Cognitive and managerial challenges for the design of sustainable social-ecological systems

Elsa Berthet, Marine Agogué

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Introduction

Folke et al. 2011
Westley et al. 2011

- SES trajectories are often locked in unsustainable pathways
- A need to enhance our ability to envision innovative SES
- A new stake for science:
  - not only inform decision
  - but also contribute to design capacity building
- How can science meet this challenge?
  - Focus on ecology

Outline

1. Formal distinction between modeling and design reasoning
2. Case study: from modeling to designing an agro-ecosystem
3. Principles of a “generative” ecology
4. Implications on the role of ecology in SES governance

1. Formal distinction between modeling and design reasoning

Modeling

- Inputs:
  - X_i is an object considered as:
    - Existing
    - Partly unknown
    - Observable
  - $K(X_i)$: initial knowledge on X_i
- Output:
  - Increased knowledge on X_i:

  $K'(X_i) > K(X_i)$
- ***The aim is not to produce new X***

Design

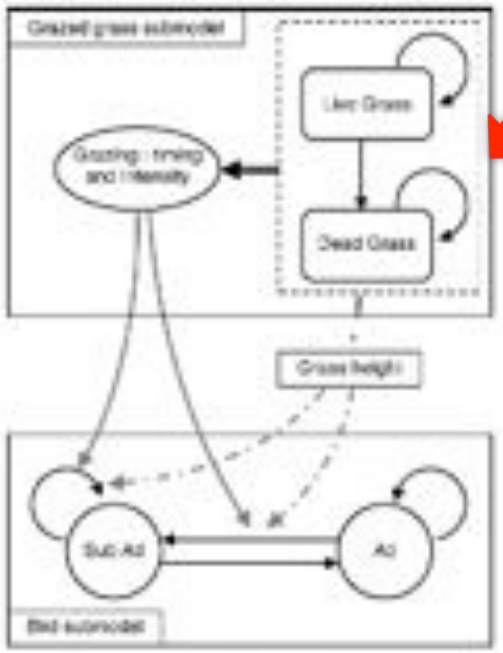
- Inputs:
  - X_x is an object considered as:
    - Not existing
    - Partly unknown
    - Not observable
    - Desirable: desirable property $P(X_x)$
  - $K(X_x)$: initial knowledge on X_x
- Outputs:
  - X_D exists, and $[X_D, P(X_D)]$ true
  - X_D is a combination of expansions of X_x
  - $K'(X_x) > K(X_x)$
- ***The aim is to create both knowledge and objects***

Hatchuel et al. 2013

Illustration

Modeling

- Let X_i be a landscape of wet grasslands



Output: Knowledge on bird population dynamics as a function of livestock grazing

Sabatier et al. 2010

Hatchuel & Weil 2009

Design

- Let X_i be an intensive cereal agro-ecosystem
- We want it to be a "harmonious place to live" (P_J)
- $[X_i, P_J(X_i)]$ untrue; $[X_x, P_J(X_x)]$ unknown

