Biophysical Resources and Socio-economic systems
ENSb1302

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ENSb1302: Syllabus highlights

- **Course Description**:
  - This course deals with the relationships between *human society* and *natural ecosystems* as they relate to the ***sustainability*** of both. Relevant scientific, socio-economic, and ethical issues will be addressed in connection to current events such as global climate change, energy, conservation, agriculture, and cities.

- **Grade evaluation (points available):**
  - Presentation (50), Reflections/Homework (50), Participation (50), Paper (100), Final Exam (150) = Total (400)

Schedule

- Thursday 26. 9., 10:00–11:40, room nr. P31
- Lecture 1: Systems thinking, system diagrams, systems analysis
- **Ecological Systems Thinking: Orr, Niccolucci, Bastianoni**
-
- Thursday 10. 10. 10:00–11:40, room nr. P31
- Lecture 2: Ecosystems, Succession, Dynamics, Complex systems cycle (Holling)
- **Ecosystems: Fath**
- **Succession: Pandolfi**
-
- Thursday 17. 10. 12:00–13:40, room nr. P52
- Lecture 3: Human population
- **Human Population Growth: Goujon**
-
- Thursday 24. 10. 12:00–13:40, room nr. P52
- ***PAPER TOPIC DUE***
- Lecture 4: Agriculture
- **Agriculture Systems: Andrén, Kätterer**
- **Organic Farming: Nielsen**
-
- Thursday 31. 10. 10:00–11:40, room nr. P31
- Lecture 5: Energy basis for socio-ecological development: from solar to fossil fuels back to solar
- **Water-Energy-Food-Ecosystems Nexus: Bidoglio, Vanham, Bouraoui, Barchiesi**

- Thursday 7. 11. 10:00–11:40, room nr. P31
- Lecture 6: Global Climate Change
- **Greenhouse Gases Formation and Emission: Barbera, Vymazal, Maucieri**
-
- Thursday 14. 11. 10:00–11:40, room nr. P31
- Lecture 7: Sustainability and Sustainable Development Goals
- **System Sustainability: Pulselli**
- **The Sustainable Development Goals: Gigliotti, Schmidt-Traub, Bastianoni**
-
- Thursday 21. 11. 10:00–11:40, room nr. P31 – Tuesday 26.11., 10.00 – 11.40, room nr. U35
- Lecture 8: Ecological Economics and Ecosystem Services
- **Ecological Economics 1: Costanza**
- **Ecological Economics 2: Costanza**
-
- Thursday 28. 11. 10:00–11:40, room nr. P31,
- Lecture 9: Urban systems
- **Urban Systems: Elmqvist, Alfsen, Colding**
-
- Thursday 5. 12. 12:00–13:40, room nr. P52
- Lecture 10: Student presentations, summary and future research directions

specific readings from *Encyclopedia of Ecology*, 2nd Edition, 2019, Fath (editor), Elsevier

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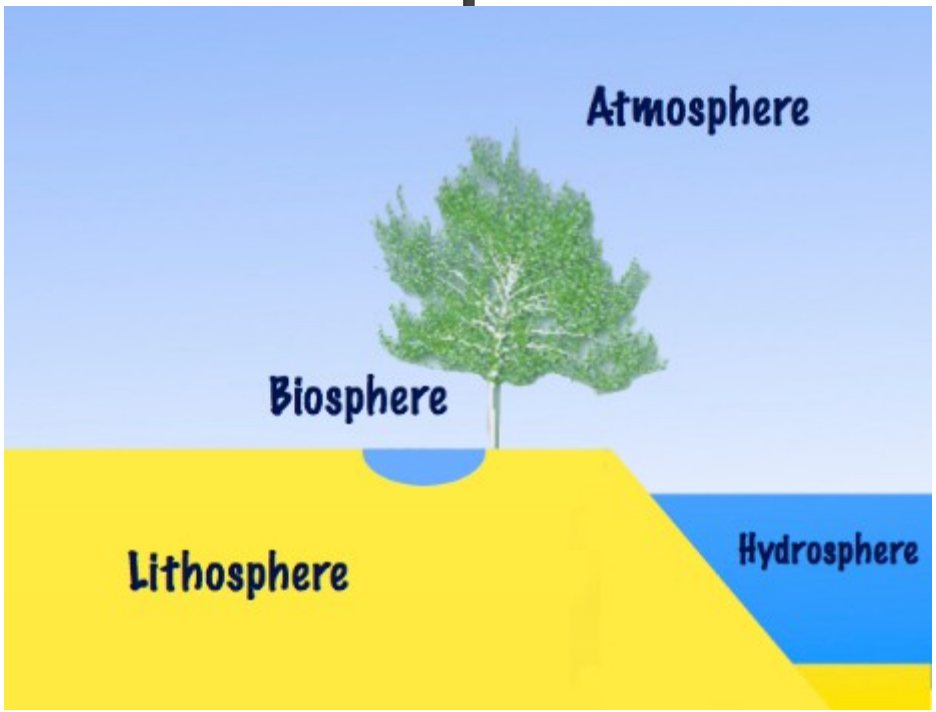
What are some the ways humans have impacted the environment?

Earth's environment can be partitioned into four+one spheres



- Atmosphere
- Lithosphere
- Hydrosphere
- Biosphere

- Noosphere (sphere of human thought; nous – Greek for mind) also called anthroposphere

How are ways that you depend on the environment?

