



# **INDICADORS DE PAISATGE. REPTES I PERSPECTIVES**

**Barcelona, 29-30 novembre 2007**



# Indicadors ecològics del paisatge

Ecological indicators for a landscape assessment:  
an eco-semiotic perspective

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The present-time energetic/economic models are possible because we have an easy access to natural resources **perceived** by Western societies as unlimited: this is the origin of an environmental crisis  
(Social, Economic, Climatic)

## **Global Uncertainty?**

The past **Uncertainty** was based on local figures

A world map showing population density, with the most densely populated areas highlighted in a bright blue color. The map is centered on the Atlantic Ocean, showing North and South America on the left, and Europe, Africa, and Asia on the right. The text is overlaid on the map.

Why (ecological) indicators?

an obligatory path to  
appreciate environmental  
conditions?

*“It is difficult and often even impossible to characterize the functioning of a complex system, such as an eco-agrosystem, by means of direct measurements.*

*The size of the system, the complexity of the interactions involved, or the difficulty and cost of the measurements needed are often crippling.*

*The terms **ecological indicator** and **environmental indicator** are often used interchangeably. However, ecological indicators are actually a sub-set of environmental indicators.*

*Generally, environmental indicators provide information on pressures on the environment, environmental conditions and societal responses.*

*Ecological indicators refer only to **ecological processes**. (?)*

## ***Ecological indicator***

*A characteristic of the environment that, when measured, quantifies magnitude of stress, habitat characteristics, degree of exposure to a stressor, or ecological response to exposure.*

## ***Ecological indicators***

*Plant or animal species, communities, or special habitats with a narrow range of ecological tolerance. For example, in forest areas, such indicators may be selected for emphasis and monitored during forest plan implementation because their presence and abundance serve as a barometer of ecological conditions within a management unit.*



## ***Ecological indicators***

*are used to communicate information about ecosystems and the impact human activity has on ecosystems to groups such as the public or government policy makers.*

*Ecosystems (**Landscape**) are complex and ecological indicators can help describe them in simpler terms that can be understood and used by non-scientists to make management decisions. For example, the number of different beetle taxa found in a field can be used as an indicator of biodiversity.*

*Many different types of indicators have been developed.  
They can be used to reflect a variety of aspects of  
ecosystems, including biological, chemical and physical.  
Due to this diversity, the development and selection of  
ecological indicators is a **complex process**.*





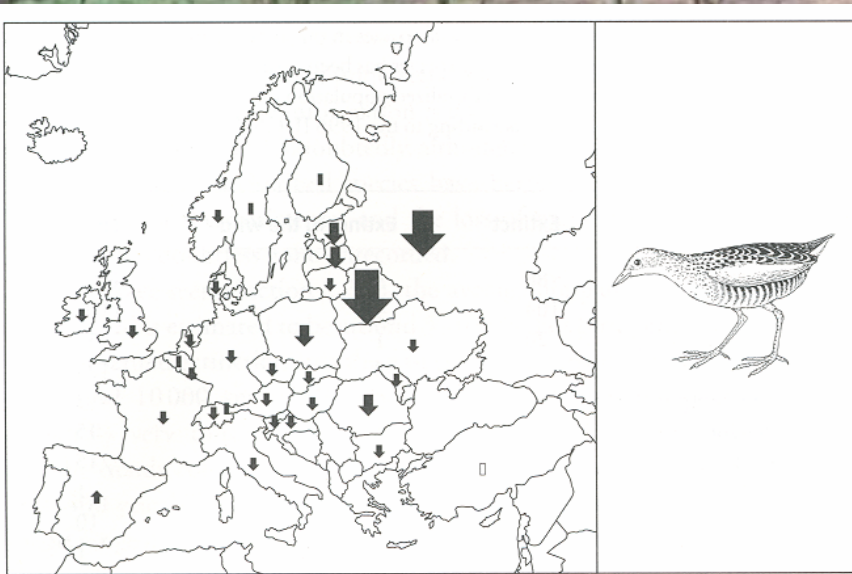
*Using ecological indicators is a pragmatic approach since direct documentation of changes in ecosystems as related to management measures, is cost and time intensive.*

*For example, it would be expensive and time consuming to count every bird, plant and animal in a newly restored wetland to see if the restoration was a success. Instead a few indicator species can be monitored to determine success of the **restoration**.*

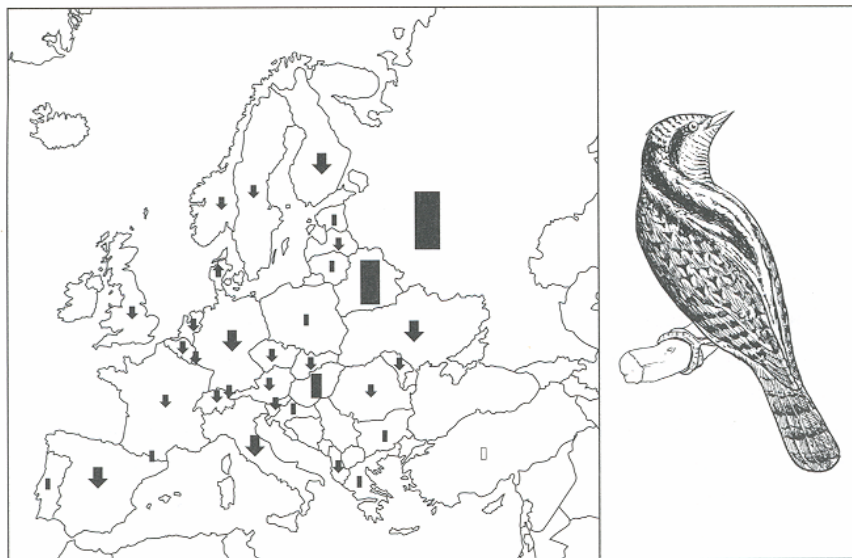




Air/water pollution



(a)



Breeding population trend    ↑    ■ Stable or fluctuating    ↓ Decreasing    □ Unknown

Number of pairs (overall symbol height)    —<5-2,400    —4,200-7,200    —32,000    —57,000



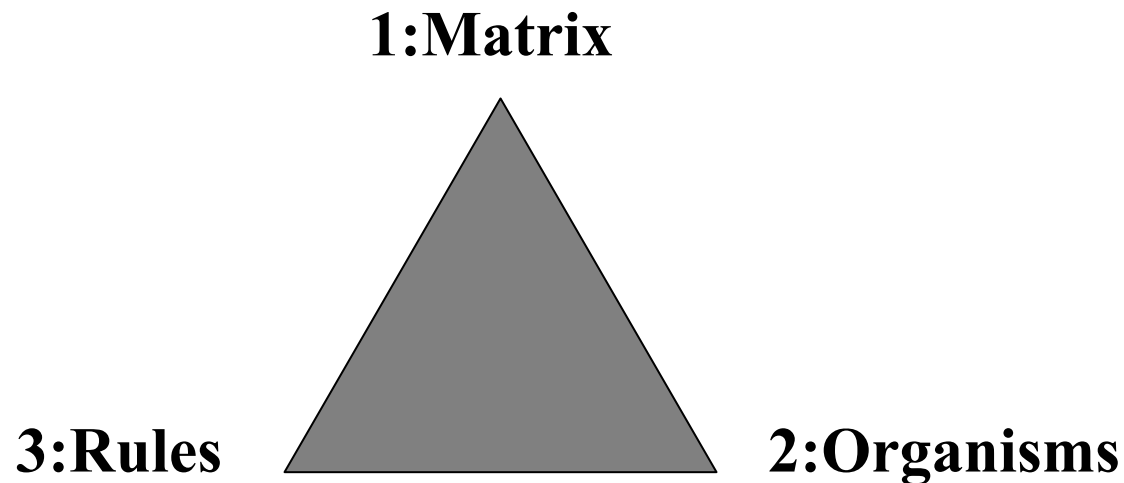
Changes in land uses across Europe



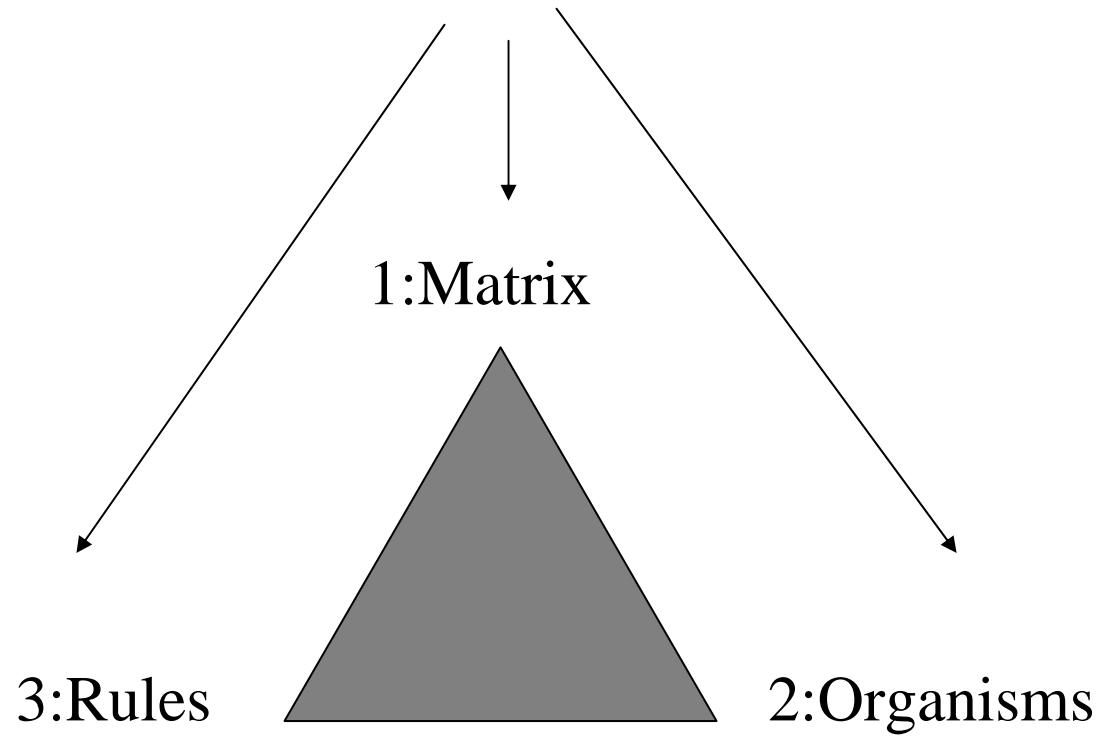
## The **Landscape Grand Synthesis:**

from geography to eco-semiotics and human society (*via* legislation)

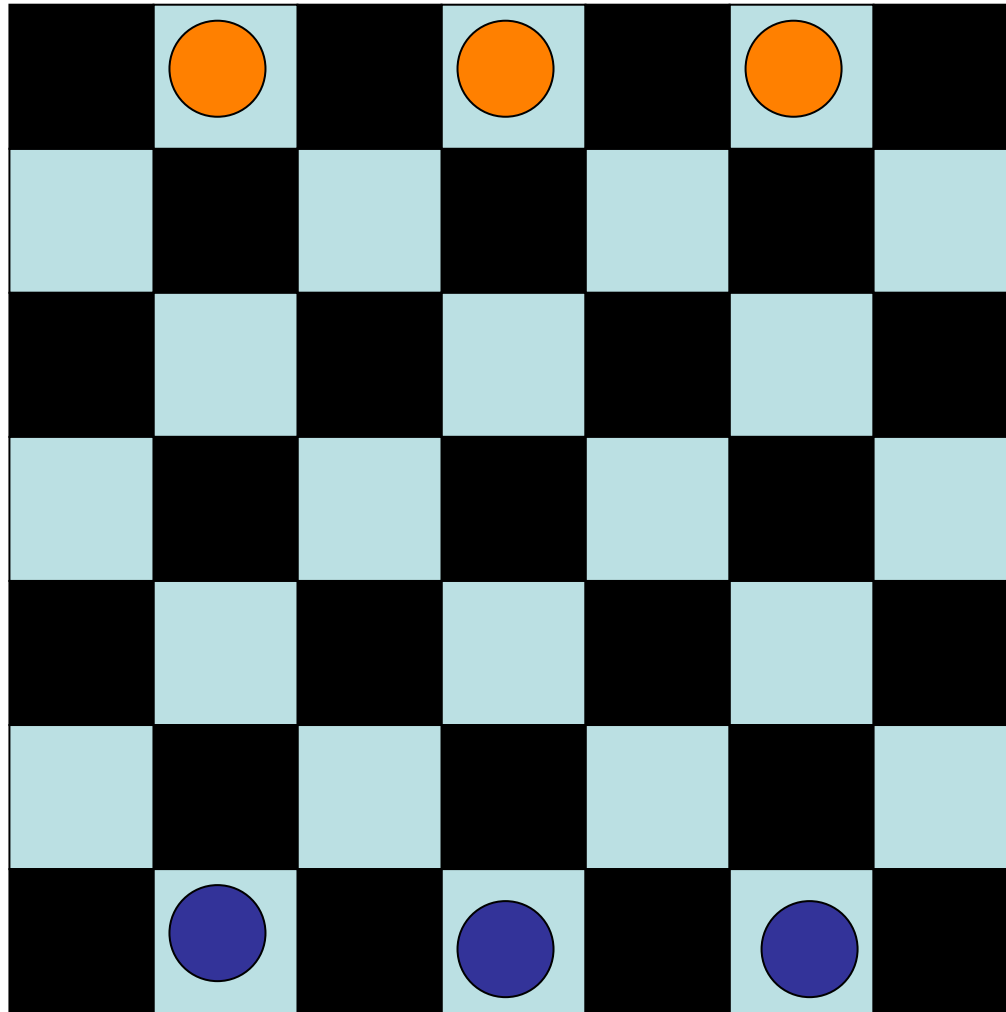
The elements composing the “**landscape agency**”



