Modeling the impacts of freshwater scarcity in the coastal zone
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Modelling the impacts of freshwater scarcity in the coastal zone: a system dynamic approach

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Content

1) SPICOSA and the System Approach Framework (SAF)
2) Policy Issue: Freshwater scarcity in the Pertuis Charentais area
3) Methods: analytical framework and modelling approach
4) Results:
   - Effects of new institutional arrangements
   - Magnitude of economic impacts
5) Discussion

SPICOSA and the System Approach Framework

The SPICOSA project (2007-2011) has developed a System Approach Framework, which aims at integrating the ecological, social and economic dimensions of Coastal Zone Management in order to support decision-making.

Within this framework, dynamic models are used to explore policy options following a problem oriented and scenario based approach. Model outputs are expected to contribute to the integrated assessment of coastal systems.

The simulation modelling platform is developed using the software ExtendSim®, with special attention to user-friendly interfaces.

Meetings of the participant group in the Charente study site.

SPICOSA and the System Approach Framework

Four steps of the system approach for coastal system assement:

Step 1: Issue resolution
Working with stakeholders in order to identify the main "sustainability problems" of the coastal zone, according to the local policy agenda and social concerns.

Step 2: Defining the system ("virtual modelling")
Defining the natural, social and economic components of the system (Ecosystem and the natural resources, Human activities, Governance bodies), the processes and interactions.

Step 3: Formulation of the system ("numerical modelling")
Mathematical formulation of the processes, including dynamics and feedback loops.

Step 4: Appraisal of the models, scenarios and model outputs.

Tett, Paul, Audun Sandberg and Anne Mette (eds.), 2011. Sustaining coastal zone systems. Dunedin Academic Press, Edinburgh, Scotland, 173 pages.

Freshwater scarcity in the Pertuis Charentais area

The water shortage management plan (PGE) dedicated to the Charente river addresses the ecological, social and economic issues raised by freshwater scarcity according to the following principles and objectives:

- there is a hierarchy of the freshwater uses
    1. good ecological status of the coastal ecosystems
    2. drinking water for households
    3. other uses: agriculture, shellfish farming…
- Reachable Discharge Thresholds (RDTs) are defined at different control points on the river ; these RDTs should be reached 8 years out of 10.

Charente watershed on the Atlantic coast of France: hydrological units and coastal area.

