

system sustainability

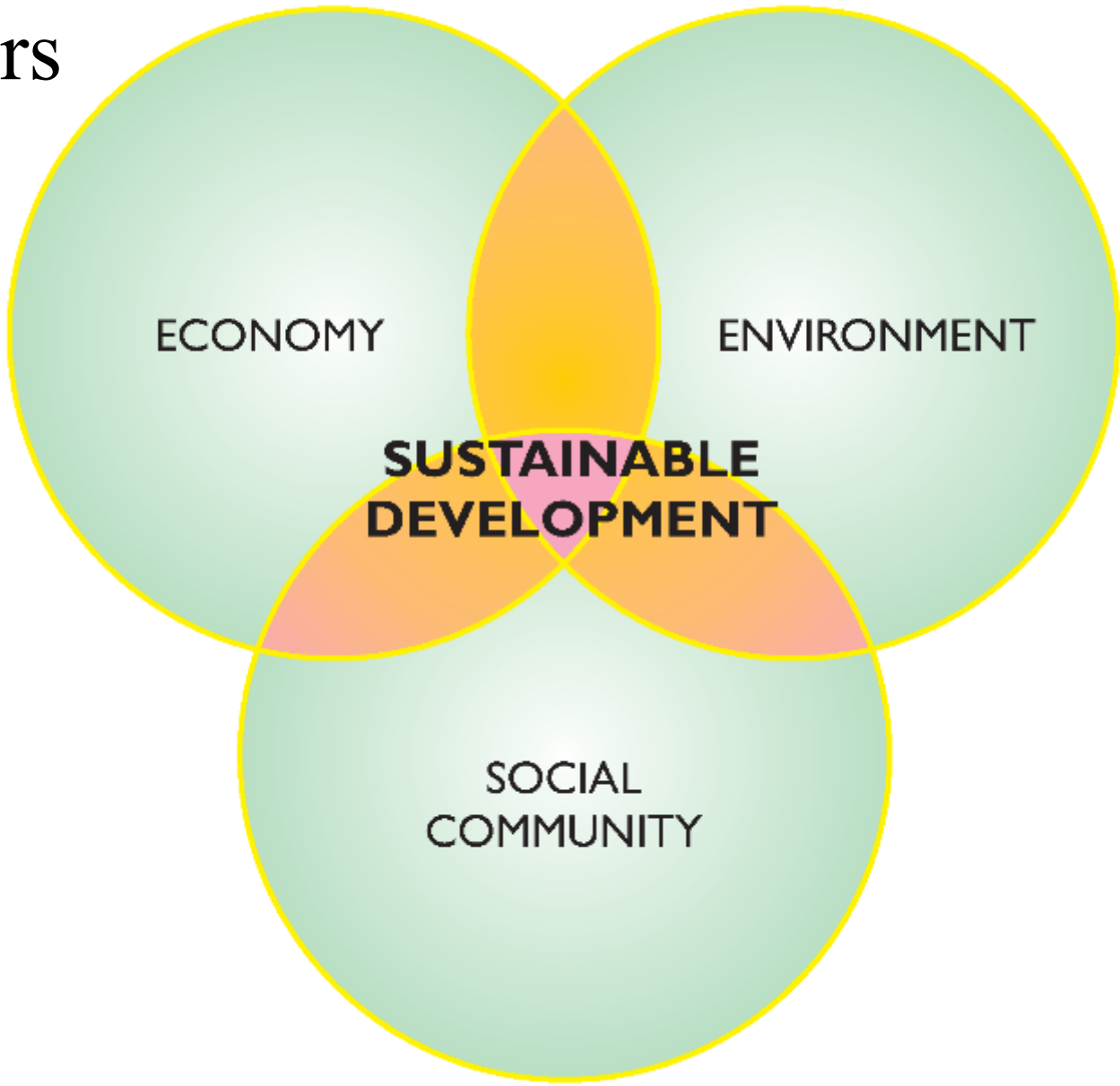
A decorative teal gradient shape is located at the bottom of the slide, starting from the left edge and extending towards the right, with a slight upward curve on its top edge.

Sustainable Development vs Sustainability

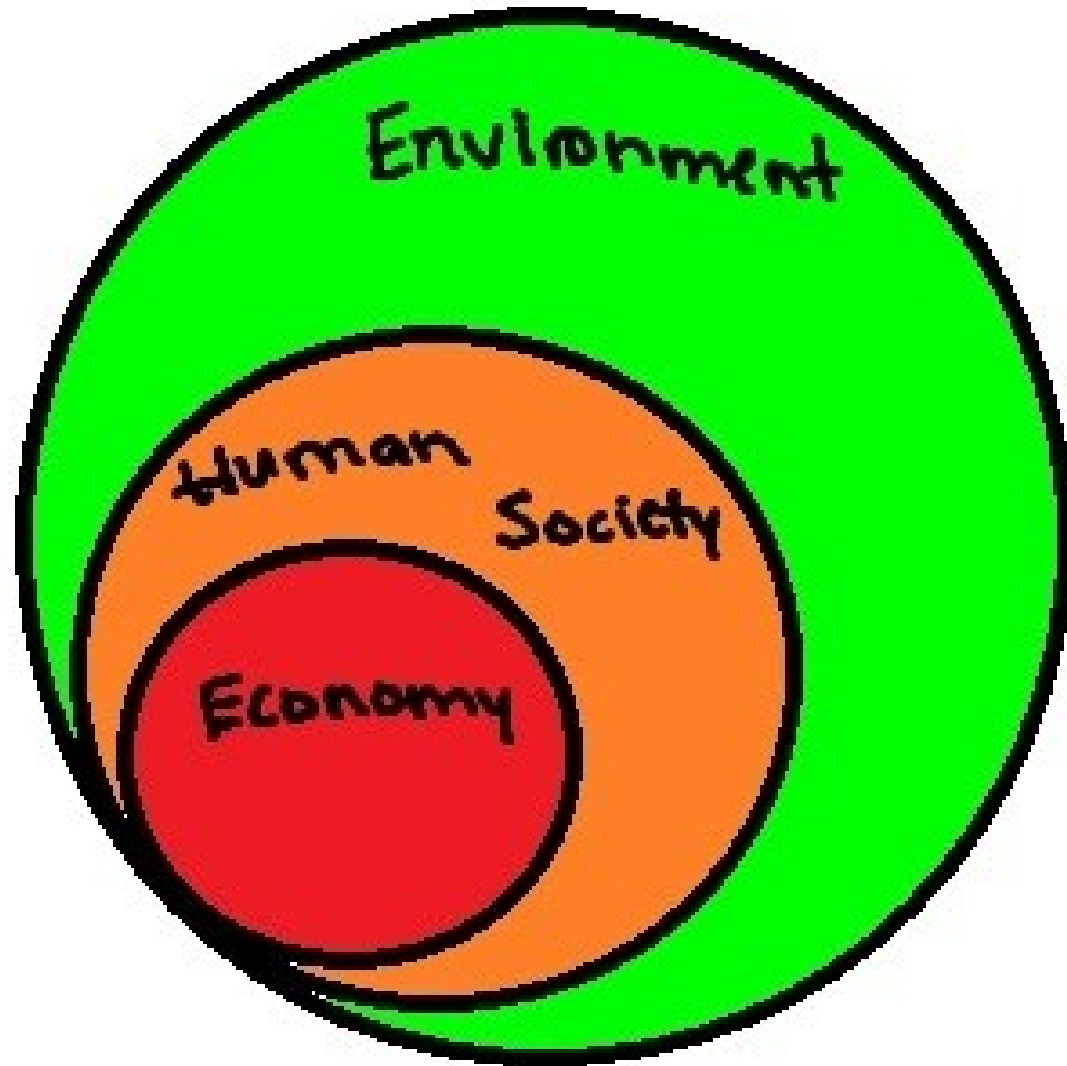
- ▶ Sustainable Development: “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” – *Our Common Future*/ Brundtland Report, 1987
- ▶ Sustainability: “the capacity to endure; how systems remain diverse and productive over time” – wikipedia

What are our “needs”?

