Virtual Academy of Sustainability

Lecture 4: Systems Inquiry

Episode 1: Thinking in Systems

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Overview of the Lecture

Episode 1: Thinking in Systems

Episode 2: Embracing Complexity

Episode 3: Interview

Learning Outcomes

- You will learn the emerging concept of social-ecological systems (SESs).
- You will learn the systems approach to understanding interconnections within and between systems.
- You will know the concept of feedbacks.

Structure of Episode 1

1. Defining Social-Ecological Systems
2. Understanding Systems Thinking
3. Conclusion

Social-Ecological Systems

- Current human activities are changing the Earth environment at rates and scales fundamentally different from those at any other time in history.
- "We are changing Earth more rapidly than we are understanding it." (Source: Vitousek et al. 1997).
- Given the pervasive human presence on the planet, it has become impossible to understand nature without society, and society without nature.
- Both the idea of a pristine nature and a denaturalized society are outdated and the academic separation of the natural sciences from the humanities and social sciences poses a serious obstacle to solving our most urgent problems.

Social-Ecological Systems

- Until the past few decades, the point of contact between social sciences and natural sciences was very limited in dealing with human and natural systems.
- Just as mainstream ecology had tried to exclude humans from the study of ecology.
- Many social science disciplines had ignored environment altogether and limited their scope to humans (Source: Berkes et al. 2008).
- In the last two decades, concerned scientists in different fields of research have come to agree on a new description of the world we are living in.

Social-Ecological Systems

- Planet Earth is a self-organizing complex system in crisis.
- Humankind is an integral part and a powerful driver of planetary change.
  - The tightly coupled relations between humans and nature, in a particular place, constitutes a social-ecological system (SES).
  - The term has been used to emphasize the integrated concept of humans in nature and to stress that the delineation between social systems and ecological systems is artificial and arbitrary (Source: Berkes et al. 2000).

Systems Thinking

- Social-ecological systems (SESs) studies draw heavily on systems thinking and complexity theory
- Systems thinking emerged in the mid-20th century as an inquiry into the relationship between patterns and processes of organization in natural and social systems.
- Ludwig von Bertalanfy (1901-1972) is credited as one of the founders of General Systems Theory .

Systems Thinking

- Systems thinking is an approach to integration that is based on the idea that the component parts of a system will behave differently when isolated from the system's environment or from other parts of the system

- Standing in contrast to positivist and reductionist thinking, systems thinking sets out to view systems in a holistic manner.

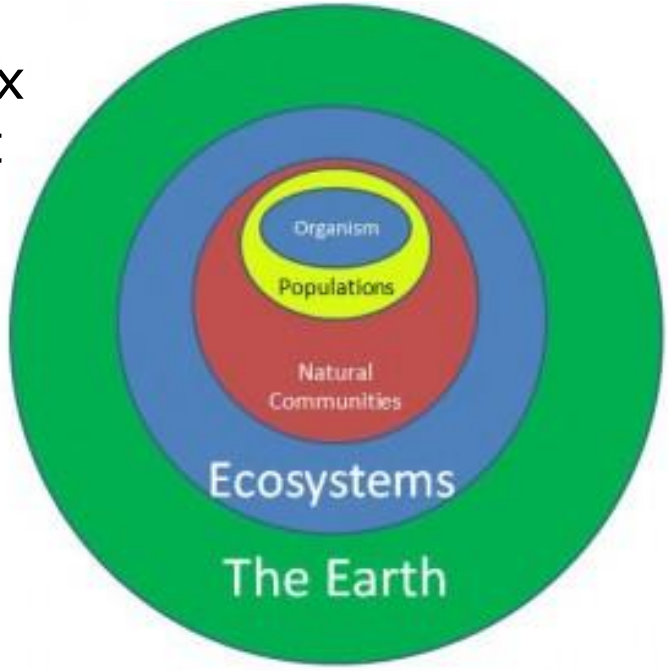
- "The whole is greater than the sum of its parts."

