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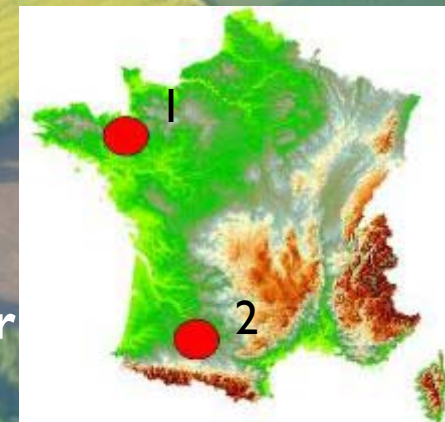
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Landscape agroecology: from patterns to resilience

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*Warm-up workshop “Agroecological transition and resilience”,
Montpellier, 24th of October - in the frame of Resilience 2014
International Congress organization.*

How do we handle the issue of « agroecological transitions and resilience » in landscape agroecology?

Why and how

...to accompany even foster...

... the management of landscape resources by/for agriculture

... in order to maintain, foster or recover the ecological
functions

... that are necessary for biodiversity conservation and key
associated ecological services



Take home messages

1. Landscapes as key factors in agroecology
2. We can modify landscapes to produce ecosystem services
3. Landscapes, as complex socio-ecosystems need new approaches and tools
4. People are part of the system
5. Scientists have to be prepared to deal with conflicts induced by transition





Part A. **Crossing spatial scales and boundaries** to identify levels of organization in agroecological systems

Part B. Characterizing **trajectories of interactions** in agroecological systems

Part C. Orienting knowledge and methods **toward management support**

An aerial photograph of a rural landscape. The scene is dominated by various agricultural fields in shades of green and yellow. A prominent feature is a river or stream that flows through the center of the image, bordered by a dense line of trees. The terrain appears to be a valley or a low-lying area, with the fields and forest interspersed. The overall impression is of a well-managed agricultural system with natural features integrated into the landscape.

Part A. Crossing spatial scales and boundaries to identify levels of organization in agroecological systems

Landscape ecology: heterogeneity

- ▶ **Landscape**: *spatial organization produced by a society in interaction with the environment to use and manage natural resources (European convention for Landscape)*
 - development and dynamics of spatial heterogeneity,
 - spatial and temporal interactions across heterogeneous landscapes,
 - influences of spatial heterogeneity on biotic and abiotic processes,
 - management of spatial heterogeneity for society's benefit
-



Landscapes: levels and scales

- ▶ Heterogeneity can be decomposed in relative homogeneous sub-components aggregated in levels of organization
- ▶ Interactions/feed back loops → Complexity
- ▶ Consequences:
 - ▶ Cross scaling: a method for dealing with landscape complexity
 - ▶ Modifications in farms have consequences at landscape level:
 - ▶ can be difficult to deduce consequences at landscape level from modifications at the farm level

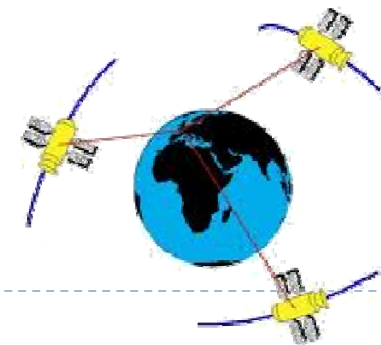


Landscape patterns: footprint of human activities

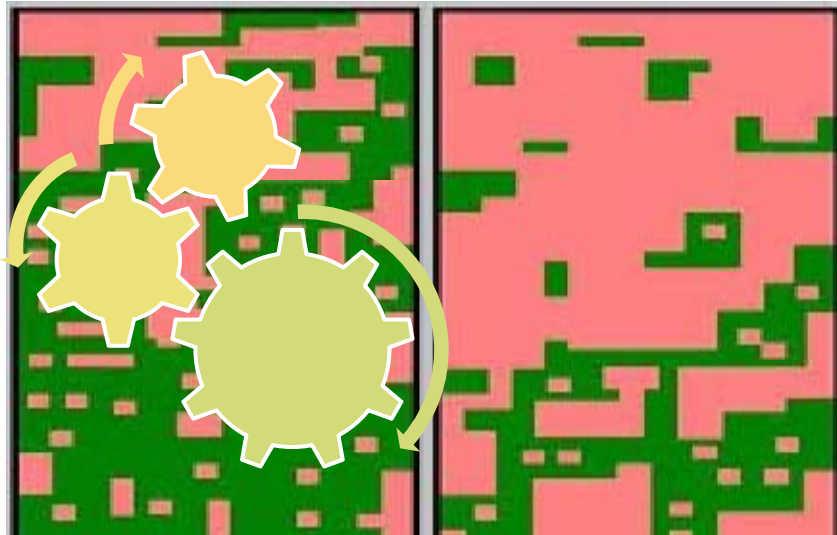
- ▶ Recognizable patterns (visible or not)



- ▶ New spatial data and tools (GIS, remote sensing, GPS...)
- ▶ Needs for new robust and up to date methods
 - ▶ Up/down scaling: too easy to do wrong things
- ▶ Uncertainty of (spatial) ecological models



From patterns to processes



- ▶ Landscape as driver and consequence of process
- ▶ Processes: e.g. flux of matter, species dynamics, social relationships, economic competition...
- ▶ Landscape composition, structure, interface, connectivity... have consequences on processes
- ▶ Key components for landscape functioning
- ▶ Landscape/territory

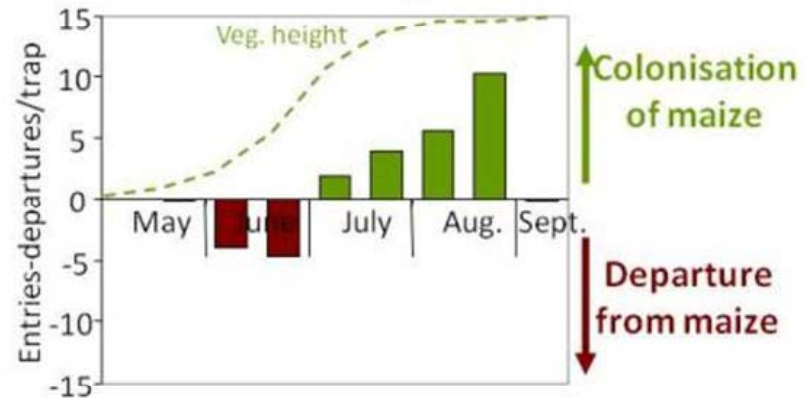


Flux between patches: key process for regulation ecosystem services

There are important exchanges of beneficials between crops during a growing season



