TED4LAT
Workshop and doctoral school
> 21-25 October 2024

Modelling and managing the sustainability of complex dynamical systems

Participative and Transformative Modelling, an alternative for action between science, society and politics.

The case of livestock farming in Uruguay

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cirad

ComMod

International Cooperation in Agricultural Research for Development

3 research departments:

- **Department BIOS: Biological Systems**
- **Department PERSYST: Performance of Tropical Production and Processing Systems**
- **Department ES: Environment and Society**
  - UMR SENS, “Knowledge, Environment, Societies”: https://umr-sens.fr
    - CORMAS: http://cormas.cirad.fr
    - ComMod: http://www.commod.org

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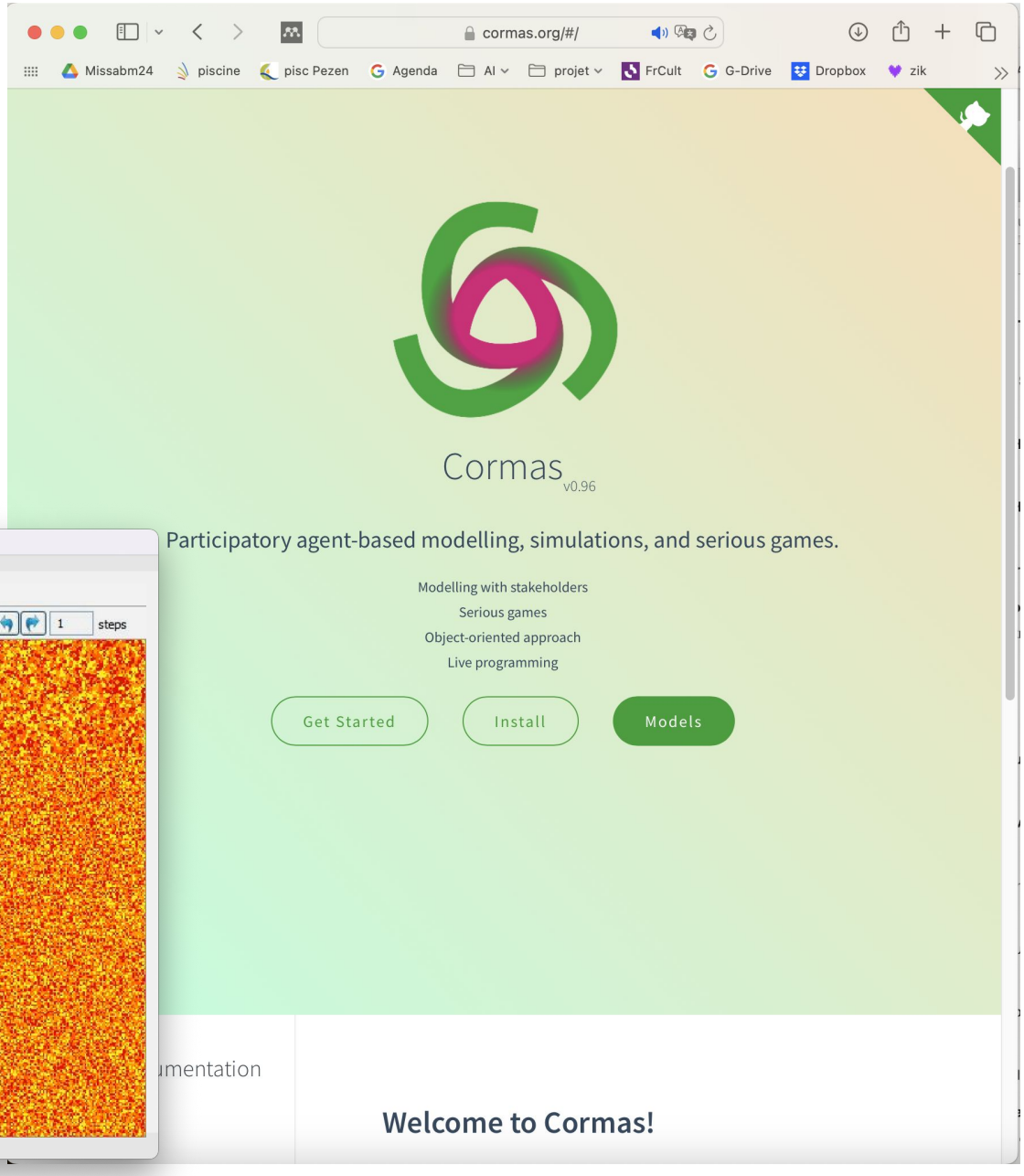
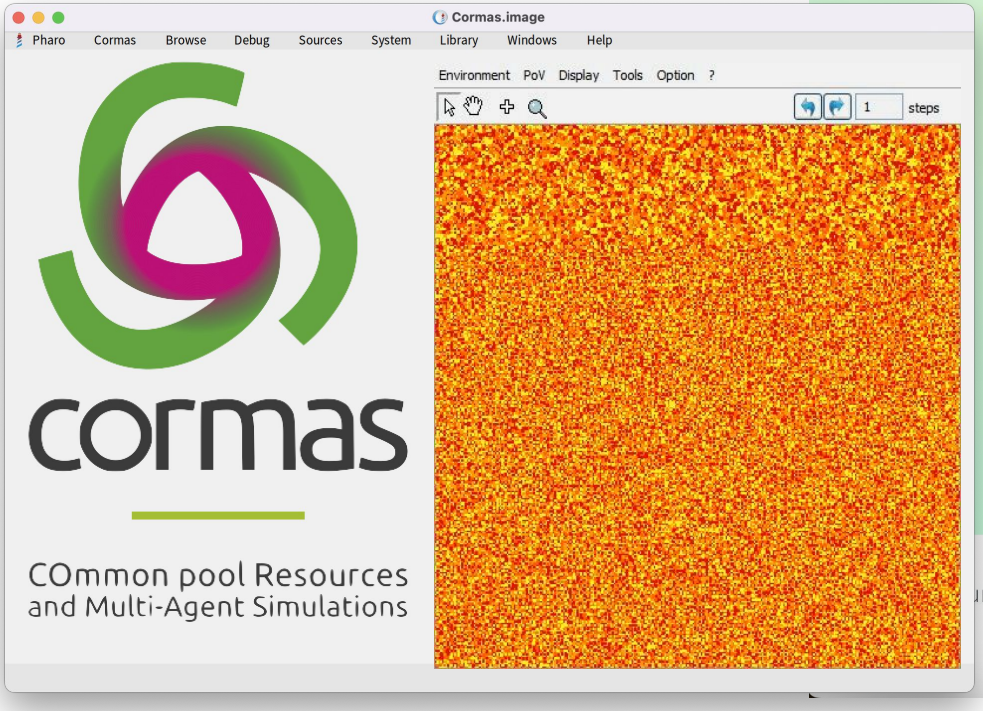
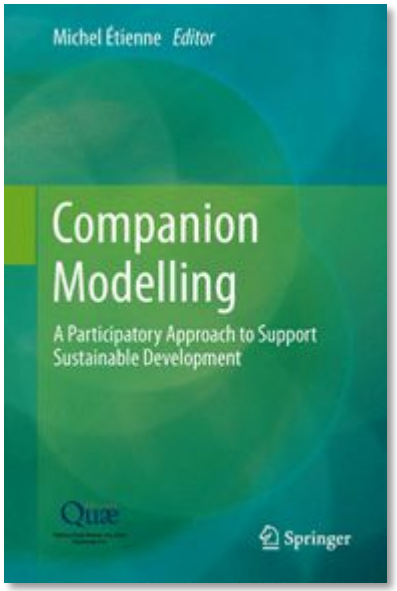




ComMod Companion Modelling

Objective: Supporting stakeholders in decision-making

1. Knowledge : understand complex environments in uncertain situations
   Collectively building a shared representation of the system
2. Decision : support collective decision-making
   Immersion in the field
   Willingness to address complex social issues



