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# Intermediate hydro-morphodynamic disturbances amplify riparian vegetation dynamics

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In river ecosystems riparian vegetation, flow field and sediment transport are interconnected by non-linear complex feedback.

Riparian vegetation grows and encroaches river ecosystems developing a capacity of recovery against the morphodynamic disturbance. In literature there are evidence that the ratio between vegetation recovery and morphodynamic disturbance can play a key-role in the equilibrium of river ecosystems. The “intermediate disturbance hypothesis” postulates that an intermediate ratio between vegetation recovery and disturbance can amplify vegetation dynamics response. Instead, high or low ratio create stability and a low vegetation dynamics response.

Not many models are designed to address such complex relationships in a coupled and quantitative way. Therefore, in this study we aim at quantifying numerically the response of vegetation dynamics to the morphodynamic disturbance in a simplified case study. The case study is a homogeneous straight channel with a vegetated patch perturbed periodically by a succession of sinusoidal floods of constant amplitude.  The frequency of floods is changed during the analysis with the purpose of modifying the ratio between recovery and disturbance, analysing different vegetation responses.

We performed numerical simulations through the new version of the 2D shallow water model BASEMENT coupled with a vegetation growth component (BASEveg). BASEveg is able to simulate the main feedback between river morphodynamic processes and vegetation dynamics (growth and uprooting). In the case study, the intensity of the morphodynamic disturbance itself is strictly dependent on the vegetated patch, infact vegetation modifies the flow field and sediment transport, causing erosion and uprooting.  Vegetation grows during low flow periods and it may be uprooted during flood events, determining biomass oscillations in time.

Model results highlight that for low frequency of disturbance, vegetation dynamics is low, in fact the recovery mechanism (growth) prevails over the collapse mechanism (uprooting) and vegetation settles in a stable configuration, reaching the carrying capacity after every low flow period. For high frequency of disturbance, vegetation dynamics is still low but in this case the uprooting mechanism prevails over the recovery mechanism and vegetation tends to settle in a bare soil configuration. For intermediate frequency the behaviour of the system is more complicated, vegetation dynamics shows larger fluctuations not reaching a stable configuration and resembling a chaotic behaviour.

Our results paves the way to better understand the relation between recovery and disturbance providing insights into how to avoid irreversible anthropogenic modifications, and implement efficient restoration projects and possibly mitigating the effects of climate change.