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The balance between uplift and fluvial erosion over a single seismic cycle – an example from Taiwan

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The relationship between tectonic and geomorphic processes is important for understanding how topography evolves, and how the landscape reflects tectonic and climatic signatures. We present a case study of the relationship between uplift and erosion on the scale of a single seismic cycle, in which we can observe the creation of substantial coseismic topography and its subsequent removal by fluvial erosion. In Sept. 1999, the Mw 7.6 Chi-Chi earthquake struck western Taiwan. At the northern end of the rupture zone, in the Daan River valley, the earthquake activated the Dongshi Anticline, resulting in up to 13 of uplift due to coseismic folding. Where the Daan River crosses the anticline, the river responded to the coseismic uplift by very rapidly cutting into the uplifted topography, and by 2009 the river had carved a narrow bedrock gorge extending the width of the anticline. In the current stage of erosion, the river has ceased cutting down, and is now eroding laterally. Although widening within the gorge is relatively slow, the river is cutting back the upstream boundary of the anticline at a rate of $\sim$15 m/yr. At this rate, the river will remove the uplifted topography and returned to its pre-uplift morphology in $\sim$50 years. The post-1999 erosion rates in the Daan River are several orders of magnitude faster than background rates, and represent a transient phase of erosion in response to the disequilibrium created by coseismic uplift. In this case, the river is able to respond to the coseismic uplift of the Dongshi anticline solely through this transient response, and without long term changes in the river's morphology. This example highlights the potential importance of short-lived signals of uplift and erosion in the relationship between tectonics and landscape morphology.