

Global Change: an introduction



**Master in Interdisciplinary Studies in
Environmental, Economic and Social Sustainability
Global Change**

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Interactions between biophysical changes in the earth's physical and biological structure and the broader effects of human activity. Thus, global change includes changes in many aspects of the globe's environmental systems, including climate.

It is the set of alterations in natural, physical or biological systems, with impact effects at a global scale. (Stern et al., 1992; Boada y Saurí, 2002).

Global change is therefore, a multidimensional (and multiscale) process that requires an interdisciplinary and socioecological analysis framework.

Meyer & Turner (1992):

“Any change is global in a sense of uniform manifestation in the whole planet.”

Two typologies of global change:

1. Systemic changes: occurring at a planetary scale, directly affecting global systems: main atmospheric, terrestrial and oceanographic cycles.

Changes can start by actions produced in any point of the planet, and its effects equally are manifested in any point of the planet. Example: CO2 emissions.

2. Cumulative changes: occurring at a regional and local scale, but overall contributing to global change by accumulation.

Example: Land use and cover change

Annu. Rev. Ecol. Syst. 1992, 23:39-61
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HUMAN POPULATION GROWTH AND GLOBAL LAND-USE/COVER CHANGE

William B. Meyer and B. L. Turner II
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$$I=P \cdot A \cdot T$$

Impact (I)

Population (P)

Affluence (A)

Technology (T)

[Ehrlich, Paul R.; Holdren, John P. \(1971\). "Impact of Population Growth". *Science*. *American Association for the Advancement of Science*. 171 \(3977\): 1212–1217. *JSTOR* 1731166. doi:10.1126/science.171.3977.1212.](#)

Commoner, Barry. "The Environmental Cost of Economic Growth." in [Population, Resources and the Environment](#). Washington, DC: Government Printing Office Pp. 339-63, 1972.

The **IPAT equation** describes the multiplicative contribution of population (P), affluence (A) and technology (T) to environmental impact (I).

Environmental impact (I) may be expressed in terms of decreasing resources or waste accumulation; population (P) refers to the size of the human population; affluence (A) refers to the level of consumption by that population; and technology (T) refers to the processes used to obtain resources and transform them into useful goods and wastes.

The formula was originally used to **emphasize the contribution of a growing global population on the environment, at a time when world population was roughly half of what it is now.**

The IPAT equation made a contribution to understanding the multiple causes of environmental impact, and it continues to be developed as a method for improving our understanding of these issues. It has not helped in identifying sustainable scale, but it is a **useful framework to assist in thinking about ways of reducing environmental impacts.**

Global Change

A conceptual model illustrating humanity's direct and indirect effects on the Earth system