Expansions of Xx

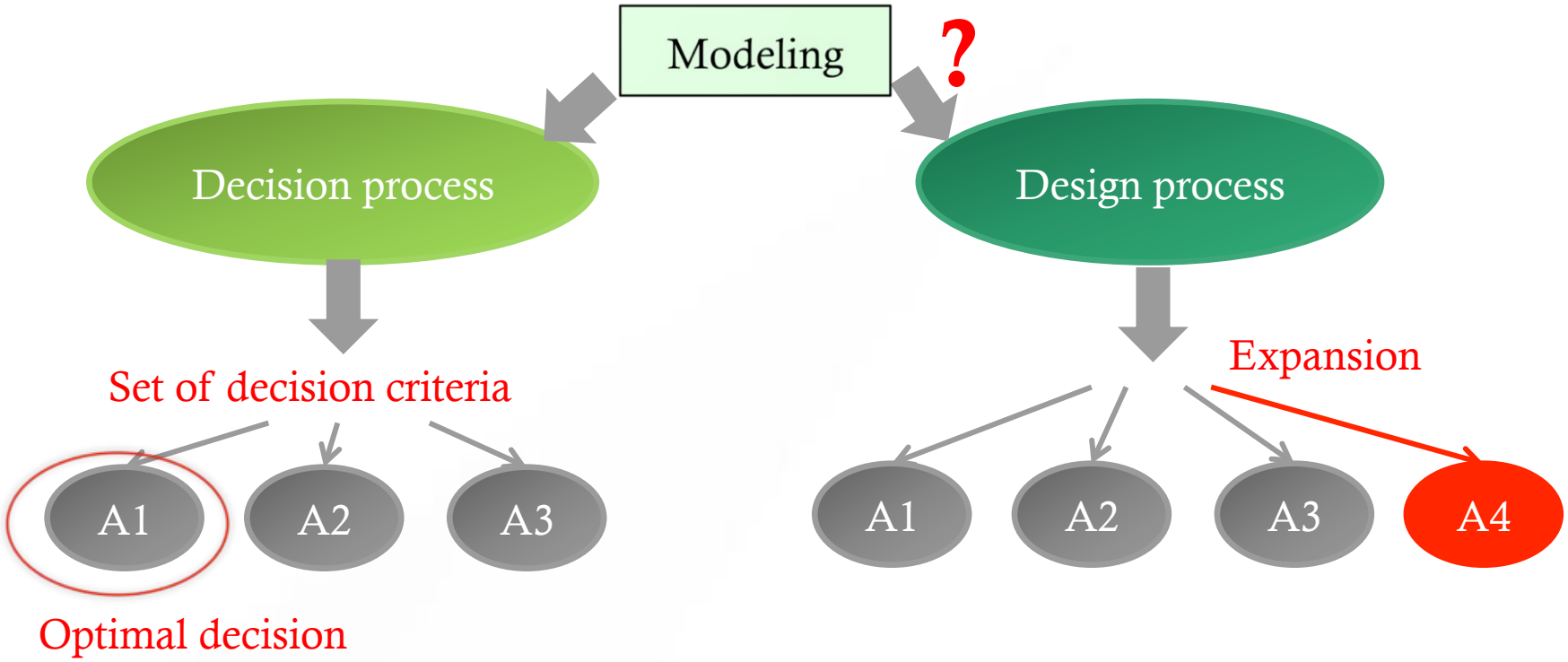
Recreate landscape heterogeneity?

Foster other activities?

Develop organic farming?

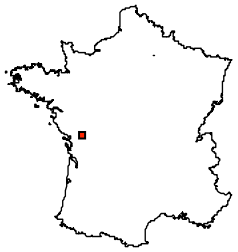
Toward a new role for modeling

Hatchuel 2002



Under what conditions can modeling support an innovative design process?

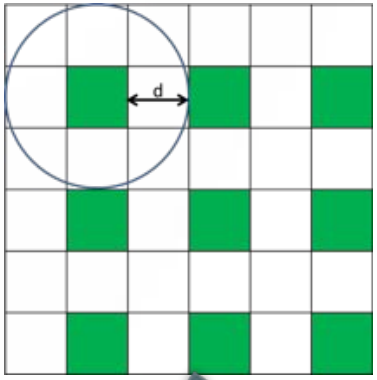
2. Case study: from modeling to designing an agro-ecosystem



- Intensive cereal agro-ecosystem
- Biodiversity loss and water quality degradation
- Long term research program in ecology

