JOURNÉES SCIENTIFIQUES

28 NOV 2022

SERVICES ÉCOSYSTÉMIQUES
CONTRIBUTION DE LA NATURE À L'HOMME

29 NOV 2022

SOLUTIONS FONDÉES SUR LA NATURE

Journée SFN organisée en partenariat avec :

SOLUTIONS FONDÉES SUR LA NATURE

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

Dov Corenblit et al.

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

D. Corenblit*, V. Garófano-Gómez, F. Arrignon, F. Vautier, E. Tabacchi, T. Otto, F. Luce, E. Allain, A. Bonis, S. Delmotte, E. González, A. Henry, F. Julien, L. Lambs, F. Martínez-Capel, A-M. Planty-Tabacchi, E. Roussel, J. Steiger, J-P. Toumazet, I. Till-Bottraud, O. Voldoire, R. Walcker

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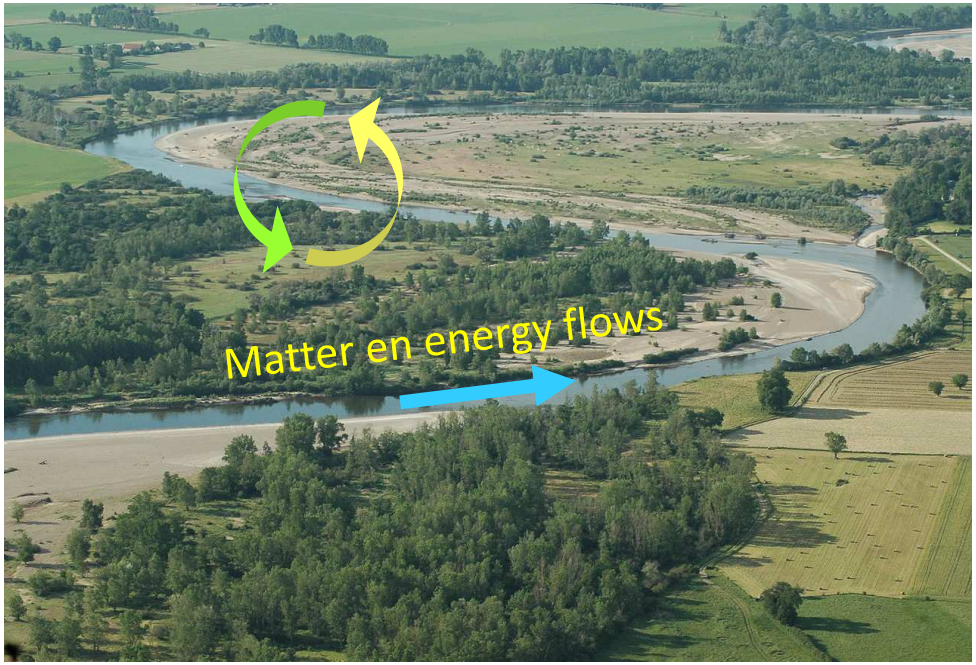
NUMRIP (ANR Project 2022-2025)