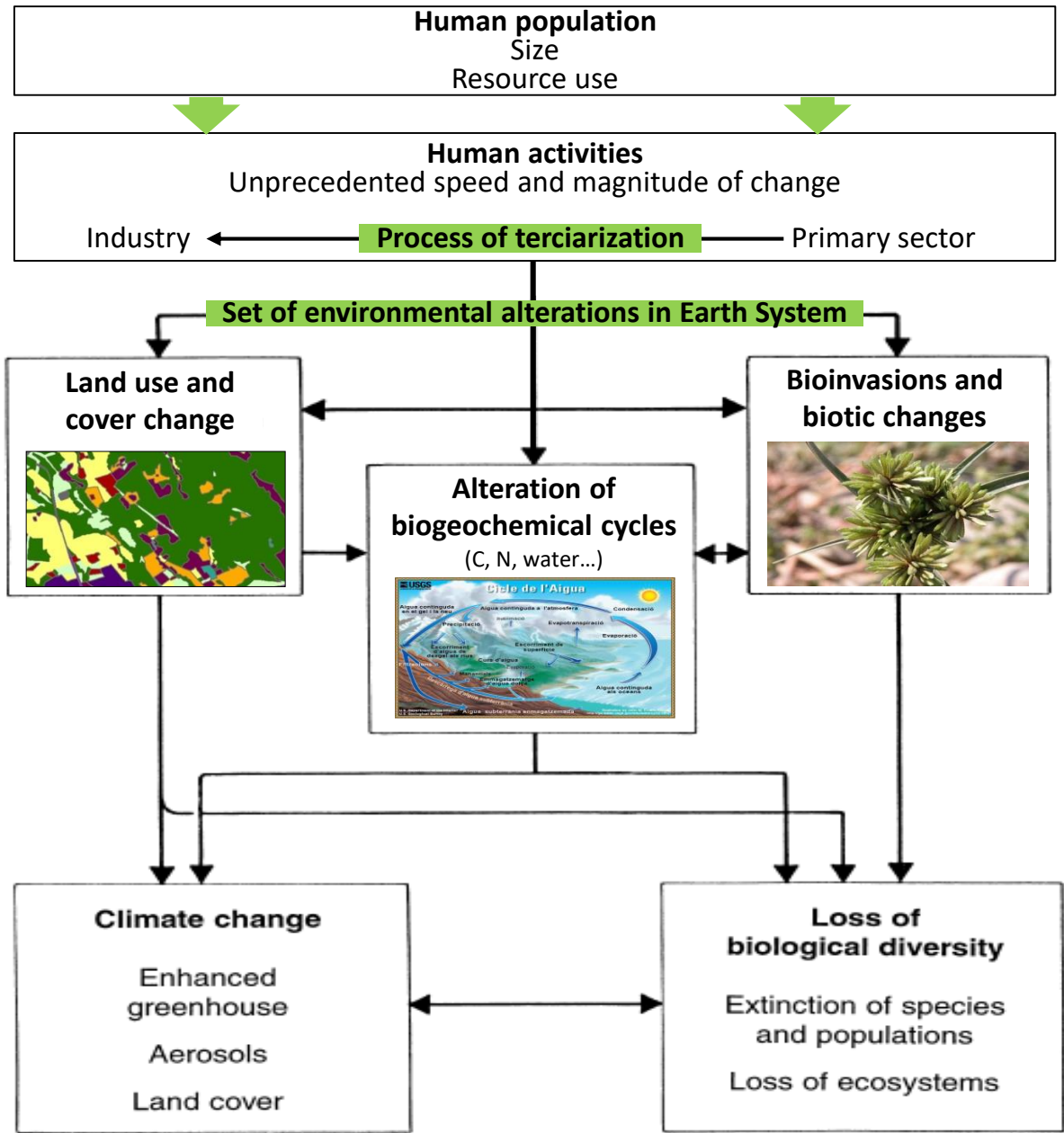
Global scale



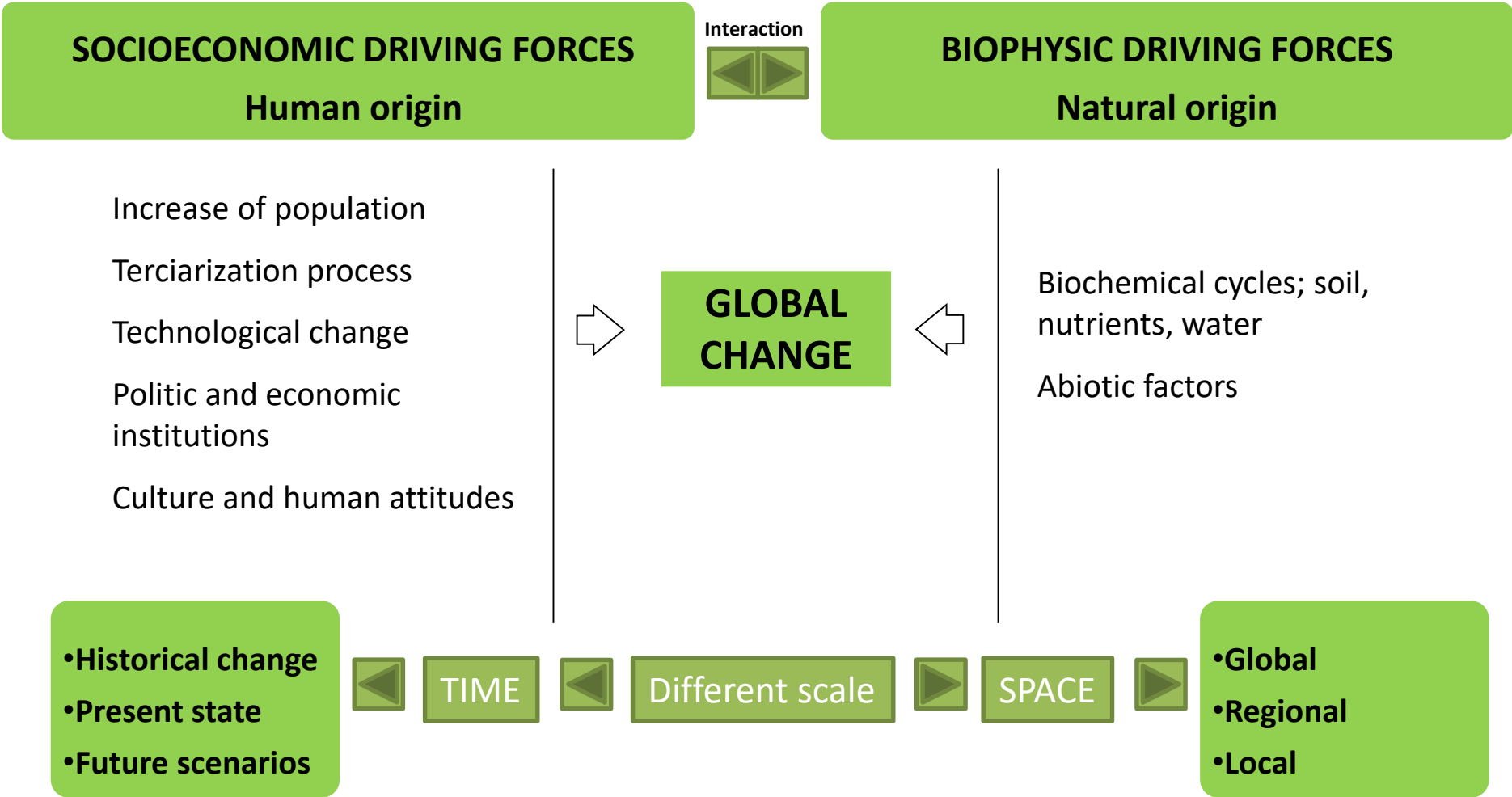
Regional and local manifestations

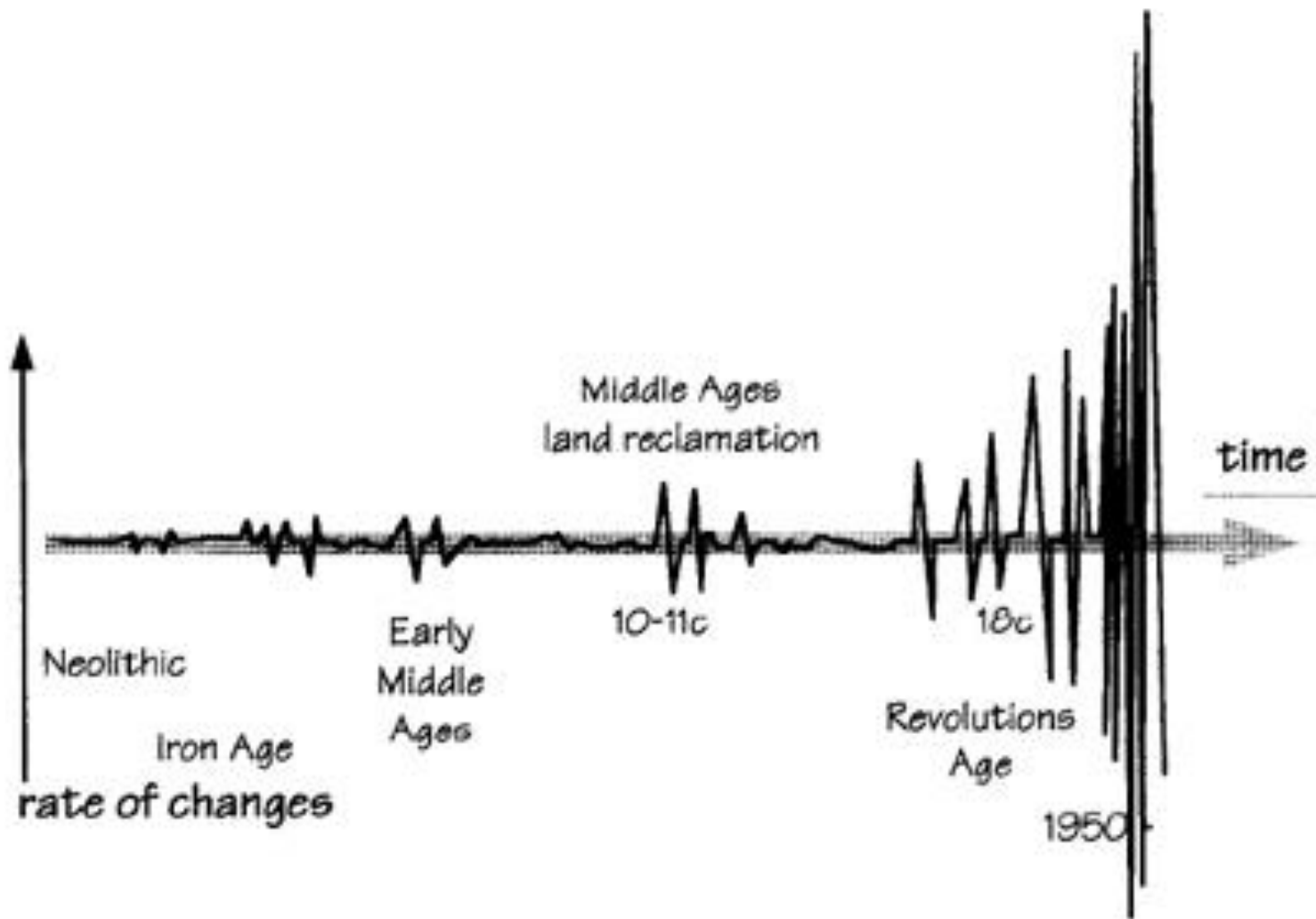


MULTISCALE EFFECTS
MULTISCALE ANALYSIS

