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Fluvial ecosystem resilience and stability: the role of riparian vegetation

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Riparian vegetation impacts fluvial landform resistance and resilience. Here we analyse the spatial and temporal pattern of biogeomorphic equilibrium conditions within a high energy river system. We quantified rejuvenation and maturation of the biogeomorphic succession using a spatial explicit analysis based on aerial photographs at six dates between 1942 and 2000. The Mediterranean River Tech, France, was chosen because a catastrophic flood in 1940 (recurrence time > 100 years) nearly completely destroyed the riparian forest and thus rejuvenated the biogeomorphic succession, providing a reference state in 1942. Interactions between vegetation establishment and flood regime enhanced the replacement of the dense riparian forest removed in 1940 at the scale of the corridor. Following this major disturbance, the riparian landscape demonstrated a very high resilience related to a positive biogeomorphic feedback driven by pioneer riparian engineer plants trapping sediments. This positive feedback enhanced floodplain construction, vegetation succession and a non-linear increase in biogeomorphic stability. Biogeomorphic equilibrium (ratio between instable active tract and stabilised riparian margins) driven by the interplay of vegetation dynamics and hydrogeormorphic processes was reached thirty years after the catastrophic flood event. The results suggest the existence of abrupt transitions between alternative domains of stability and hysteresis cycles. Based on these findings we propose a topological model of riparian ecosystem resistance and resilience according to biogeomorphic feedbacks. Furthermore, the proposed model developed on the River Tech suggests that biogeomorphic feedbacks play a critical role for transitions between different fluvial styles which determine the evolutionary trajectories of rivers.