Integrated modelling in the coastal zones: some (early) learnings from the SPICOSA project

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SIXTH FRAMEWORK PROGRAMME

Science and Policy Integration for COastal Systems Assessment

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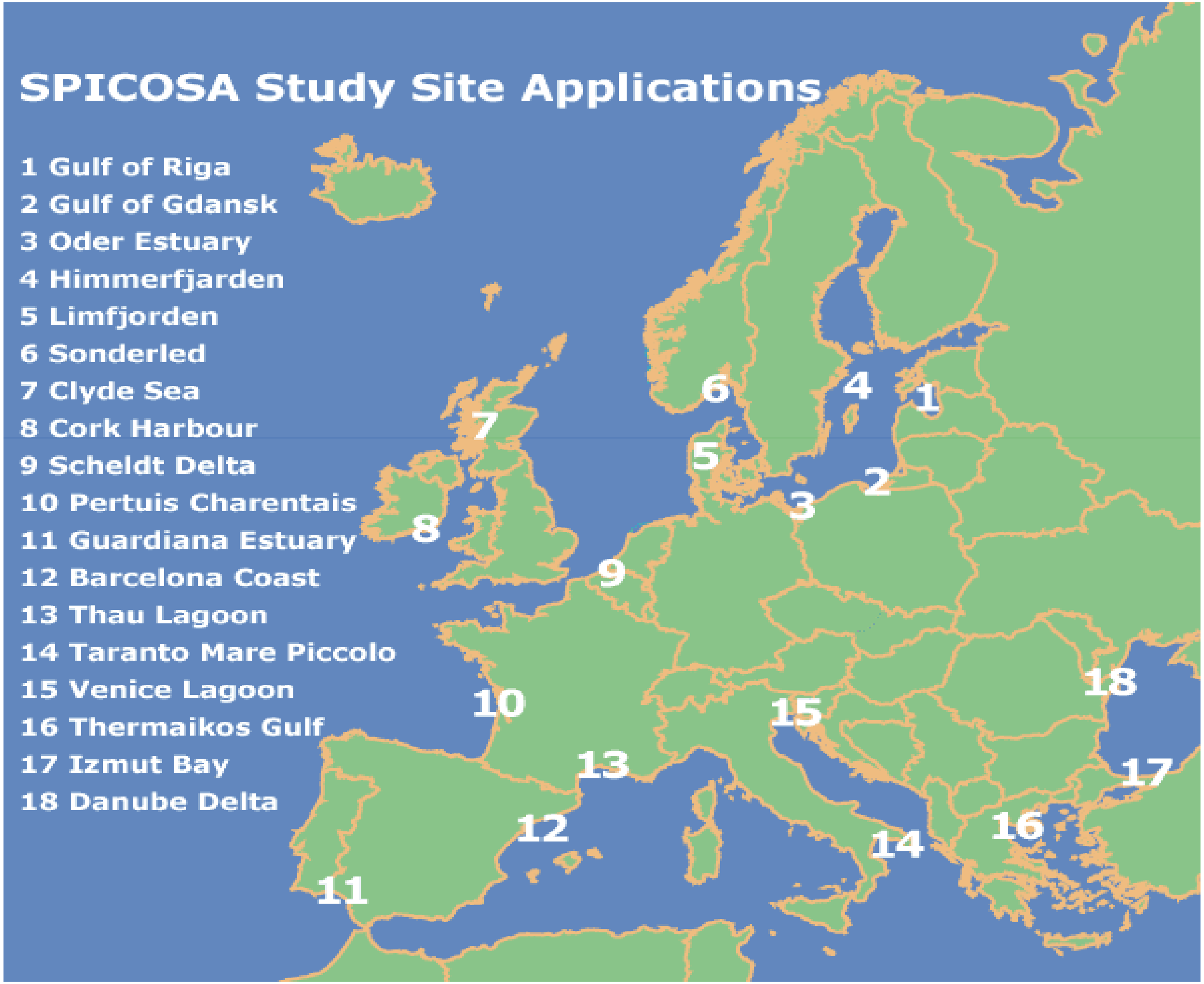
Introducing the SPICOSA Project

A four years (2007-2011) Integrated Project under the “global change and ecosystems” priority of the 6th Research Framework Programme of the EU, dedicated to Integrated Coastal Zone Management (ICZM).

A large scale project (21 countries, 54 research institutes, universities, SMEs and NGOs, 18 study-sites, a community of more than 100 persons).