Three pillars of SD



Environment is foundation for all aspects, others are subsets



Misuse of the term sustainable

- ▶ Adjective that means “green”
- ▶ “A little better for the environment than the alternative”
- ▶ Less bad
- ▶ greenwashing



SUSTAINABLE DEVELOPMENT GOALS



Adopted September 2015 – also called Agenda 2030





Amsterdam
airport
promotes
the SDGs!!

SUSTAINABLE DEVELOPMENT GOALS



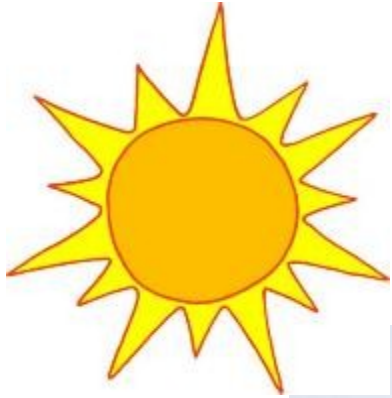
Ecological basis

- ▶ Why eco-literacy matters; understanding ecosystems
 - Energy flow
 - in ecosystems
 - In society
 - Biogeochemical cycles – Where does it come from? Where does it go? What is it used for?
 - Carbon
 - Nitrogen
 - Phosphorus
 - Water, ...
 - Dynamics – how systems change over time
 - Succession
 - Human development

What is life?



A single cell possesses all the necessary aspects to be alive



Abiotic and ecological interactions



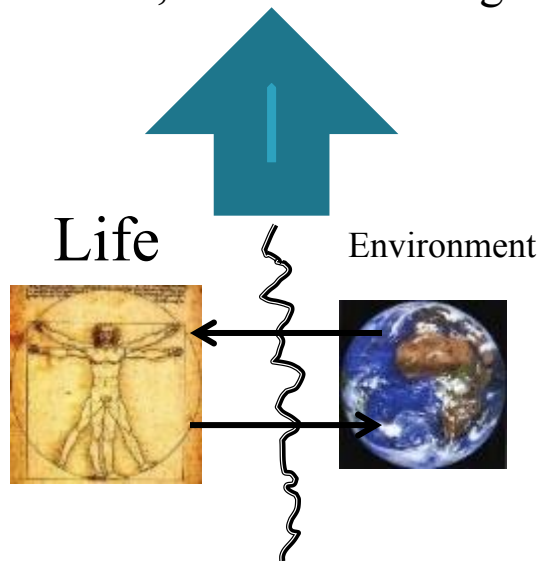
A single organism possesses all the necessary aspects to be alive

Mental models and outcomes

Real impacts of choice of system boundaries

Tragedy of the Commons

Humans win, environment degrades



Figures by Dan Fiscus

- Inherent in this paradigm, life is separate from environment in mind and action
- Once fragmented, it is possible and likely that the value of environment is seen and treated as less than the value of life
- Environment is consumed and degraded as manifest in many symptoms of ecological crisis



Ecosystem is full
of

Interconnections
and
Interdependencies

Art work of Jan Heath, entitled "food chain"

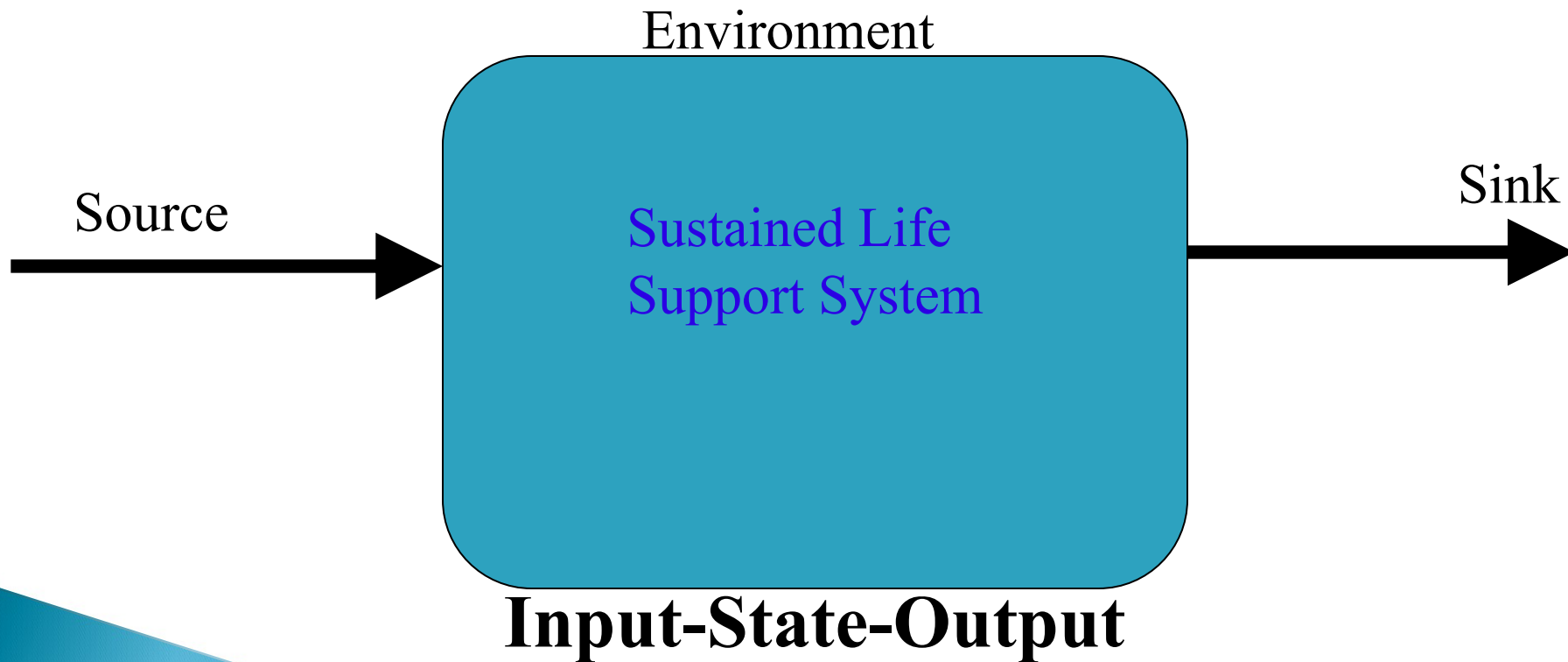
Interacting ecological community and its abiotic environment is an ecosystem



