Precipitation stochasticity and its effects on discharge and erosion in the Himalaya

Eric Deal, Jean Braun[1]

[1]ISTerre, University Grenoble Alpes, Grenoble, France, eric.deal@ujf-grenoble.fr

Despite the modern availability of high quality datasets for climate, topography, and erosion rates in the Himalaya, it remains challenging to untangle the importance of climate on observed landforms and erosion rates. Due to the importance of water for erosional processes, it is often expected that precipitation rates and erosion rates will correlate positively. However this is not always the case, as shown for example by the Pliocene uplift of the Shillong plateau in northeast India that has created a strong east-west gradient in rainfall downwind on the southeastern front of the Himalaya not matched by a measurable gradient in exhumation rate (Adlakha et al, 2012). Modelling studies have shown that such discrepancies between rainfall and erosion can be well explained by an erosion threshold, a water runoff rate below which no erosion occurs (Snyder et al, 2003). This discharge threshold leads to a complex relationship between precipitation, river discharge and erosion rates, obfuscating the effect of rainfall on erosion. Additionally, it implies that the characterization of precipitation and discharge must take into account not just magnitude but also stochasticity because the relative ratio of discharge events below the threshold to discharge events above the threshold is important.

Therefore, to better elucidate the effect of rainfall patterns in the Himalaya on erosion rates we have described precipitation for the region by measuring magnitude and stochasticity with the TRMM satellite dataset. Using this more complete characterization of precipitation over the Himalaya, we work to establish a statistical relationship between the stochasticity of precipitation and that of river discharge. The development of this important link between climate patterns and discharge patterns will allow for the upscaling of climate data for use in landscape evolution models (LEMs). This opens up several interesting possibilities for future work with LEMs such as using modern climate data and erosion rates to constrain certain parameters such as the erosion discharge threshold or using climate data from paleo-GCMs in conjunction with erosion rates derived from the sedimentary record to test past climate scenarios for the region.

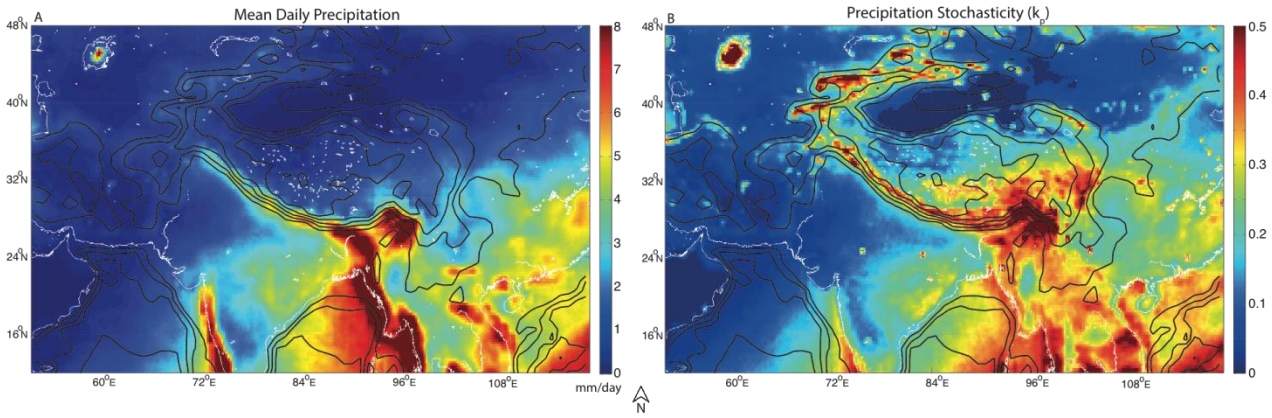

Figure 1. On the left a map of mean daily precipitation over the Tibetan plateau as measured by the TRMM dataset from 1998 until 2013. On the right a map of stochasticity for the same region. The black lines are 1000m contours and the white lines delineate coastlines and lakes.

References

Adlakha, V., Lang, K.A., Patel, R.C., Lal, N. and Huntington, K.W., 2012, Rapid long-term erosion in the rain shadow of the Shillong Plateau, Eastern Himalaya, Tectonophysics, 582, 76-83.

Snyder, N.P., Whipple, K., Tucker, G.E. and Merritts, D.J., 2003, Importance of a stochastic distribution of floods and erosion thresholds in the bedrock river incision problem. Journal of Geophysical Research: Earth Surface, 108(B2). doi:10.1029/2001JB001655.

Cite as: Deal, E. and Braun, J., 2014, Precipitation stochasticity and its effects on discharge and erosion in the Himalaya, in Montomoli C., et al., eds., proceedings for the 29th Himalaya-Karakoram-Tibet Workshop, Lucca, Italy.