An operational methodology for riparian land cover fine scale regional mapping for the study of landscape influence on river ecological status

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AN OPERATIONAL METHODOLOGY FOR RIPARIAN LAND COVER FINE SCALE REGIONAL MAPPING FOR THE STUDY OF LANDSCAPE INFLUENCE ON RIVER ECOLOGICAL STATUS

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INTRODUCTION

Preserving or restoring the ecological quality of aquatic ecosystems is a major objective of Water Framework Directive (WFD). A pending question deals with the gain in river ecological status indicators that could be allowed by restoring riparian tree vegetation. In order to quantify in a statistically relevant way the role of riparian vegetation on river ecosystems, a regional approach is required that mobilizes three complementary fields of research :

(1) the use of very high spatial resolution satellite imagery to map river corridor land use and riparian vegetation along large river networks ;
(2) the design and quantification of synthetic spatialized indicators of river corridor land use;
(3) the development of pressures/state statistical models that quantify the relation between river corridor land cover indicators and river ecological status indicators.

The corresponding methods were developed and implemented on Herault river basin (1150 km long, southern of France) and over Normandy river networks (6000 km long, 155 ecological stations, northern of France).

1. MAPPING RIPARIAN LAND COVER

Tormos, T., Durrieu, S , Kosuth, P., Dupuy, S., Wasson, J.G. & Villeneuve, B. (SUBMITTED-2010) Object oriented approach for operational broad-scale mapping and quantification of land cover spatial indicators along river corridor. *International Journal for Remote Sensing of Environment.*