Projet-ANR-21-CE32-000

Sharing is encouraged

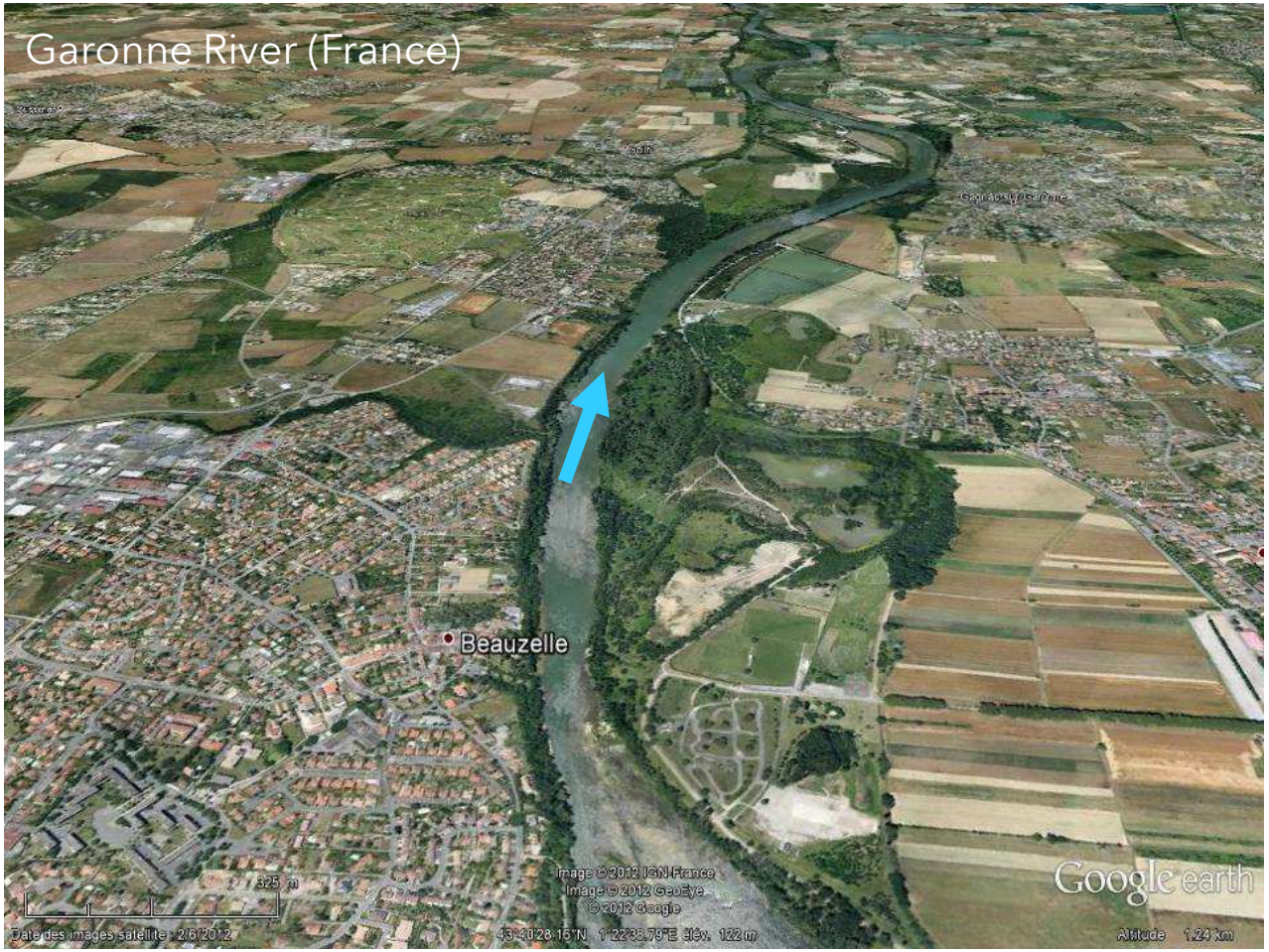
Context

- Fluvial corridors are among the most dynamic ecosystems on Earth; they are subject to material and energy flows.
- Riparian vegetation responds to hydrosedimentary constraints and at the same time affects the river morphodynamics; the effect of riparian plants on geomorphology involves in return a set of feedbacks at different spatiotemporal scales.