# Indicators for the landscape



*Big Shot Checker  
metaphor*



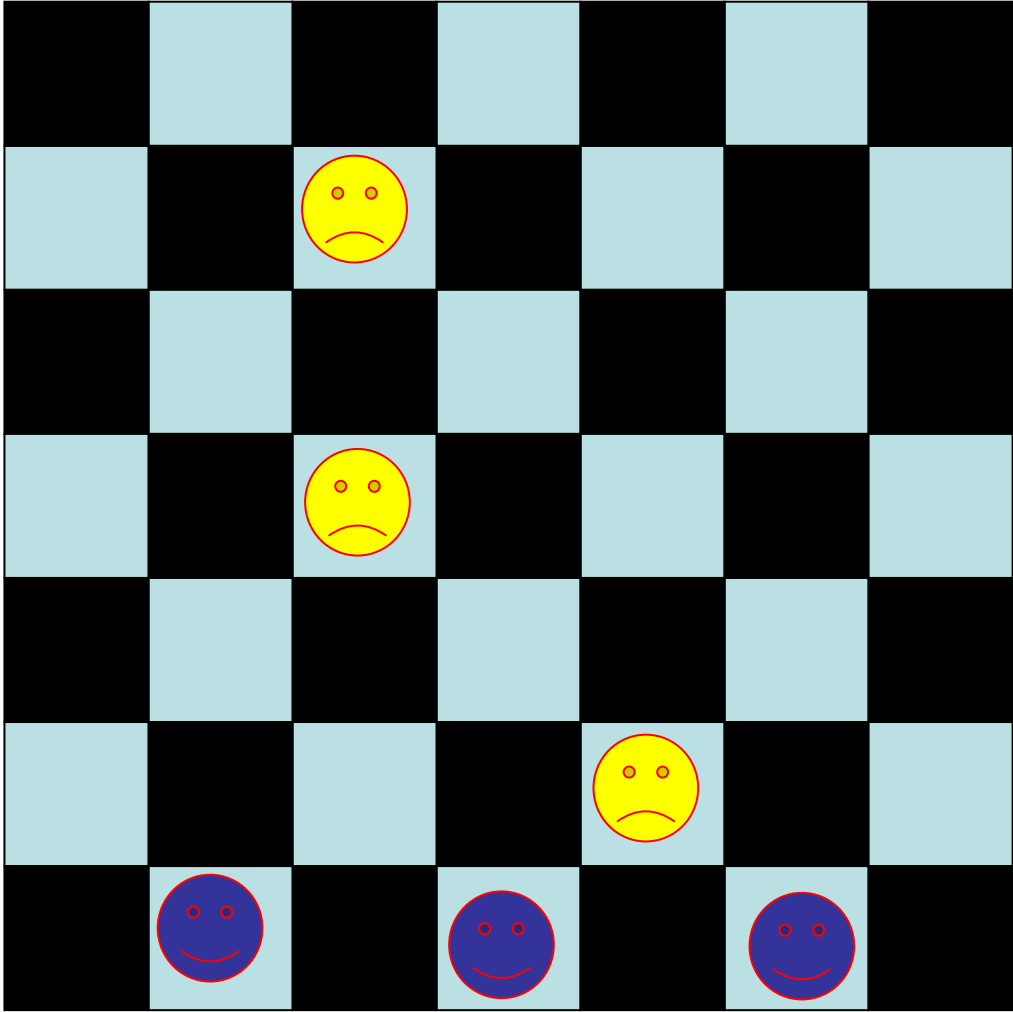
**Organisms  
(pieces)**

**Matrix**

**Rules  
(In,Ex)**

**Resources**

**Competition**

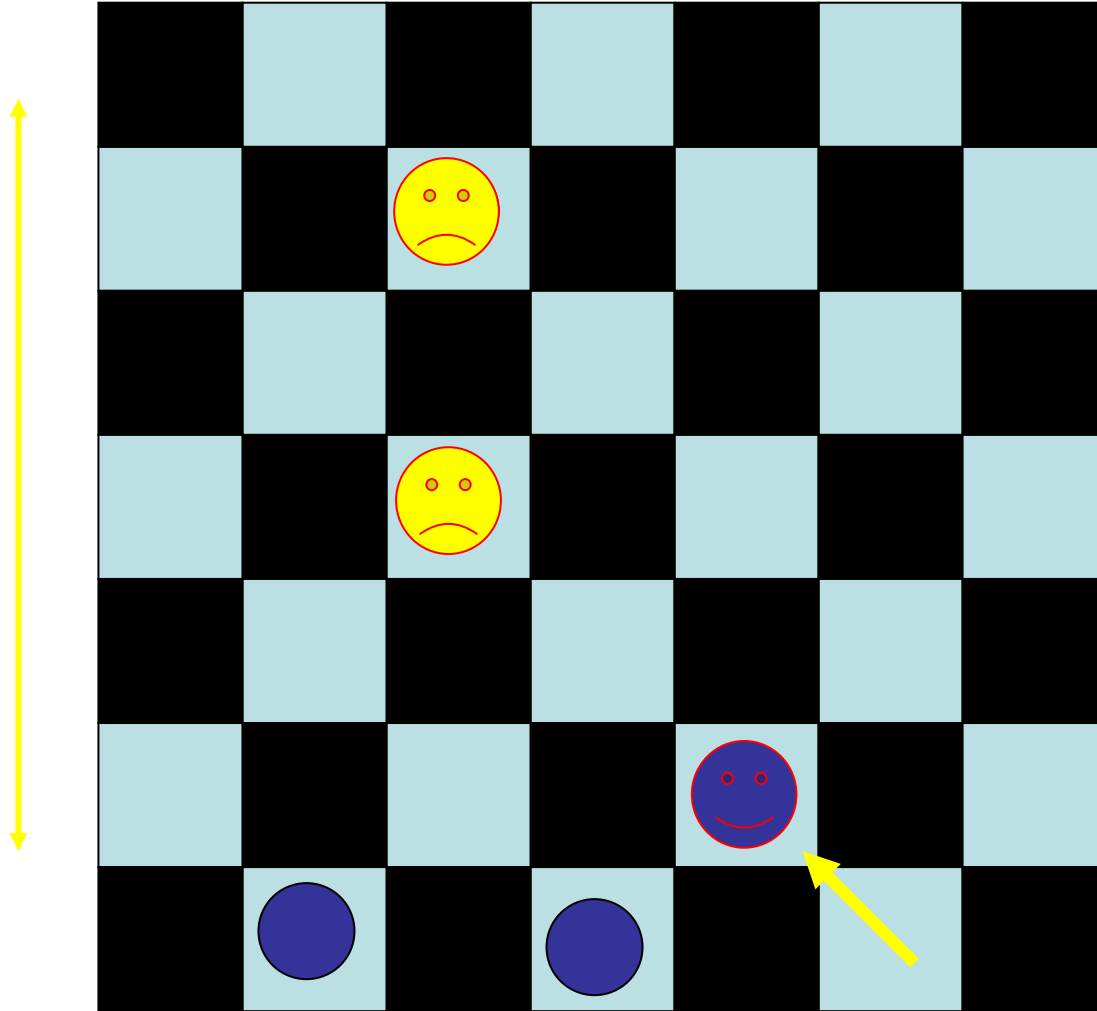


**Rules**

**Resources**

**Resources**

**Competition**



**Rules**

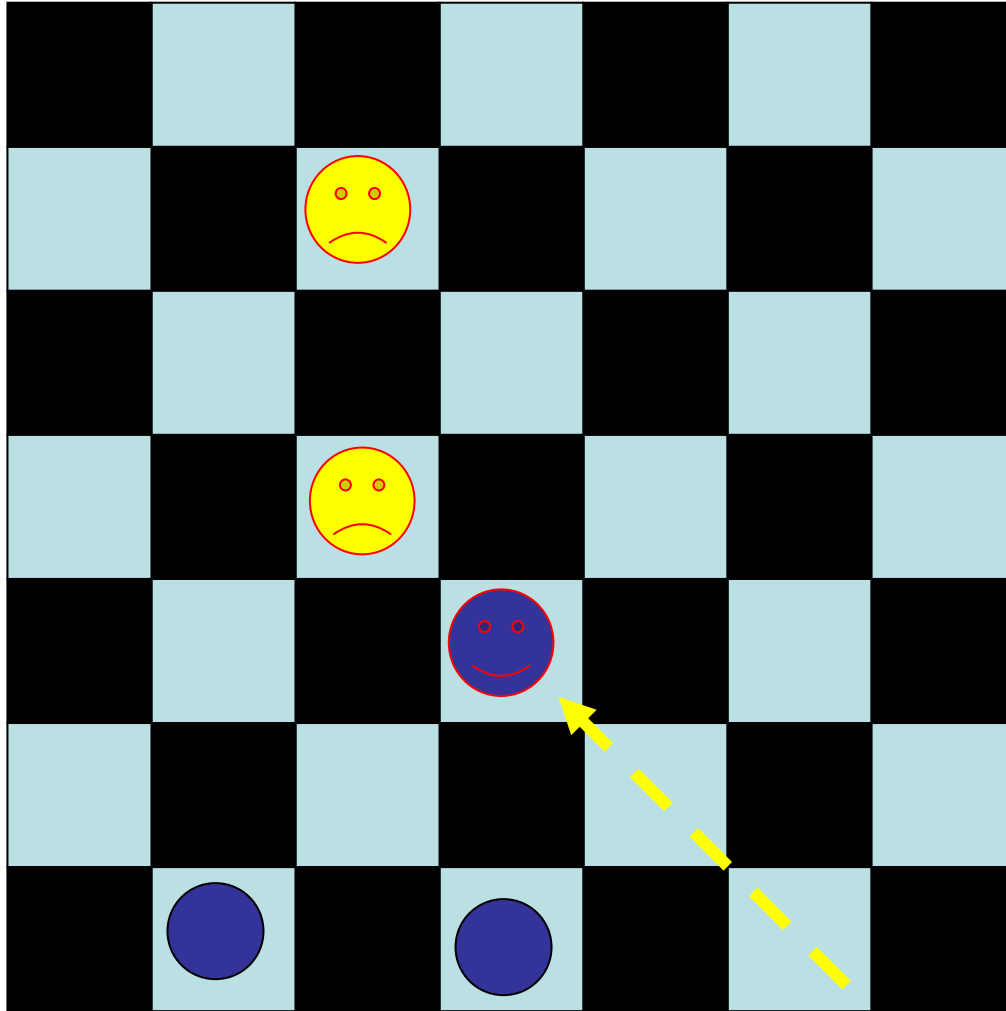
**Resources**



**Resources**

**Competition**

**Rules**



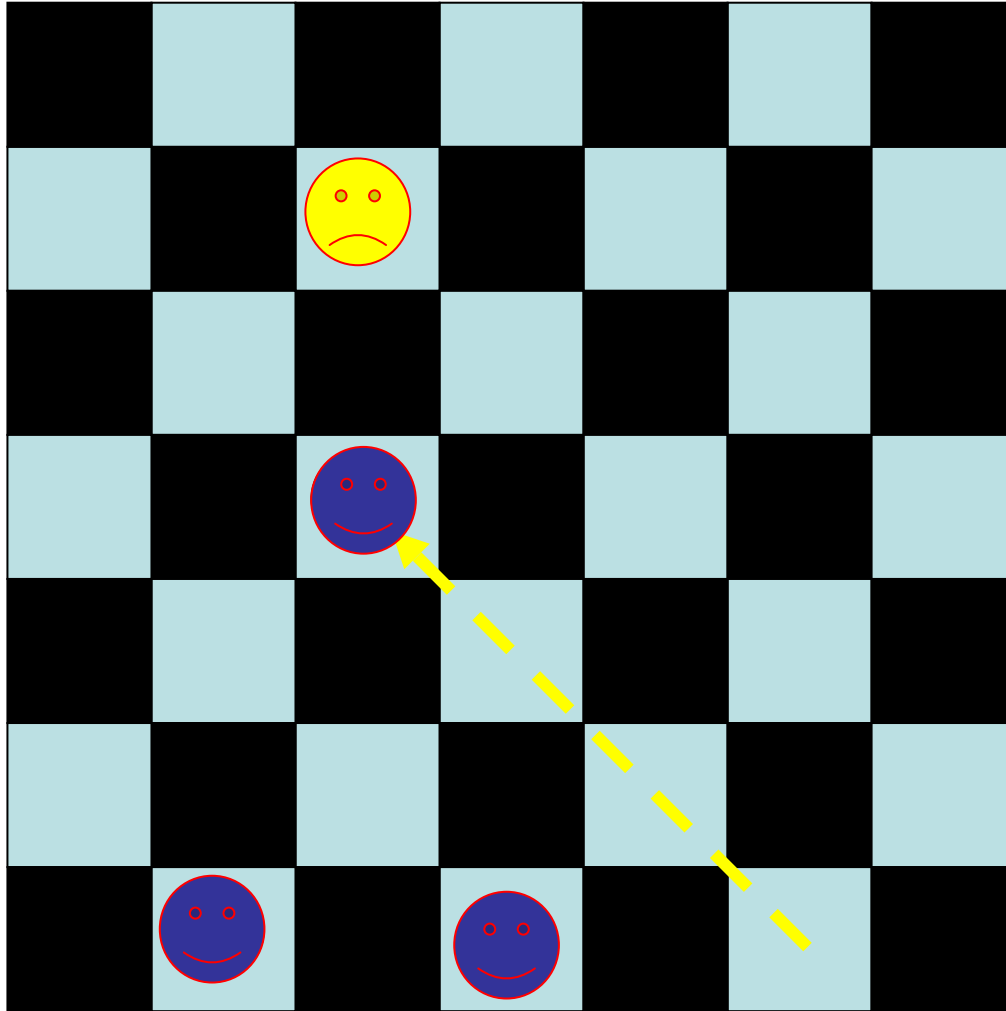
**Resources**



**Resources**

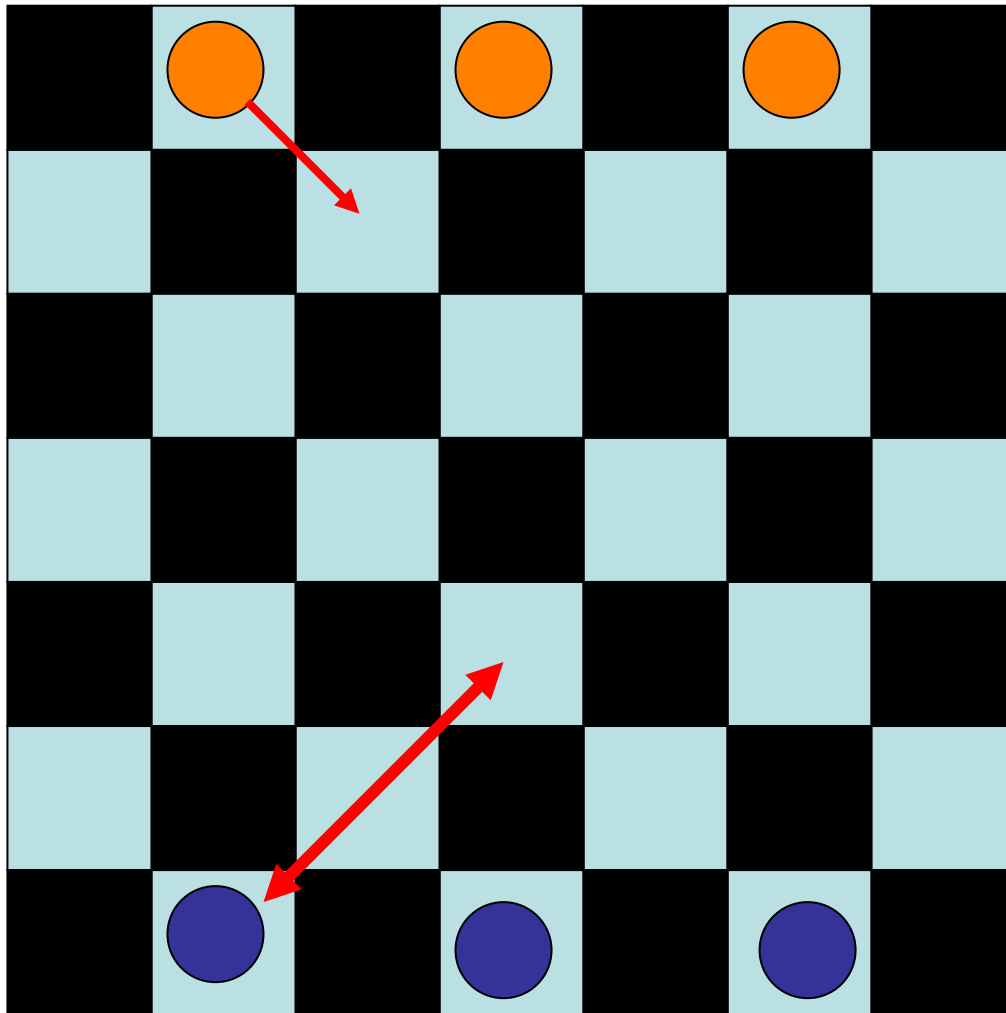
**Competition**

**Rules**



**Resources**



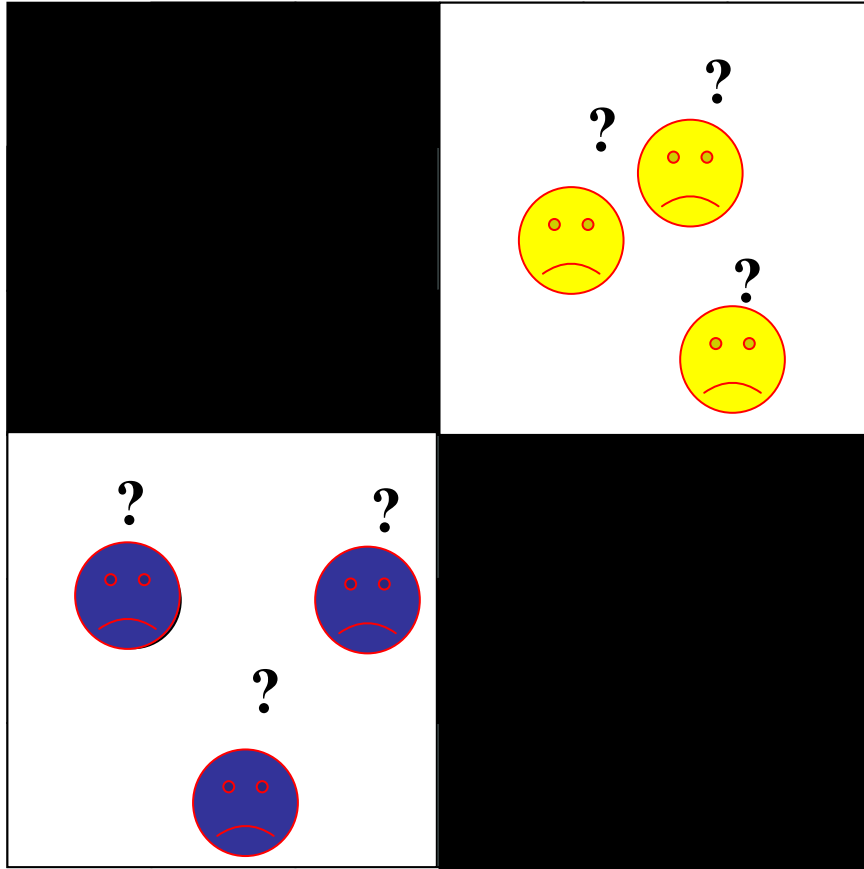


**Changing  
Rules  
(In,Ex)**