Introducing the SPICOSA Project



Introducing the SPICOSA Project

The general approach: it is oriented toward problem solving and it is based on stakeholders' participation.

The project aims at delivering tested outputs to support sustainability in the coastal zones:

- the System Approach Framework (SAF) = a platform for knowledge integration and for exploring the conditions and the potential consequences of alternative policy options, to be developed using a commercial software (ExtendSim)

- a Model Library = Building Blocks representing key processes and functional components typically required in applying the Systems Approach for simulation of Policy Issues or Research Questions related to the Coastal Zone

- Deliberation support tools = Multimedia methodologies specialized for the ICZM science-policy interface through the use of state-of-the-art communication tools, stakeholder-policy mapping, and deliberation of the SAF Outputs: deliberation matrix, indicator box, information systems (Ker-Coast by University of SQY)

- Training activities, incl. material for academic or professional training based on the SAF for ICZM

The System Approach Framework

Our System Approach Framework aims at incorporating the ecological, social and economic dimensions of the Coastal Zones together with emerging concepts on system complexity.

Indeed, management problems in the CZ are complex as long as they involve multiple interests (different uses or claims for non-use benefits), distant drivers and interactions over space or time, transboundary elements (ecosystemic, administrative, cultural). They are also subject to dynamic changes and feedback loops. In addition, high level of uncertainty or lack of knowledge may be part of the problems or be used to justify statu-quo.

A way to overcome the difficulties raised by complexity is to build a platform for knowledge integration and for exploring the conditions and the potential consequences of alternative policy options under a problem oriented and scenario based approach.

For that purpose, a simulation modelling platform is developed using a commercial software (ExtendSim), rather than a lab developed software: this tool is expected to be end-user-friendly.

The System Approach Framework

Step 1: Issue resolution

- Working with stakeholders: institutional mapping, stakeholder forum
- Identifying the issue: (one of) the main « sustainability problems » of the coastal zone, according to the local policy agenda and social concerns
- Building scenarios and selecting indicators: exploring the possible futures (trends, management options) and the way to assess them (deliberation)

Step 2: Defining the system

- Defining the natural system, the social system and the economic system
- Explaining the relationships between the Ecosystem services (cf MEA), the Human activities and the Governance bodies (esp. rules in use)