Homework – identify 1 mineral element that is used in the making of your smart phone, describe where it comes from and the extraction methods to get it. What happens to it at the end of the product life?

Systems Perspective

- See how things are connected and interrelated

- *Complex* – many parts, many interactions
- *Adaptive* – respond and change
- *Systems* – set of parts interacting together to function as a whole

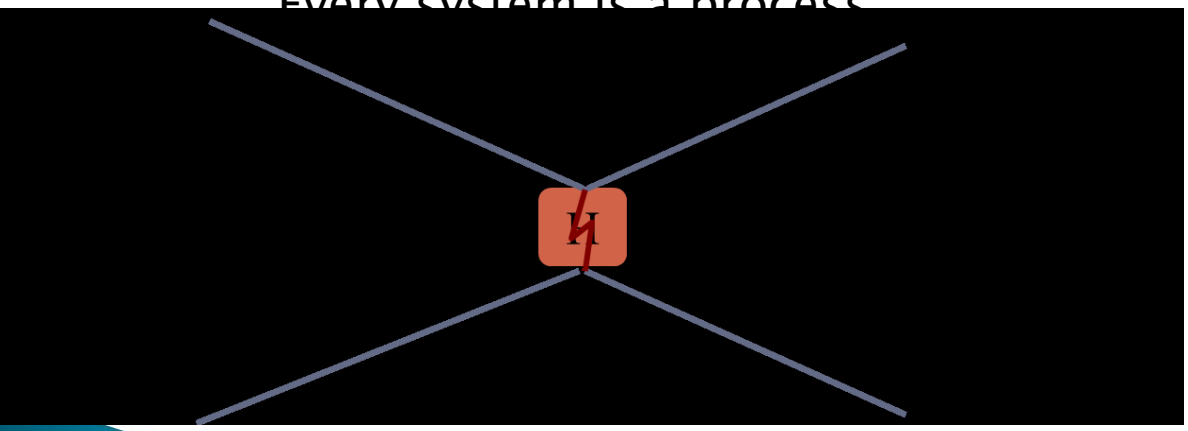
Systems Theory

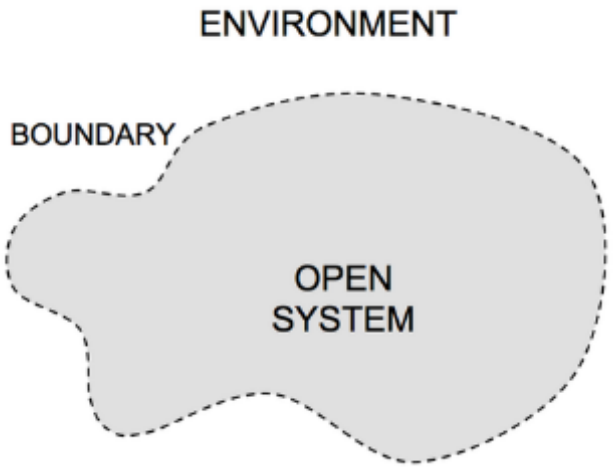
- "…is, strictly speaking, not a theory of systems, but of system-environment distinctions." Moeller *2006, p. 40*

"If you want to make an apple pie from scratch, first you must make a universe." -- Carl Sagan

System boundaries

- What is part of your question and what is not?
- How you determine this first part largely determines the answers the question

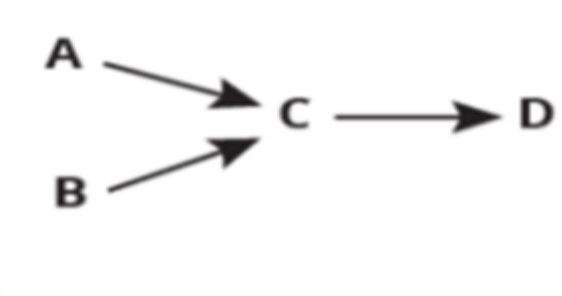




Systems Perspective

Event Oriented Thinking

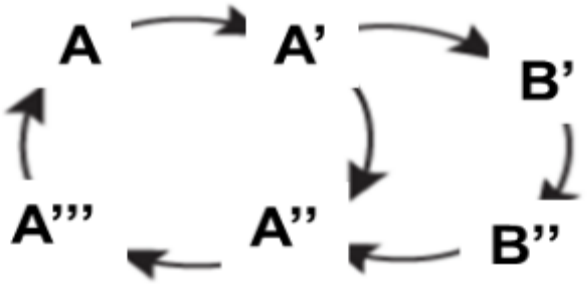
Thinks in straight lines



In event oriented thinking everything can be explained by causal chains of events. From this perspective the **root causes** are the events starting the chains of cause and effect, such as A and B.