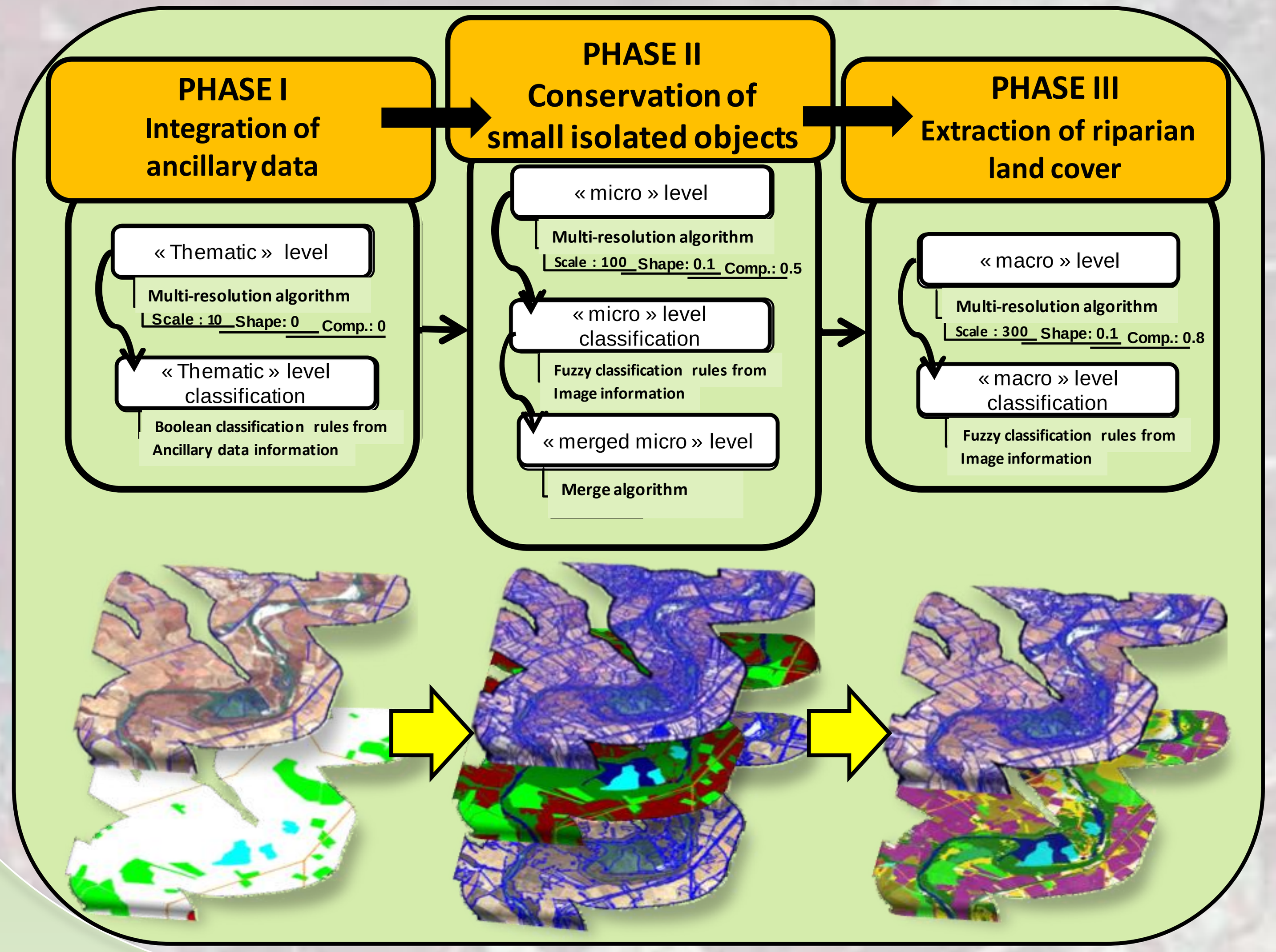
1.1 DATA

As the structure of land cover along rivers is generally not accessible using moderate-scale satellite imagery, finer spatial resolution imagery are needed. We acquired information available with affordable cost over the French territory for managers from very high spatial resolution imagery (satellite and airborne) and metric to decametric spatial ancillary data.

(CLC) CORINE Land Cover artificial soils classes
(RNB) Road network database
(NPR) Numerical Parcel Register (agricultural parcels)