Do not provide "ready to use" solutions

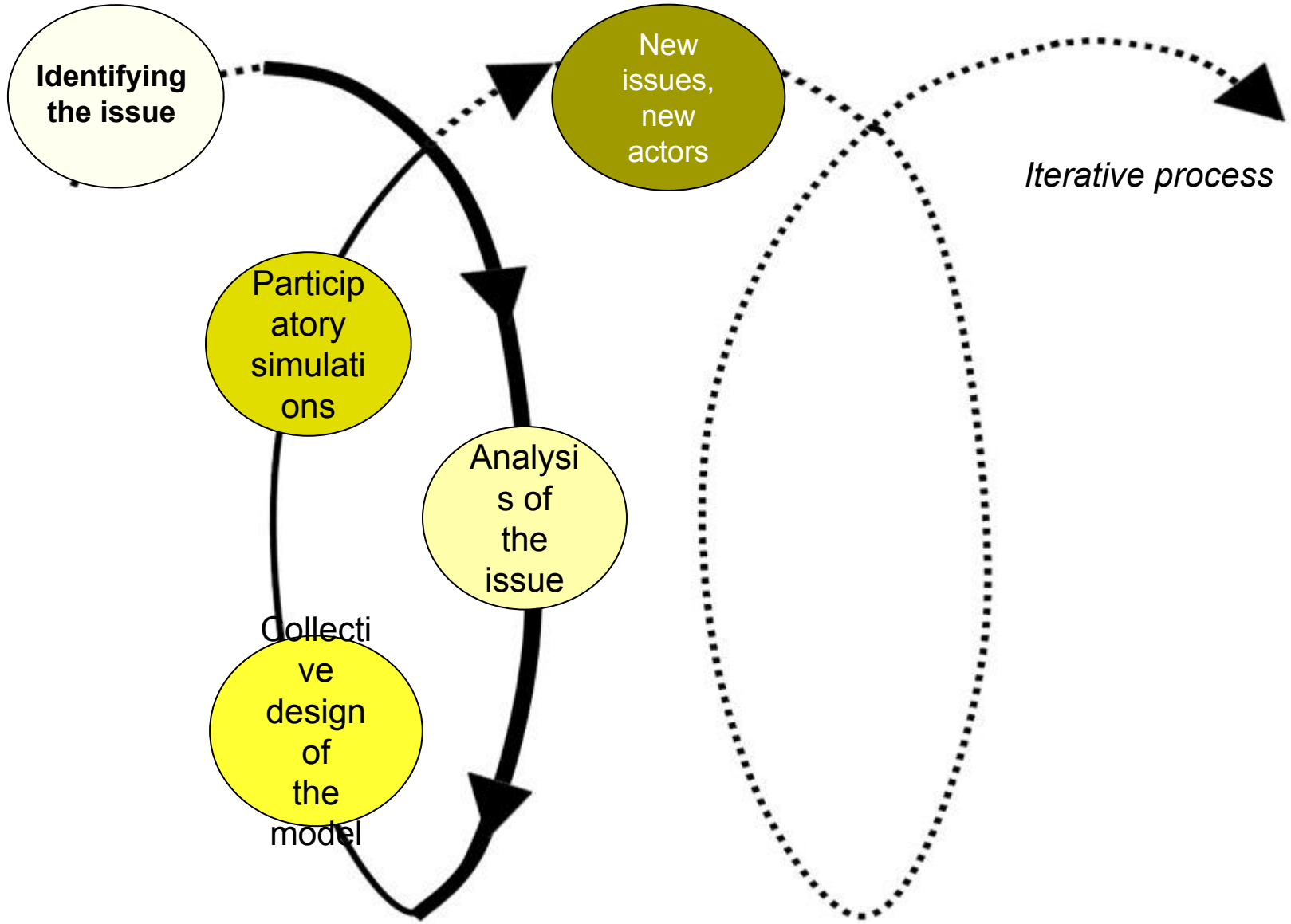
The model as an object of **mediation**

References to Ostrom's work since 1993

"Governing the Commons" (Ostrom 1990)

Promote self-organised management of resources

ComMod iterative and adaptive learning process



Towards transformative sciences

A specific type of science that does not only observe and describe societal transformation processes, but rather initiates and catalyses them »
(Schneidewind et al. 2016, Pledge for a transformative science)

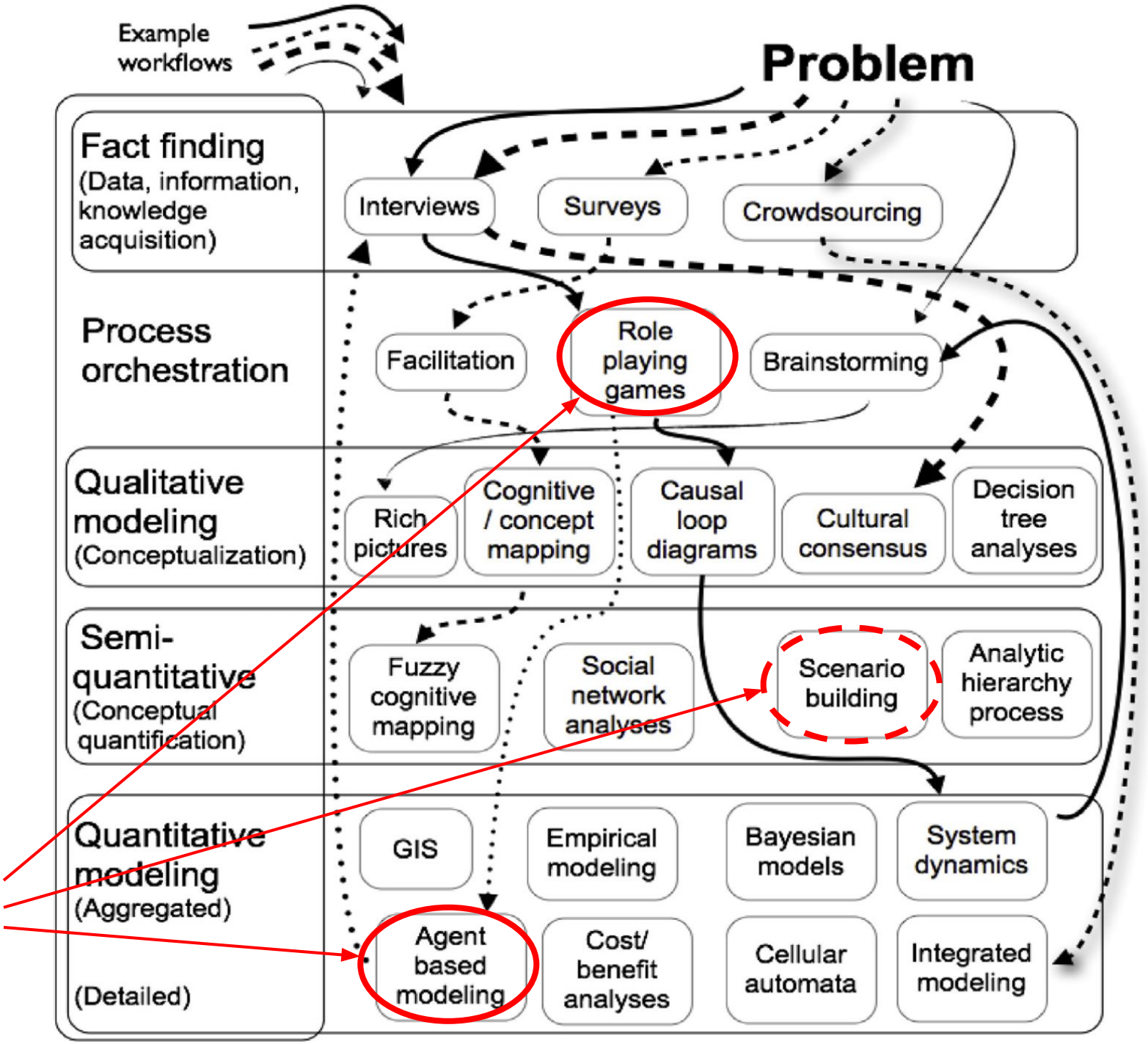
When « Science » engage « other » stakeholders

- Scientific activity (knowledge production) is a social process engaging diverse people, inside and outside the labs, and impacting them… sometimes…
- « Participation » aims at including people in processes which usually exclude them: opening the righ of knowing, thinking, saying, deciding, acting on…
- Scientists co-design models with people and assess if they induce usefull results for a given social project => Transformation

(Ferrand, 2024)

Typology of methods used in PM

Voinov et al. 2018, Tools and methods in participatory modeling: Selecting the right tool for the job



ComMod

Hybrid forms of models

(Le Page et al. 2010)

Who makes the decisions?

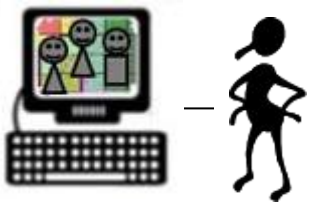
RPG
100 % human

... Intermediate ...

