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Spatial and Temporal Patterns of Uplift in Taiwan from Geomorphic Analysis

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We apply several methods of analysis of river profiles to establish the spatial and temporal patterns of rock and surface uplift and drainage pattern in Taiwan. The ongoing arc-continent collision in Taiwan produces high rates of tectonic shortening and uplift which, combined with the sub-tropical climate and frequent Typhoons, makes Taiwan one of best testing laboratories for fluvial incision linked to tectonic uplift. We present a method for inverting digital topographic data for rock uplift rate, based on a stream-power incision law. Assuming linearity in slope (n=1), and drainage area constant in time, allows us to use linear analytical solutions to develop a simple linear matrix method for least-squares optimization of fit to the full topography using an uplift function that varies smoothly in space and time. Such formal inverse methods permit explicit presentation of parameter (uplift rates) resolution and variance, thus demonstrating where uplift rates are well-estimated and where they are not. Topographic data contain no information on absolute rates, only relative rates, so we rely on other methods, primarily thermochronometry, to dimensionalize the problem. We find that modern uplift rates are highest near the crest of the Central and Hsuehshan ranges and are higher today than in the past, although we lack spatial resolution in the past. An important restriction in river profile or DEM inversion such as we apply here is the assumption that river basin geometry and contributing area have remained constant in time. We test this by looking at individual drainage basins and analyzing the drainage divide symmetry and channel profiles in individual subbasins. By using drainage-area scaled elevation, we can identify area-starved basins and relative migration directions of divides. We find considerable mobility of divides throughout Taiwan suggesting that even this textbook example of a steady topography is changing constantly with time and the influence of these transients on river profiles and topographic inversions must be assessed.