2015

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

Chapter 1 - Introduction

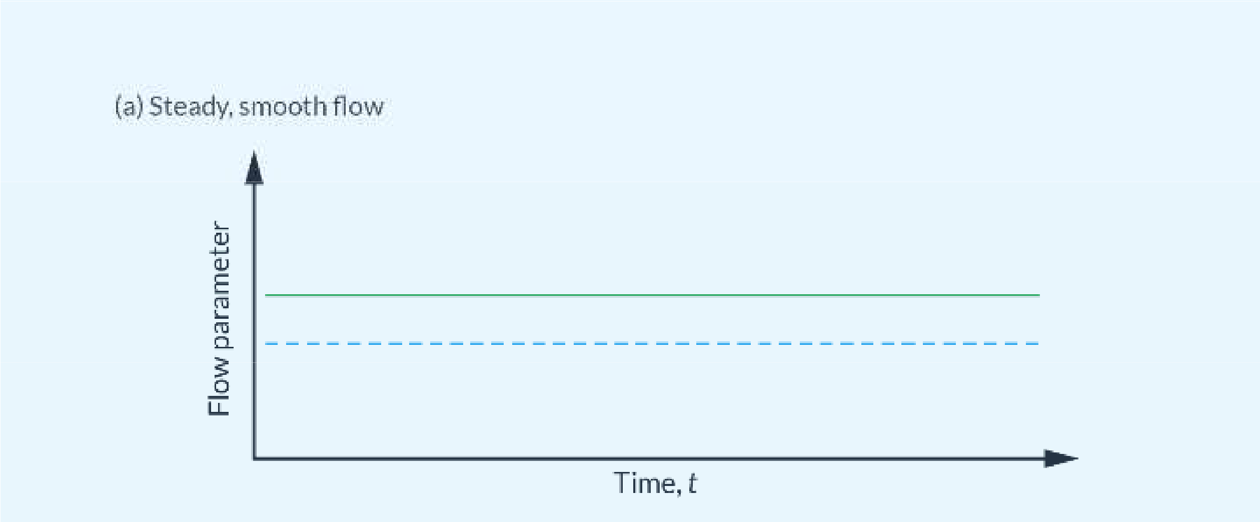
- *Natural principles of chemistry, mechanics and biology are not merely limits. They're invitations to work along with them.* —Jane Jacobs, *The Nature of Economies*, 2000, p. 12

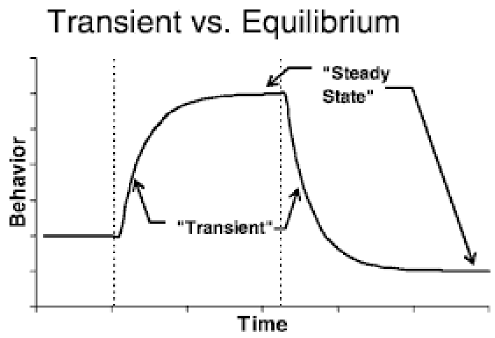
Your reaction

1) What does the quote mean and what does it have to do with this chapter?

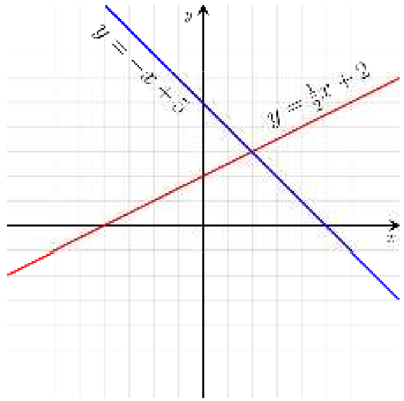
2) What part was most confusing or most difficult to understand?

Steady state and linear growth





$$\frac{\partial p}{\partial t} = 0 \quad \text{for all present and future } t.$$

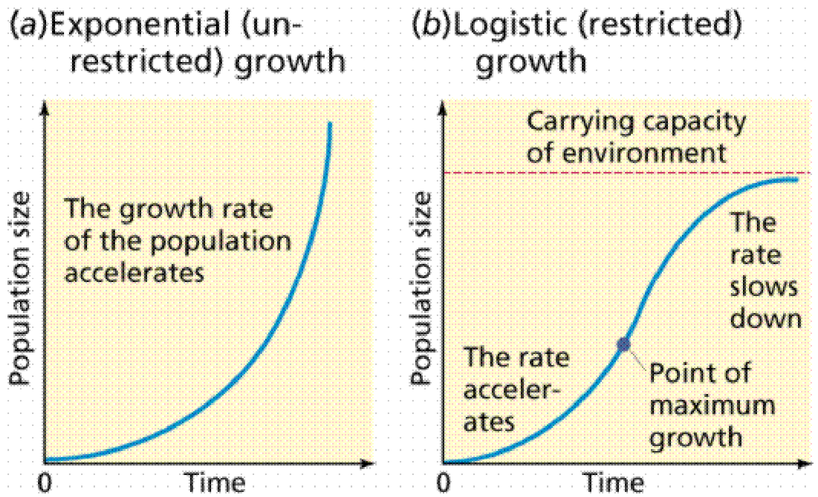


$$f(x) = ax + b,$$

Linear growth – change in constant amount

Exponential and logistic growth

Unconstrained Growth



Constrained Growth
(environmental resistance)

Exponential growth – change at a constant rate (unconstrained positive feedback)
Logistic begins exponential but then feels the negative feedback pressure of the CC

Drake Equation – is there life out there?

$$N = R_* \cdot f_p \cdot n_e \cdot f_l \cdot f_i \cdot f_c \cdot L$$

- Where, N = the number of civilizations in the Milky Way galaxy with which communication might be possible (i.e. which are on the current past light cone);
- R∗ = the average rate of star formation in our Galaxy.
- fp = the fraction of those stars that have planets.
- ne = the average number of planets that can potentially support life per star that has planets.
- fl = the fraction of planets that could support life that actually develop life at some point.
- fi = the fraction of planets with life that go on to develop intelligent life (civilizations).
- fc = the fraction of civilizations that develop a technology that releases detectable signs of their existence into space.

Fermi paradox - Where is everybody?

Explanations can be divided into three classes:

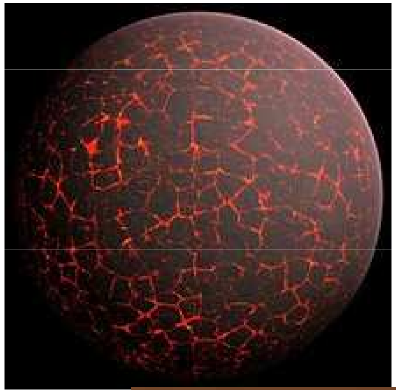
- Few intelligent civilizations ever arise.
  - This is an argument that at least one of the first few terms, $R* \cdot fp \cdot ne \cdot fl \cdot fi$, has a low value. The most common suspect is fi, but explanations such as the rare Earth hypothesis argue that ne is the small term.
- Intelligent civilizations exist, but we see no evidence, meaning fc is small.
  - Typical arguments include that civilizations are too far apart, it is too expensive to spread throughout the galaxy, civilizations broadcast signals for only a brief period of time, communication is dangerous, and many others.
- The lifetime of intelligent, communicative civilizations is short, meaning the value of L is small.
  - Drake suggested that a large number of extraterrestrial civilizations would form, and he further speculated that the lack of evidence of such civilizations may be because technological civilizations tend to disappear rather quickly. Typical explanations include it is the nature of intelligent life to destroy itself, it is the nature of intelligent life to destroy others, they tend to be destroyed by natural events, and others.