1.2 OBJECT ORIENTED APPROACH

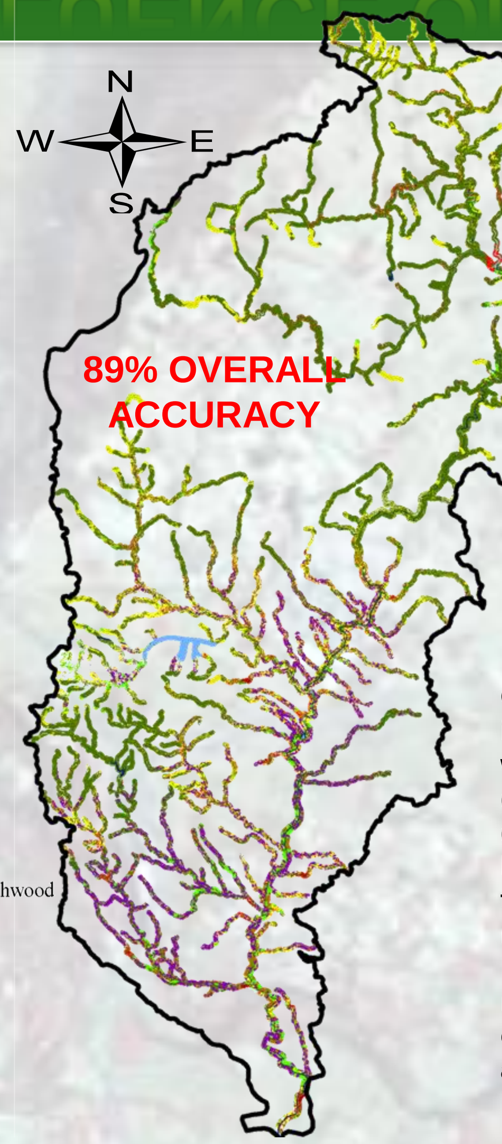
A generic multi-scale Object Based Image Analysis (OBIA) scheme based on fuzzy expert knowledge classification rules was developed. It composed of 3 successive segmentation-classification phases : phase I allows integrating information from ancillary data in the classification process ; phase II allows keeping small isolated objects near the river in the segmentation process ; and phase III allows classifying riparian land cover according to the most detailed typology as possible.