An ecosystem possesses all the necessary aspects to sustain life

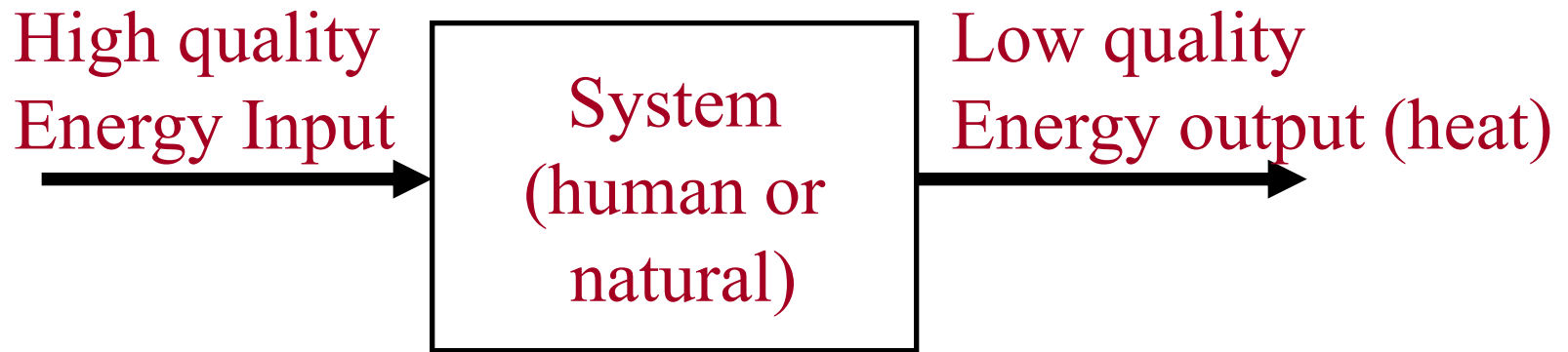
Open Systems

Open systems connect to their environment through both inputs and outputs

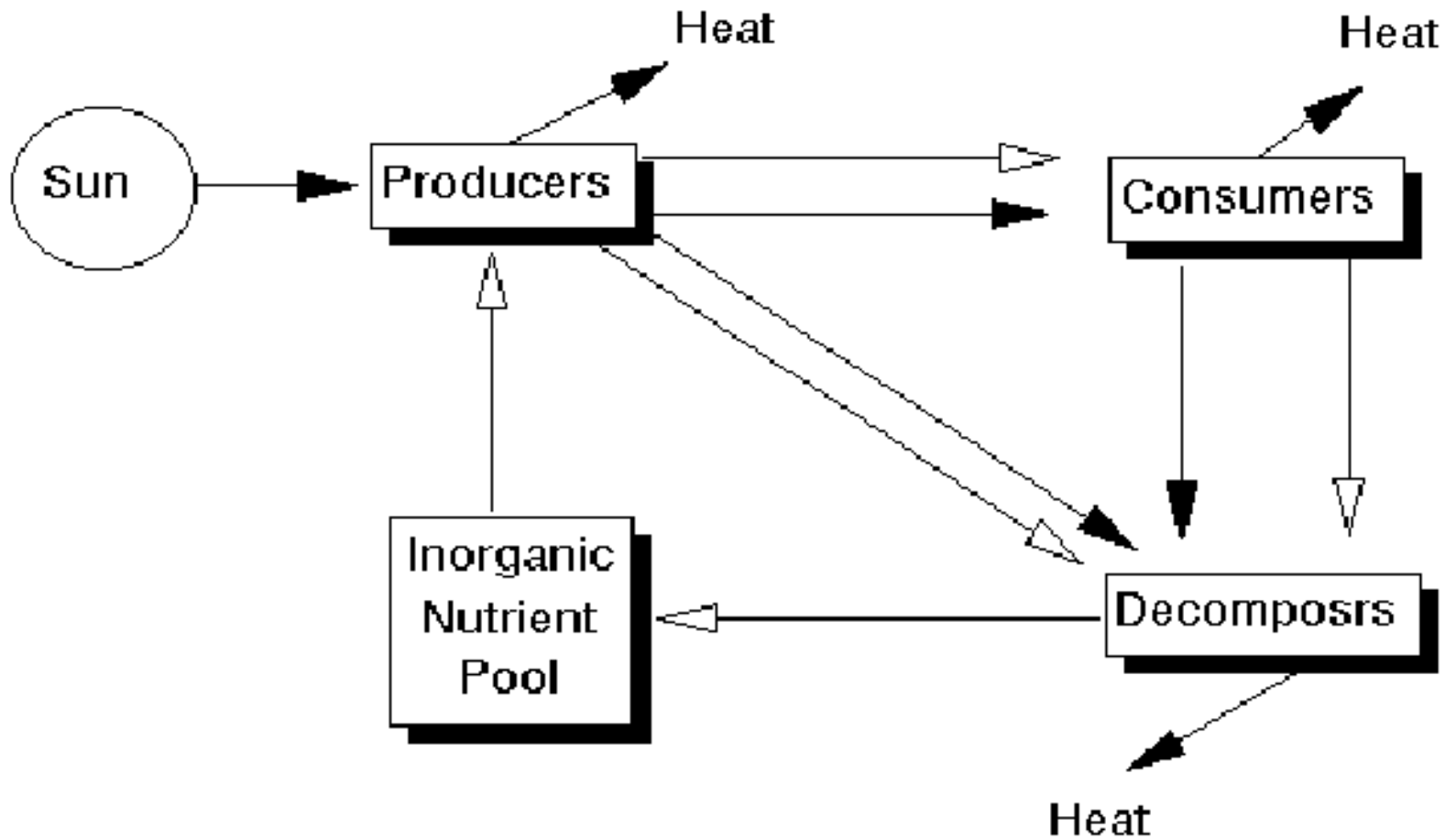


Thermodynamically, Open Systems

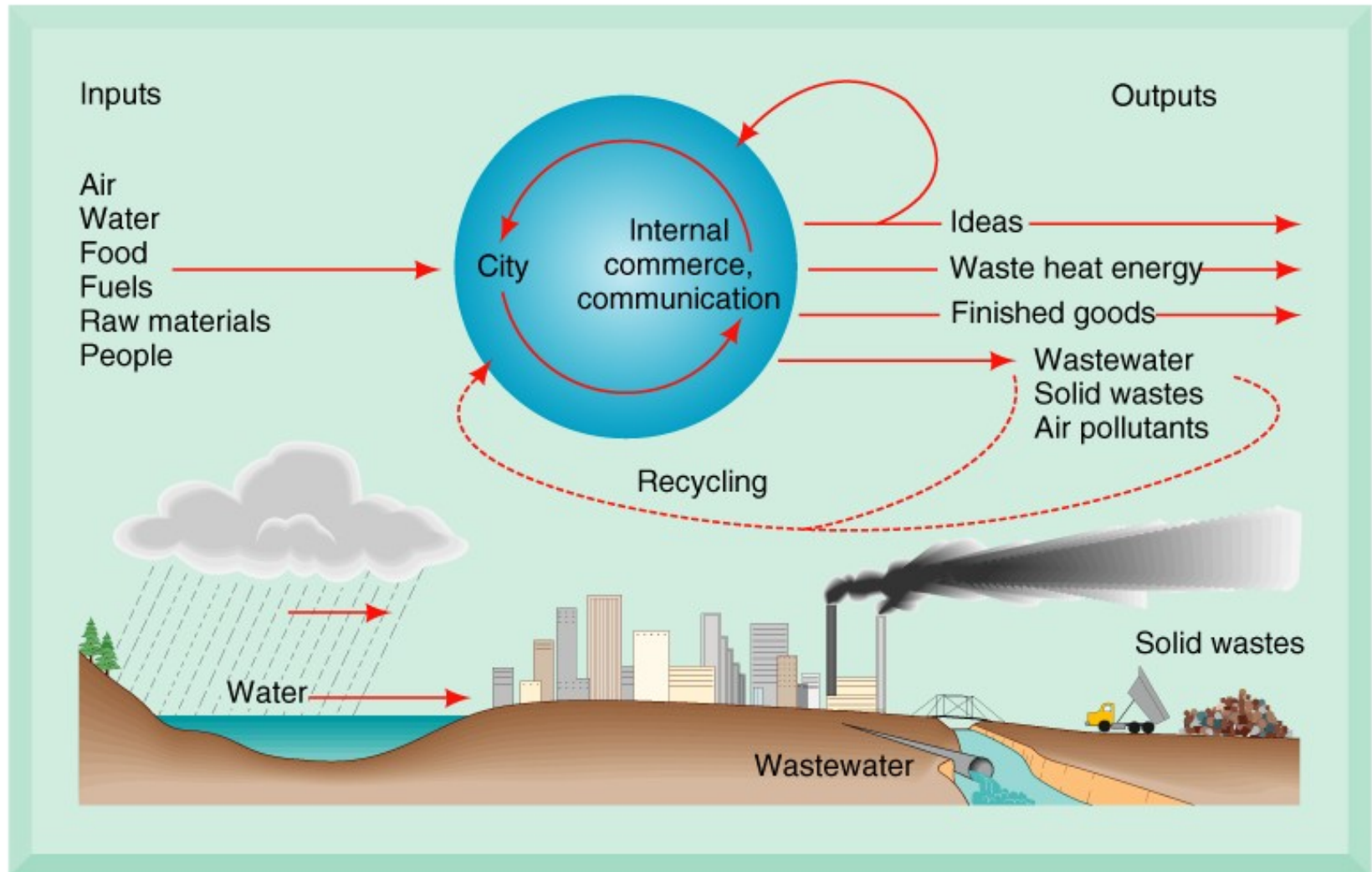
...build and maintain order and organization by taking in high quality energy, using it, and passing degraded energy outside of the system.



Simplified Ecosystem