Systems Thinking

Thinks in loop structure



In systems thinking a system's behavior emerges from the structure of its feedback loops. **Root causes** are not individual nodes. They are the forces emerging from particular feedback loops.

www.thwink.org/sustain/glossary/EventOrientedThinking.htm

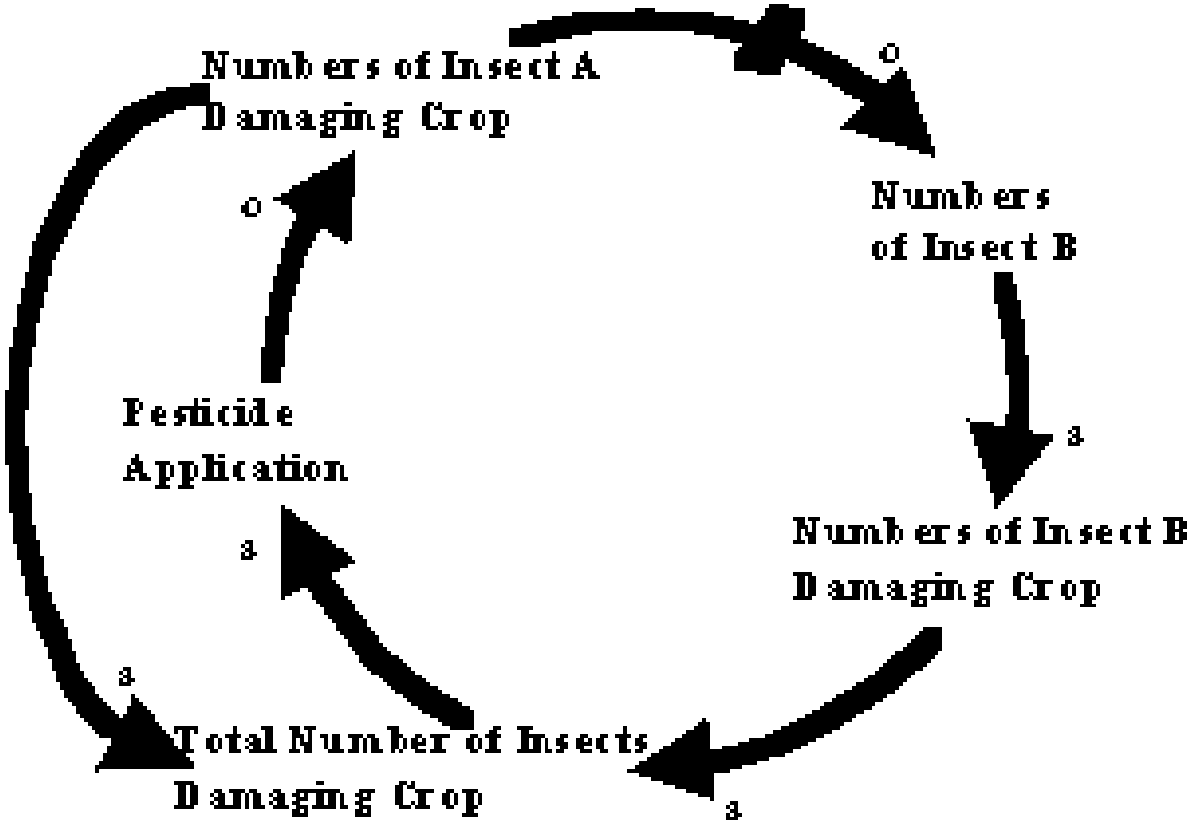
Problems arise when we don't see systems, relations, and connectivity…

Pest management example

Conventional response to crop pest is spraying pesticide designed to kill that insect. Imagine a perfect pesticide that kills all target insects and which has no side effects on air, water, or soil.

Is using this pesticide likely to make the farmer better off?

E.g., the pest was controlling another insect population, either by predation or competition. The effective pesticide eliminates the control that those insects were applying on the population of the other insects. Then non-target insect populations explode and cause more damage than the insects killed by the pesticide.



In other words, the action intended to solve the problem actually makes it worse because unintended side effects change the system & end up exacerbating the problem.

Unintended consequences

- Acid precipitation/rain
- Ozone depletion
- Eutrophication
- Global climate change
- Automobile dependency
- …
- All of today's major environmental problems emerge from yesterday's solutions.