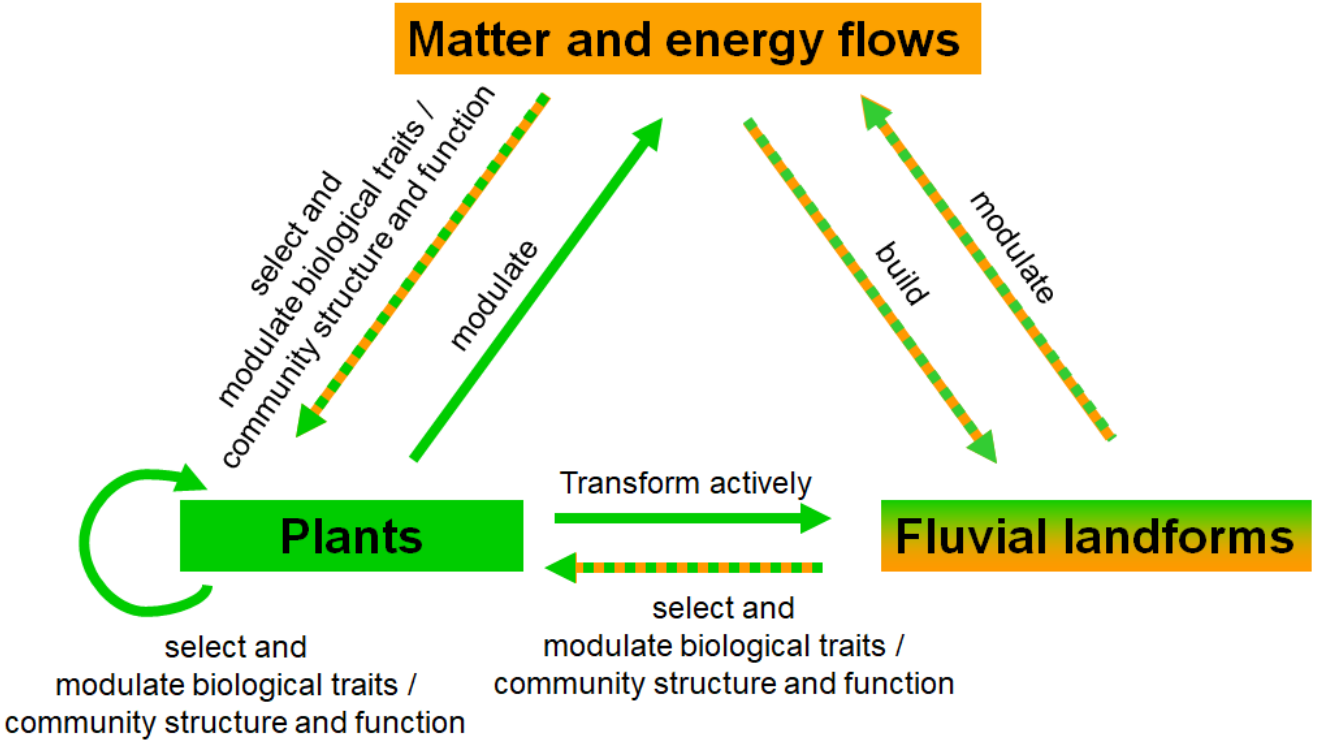
Context

- Strong need to restore the hydrogeomorphological and ecological functioning of rivers.



Context

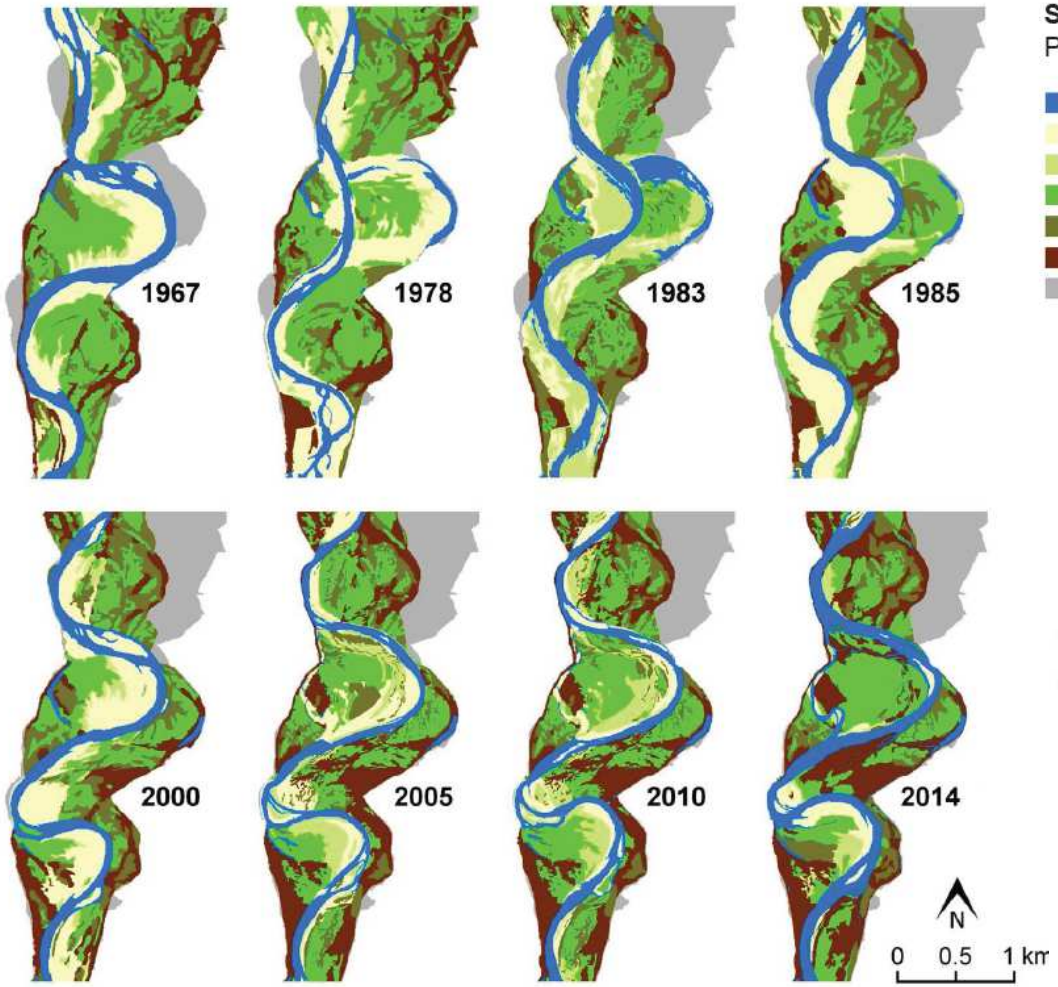
- NUMRIP project aims to build a tool (numerical model) to simulate fluvial landscape dynamics with the explicit consideration of feedbacks between vegetation dynamics and river morphodynamics integrating a functional trait approach.