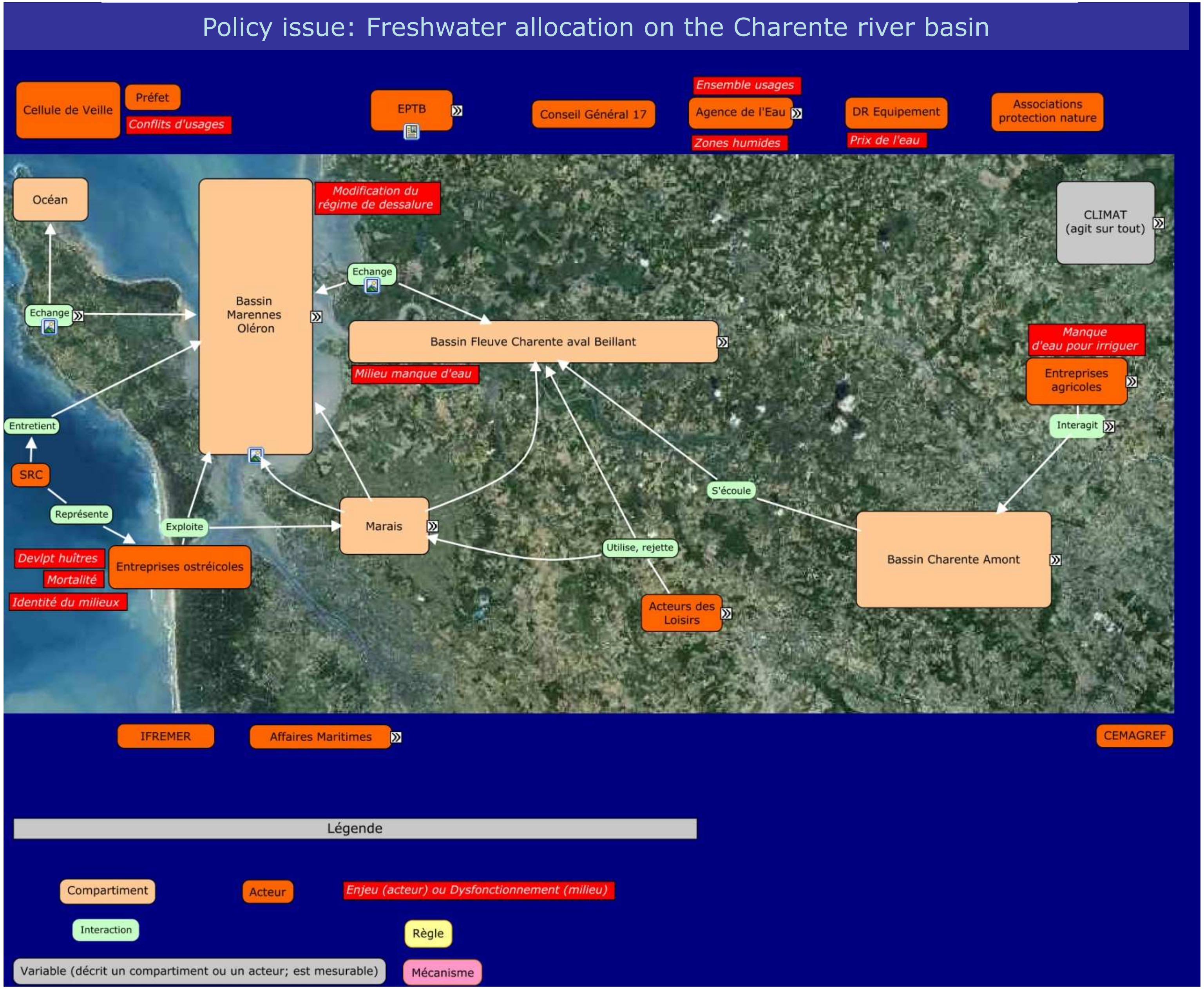
Step 3: Formulation of the system

- Mathematical formulation of the processes (dynamics and FBL)
- Numerical modelling (using the ExtendSim software)
- Scoping but remaining complex: x stakeholders, x relationships, x scales

Step 4: Appraisal of the models, simulation of scenarios and model outputs (back to step 1)