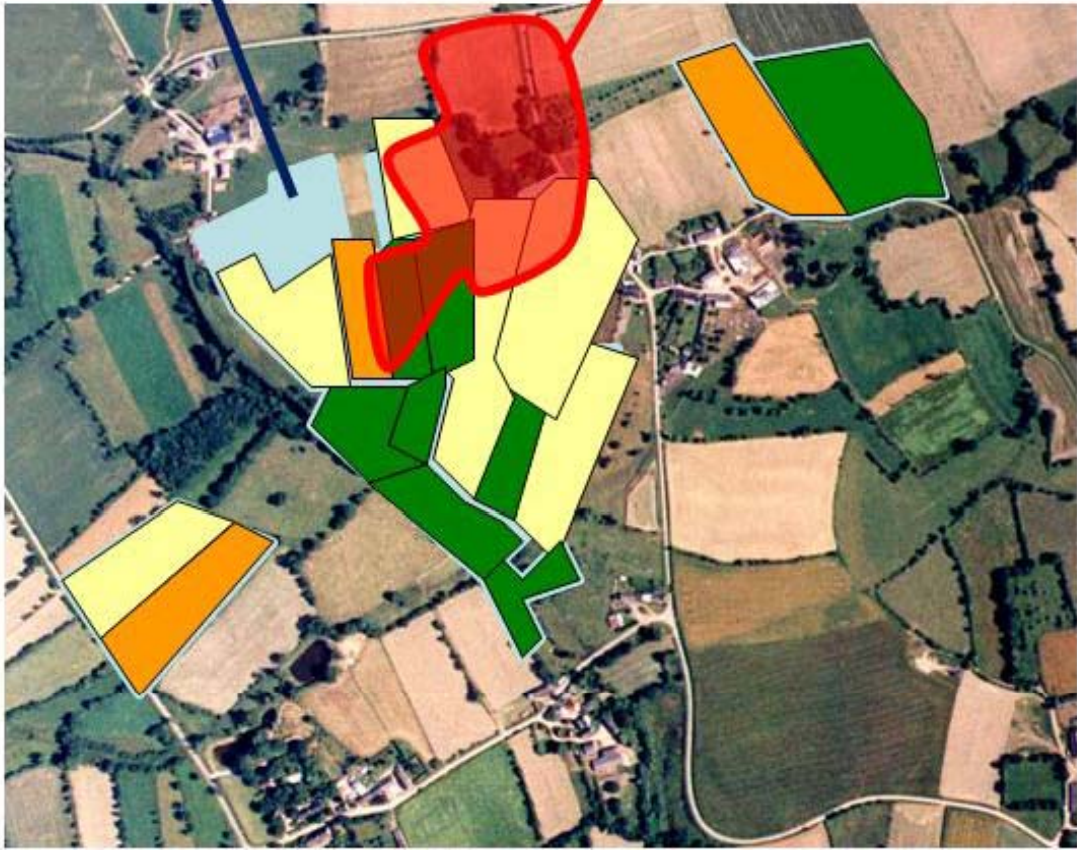
Movement orientation at maize edges



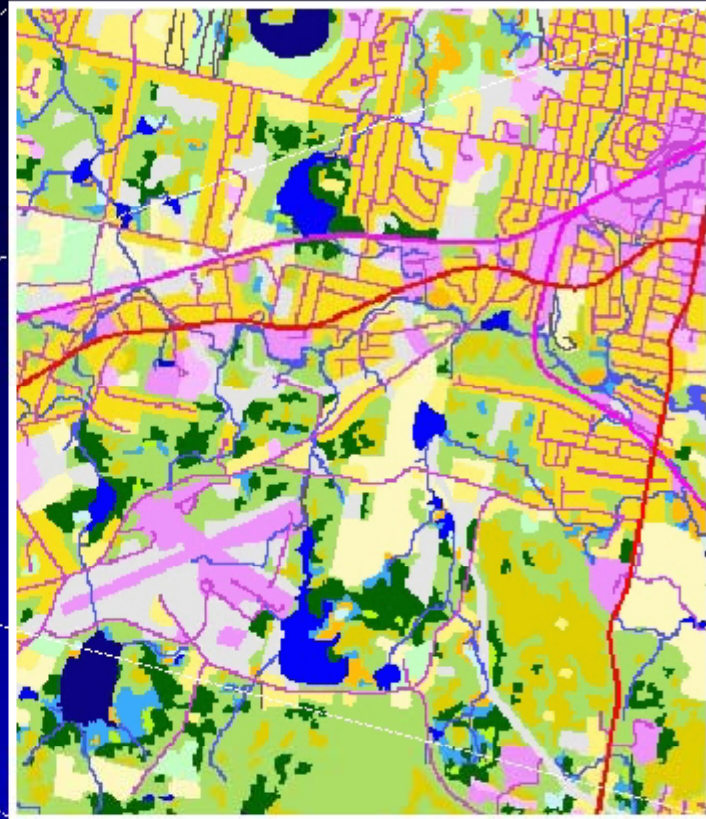
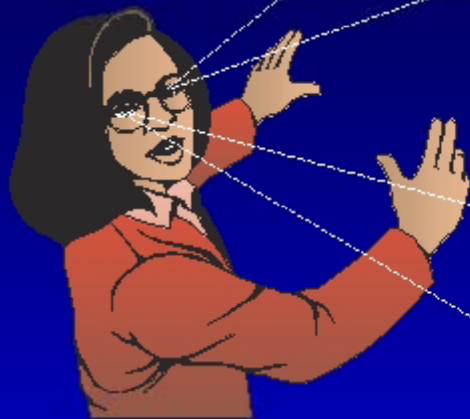
Seasonal changes in adjacent crops

Aviron, Vasseur (PhD)

