Extending the multi-agent modelling platform MAELIA to support land conversion to agroforestry systems

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Background and objectives

Assessment of environmental, economic and social impacts of agroforestry at local level requires development of adapted modelling tools.

The platform **MAELIA**[1] (http://maelia-platform.inra.fr) is a **multi-agent platform of socio-agro-ecological systems simulating at fine spatio-temporal resolution dynamic agricultural activities** (rotation and crop management within each production system) **and their biophysical and socioeconomic effects over the landscape**.

The objectives here are to extend the functionalities of MAELIA to simulate:

- **management strategies in agroforestry systems**;
- **growth of trees and their biophysical interactions with underlying crops and grasses**.

Methods and modelling approaches

MAELIA allows simulating:

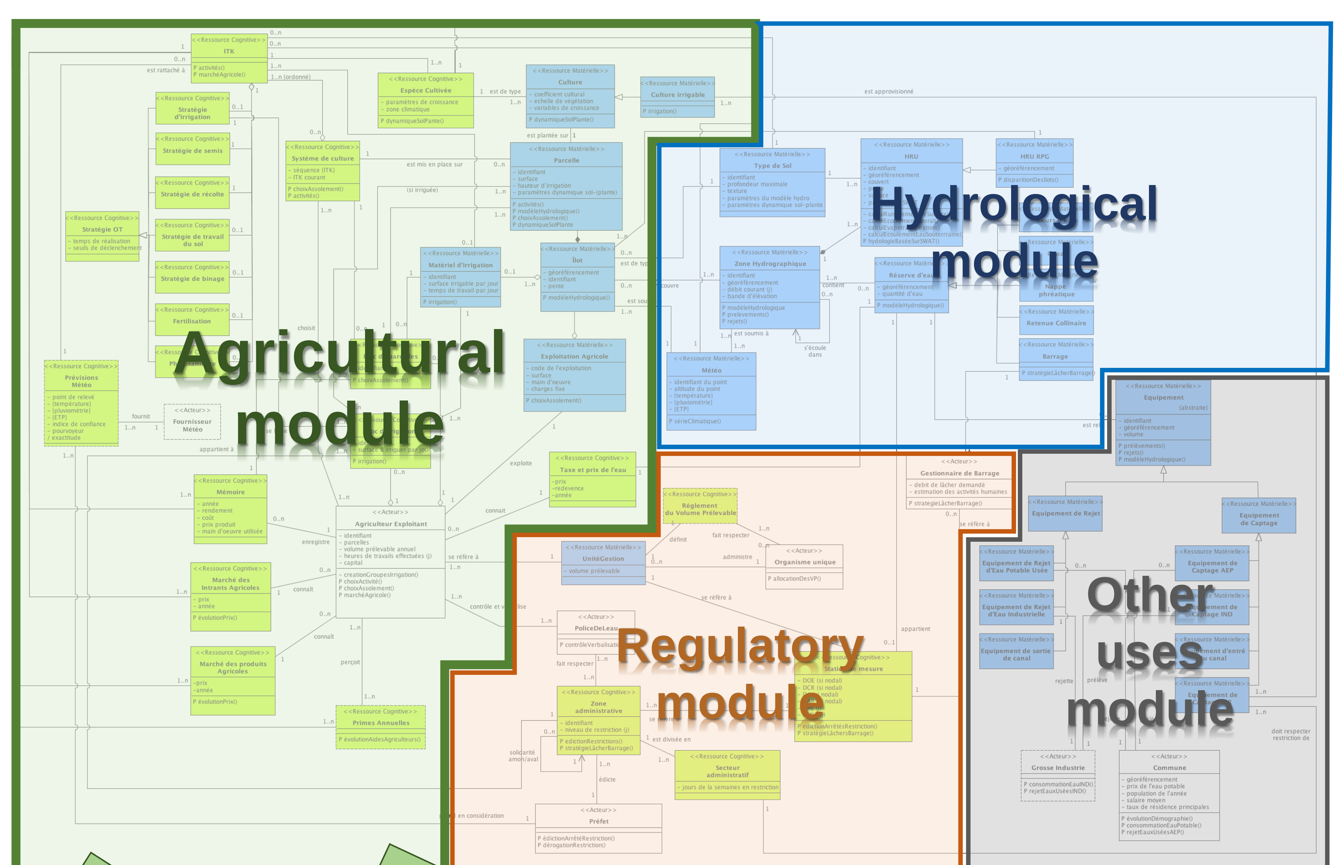
- technical operations
- development and yield
- workload
- gross margins

of arable crops and grasslands and their interactions with the dynamics of:

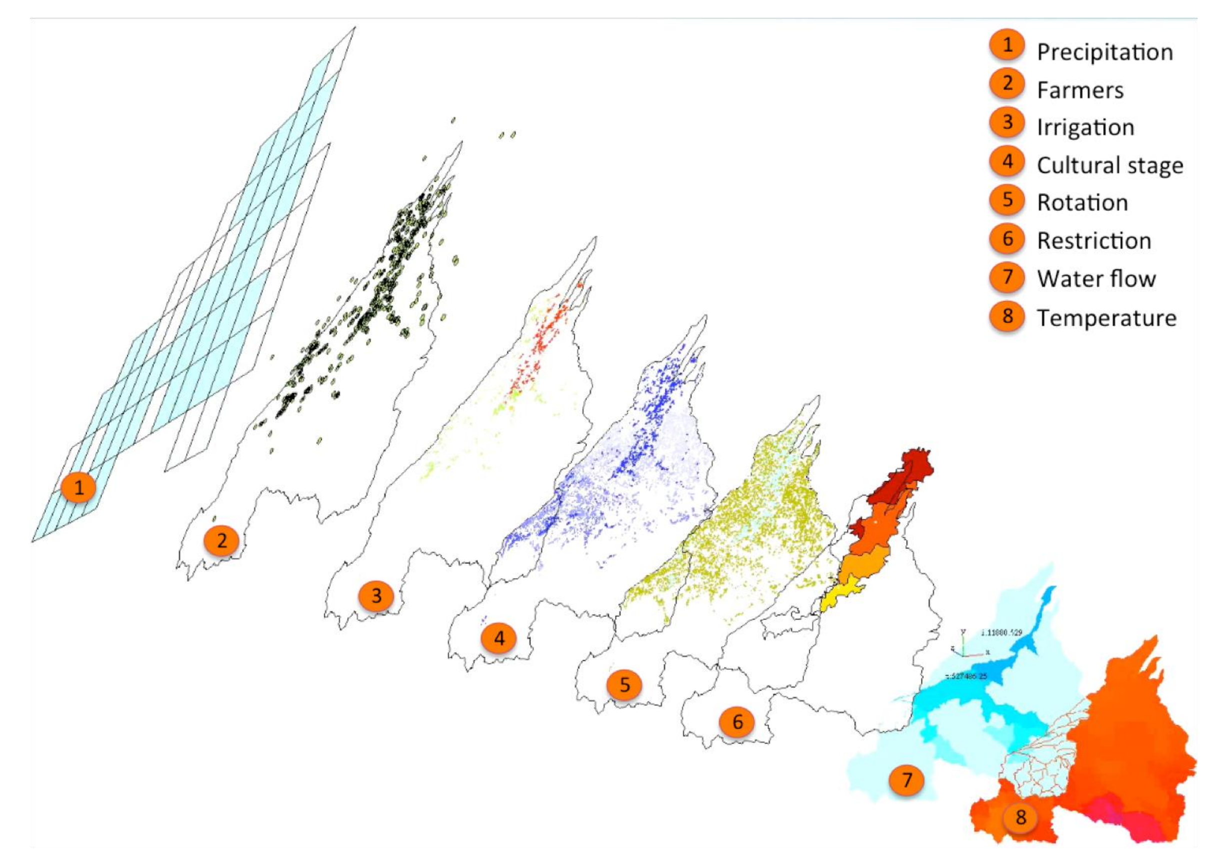
- water
- carbon
- nitrogen

in each field of the landscape, considering farm and resource management constraints.

MAELIA Actor-Resource Diagram



3D visualization of some MAELIA's entities



Comparing 2 modelling approaches

1. Implementing Yield-SAFE into MAELIA to simulate agroforestry systems
2. Coupling Yield-SAFE tree subpart and AqYield + Herb'sim for simulating tree-crops interactions

Soil-crop model

- AqYield[2] → crops (Step 2)
- Herb'sim[3] → grassland (Step 2)
- Yield-SAFE[4] (Step 1) → trees (Step 1, Step 2), crops/grassland (Step 1)

Collecting data on management strategies

Parameterization

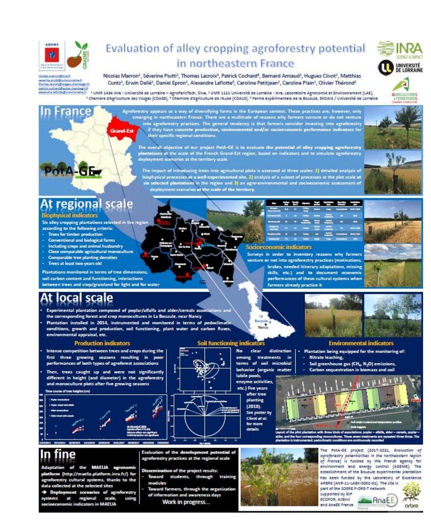
- **Decision rules for technical operations**
- **Economic module**

Platform calibration and validation

Using:

- Data on biophysical processes from an instrumented experimental site
- Data on a subset of processes from 6 field sites

See poster L20.P.06 by Marron *et al.*



« Evaluation of alley cropping agroforestry potential in northeastern France »

Expected results and perspectives

(i) Robust representation and simulation of plant growth and water fluxes in temperate agroforestry systems.
(ii) Assessment of environmental and socio-economic impacts of scenarios introducing alley cropping in a French temperate region.
(iii) Ongoing developments in MAELIA will allow to address agri-environmental issues related to carbon and nutrient cycling in agroforestry systems.

References:

[1] Gaudou *et al.* (2013) The MAELIA multi-agent platform for integrated analysis of interactions between agricultural land-use and low-water management strategies. In: *International workshop on multi-agent systems and agent-based simulation*. Springer, Berlin, pp 85-100.
[2] Constantin *et al.* (2015) The soil-crop models STICS and AqYield predict yield and soil water content for irrigated crops equally well with limited data. *Agricultural and Forest Meteorology*, 206: 55-68.
[3] Duru *et al.* (2010) Herb'sim: a model for a rational management of grass production and grass utilization. *Fourrages*, 201: 37-46.
[4] van der Werf *et al.* (2007) Yield-SAFE: A parameter-sparse, process-based dynamic model for predicting resource capture, growth, and production in agroforestry systems. *Ecological Engineering*, 29: 419-433.

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