Key systems concepts

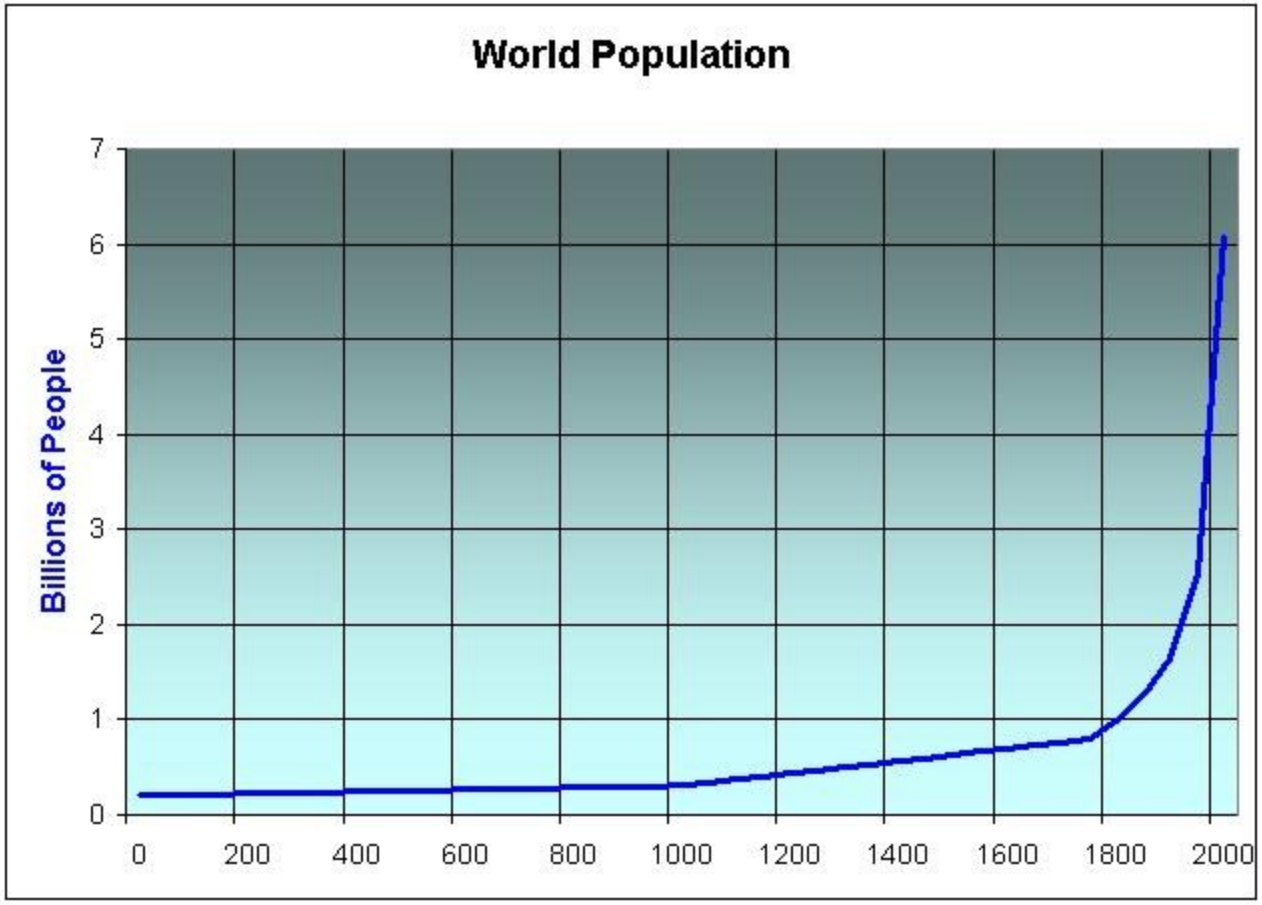
- Input–Output models
- Feedback
- Time lags
- Exponential growth
- Irreversibility

6 key themes how biophysical human systems interact

1) Human Population
2) Sustainability
3) Global Perspective
4) Urban Systems
5) People and Nature
6) Science and Values