**Organisms  
(pieces)  
Matrix**





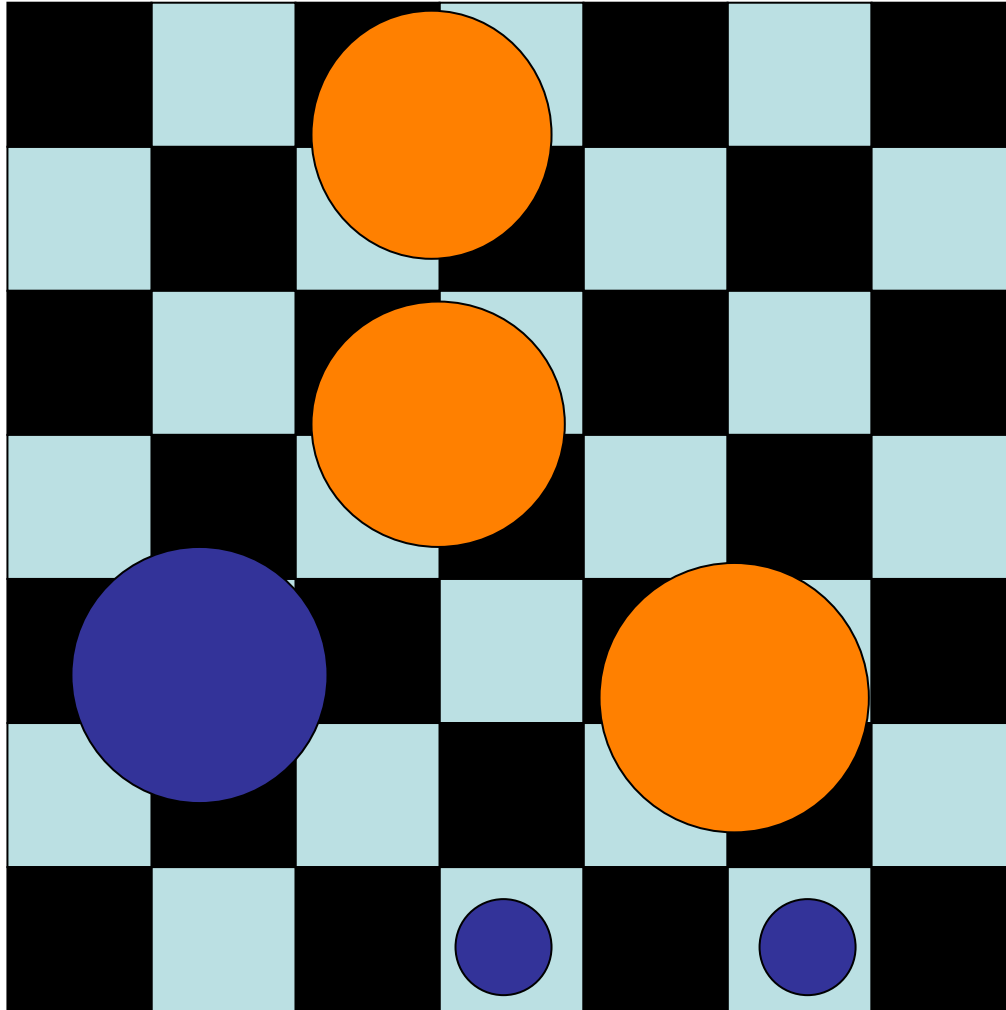
**Changing Matrix**



**Rules  
Organisms**







**Changing  
Organisms**



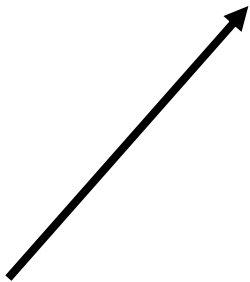
**?  
Rules  
Matrix**

Organism:

size

niche

dimension



**Matrix:** Patterns, Processes

**Rules:** Overlap, Conflict, Integration

**Organisms:** Presence, Abundance, Dynamics (source-sink, metapopulation), Perception components, Cognition (ss: Humans)

Matrix categories: comparative analysis

*Patterns*

**Patch shape**

**Ecotones**

*Processes*

**Percolation capacity**

**Fragmentation trend**

**Average mutual information (AMI)**



Signs from the landscape:

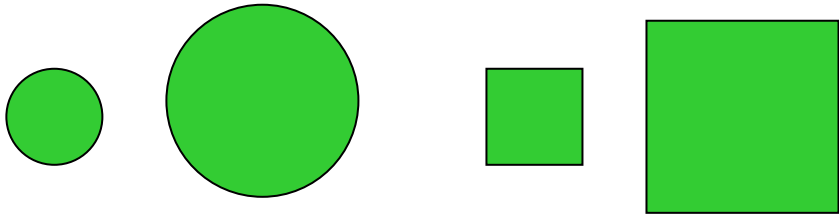
Openness-closeness

Shape

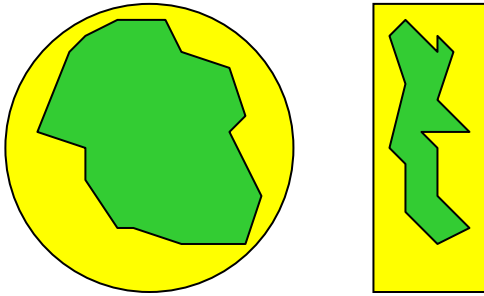
Margin structure

Distance from

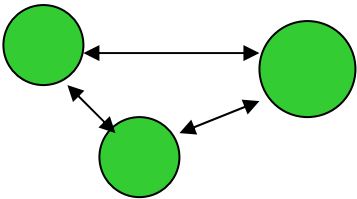




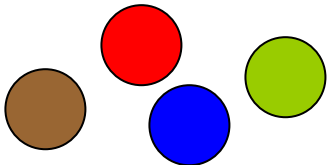
**Shape & Size**



**Irregularities**

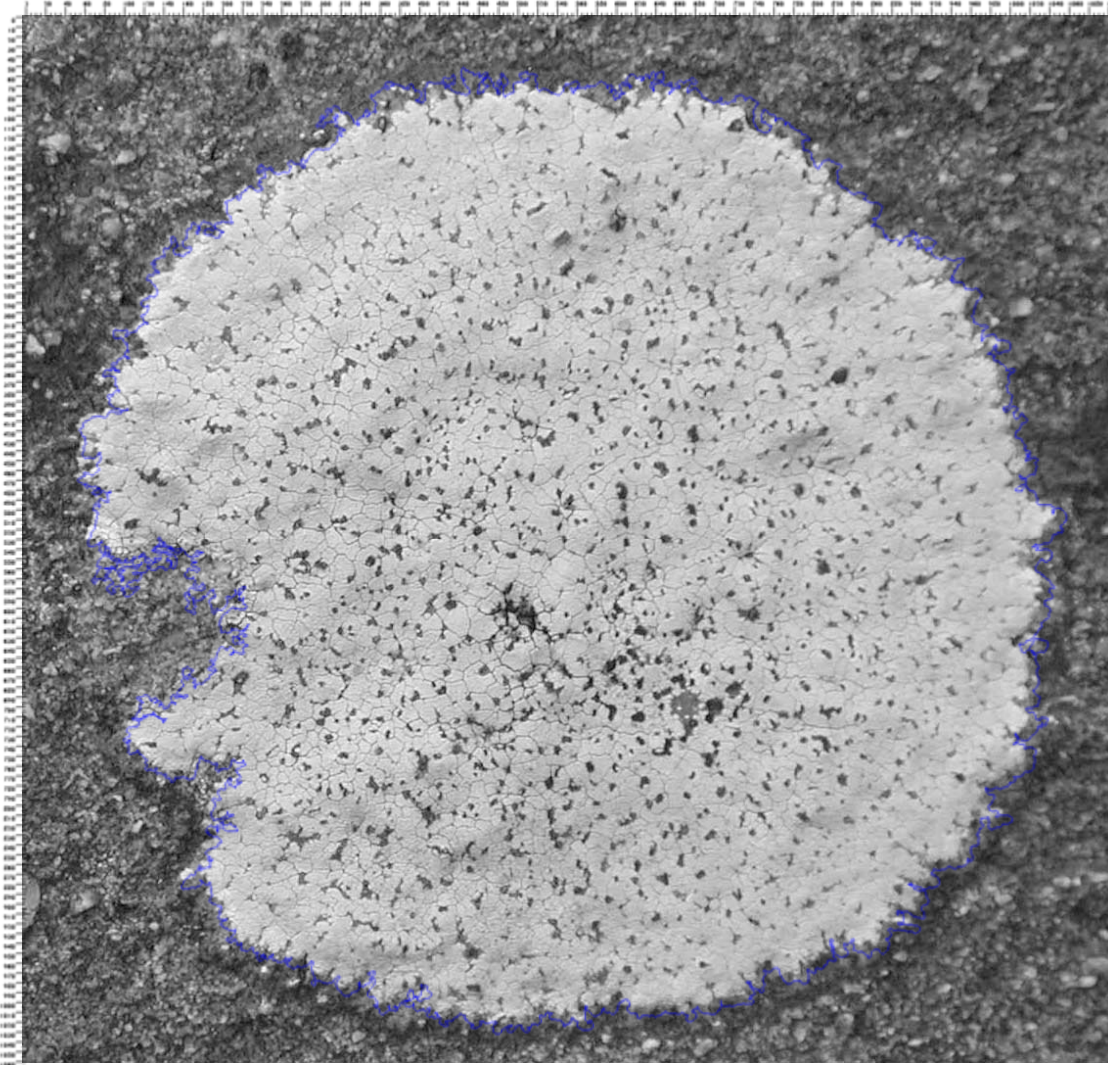


**Spatial arrangement**

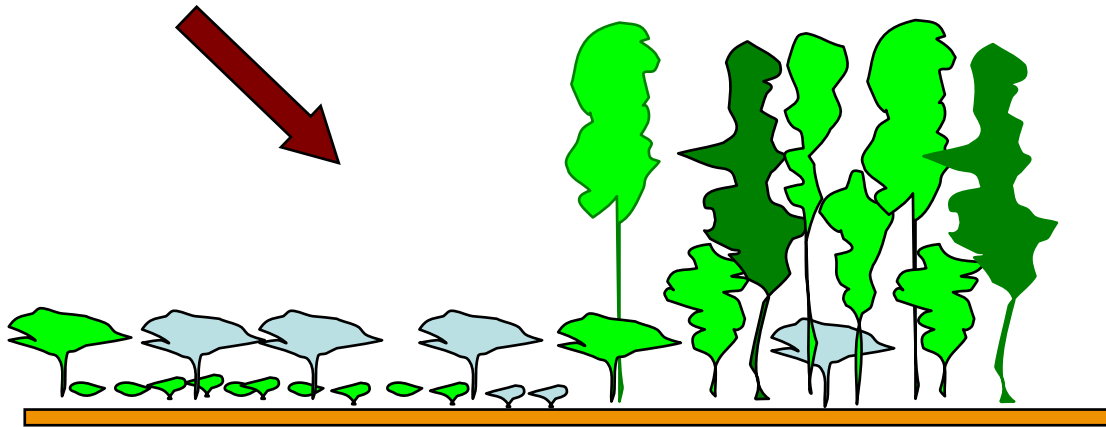
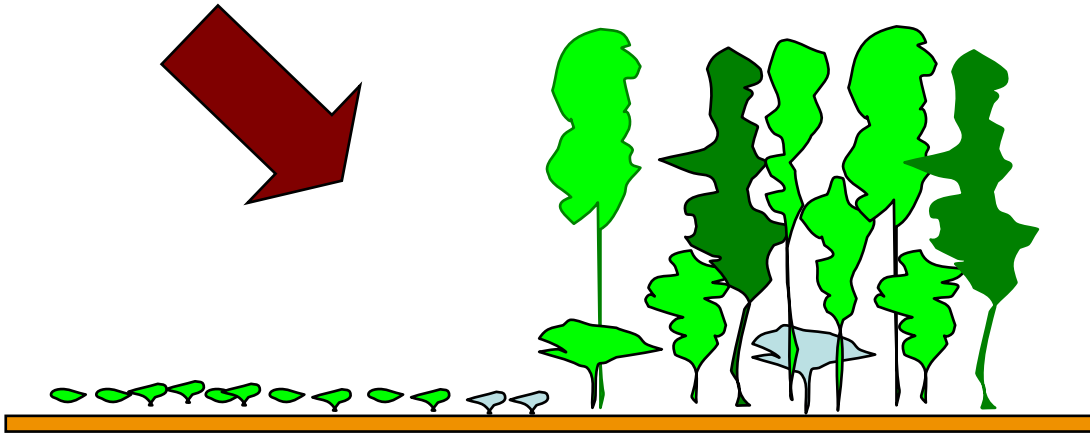


**Diversity**

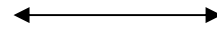
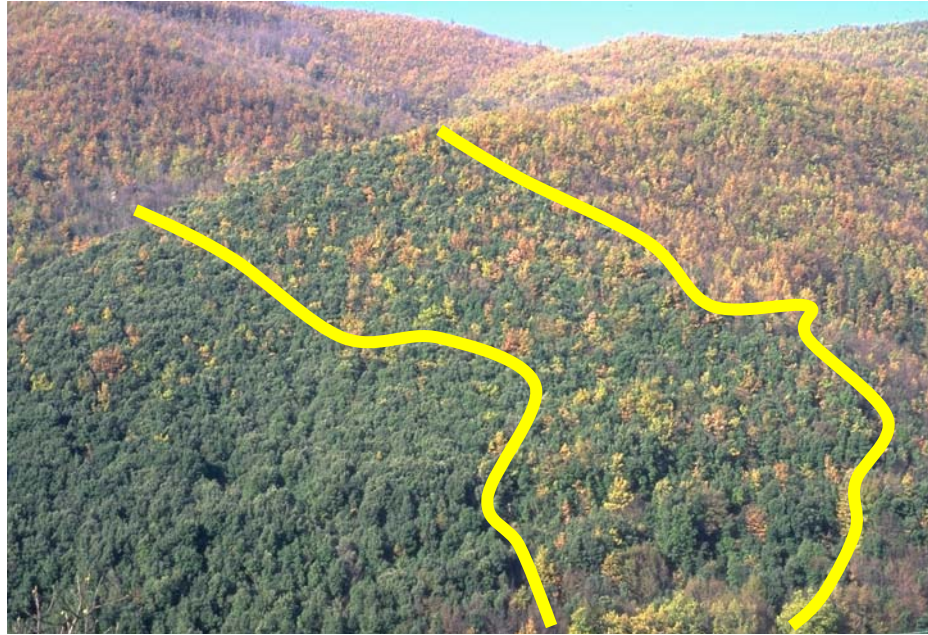
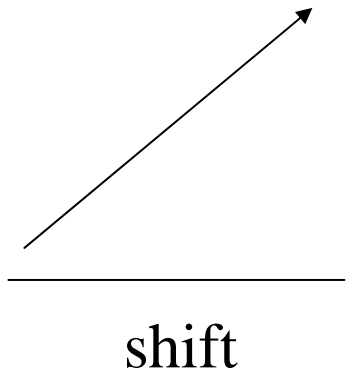
# Patch shape & resource availability



# Ecotone complexity & human land use

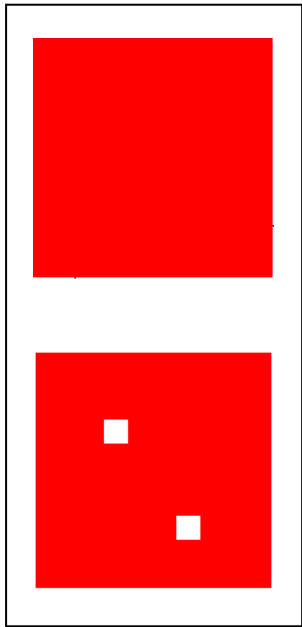


# ecotone & climatic changes



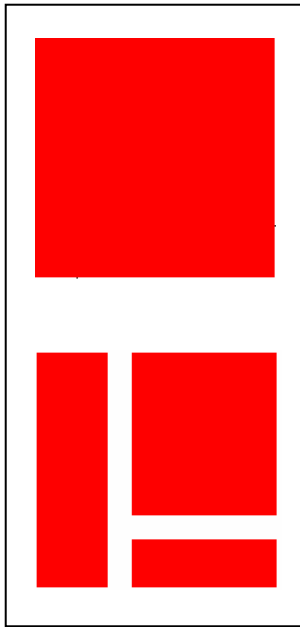
width

# Fragmentation & Biodiversity decrease



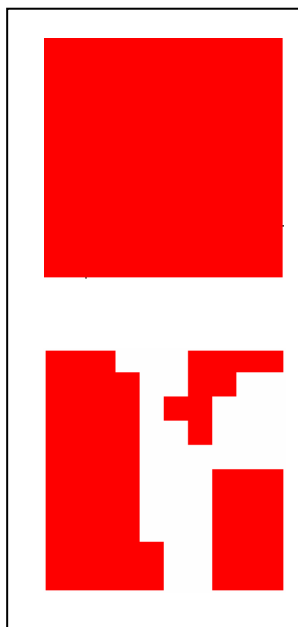
**A**

**Perforation**



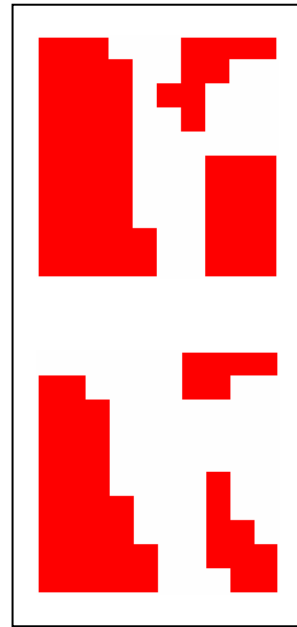
**B**

**Dissection**



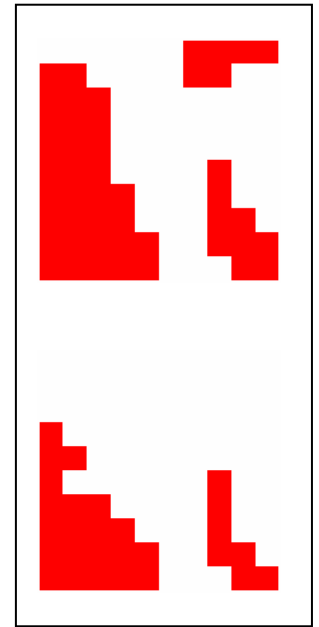
**C**

**Fragmentation s.s.**



**D**

**Shrinkage**

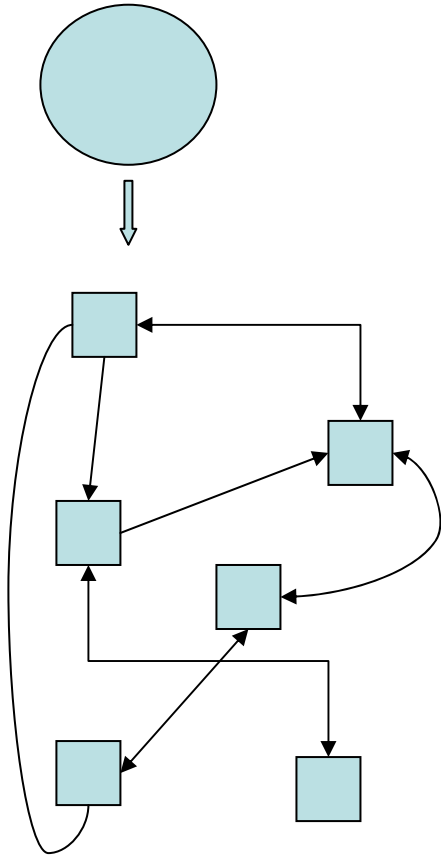


**E**

**Attrition**

Plus associated metrics

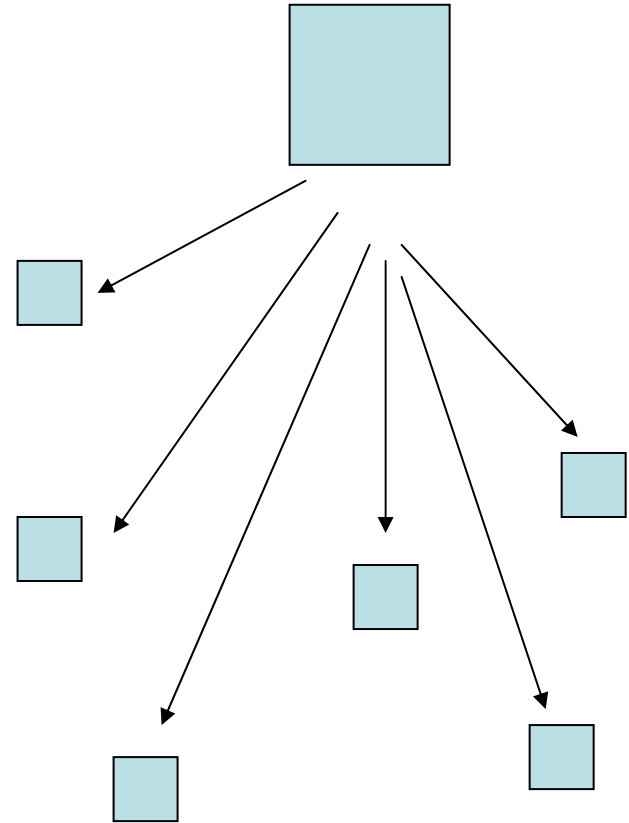
# Solar Energy



<<<<<<

AMI (average mutual information)

# Fossil/nuclear Energy



<<<<<<

**Organisms:** Presence, Abundance, Dynamics (percolation, source-sink, metapopulation), Perception components, Cognition (ss: Humans)

if **g** then  $\longrightarrow$  abcbdefgthecxzku

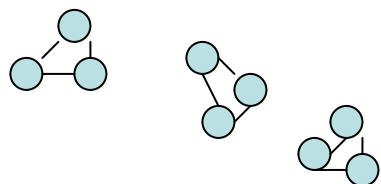
if **#a** then  $\longrightarrow$  baaaaaaaaaabaab

if **Sai>Dai** then  $\longrightarrow$  i= source

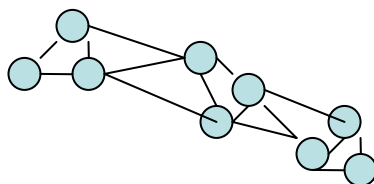
if **Dai>Sai** then  $\longrightarrow$  i=sink

if **ai+++aj** then  $\longrightarrow$  metapopulation

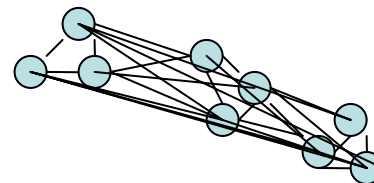
## Scaled indicators



1 km



1.5 km



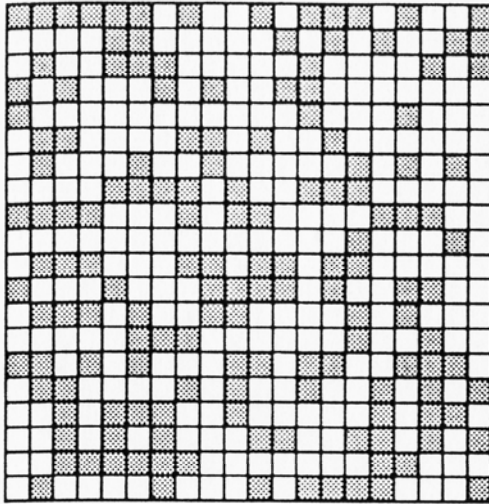
3 km



# The percolation theory

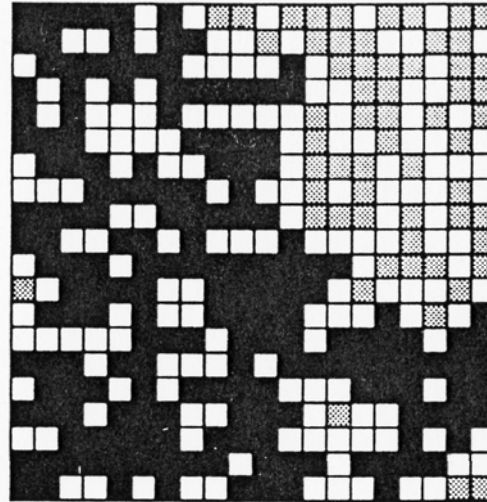
A percolation threshold marks the differences between finite regions in which fluid remains when the percolation threshold  $p_c$  is  $< 0.5928$  (called also critical probability) (Ziff 1986) or the fluid cross the lattice connecting every molecules of fluid with the others when  $p$  (probability)  $>$  to  $p_c$ .

