



Modelling of Water Withdrawal Policies for Impact Assessment

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MAELIA: Objectives and Principles

- Socio-Ecological Systems:
interaction between ecological processes and anthropic processes
- A multi-agent platform for numerical experiments
about the ecological, economic and social impacts of norms
- Integrated Assessment and Modelling:
requires a robust meta-model for
 - a common representation of the system
 - supporting particular knowledge from many disciplines
- Confidence of the stakeholders in the simulation results
- Fine grain model: requires numerous and diverse field data

MAELIA focus: Low-water Regulation

- The management and use of water: rapid evolution of norms due to
 - central resource: drinking water, industry, energy, agriculture, fishing, tourism, sport
 - Climate Change: what about sustainability of aquatic ecosystems?
- Water scarcity is one of the main issues
- During low-water periods, agriculture
 - is the main consumer of water for irrigation
 - endures the adjustment to available water volume
- Adour-Garonne basin (SW of France)
a structural deficit: 250 million m³ / year

What are the consequences of changes in low-water norms?

A Complex Regulatory System

- A hierarchical system in
 - space: EU / elementary watershed
 - matter: general / concrete objectives, plans, means, ...
 - time: long / short term
- Including a variety of actors: (local or global)
 - EU and State services
 - political and administrative authorities
 - resource holders
 - users
- Democratic management of conflicts
participatory while long-term regarding

The French Water Legal Framework

- 1964: set the management of water resources at the basin level
- 2000, European *Water Framework Directive*: ambitious objectives
- 2006, *Law on Water and Aquatic Ecosystems*:
 - reinforces of the protection of aquatic ecosystems
 - sets new regulation principles (under implementation)
- **Basin level:** *Water Management Master Plan (SDAGE)*
defines the measures to be undertaken in the next 5 years
 - elaborated by the *Water Agency*
 - adopted and monitored by the *Basin Committee* (water parliament)

The Management of Low-water Periods

- Take place at the sub-basin level
 - framed by the *Low-water Management Plan (PGE)*
- *Drought Cell*:
 - an arena gathering authorities and stakeholders
 - to share information and debate appropriate actions
- Management tools

Management Tools (1)

- **Prevention:**

- *Withdrawal authorisation*: yearly volume of water, to be applied by any user abstracting water from a public resource
- *Reserved water flow*: to be let flow from every dam
- *Contracted volume*: volume of water to be released on demand

- **Monitoring:**

- *Withdrawal declaration*
- *Monitoring Points*: measure of the flow, with associated thresholds:
 - *DOE*: Objective Low-Water Flow
 - *QA*: Alert Flow
 - *QAR*: Reinforced Alert Flow
 - *QCR*: Crisis Flow
- *Assessment Report* on the previous season

Management Tools (2)

- **Actions:**

- *release order*: water supplied from the contracted volume
- *Drought Decree*: withdrawal restriction for irrigation
 - 1 or 2 days a week
 - 3 days a week
 - 7 days a week

according to the flow measured at monitoring points compared with thresholds, downstream situation, weather forecast, agricultural needs, ...

- **Control** by the *water police*
of the compliance of farmers with the regulation

Scenarios tested by the MAELIA Platform

Scenarios about the allocation to farmers

of water volumes that may be withdrawn for irrigation

1. The current regulation
2. The regulation whose implementation is ongoing more pro-active and decentralized, which raises protests from farmers
3. The alternative regulation proposed by farmers, which requires to improve the reactivity of State services
4. An other regulation that makes available all the water not needed for the preservation of aquatic ecosystems, which requires a high reactivity of State services and to improve the management tools

SES Integrated Modelling

- **Structure of the system:**

to be shared by all the modellers,
a set of related entities:

- *actors*: individual or collective
- *material resources*: located in space and time
- *cognitive resources*: factual and procedural believes, goals, ... used by actors to determine their behavior

