

# Challenges for integrated assessment modeling of socio-agro-ecological systems

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## Abstract

MAELIA is a simulation platform for integrated assessment modeling of socio-agro-ecological systems. It has been designed to assess environmental, economic and social impacts of combined changes in agricultural activities, biomass transformation and recycling chains, natural resource management strategies (e.g. water) and external drivers (e.g. demography, climate changes). This platform enables users to simulate the dynamics and the interactions of the four main sub-systems of social-ecological systems: 1) resource systems (e.g. hydrological systems), 2) resource units (e.g. water volume and flow), 3) governance systems (e.g. which manage water resources) and 4) users (e.g. individuals and collectives who use water). MAELIA is a spatially explicit fine scale platform in which the interacting behaviors of plots, farmers, farms, agro-chain agents and governance agents are represented on an individual level. Hence, users can define and use outputs from field to local scale (e.g. watershed scale). This makes MAELIA a powerful and detailed tool used to simulate agricultural landscape dynamics from a few isolated farms to a thousand sq. km.

MAELIA is an ambitious platform that aims to offer an integrated perspective on socio-agro-ecological systems. For this purpose, the platform has a modular structure that enables users to activate/deactivate sub-models according to their research objectives. Modules are articulated around a core set of sub-models that is the simulation of farmer agent behavior based on Belief-Desire-Intention (BDI) architecture and decision rules. Four sub-models are actually organized around this agricultural core and interact with each other:

- The crop sub-model that simulates interactions between water, nitrogen and carbon-cycles and crop growth, at the field level;
- The agroforestry sub-model that simulates interactions between crop and tree growth (competition for water and light);
- The hydrological sub-model that simulates water flows and volumes in rivers, lakes, groundwater and dams;
- The organic resource chain sub-system in which exchanges and transformation processes of organic resources are represented (e.g. anaerobic digestion).

Each of them is based on external models that have been implemented and adapted in MAELIA platform (respectively AqYield, Yield-Safe, SWAT and UPUTUC). These models have been chosen based on their robustness as well as their simple handling (ease of use, parsimoniousness). The combination of these models results in a very large model that pushes GAMA to its limits. This situation has led the MAELIA development team to adapt implementation strategies.

Besides these technical challenges, MAELIA faces other challenges due to its fine-scale, integrative and generic modeling ambitions and its maintenance requirements. The use of such a platform in a new study area requires a huge amount of work regarding data integration. It usually implies fieldwork campaigns usually conducted along with local partners involved in research projects that aim using MAELIA. In addition, the integrative approach implies a wide range of scientific skills and knowledge to deal with specific research questions and to implement new modules.

Our communication aims to address the challenges that faces the development and utilization of such a platform and to discuss the work strategies selected throughout the twelve years history of MAELIA.