a  $P = 0.4$



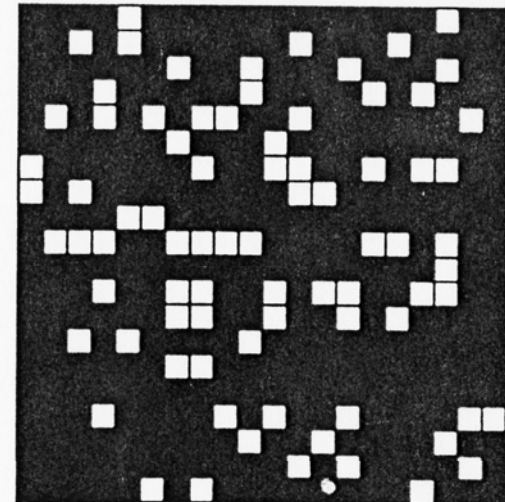
No. of clusters: 49  
Size of largest: 18

b  $P = 0.6$



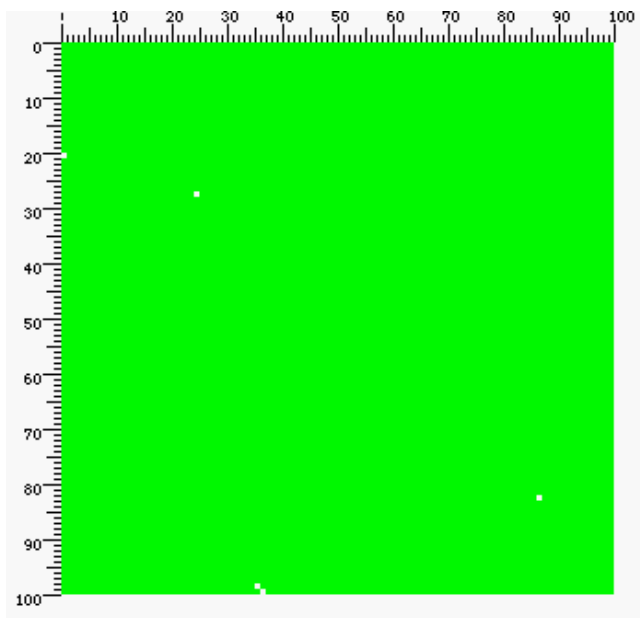
No. of clusters: 17  
Size of largest: 163

c  $P = 0.8$

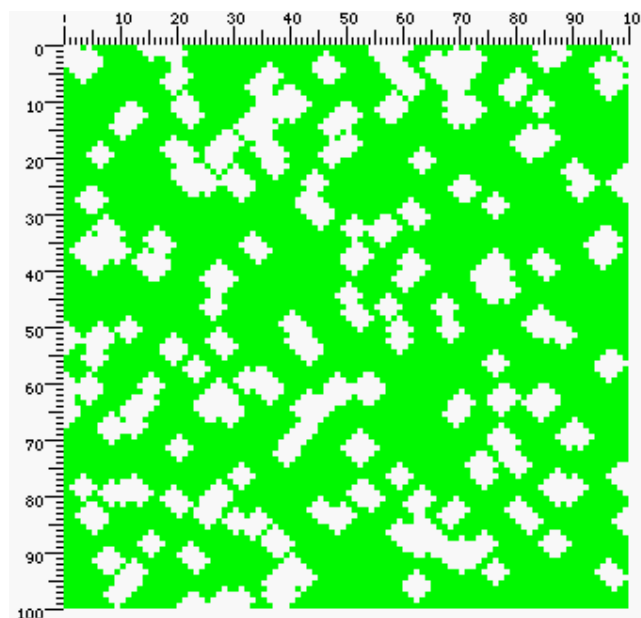


No. of clusters: 1  
Size of largest: 320

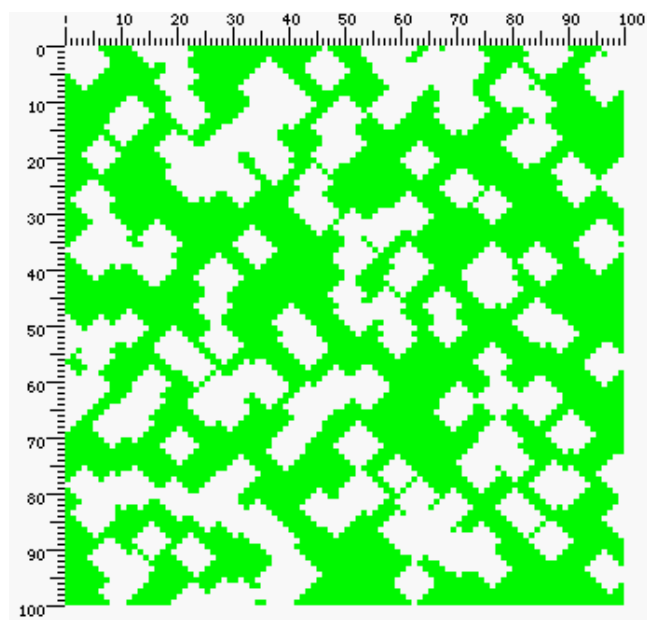
Example of three random maps (20 x 20) with different values of percolation: a) no percolation  $p=0.4$ , b) percolation  $p=0.6$ , c) percolation  $p=0.8$  (the percolation cluster is indicated in black and the other occupied cells in grey) (from Gardner et al. 1992 with permission)