Race to the stars (or at least Mars)

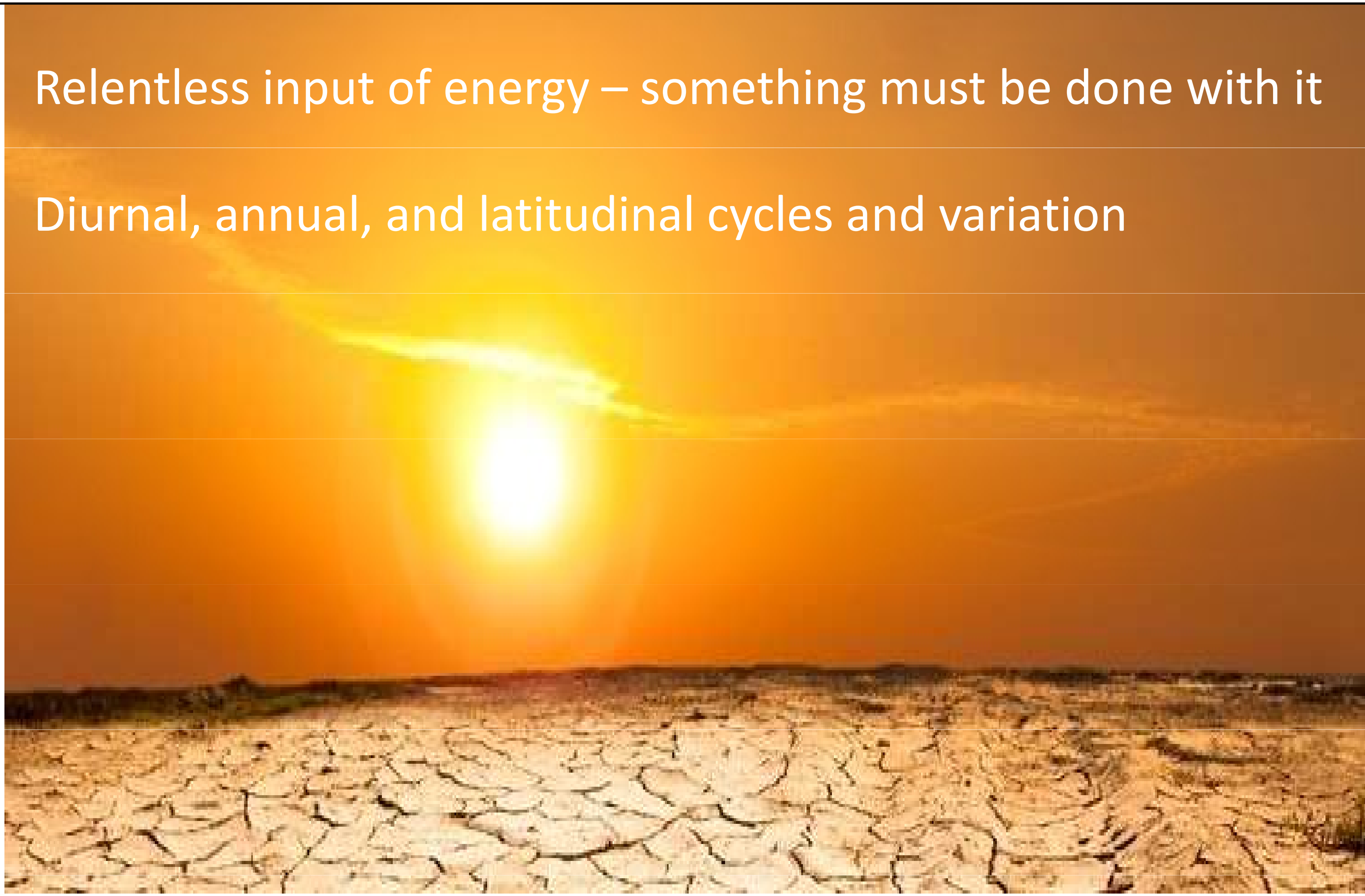
Ecosystemic Life hypothesis

- Which came first the organism or the ecosystem?

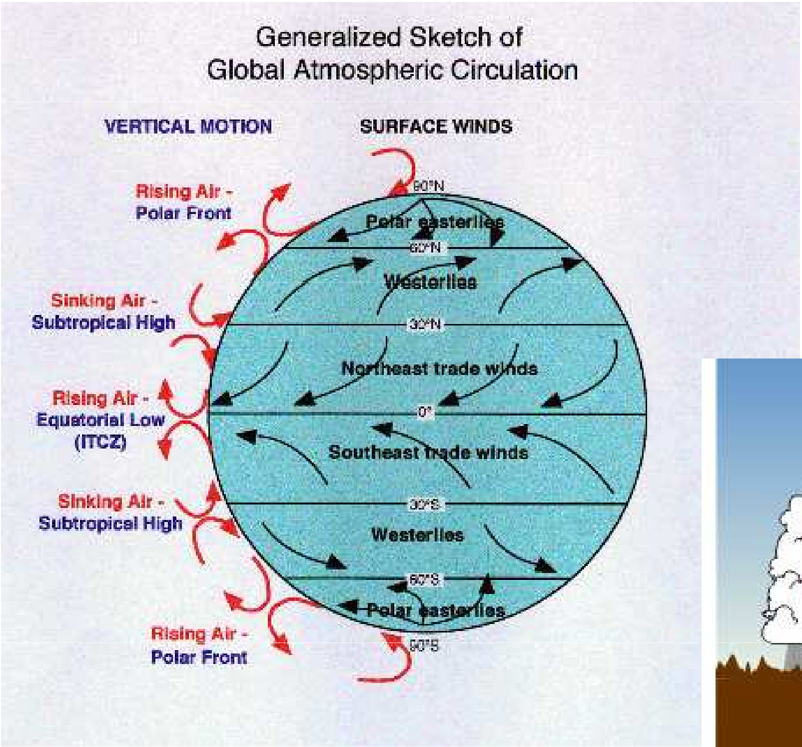
Earth before Life



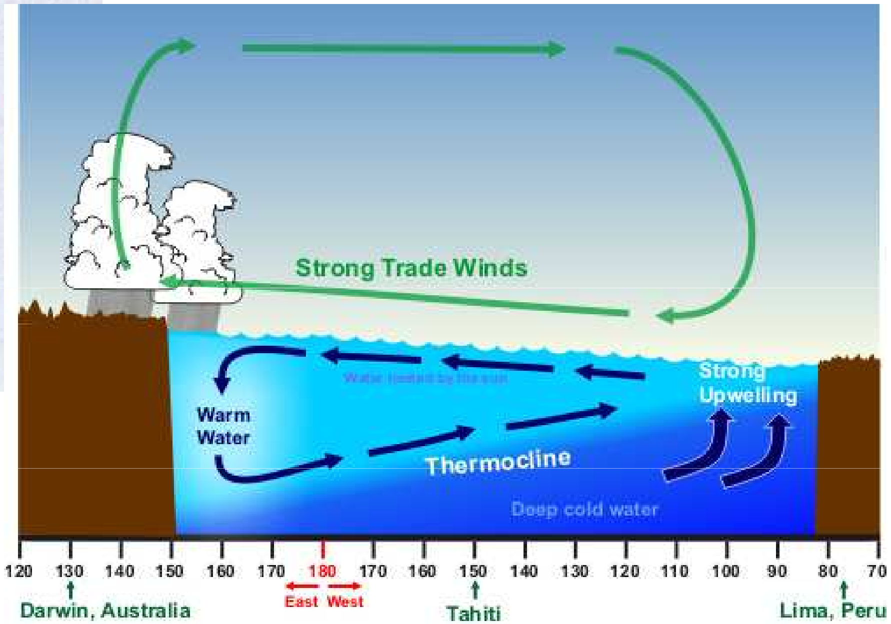
Solar energy


Relentless input of energy – something must be done with it
Diurnal, annual, and latitudinal cycles and variation