1.3 APPLICATION ON HERAULT WATERSHED (1150 KM LONG)

The implementation on the Herault watershed reveals that the OBIA scheme is:

-*Reproducible*: whatever the geographic context, river size and image acquisition date, the overall accuracy of the classification was good to very good;
-*Easily transferable*: Transferring the method to another area has proved to be easy despite the diversity of landscapes in the study area;
-*Quickly applicable over large areas*: The processing timewas 3 days with the use of a 8 core cluster machine;
-*Portable and scalable* The method can easily manage information from multiple data sources by resolving conflicts between these sources using fuzzy logic.



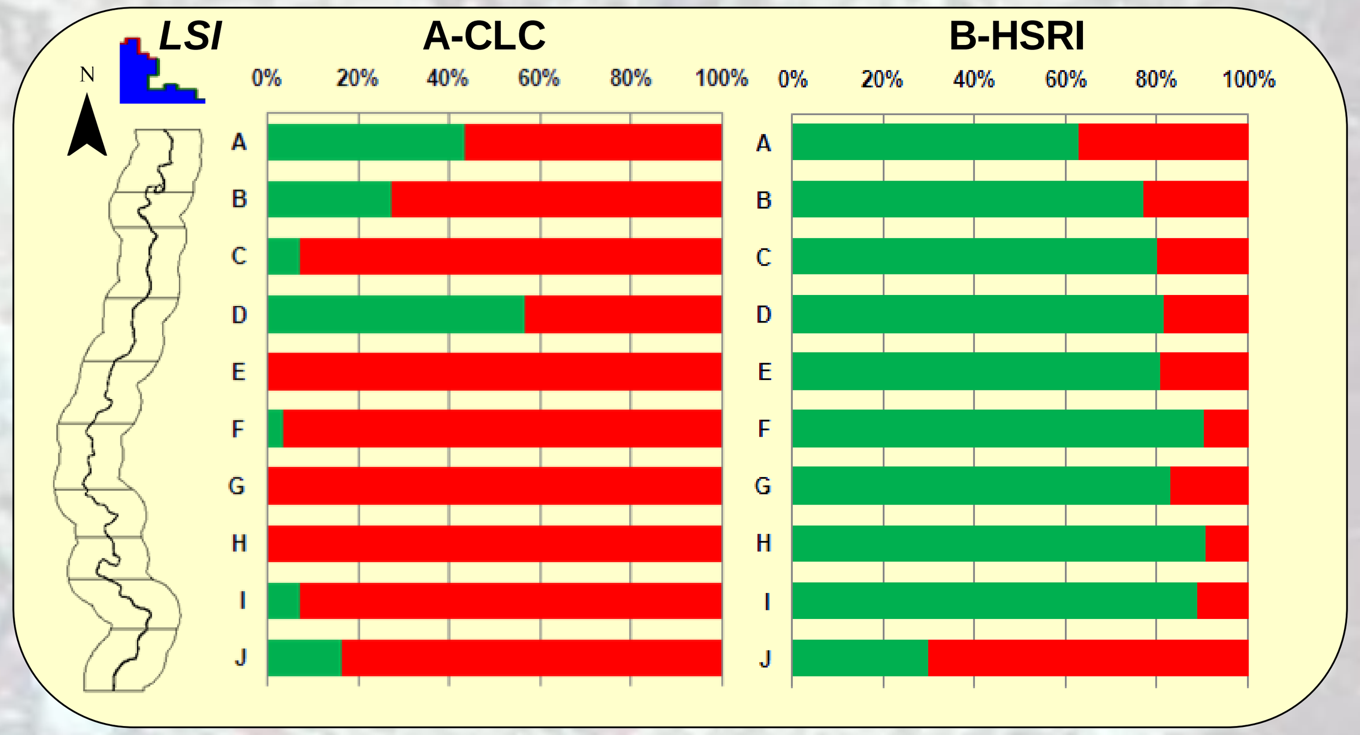
Legend
- Herault watershed
- Continuous urban fabric
- Artificial soil
- Industrial or commercial units
- Road and rail networks and associated land
- Sport and leisure facilities
- Road network
- Ploughing
- Active cultures
- Vineyards
- Pastures
- Forest
- Transitional woodland shrub, brushwood
- Semi-natural grassland
- Sparsely vegetated areas
- Beaches, dunes, and sand plains
- Sand and mineral soil
- Bare soil
- water courses
- Water bodies
- Sea and ocean

