erosion indicators allow us to assess the effectiveness of natural infrastructure interventions across the Andean range? (2) What is the overall impact of implementing natural infrastructure interventions for on-site and off-site erosion mitigation?

The systematic review shows that the effectiveness of protective vegetation on soil erosion mitigation is the most commonly studied characteristic, accounting for more than half of the empirical studies. From the suite of physical, chemical and biological indicators that were commonly used in soil erosion research, our review identified two indicators to be particularly suitable for the analyses of the effectiveness of natural infrastructure interventions: soil organic carbon (SOC) of the topsoil, and soil loss rates at plot scale. The implementation of soil and water conservation measures in areas under traditional agriculture had positive effects on SOC (1.28 to 1.29 times higher SOC than in agricultural land). Soil loss rates were 54% lower when implementing SWC than on cropland. When implementing SWC in rangeland, the data indicated

an increase in soil loss rate by 1.54 times. Untreated degraded land is reported to have significantly higher soil loss and specific sediment yield compared to cropland.

The results of this systematic review allows to assess the overall effectiveness of commonly used natural infrastructure interventions, which can guide policy and decision making in the Andes. Similarly, the review identified critical gaps in knowledge that must be attended by more comprehensive research to consider the high spatiotemporal variability of the Andes region.