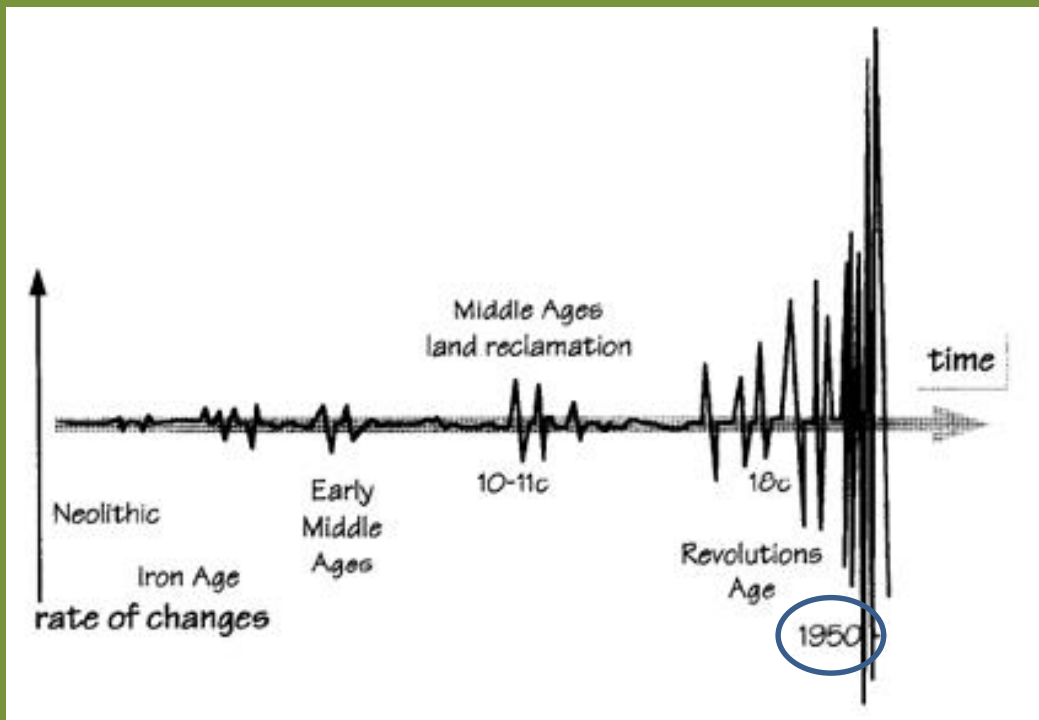


Own elaboration from:
Human Domination of Earth's Ecosystems
Peter M. Vitousek *et al.*
Science **277**, 494 (1997);
DOI: 10.1126/science.277.5325.494





The main important changes have taken place in the last decades. There is broad evidence that humans have vastly accelerated the pace of global change, largely due to the increasing human population and its activities.