Freshwater scarcity in the Pertuis Charentais area

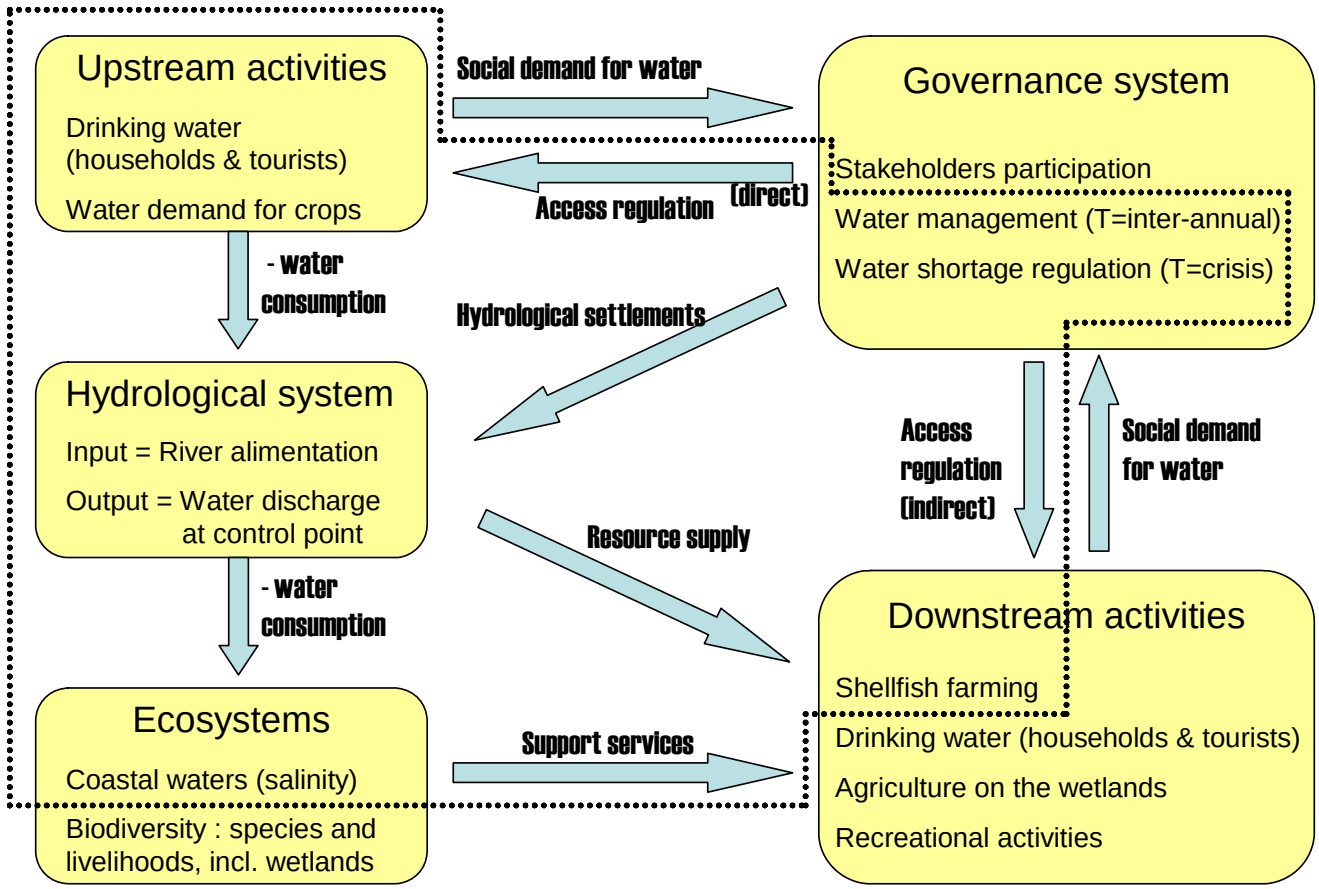
The political debate is now focusing on:
-the modification of the "total authorized volumes" of water for each use (drinking water and irrigation);
-the improvement of the restriction rules which apply during the periods of water shortage;
-the search for new freshwater resources (individual dams for farmers, not explored in this communication).

One objective of the integrated assessment of the coastal system is to estimate the costs of freshwater scarcity and their distribution among uses, considering various management options.

The current level of access-rights to water is unsustainable, but any governance change will result in a new distribution of costs.

Minimizing the losses for each user group may favor the social acceptability of future management measures.