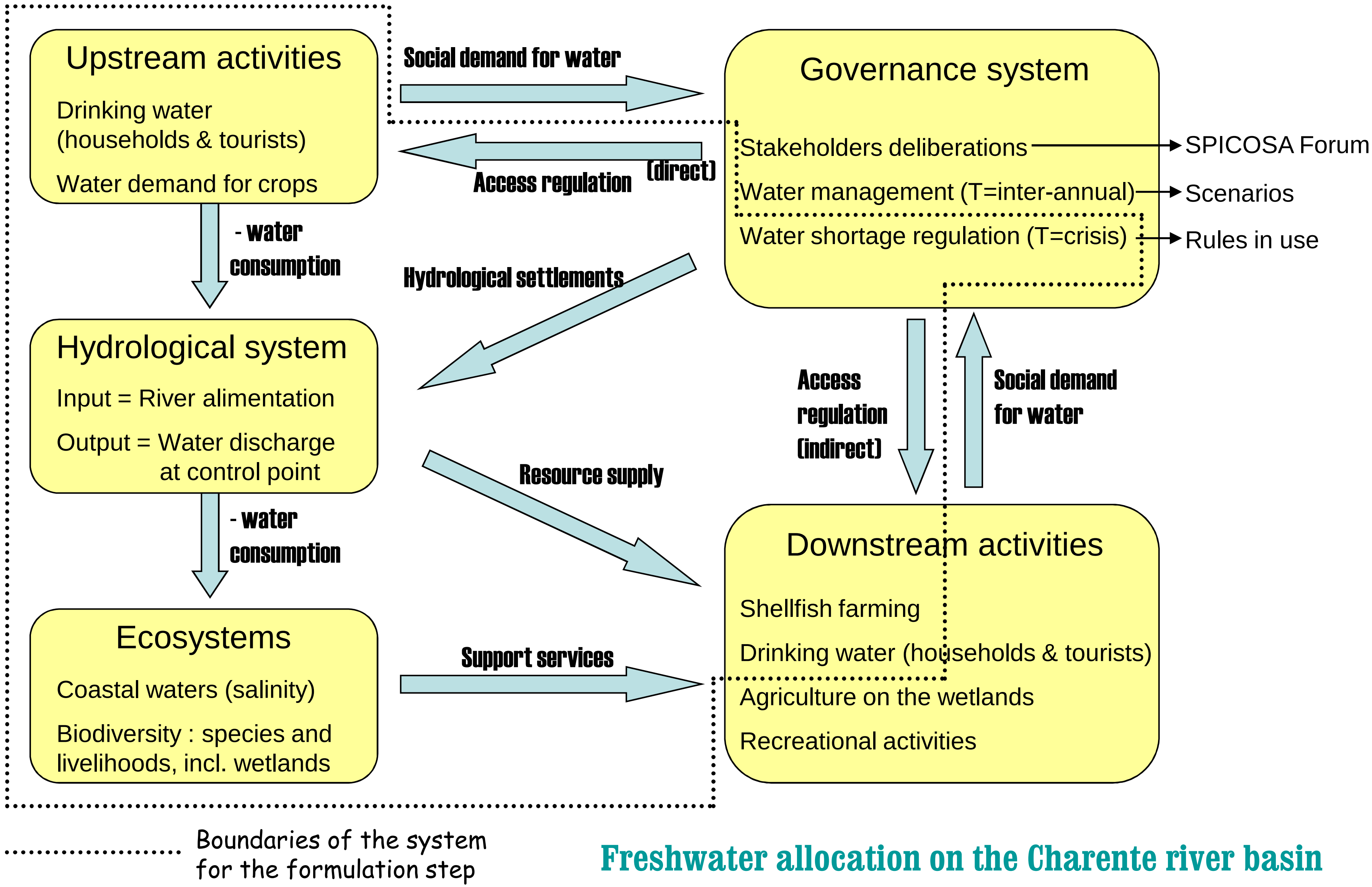
Conceptual model for PC study site

Steps 1 & 2: defining the policy issue and identifying the components of the related socio-ecosystem



Conceptual model for PC study site

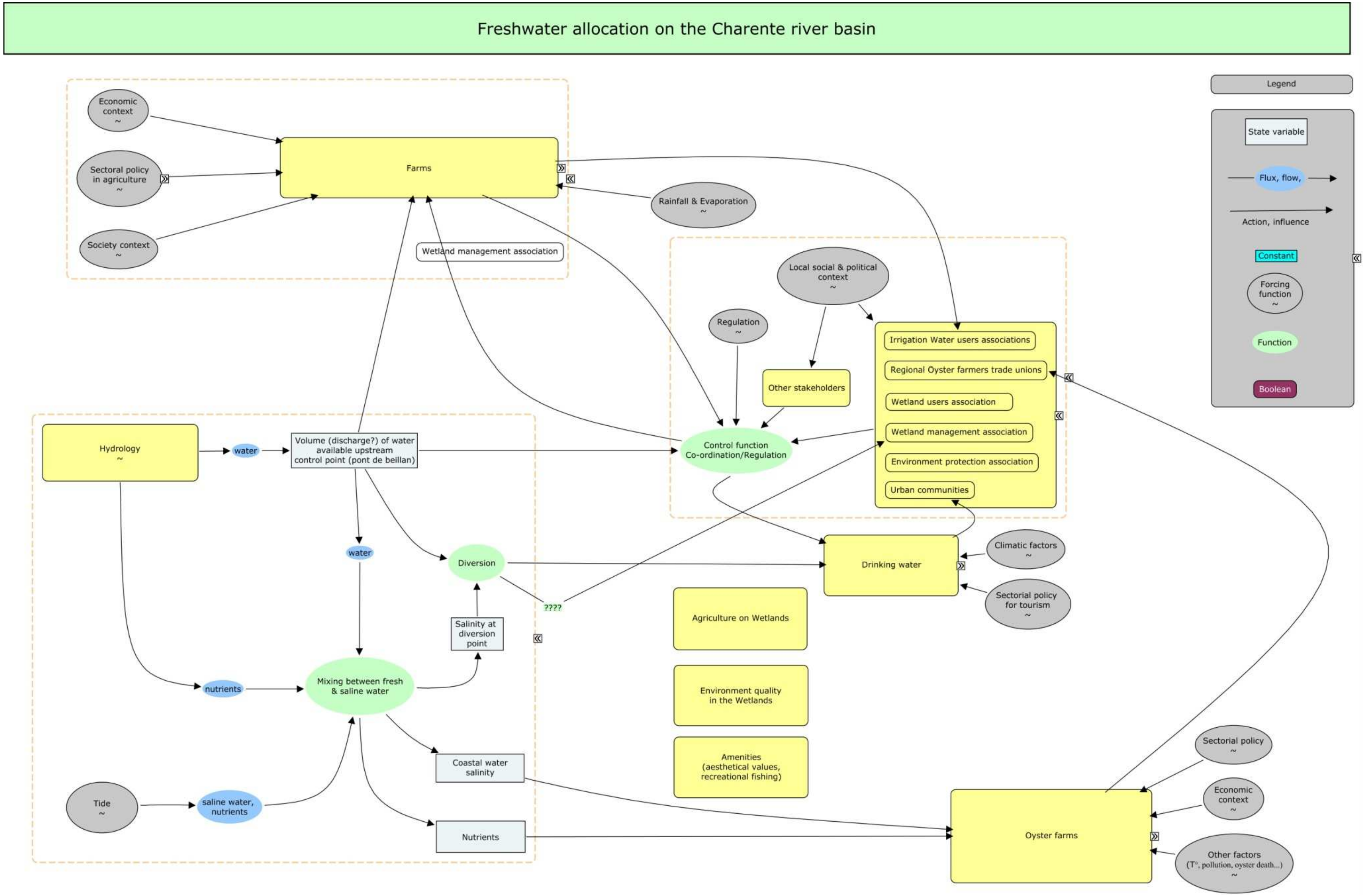
Step 2: building a logical framework explaining the links between ES, HA and GB