Simplified Human System



What is sustainable?

Sustainability Constraints

Input, Output, and System Dynamics



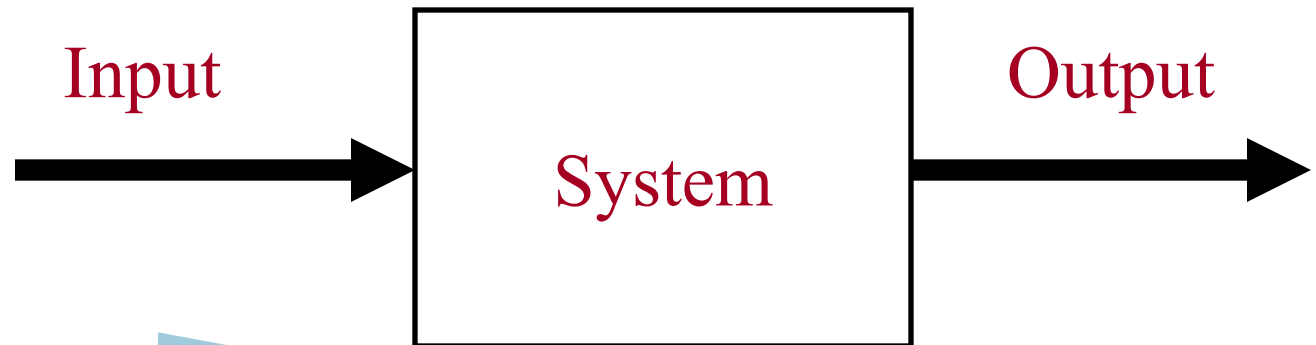
Input availability AND **Output** absorbance

VALUING THE EARTH

Daly and Townsend (1993)

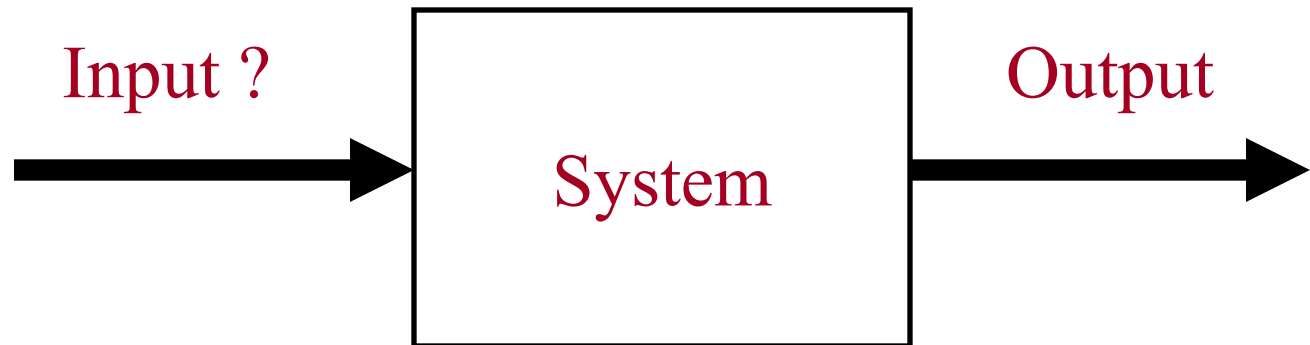
Renewable resources should be used such that:

- 1) harvesting rate \leq regeneration rate, and **DON'T TAKE TOO MUCH**
- 2) waste \leq assimilation capacity, and **DON'T LEAVE TOO MUCH BEHIND**