Systems Thinking

- According to systems philosophy, the Universe is organized into networks ("nested" systems) of dynamic and reciprocal relationships expressing increasing holistic embrace and complexity.

- A system is a dynamic and complex entity composed of interdependent and interacting parts in an orderly arrangement.

- Every system shares a dual nature: as a whole unto itself, and as a part of some greater system (whole).



Source: http://johngerber.world.edu/2010/10/

Systems Thinking

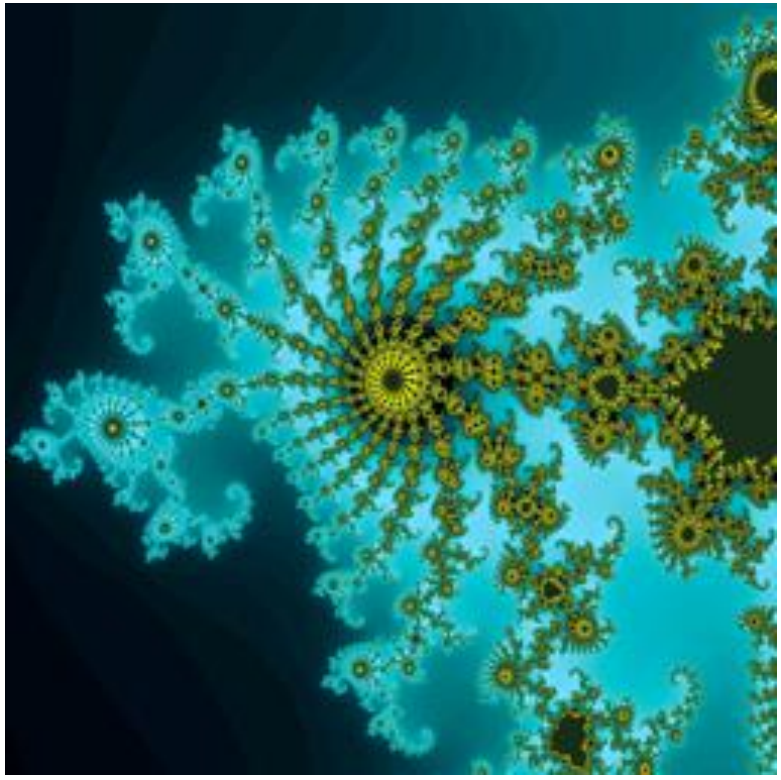
- Everything is intertwined, interrelated and in flux.
- One cannot understand the property of any part without understanding how this part is related to the others and how the others influence it.
- Unique and novel qualities emerge through the evolution of increasingly complex organizational patterns and processes.
- Rather than separate from matter in the Cartesian sense, mind is embedded in the natural processes that give rise to life.

Systems Thinking

- Consistent with systems philosophy, systems thinking concerns an understanding of a system by examining the linkages and interactions between the elements that comprise the whole system.
- This perspective helps us to see the big picture – from which we can identify multiple leverage points that can be addressed to support constructive change.
- The importance of each component of a system **is tied to its relationship to the whole.**
- By looking at just one component in isolation (for example, an atom), we would not have a realistic picture of its importance.