2. BUILDING SPATIAL INDICATORS

Tormos, T., Kosuth, P., Durrieu, S., Villeneuve, B. & Wasson, J.-G. (IN PRESS - 2010) Improving the quantification of land cover pressures on stream ecological status at riparian scale using High Spatial Resolution Imagery. *Physics and Chemistry of the Earth*

A spatial indicator is invariably defined by aggregating a landscape structure attribute over a delimited area (spatial scale). Synthetic spatial indicators derived from land cover map were built to quantify anthropic pressures and riparian vegetation conditions (Tormos et al., 2010).

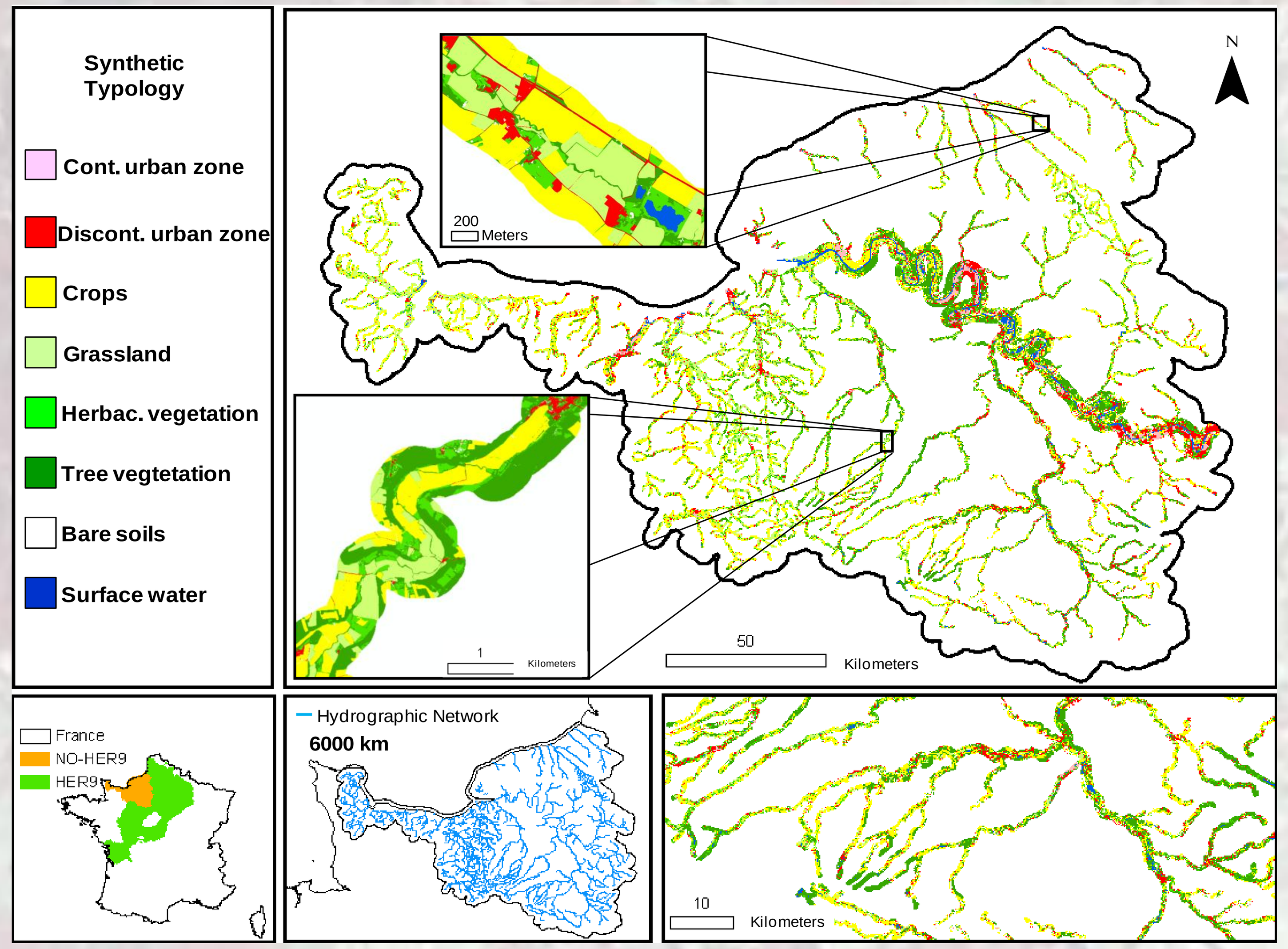
On the right, you can see an illustration of linear surface indicators (LSI : percentage of a given land cover type within a 10-m buffer width) of anthropic pressures (urban and agricultural zones) and semi-natural pressure (herbaceous, scrub, tree vegetation and bare soils) building from CLC database (30 m, generally used) and the High Spatial Resolution (HSR) derived map on 10 reaches (A to J) over the most downstream part of Herault River (80 Km). Such result highlights the drastic need for HSR-maps to quantify in a relevant way the riparian vegetation characteristics along the stream.