X_i : agro-ecosystem

$K'(X_i)$

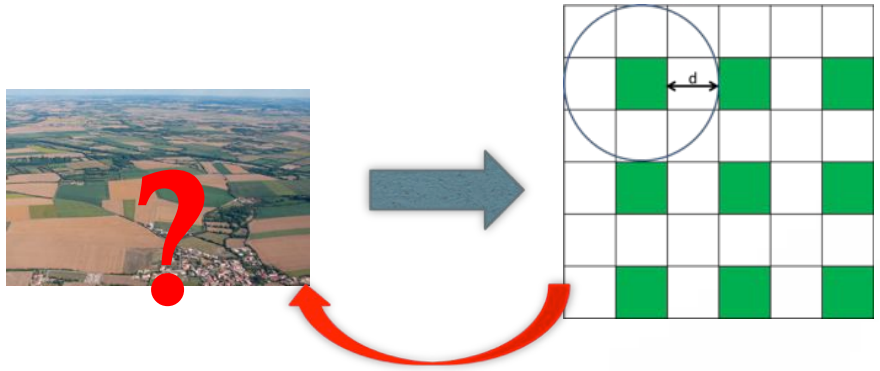


$D^*(d_i)$

- Maintain >10% grasslands

Bretagnolle et al., 2011

Using ecology's modeling to initiate design

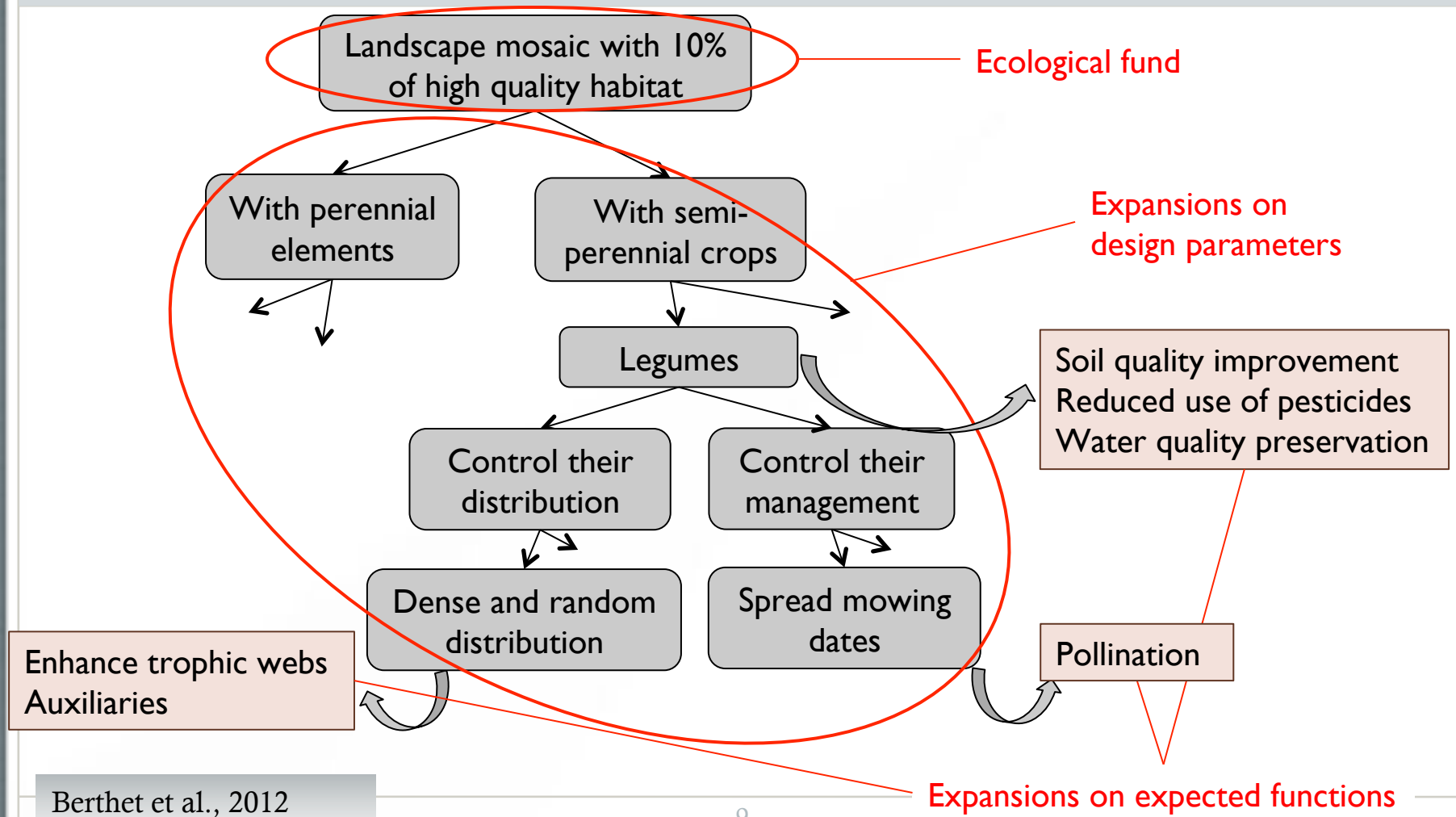


- X_x : a desirable agro-ecosystem
- $K'(X_x)$ is the landscape mosaic
- P_J: the desirable property "with 10% of high quality habitat"
  - P_J is necessary but not sufficient to design an acceptable X_x

$\Rightarrow [X_x, P_J(X_x)]$ is the departure point of a design process: "ecological fund"