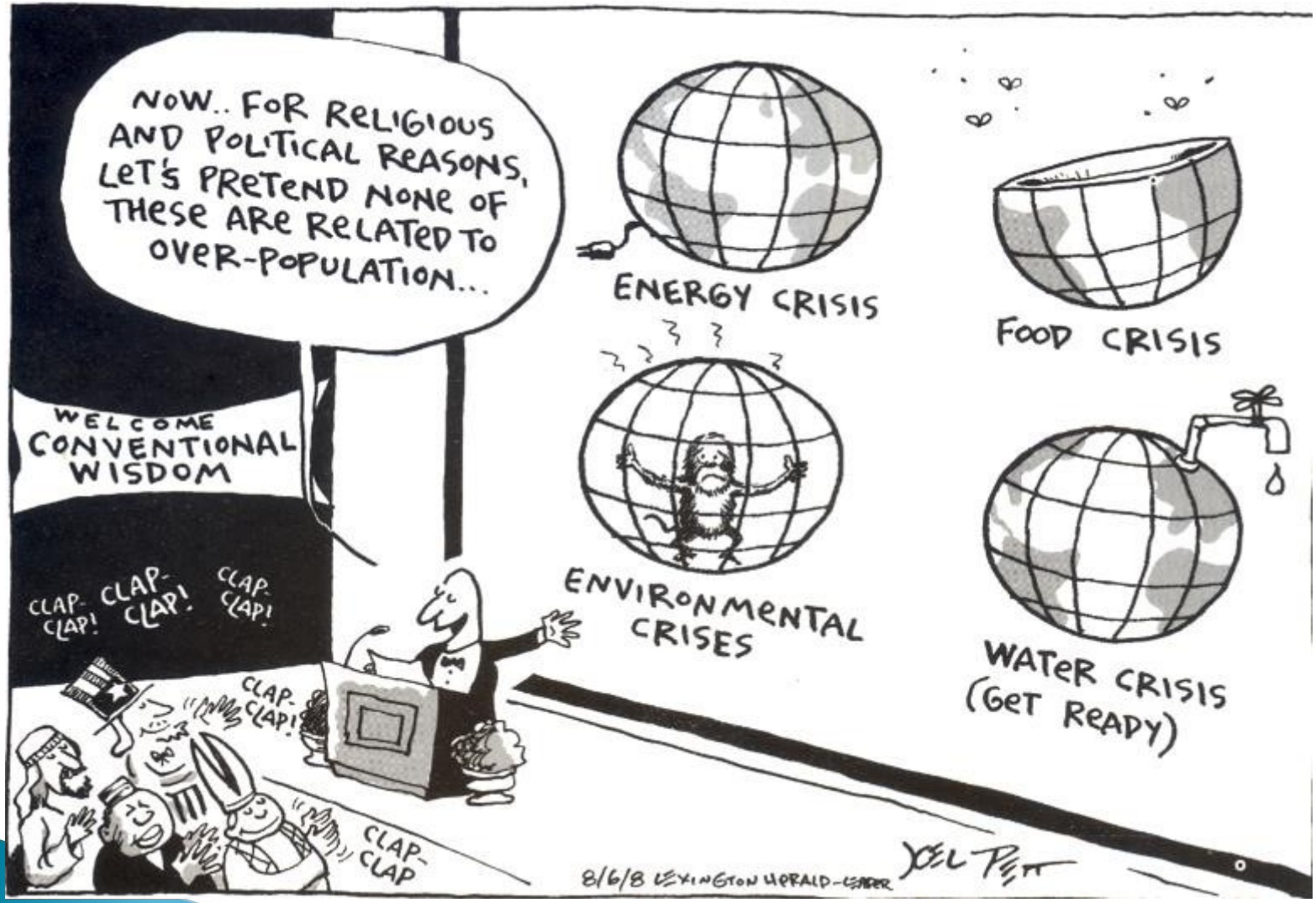
Human Population

- World 7,732,909,210



Great Acceleration

SOURCE: igbp.net | Steffen et al., 2005, Global Change and the Earth System, Springer, pp. 132-133
DESIGN: Globaia.org

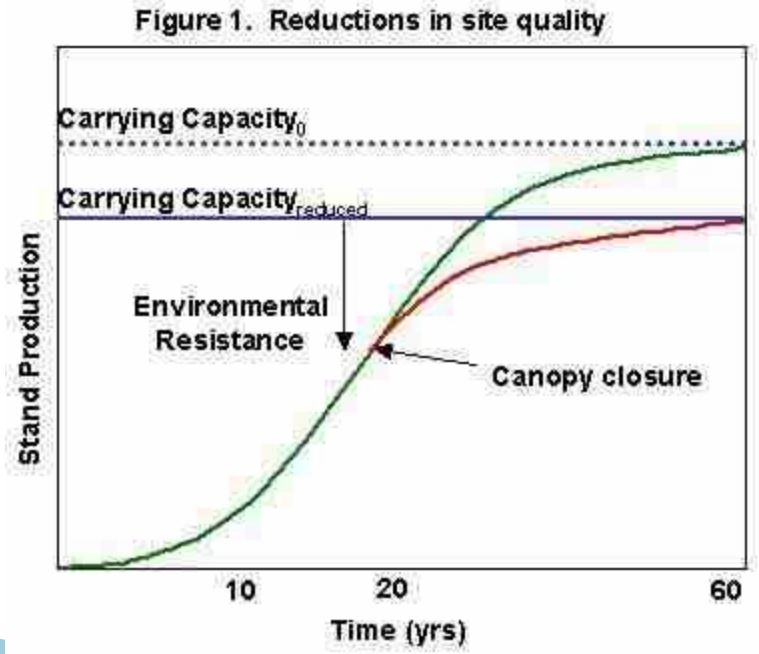

NOW.. FOR RELIGIOUS AND POLITICAL REASONS, LET'S PRETEND NONE OF THESE ARE RELATED TO OVER-POPULATION...
WELCOME CONVENTIONAL WISDOM
CLAP-CLAP!
CLAP-CLAP!
CLAP-CLAP!
CLAP-CLAP!
CLAP-CLAP
ENERGY CRISIS
FOOD CRISIS
ENVIRONMENTAL CRISES
WATER CRISIS (GET READY)
8/6/8 LEXINGTON HERALD-LEADER
JOEL PETT

2) Sustainability – the capacity to endure

- Resource Harvest
  - continuous supply for an unlimited or specified amount of time
- Ecosystem
  - able to maintain its functions
- Economy
  - maintains its level of activity in spite of its use of environmental resources
- Development
  - "ensure that humanity meets the needs of the present without compromising the ability of future generations to meet their own needs." Gro Harlem Brundtland, 1986

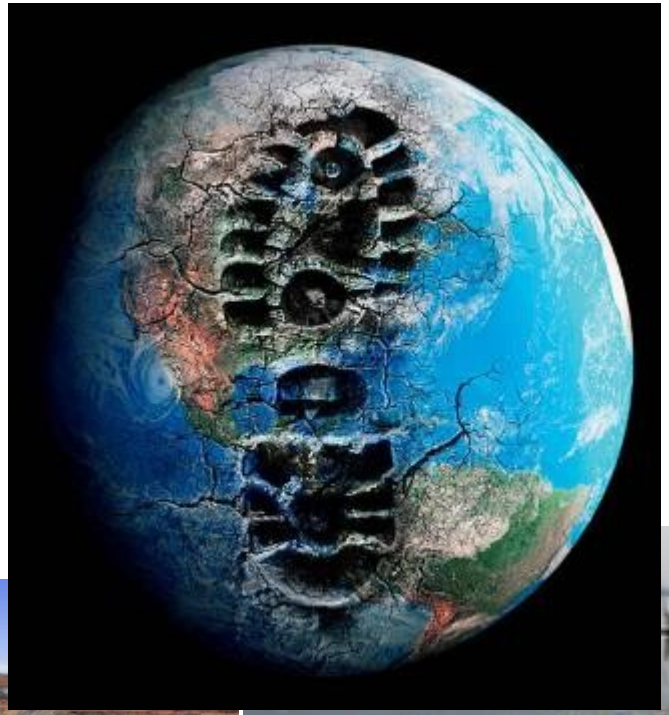
Carrying Capacity

- max number of individuals of a species that can be sustained by an environment without decreasing the capacity of the environment to sustain that same amount in the future.