100 % computerized simulation

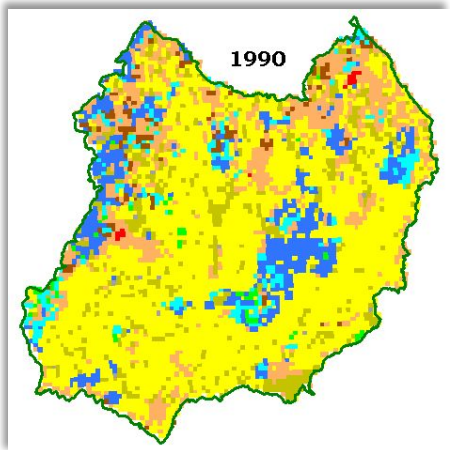
Player

Player acting on virtual environment



Partial decision-making avatar

Autonomous agent

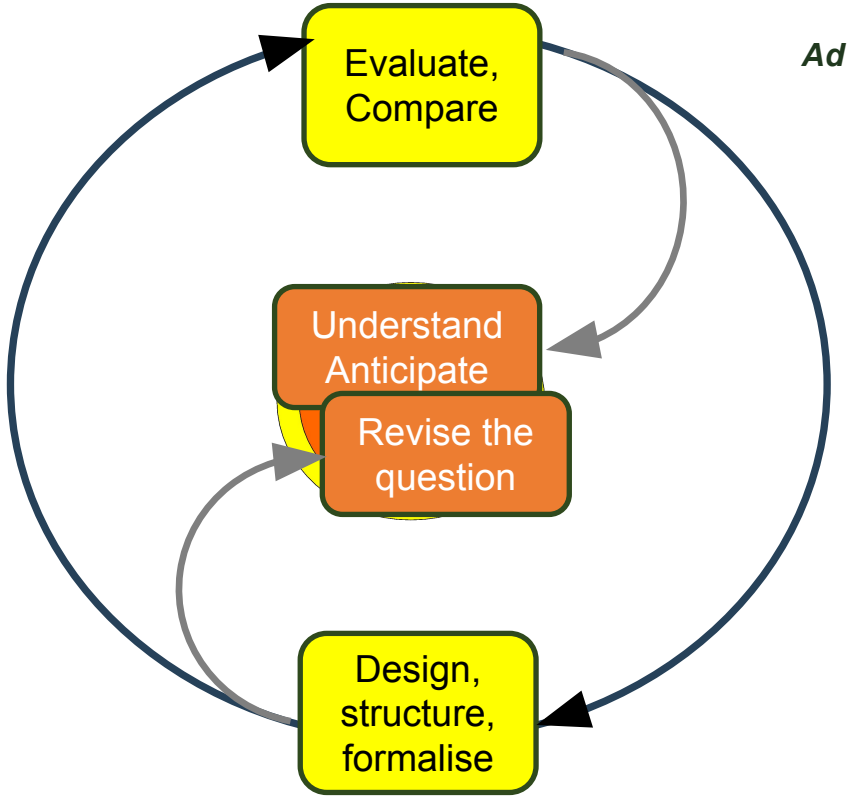


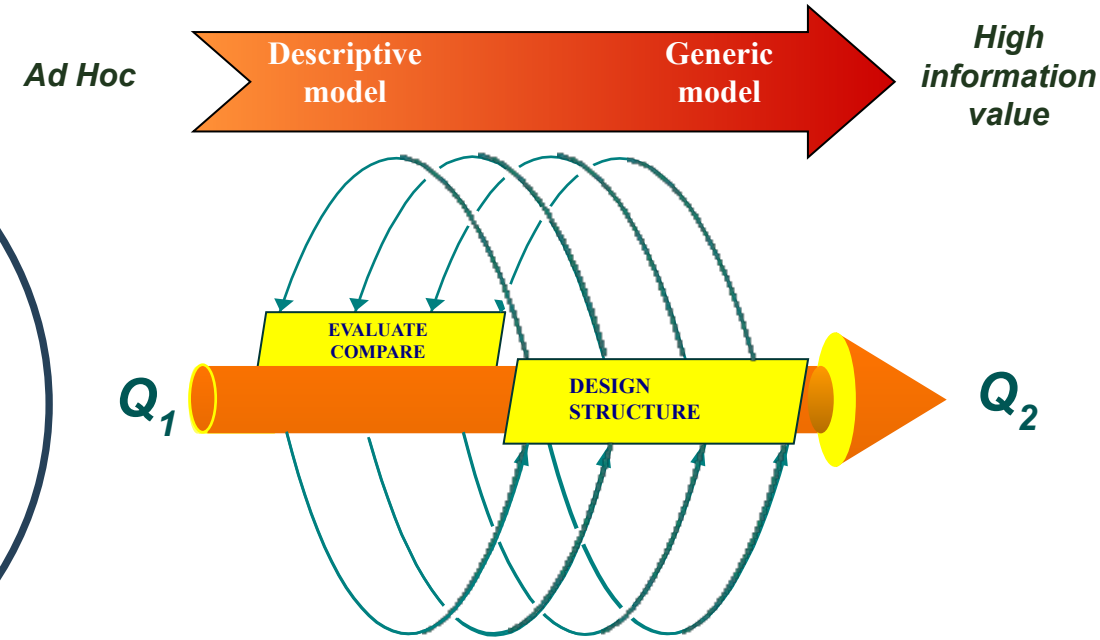
Modelling: a dynamic learning process

?

Modelling: a dynamic learning process

- An iterative process, focused on a question





Project *Sequía*, Uruguay - 2014

Adapting livestock farming to climate change in Uruguay

Instituto Nacional de Investigación Agropecuaria
URUGUAY

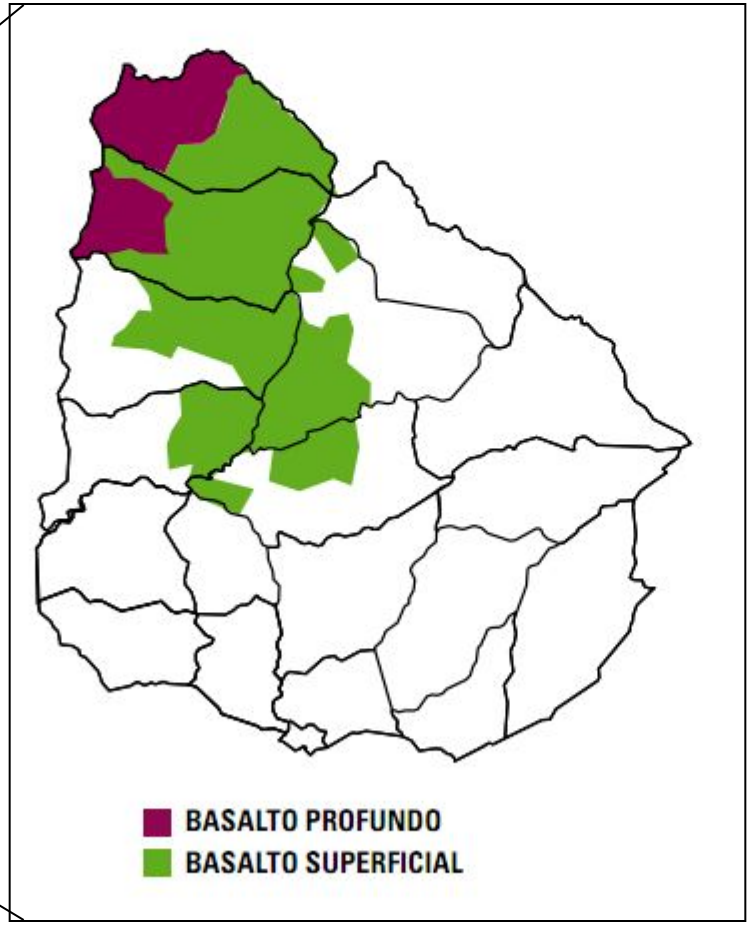
Involving local stakeholders in the design of models for participatory foresight studies

PLAN AGROPECUARIO

Pierre Bommel, Francisco Dieguez, Hermes Morales, Danilo Bartaburu, Emilio Duarte, Esteban Montes, Marcelo Pereira & Jorge Corral

Uruguay

basaltic shallow soils,
more sensitive to drought



Context: cattle farming in Uruguay

- Agriculture = central role in Uruguay's economy
- Extensive cattle farming on natural grasslands
  - cattle herd of 12 million heads (3.8 cows / inhabitant)
  - produces about 600 000 tons of beef / year (65% export).
- Severity and frequency of the droughts
  - millions of animals died (slaughtered)
  - numerous bankruptcies.

Sequía objective

- Compare various strategies of livestock management
  - Diversity of livestock managements
  - Certain farmers were less affected by extreme situations
- to help breeders to reduce risk:
  - Imagine new strategies more robust in the long-run
  - Involve farmers in a participative approach to give them ownership on the project

Question

Which livestock management is resilient?

PLAN AGROPECUARIO

IPA recommends a cautious strategy:
'*Pastoralist*' management

Who participates?