==> *Actor-Resource Diagrams*

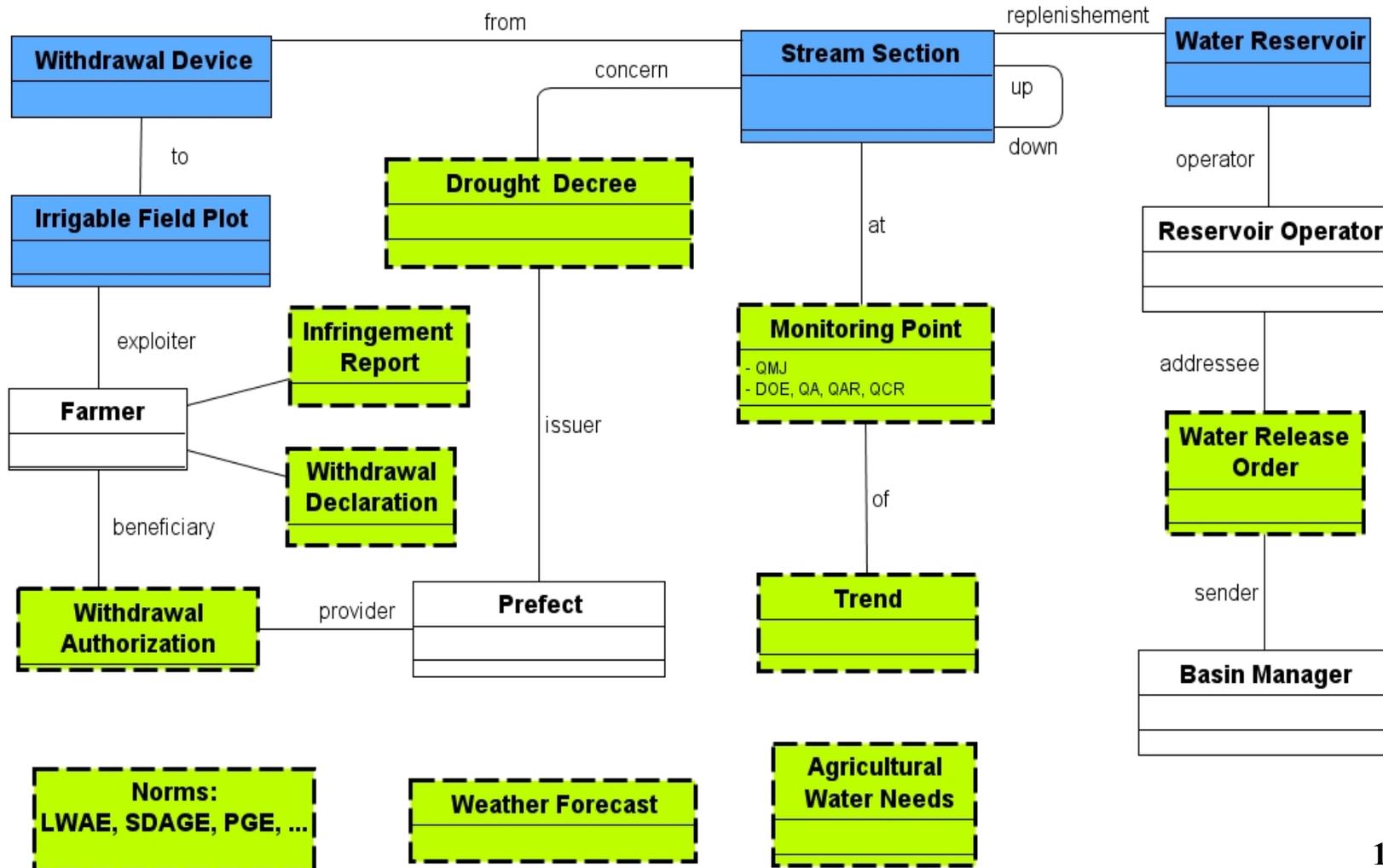
- **Dynamics of the system:**

embed the disciplinary knowledge,
a set of processes, which act upon and interact through entities:

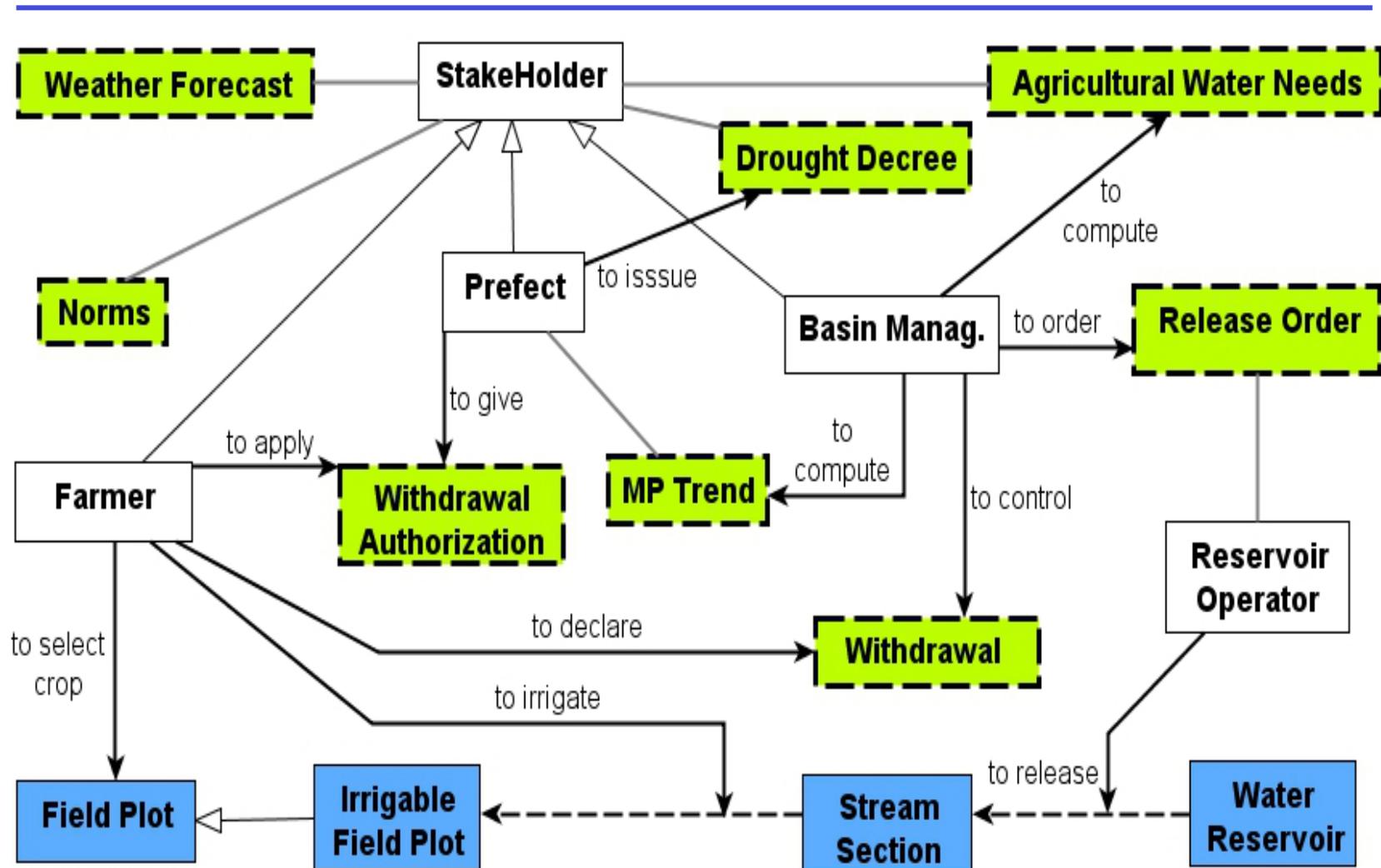
- *ecological processes*
- *socio-economic processes*
- *activities*, performed by actors

==> *Interaction Diagrams, Process Diagrams*

The Actor-Resource Diagram (excerpt)