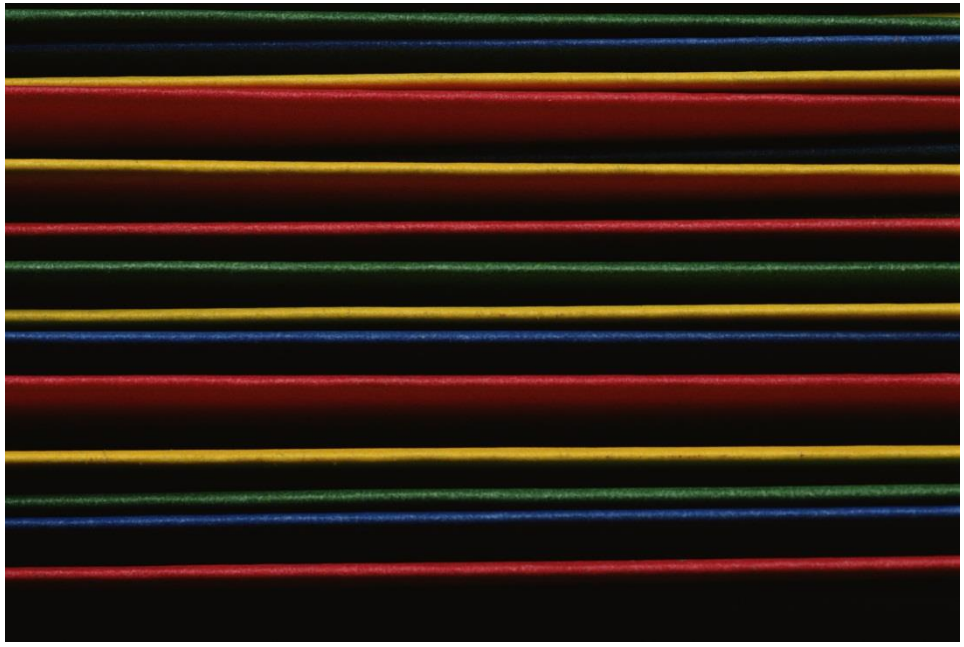
Systems Thinking

- Helps us explore interdependencies and looking for patterns.



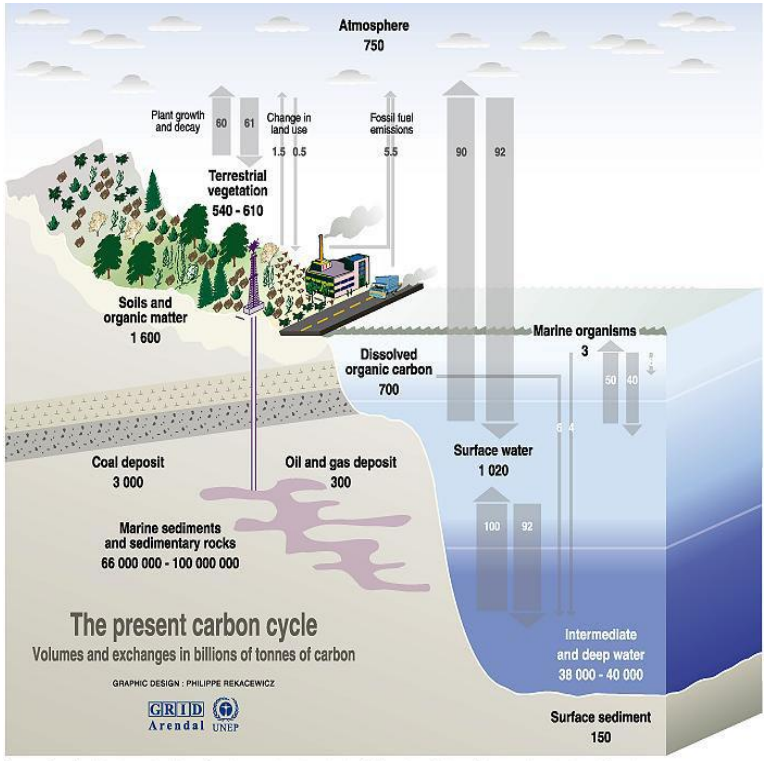
Systems Thinking

- Helps us understand feedback structures that change systems over time.



