Geophysical Research Abstracts
Vol. 14, EGU2012-9703, 2012
EGU General Assembly 2012

On the role of vegetation in the formation of river anabranching patterns

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Part of studies on the couplings between the evolution of riparian vegetation and the river morphodynamics, we investigate the effect of spatial interactions between vegetation located at different positions within the channel. This work generalizes the experimental and theoretical results by Perona et al. and by Crouzy and Perona (both Advances in Water Resources, in Press) on colonization of riverbars by seedlings or large woody debris by relaxing the hypothesis made in those two works of the biomass growth and uprooting being independent on the presence of neighboring plants.

While the hypothesis of independent vegetation growth and uprooting is justified for sparse vegetation cover or young seedlings, it fails as soon as the canopy significantly disturbs the flow or changes the sediment stability. Then, flow-mediated interactions between riparian vegetation located at different positions within the channel can be observed. Those interactions are either constructive or destructive. For example, a region favorable to the development of biomass appears on the lee side of a vegetated obstacle (with bleed flow) due to increased deposition of seeds and sediment (Schnauder and Moggridge, 2008) while conversely scouring can be increased laterally due to obstacle-induced flow diversion (Roulund et al., 2005; Melville and Sutherland, 1988; Zong and Nepf, 2008).

We focus on the role of vegetation in the formation of the regular vegetated ridge patterns found in ephemeral rivers (see for example the work by Tooth and Nanson, 2004 on anabranching patterns) or as a succession of swales and ridges on the inside of meander bends (scroll bars). From the analysis of aerial images, we obtain the characteristic length scale of the patterns. We show how in the limit where the hydrological (interarrival time of floods) and the biological (germination and growth rates) timescales are comparable the combination between both positive and negative feedbacks between vegetation located at different positions can lead to the spatial organization of the vegetation. Classically, the presence of the anabranches has been ascribed to an optimization of the sediment load transport (Huang and Nanson, 2007) or for the scroll bars to channel migration, without explicitly accounting for the role of vegetation.