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Tectonic activities along the eastern flank of the Central Range in the active Taiwan orogen Inferred from river steepness index

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The tectonic activity of the Taiwan orogenic belt has been well studied by different methods in various time scales, such as long-term (>1 Ma) thermochronologic data and short-term (yearly to decadal) geodetic analysis. However, constrains on millennial-scale tectonic characteristics is limited, especially in the mountainous core of the island. Recent studies show the channel networks in active orogens reflect the pace at which landscapes respond to tectonic processes and provides a record of relative changes in rock uplift. Therefore, we attempted to use river steepness index (ksn) derived from the stream power incision model, combined with knick point distributions from bedrock rivers to obtain the signature of tectonic forcing spatially and temporally.

We analyzed 21 rivers along the eastern flank of the Central Range, Taiwan. We chose the main trunk of each river system as the major branch flowing from the ridgeline of the Central Range and perpendicular to the main structures and the strata. Our results show that the ksn numbers of the rivers from slope and area plot fall in a wide range, from 60 to 570. The average of ksn is about 190 in the central part of our study area, and decreases to 120 and 130 toward the north and south. Based on the characteristics of the longitudinal profiles and the slop-area plot, we can divide these 21 rivers into 6 distinctive groups. It is noteworthy that some of the rivers show ''anti-knick points", which are believed to be the results of the reduction of uplift rates. This phenomenon has been discussed in theory, but may be the first time observed in the field data.

We believe the differences in ksn in our results are related to tectonic activities in the region, rather than influences of climate or lithologic controls, since all of the rivers are located on windward side of the Taiwan orogen, and the similarity in metamorphic and deformational degrees in the bedrocks reduced the differences of rock strength. The patterns of the ksn variations are quite consistent with the patterns of tectonic evolution in Taiwan, where in the southern part the orogen is growing, but in the northern part the active collision and mountain-building has waned and the orogen is collapsing. Furthermore, our results not only enabled us to better identify the transition area between rapid and waning collisions in Taiwan, but also provides information to quantify the relative rock uplift rates in the millennial time scale in the mountainous core of the island.