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The effect of a rainfall and discharge variability on erosion rates in a highly active tectonic setting: a stochastic approach

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The influence of climate on surface processes and consequently on landscape evolution is undeniably important; despite this, many fluvial landscape evolution models do not integrate an accurate or physically based parameterisation of precipitation, the climatic forcing most important for fluvial processes. This is likely due to two major challenges; first of all there is the difficulty in moving from the hourly, daily and monthly timescales most relevant to precipitation to the millennial timescales used in landscape evolution modelling. To confront this challenge, we adopt the approach of Tucker and Bras, 2000 and Lague, 2005, and upscale precipitation with a statistical parameterisation accounting for mean precipitation as well as short term (daily) variability. This technique is key in capturing and quantifying the importance of rare, extreme events.

The second challenge stems from the fact that erosion rates are proportional not to precipitation, but rather to discharge, which results from a complex convolution of the regional precipitation patterns with the landscape. To address this second obstacle we present work that investigates the relationship between a stochastic description of precipitation and one of discharge, linking general patterns of precipitation and discharge rather than attempting to establish a deterministic relationship. To achieve this we model the effect of precipitation variability on runoff variability as well as compare associated precipitation and discharge measurements from a range of climatic regimes and spatial scales in the Himalayas. Using the results of this work, we integrate the statistical parameterisation of precipitation into a landscape evolution model, allowing us to explore the effect of realistic precipitation patterns, specifically precipitation variability, on the evolution of relief and topography.

References

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