Freshwater allocation on the Charente river basin

Conceptual model for PC study site

Toward step 3 (mathematical formulation): dynamic relationships and FBLs



Conceptual model for PC study site

Step 3 (mathematical formulation): incorporating the rules in use = the example of the control function of the Governance Body

Table 1: Freshwater marks (flow rates thresholds) and management objectives

Flow rates Thresholds	Objective
Objective Thresholds	
DOE : Low Flow	drinking water, wildlife and all uses preserved
DCR : Crisis	drinking water, wildlife not preserved
Retriction thresholds	
DSA : Alert	prevents DOE, restriction
DI : Intermediary	prevents DCR, restriction
DC : cut	no more pumping allowed

Table 2: Restrictions on Authorized Water Volumes for agriculture (VTW) during summer

Flow rates Thresholds	VTW_{yt} before exceeding thresholds	decreasing percentage	VTW_{yt} when exceeding thresholds
DSA	VTW_{yt}	α_t	$VTW_{yt}\ (1 - \alpha_t)$
DOE			
DI	$VTW_{yt}\ (1 - \alpha_t)$	$\alpha_t + \beta_t$	$VTW_{yt}[(1 -(\alpha_t + \beta_t)]$
DC	$VTW_{yt}[(1 -(\alpha_t + \beta_t)]$	$\mu_t = 1$	0
DCR			

- -Cutting percentages are fixed each year by a decision of the representative of the State
- -The model will be able to simulate the restrictions on authorized water volumes
- -Restrictions application results in productivity losses for agriculture ("damage costs")

Numerical model for PC study site

Step 3 (numerical model): example of the « Shellfish farming box » (principles)

- Figuring the shellfish farming sector

The industry is considered as a whole (at a first stage), but several exploitations systems may be also considered (various specialisations)

- Rationale of the approach

. Oyster production (at each stage: spat collection, growing) depends on natural environment factors (drivers), esp. river flows (salinity, nutrients)

. Producers target an « objective function » = maintaining the current mean annual production over time

. Producers decisions: if the current production differs from the objectives, the producers may import (export) the equivalent of the negative (positive) differential in order to minimize (maximize) commercial losses (gains)

- Expected results

The model will estimate the gaps between real production and objectives:

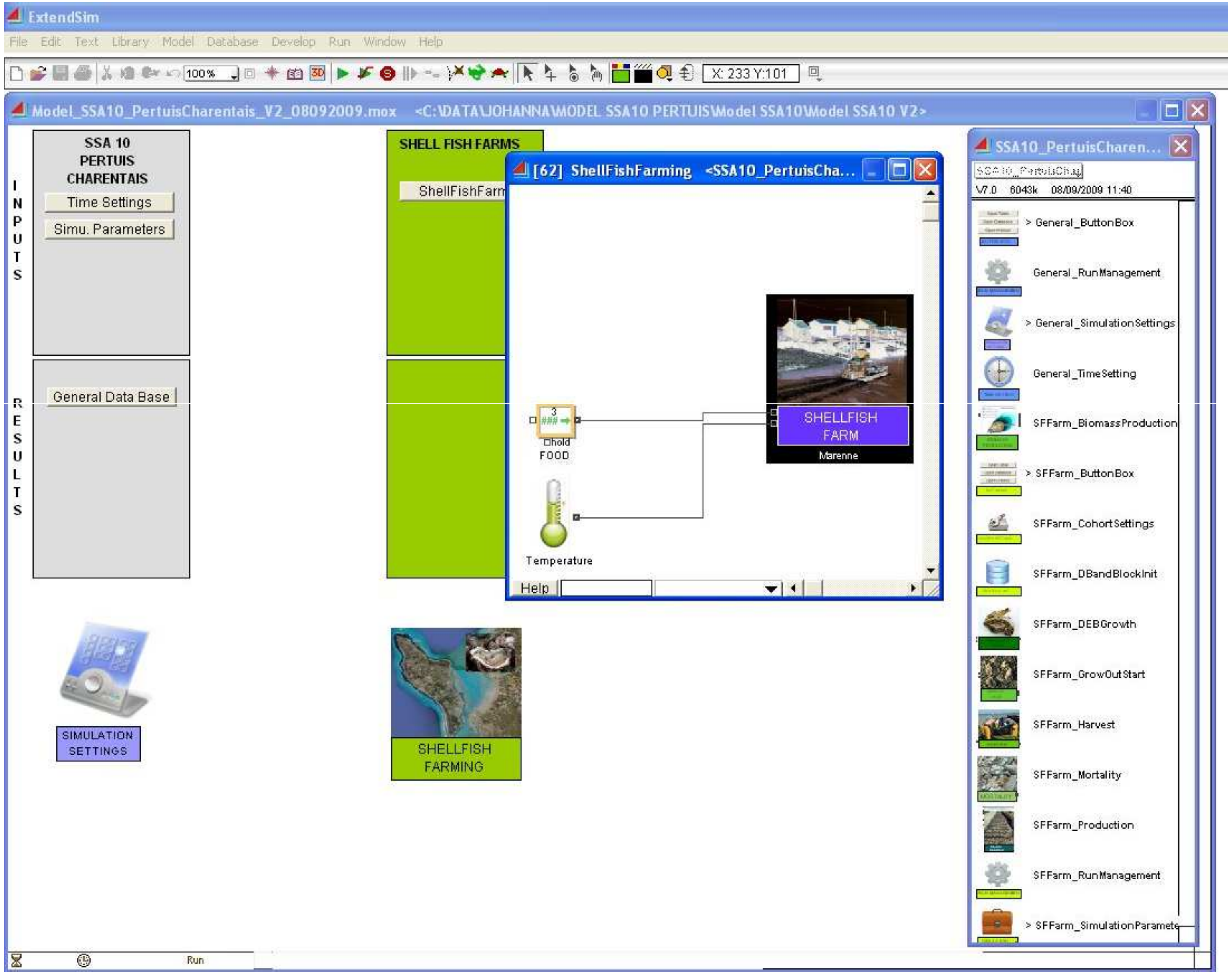
. frequency and intensity of required adaptations

. additional costs (benefits) associated with the productivity losses (gains) due to freshwater relative scarcity (abundance)

NB: the same kind results are expected from the « Agriculture box »