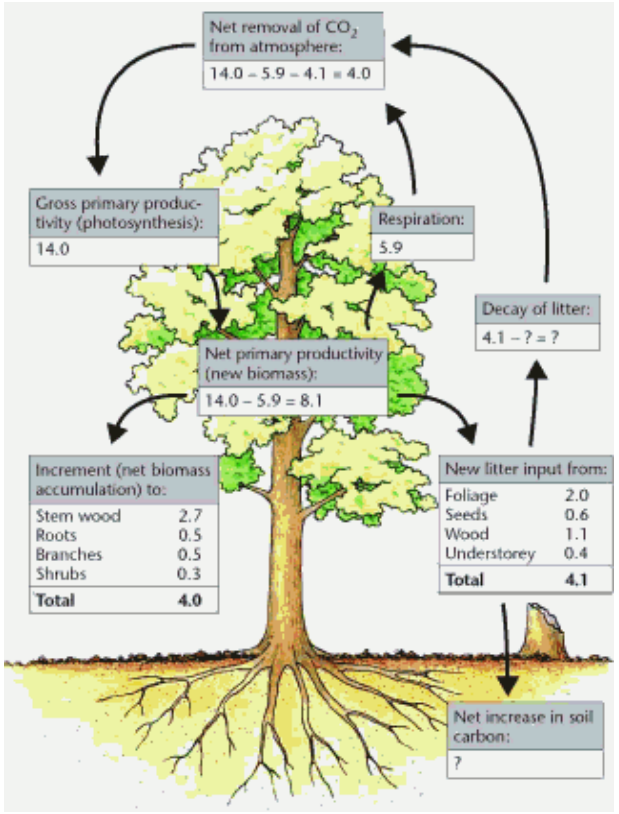
Systems Thinking

Global Carbon Balance



Sources: Center for climatic research, Institute for environmental studies, university of Wisconsin at Madison; Okanagan university college in Canada, Department of geography; World Watch, November-December 1998; Climate change 1995, The science of climate change, contribution of working group 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge press university, 1996.

