Differential incision and channel dynamics across structural boundaries along the Peikang River, central Taiwan

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Abstract:

The Peikang River in central Taiwan flows perpendicular to the dominant structural trend of the island. By using this geometric relationship and documenting the river morphodynamics, we explore the controls on river morphology in tectonically active regions and pinpoint where deformation is currently occurring in the Hsuehshan Range of Taiwan. We estimated unit stream power and basal shear stress by mapping channel width and slope in the field and using a digital elevation model (DEM). Additionally, we have constrained incision rates using optically stimulated luminescence methods to date fluvial deposits on strath terraces along the reaches where these terraces are preserved. The pattern of stream power and shear stress matches the river incision rate fairly well (r^2=0.52) over the measured range of erosion rates (~0.5 to 7 mm/yr) allowing us to calibrate a river incision rule to predict incision rates throughout this region. Using drainage area to scale channel width in the stream power calculations (as is often done), removes any correlation between stream power and incision rate (r^2=0.02) suggesting that channel width is an important dynamic response to differential rock uplift in this region.

Using our calibrated river incision rule, we infer important tectonic boundaries in the study area. The region of highest stream power (and thus highest incision rate) is located at the upstream end of our study location and can be interpreted to represent a reach of high rock uplift rate due to either a ramp in the decollement or a zone of significant underplating. The region of lowest stream power and incision rate occurs just downstream where this ramp becomes flat and is near GPS stations that recorded downward motion during the 1999 Chichi earthquake. Downstream of this reach, stream power and incision rate both rapidly increase and then decrease as the river approaches and then crosses the Shuilikeng Fault, suggesting that this fault is an active structure. We interpret the activity of this fault to be a response to a topographic deficit (the Puli Basin) in the critical wedge immediately to the south of the study river. The work presented here suggests that channel morphodynamics is a powerful tool for investigating recent deformation throughout the Taiwanese orogen.