Energy gives rise to gradient formation

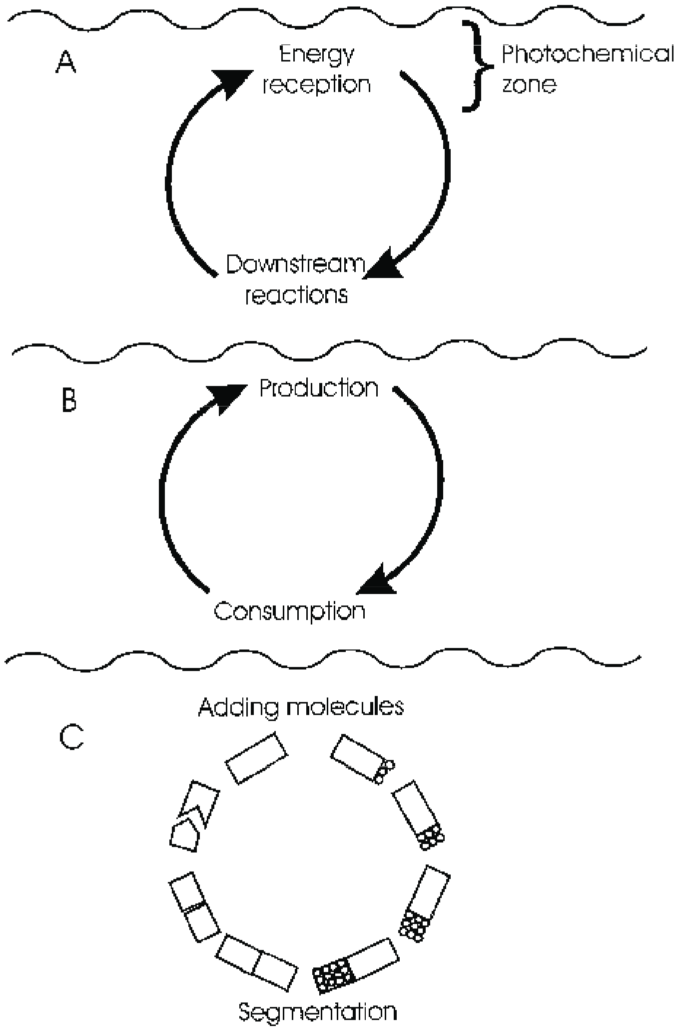


In air and sea together



Geothermal energy

Also gives rise to gradients and flow



Ecological Origin of Life

HT Odum

Prebiotic coupled complementary processes

- Production
- Consumption

The ecological cycle generated

- cells
- organisms

Encapsulation of the processes

In the seas and at the margins of land
Estuarine turbidity maximum

An alternative – the first organism

An organism without an ecosystem?

Gandhi

- There is enough for everyone’s need, but not enough for everyone’s greed
- What ethics, policies, motivations can promote this worldview (and suppress the alternative)?
- Questions

Chapter 2 – Limits to growth

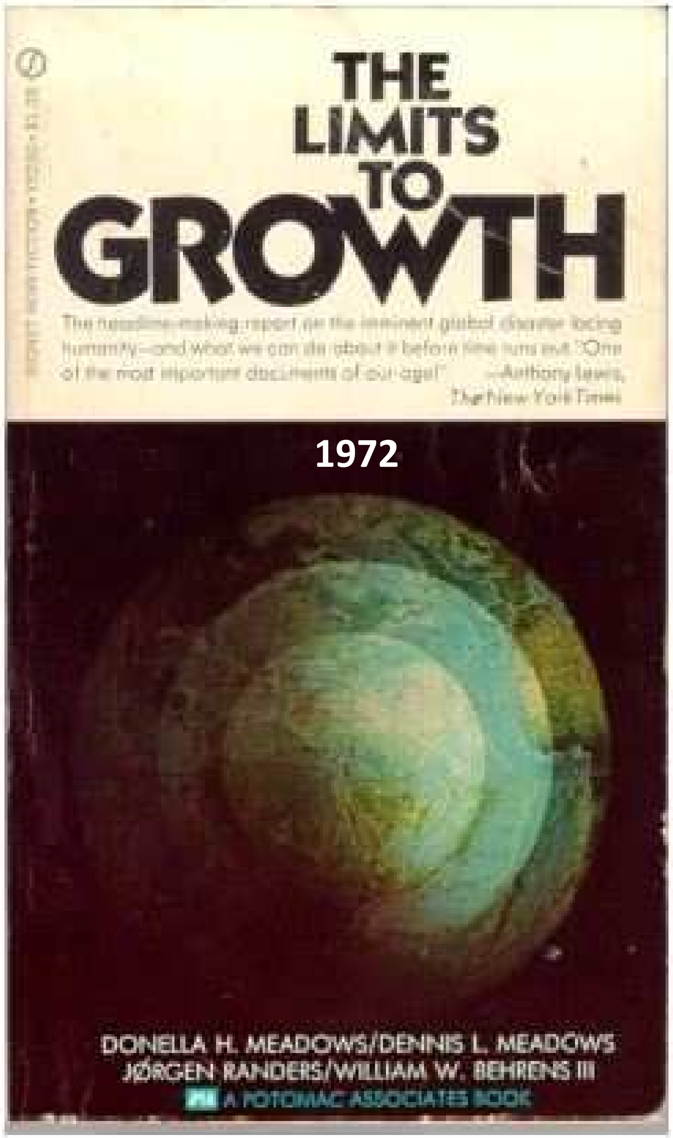
- *Trees cannot grow into the sky*

Your reaction

1) What does the quote mean and what does it have to do with this chapter?

2) What part was most confusing or most difficult to understand?

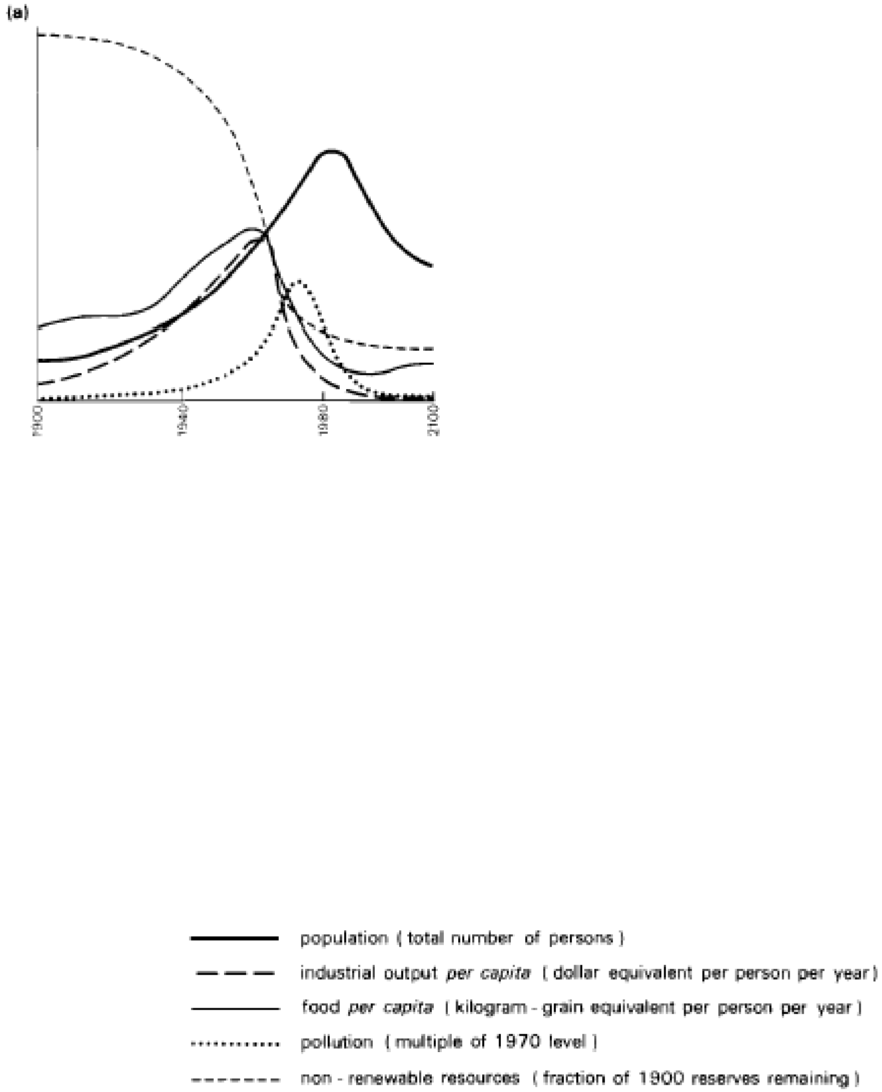
How long does it take to grow a 100-year-old tree?



