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Going beyond the river long profile

Fiona Clubb
Department of Geography, Durham University, Durham, United Kingdom (fiona.j.clubb@durham.ac.uk)

Quantifying landscape form can provide crucial insight into the interactions between tectonics and climate. River long profile morphology, quantified by metrics such as channel steepness, is the most commonly used tool to investigate topographic form, with many studies relating long profile morphology to uplift rate, precipitation, sediment properties, or lithology, for example. River long profiles record the signal of external forcing over large spatial scales (i.e. tens of kilometres). This has many advantages: for example, it is a convenient scale for analysing variations in large-scale processes, such gradients in tectonic uplift. It also means that high resolution digital elevation models (DEMs) are not required and therefore river long profiles can be extracted globally. However, analysis of river long profiles over tens of kilometres can also result in signal smoothing and subsequent loss of finer scale tectonic or climatic signatures encoded into the landscape.

Tectonic and climatic processes do not only leave their fingerprint in the long profiles of rivers. Hilltops, hillslopes, and valleys make up the majority of Earth's landscapes by area, yet their morphology has received much less attention than that of rivers. This is in part due to the difficulty in accurately extracting hilltops and valley morphology from DEMs, especially on a global scale. Here, I show that we can now extract hilltop and valley metrics from high-resolution (< 15 m) DEMs over orogenic to continental scales using new topographic analysis techniques and high-performance computing facilities. I argue that by combining hilltop, hillslope, and valley metrics, we can obtain more information about tectonic and climatic processes than from river profiles alone.