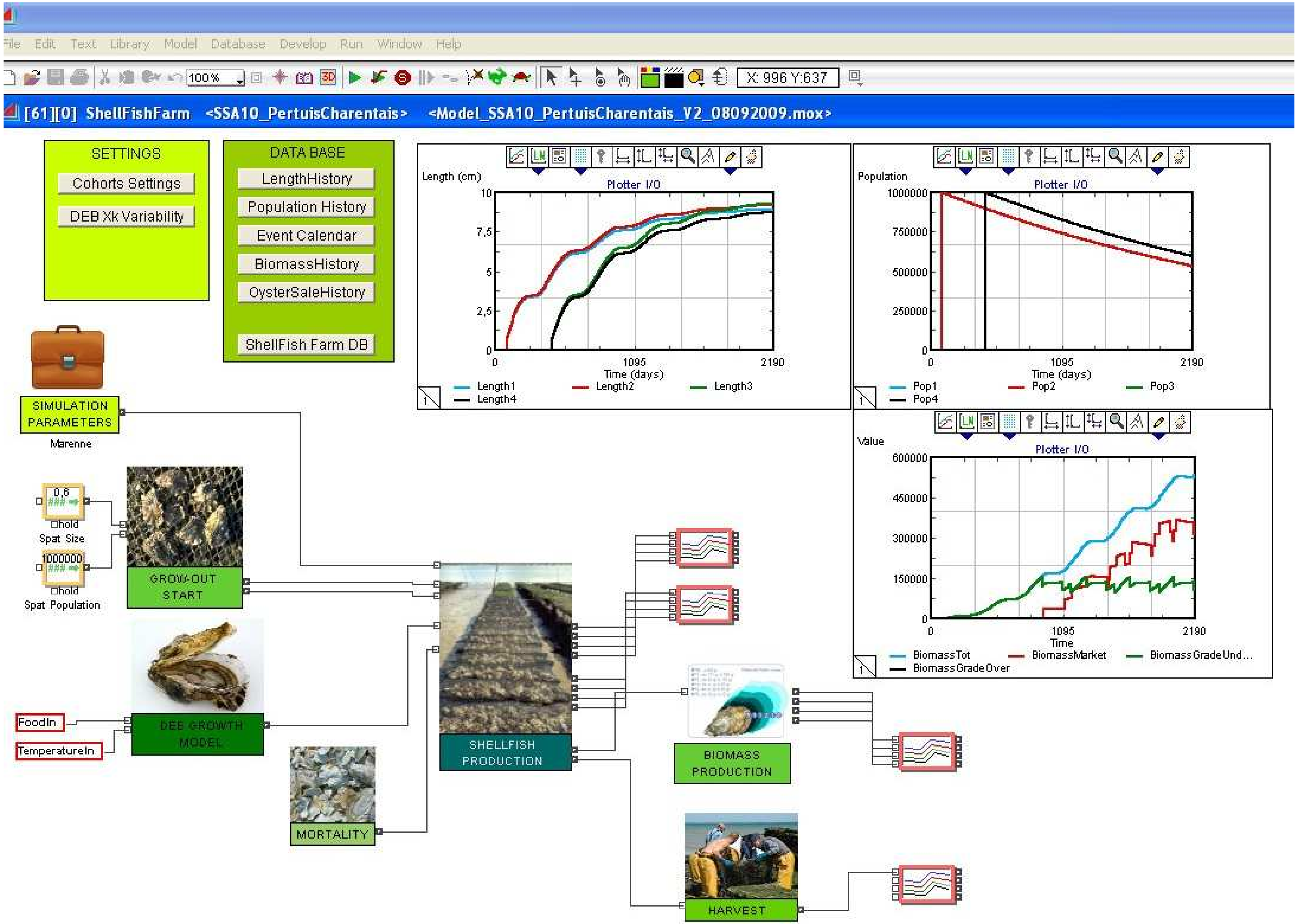
Numerical model for PC study site

Step 3 (numerical model): example of the « Shellfish farming box » (ExtendSim)



Numerical model for PC study site

Step 3 (numerical model): example of the « Shellfish farming box » (ExtendSim)