The 11 state variables selected were:

1. Nonrenewable resources
2. Service capital
3. Industrial capital
4. Agricultural capital
5. Population aged 0–14 years
6. Population aged 15–45 years
7. Population aged above 45 years
8. Pollution
9. Urban and industrial land
10. Arable land
11. Potential arable land.

What, if anything, is missing?



Forrester-Meadows world model

(a) A standard computer simulation based on 1970 values.

(b) Pollution-induced collapse even when known natural resource reserves are 2x.

(c) Collapse due to population growth even though resources are set as unlimited and pollution controls are assumed.

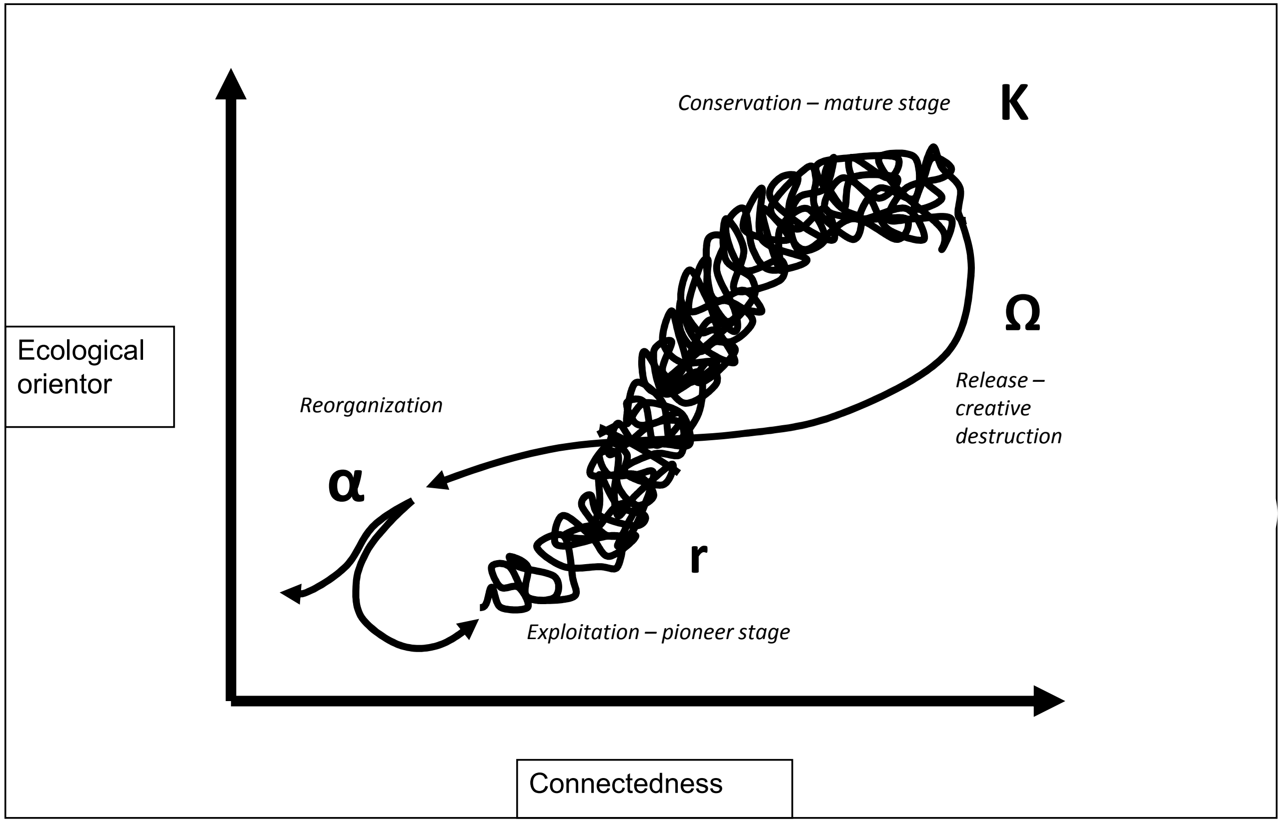
(d) Stabilized model producing a sustainable future. Assumptions: birth rate= death rate, capital investment= capital depreciation, and technological policies are implemented, e.g., resource recycling, pollution control, and restoration of eroded and infertile soils.

Baseline model points towards a resource crisis

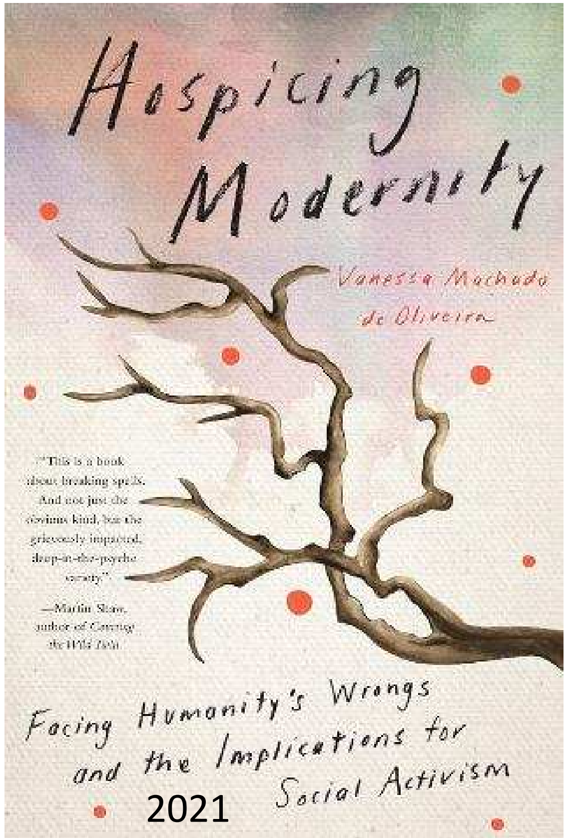
(After Meadows, 1971)

Doomsday or collapse

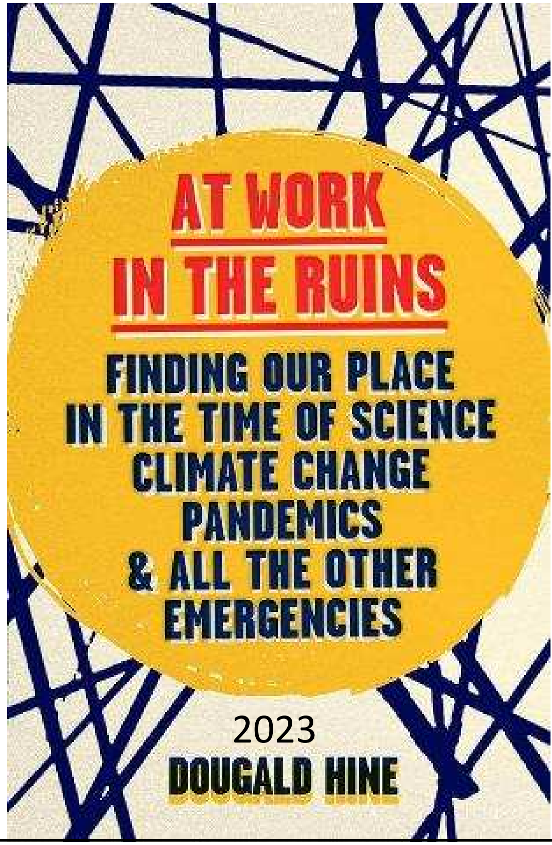
Resilience is the capacity to successfully navigate all stages of the adaptive cycle