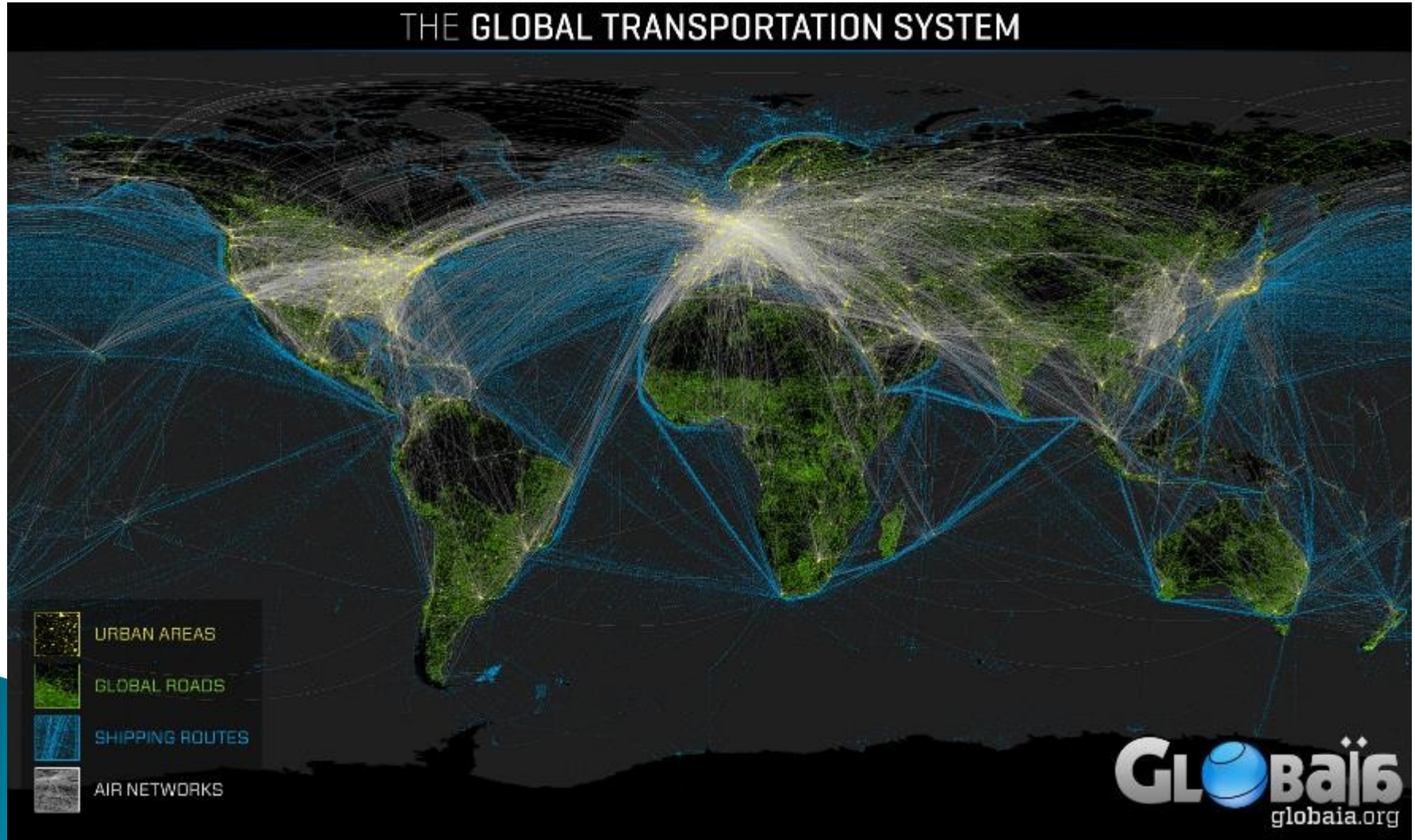


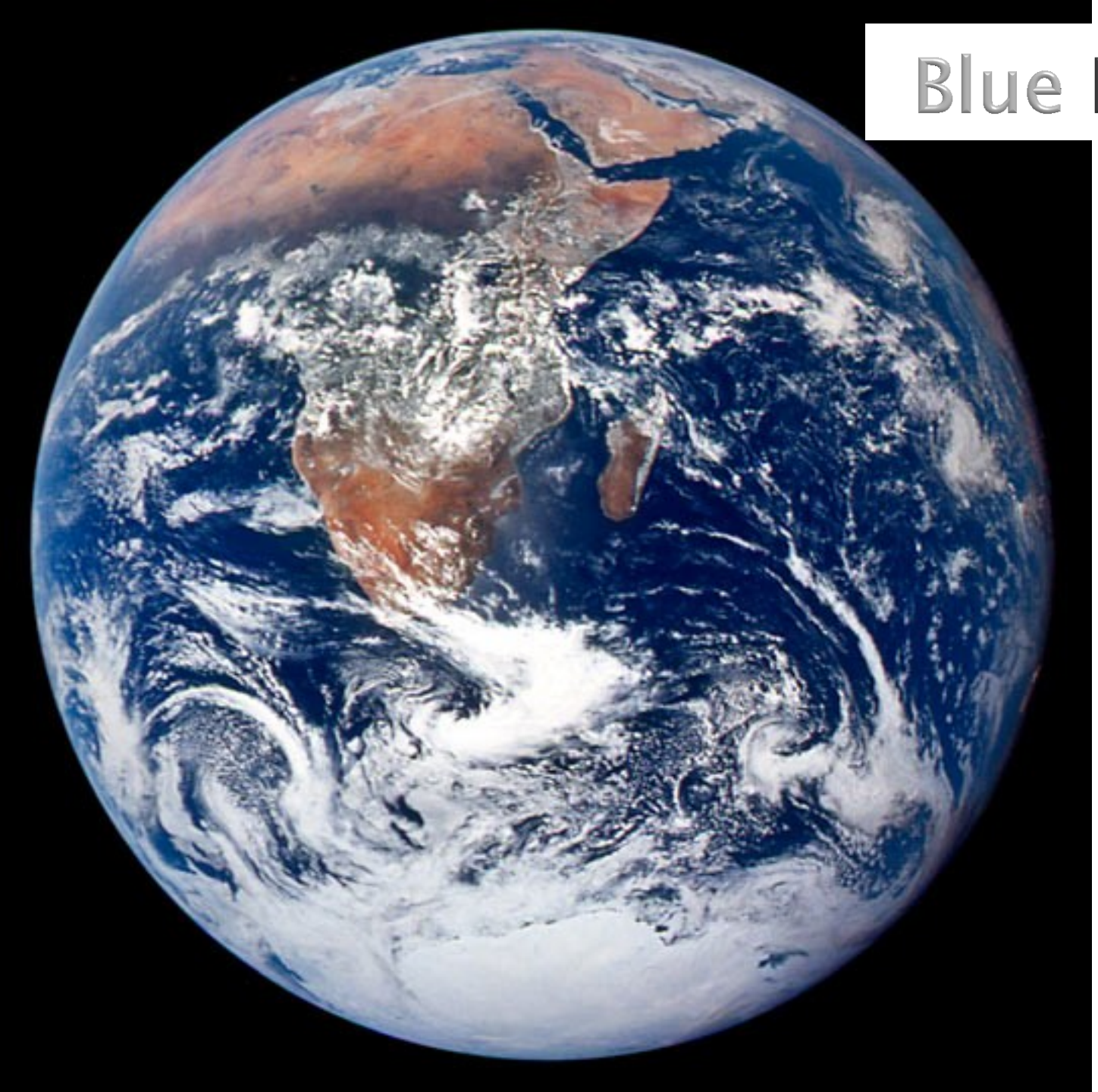
3) Global Perspective

- Civilization can change the entire planet's environment
- Spaceship earth



Anthropocene – term to denote the present time interval, in which human activities