Corenblit et al., 2007. *Earth-Science Reviews*

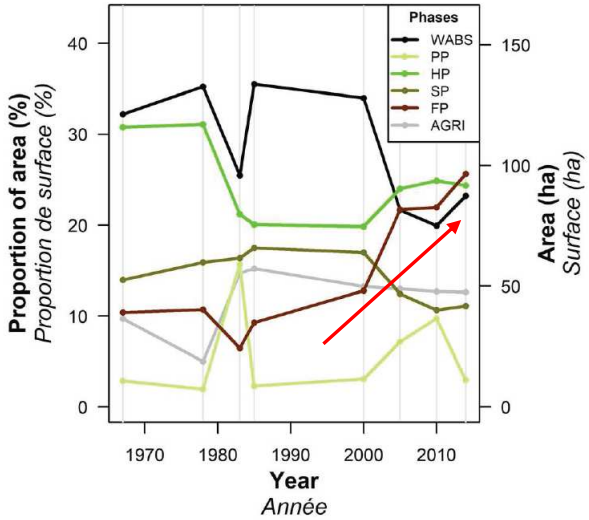
Study site : Garonne and Allier Rivers

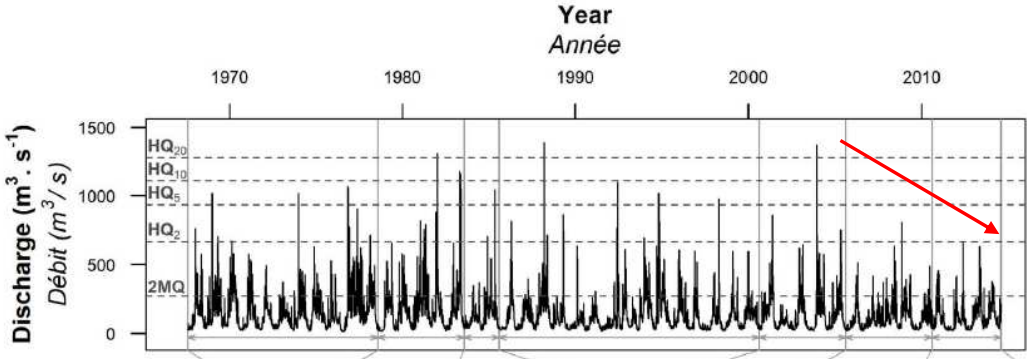
Réserve Naturelle du Val d'Allier



Succession phases /
Phases de succession

- **WA**: Water / *eau*
- **BS**: Bare soil / *sol nu*
- **PP**: Pioneer phase / *phase pionnière*
- **HP**: Herb phase / *phase herbacée*
- **SP**: Shrub phase / *phase arbustive*
- **FP**: Forest phase / *phase arborée*
- **AGRI**: Agricultural land / *terrain agricole*





	1967-1978	1978-1983	1983-1985	1985-2000	2000-2005	2005-2010	2010-2014
2MQ	5.1 / 59.5	5.6 / 68.0	4.5 / 26.5	3.5 / 30.6	3.6 / 39.6	3.6 / 22.8	3.8 / 24.0
HQ_2	1.0 / 3.5	1.4 / 5.6	1.0 / 2.5	0.5 / 1.6	0.6 / 1.8	0.2 / 0.2	0.0 / 0.0
HQ_5	0.4 / 0.5	0.6 / 1.8	0.5 / 1.0	0.3 / 0.5	0.2 / 0.4	0.0 / 0.0	0.0 / 0.0
HQ_{10}	0.0 / 0.0	0.6 / 0.8	0.0 / 0.0	0.1 / 0.1	0.2 / 0.4	0.0 / 0.0	0.0 / 0.0
HQ_{20}	0.0 / 0.0	0.2 / 0.2	0.0 / 0.0	0.1 / 0.1	0.2 / 0.4	0.0 / 0.0	0.0 / 0.0