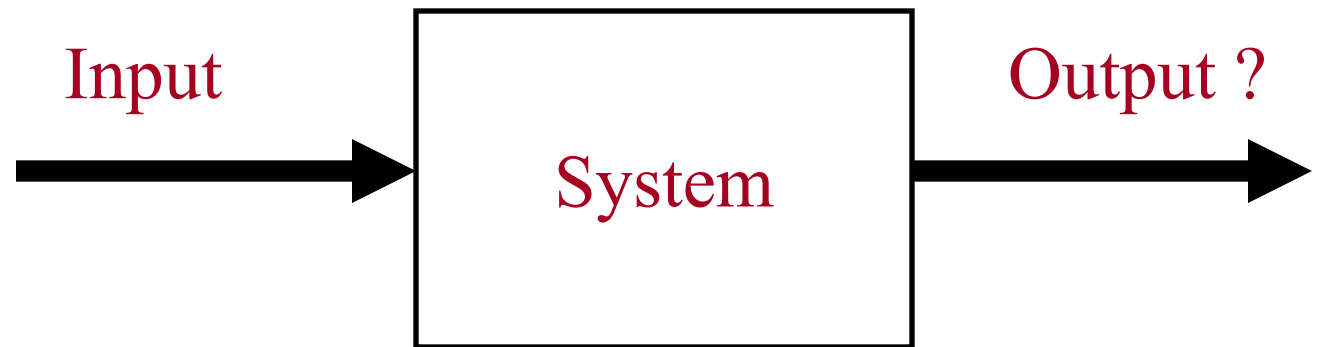
Ecosystem Input Constraints

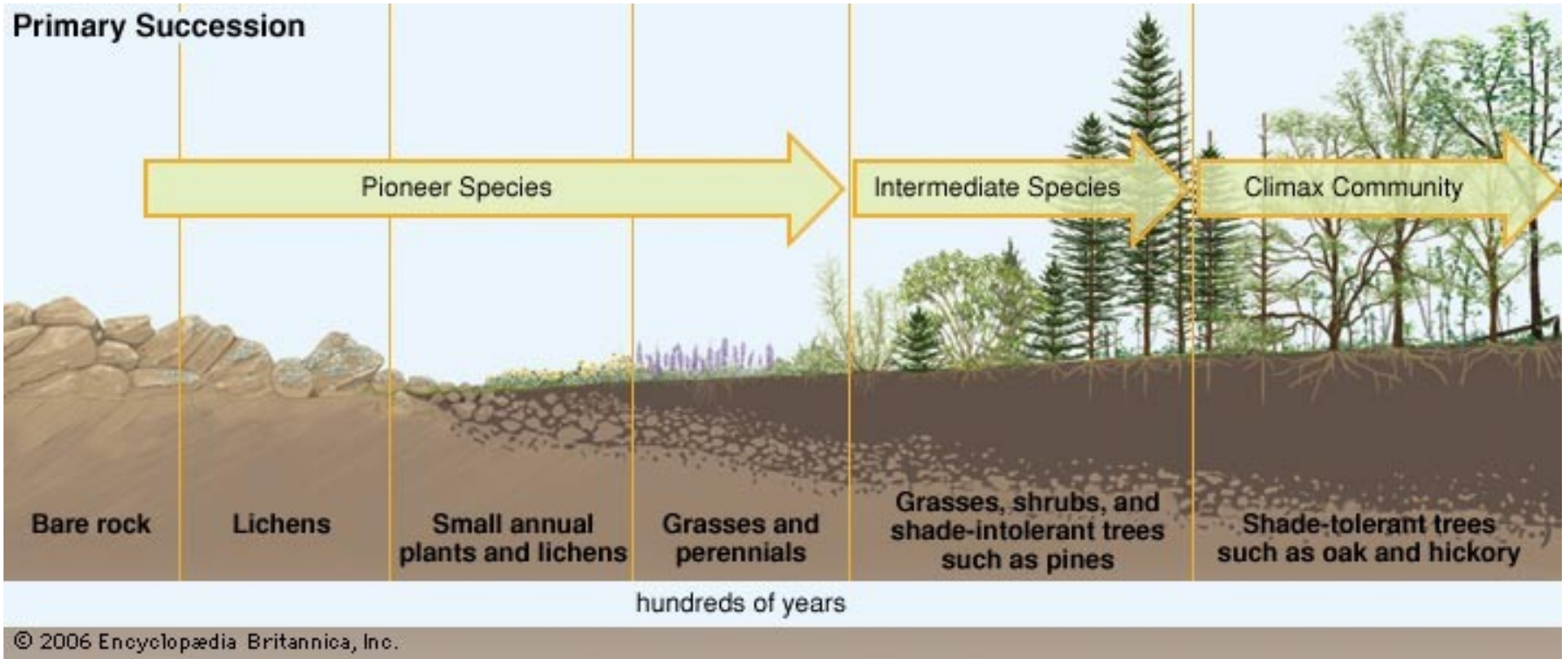
- ▶ Solar radiation
- ▶ Global carbon cycle
- ▶ Rate of nutrient cycling
- ▶ Rate of hydrological cycle



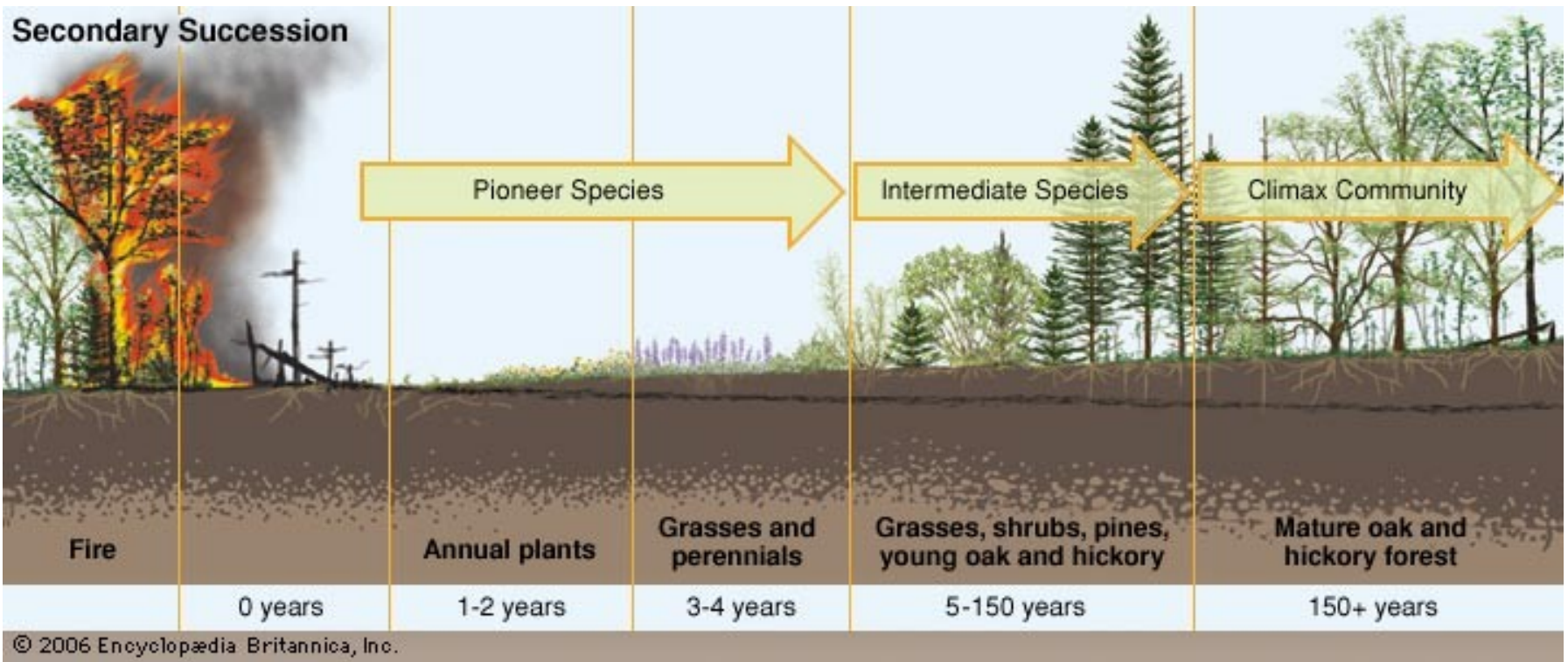
Ecosystem Output Constraints

- ▶ Rate of decomposition
- ▶ Rate of accumulation of unwanted byproducts
- ▶ Finding others to take your waste