1. Co-designing the 1st version of the model with a group of experts

2. Involving stakeholders, reviewing the model and testing strategies

Overview of the basic model: 2 strategies

(Niño/Niña)

Climate

Pasture

growth rate

grass height

stocking density

Cattle

corporale condition

Production

Mortality

observes

observes

The breeder makes decisions by assessing

manage

« Pastoralist »

« Traditional »

grass availability and climate

livestock health (body condition)

UML class diagram

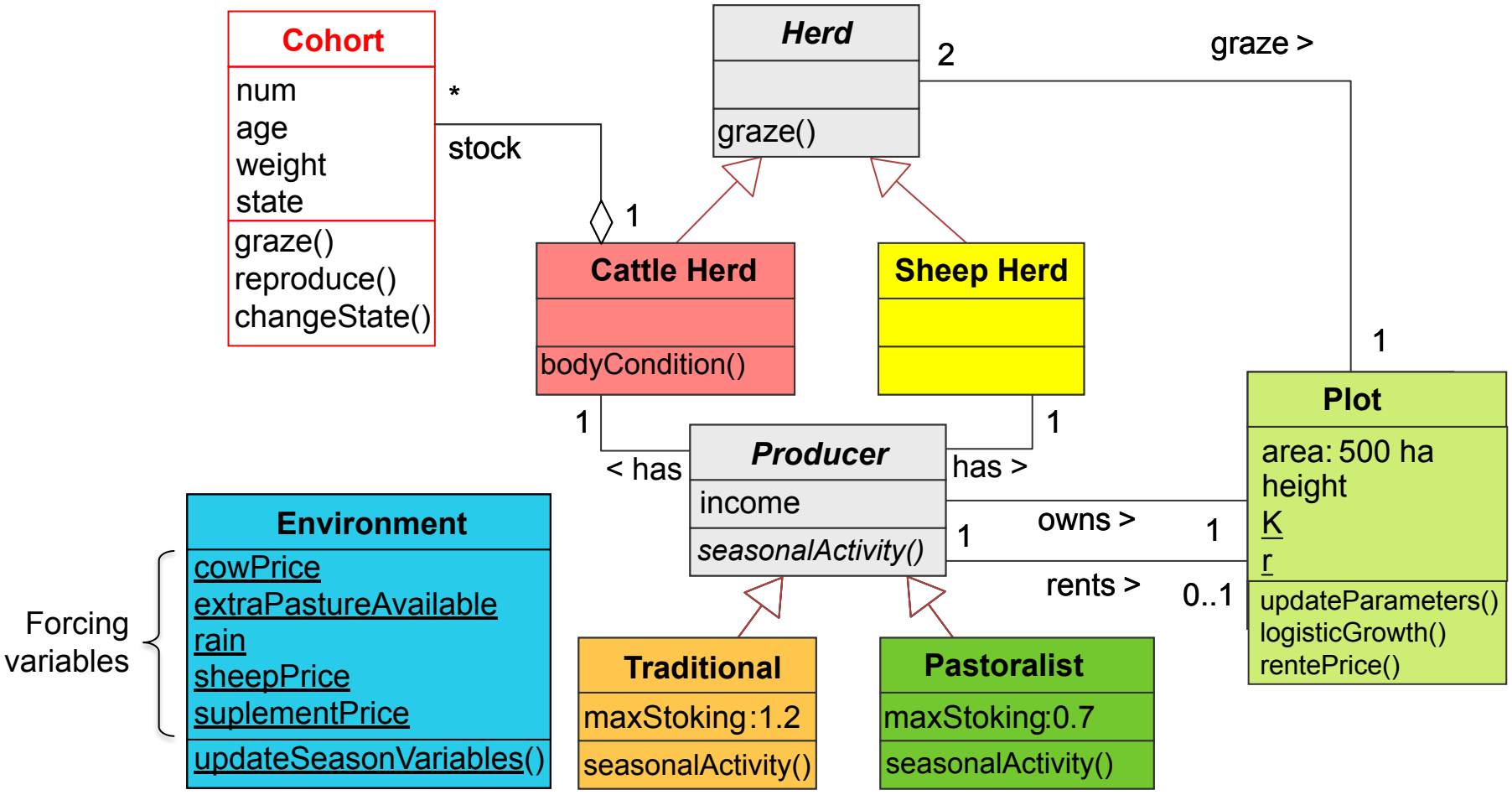
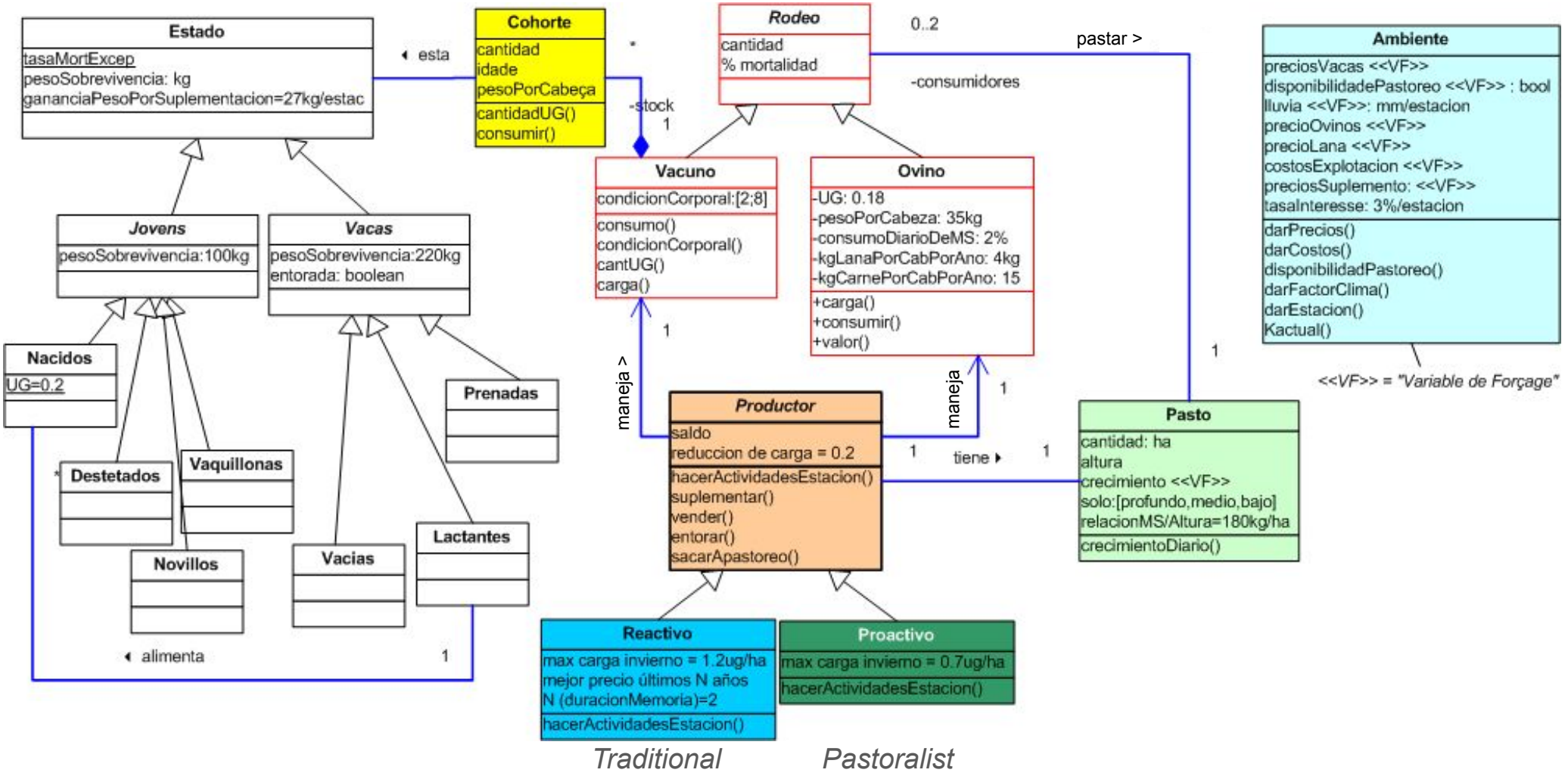
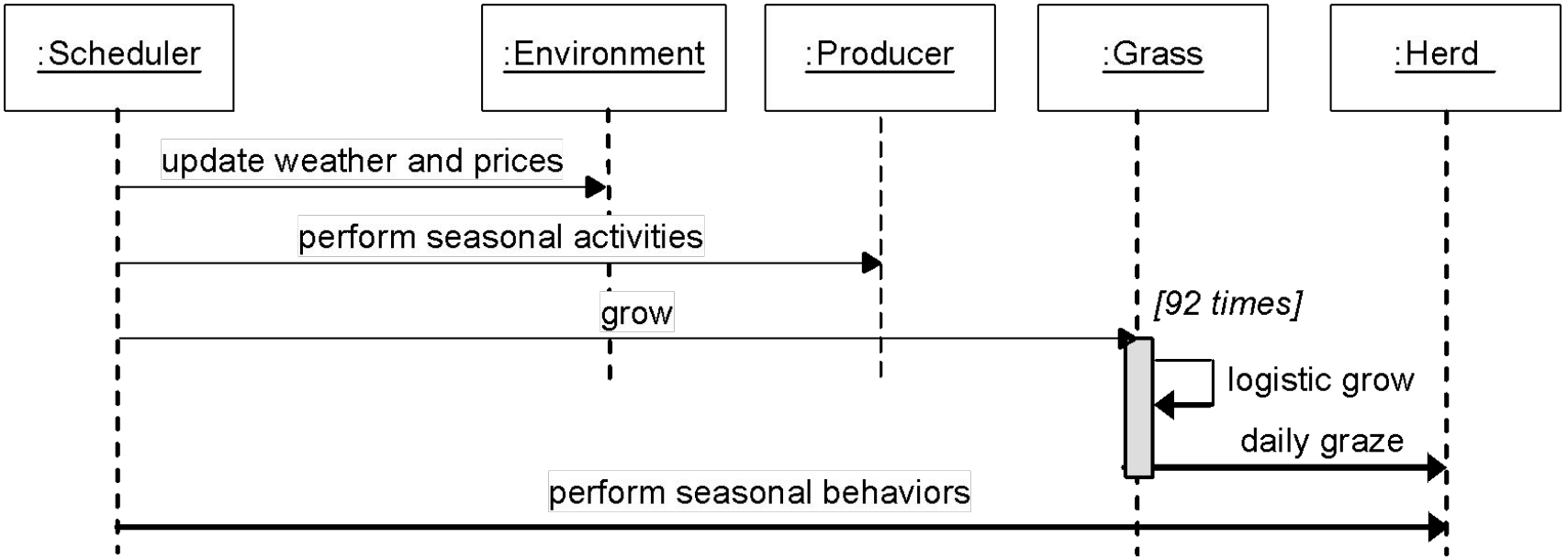