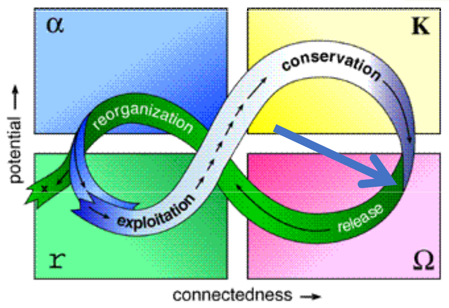
Doomsday or collapse – there is something in the air
What comes next?

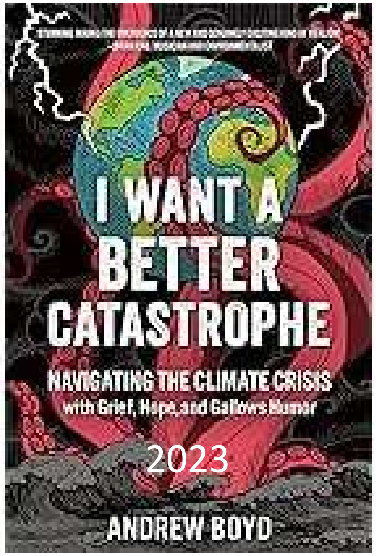


2021

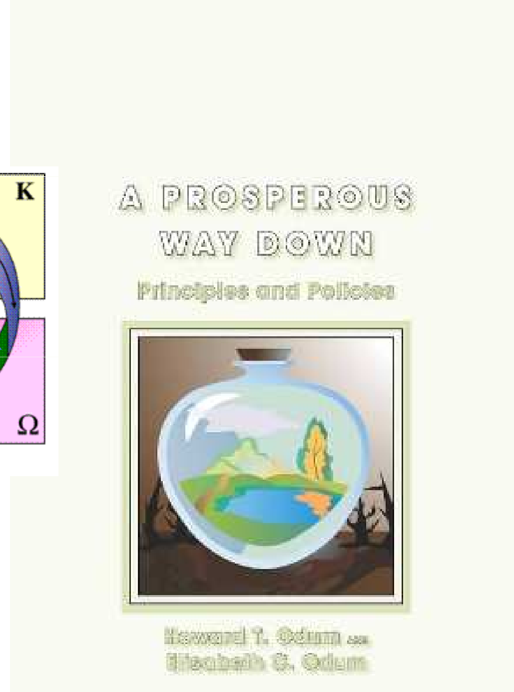


2023



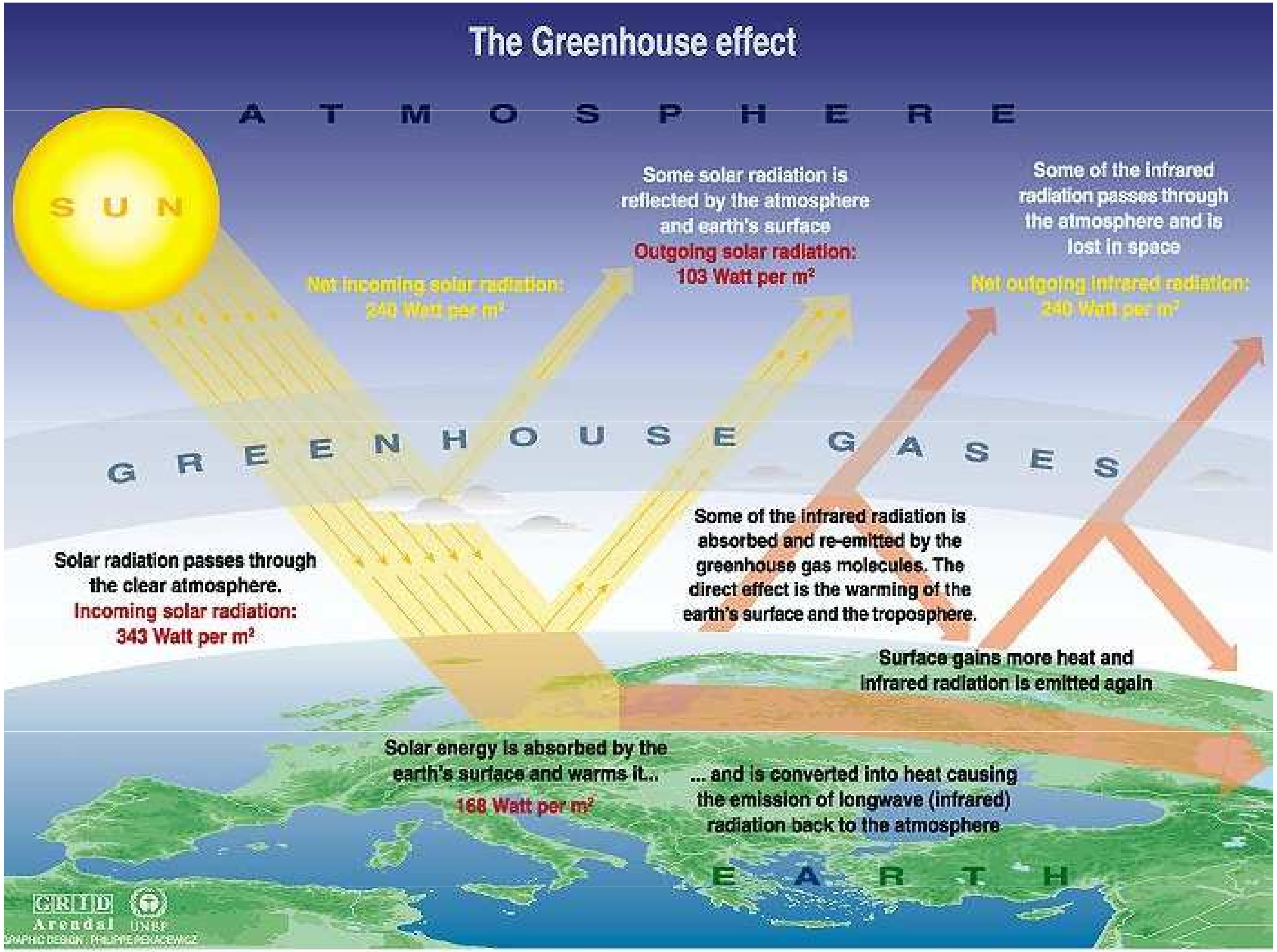


2023



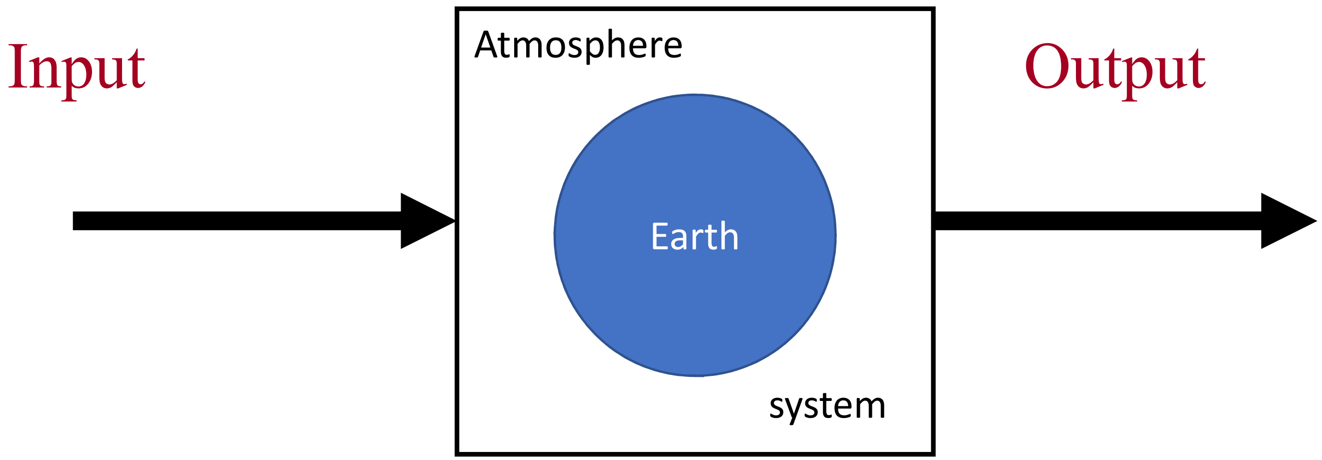
2001

Climate change and IPCC



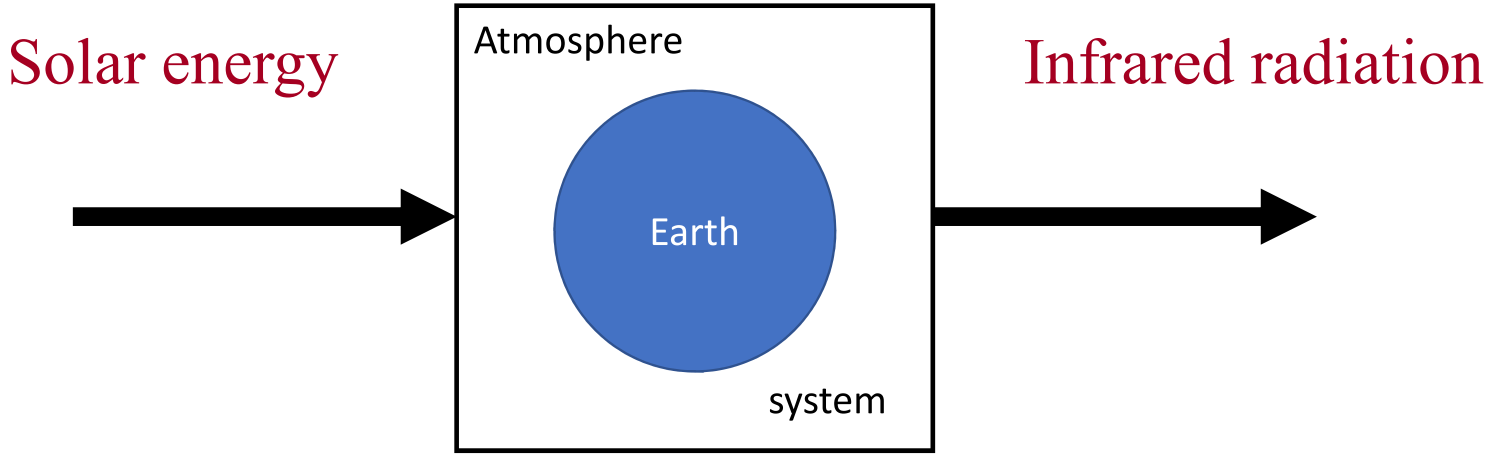
Sources: Okanagan university college in Canada, Department of geography, University of Oxford, school of geography; United States Environmental Protection Agency (EPA), Washington; Climate change 1995, The science of climate change, contribution of working group 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge university press, 1996.

Energy Balance



Energy Balance

More energy in the system leads to warming



Energy In > Energy out

Not because E_{in} is ↑,
but because E_{out} is ↓