Scale mismatch between management and ecological process



(2) From Anthropocentric to Organismic/ process-centered Landscape Patterns



McGarigal, 2003



Landscape ecology for agroecological transition

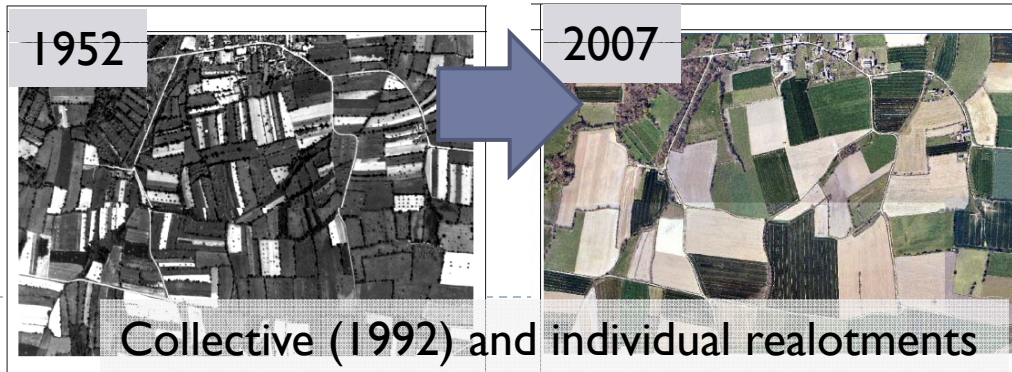
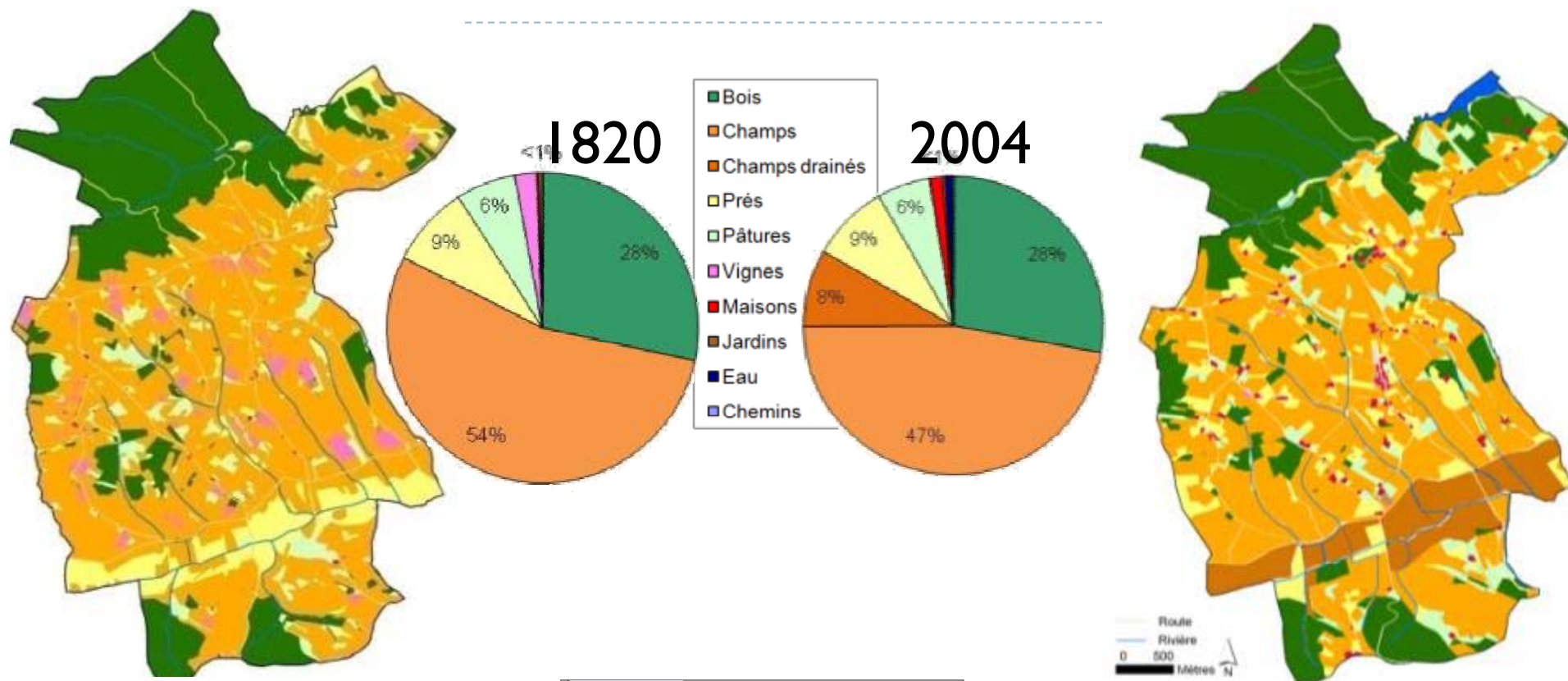
- ▶ Despite their complexity, there are robust methods to study landscapes and their process, mostly from their pattern
- ▶ There are many ways to « see » the landscapes
- ▶ Landscape agroecology requires to develop new methods and concepts, less dominated by anthropic point of view, while acknowledging key roles of human activities
- ▶ Many agroecological processes are influenced by their spatial context



An aerial photograph of a rural landscape. The scene is dominated by a patchwork of agricultural fields. Some fields are a vibrant yellow, likely rapeseed, while others are a lush green, possibly corn or soybeans. Interspersed among these are large areas of brown, tilled soil. A dense forest of green trees runs through the landscape, particularly in the lower and right portions. A small cluster of buildings, including a white house and a church with a steeple, is visible in the center. A road or path winds through the fields. The overall impression is of a well-managed agricultural system with diverse land use.

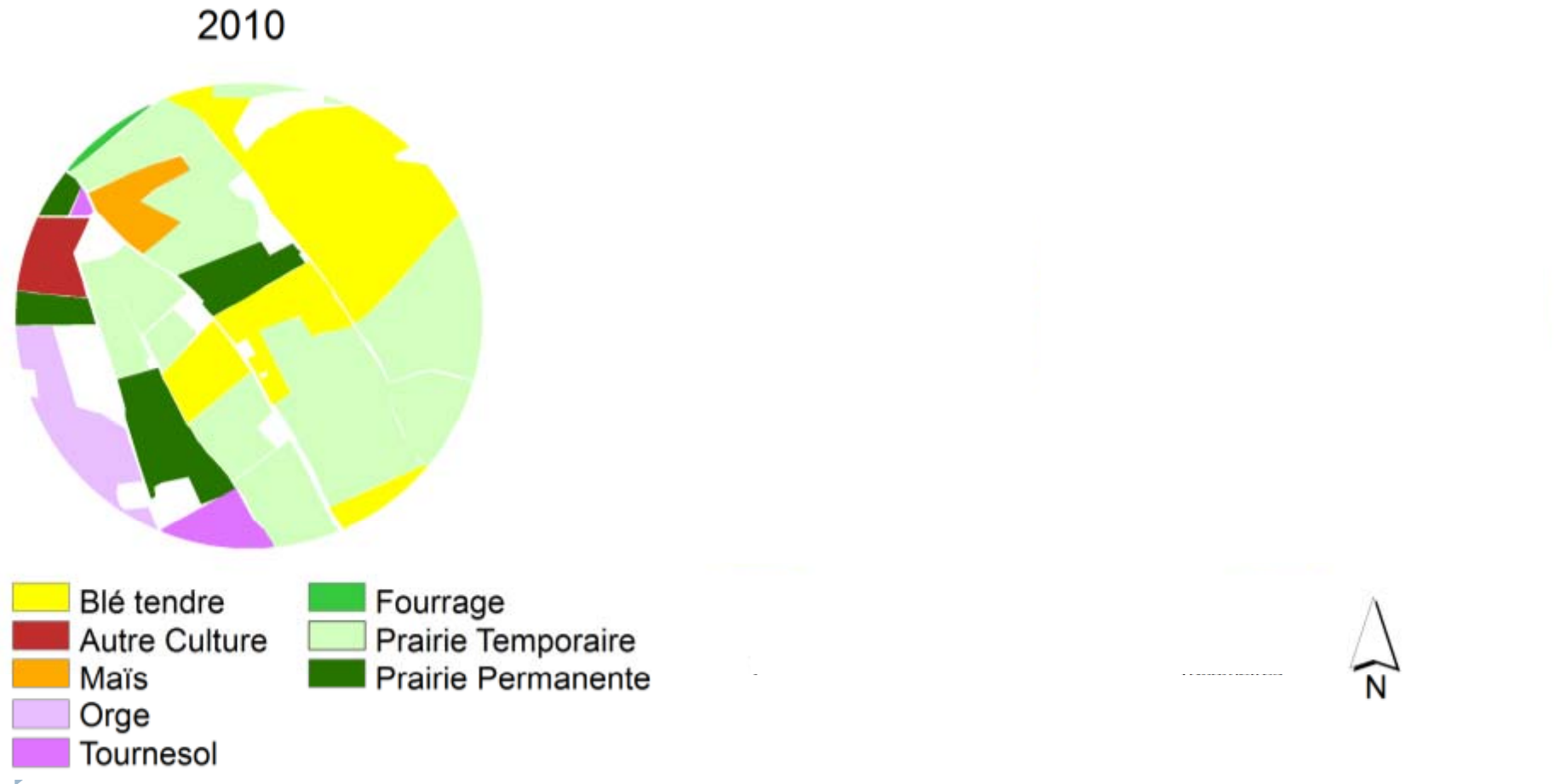
Part B. Characterizing **trajectories of interactions** in agroecological systems

Landscapes change slowly (generally)



Abrupt one way change:
hedgerows removal for
enlarging fields

Landscape components may change rapidly (crop rotation)