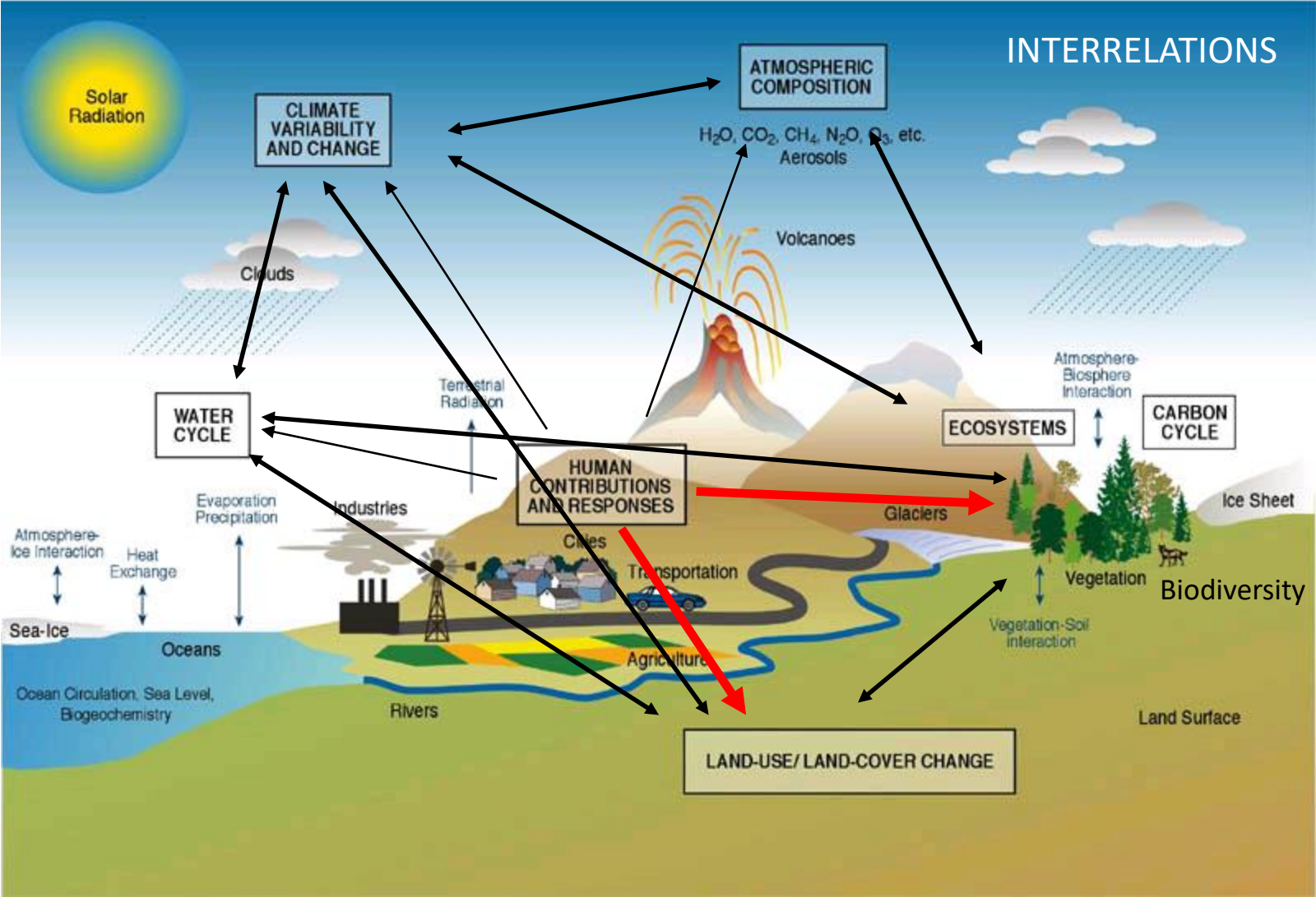
Antrop, M. (1997) The concept of traditional landscapes as a base for landscape evaluation and planning. The example of Flanders Region. *Landscape and Urban Planning* 38: 105-117.