$\Rightarrow$ New properties $P_j(X_x)$ can be imagined, by various stakeholders

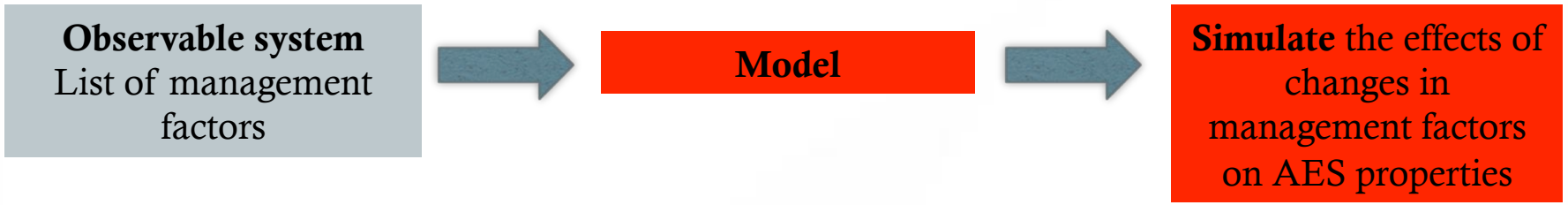
Expansions explored during a collective design workshop



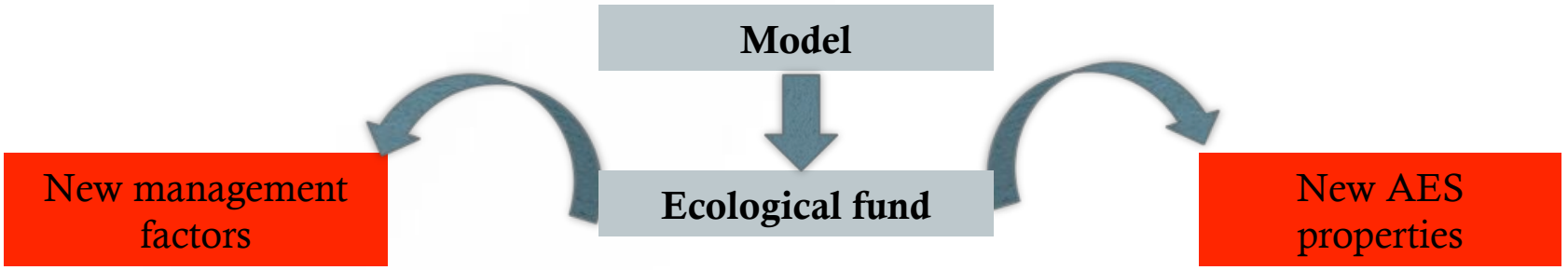
Berthet et al., 2012

3. Principles of a "generative" ecology

Classic AES modeling



Ecology-based AES design



Ecology is not used to provide an expertise in a decision process, but to open new design spaces

4. Implications on the role of ecology in SES governance

a) Role of ecology in existing governance models

- **Instruments based on the concept of ecosystem services**
  - Let X_i be an existing ecosystem
  - Let P_J be an desirable property of the ecosystem
    - (e.g.: "reduce pesticides to preserve heritage species)
  - $[X_i, P_J]$ is constraining

  ⇒Design of incentivizing or coercive instruments

  - Ecology is called upon to identify P_J and support the design of regulation/market instruments
  - Problems:
    - Ecology is seen as a constraint
    - High costs, conflicts…

Boyd & Banzhaf 2007
Swinton et al. 2007

a) Role of ecology in existing governance models

- **Self-governance of common pool resources**
  - Let X_i be an existing resource system (e.g. fisheries)
  - Let P_J be an existing property of this system that the community wants to preserve
    - (e.g.: "sustainably provides fish")
  - $[X_i, P_J]$ exists but is threatened

  ⇒Design of self-governance rules and norms

  - Ecology is called upon to support the design of solutions to maintain $[X_i, P_J]$
  - Problem: the CPR model is very specific; it does not hold for AES

Ostrom 1990

b) A new role for ecology: support SES collective design

- Social ecological systems are not stocks to preserve (X_i), but ecological funds to design (X_x)
  - They can be assigned other properties than the initial targeted ones
  - Ecological fund: not a common good, but a "common unknown"
    - Collective action is facilitated by the open dimensions to explore
    - This exploration can be carried out by various stakeholders
- A crucial role for ecology:
  - Qualify the ecological fund and the basic specifications [X_x, $P_J(X_x)$]
  - Open collaborative design spaces, to explore new $P_j(X_x)$
- Toward more democracy in both governance processes and research

Conclusion and perspectives

- Developing a generative ecology: a first step for SES innovative design

- However, managerial challenges:
  - Whom should be involved, and how?
  - Which design tools and methods?
  - How to adapt local governance?
    - Facilitators and new collaboration spaces at a territorial scale
  - New policy instruments
    - Not only incentivizing or coercive
    - but that foster local exploration processes and collaboration

Thank you!

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