Freshwater allocation on the Charente river basin



Analytical framework: Ecosystem services and user conflicts

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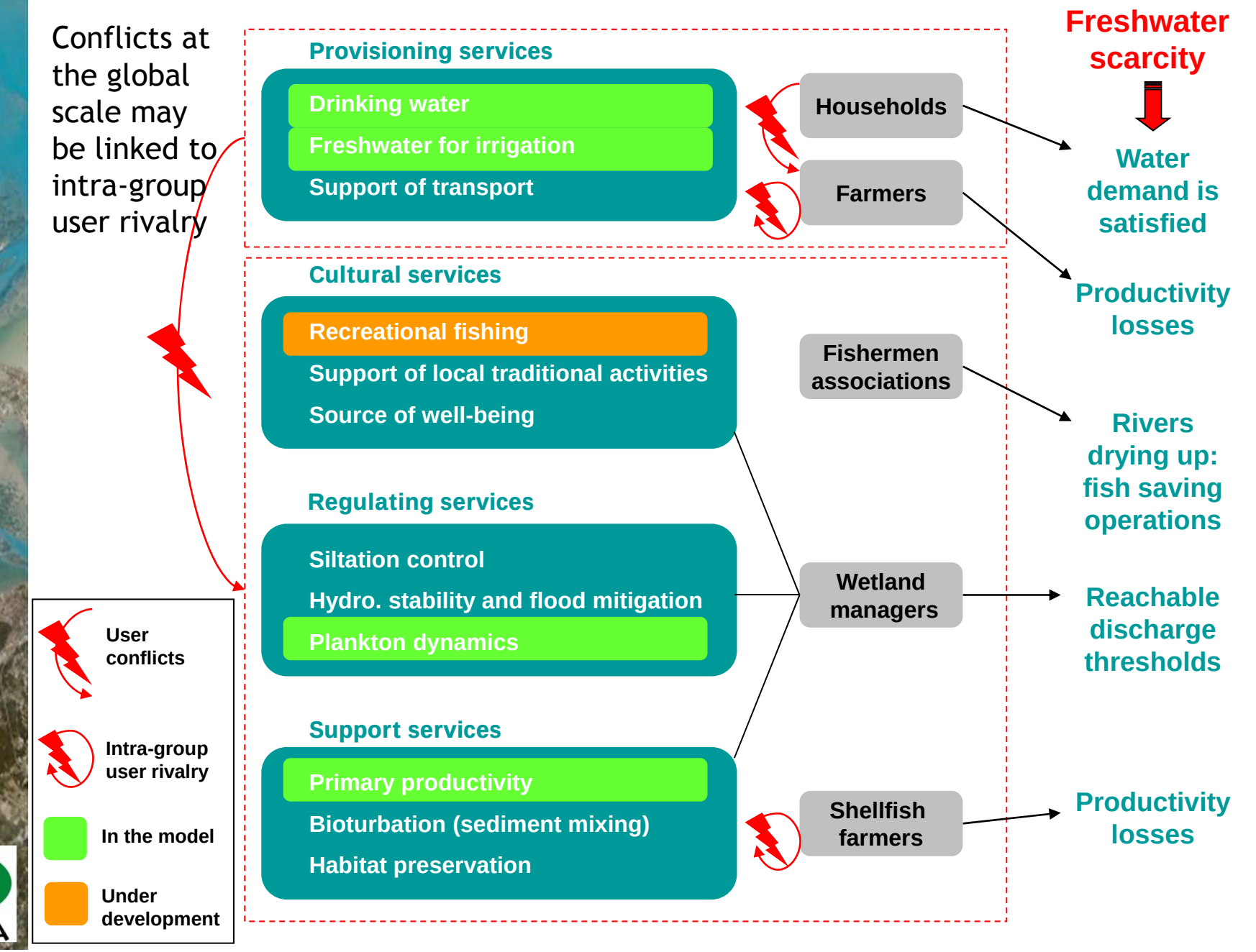
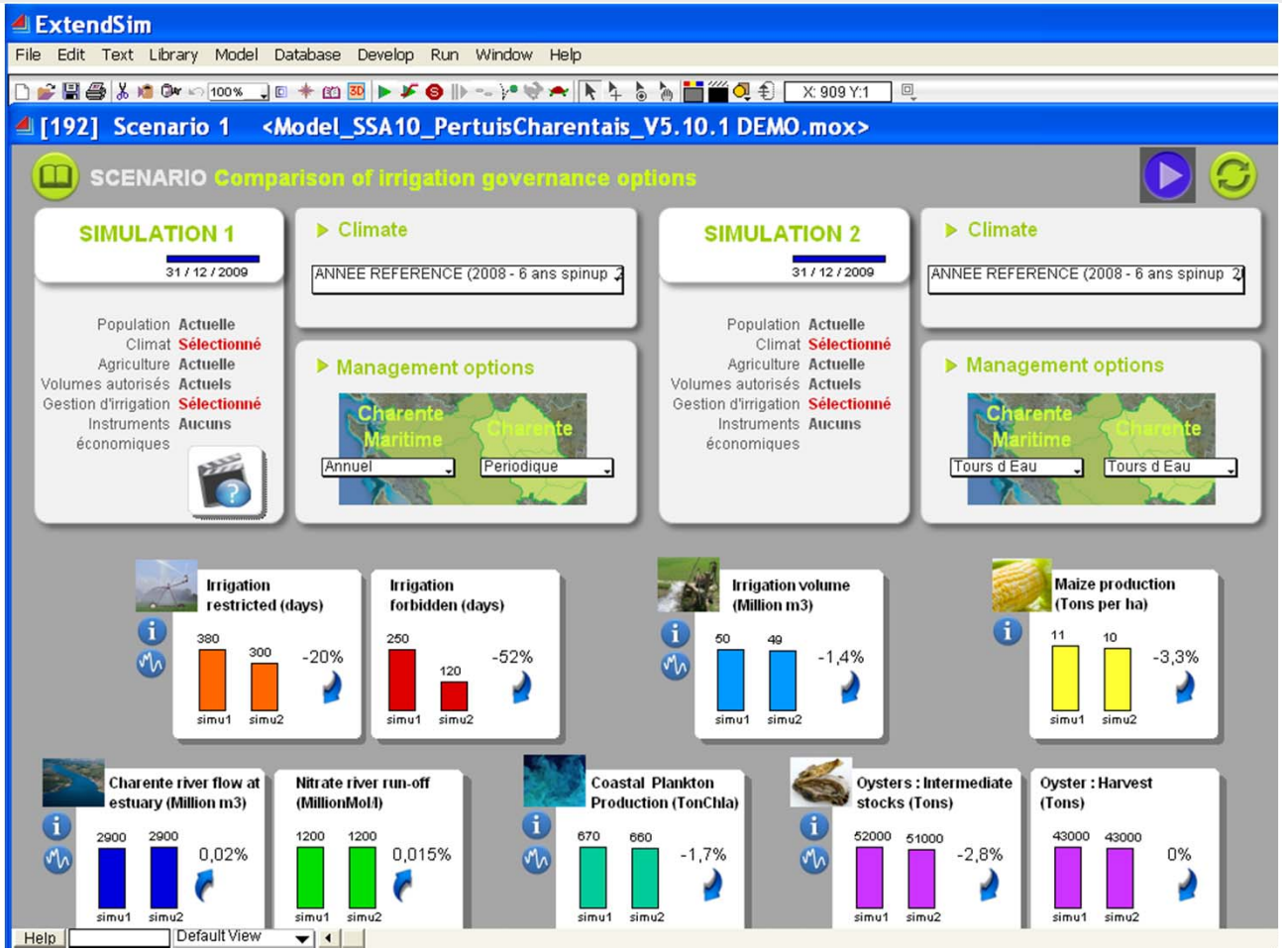
Conflicts at the global scale may be linked to intra-group user rivalry