1950: considered as Before Present (BP) for scientists. WHY?

- Economic growth
- Improvement of living conditions
- Demographic growth
- Technological development



- Conversion of natural landscapes into agrarian and urban landscapes
- Intensification of nutrient cycles
- Introduction of non-native species
- Changes in hydrologic cycles
- Changes in atmospheric chemistry
- Changes in size and distribution of human population
- Etc.



Strategic Plan for the U.S. Climate Change Science Program, Final report 2003

Global change: socioecological systems

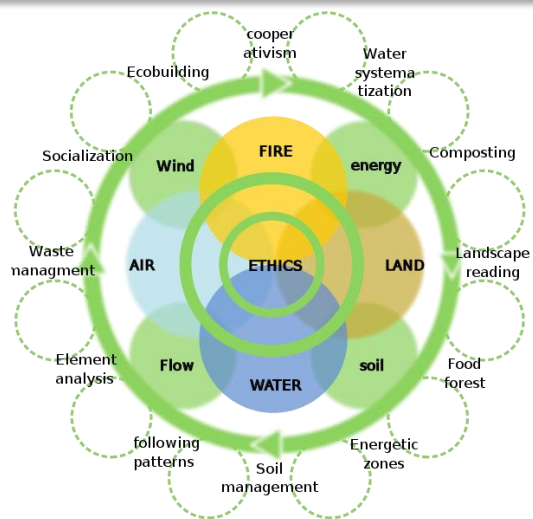
ANTHROPOGENIC VISION
Human as center

- Economy as the most important system.
- Nature as resources and ecosystem services provider.
- Nature as waste and pollution sink.
- Sustainability only important regarding to sustainability of human society

BIOCENTRIC VISION
Nature as center

- Human species is just another component of the system.
- Nature considered harmonic by definition.
- Modern and industrial society is responsible of environmental crisis

Reductionist visions!!! They don't match with a systemic vision and its approaches



Division between **natural systems** and **cultural systems** is artificial and arbitrary (Berkes *et al.*, 2003)



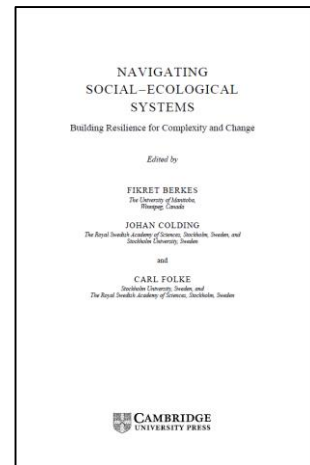
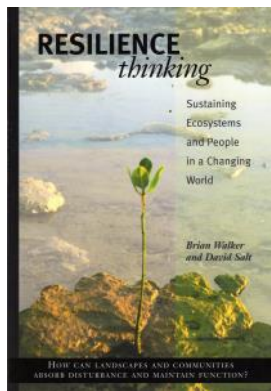
To overcome this duality it was proposed to study socioecological systems from an integrated point of view