Diagrama de classe



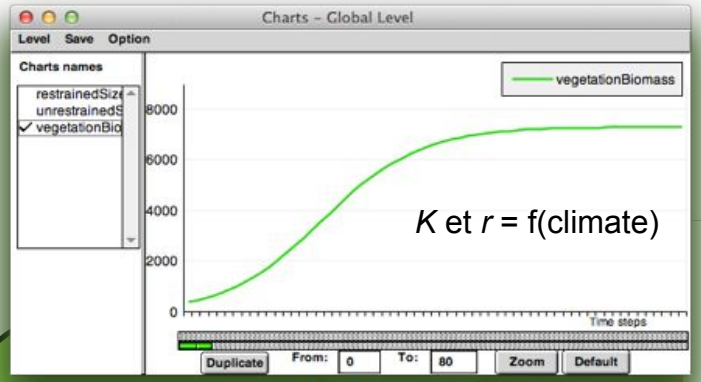
1rst version: seasonal step

Sequence diagram

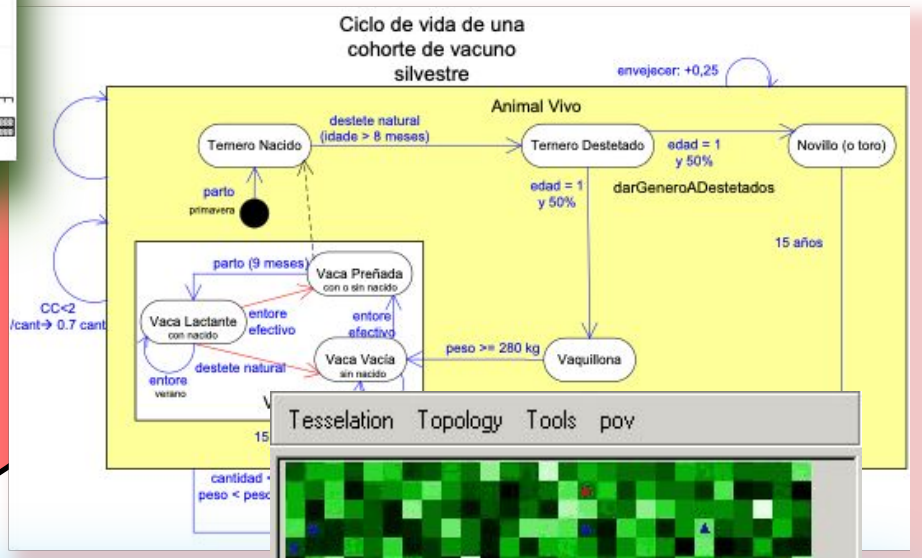


An ABM composed of 3 sub-models

Pasture dynamics



Animals dynamics



Forcing variables

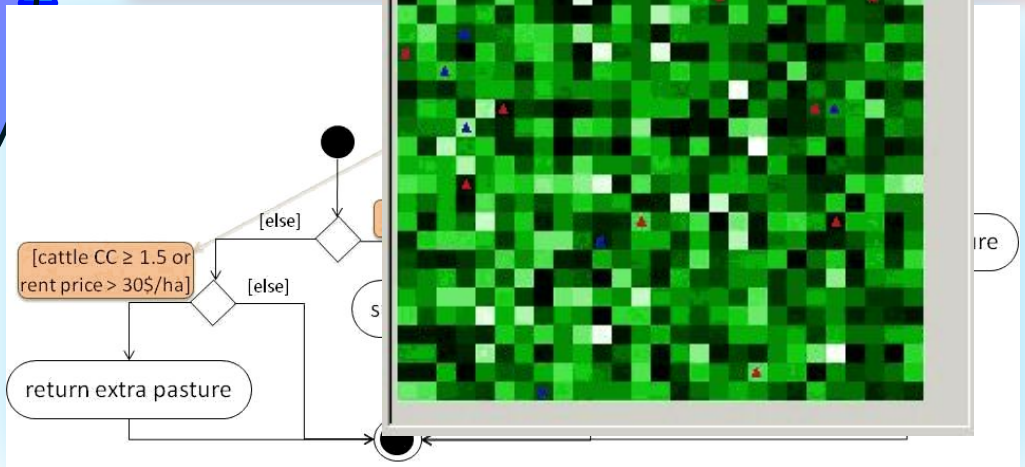
Observed data (time series) of

Climate

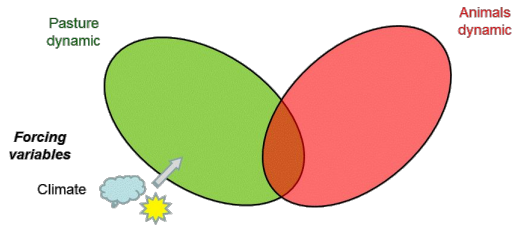
Prices

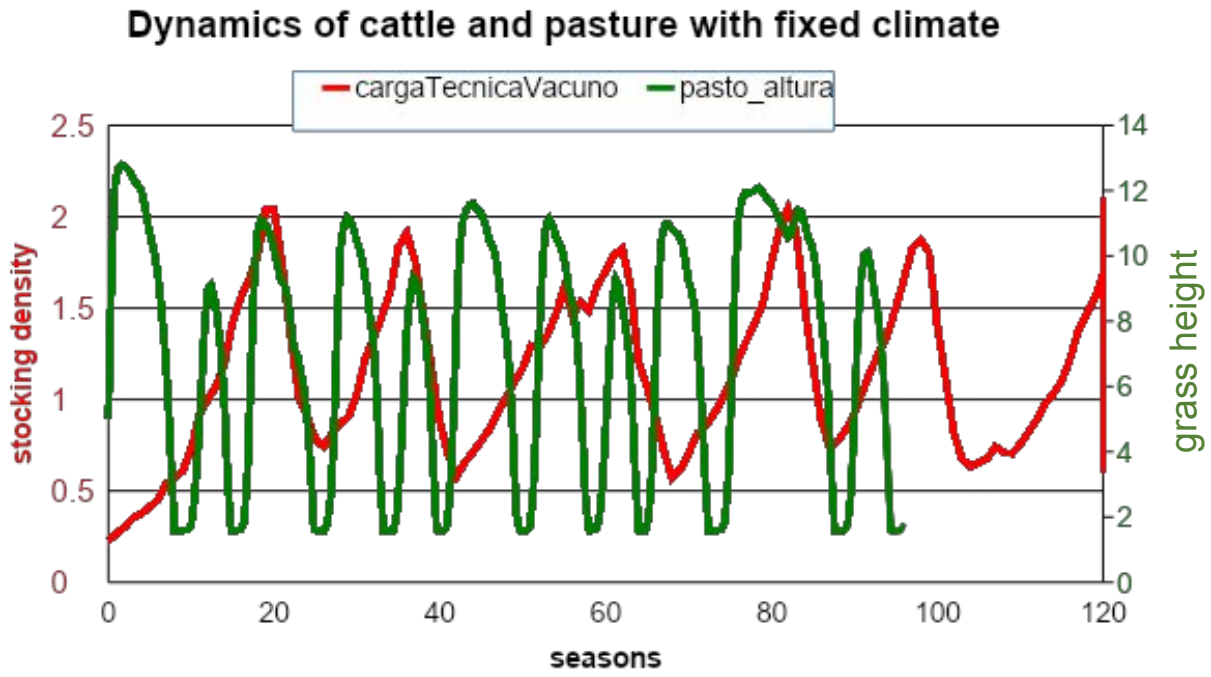
$

Producer's decisions



Simulation’ results from 1rst version



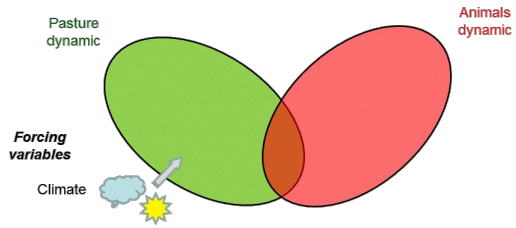


Without climatic scenario

≈ Lotka-Volterra => Model “alignment”

