Geophysical Research Abstracts
Vol. 17, EGU2015-7156-1, 2015
EGU General Assembly 2015

Laws of valley growth

Hansjoerg Seybold (1), Robert Yi (2), Jane Willenbring (3), James Kirchner (1), and Daniel Rothman (2)

(1) ETH Zurich, Zurich, Switzerland, (2) MIT, Cambridge, United States, (3) University of Pennsylvania, Philadelphia, United States

The question of how the channel heads advance has long been debated [1,2]. By studying a simplified setting – channels incised by re-emerging groundwater flow – we seek insight into the headward growth of channel networks, by combining theoretical modeling with field observations.

A concept for how such seepage channel systems form was first proposed by T. Dunne in the early 1980s [2]. A small bulge in the sidewall of a stream focuses ground water flow. This results in a larger flux and therefore a higher erosion rate in this direction. Over time such small perturbations grow into newly formed streams, but how they do so and how erosion depends on the water flux is unclear. The theory of diffusive growth provides a theoretical framework to describe channelization in response to groundwater flow. For this system the underlying physical equations are well-defined, and numerical and analytical predictions can be obtained and tested in the field. If a stream advances at a rate $v \sim q^{\eta}$, where q is the discharge of ground water into the tip, theory predicts that η has to be smaller than a critical value $\eta^{\star}$ to obtain ramified networks [3]. We test this hypothesis by measuring erosion rates in a field site in the Florida Panhandle, which provides a natural laboratory to study channel incision by re-emerging groundwater flow [4].

Our theoretical network reconstruction yields tip growth rates which we can directly compare to observational rates obtained from cosmogenic ^{10}Be measurements. This comparison of theory and observation allows us to verify the existence of a constitutive discharge-erosion relation, and to better characterize growth and competition of streams at the channel head.

[1] Montgommery, D. R. and Dietrich, W. E. *Where do channels begin?*, Nature, 336, no. 6196 (1988): 232-234
[2] Dunne, T. *Formation and controls of channel networks*, Prog. Phys. Geogr., 4 (1980): 211-239
[3] Carleson, L. and Makarov, N. *Laplacian path models*, J. Anal. Math., 87, no. 1 (2002): 103-150
[4] Devauchelle, O., Petroff, A. P., Seybold, H., Rothman, D. H. *Ramification of stream networks*, PNAS, 109 (51), 20832-20836.