SOCIOECOLOGICAL SYSTEM

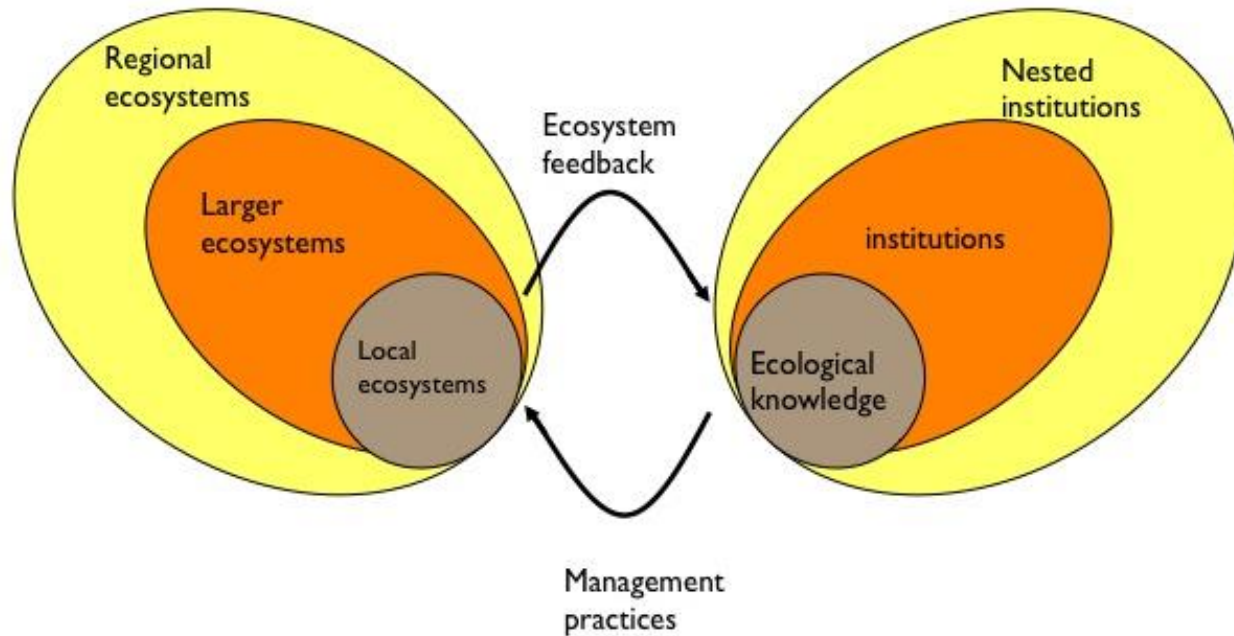
System defined as the result of the interaction between a social (human) component and an ecological (biophysic) component which determines a complex system in continuous evolution according to changes.



Socioecological systems can be defined at different scales, from local to global, delimited by spatial or functional limits.



Socioecological systems



Berkes, Folke, Colding. 2003 Navigating social-ecological systems

Recognition that human cannot stand outside the nature-society system (Berkes et al., 2003)

Socioecological systems

Socioecological systems are considered **complex adaptive systems**.

That means they don't change in a predictable, linear or incremental way, but it is possible that the system exists on more than one alternative stable state, where its function, structure and retroalimantation is different (Walker & Salt, 2006).

The previous vision of nature and society as systems close to equilibrium, statics, is substituted by a dynamic vision which emphasizes non-linear complex relationships between entities under continuous change, facing discontinuities and uncertainties arising from sets of pressures and synergic impacts (Folke et al., 2002).

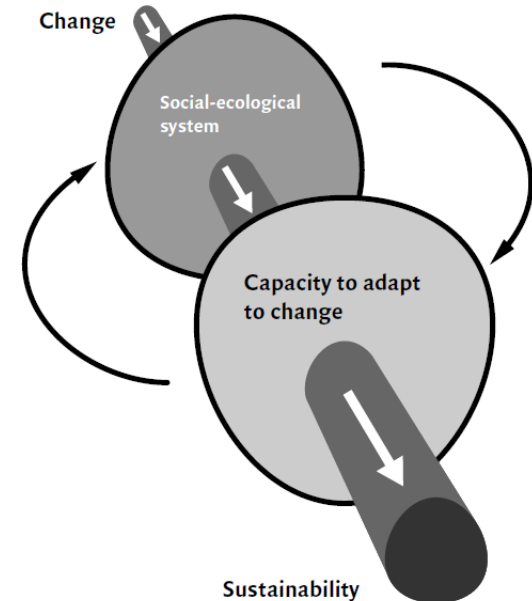


Figure 1.1 The focus on adaptive capacity for sustainability. Sustainability is viewed as a process, rather than an end-product, a dynamic process that requires adaptive capacity in resilient social-ecological systems to deal with change.

Socioecological systems

To understand the dynamics of complex adaptive systems it is very important the concept of **resilience**

RESILIENCE

Definition:

- Degree of perturbation that a system can absorb maintaining its functionality and structure,
- the capacity of the system to self-organize
- and, finally the capacity of the system to increase its capacity of learning and adaptation (Carpenter, 2001, cited in Folke, 2006)



Socioecological systems

To understand the dynamics of complex adaptive systems it is very important the concept of **resilience**

- Resilient socioecological systems present higher capacity to avoid changes caused by external perturbations, can face better **uncertainty** and **surprise**.
- When a socioecological system loses resilience becomes more **vulnerable** to changes which previously could be absorbed.
- Resilience and vulnerability are antithagonic concepts.
- Maintaining resilience capacity requires comprehension and management of feedbacks and relationships between ecologic and socioeconomic components which conform the system, while considering multiple spatial and temporal scales.

