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Global scale analysis of the stream power law parameters based on worldwide ^{10}Be denudation rates

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The stream power law, expressed as $E = KA^mS^n$ where E is erosion rate $[LT^{-1}]$, K is erodibility $[T^{-1}L^{(1-2m)}]$, A is drainage area $[L^2]$, S is channel gradient $[L/L]$ and m and n are constants, is the most widely used model for bedrock channel incision. Despite its simplicity and limitations, the model has proved useful for a large number of applications such as topographic evolution, knickpoint migration, palaeotopography reconstruction, and the determination of uplift patterns and rates. However, the unknown parameters K, m and n are often fixed arbitrarily or are based on assumptions about the physics of the erosion processes that are not always valid, which considerably alters the use and interpretation of the model.

In this study, we compile published ^{10}Be basin-wide erosion rates ($n = 1335$) in order to assess the m/n ratio (or concavity index), the slope exponent n and erodibility coefficient K using the integral method of channel profile analysis. These three parameters are calculated for 66 areas and allow for a global scale analysis in terms of climatic, tectonic and environmental settings. Our results suggest that (i) many sites are too noisy or do not have enough data to predict n and K with a satisfying level of confidence; (ii) the slope exponent is predominantly greater than one, meaning that the relationship between erosion rate and the channel gradient is non-linear, supporting the idea that incision is a threshold controlled process. Furthermore, a multi-regression analysis and the calculation of n and K using a reference concavity index $m/n = 0.45$ demonstrate that (iii) many intuitive or previously demonstrated local-scale trends, such as the correlation between erosion rate and climate, do not appear at a global scale.