profoundly impact geology and ecosystems.





Blue Marble

Dec. 7, 1972
– Apollo 17

4) Urban places

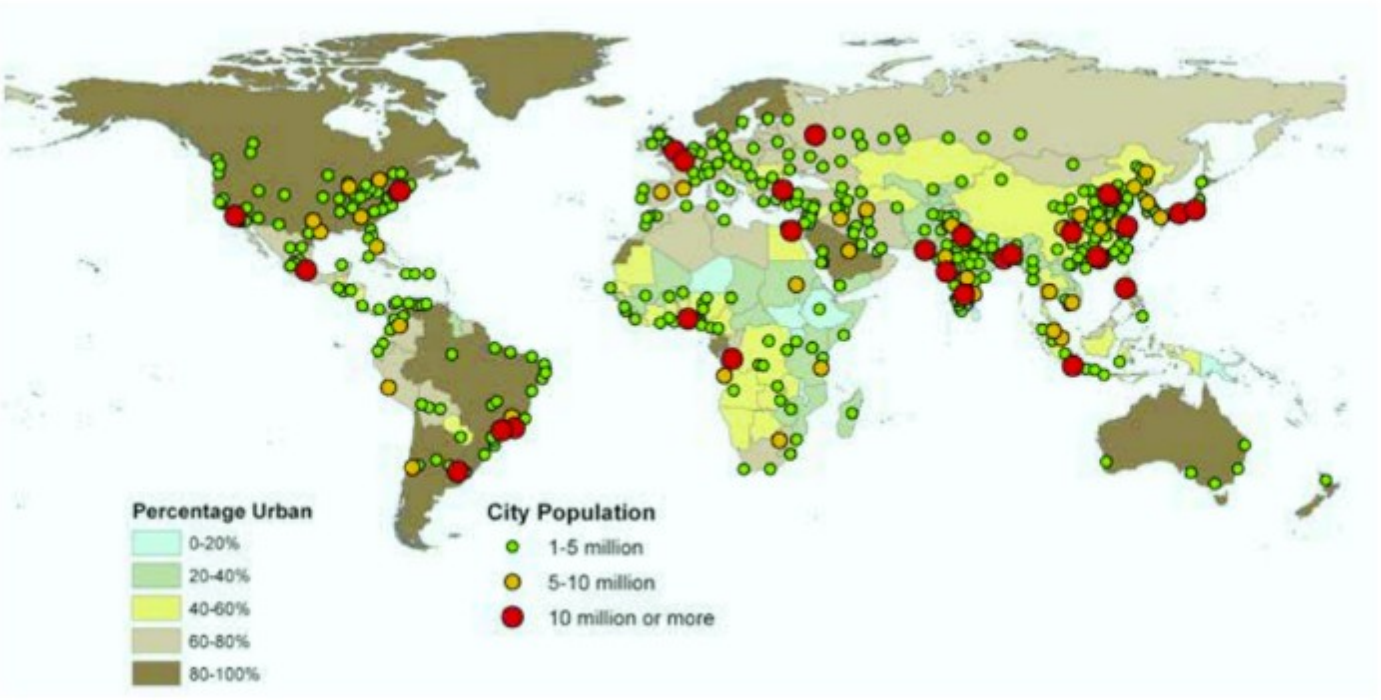
- In developed countries 75% of population live in urban areas and 25% in rural areas; in developing countries about 40% are urban