Simulation' results from 1rst version

Climate scenario,
no management



Herd size

Herd evolution according to initial size

drought

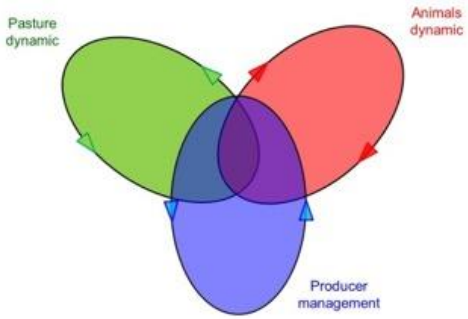
Cabezas

estaciones

cantInicial=2
cantInicial=52
cantInicial=102
cantInicial=152
cantInicial=202
cantInicial=252
cantInicial=302
cantInicial=352
cantInicial=402
cantInicial=452
cantInicial=502
clima

Simulation' results from 1rst version

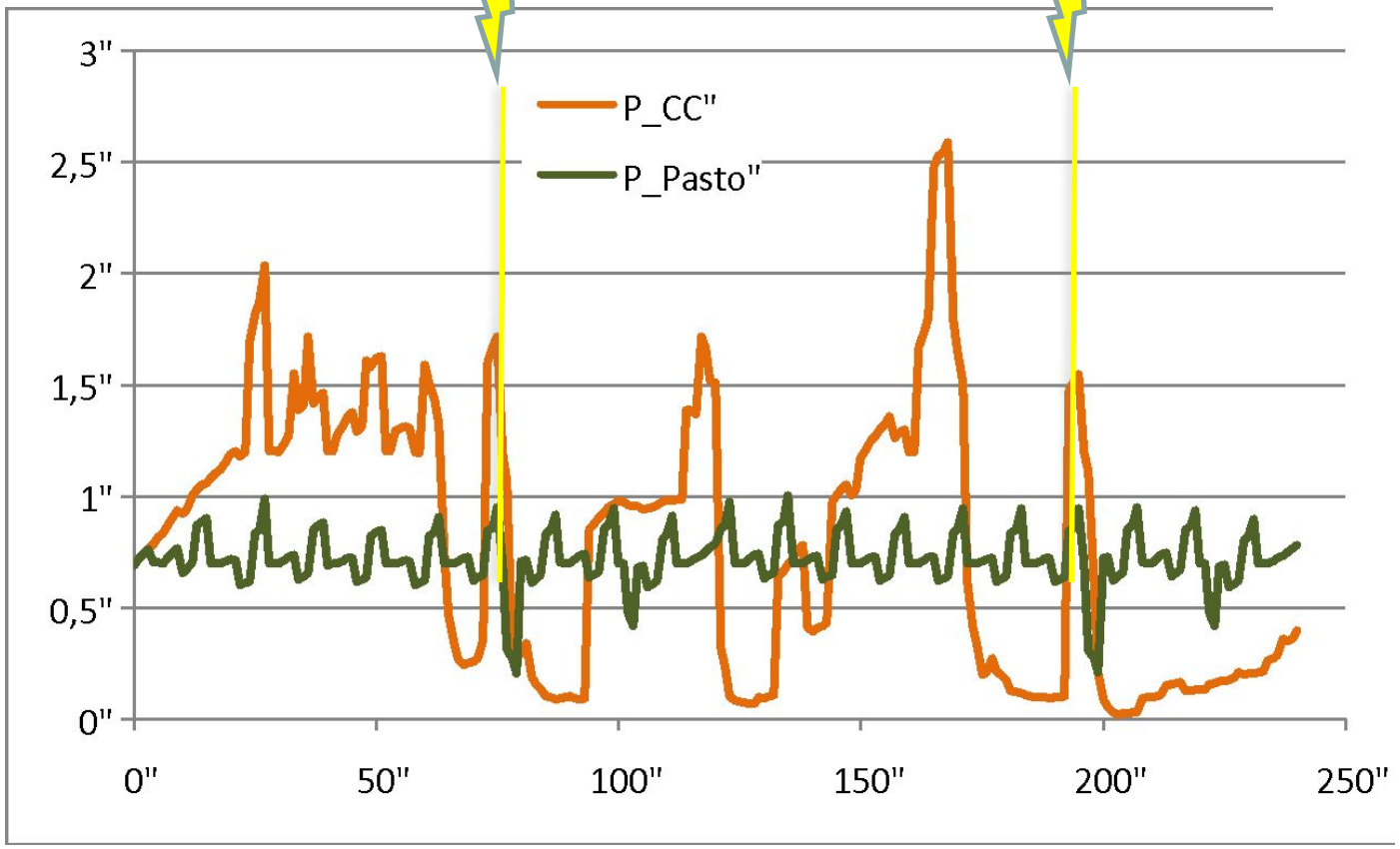
Climate scenario,
with management



stocking rate per hectare

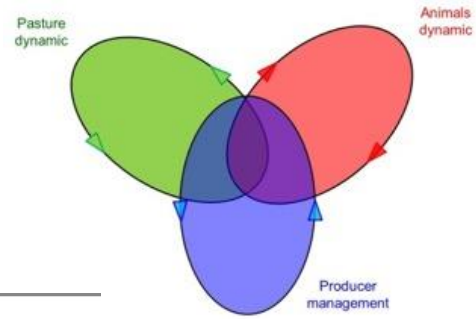
drought

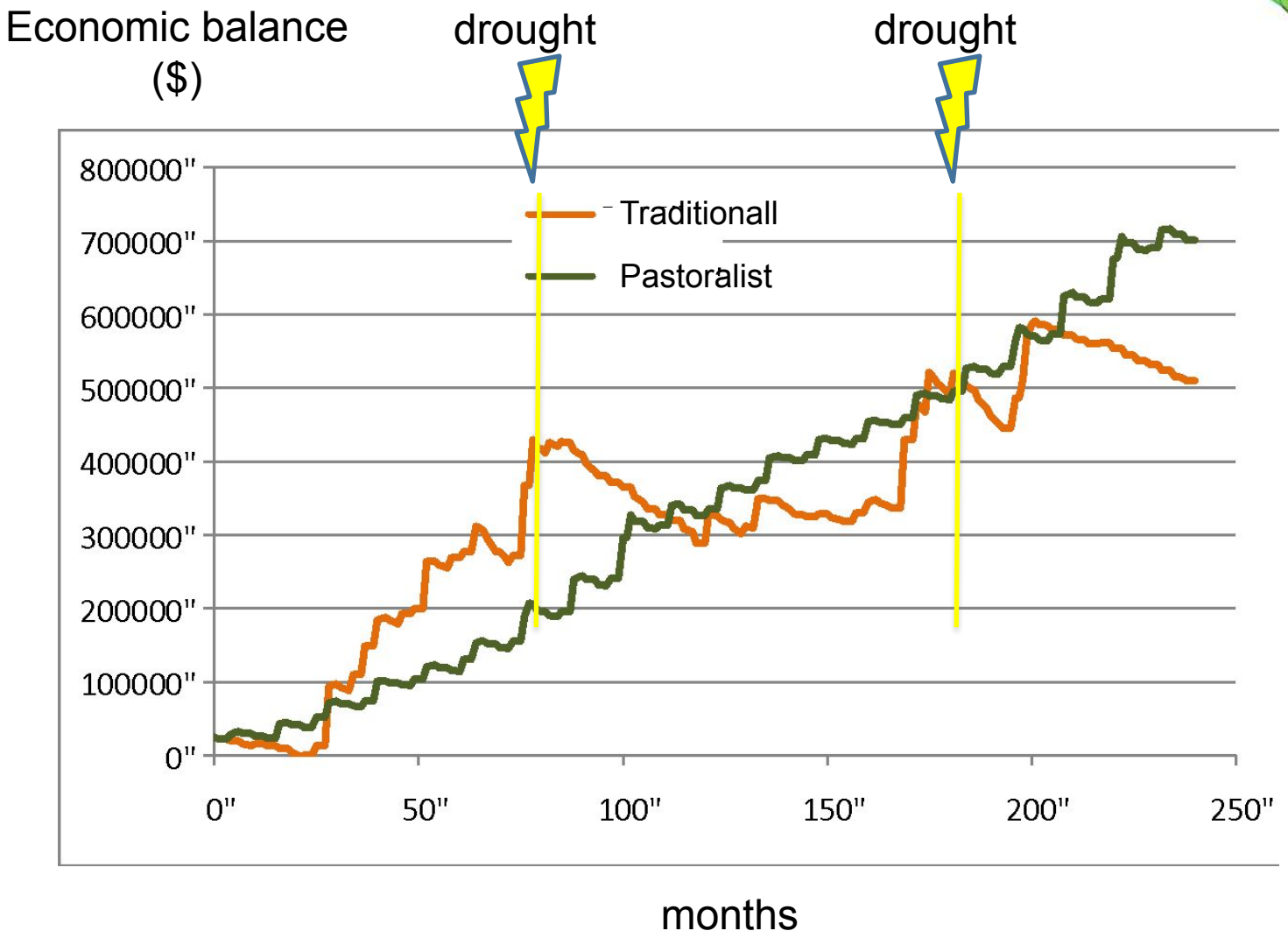
drought



Simulation' results from 1rst version

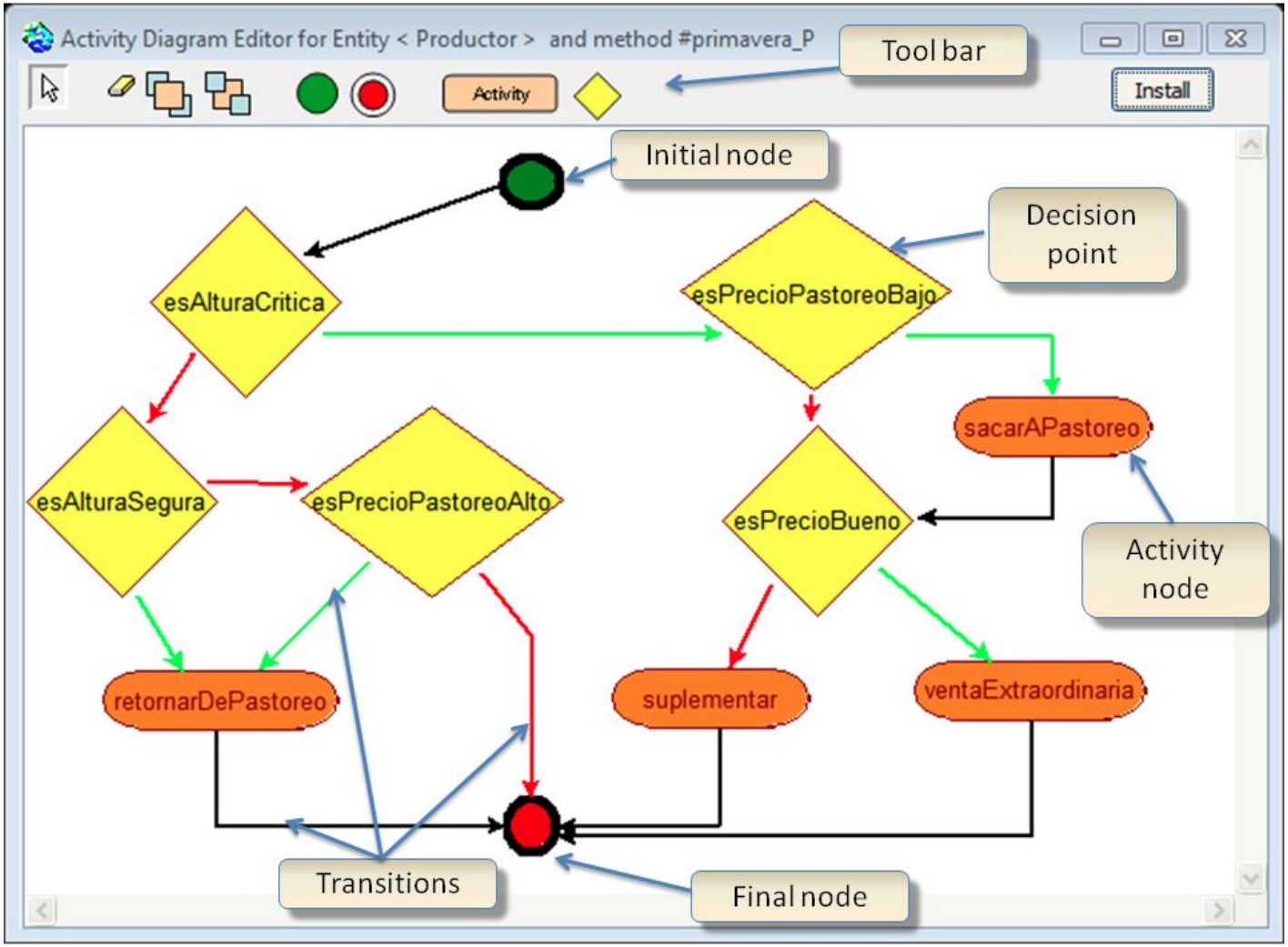
Climate scenario, with management





Simulations and revision of the model with farmers

Executable activity diagram editor to design new strategies collectively



Experimental results

By being able to modify agents' behavior

- farmers could play with the model
- better understand its logic.
- enable opening the black box

Co-Design of the model

- They **validate** a simplified representation (which they initially rejected)
- They identify **biases** in the simulations
- They **corrected** the conceptual model

Surprises and learning

- **Counter-intuitive** results for livestock technicians (but not for farmers)
- It forced the experts to acknowledge their recommendation was not always the best
- Transfer of knowledge from farmers to IPA

Interest of the model for the participants

- Greater dialogue with the institute
- Stakeholders want to use the model (to play with it themselves)
- Appropriation of the tool

This experience has facilitated the emergence of new and more resilient management practices

Papers

Bommel P., Dieguez F., Bartaburu D., Duarte E., Montes E., Pereira M., Corral J., Lucena C. and Morales H., (2014). ***A Further Step Towards Participatory Modelling. Fostering Stakeholder Involvement in Designing Models by Using Executable UML***.
