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Long-time denudation rates affected by episodic precipitation events

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Despite it is generally agreed that climate influences both the channelized and the hillslope component of a sediment transfer system, there are contrasting opinions about how, to what extent, and at which scales these influences occur. With this regard, it is a matter of interest how highly episodic precipitation events contribute to the average magnitude of sediment flux in mountainous catchments over geomorphic time scales, and how these effects are expressed in the landscape. An adequate answer to this question requires the quantification of the process rates, which is here done by investigating long-term denudation rates using the terrestrial cosmogenic nuclide ^{10}Be in sediments of the Piura river system in Northern Peru.

The Piura River drains a 10'000 km^2 large catchment area that is strongly affected by episodic heavy precipitation during El Niño events. The river catchment is made up of transverse basins with sources in the Andean Cordillera, and an axial trunk system draining into the Pacific. In the headwaters, climatic conditions are generally controlled by the easterlies that deliver moisture from the Atlantic Ocean (continuous pattern of low precipitation rates). Consequently, weathering rates have the potential to exceed sediment transport rates, and sediment is mainly mobilised by shallow-seated landslides. In contrast, in the area of the trunk stream and the depositional mudflats, precipitation rates are controlled by the westerlies and, hence, by highly episodic El Niño events. In this area, the sediment flux is supply-limited and the hillslopes are

dissected by channelized processes. The transition between these two regimes of sediment production (easterlies) and sediment export (caused by El Niño) coincides with a knick-zone in the river profile.

Based on a 20 m resolution digital elevation model, we assessed the erosional potential of the channel network by computing an erosion potential index (EI) that accounts for the spatial distribution of precipitation, drainage area and slope. In the trunk stream region, high EI values match with the positioning of the knick-zone in the river profile and, more generally, with regions where sediment discharge is supply-limited. During an El Niño year EI values are additionally increased as compared to normal years and reveal a peak in this area.

Denudation rates of the Piura drainage basin were determined based on ^{10}Be analysis of 12 river bed samples. The samples were taken consecutively downstream in the active river channel. Estimated denudation rates range from 0.01 mm a^{-1} to 0.14 mm a^{-1} and show a decreasing trend in the downstream direction (catchment-wide erosion rates; i.e. cumulatively increasing drainage area downstream). The gradient of successive downstream denudation rates indicates a peak in the area of sediment production, whereas lower values are revealed in the area of bedrock exposure (i.e. areas of actual sediment export). These long-term averaged denudation rates agree reasonably well with our previously mentioned field observations. However, they reveal certain discrepancies with the results of the actual erosional potential calculations. This raises the question about the potential influence of transient process rates and sediment storage, and about the landscape's response to its regional climate history in general.