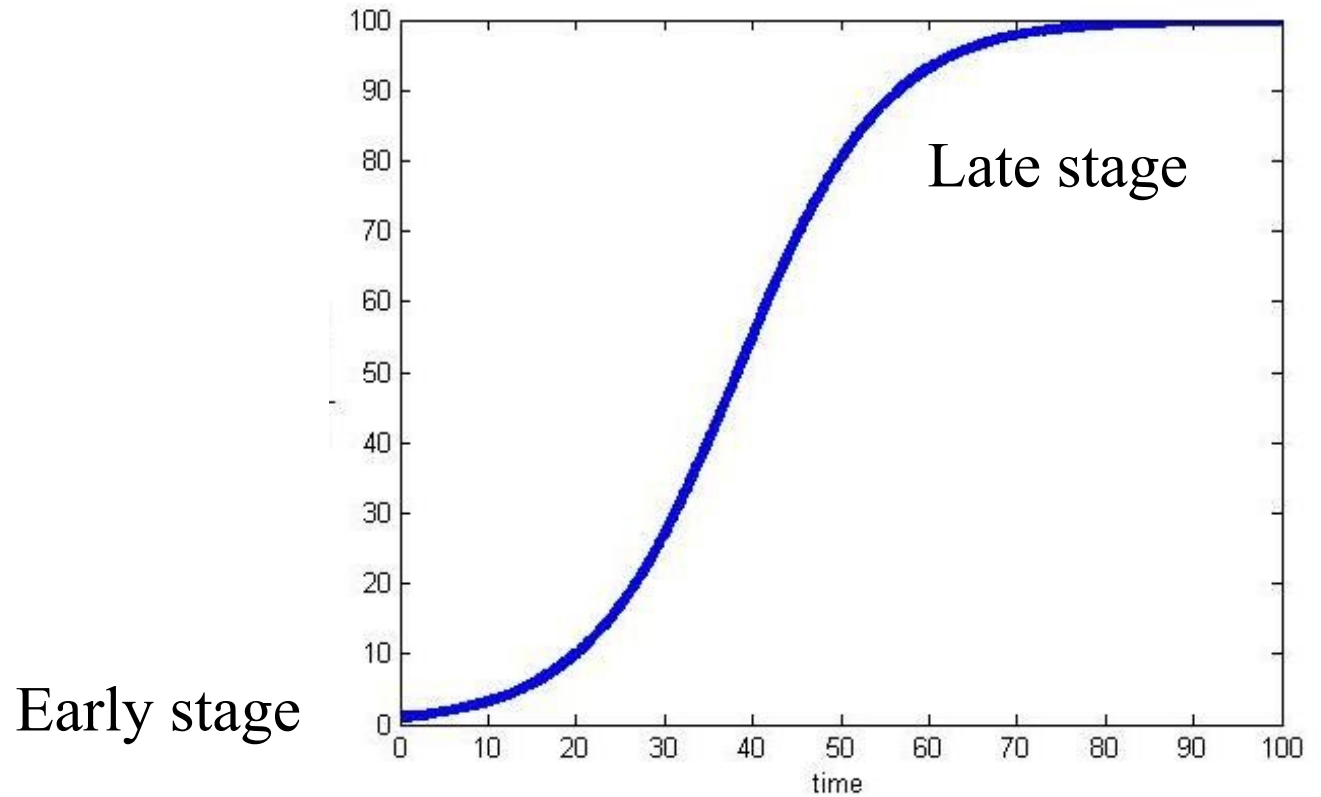


Primary succession – initial establishment and development of an ecosystem in an area devoid of an ecological community



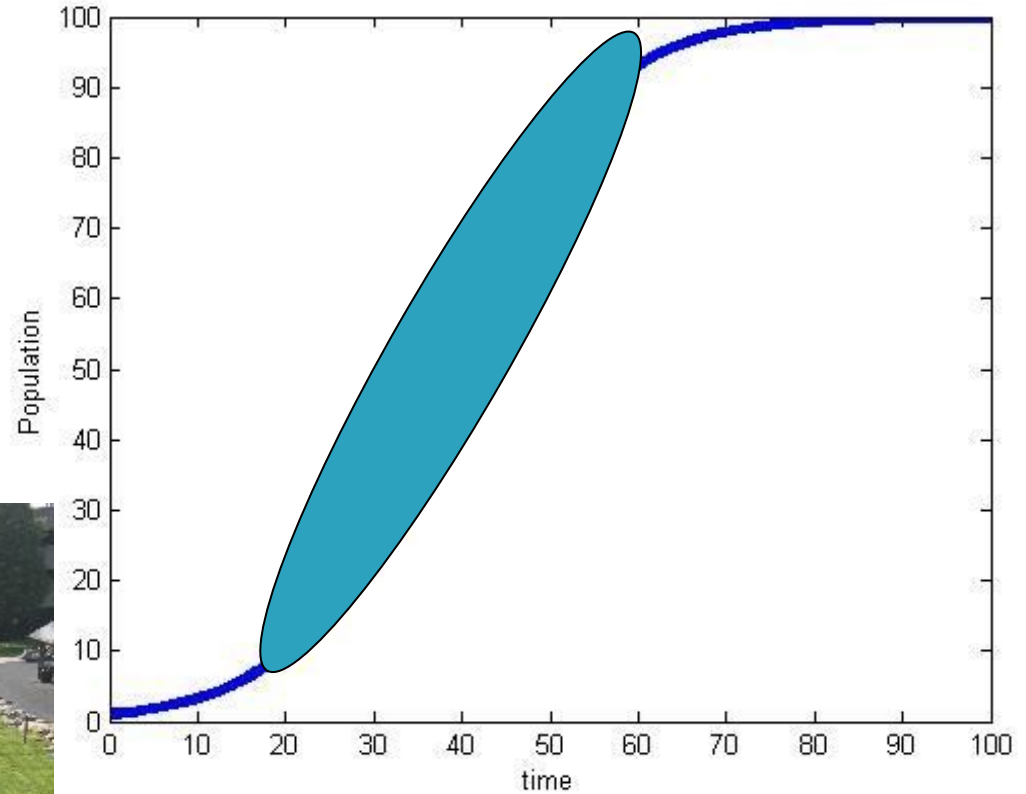
Secondary succession – reestablishment of an ecosystem from the remnants of a previous biological community following disturbance

Logistic growth from early to late successional stages




Ecosystem services are extracted to exploit growth phase

Human induced succession—deforestation, agriculture—moves the system back to earlier stage.



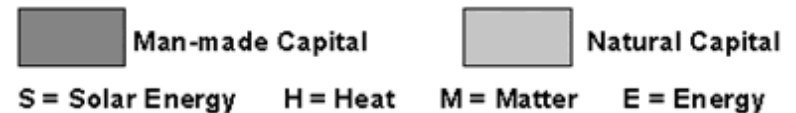
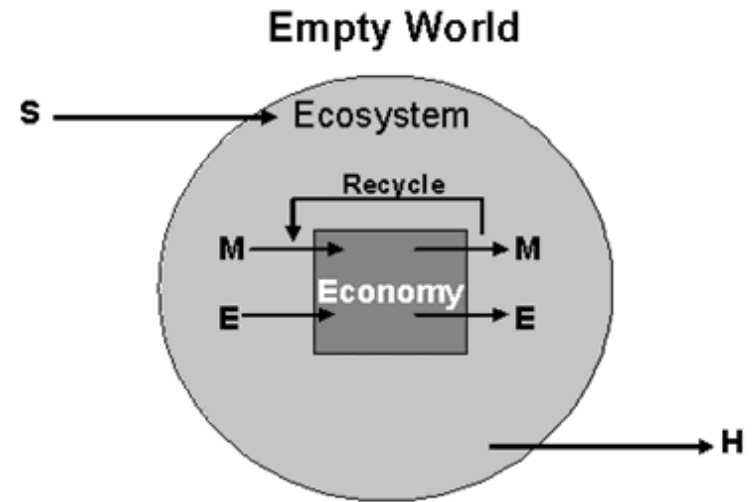
Factors influencing our goal to reach sustainability