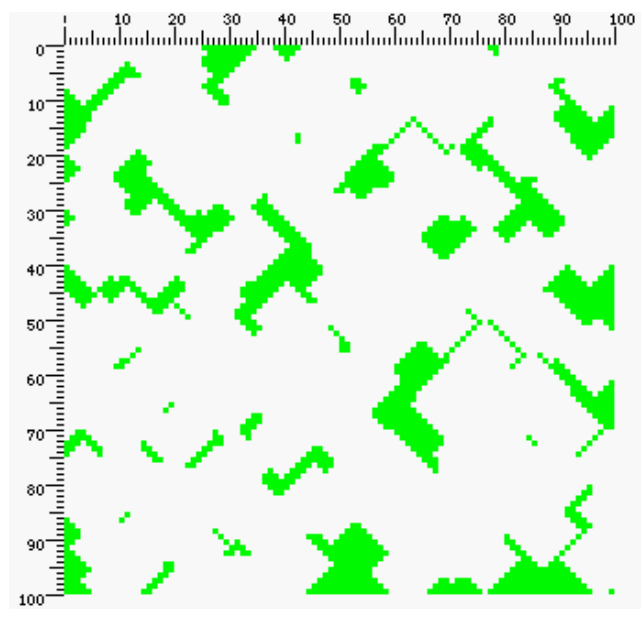
95%



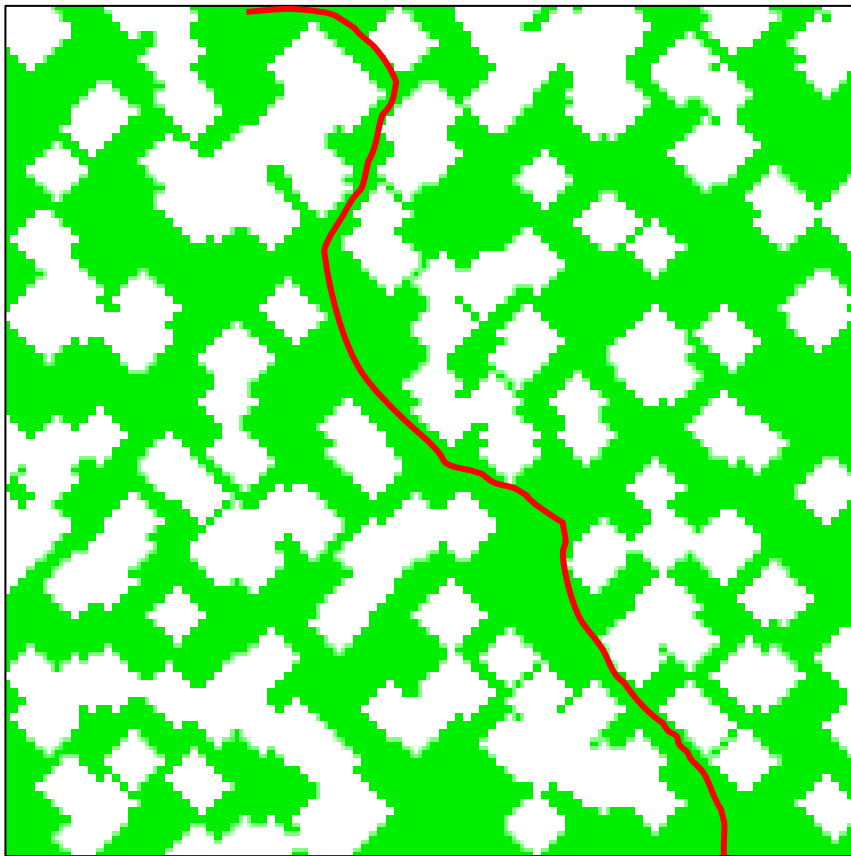
72%



56%



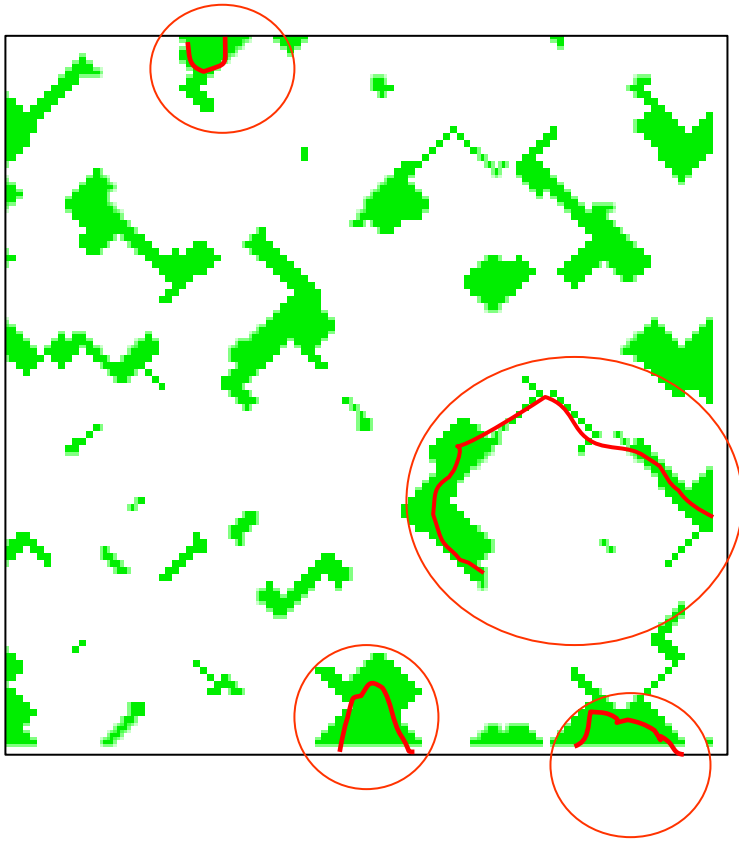
15%



Favorable

$$P_c = 0.5928$$

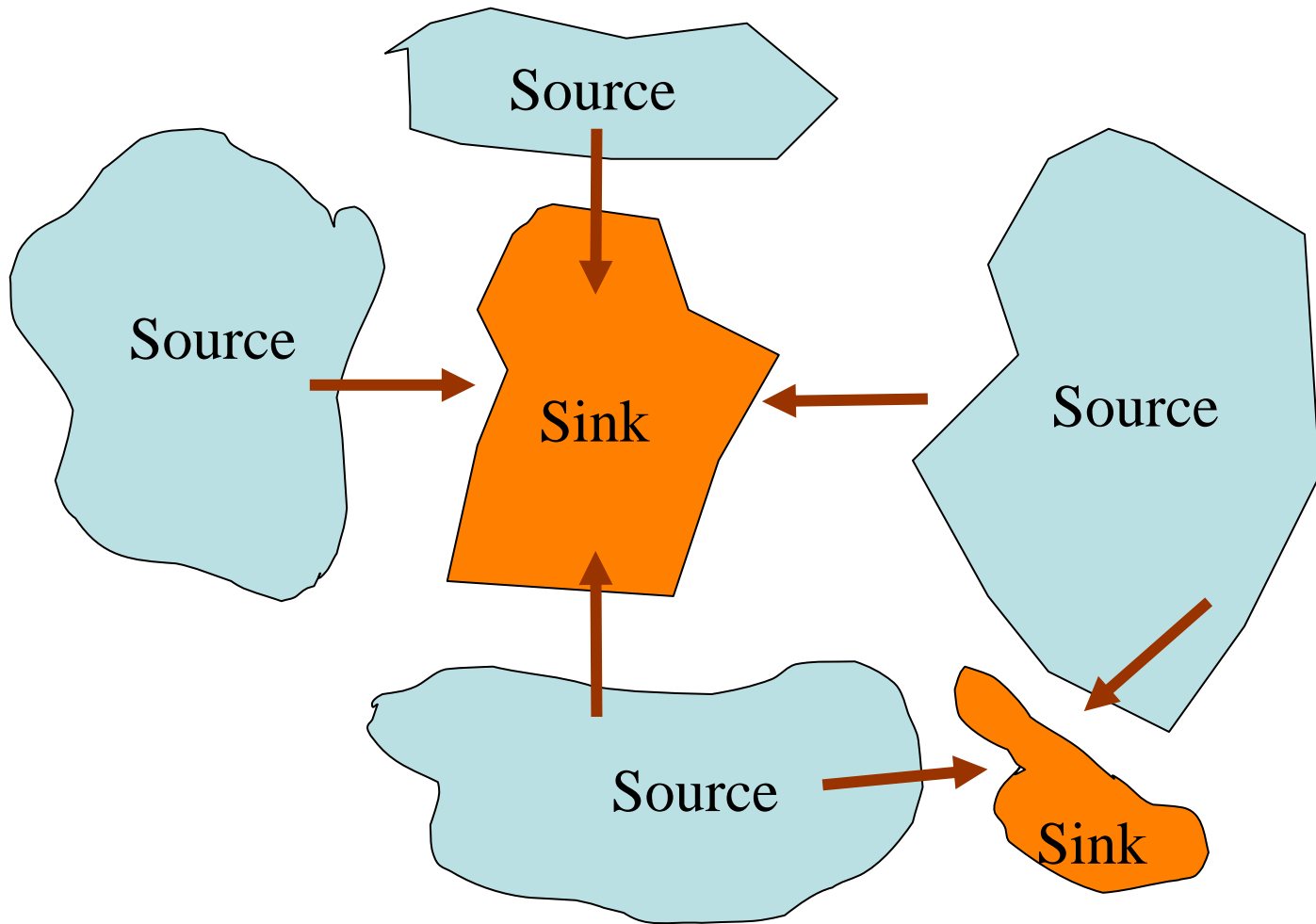




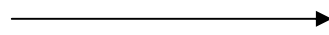
Favorable

$P_c < 0.5928$



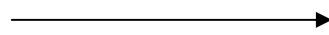


if **Sai**>**Dai** then

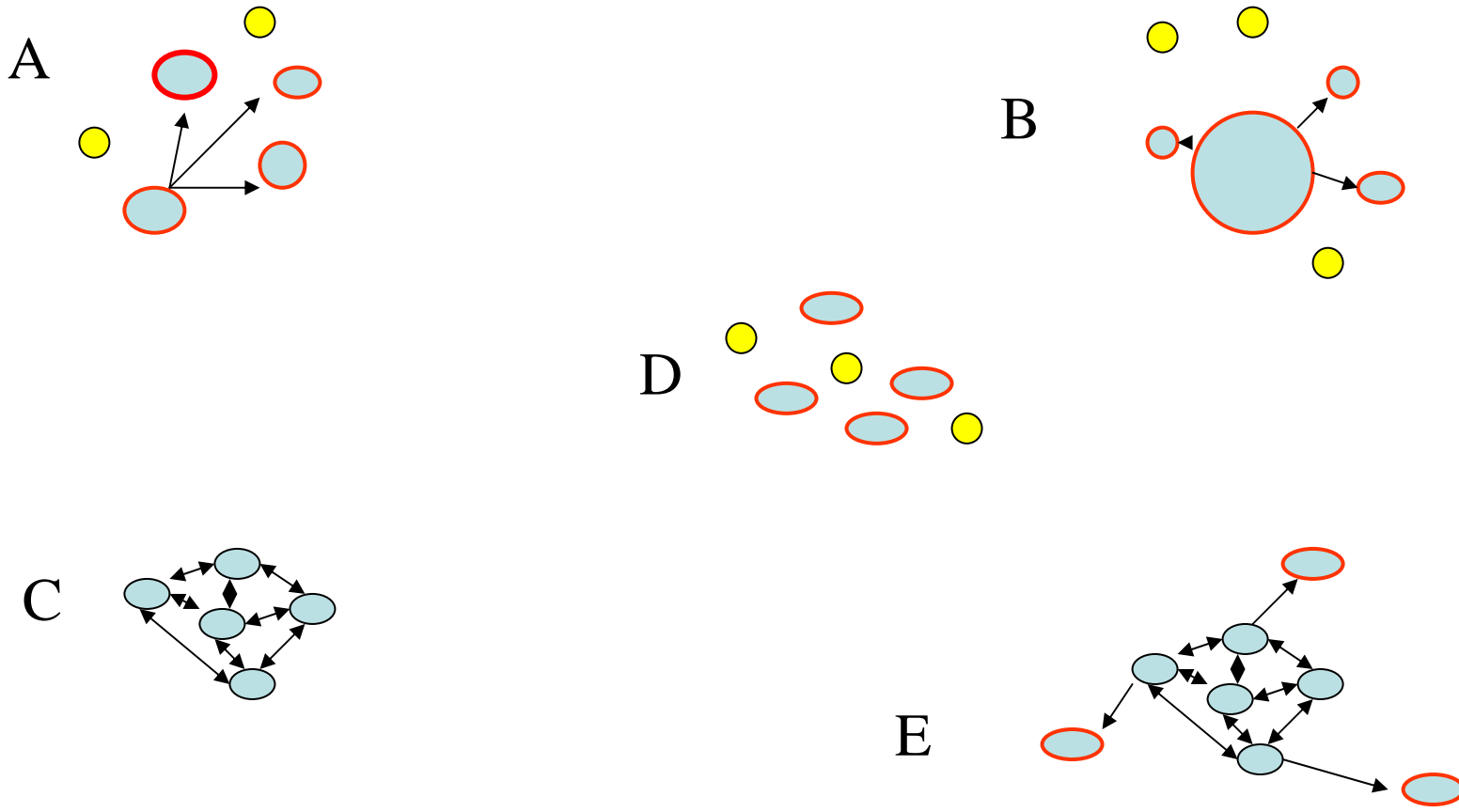


**i**= source

if **Dai**>**Sai** then



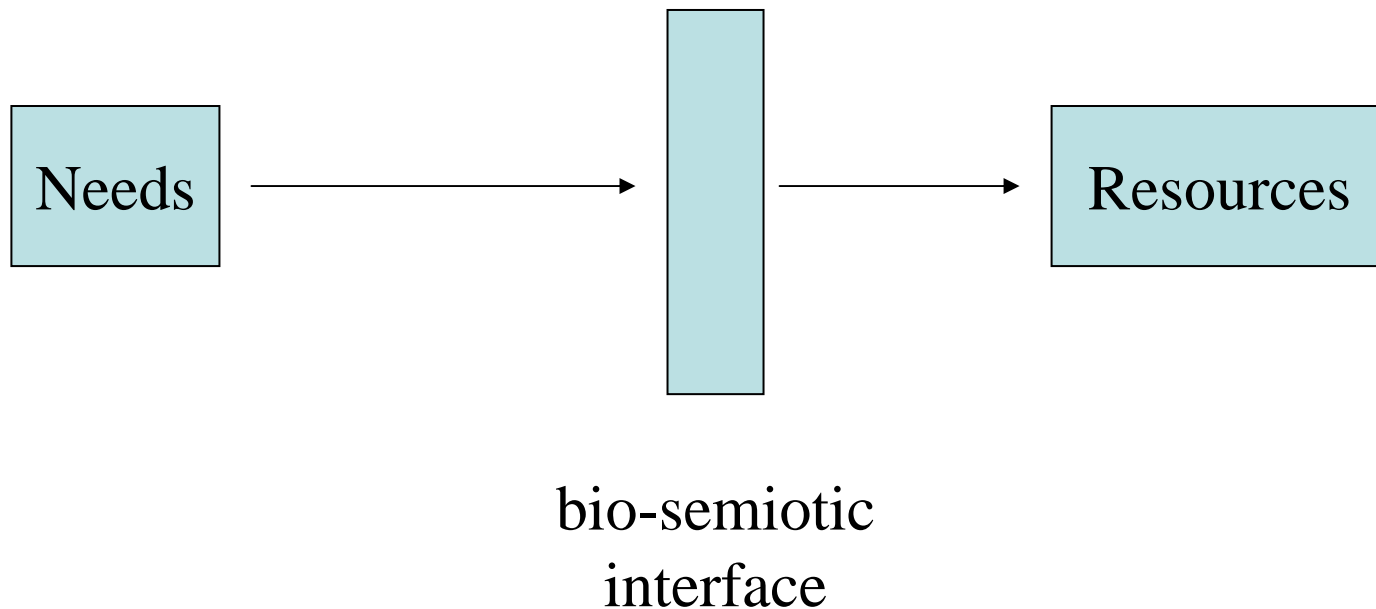
**i**=sink



Different types of metapopulation models. Filled circles=occupied, unfilled=vacant, Dashed lines represent the boundaries of a population, Arrows indicate migration. A=Levins metapopulation, B=Core-satellite metapopulation, C=Patchy metapopulation, D= Non-equilibrium metapopulation, E= A combination of C and B type (from Harrison 1991, with permission)

An epistemological introduction:

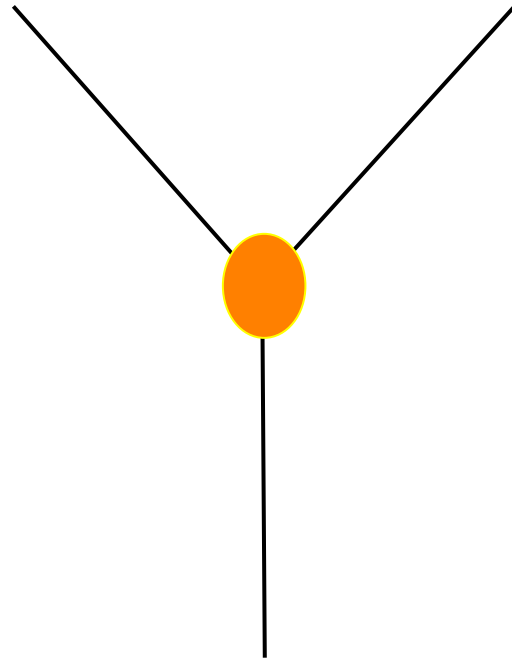
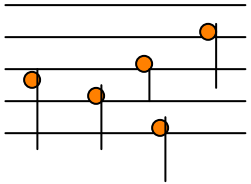
**Life** agency uses indicators!





# Sign process

*Sign vehicle*



*Interpretant*



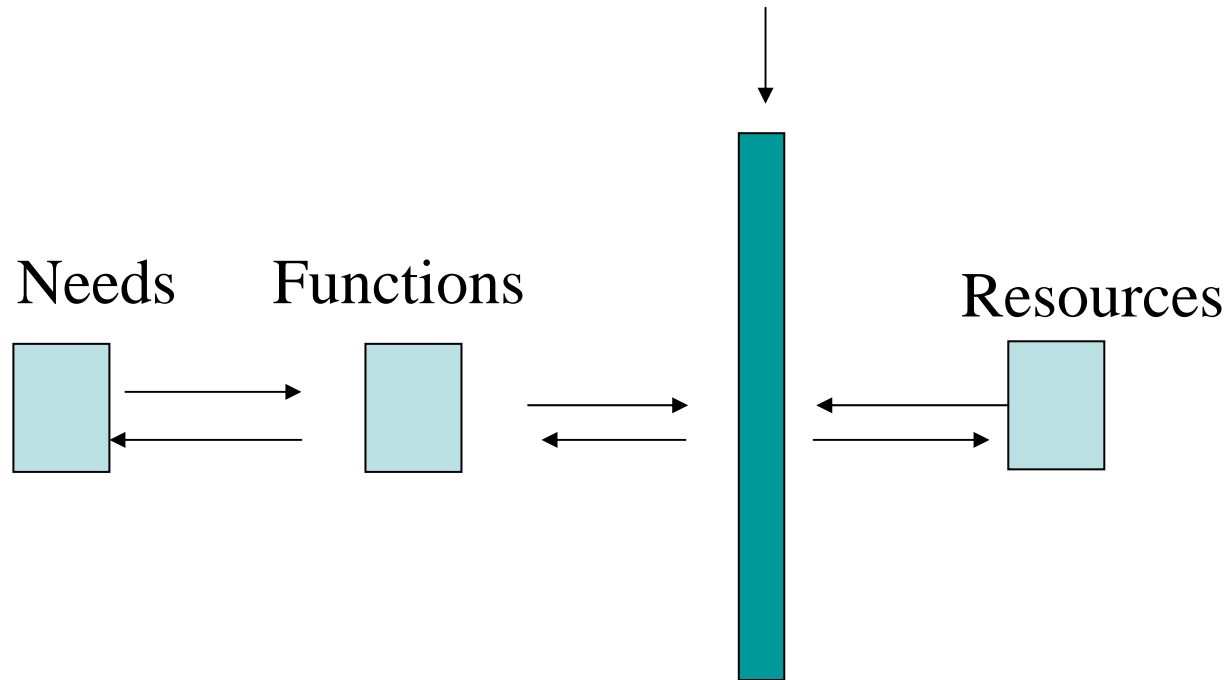
*Object*



Peirce 1931-1958  
triadic vision

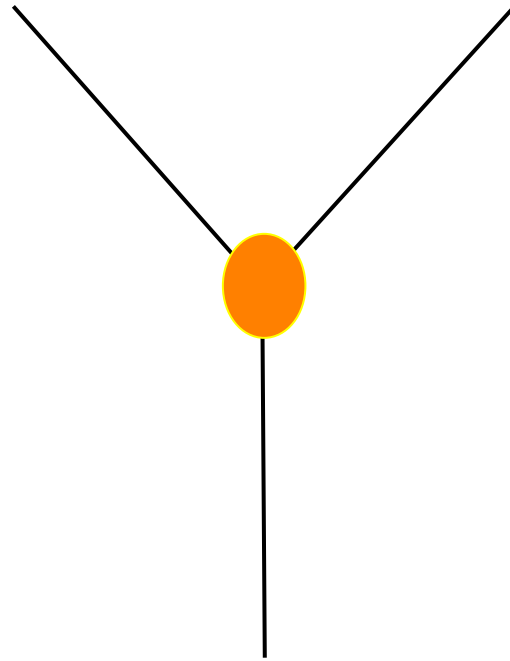
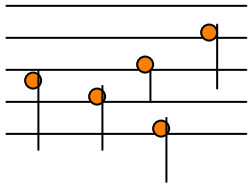
# Eco-field

a spatial configuration carrier of meaning

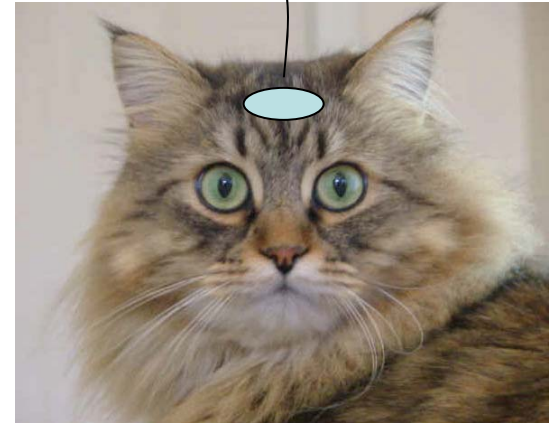


# Eco-semiotic process

**Eco-field**  
*Sign vehicle*



**Function**  
*Interpretant*



**Resource**  
*Object*



If the landscape ( $\Sigma$  **eco-fields**) is considered a source of signals converted by organisms (f.i. animal cognition, plants growth forms) in signs then

. size



. shape



. contagion

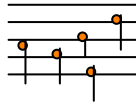


are not simply landscape (patterns) attributes but categories of identified function-specific signs of a species

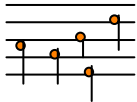
Nesting competitor

# Landscaping process

Food tracking

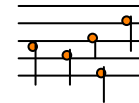


?