Journal of Artificial Societies and Social Simulation 17 (1) 6.
http://jasss.soc.surrey.ac.uk/17/1/6.html

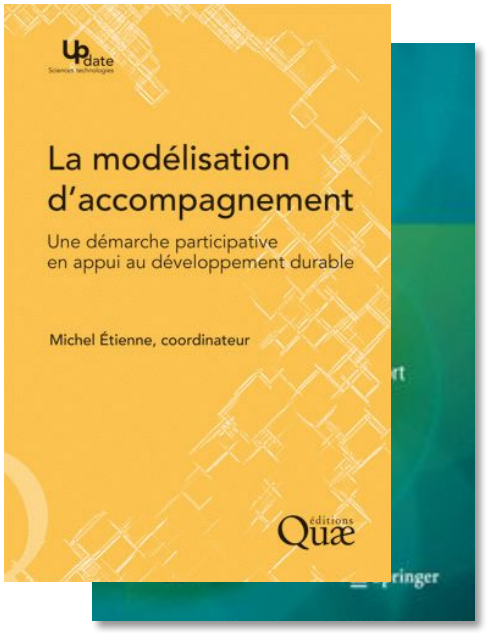
Morales Grosskopf, H., Tourrand, J. F., Bartaburu, D., Dieguez, F., Bommel, P., Corral, J., Hegedus, P. (2015). ***Use of simulations to enhance knowledge integration and livestock producers' adaptation to variability in the climate in northern Uruguay***. The Rangeland Journal, 37(4), 425-432.

Dieguez, F., Morales, H., Bartaburu, D., Duarte, E., Montes, E., Pereira, Bommel, P. (2014). ***Virtual experiments using a participatory multi-agent model to explore interactions between climatic variability and management decisions in extensive grazing systems in the basaltic region of Uruguay***. Agricultural Systems, 130, 89-104.
http://doi.org/10.1016/j.agsy.2014.07.002

ComMod : Supporting stakeholders in decision-making

Objectives

1. Knowledge : understanding complex environments in uncertain situations
   - Produce **knowledge** on a development issue,
   - gain a better understanding of the place and **role** of stakeholders in the system,
   - co-construct relevant **indicators** for all.
   - Changing pre-existing **view points**
2. Decision : support collective decision-making
   - Encouraging **mutual recognition** of points of view
   - Identify collectively
     - Acceptable solutions
     - Clarify the possible impacts (scenario simulation)
   - Highlight **collective issues**,
   - facilitate and enrich the decision-making **process**.



The model as an object of **mediation**

The ComMod tools: synergies between simulation and games

	Simulation	RPG
+	Speed of simulations Genericity	Understanding the complexity of decisions and the points of view of stakeholders
-	Black box Hard to describe and communicate	High cost, hard to replicate

Hybrid simulation

Models as catalysts for the commoning

100 % human RPG

... Intermediate ...

