EGU22-7443
https://doi.org/10.5194/egusphere-egu22-7443
EGU General Assembly 2022

Trait-based numerical modelling of feedbacks between river morphodynamics and riparian vegetation for sustainable river management in a changing climate

Virginia Garófano-Gómez[1,2], Florent Arrignon[3], Franck Vautier[4], Eric Tabacchi[5], Elisabeth Allain[1], Anne Bonis[1], Sébastien Delmotte[3], Eduardo González[6], Frédéric Julien[5], Luc Lambs[5], Francisco Martínez-Capel[2], Anne-Marie Planty-Tabacchi[5], Erwan Roussel[1], Johannes Steiger[1], Jean-Pierre Toumazet[1], Irène Till-Bottraud[1], Olivier Voldoire[1], Romain Walcker[5], and Dov Corenblit[1]

[1]Université Clermont Auvergne, CNRS, GEOLAB, F-63000 Clermont-Ferrand, France
[2]Institut d'Investigació per a la Gestió Integrada de Zones Costaneres (IGIC), Universitat Politècnica de València, Paranimf 1, 46730 Grau de Gandia, València, Spain
[3]MAD-Environnemement, S.A.R.L. F-31560 Nailloux, France
[4]Université Clermont Auvergne, CNRS, MSH, F-63000 Clermont-Ferrand, France
[5]Université de Toulouse, CNRS, INPT, ECOLAB, F-31062 Toulouse, France
[6]Colorado State University, Department of Biology, Fort Collins, CO 80521, USA

River ecosystems are spatiotemporally and intimately tied to physicochemical and biological processes, driven by strong feedbacks between riparian vegetation dynamics and hydrogeomorphic processes and fluvial landforms. Climatic and hydrogeomorphic constraints to vegetation determine a naturally shifting habitat mosaic dynamism, fostering high habitat heterogeneity and biodiversity, and providing multiple ecosystem services to society. However, most European river systems have lost their inherent highly dynamic character after major human-induced impacts, such as river channelisation and altered flow and sediment regimes. In March 2019, the United Nations designated the period of 2021–2030 as the "Decade on Ecosystem Restoration", and river ecosystems will be a significant target. Consequently, river restoration practitioners will need robust decision-making tools to guide their deliberations and subsequent management actions. Recommendations are to avoid merely reproducing river features and instead restoring geomorphic, hydrological, and ecological processes, but river science has not fully understood yet how processes develop and interact following restoration interventions. Integrative modelling of feedback mechanisms between riparian vegetation dynamics and hydrogeomorphic processes is critical for making predictions that enable river managers to optimise the use of the natural self-regulation potential of riparian corridors whilst maximising human benefits. Today's existing models, however, do not fully reflect the interactions between river hydraulics and vegetation succession. In particular, the role of vegetation needs to be included through its impact in modulating river landforms and their evolutionary trajectories. Here, we present the conceptual and methodological framework, preliminary results, and the perspectives of the NUMRIP project, funded by the French National Research Agency. Along the project, a numerical (cellular automata) model of fluvial landscape dynamics will be developed,

integrating physical, biological, and human components. The project focuses on riparian vegetation, from individual plants to communities. It explicitly considers vegetation as a dynamic component of the system, both responding to and affecting hydrogeomorphic processes and fluvial landforms. Accordingly, NUMRIP builds upon the conceptual fluvial biogeomorphological succession model and recent advances in remote sensing techniques of plant-geomorphology interactions. The NUMRIP project will explicitly associate plant functional traits (e.g., physiological, morphological, and biomechanical characteristics) to hydrogeomorphic processes and fluvial landforms, using plant functional trait approaches, remote sensing- and numerical modelling techniques. The lower course of the Allier River (France) is used as a case study. It is one of the last remaining free meandering river segments in Europe, and thus, constitutes an opportunity to investigate riparian succession processes of a dynamic, temperate river system. Despite its natural character, it is also experimenting an increase of stability (i.e., a reduction in channel migration and progression/retrogression of vegetation patches), because of a concomitant decrease of high and moderate magnitude floods due to current global climate change. The model could be used as a research tool in river science as well as a decision support system for river managers. It will be able to predict potential future evolutionary trajectories of fluvial corridors, adjusting for example to a changing hydrological regime or river restoration works.