- ▶ There are more of us
 - ▶ We are trapped in growth phase of system dynamics
 - ▶ Lack of conservation awareness/ethic
 - Systems thinking vs. Short-term thinking
 - wrong temporal and spatial scale
 - ▶ Full utilization of non renewables
 - ▶ Impact on biogeochemical cycles and global drivers
 - ▶ Human systems are designed linearly, Nature works in cycles
 - ▶ Economics
 - Externalities
 - Low rate of regeneration of renewables
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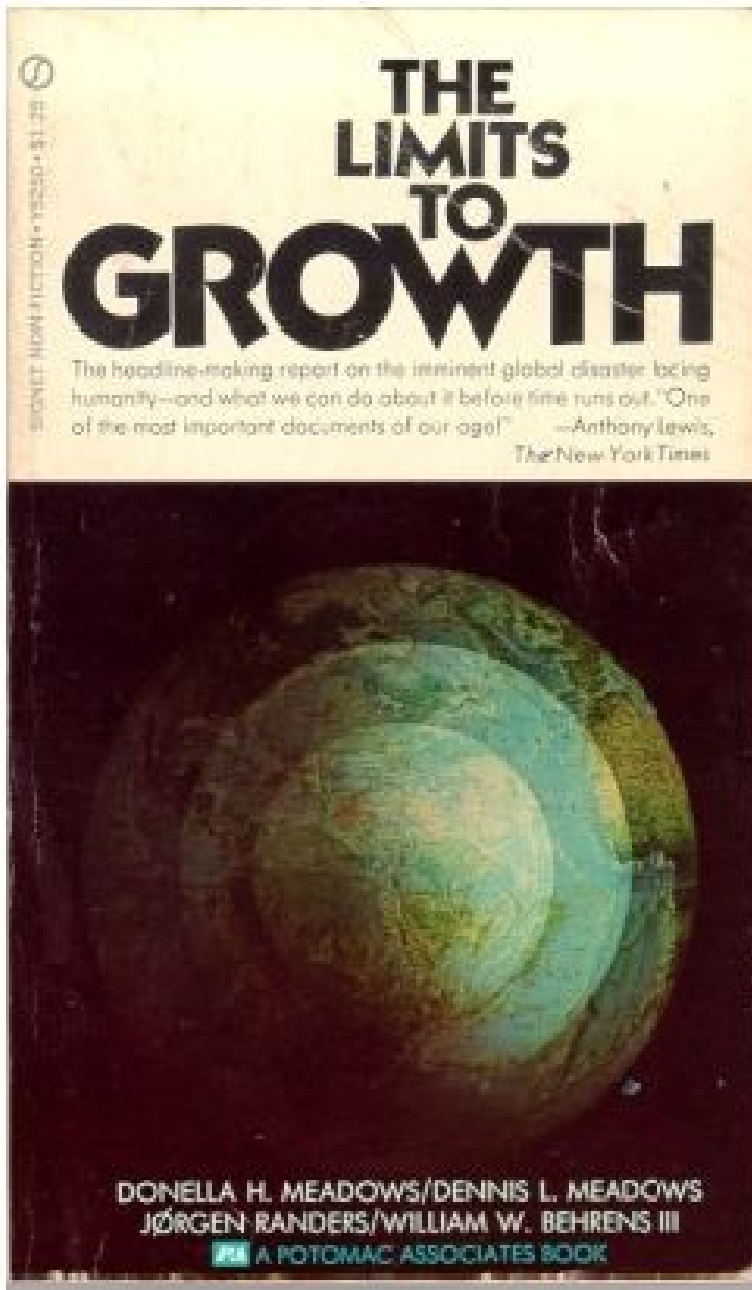
Emergence of humans, from a minor component of natural system to predominant occupant

Scale of humanity has increased greatly putting pressure on all natural resources

The changes have come so fast our customs, ethics, and religious pattern may not have adapted to them.







- ▶ *“There are limits. Let’s celebrate the limits, because we can reinvent a different future.”*

Sunita Narain

This Changes Everything

Growth → *Quantitative* increase **Extensive**
Development → *Qualitative* increase **Intensive**

"We must realize that growth and development are two very different things. You can develop without growing and vice versa."

Tibor Vasko, 2009,
www.solon-line.de/interview-with-tibor-vasko.html

Limits to Growth

- ▶ *“Natural principles of chemistry, mechanics and biology are not merely limits. They’re invitations to work along with them.”*

Jane Jacobs, 2000, p. 12
The Nature of Economies



FLOURISHING WITHIN LIMITS TO GROWTH

Following nature's way


Sven Erik Jørgensen, Brian D. Fath,
Søren Nors Nielsen, Federico M. Pulselli,
Daniel A. Fiscus and Simone Bastianoni



Recognize the bio-physical limits

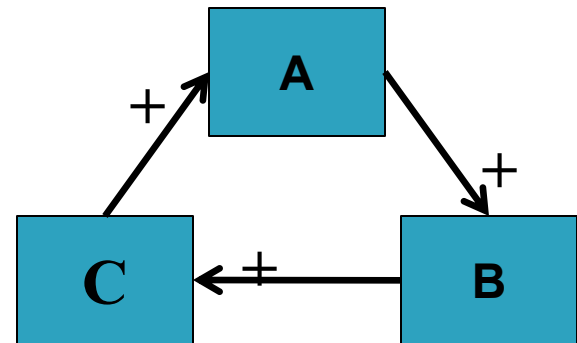
Purposefully build quality and well-being following nature's way

What are the necessary and sufficient conditions of sustainability?

- ▶ Meeting Input–Output requirements are necessary but not sufficient conditions for sustainability
 - ▶ Also, necessary for persistence of functional gradients
 - ▶ What causes the persistence?
- 

System function: Self-organization

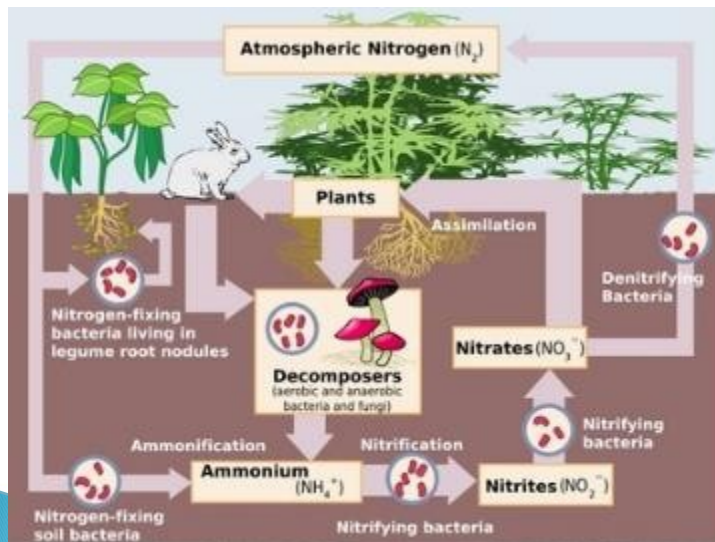
- ▶ Positive reinforcements maintain a system at high level of organization
- ▶ Each process in the cycle facilitates the next
- ▶ Sustaining systems possess a configuration of autocatalytic processes – coupled and overlapping at different scales