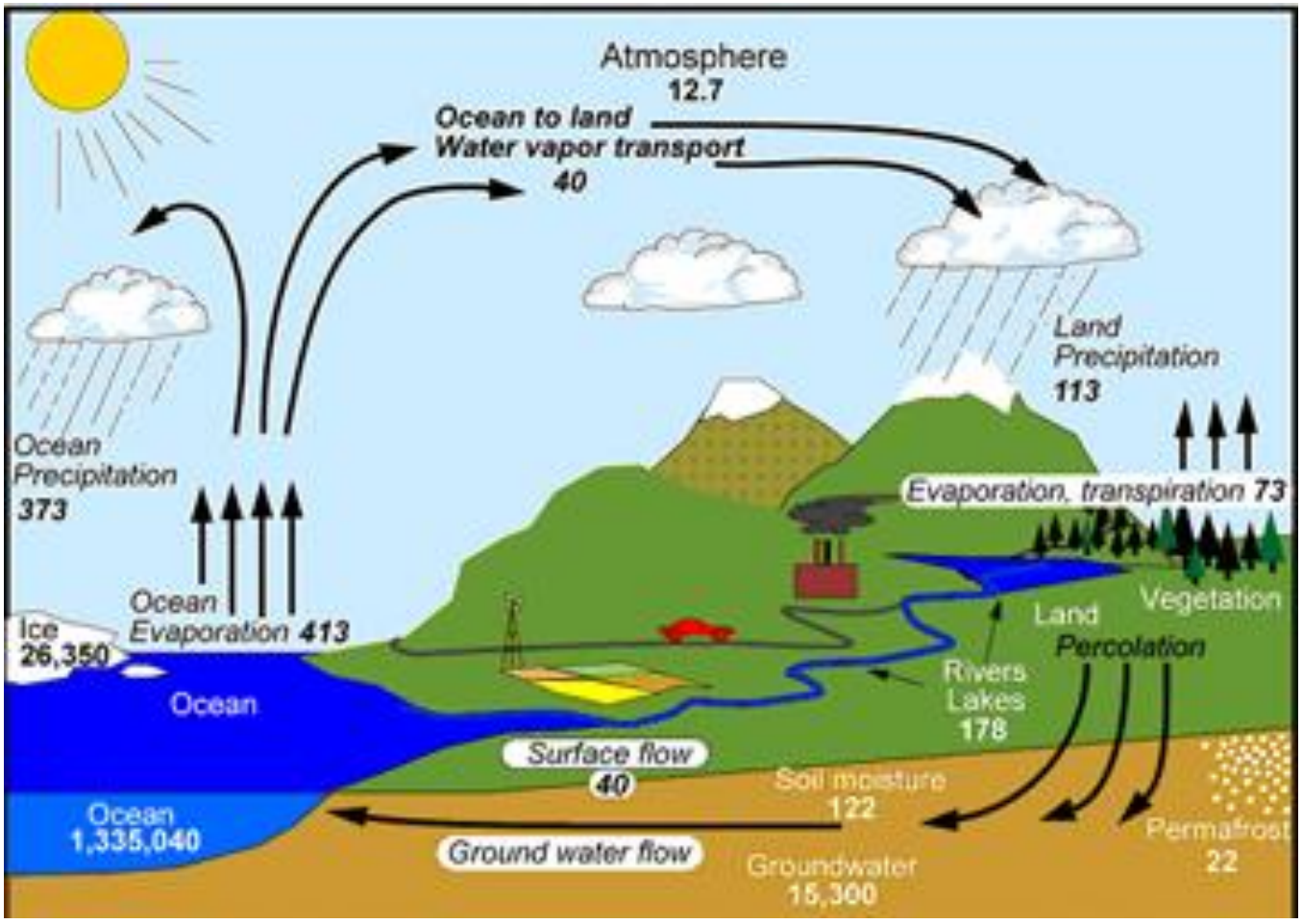
Forest Carbon Budget



Source: http://www.forestry.gov.uk/website/forestresearch.nsf/ByUnique/INFD-5Y2JFA

