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Integrating river incision rates over timescales in the Ecuadorian Andes: from uplift history to current erosion rates

Benjamin Campforts (1), Gerard Govers (1), Veerle Vanacker (2), and Gustavo Tenorio (3)

(1) Department of Earth and Environmental Sciences, K.U. Leuven, Celestijnenlaan 200 E, 3001 Heverlee, Belgium (benjamin.campforts@ees.kuleuven.be), (2) Earth and Life Institute, Georges Lemaitre Centre for Earth and Climate Research, University of Louvain, 3 Place Louis Pasteur, B-1348 Louvain-la-Neuve, Belgium, (3) Facultad de agronomia, Universidad de Cuenca, Av. 12 de abril s/n, Cuenca, Ecuador

River profile development is studied at different timescales, from the response to uplift over millions of years over steady state erosion rates over millennia to the response to a single event, such as a major landslide. At present, few attempts have been made to compare data obtained over various timescales. Therefore we do not know to what extent data and model results are compatible: do long-term river profile development models yield erosion rates that are compatible with information obtained over shorter time spans, both in terms of absolute rates and spatial patterns or not? Such comparisons could provide crucial insights into the nature of river development and allow us to assess the confidence we may have when predicting river response at different timescales (e.g. Kirchner et al., 2001). A major issue hampering such comparison is the uncertainty involved in the calibration of long-term river profile development models. Furthermore, calibration data on different timescales are rarely available for a specific region.

In this research, we set up a river profile development model similar to the one used by Roberts & White (2010) and successfully calibrated it for the northern Ecuadorian Andes using detailed uplift and sedimentological data. Subsequently we used the calibrated model to simulate river profile development in the southern Ecuadorian Andes. The calibrated model allows to reconstruct the Andean uplift history in southern Ecuador, which is characterized by a very strong uplift phase during the last 5 My. Erosion rates derived from the modeled river incision rates were then compared with 10Be derived basin-wide erosion rates for a series of basins within the study area. We found that the model-inferred erosion rates for the last millennia are broadly compatible with the cosmogenic derived denudation rates, both in terms of absolute erosion rates as well as in terms of their spatial distribution. Hence, a relatively simple river profile development model captures the essential controls on long-term landscape development in the studied landscapes.

Kirchner, J., Finkel, R., and Riebe, C., 2001, Mountain erosion over 10 yr, 10 ky, and 10 my time scales: Geology, v. 29, no. 7, p. 591–594.
Roberts, G., and White, N., 2010, Estimating uplift rate histories from river profiles using African examples: Journal of Geophysical Research, v. 115, p. 1–24.