Results 1: Effects of institutional arrangements



More provisional and collaborative strategies for agriculture irrigation have positive effects on ecosystems while generating minor losses in terms of crop production.

Oyster farming depends more on climate conditions (dry year) than on institutional change; intermediate and spat production are more sensitive than final production (harvest) to climate conditions, the river flow and the availability of nutrients.

Mongruel R. et al. Modeling soft institutional change and the improvement of freshwater governance in the coastal zone. *Ecology and Society*, in press.

Discussion: Magnitude of economic impacts

System dynamic models are used to simulate exploratory scenarios. They generate a high level of uncertainty. However, they proved to be interesting for the comparison of complex scenarios, in particular when different stakeholder groups consider different reference situations.

This is the reason why a system dynamic approach which integrates both environmental and institutional changes is useful as it may help to clarify the debate regarding the reference situations, including the issue of whether a so-called "reference situation" is realistic or not:

- Farmers may loose up to 10% of the target production (costs could be 6 Million Euros); however this is in reference to a situation where the rainfall is abundant (which is not likely to occur more than 1 year out of 10) and the authorized volumes for irrigation would not be reduced.
- Shellfish farmers may loose up to 27% of the oyster biomass and 100% of the spat production (costs could reach 20 Million Euros); however, the growth and the mortality of oysters depend on many other factors than freshwater availability and nutrient inputs from the river.