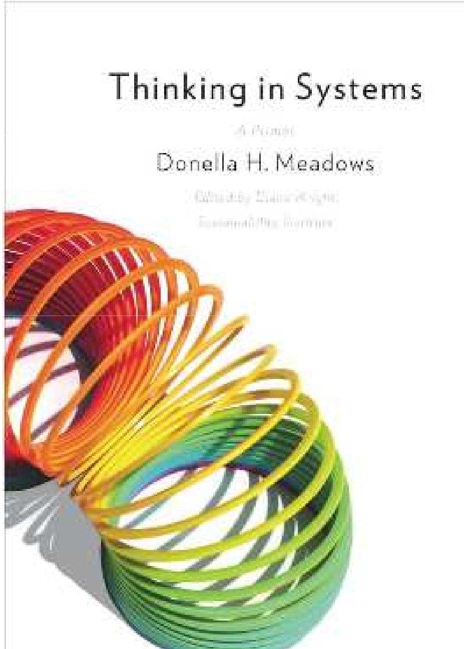
Three Climate Basics

1) Sun and Earth are at different temperatures, therefore radiate energy at different wavelengths
   - Sun emits **short-wave** mostly visible light radiation
   - Earth emits **long-wave** mostly infrared radiation
2) Certain gases (GHG) in the atmosphere respond to energy at different wavelengths (passing short, absorbing long)
3) The concentration of greenhouse gases in the atmosphere is increasing

We need to think in systems (Meadows) (think like a mountain - Leopold)

- Food for a growing population
- Climate change
- Abate poverty
- Education for all
- Slowing human population growth
- Renewable energy (down scaling)

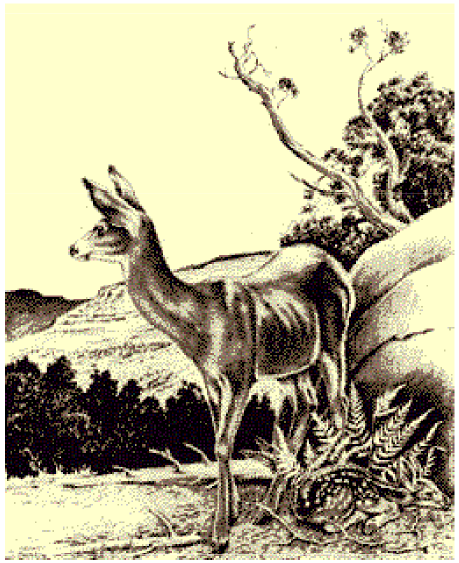
- Interdisciplinary science and problem solving – more focus on schools
- Why the emphasis still on disciplinary boundaries? Was your experience different?