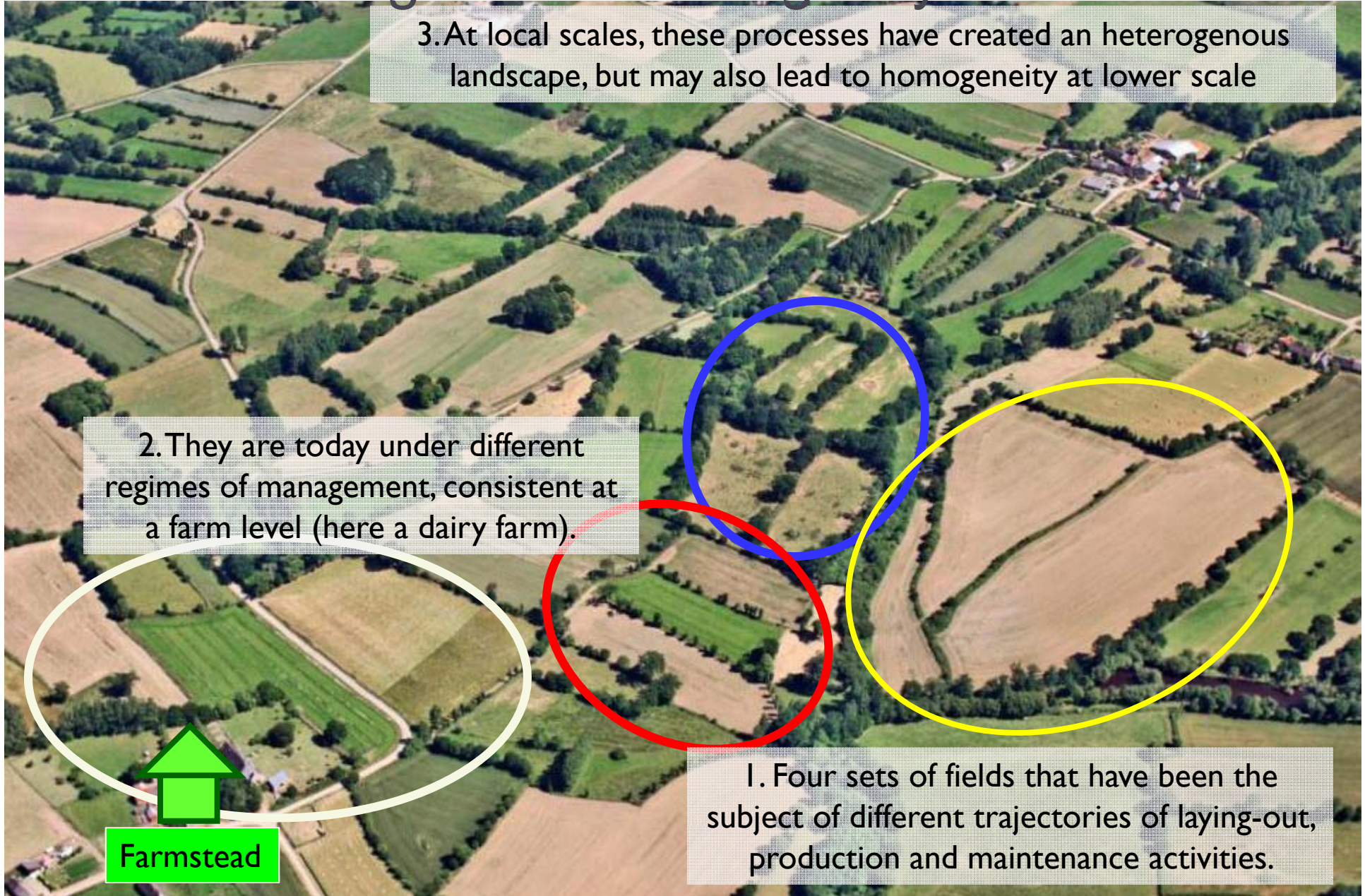
Different regime → heterogeneity

3. At local scales, these processes have created an heterogeneous landscape, but may also lead to homogeneity at lower scale

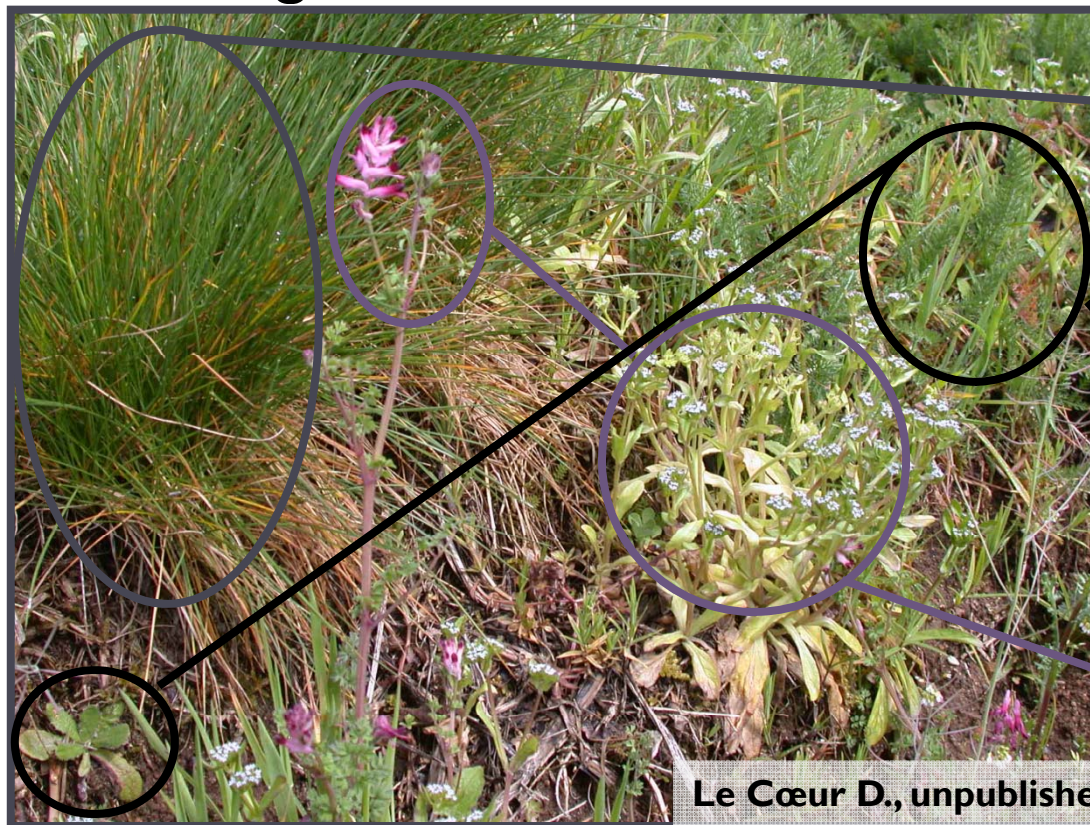
2. They are today under different regimes of management, consistent at a farm level (here a dairy farm).

1. Four sets of fields that have been the subject of different trajectories of laying-out, production and maintenance activities.

Farmstead



Agroecological implications of trajectories of farming activities



Graminae species of heatland: legacy from heatland adjacent fields in 1850

Grassland and « rosette » species: favoured by traditional management in early 20th, with grazing and vegetation cutting with handheld tools

Weeds: favoured by the herbicide sprayed the year before the taking of the picture (early 21th Century...).

