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How do Humans Affect Geomorphic Process Rates in Tropical Mountain Areas?

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Tropical mountain ecosystems are sensitive to environmental change brought about by natural and anthropogenic processes. The steep topography, shallow soils and unsustainable land use practices following forest conversion often lead to enhanced rates of geomorphic activity including soil erosion, landsliding and increased fluvial incision. Over the past few decades, rapid demographic growth and socio-economic development have accelerated environmental change. However, because of sporadic data on sediment process rates, the role of human beings in controlling sediment production, transport and delivery in large mountain catchments is still unclear.

The objective of this paper is to quantify the impact of human-induced land use/-cover change on sediment production, transport and delivery in large mountain catchments. This can now be done on two different erosion time scales by comparing present short-term erosion rates from sediment mass balances with long-term natural or geological erosion rates derived from the concentration of in-situ produced cosmogenic ^{10}Be in quartz minerals of river deposits. The Paute basin (5176 km^2) located in the southern Ecuadorian Andes was taken as a case study. Land use in the catchment is highly dynamic: more than half of the primary native forest has been converted to agricultural land use or has been replaced by secondary woody vegetation or -more recently- by exotic species, such as Eucalyptus. At present, this area is characterised by a very intense geomorphologic activity leading to a mean average annual sediment export of $c.$ 700 tkm^{-2}yr^{-1}.

Results from in-situ produced cosmogenic ^{10}Be in c. 15 sediment samples taken within the Paute basin suggest that the catchment-wide long-term (c. 10 - 25 kyr) erosion rate is of the order of 50 to 200 tkm^{-2}yr^{-1}. The spatial pattern of short-term (c. 1 - 5 yr) erosion rates was found to be remarkably heterogeneous. Present erosion rates derived from gabion and reservoir infillings range from c. 100 tkm^{-2}yr^{-1} for undisturbed catchments to up to more than c. 10,000 tkm^{-2}yr^{-1} for highly degraded areas. This large variation in short-term erosion rates can mainly be explained by differences in land use, vegetation cover; and differences in bedrock material. The results show that, at present, most of the sediment that is delivered to the river system is coming from relatively small areas of highly degraded land. Sediment generation in these highly degraded areas is strongly accelerated by human activity, and is c. 100 times higher than the natural background erosion rate.