Systems Thinking

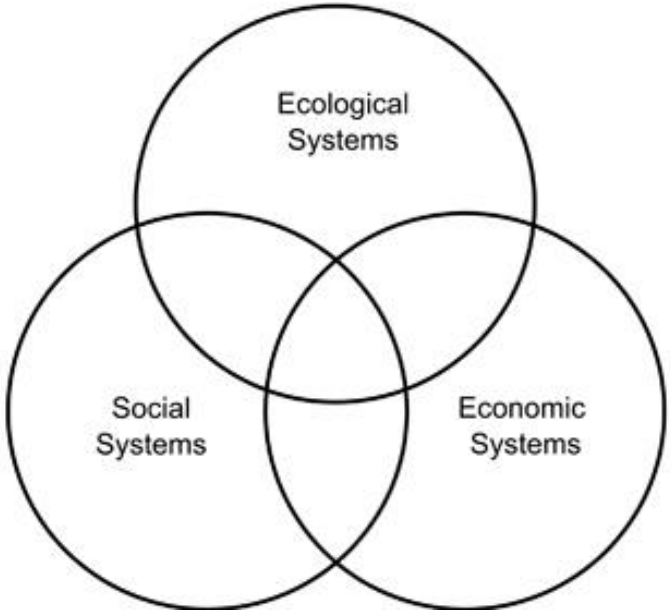
Global Hydrologic Balance

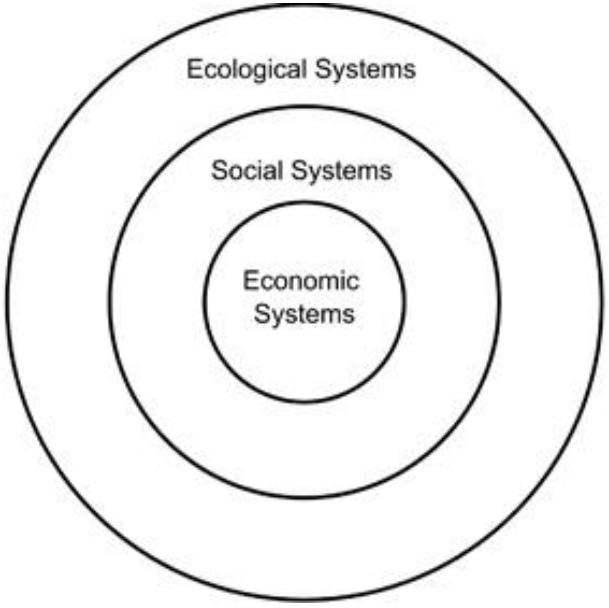


Source: Trenberth et al., 2007, Estimates of the global water budget and its annual cycle using observational and model data, Journal of Hydrometeorology

Systems Thinking

The concept of "nested systems" has particular relevance for conceptualizing sustainability.





Source: Stibbe, A. ed. (2009). The Handbook of Sustainability Literacy: Skills for a Changing World. Green Books, p. 86-87.

Shifts in Perception

Systems thinking entails making fundamental shifts of mind relative to our traditional way of thinking.

From the parts to the whole

- With any system, the whole is different from the sum of the individual parts.
- By shifting focus from the parts to the whole, we can better grasp the connections between the different elements.

From objects to relationships

- In the systems view, the "objects" of study are networks of relationships - relationships between individual parts may be more important than the parts.
- An ecosystem is not just a collection of species, but includes living things interacting with each other and their environment.

Shifts in Perception

From structure to process

- Living systems develop and evolve. Understanding these systems requires a shift in focus from structure to processes such as evolution, renewal, and change.

From contents to patterns

- Within systems, certain configurations of relationship appear again and again in patterns such as cycles and feedback loops.
- Understanding how a pattern works in natural or social system helps us to understand other systems that manifest the same pattern.
- For instance, understanding how flows of energy affect a natural ecosystem may illuminate how flows of information affect a social system.

Shifts in Perception

From objective knowledge to contextual knowledge

- Shifting focus from the parts to the whole implies shifting from analytical thinking to contextual thinking.
- This shift encourages experts to be facilitators and fellow learners, rather than experts dispensing knowledge.

From quantity to quality

- Western science has often focused on things that can be measured and quantified.
- It has sometimes been implied that phenomena that can be measured and quantified are more important—and perhaps even that what cannot be measured and quantified doesn't exist at all.
- Some aspects of systems, however, like the relationships in a food web, cannot be measured. Rather, they must be mapped.

Feedbacks

- When the output of a system is fed back into the system as part of its input, it is called the "feedback".
- Feedback is both a mechanism, process and signal that is looped back to control a system within itself (feedback loop).
- Systems thinking emphasizes circular feedback:
  - A leads to B, which leads to C, which leads back to A
- Rather than linear cause and effect:
  - A leads to B, which leads to C, which leads to D,…

Feedbacks

Positive (reinforcing) feedback:

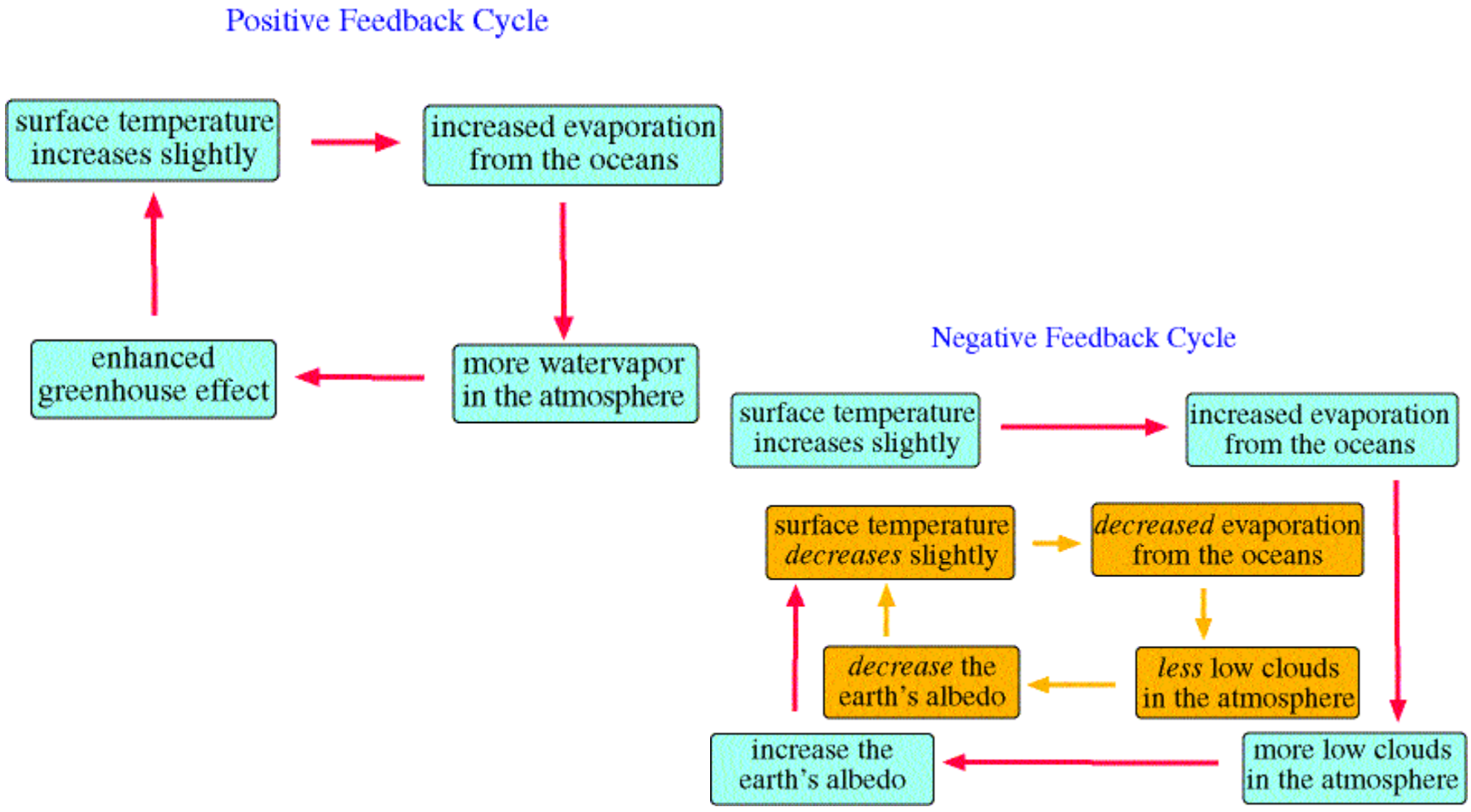
- Tending to reinforce the direction of change (generates exponential growth or collapse).

Negative (balancing) feedback:

- Tending to reverse the direction of change (helps a system maintain stability).

Examples of feedback mechanisms can be found in most complex systems, such as engineering, economics, thermodynamics, ecology, biology, societies…

Feedbacks



Source: http://apollo.lsc.vsc.edu/classes/met130/notes/chapter16/neg_feedback.html

Conclusion

- Systems thinking is a way of understanding reality that emphasizes the relationships among a system's parts, rather than the parts themselves.
- The systems view of our human systems as operating within the larger Earth ecosystem is crucial for achieving a sustainable relationship with the environment, and assuring the continual survival of our own species on the planet.
- Exploring this way of thinking and applying it in determining our future is an opportunity we cannot afford to miss.

Exercises for Self-Study

1. Explain how systems thinking differs from positivist and reductionist thinking.

2. Describe the "messages" conveyed to you by the two diagrammatic representations of sustainability used in this lecture.

3. What does the systems view of nature tell us about our place on Earth?