Path dependency: influence of the legacy or past events on field margin herbaceous vegetation

⇒ influence on ecosystem services:

e.g., weed, forest edge or grassland species do not provide the same complementary or supplementary resources for pollinators.

Understanding reasons of change



**Early
20th
century**

**Late 20th
century**

**Early 21th
Century**



The concerned owners and farmers may have changed several times.

Functions of field margins and regulations of the dedicated activities as well!

Farm size (average):

5-10ha

30-50 ha

50-100 ha

Main tendencies in production systems:

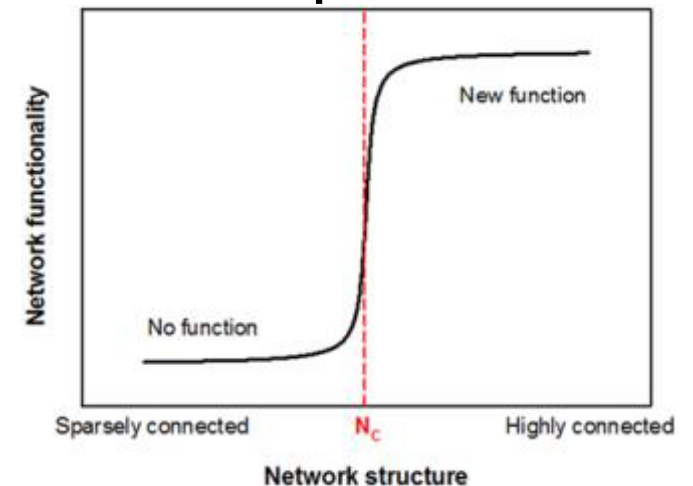
Polybreeding-cropping

Development of dairy production for agrofood industries

+
Diversification in cash crops

When change crosses a threshold

- ▶ System can shift to a new very different state
- ▶ Non-linear relationships between drivers and responses
 - ▶ E.g.: percolation effect
- ▶ Uncertainty around threshold
- ▶ How to identify meaningful changes?
- ▶ How to forecast changes?
- ▶ Which indicators?



Transition towards agroecological landscapes

- ▶ Transition = we want to change agriculture and the way we use natural resources
- ▶ Difficult to change a whole landscape structure and to keep its functioning
- ▶ Focus actions on the key components/places
 - ▶ Greenway network: not a matter of Km, but of location
- ▶ Some large changes may have small effects if far from threshold / some small may have critical effects if close to threshold



How to study the behavior of landscapes as complex systems ?

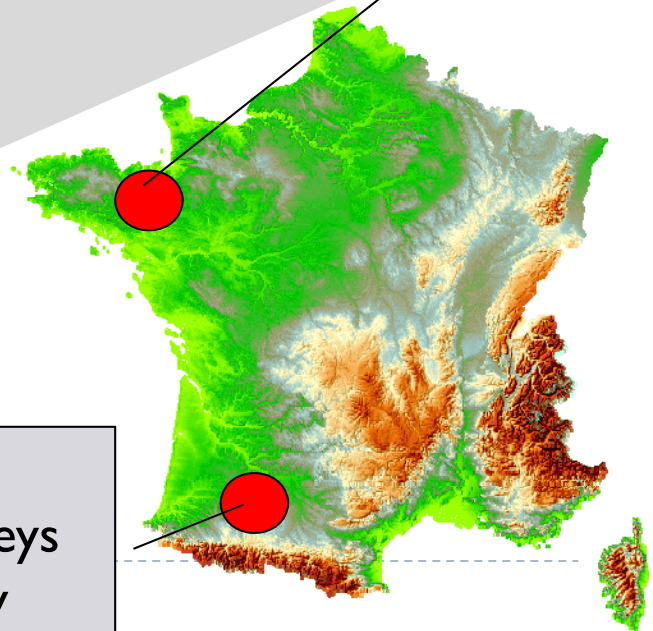


Long Term (and integrated) Social & Ecological Research (LTSER) sites

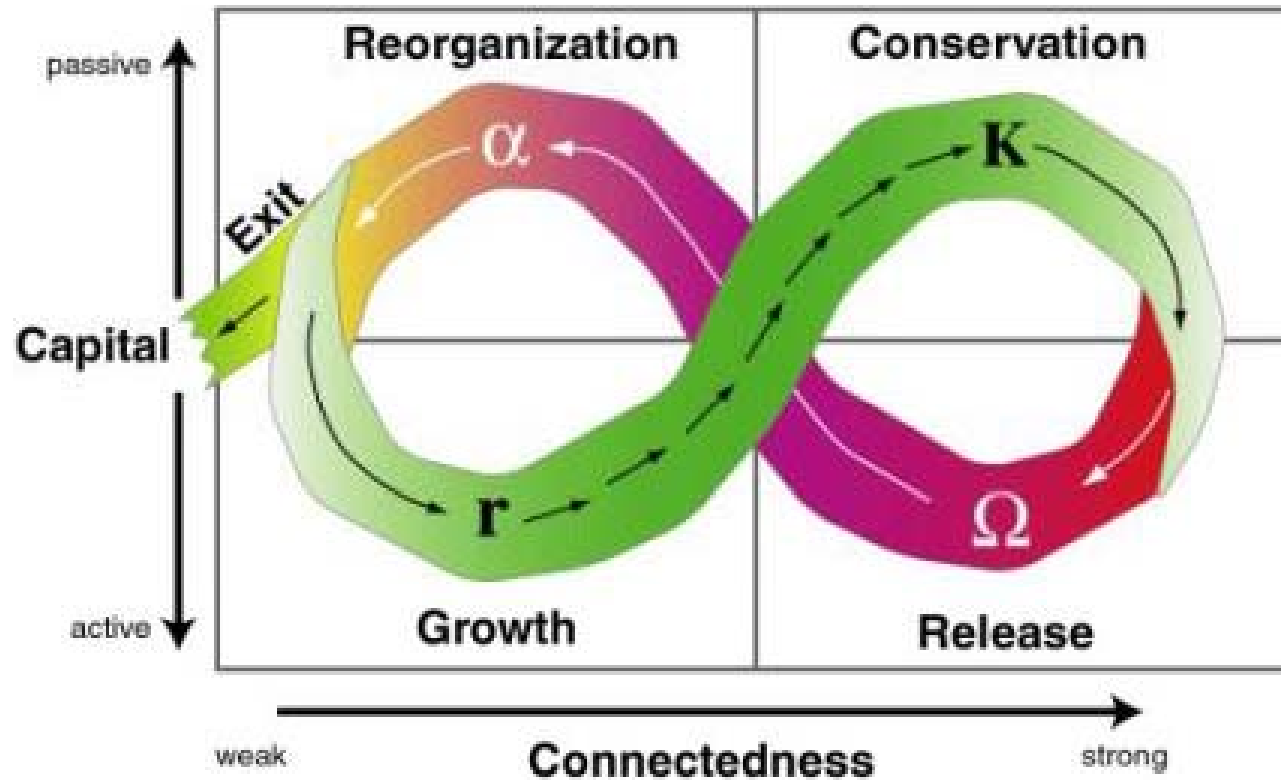
- ▶ Detailed analysis of processes
- ▶ History
- ▶ Scenario
- ▶ Participative research
- ▶ Interdisciplinarity
- ▶ Comparison

Are we in the places where the most interesting transitions are happening?