Simple autocatalytic cycle

Material reuse and recycling

- ▶ Output feeds in as input to another part of the system
- ▶ Recycling – nature and humans



Process coupling

- ▶ The process or action of fitting into the system, provides roles or actions for others in the system
- ▶ The act has to be in the flow of the already chosen actions



Process uncoupled



Coupling in space

Main Street

- ▶ once a vibrant economic system, existing to reinforce other activity in the town, now a Disneyfied, nostalgic, showcase of boutique shops, restaurants, and ice cream parlors to attract tourists, but dependent on external inputs and not efficiently closed



Coupling leads to coherence

- ▶ “Each center is (recursively) dependent on other coherent centers for its own coherence”
Alexander (2012) referring to urban planning

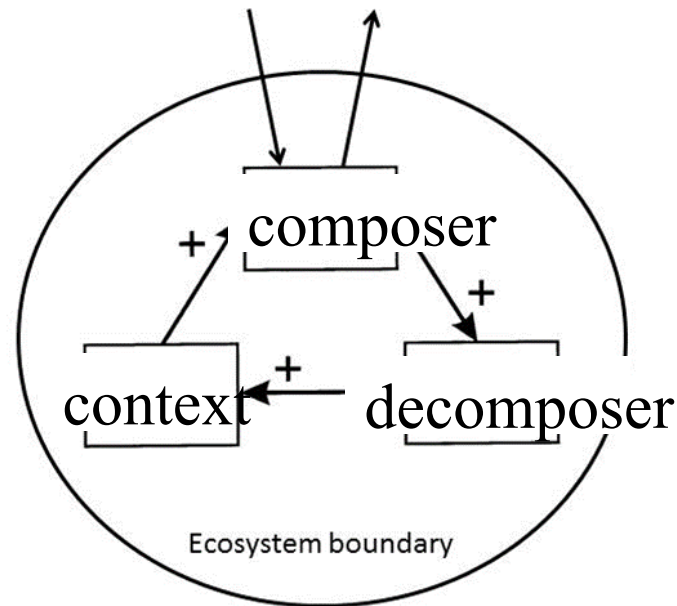


Spiral up

Spiral down – lack of coherence



Coupled transformers



Most basic sustainable system requires a producer/composer and consumer/decomposer in an autocatalytic process



“It may be that all self-sustaining systems are reciprocating”

Jacobs, 1969, p. 126

Importance of place


- ▶ Protection and investment in place
- ▶ Finding the balance of what the environment offers: sustaining (and enhancing) those flows
- ▶
- ▶ Geography of Nowhere



Place worth protecting

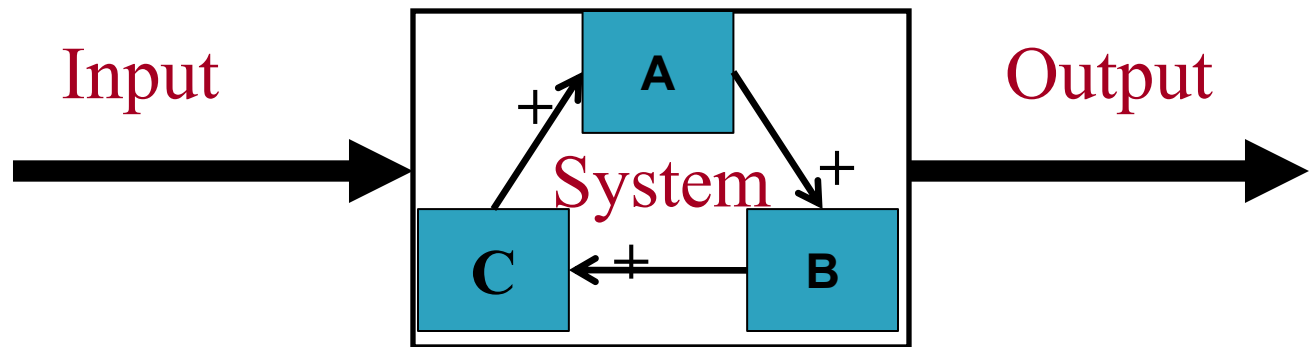


Summary: Process coupling


- ▶ Linking together of processes that are positively reinforcing: autocatalysis
 - ▶ Systems are costly to maintain unless closing its own function
 - ▶ Closure leads to niche extension and creation: Emergence of diversity and complexity
- 

Conclusions: Sustainability is a property of interaction networks

- ▶ Reliable Inputs
- ▶ Healthy Outputs
- ▶ Recycling of material – my output is your input
- ▶ Processes functionally linked together – my useful byproducts happen in the act fitting into the network

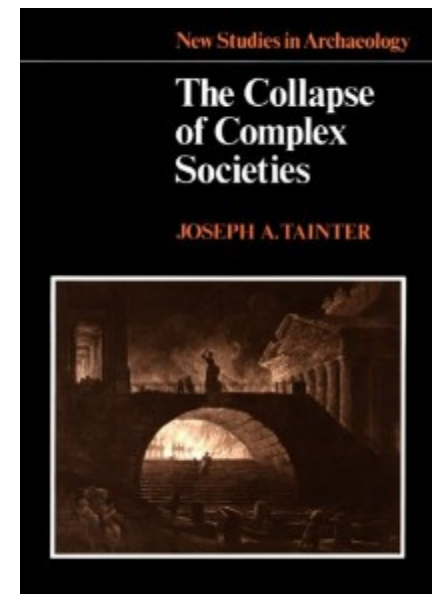


Summary


1. Ecosystems are very good at maintaining at the carrying capacity with substantial but not growing production.
 2. Current economics emphasizes increasing production—in addition to supporting all the existing built structure.
 3. Quantitative production/growth is an early immature stage according to ecological succession.
 4. How production/growth is viewed in ecological versus societal systems is one of the main conflicts and leads to much of the tension in resolving environmental management.
- 

Is sustainability still possible?

- ▶ “Growing human populations are eating more meat, using more carbon-based energy, shouldering aside more natural resources, and tapping into more renewable and nonrenewable commodities than ever before.”
- ▶ “If humanity fails to achieve sustainability, when, and how, will unsustainable trends end?”

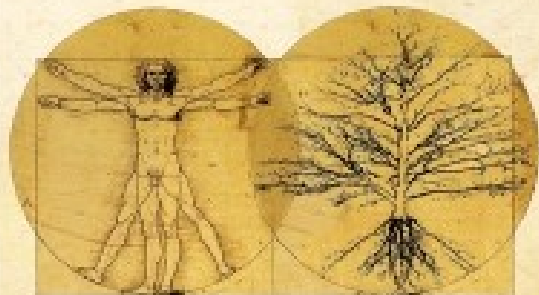


Is sustainability still possible?

- ▶ Why has it proved so hard to conform human behavior to the needs of a life-supporting future?
 - ▶ Our political and economic institutions evolved before anyone imagined the need to restrain human behavior out of concern for the future.
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Foundations *for* Sustainability

A Coherent Framework of Life–Environment Relations



Daniel A. Fiscus, Brian D. Fath



Foundations *for* Sustainability



THANK YOU FOR YOUR ATTENTION