2008

Ecological Cascades

[Thinking like a mountain]()



Recycling – Indians… and Astronauts

LtG still not acceptable

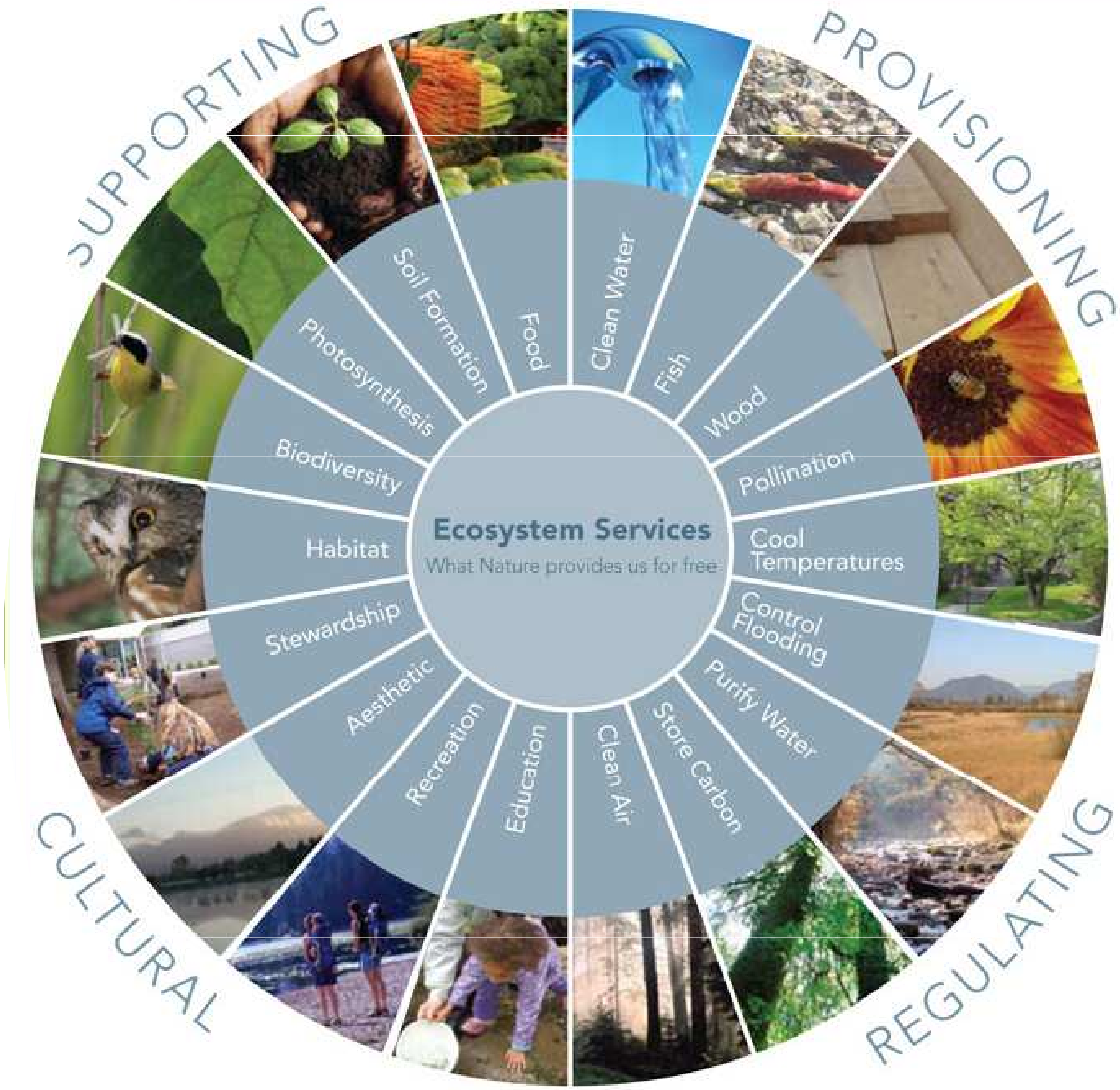
- Business as usual mostly continues
  - Short-term costs versus long-term consequences

- Ozone depletion was handled which gave confidence for other areas

- 1950 – 2000 (also see Millennium Ecosystem Assessment Report)
- Human population increased 2 ×
- Number of registered vehicles increased 10 ×
- Oil consumption increased 7 ×
- Rice production increased 4 ×
- Wheat production increased 4 ×
- Iron and steel production increased 4.5 ×
- Aluminum production increased 15 ×

Ecosystem services

1. Primary production and the creation of new biomass
2. Purification of water and air
3. Decomposition of organic matter that otherwise would deplete the oxygen in aquatic ecosystems
4. Decomposition of harmful toxic organic compounds
5. Mitigation of droughts and floods
6. Recycling of important elements
7. Moderation of extreme weather conditions
8. Storage of the genetic pool and maintenance of biodiversity
9. Pollination
10. Pest control
11. Aesthetic and recreational areas.

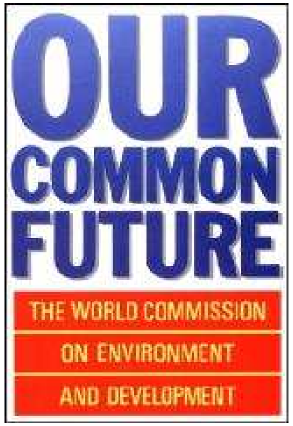


Sustainable Development

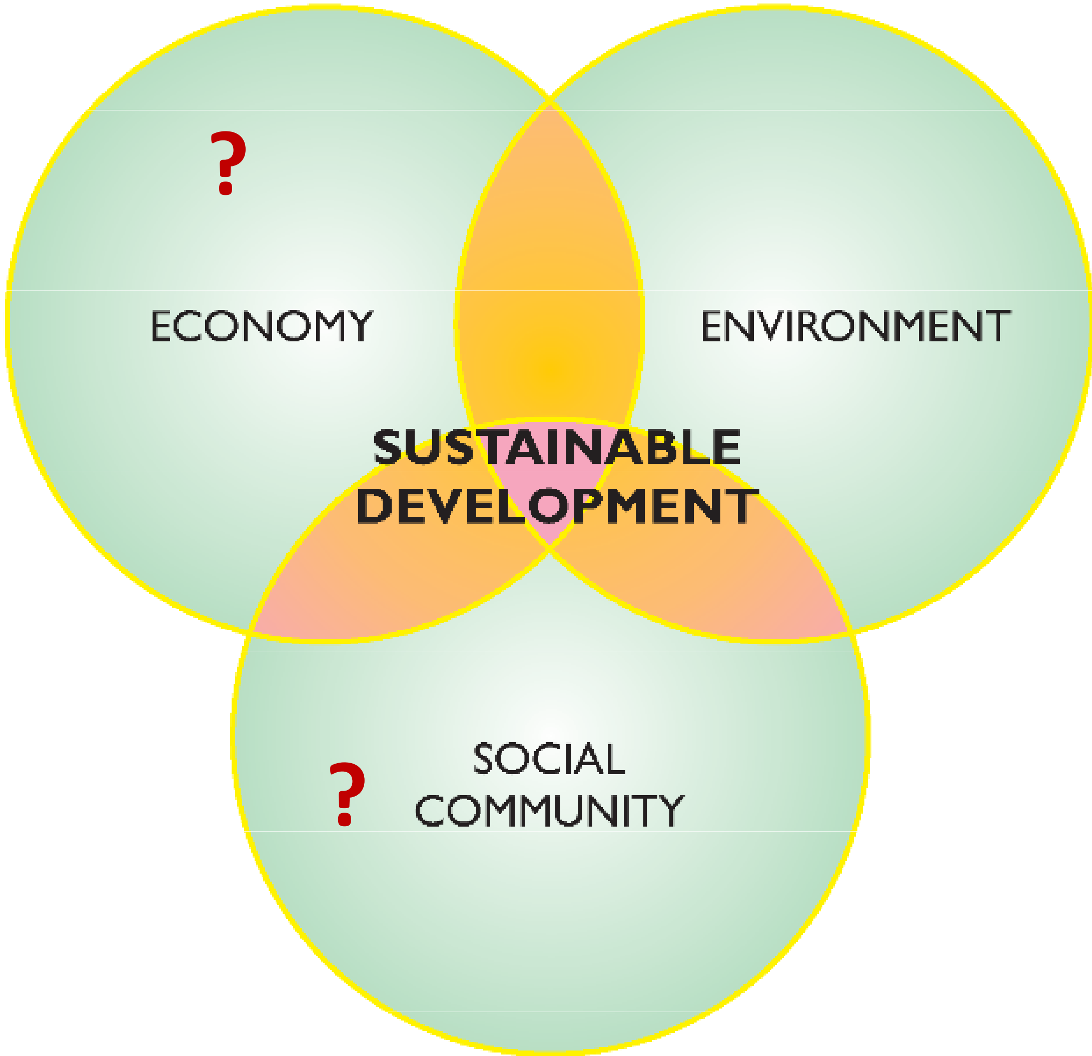
Sustainable Development vs Sustainability

