

Development and implementation of Agent Based Models in the Mediterranean

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What is Nostrum-DSS?

It is a Co-ordination Action, funded by the EC FP6, which aims to improve governance and planning in the field of sustainable water management in the Mediterranean area:

- by establishing a network between the science, policy, and civil society spheres,
- by fostering active involvement of the relevant stakeholders,
- through the development and dissemination of Best Practices Guidelines for the design and implementation of DSS tools for IWRM.

What are the Nostrum-DSS Leaflet Series?

These short documents summarise the main output of the project and represent an **entry door** to the wide range of products and resources available on the project's web site. They are composed of three kind of leaflets:

- Case studies leaflets
- Policy leaflet
- Technical leaflet

To whom is this leaflet addressed?

As part of the Technical leaflet series, this document is mainly addressed to **researchers and technicians** interested in gaining insights on how *DSS tools and approaches* can support them in their everyday job, but may be useful to policy and decision makers too.

For further information see the NOSTRUM-DSS website:

→ <http://www.nostrum-dss.eu>

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Public participation in water management

Problems in water management are exacerbated by unsustainable development, climate change and the uncontrolled growth of the world population. The primary purpose of water resources management is, thus, to assure and improve the **allocation** of water, preserve its **quality**, cope with **extreme events** (such as floods), mitigate **droughts**, and manage the inter-annual **variability of water supply**, especially in the Mediterranean Area.

In all the above cases, ensuring communication and exchange of information and knowledge is a decisive factor for providing enduring and socially approvable solutions. That is exactly why the **participatory approach** is becoming a prerequisite to every legislative or planning process dealing with Integrated Water Resources Management (IWRM). According to GWP public participation (PP) requires "that stakeholders at all levels of the social structure have an impact on decisions at different levels of water management", thus fostering the adoption of more decentralized and cooperative approaches that take into account all processes involved in human-influenced ecosystems.

Evident is the need for Decision Support Systems (DSS) that integrate the ecological and socio-economic dimensions of water management. **Agent-Based Modeling and Simulation (ABMS)** techniques due to their inherent characteristics can be effectively used to model both the ecosystem dynamics and the complexity of natural resource management.

What is an agent based model?

The term **agent** is used to denote a hardware or software system that is:

- autonomous* – it operates without the direct intervention of others;
- social* – it interacts with other agents using an agent-communication language;
- reactive* – it perceives its environment and responds to changes in it; and
- proactive* – it is able to exhibit goal-directed behaviour.

Multi-Agent Systems comprise multiple agents, which interact among themselves or with objects in their environment, having a limited viewpoint and in the absence of a system global control point.

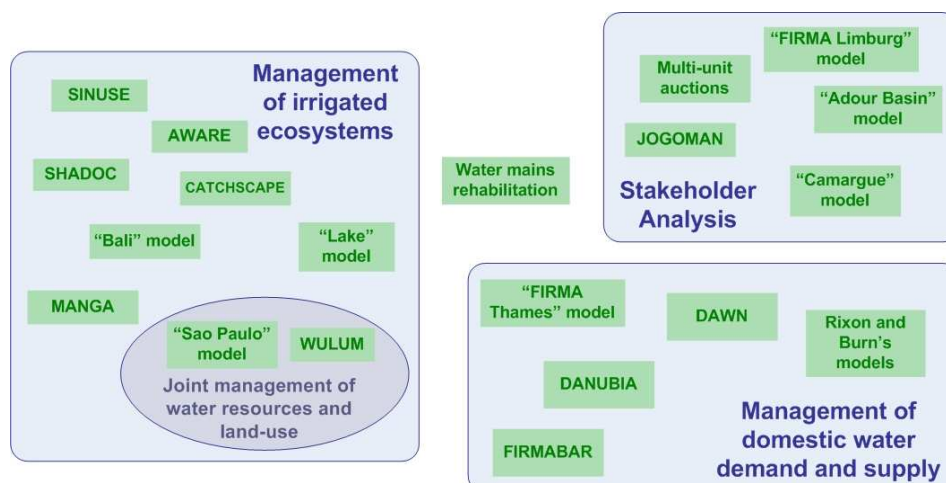
Building on the above definitions, **ABMS** takes a slightly different stance and tries to represent complex systems by defining the involved entities (individual or collective) and by formulating their behaviour and interaction in the specific environment. To this end, ABMS fuses insights and concepts from several disciplines, including economics, psychology, sociology, environmental and management sciences in an actor-based analysis for integrating social processes in the developed tools.

Developing Decision Support Systems using ABMS, thus, has a great potential for a) representing dynamic processes, and specifically social ones, in integrated assessment tools and b) facilitating participatory and negotiation procedures among stakeholders.

Agent-based models are used to estimate the effects of alternative management policies in order to support decision makers in the water management sector.

Agent-based modeling has successfully been used to tackle water management problems, thus, showing a great potential for future DSS development.

Examples and classification of agent-based models for water management according to their modelling approach and objectives



Agent-based models for water management

Different types of agent-based models are developed to support specific aspects and phases of the IWRM process:

- 1) *models simulating the **management of irrigated ecosystems*** aim at exploring the relation between biophysical and socioeconomic variables in irrigated ecosystems;
- 2) *models for **stakeholder analysis*** seek to reveal the network of interactions between stakeholders, by means of formalizing decision-making processes as negotiations or auctions;
- 3) *models for simulating **domestic water demand and supply*** capture the socioeconomic aspects of potable water management and evaluate scenarios representing alternative demand control measures; and
- 4) *models for **water supply infrastructure rehabilitation*** analyze the decision-making process of water supply companies, in an attempt to support the discovery of effective infrastructure rehabilitation strategies.

This classification is illustrated in the above figure, along with representative examples of existing ABMS tools for each application domain.

For further information, please refer to the full Nostrum-DSS deliverable D6-3: *Report on the development of agent based models for water demand and supply*

→ | <http://www.nostrum-dss.eu>

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Recommendations for the development and use of ABMS tools

- ✓ ABMS tools can be used for simulating irrigated ecosystems, domestic water demand and supply systems, or stakeholder analyses.
- ✓ ABMS tools typically involve models with high uncertainty, thus they should be considered as tools for exploring future trends under specific scenarios, rather than accurate projections of the future.
- ✓ ABMS tools can be validated either in a conceptual or a statistical fashion. However, social processes are very difficult to simulate as typically there are few data available on the level of the individual behavior and decision making.
- ✓ ABMS tools are complementary to participatory methods. They can be used as computer tools (games) for revealing to stakeholders the consequences of their actions or they can engage stakeholders in the development phase for assessing policy implications.
- ✓ As ABMS tools are primarily used for exploring future trends, their results should be read in a relative fashion for comparing policy consequences, and ABMS results should not be considered as absolute predictions of the future.
- ✓ Future application areas of ABMS tools may include cases of shared water bodies among countries or regions where transboundary regulation and negotiation must be captured.

