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# A graphical method for fluvial network analysis: a case study of the dynamic landscapes in the eastern Central Range of Taiwan

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We construct a graphical method to analyze dynamic reorganization of river basins and infer the tectonic forcing encoded in the landscapes of Taiwan. The island of Taiwan is built by ongoing arc-continent collision of the Luzon Arc and the Asian continental margin. The high tectonic convergence and uplift rates together with the sub-tropical climates and frequent typhoons result in high exhumation rates, and well-developed detachment-limited river networks.

To analyze these rivers, we propose a new graphical method similar to a $\chi$-plot, in which distance along channel is rescaled by drainage area so as to make an equilibrium river profile linear. We generate the equivalent plot for an entire river basin, but rather than collapsing all tributaries onto a single set of Cartesian axes, we map the basin into polar coordinates in which the radial dimension is chi. The angular coordinate is arbitrary, but we assign each channel head a unique value by numbering them topologically clockwise so to spread the basin over an azimuth of 90-180 degrees depending on the size of drainage basin. The elevations are then contoured on this mapping. Channel steepness (scaled uplift rate) is estimated by fitting a conical surface to the elevations. This can be plotted on the radial plot as a series of concentric circles. The advantage of this graph is it maintains a shape comparable to the original drainage basin, which simplifies comparison of $\chi$ and elevation among different channels to aid in interpretation of differences. The misfits between the predicted and observed elevations in radial plots highlight transient signals of landscapes. If the uplift rate and erodibility are spatially uniform, the misfits can be interpreted in terms of changes in drainage area. We identify many examples indicating migration of divides and discrete river captures, which must be taken into account when estimating the channel steepness.

The estimated channel steepnesses of basins in eastern Taiwan increase towards the north from the southern tip of Taiwan, reaching a near constant value from Hisnwulu basin to Liwu basin in the center of the Island. Further north, channel steepness again decreases. These estimates show a good correlation with erosion rates derived from zircon fission track ages of modern sediments derived from the same basins. We conclude that there are systematic differences in rock uplift rate and erosion rate that are reflected in river basin steepness. However, at the smaller scale the widespread transient signals in drainage basins suggest the landscapes of Taiwan are very dynamic and not in steady state.