- Sustainable Development: "development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs" – *Our Common Future*/ Brundtland Report, 1987
- Sustainability: a system's ability to generate and maintain self-organizing processes

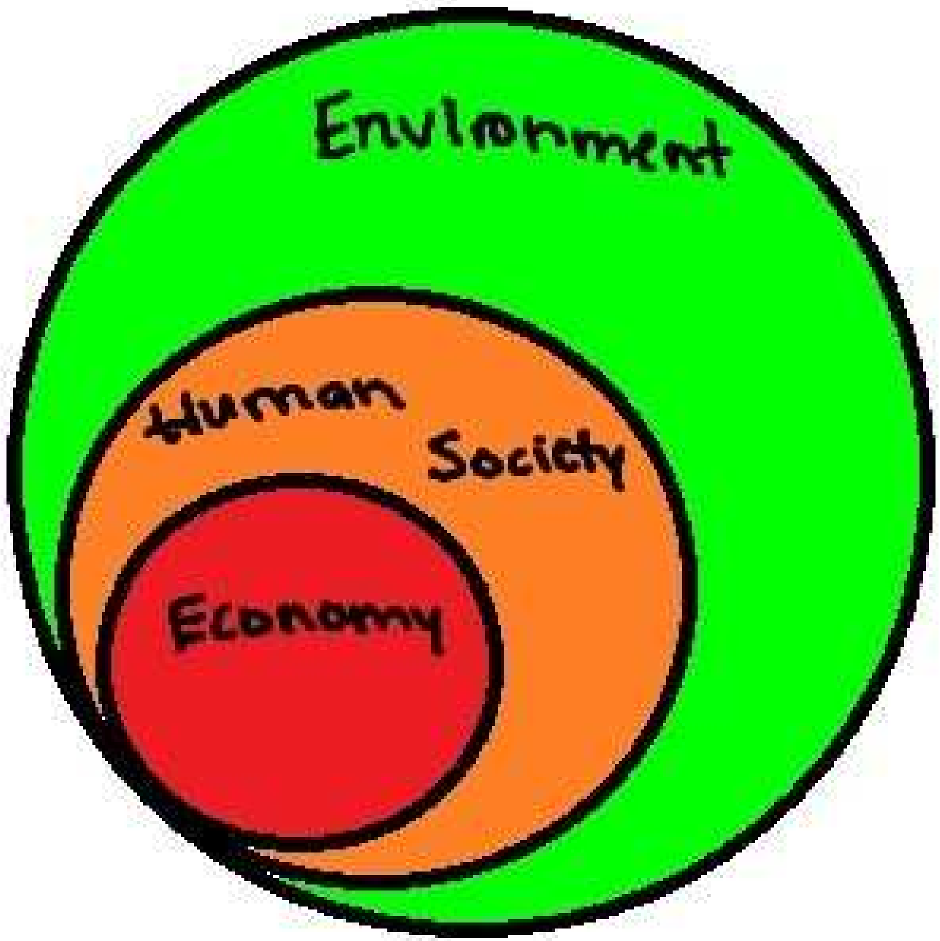
What are "our needs"?



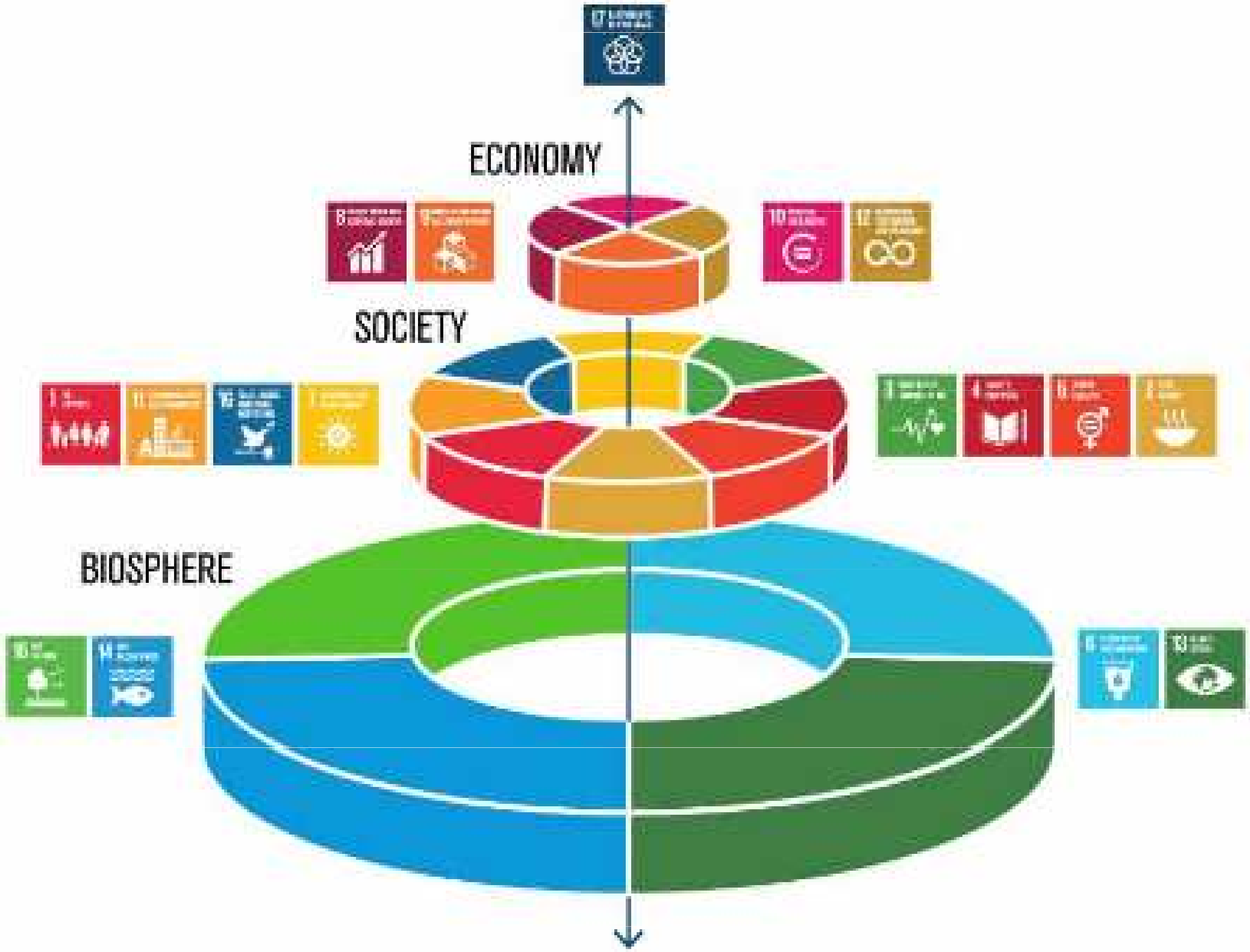
Three dimensions of **Sustainable Development**



Environment is foundation for all aspects, others are subsets



Adopted September 2015 – also called Agenda 2030


ECONOMY
SOCIETY
BIOSPHERE

How to shift from quantitative growth to qualitative development?

1. Increase education investment
2. Internalize externalities
3. Agriculture increase through efficiency
4. Halt deforestation increase reforestation
5. Decrease GHG emissions
6. Low carbon mobility
7. Use efficiency

- Next steps, barriers, questions?