Garófano-Gómez et al., 2017. *Geómorphologie.*

Methodology

Task 1: Trait-based characterisation of vegetation
Define functional groups of responses to and effects on the physical environment.
-GEOLAB, Lab Ecol Fonc Env-

Task 2: Spatial analysis
Define a semi-automatic procedure for the constitution of 2D and 3D spatial information (DEMs and plant characteristics).
-IntelEspace, GEOLAB-

Task 3: Model development
Optimization of the pre-existing hydrogeomorphological modulus of GALET; coding and calibration of the new trait-based vegetation modulus; development of an optimized code.
-MAD-Env-

Task 4: Model validation and application
Investigate the potential trajectories of rivers.
-MAD-Env, GEOLAB, Lab Ecol Fonc Env-

Methodology

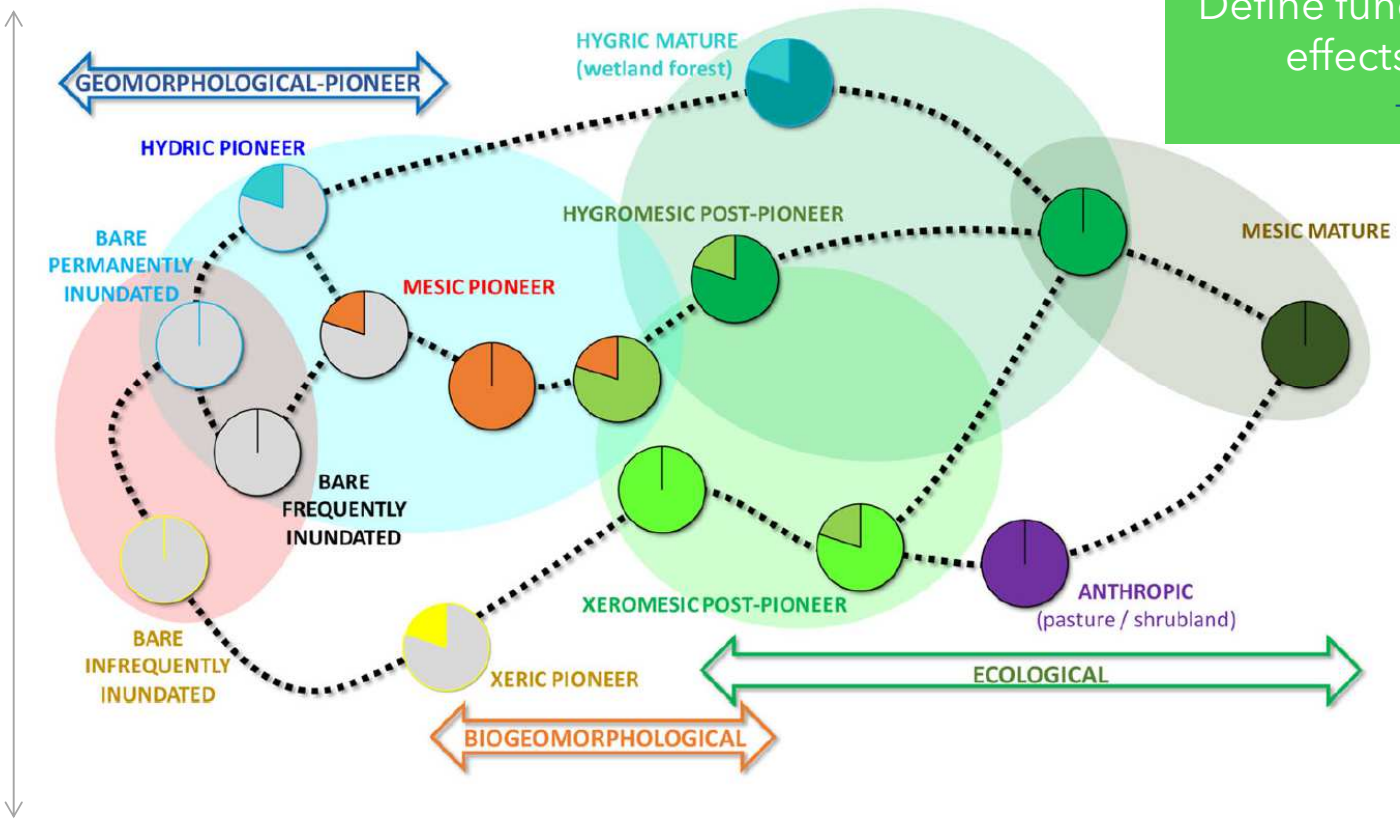
A functional trait approach will be followed.