?

?



?

Predator in action



Predator Sentinel



# Data processing:

Information<sub>tot</sub> (for each session) :  $\sum H_j$

were  $j = 1$  to  $207$  (interval of Frequency , 43:9000Hz)

$$H_j = \sum L_j / I_j$$

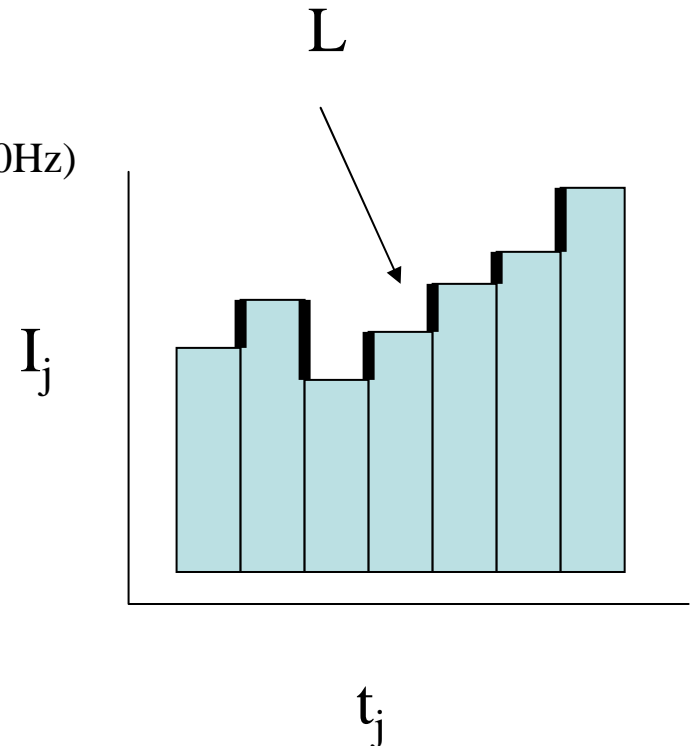
$$L_j \text{ (border length)} = \sum I_{jt} - I_{jt+1}$$

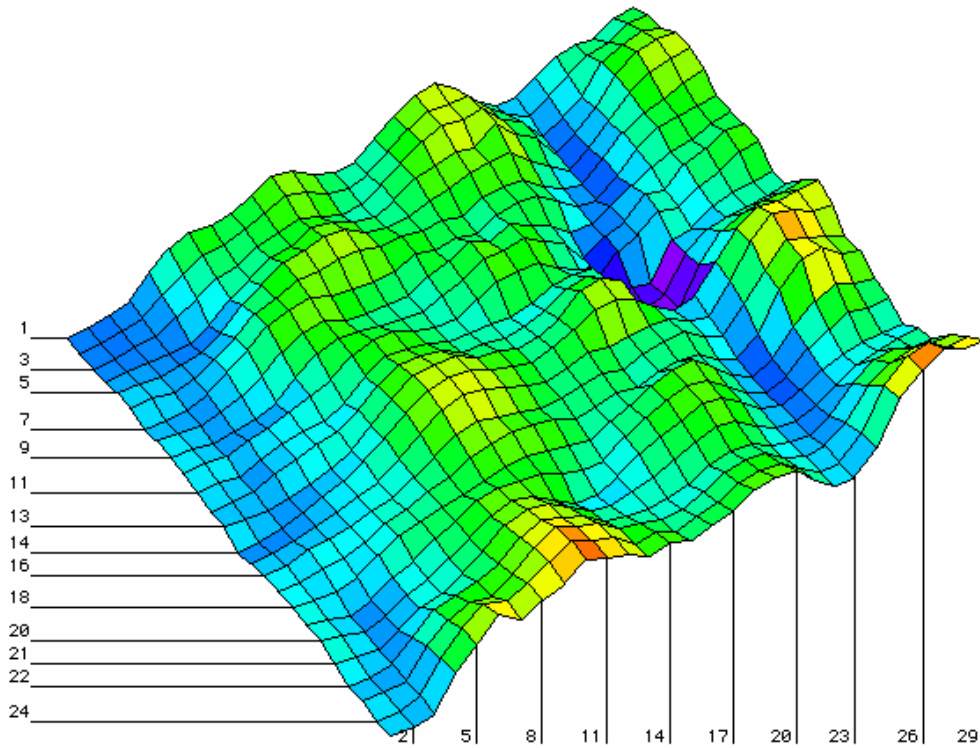
$$I_j = \sum I_{jt}$$

$j$  = Hz category

$I$  = Intensity ( $\mu$ Pascal)

$t$  = Temporal steps (130 data x second)



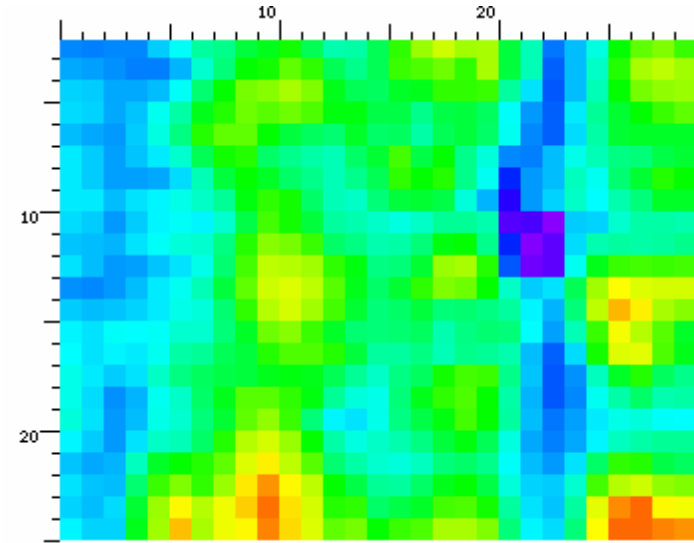


April-May 2007 900 m,  
29 rp, 24 sessions

Sessions

Acoustic information

“landscape”



recording points

**Rules: Diversity, Overlap/Conflict, Integration**

Master plan - Development- Conservation-Exploitation

Conventions





Indicators for a cognitive landscape:

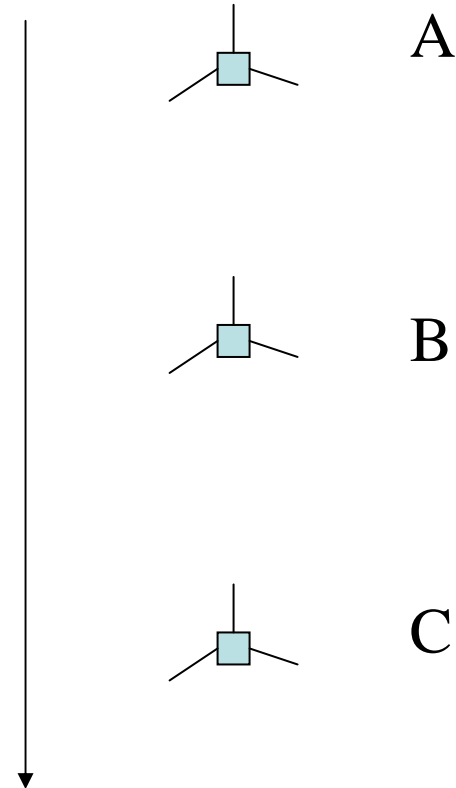
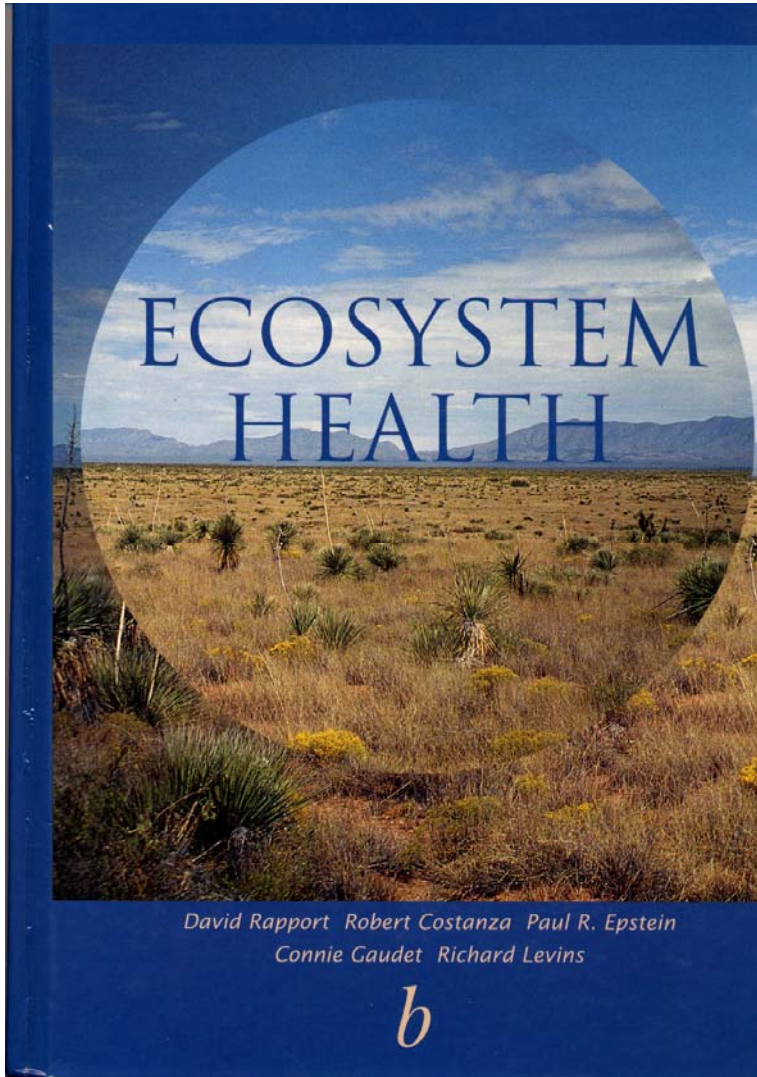


cultural filter



sense of place, local identity,  
traditions, local uses of  
resources

Ecology is contaminated by other semantics, f.i.  
“therapeutic”, “the economy of nature”, “ecosystem  
health”, “ecosystem services”



# From an “Empty-world” to a “Full-world” model

The Mediterranean region is characterised by a high diversity mainly due to the integration between natural (land heterogeneity) and human (stewardship) processes. Cultural landscapes are the results of such coevolutionary processes. A better understanding of the mechanisms that have assured along the millennia, the maintenance of biological as well as ecological processes seems of extreme importance for our future survival. In North America, a frontier mentality persists in the cultural mindset and rich biodiversity is associated only with remote areas, reflecting a model of an empty world in which human development is completely isolated from the natural (wild) processes. This vision is in contrast with the full world vision of the Mediterranean dwellings. Plasticity, adaptation to disturbance, and the persisting of biological refugia can be considered the most relevant factors responsible for the Mediterranean dynamics. These factors are rare or impossible to find in the North America context from which the dominance of the economic capital over the natural and cultural ones is a very popular model exported worldwide. In this commentary the full world paradigm is presented as an extension of the concept of resilience and ascendancy to propose a new grammar that incorporates self-organisation of natural and human dominated systems into a process of diffuse globalisation of economics and human behaviour.

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*Keywords:* Biodiversity; Ecological complexity; Globalisation; Ecosystems