Gascony:
Hills & Valleys
of Gascony



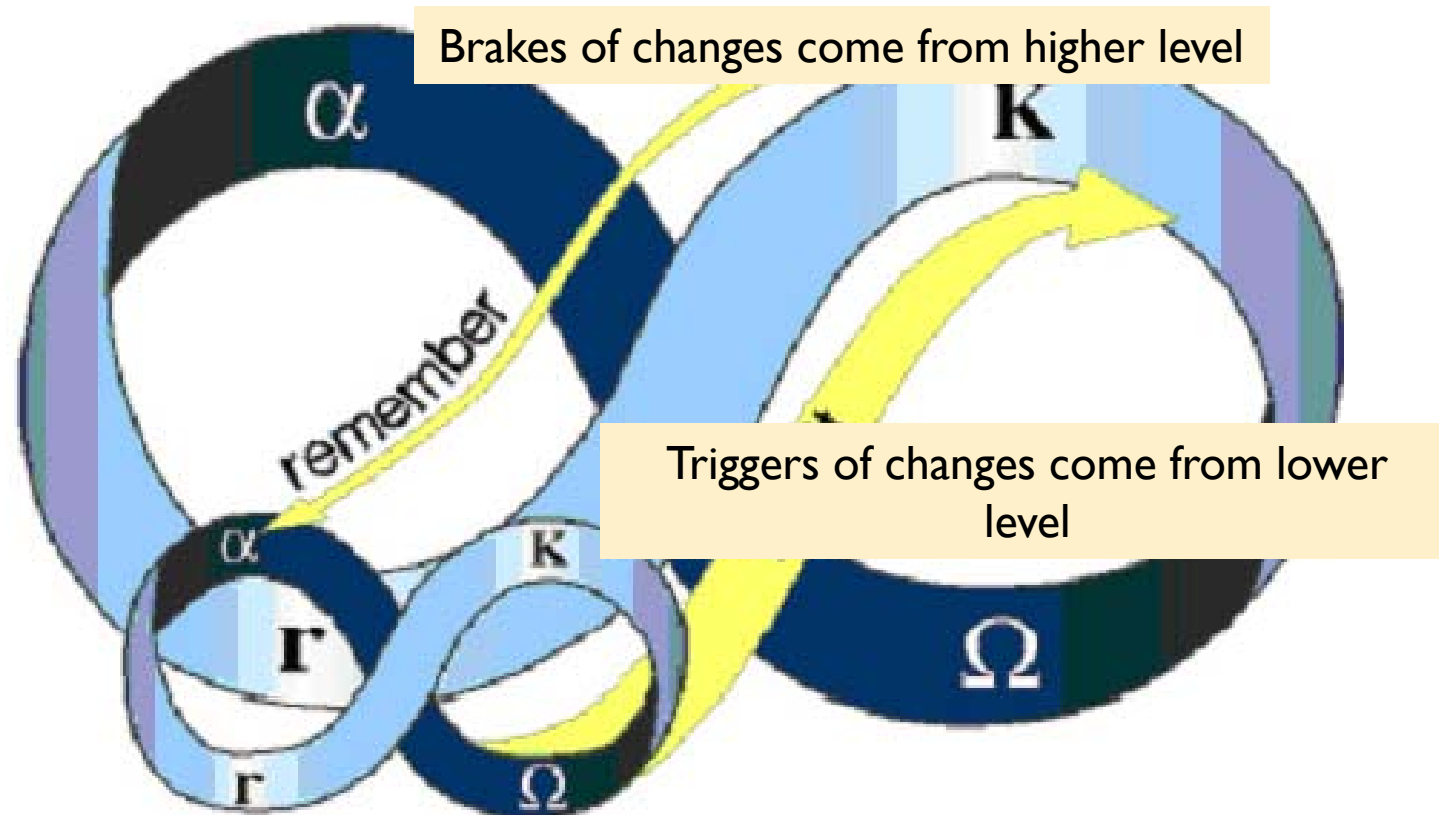
Panarchy as a theoretical framework of the dynamics of complex systems



Is the transition at the end of a K-phase or at the beginning of r-phase?



Links between levels



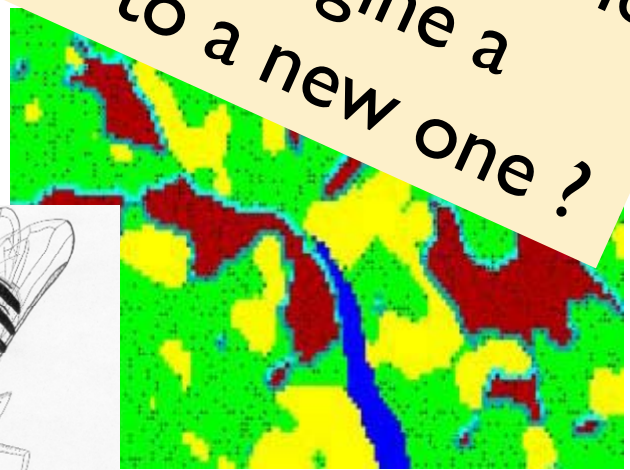
?? *What about the spatial interactions between different systems ??*

Models : tools to study landscapes as complex changing ecological systems

- ▶ Realistic models (ex: Multi agent models)
- ▶ Spatially explicit/ availability of data
- ▶ --> In silico landscape

- Companion modeling (Commod)
- RECORD
- Modelisad
- Payote

Model of a known world
as a tool to imagine a
transition to a new one ?




HoverWinter model
(Arrignon *et al.*, 2007)



A model of landscape made of food...

