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Unraveling the controls on biogeomorphic succession: the influence of groundwater, soil and geomorphic setting on bio-geomorphic channel evolution

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Braided rivers are characterized by high rates of morphological change. However, despite the potential for frequent disturbance, vegetated patches may develop within this system and influence long-term channel dynamics and channel patterns through the "engineering effects" of biogeomorphic succession. The stabilizing effect of developing vegetation on morphological change has been widely shown by flume experiments and (historic) aerial pictures analysis. Thus, there is a balance between disturbance and stabilization, mediated through biogeomorphic succession, that may determine the long-term geomorphic and biogeomorphic evolution of the river. Research has addressed how changes in disturbance frequency affect river channel pattern, but much less has been done to understand what influences the rate of biogeomorphic succession and how it affects river morphodynamics.
This study explores the complex pattern of ambient conditions in braided river systems driving the rate of biogeomorphic succession. In particular, we focus on the interplay between groundwater access, soil formation, disturbance frequency and geomorphic setting, in defining what drives vegetation succession rates and its long-term implications on channel pattern evolution. We studied these feedbacks in a transitional gravel-bed river system (braided, wandering, meandering) close to Geneva (Switzerland) - the Allondon River.
Results show that, at the beginning of the succession, humification plays a negative role on local ambient conditions necessary for sprouting. Successful vegetation establishment is then related positively to humification, but also to higher disturbance rates. The third biogeomorphic phase, with the highest feedbacks on river morphology, appears to be mainly driven by groundwater access, which in turn defines the rates of humification in this gravelly environment. This in turn defines the decadal morphological response of the channel after a reduction in disturbance frequency over the last 50 years. Overall, these results show how the functioning and the developing ecosystem at local scale affect the ecosystem resilience at a larger scale, and thus affects the long-term geomorphological river response.