Task 1: Trait-based characterisation of vegetation

Define functional groups of responses to and effects on the physical environment.

-GEOLAB, Lab Ecol Fonc Env-

Wet conditions



Dry conditions

Components of the plant successional units (circles)

- Bare sediment
- Aquatic / wetland herbaceous vegetation
- Frequently flooded forest
- Pioneer herbaceous vegetation
- Alluvial shrubland / pioneer forest
- Post-pioneer and mature forest
- Dry herbaceous vegetation
- Dry meadow
- Late stage forest
- Artificially controlled

Tabacchi et al., 2019. *River Res Applic*

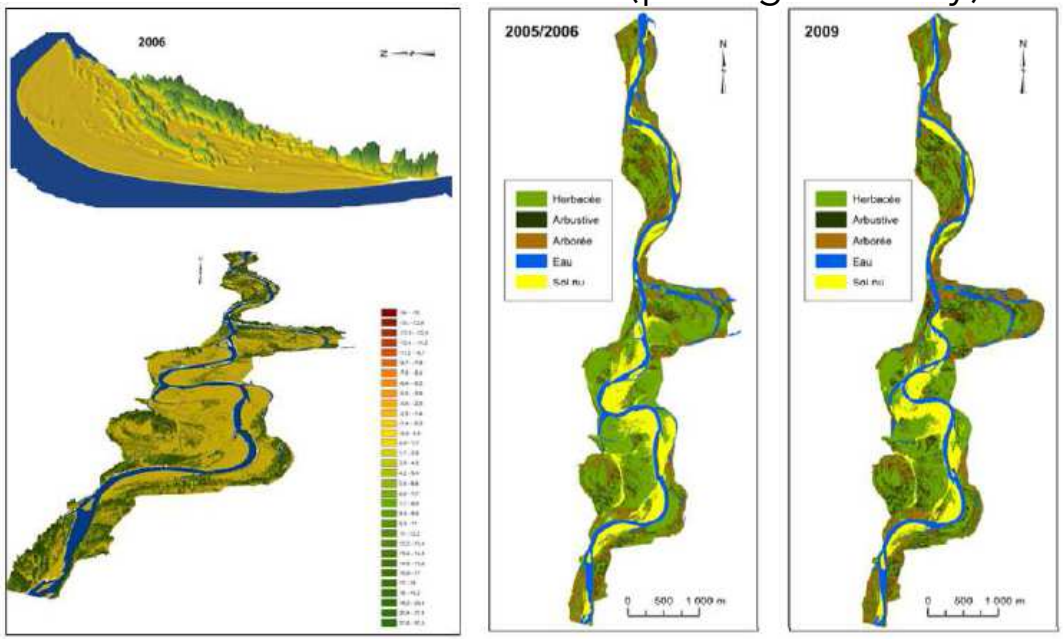
Methodology

Task 2: Spatial analysis

Define a semi-automatic procedure for the constitution of 2D and 3D spatial information (DEMs and plant characteristics).