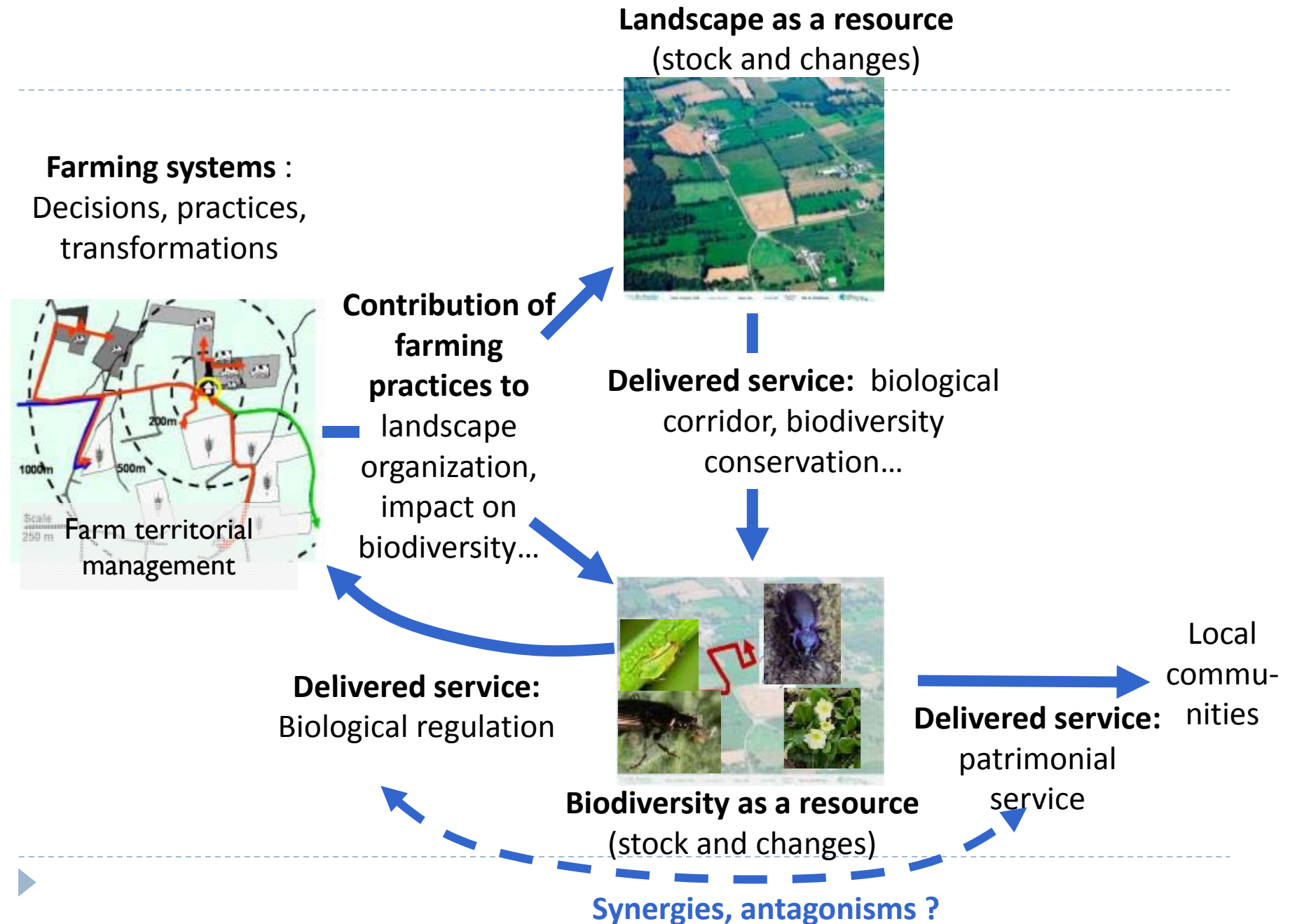


Car Warner

An aerial photograph of a rural landscape. The scene is dominated by agricultural fields in various stages and colors: vibrant green, bright yellow, and brown plowed earth. A small farmstead with a white house and a red-roofed building is visible in the center. A dense forest of green trees runs along the top and bottom edges of the fields. The overall scene is a patchwork of natural and cultivated land.

Part C. Orienting knowledge and methods
toward management support

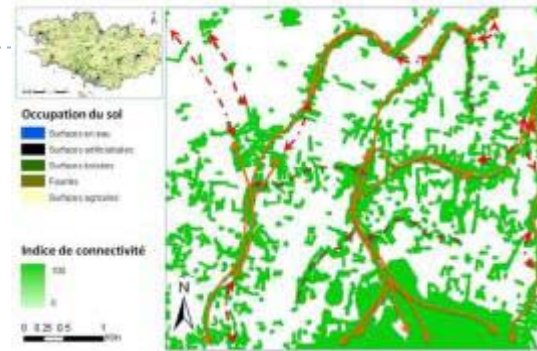
Landscape as part of a management system



Ecosystem service: from potential to efficient

Potential services?

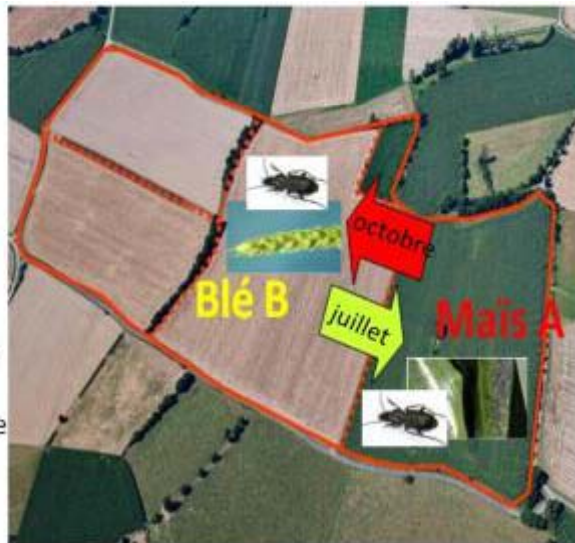
The resources, the conditions are gathered so that the service could be delivered. But the service is not directly observed.



Existing service? Processes at the origin of the service are observed



Signs of movements and predation of beneficial insects are observed

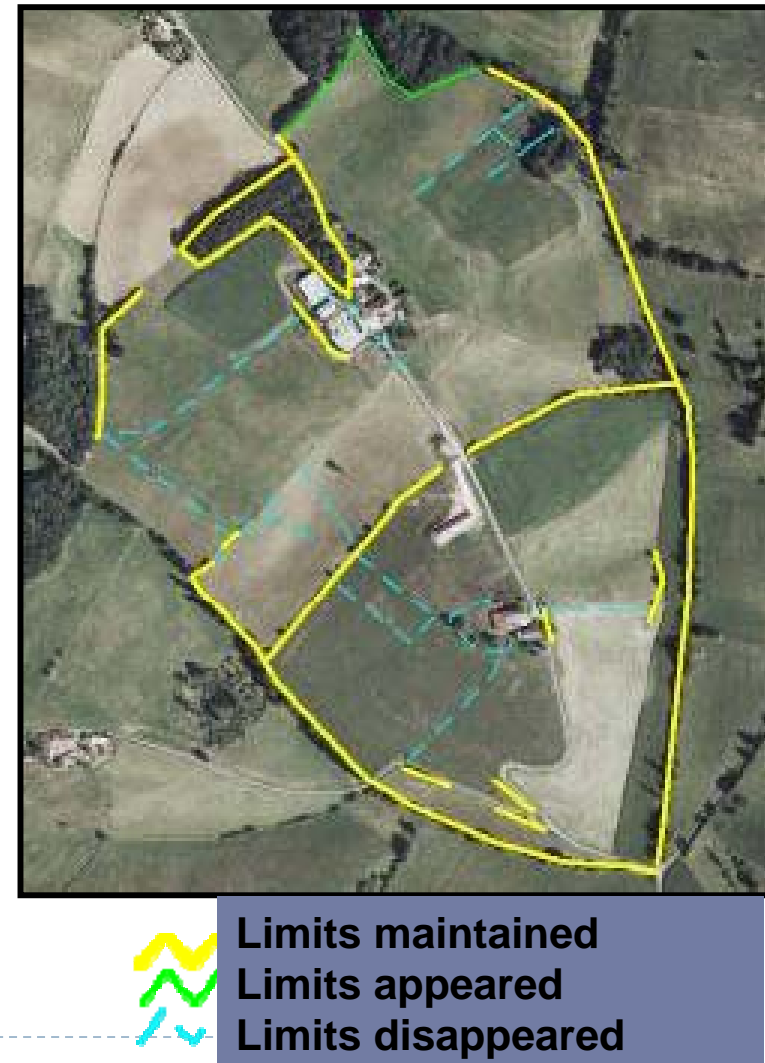
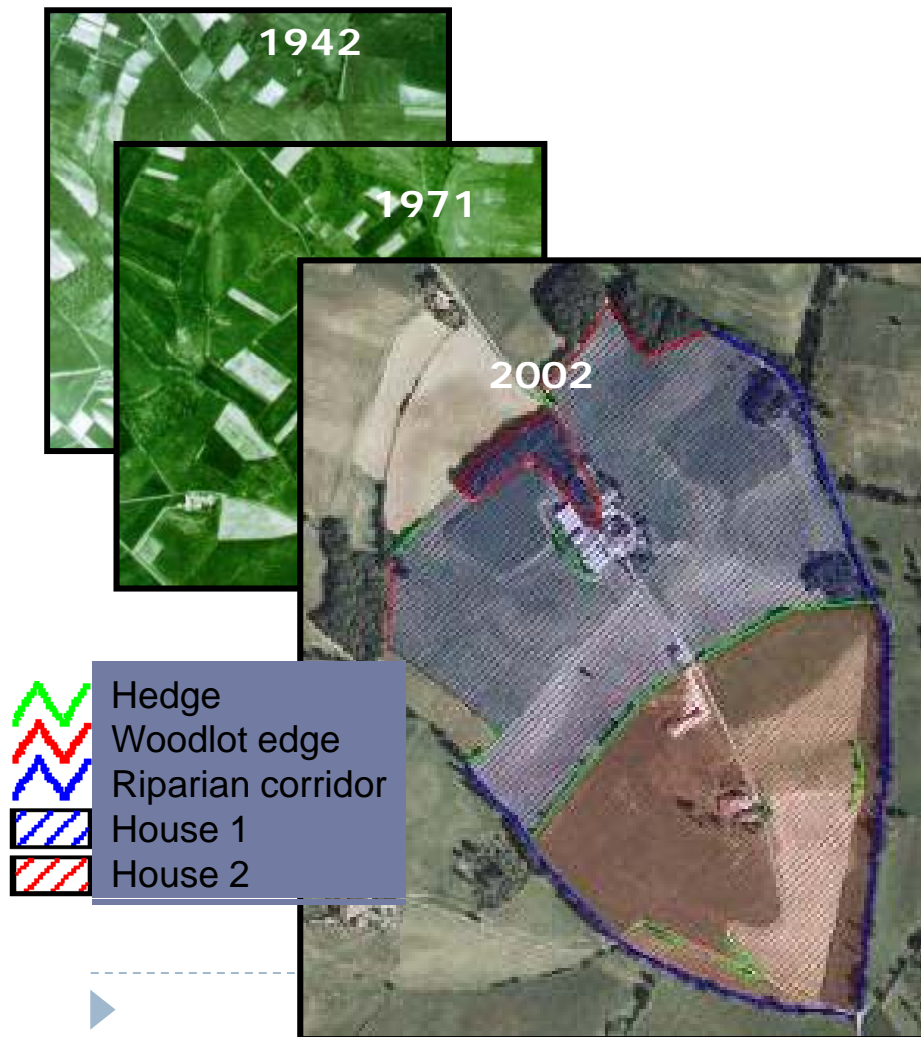


