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Effects of vegetation cover on landscape denudation rates

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Increasing slope or relief in a landscape has long been known to correlate with faster denudation rates. Despite a number of studies that have attempted to clarify the additional role of precipitation on denudation, deciphering the complex influence of climate on erosion rates in a landscape with variable slope and relief has remained difficult.

The eastern and western branches of the East African Rift System (EARS) constitute first-order tectonic and topographic features in East Africa, which have a profound influence on the distribution and amount of rainfall. The Kenya Rift is an integral part of the eastern branch and is characterized by pronounced differences in morphology, rainfall, and vegetation cover. While paleoclimatic studies in this region reveal general stability of the precipitation and vegetation patterns, short-term changes on timescales of ca. 10^4 yrs have affected the area multiple times throughout the Pleistocene.

We present 20 ^{10}Be-derived catchment-wide mean denudation rates from various morphotectonic sectors of the Kenya Rift. The sampling locations include steep rift escarpments, step-faulted composite escarpments, and gently inclined rift-shoulder areas. These different environments also span a rainfall gradient of 0.004 to 4 m/yr, and vegetation covers that range from very sparse to dense. For comparison, ^{10}Be-derived denudation rates are also available from the Rwenzori Mountains in the western branch of the rift system. There, rainfall is high and the vegetation cover is denser than the studied sites in Kenya, but the range of relief and slopes is similar. A first-order comparison of our new denudation rates from Kenya with climatic and topographic characteristics of the catchments show no obvious correlations. However, denudation rates from sparsely vegetated environments in the Kenya Rift define a steep trend in the denudation rate-slope relationship, while denudation rates from the densely vegetated portion of the Kenya Rift and the Rwenzori Mountains define a shallower trend, with rates that are more than 50% lower when comparing areas of similar slope. Generally, millennial-scale denudation rates in the East African Rift increase faster with topographic slope where vegetation is sparse, implying that (1) vegetation stabilizes the soil layer and supports steeper slopes, creating a negative feedback in the relationship between precipitation and denudation, and (2) minor changes in climate can substantially affect denudation rates if they cause vegetation cover to change.