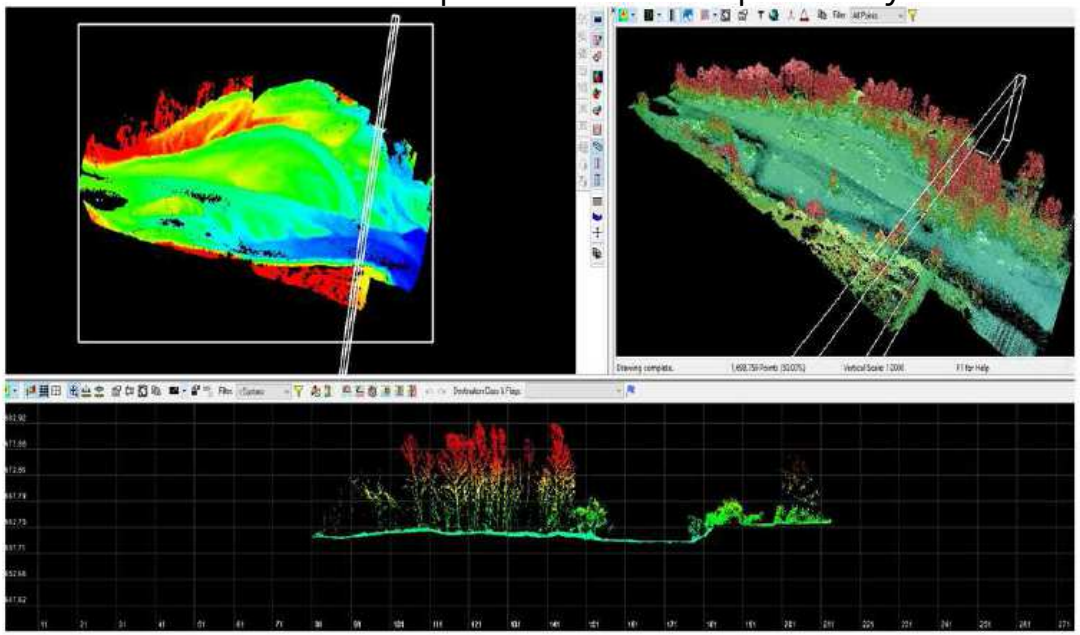
-IntelEspace, GEOLAB-

Diachronic 3D reconstitution (photogrammetry)



Hortogágyi, 2014

LiDAR 3D and multispectral data acquired by drone



MSH-IntelEspace

Methodology

- Inputs from Tasks 1 and 2.
- Flow model (LISFLOOD).
- Sediment model (adapted from CAESAR).
- Vegetation (new module).
- Cellular automaton.

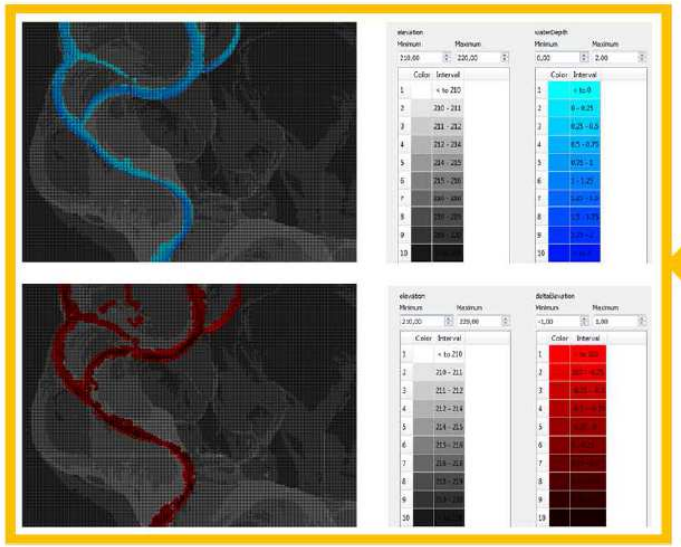
Task 3: Model development

Optimization of the pre-existing hydrogeomorphological modulus of GALET; coding and calibration of the new trait-based vegetation modulus; development of an optimized code.