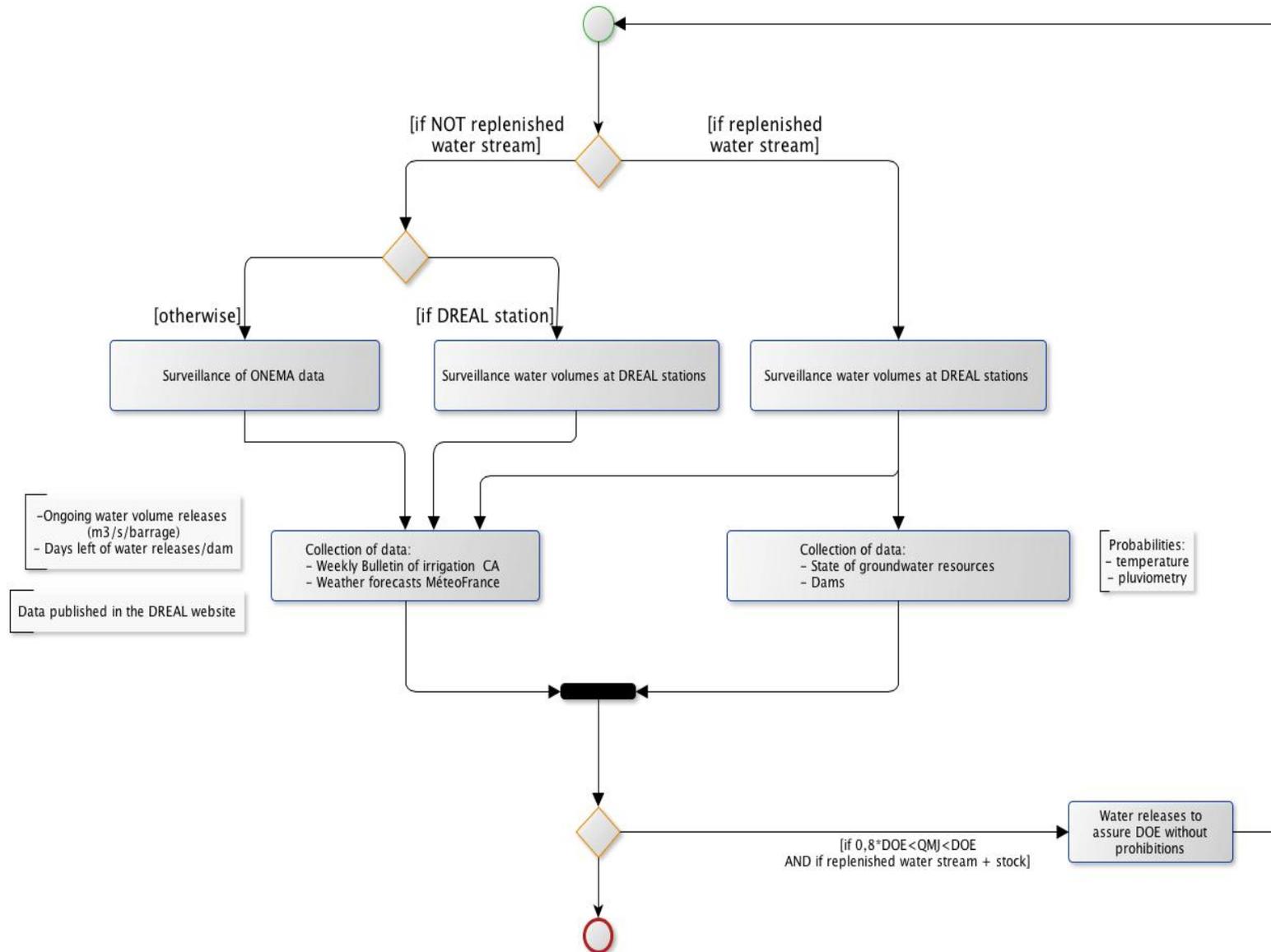
The Interaction Diagram



Status of the processes

- Not considered for unpredictability : to delineate areas, to fix thresholds
constant entities
- External processes: to rain, to increase price
input series of entities values
- Processes which are trivial in the numerical world:
to measure flow at *Monitoring Points*
- Discarded processes:
 - only purpose is to ensure the quality of social relationships:
to meet the *Drought Cell*
 - fictitious process having no impact: to apply (give) *Withdrawal authorisation*