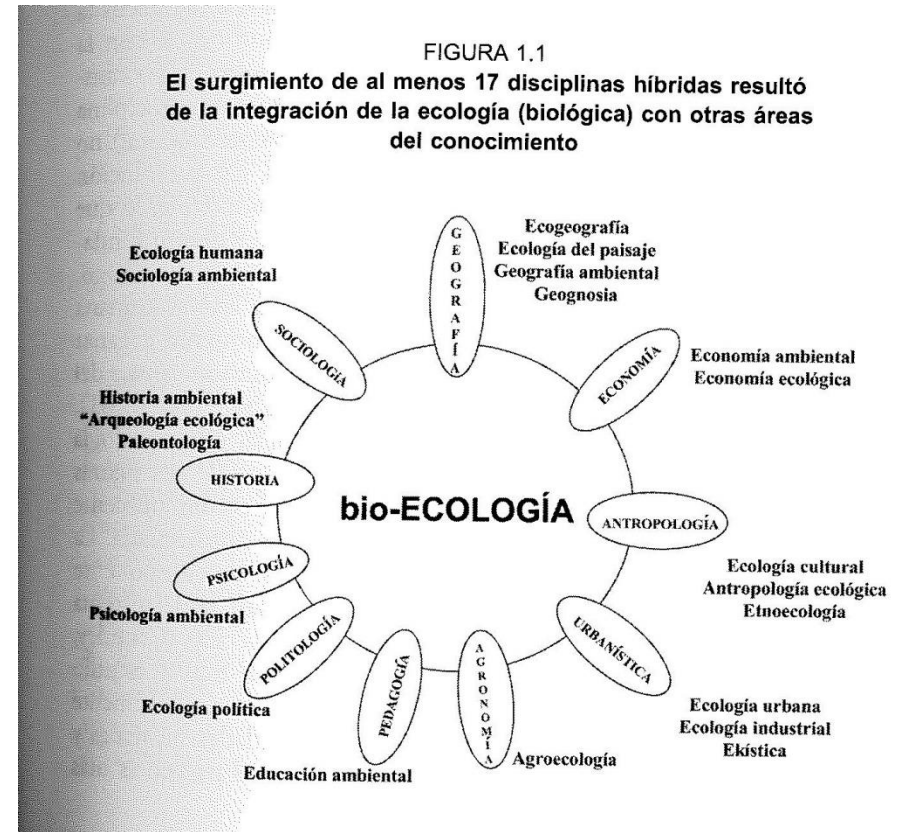
Environmental history

To understand the current dimension of environmental problems and predict its future evolution, we need to incorporate a historical perspective to its study.

A new integrated vision is needed to understand relationships between **nature** and **culture** (Toledo *et al.*, 1998).



Hybrid disciplines



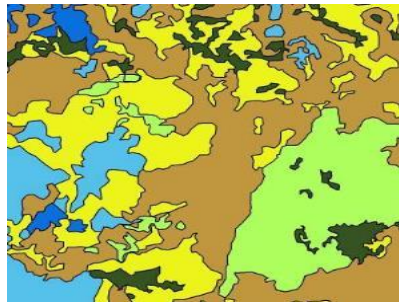
Environmental history: can be defined as the discipline to study the evolution in the relationships between society and environment through **time**.

It can also be seen as the evolution of socioecological systems through time.

Even though environmental history as a discipline is of recent origin, the study of the relationship between society and environment has always been an important issue for humans (González de Molina i Toledo, 2011).

Environmental history

- Environmental history is based in the integration of history and ecology.
- Environmental history aspires to “ecologize” history, but not to substitute it (González de Molina & Toledo, 2011).
- It is an effort to make history a discipline more inclusive than it has been traditionally, refusing the assumption that human experience is free of natural limitations (Worster, 1988).
- To interpretate environment and its problems we need to adopt a holistic view, allowing interdisciplinarity and cooperation between historians, experimental scientists and social scientists.
- This approach becomes the most innovative element on environmental history.



Before ending...

Which are the main GC effects in Mediterranean areas? Joint discussion.

In Mediterranean region we can not understand the nature on the one hand
and society on the other.

The sum of both factors is the current landscapes as a result.

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