Study area, Allier River in France

THE INTERPLAY BETWEEN RIVERS AND RIPARIAN VEGETATION

River systems are amongst the most dynamic and productive ecosystems in the world. Dynamics in river flows create a mosaic of habitats for fluvial species, where species with specialist characteristics have adapted to the highly dynamic conditions close to the river. Riparian vegetation regularly interacts with river flows and, when these plants are strong enough to withstand fluvial forces, they can start to act as 'ecosystem engineers', actively shaping river flows, sedimentation and erosion in and around vegetated areas.

In turn, river flows and river shape determine the timing, frequency and magnitude of flooding, dry periods, erosion and sedimentation that affect plant growth and survival. There is therefore a continuous interaction between hydro-morphodynamic processes and vegetation, resulting in dynamic landscape patterns with heterogeneous habitat mosaics.

In many rivers, natural processes have been altered by pressure factors such as river fixation, dam construction and climate change. There are many ongoing projects in place to restore river systems to a more natural state and to mitigate the impact of climate change. However, in order to design ecological restoration plans and to forecast their long-term effects, we need a better understanding of how natural interactions between plants, water flows and sediment produce river landscapes, as well as predictive models to simulate these processes.

To study the evolution of river landscapes as a product of plant-river interactions, a new vegetation model was developed and dynamically coupled to the Delft3D-FLOW model. The model contains eco-engineering species that colonise, grow and interact with hydro-morphodynamic processes. The model produces natural patterns in river morphology and vegetation with realistic distributions of vegetation age.

The model was used to simulate the long-term effects of invasive species, dams, climate change and river restoration on natural vegetation, river shape and hydro-morphodynamic processes. The results demonstrate that vegetation properties such as settlement conditions, density, growth and survival conditions are important factors shaping river landscapes. Changes in vegetation type and distribution, for instance by invasive species, or flow alteration by dams and climate change, alter these interactions and processes, possibly leading to unexpected small-scale changes in native vegetation cover, water levels, and erosion and sedimentation. These changes eventually affect larger-scale processes such as river migration and chute cut-offs. The new understanding and the newly developed model will allow us to study bio-geomorphological interactions, and identify and test river management strategies and river restoration plans. This will help to enhance or maintain the ecological value of rivers and their floodplains.

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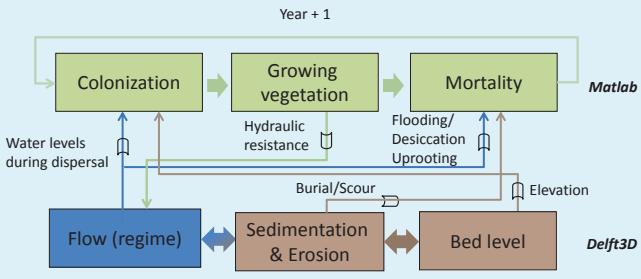
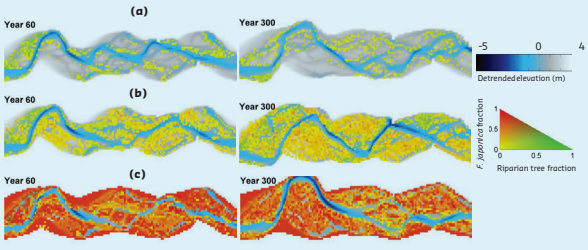
Further reading:
Van Oorschot et al. (2016), Distinct patterns of interaction between vegetation and morphodynamics, Earth Surface Processes and Landforms



Flow diagram with model processes and interactions



Bed level and vegetation cover without invasive species (a) and with low (b) and high abundance (c) of invaders