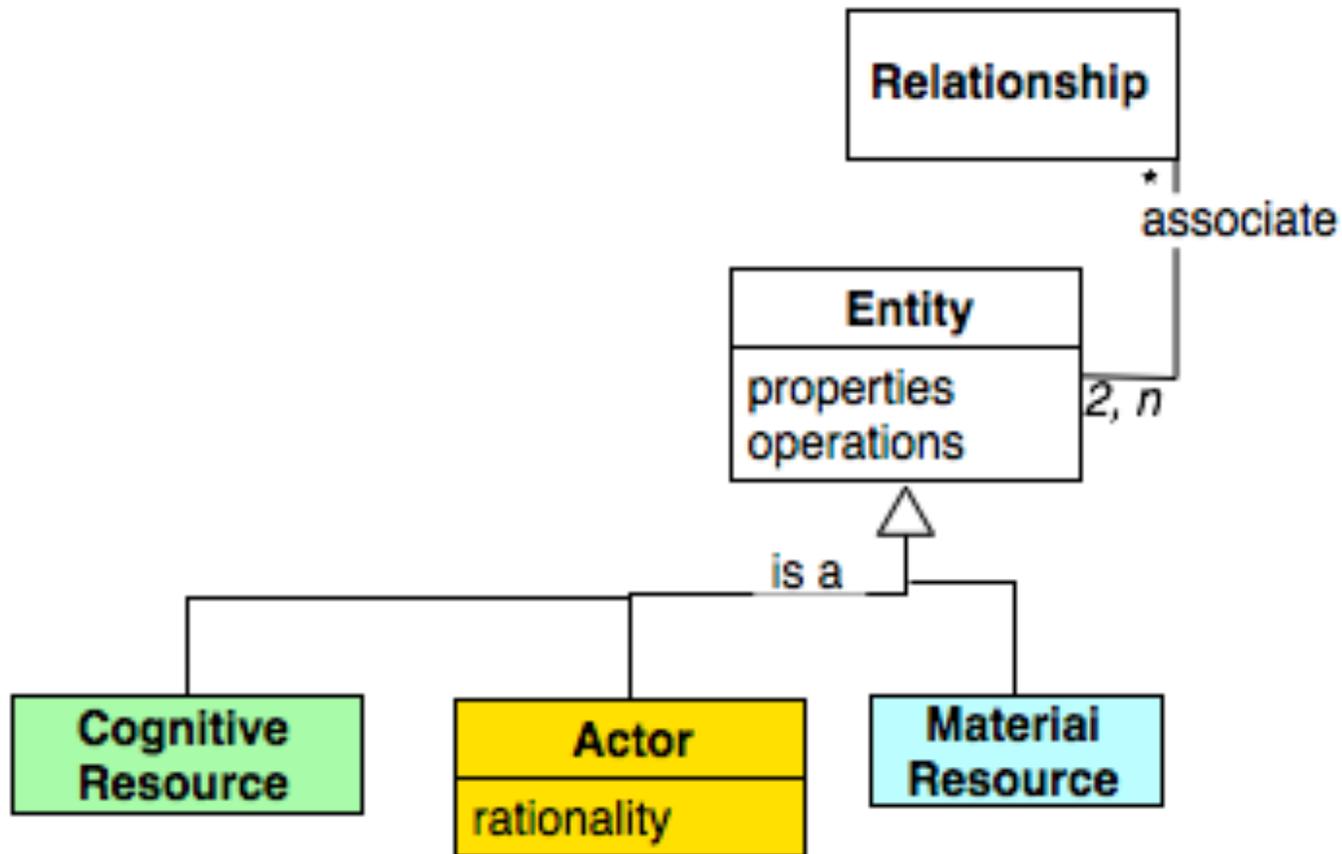
A Process Diagram



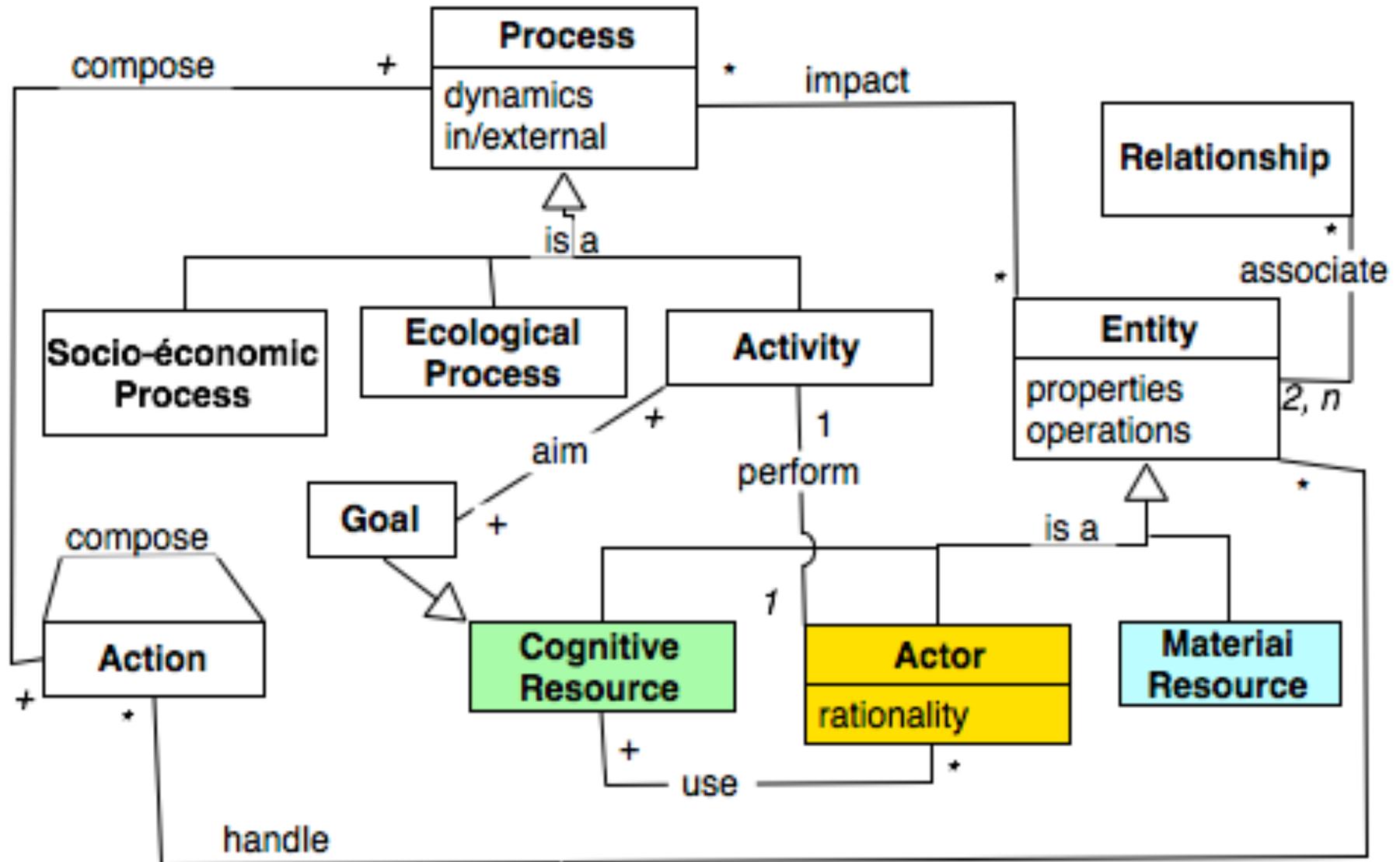
Concluding Remarks

- Necessity of a rigorous meta-model for:
 - A tight integration of disciplinary knowledge
 - Structuring the modelling process
 - supporting incremental modelling, versioning, ...
- Modelling of regulation processes:
 - fine grain: to account for the production and use of all cognitive resources that determine actors' behaviors
 - coarse grain: to abstract from some processes details and just retain their phenomenal results
- Complexity of the data necessary for the instantiation of the material resources

The structure of a SES



The dynamics of a SES



Interaction between the System and its “Environment”