-MAD-Env-

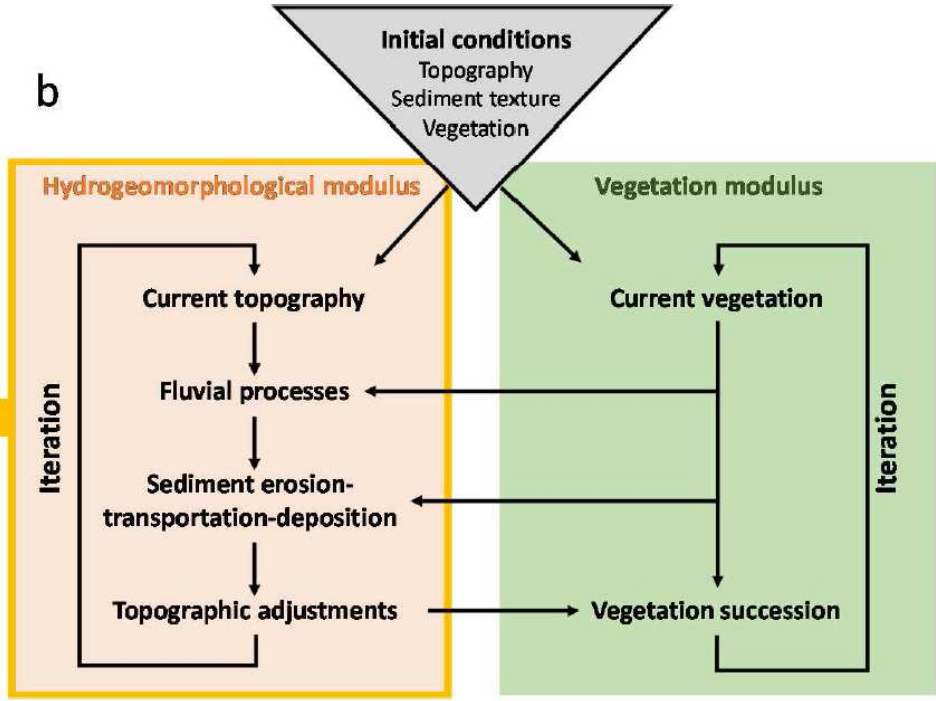
a

2D maps of dynamic variables



Arrignon et al., 2012; Steiger et al., 2013

b



Perspectives

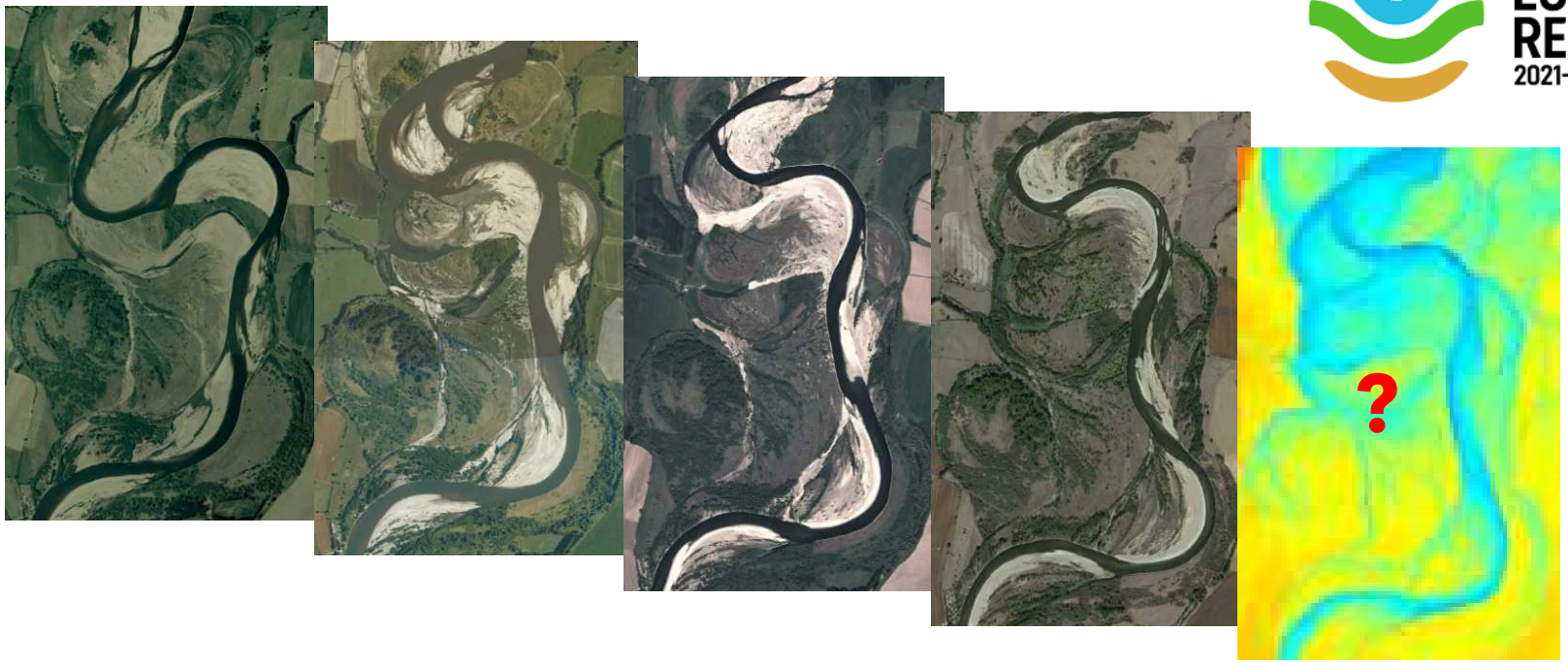
- Research tool in river science.
- Decision support system for river managers.
- Simulation of different scenarios.

Task 4: Model validation and application

Investigate the potential trajectories of rivers.

-MAD-Env, GEOLAB, Lab Ecol Fonc Env-

Future evolutionary trajectories of fluvial corridors?



UNITED NATIONS DECADE ON ECOSYSTEM RESTORATION 2021-2030

Perspectives

Task 4: Model validation and application

Investigate the potential trajectories of rivers.

-MAD-Env, GEOLAB, Lab Ecol Fonc Env-

Application to the other water-terrestrial interfaces

- (b) Salt marshes
- (c) Mangroves
- (d) Coastal dunes

Thanks!