Efficient service?

Ecological processes are developing in such a way that new indicators to support farming decision could be tested.



From social structures to ecological structures: the contribution of ethnology



Farm T12

↗ Farm size to
↗ dairy production

Search for work simplification

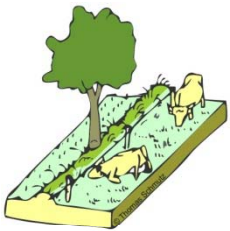
Farm T06

Compact farm territory + opportunities of new land close to the farmstead

Scattered farm territory, no opportunity for grouping plots

Specialization of the farmstead pasture + perm

... with grassland even far from the farmstead, and ...-based electric fences



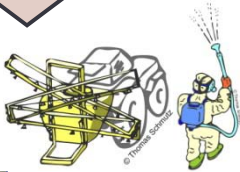
Farm
Grassland-grassland



Less work



Farm T06
...-oriented
...nd margins

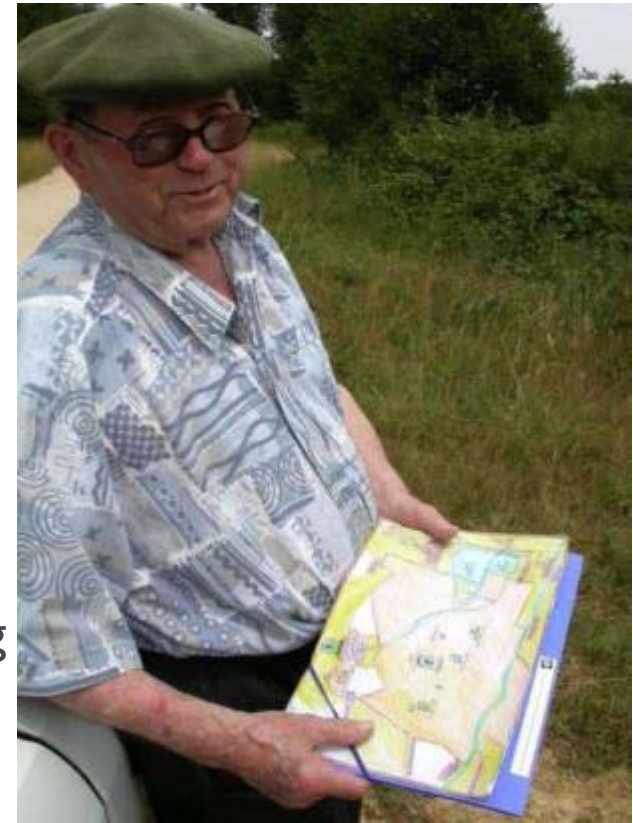


More work



Landscape agroecological engineering

- ▶ How to use and modify landscape structures to improve ecosystem services: Not just a matter of technical issues
- ▶ Policy & regulation of land management
- ▶ Governance (formal and informal)
- ▶ Must consider the social limits and opportunities
 - ▶ Local society cultural rules
- ▶ Involve people (farmers, foresters, land managers...) :
 - As producers of patterns that influence biodiversity at different scales
 - As managers who adapt their practices according to landscape structure
- ▶ Where and how to promote constructive interactions between stakeholders?



*Scientists involved in transition: be
prepared to conflicts*

Shifts in principles for natural resource management (Liu&Taylor, 2002)

- ▶ **1. From single scale to multiscale management**
- ▶ **2. From within-boundary management to cross-boundary management**
 - Integrate farmers and other land users in cross-boundary management design
 - Build up indicators based on landscape descriptors that permit to infer interactions between (farm) territorial dynamics and ecological dynamics
- ▶ **3. From static to adaptive management**
 - ▶ Account for path dependency in scenarios of landscapes / social-ecological trajectories
 - Indicators of adaptive capacity or lock-in at different levels of agricultural management
- ▶ **4. From isolated (single-objective) management to integrative management**
 - Indicators identify synergies or antagonisms between ecological functions



Landscape: the collective side of our society

- ▶ There is no owner of landscapes
- ▶ Many stakeholders, with different objectives, constrained by cultural & social rules are involved
- ▶ Conflicts between them is part of the “normal” functioning
- ▶ Landscape management calls for a renewed/restored governance at several spatial scales
- ▶ Spatial dimensions of these relationships will get more importance in the future



Scientists in transition

- ▶ Transition will be/will trigger disturbances for social & economical systems
- ▶ We may need much faster transitions to cope with faster global change consequences
- ▶ There many concurrent options for transition
- ▶ Transitions will not satisfy every body, there will be losers even if we win globally (or loose less than forecasted)
- ▶ As scientists, we (will) have to clarify our options as we are part of the society and impacted as well.

