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Groundwater controls on river channel pattern

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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 vegetation. 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 vegetation, that may determine the long-term geomorphic and biogeomorphic evolution of the river. It follows that with a change in disturbance frequency relative to the rate of vegetation establishment, a systematic geomorphological shift could occur. Research has addressed how changes in disturbance frequency affect river channel pattern, but has rarely addressed the way in which the stabilizing effects of biogeomorphic succession interact with disturbance frequency to maintain a river in a more dynamic or a less dynamic state.
Here, we quantify how the interplay between groundwater access, disturbance frequency and vegetation succession, drive changes in channel pattern. We studied this complex interplay on a transitional gravel-bed river system (braided, wandering, meandering) close to Geneva (Switzerland) - the Allondon River. Dendroecological analysis demonstrate that vegetation growth is driven by groundwater access. Groundwater access conditions the rate of vegetation stabilization at the sub-reach scale and, due to a reduction in flood-related disturbance frequency over the last 50 years, drives a change in channel pattern. Where groundwater is shallower, vegetation encroachment rates were high and as flood-related disturbance decreased, the river has shifted towards a meandering state. Where groundwater was deeper, vegetation growth was limited by water-access and thus vegetation encroachment rates were low. Even though there was a reduction in flood disturbance, it was still sufficient to maintain a wandering/braided state. Thus, it appears that access to groundwater can control river channel pattern through its impact upon the "engineering effects" of vegetation. The results are important for river management as they highlight the non-linearity of developing vegetation in dynamic alluvial floodplains and the importance of considering the wider environmental setting and associated feedbacks between biotic and abiotic river components in defining long-term geomorphological river response.