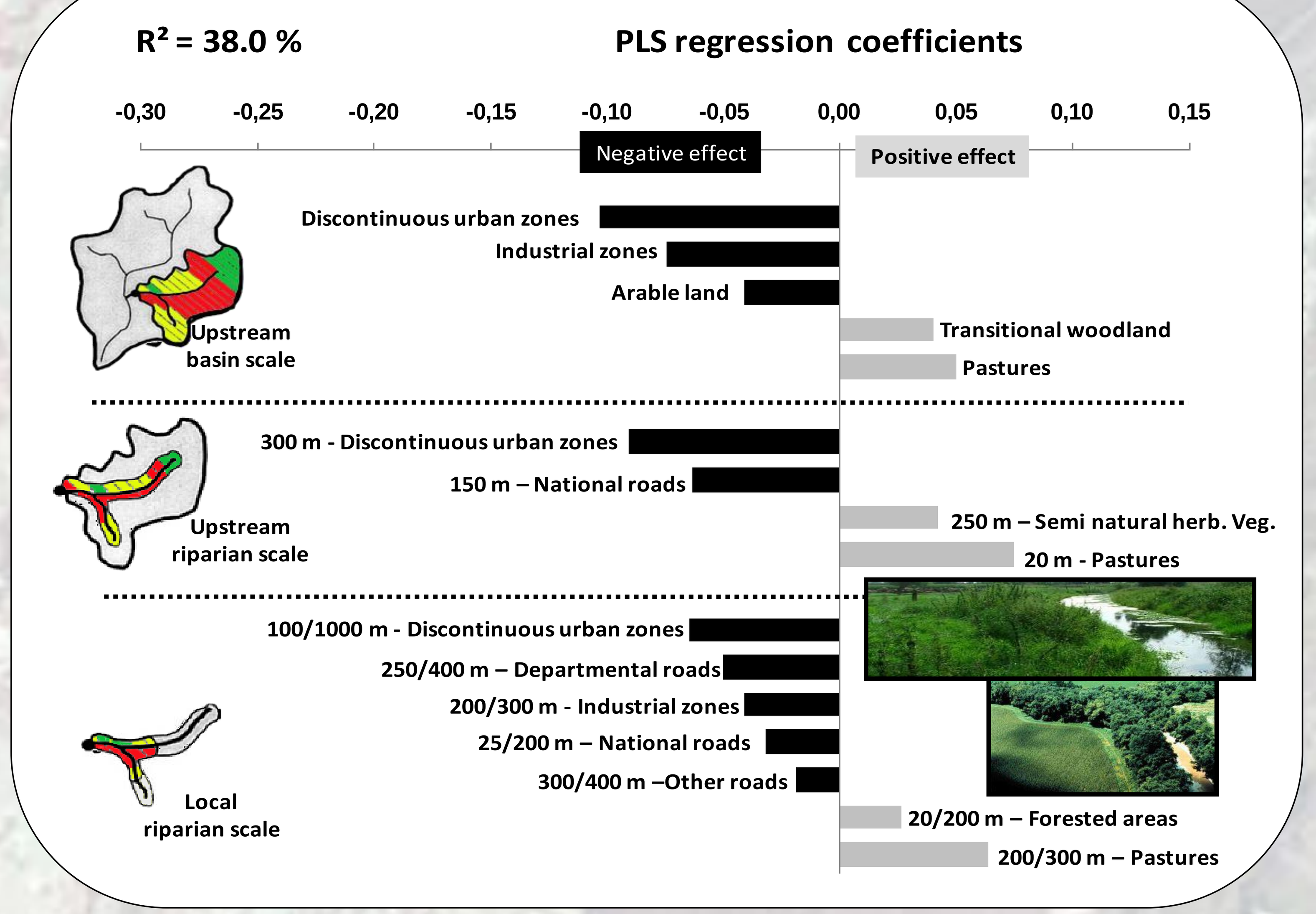


3. MODELLING LANDSCAPE INFLUENCE ON RIVER ECOLOGICAL STATUS

(APPLICATION OVER NORMANDY RIVERS (6000 KM LONG, 155 ECOLOGICAL STATIONS)

In this part, we developed pressures/states statistical models studying large scale relationships between river ecological status and land cover at 3 scales : the upstream watershed, the upstream riparian and the local riparian scales. For that purpose, river ecological status was firstly assessed on 155 stations using normalized macroinvertebrate indicators (EQR-IBGN). Secondly, we implemented the OBIA classification using the same data sources used on Herault watershed (HSR imagery and ancillary data) over the riparian corridor of the Normandy river (see the illustration below on the left) in order to build more precise surface spatial indicator indicators within a wide range of riparian footprints. A footprint is a buffer with a given lateral distance to the river at the upstream riparian scale and given longitudinal distances upstream and downstream from the ecological station too at the local riparian scale. At the upstream watershed scale, surface indicators were computed from CLC database. Finally, we implemented multiple linear regression using the Partial Least Square (PLS) algorithm. Thanks to the fine riparian land cover mapping and the indicators computed on a spectrum of riparian footprints it was possible to identify and localize more precisely the different pressures and to demonstrate the specific influence of riparian vegetation (on a 20m wide strip on both sides of the river) on river ecological status at regional level (see the illustration below on the right).





CONCLUSION

First, a cost-effective, accurate, time-efficient and spatially extensive technique was developed in this study to quantify riparian land cover in the context of its functional links to river ecological status. Second, spatial indicators built from this land cover map were defined and computed in order to reflect the impact mechanisms of the human and riparian vegetation on river ecological status at riparian scale. Finally, pressures/states models using only surface indicators allowed demonstrating the specific influence of riparian vegetation (on a 20m wide strip on both sides of the river) on river ecological status at regional level. The next step will be to test in such models spatial indicators links to riparian vegetation conditions in order to support stakeholders in riparian buffer policy decisions for WFD implementation.

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