Empty world ..... nature apart... focusing on  
excellence

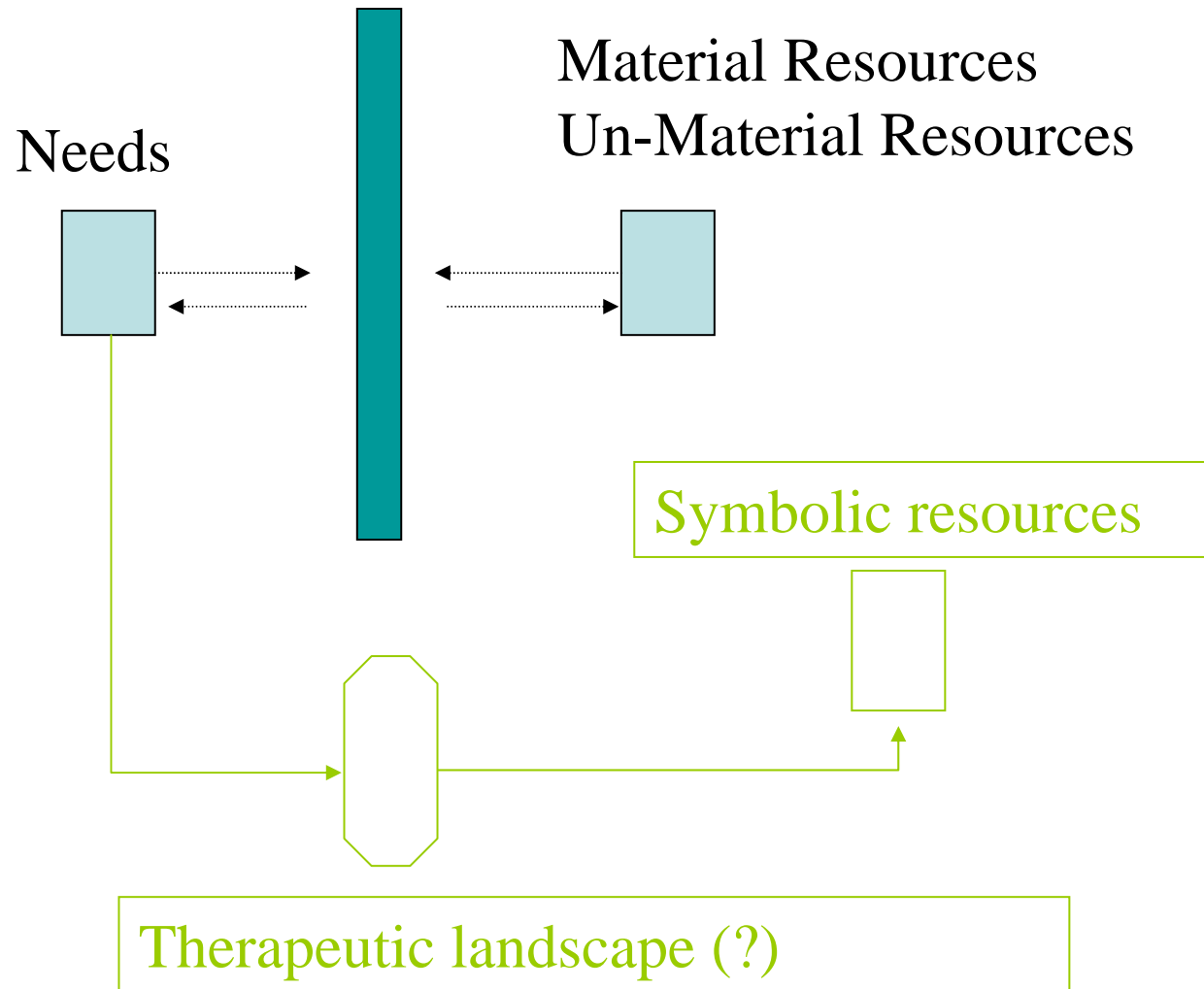


Full world .... nature partnership ... focusing on ordinary landscape

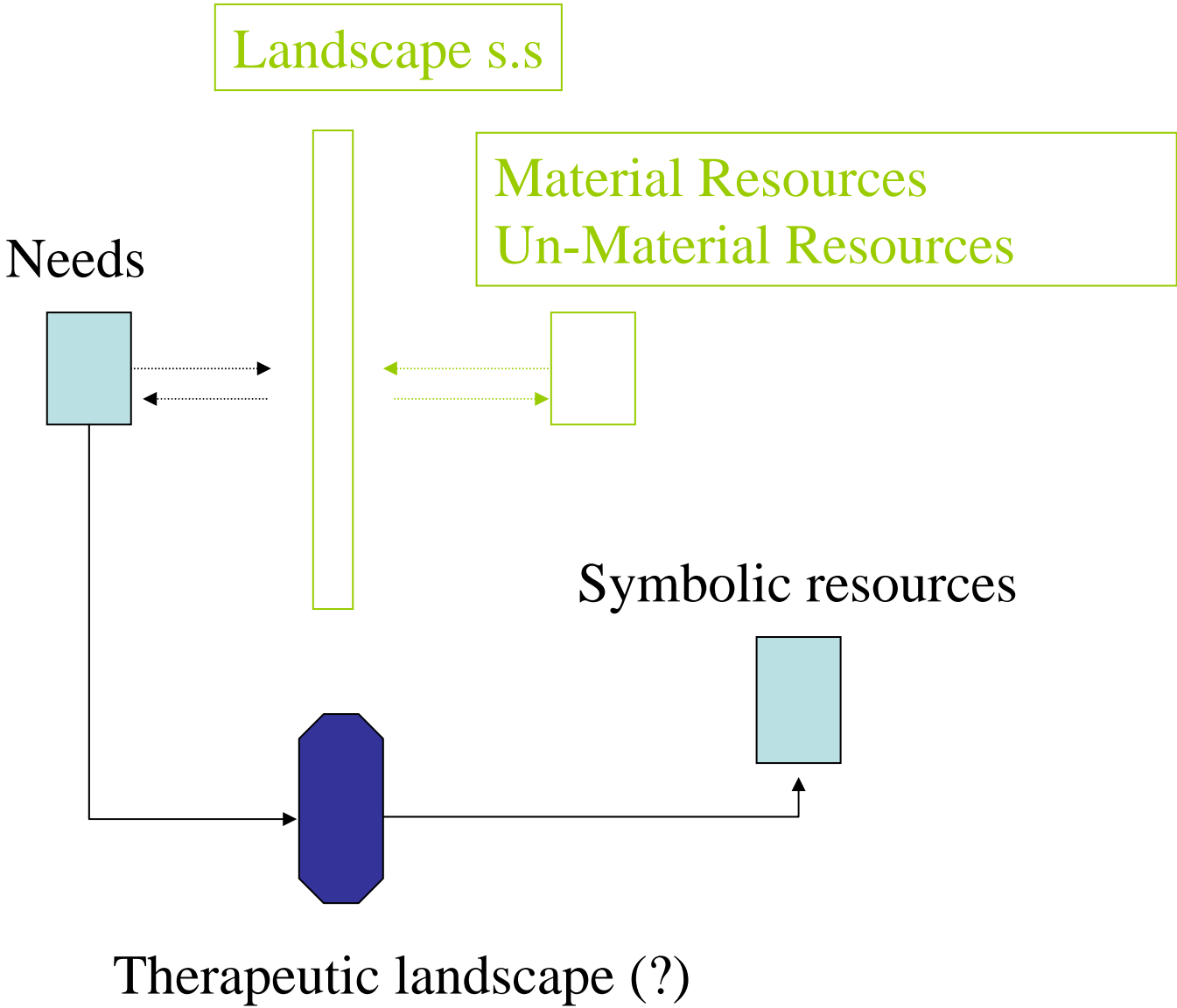


# Residents

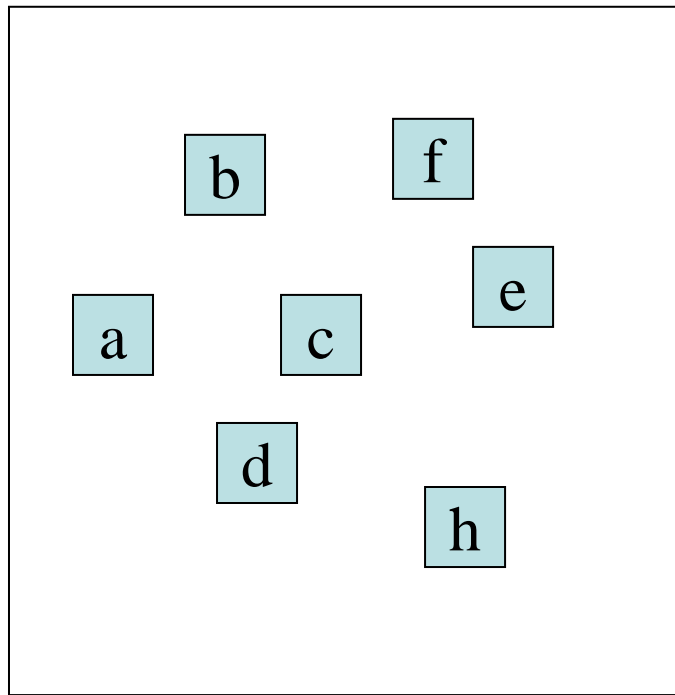
Landscape s.s



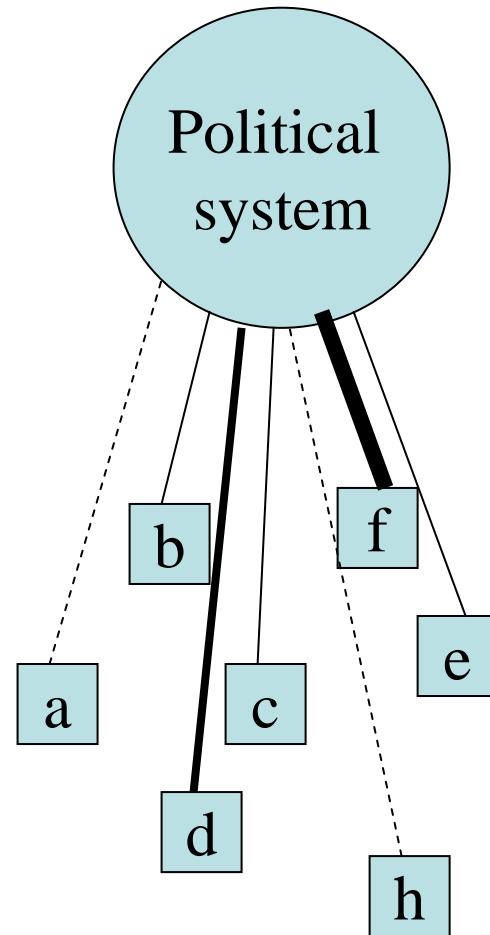
# Visitors



# Mistrust/Individualism



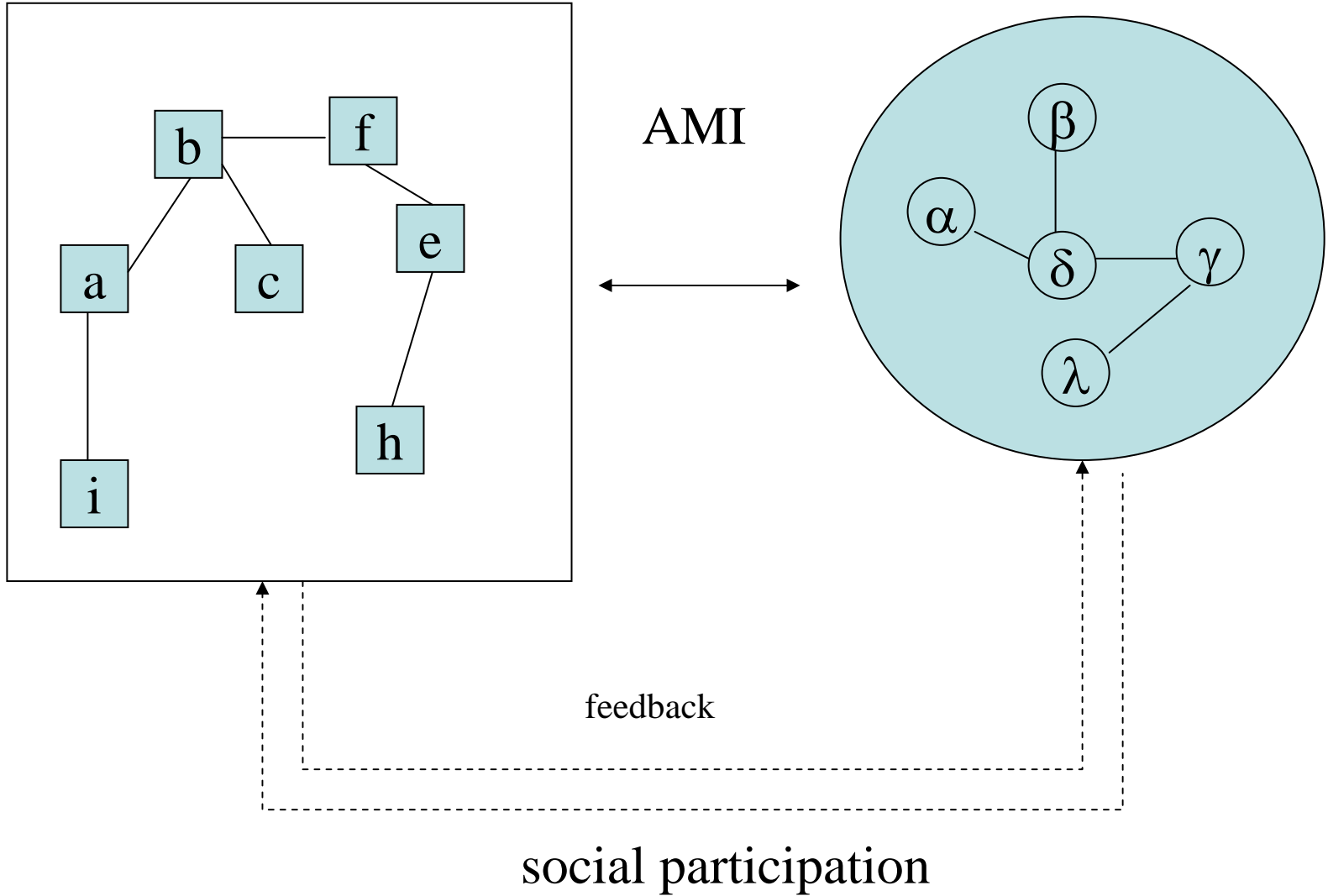
No system





Social and environmental project  $i$

Political project  $i$



$$\mathbf{Human\ Well-Being} = \Sigma N \quad e \quad \overrightarrow{\square} \quad \bullet \quad \square$$

Food, Job, Democracy, Health care, Shelters, Safety, Spirituality, Cultural values, Social values, Sense of place, etc

Larger is the number of needs that are satisfied and more complex and quality relevant becomes the resulting landscape interface.





dung beetle



Sheep flock

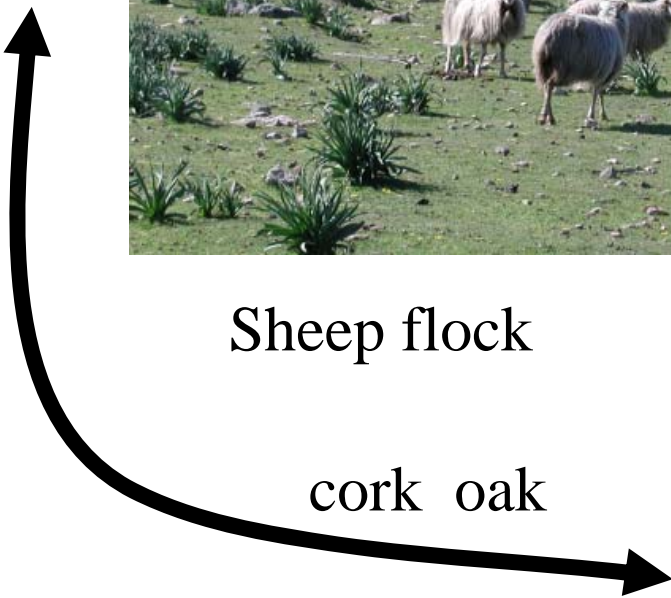
cork oak



Shepherd



Sardinia, Italy



A close-up photograph of a basket filled with various fresh fruits. The basket contains several ripe peaches with red and orange skin, numerous yellow plums, a few green pears, and some dark purple grapes. The fruits are piled together, creating a vibrant and colorful scene. A semi-transparent grey rectangular box is overlaid in the center of the image, containing text in a blue serif font.

**Indicators for all  
purposes are not a  
realistic target !?**