



On the dynamics of stream piracy

L. Goren and S. D. Willett

ETH, Department of Earth Sciences, Zurich, Switzerland (liran.goren@erdw.ethz.ch)

Drainage network reorganization by stream piracy is invoked repeatedly to explain the morphology of unique drainage patterns and as a possible mechanism inducing abrupt variations of sediment accumulation rates. However, direct evidence of stream piracy is usually rare, and is highly interpretation dependent. As a first step in assessing how probable capture events are and establishing the conditions that favor stream piracy versus the those that favor stable landscapes, we formulate analytically the physics of divide migration and capture events and study this formulation from a dynamical system point of view.

The formulation is based on a one-dimensional topographic cross section between two channels that share a water divide. Two hillslope profiles diverge from the divide and drain into two fluvial bedrock tributaries, whose erosion rate is controlled by a stream power law. The rate of erosion at the bounding channels is thus a function of the upstream drainage area and local slope. A tectonically induced downward perturbation of the elevation of one of the bounding channels lowers the channel slope but at the same time increases the drainage area due to outward migration of the water divide. The changes in slope and area have opposing effect on the erosion rate at the bounding channels, so that the perturbation may either grow or be damped.

We define the geomorphic and tectonic parameters that control the behavior of the system and find the regimes that lead to stable landscapes and to capture events.