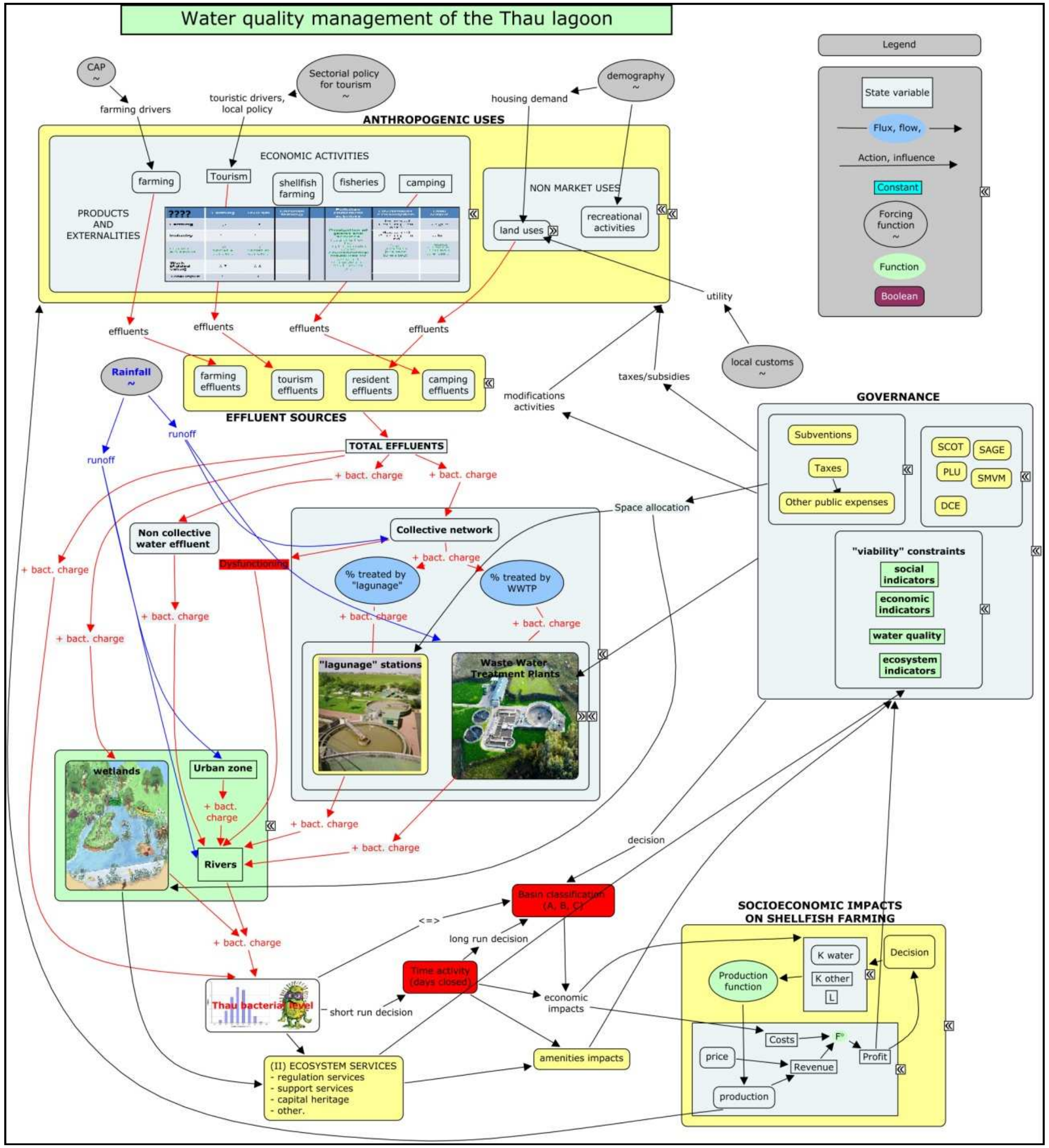
Socio-economics of TL study site

Steps 2 & 3: links between ES, HA and GB + dynamic relationships and FBLs

Microbiological contamination and the economic drivers: residents, tourists, WTP

Impacts on the shellfish farming areas: closure of the area and the possible bankrupcy of businesses

Local management objectives: what level of water quality, for which uses, according to the available public budget



Socio-economics of TL study site

The context: the local "Territorial Coherence Scheme" (SCOT) for coastal planning, which defines several (conflicting) objectives, including economic development, environment preservation and the maintaining of traditional activities

The approach: multicriteria analysis; a previous work has been done on the basis of the « principle-criteria-indicator » methodology, which allows for the characterisation of the evolution of the state of the system according to a set of indicators that the model should be able to estimate (through scenario simulations)

Economic dimension 1: businesses mortality in the shellfish farming sector

Approach = financial analysis and the vulnerability of businesses to the closures of the shellfish farming area (period during which sales are forbiden)

Economic dimension 2: cost (-effectiveness) analysis of water quality preservation

Approach = investment and running costs of various water treatment settlements

Economic dimension 3 (optional) : a regional economy matrix may be used to integrate in the model macro-economic dimensions at the site scale

Approach = incorporating direct and indirect relationships between the environment and the macro-economic dynamics (feedback loops)

NB: basis for contributions to SPICOSA methodological WPs (2, 3 and 4)

Concluding remarks

1 – Building partnerships in the Study Sites

. How to engage stakeholders and keep them involved (during 4 years)?
The need for another type of partners: the mediators??
. Behind multidisciplinary collaboration: it takes time to convince each one to work first for the global model (and not for the refinement of his favourite component)

2 – French sites: different ways of modelling similar processes

. Water management: managing the water quantity (PC) or the water quality (TL)
. Shellfish farming: estimating economic losses on the basis of a production model (PC) or estimating the businesses vulnerability to administrative closures on the basis of a model of pollutant flows coupled with a static financial analysis (TL)?
. Upstream-downstream users conflicts: in the context of recurrent short-term crisis events due to low water marks (PC) or in the context of a mid-term "Territorial Coherence Scheme" (SCOT) for coastal planning, which encompasses broader objectives than the allocation of water between users (TL).
[Damage costs assessment vs Multi-criteria analysis]

3 – Will our models be sensitive to all the internal processes?

. Scientific risk: along the process of integrated model specification, one particular component may turn out to be over-determined by some external driver, or some internal interaction may appear to be weaker than expected…
[no time for a second iteration of the SAF before the end of the project]

Thank you for your attention