100% computing ABM

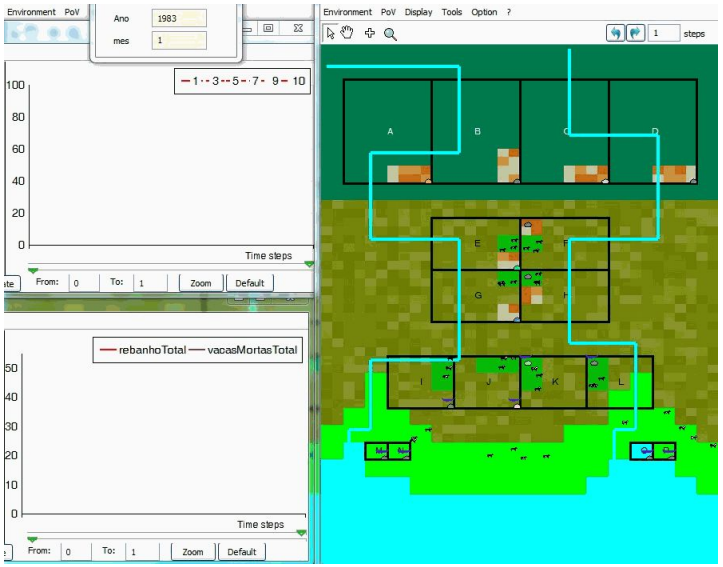


Illustration of varzeas in Amazonia

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Micro level

Debriefing : the most important phase

→ **Collective agreement, Common action**

Models as catalysts

- Aubert at al. 2017

  "*It is necessary to use suitable **tools** to support stakeholders in examining possible **changes** in the ways of **producing** individual, common and collective **rules** that respect **common values** and objectives*"

- Expecting changes by using ***catalyst objects***
  - bring people closer
  - offer human warmth and complicity
  - stimulate awareness about the need to manage their commons in a fair and viable way.

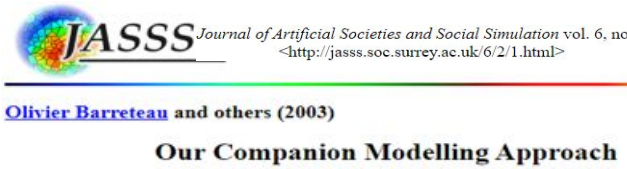
- Designing aesthetic "*catalyst*" tools
- **KISS, KIDS… "KILT" & "Kictec"**:
  Keep **i**t a **L**earning **T**ool
  Keep **i**t a **C**atalyst **T**ool to **E**mpower **C**ommunities

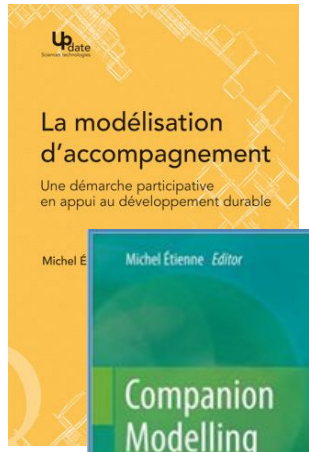
Modeller as facilitator for transdisciplinary research

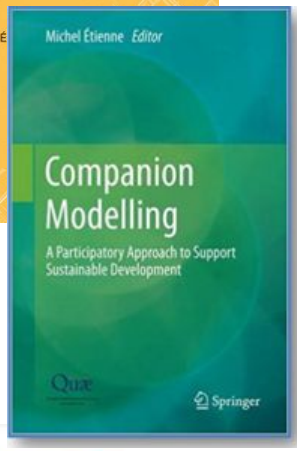
- UML, the modelling language of transdisciplinary?
- Modeller as facilitator
  - Animation and listening postures
- Participatory modelling for
  - Social learning (KILT, Le Page 2017)
  - Empowering communities to develop their own solutions (KICTEC, Bommel 2020)
- Supporting agreements among stakeholders
  - Sharing and learning-by-modeling generate empathy and mutual understanding
  - Catalyst tools allowing actors to project themselves over the long term
  - Supporting them for producing individual, shared and fair collective rules
  - Developing ways to manage their commons

For more information about ComMod…

- The Commod Book « Companion Modelling »
- Web site http://www.commod.org
- Special journal issues
  - JASSS 2003
  - IEMS 2011
  - Simulation & gaming 2010







Formation – Ecole-Chercheurs

Concevoir une démarche de modélisation d'accompagnement (ComMod) :
Mettre des acteurs en situation pour partager des représentations et simuler des dynamiques

Du 7 au 11 octobre 2024 à Crillon-le-Brave (Vaucluse) :

Contexte et enjeux

Un groupe de chercheurs et d'enseignants-chercheurs du CIRAD, du CNRS, de l'INRAE, de l'IRD et d'Universités françaises et étrangères a mis au point et a formalisé dans une charte spécifique*, puis dans un ouvrage**, une nouvelle façon d'aborder la modélisation en appui à des processus de décision collective concernant la gestion des ressources naturelles renouvelables, dans un contexte de développement durable. Ce groupe dénommé ComMod (Companion Modelling) est aujourd'hui constitué en une association de praticiens. Il propose une démarche dans laquelle la modélisation est perçue comme un mode co-construit de représentation des objets, de leurs relations et de leurs dynamiques. Le processus d'accompagnement vise à amener progressivement les différentes parties prenantes à se connaître, échanger, partager leurs arguments et points de vue afin de construire une vision commune d'une question socialement vive et élaborer une solution acceptée.

La formation propose d'expliquer la posture, la méthodologie, les outils spécifiques, les effets attendus et les conditions d'application de la démarche de modélisation d'accompagnement dans le cadre d'un appui aux processus de décision territoriaux et environnementaux. Elle est construite à partir d'une mise en situation qui permet aux participants de comprendre et de mettre en pratique les différentes phases qui jalonnent la démarche.

Un site web pour en savoir plus : http://www.commod.org

* *Nature Sciences Sociétés 13, 165-168 (2005)*
** *Editions Quae (2010)*

Objectifs opérationnels

À la fin de cette formation, les participants seront capable de :

Planifier une démarche ComMod :
- Identifier la question sur laquelle travailler
- Analyser et prendre en compte le contexte
- Sélectionner et mobiliser les participants

Co-construire un modèle conceptuel :
- Mettre en oeuvre un atelier de co-construction PARDI

Concevoir un jeu de rôles (non informatisé) :
- Concevoir un jeu de rôles
- Animer et observer un jeu de rôles
- Débriefer une session de jeu de rôles

Explorer des scénarios (intérêts/contraintes de l'informatisation) :
- Comprendre les enjeux liés à l'association de jeu de rôles et de modèles informatiques
- Co-construire des scénarios, des indicateurs

Suivre et évaluer les effets de la démarche :
- Acquérir des outils liés au suivi-évaluation de la démarche

Public

Chercheurs, étudiants et praticiens du développement territorial et du développement durable qui travaillent sur les démarches de modélisation participative et la gestion adaptative de systèmes complexes anthropisés.

Aucun prérequis n'est nécessaire pour participer à cette formation.

Organisateurs

Cette école-chercheurs existe depuis 2009 et évolue chaque année en fonction des expériences acquises. Elle a été portée et organisée successivement par plusieurs membres du collectif ComMod.

Co-organisation 2024 : CIRAD, INRAE, Association ComMod
(voir la liste des formateurs au dos)

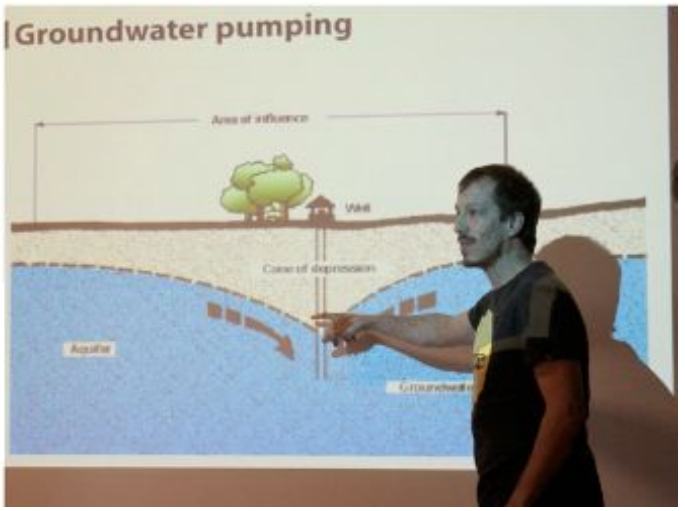
ComMod Research school:
https://www.commod.org/formations/sessions-commod

Courses on ABM

- MISSABMS

  Multi-platform International Summer School on Agent-Based Modelling & Simulation for Renewable Resources Management

  - 3 platforms: Netlogo, Gama, Cormas
- Diversity of participants
- Promote UML formalization rather than coding
  - Especially appreciated by the participants



(Le Page et al 2017)

Gracias