- Globally about 54% in urban areas; it is expected that 70% of world population will be urban by 2050

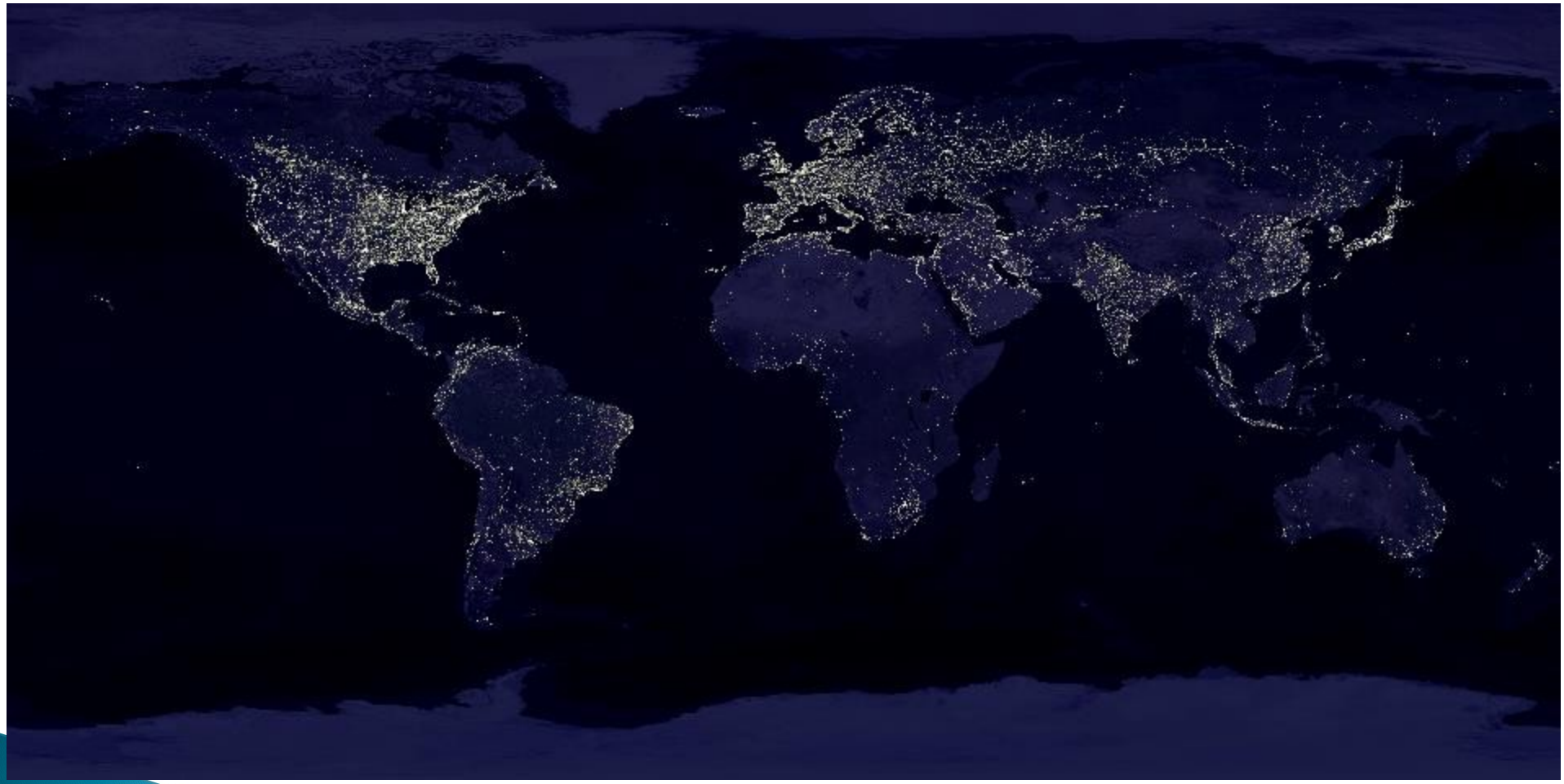
- Environmental organizations have often focused on wilderness, endangered species, and natural resources. Although they remain important, more emphasis on urban areas is needed

Figure 1.3: Global patterns of urbanization, 2015

Source: Based on United Nations, 2014b.



Anthropocene – urban perspective



5) People and Nature

- Principle of Environmental Unity –
  - Everything affects everything else
- Things we get from nature: **Ecosystem Services**
- Unintended consequences – today's problems were yesterday's solutions

6) Science and Values

- Science is process of discovery
- Science is one way of looking at the world
- Scientists rely on critical thinking

Placing value on the environment

- Utilitarian – survival or economic
- Ecological – essential to larger life support systems
- Aesthetic – our appreciation of nature's beauty
- Moral – environment has a right to exist

Environmental Ethics 1970s

- Why a new code of ethics?
  - New effects on nature
  - New knowledge about nature
  - Expanding moral concern
    - People-people relations
    - People-group relations
    - People-nature relations

- Land Ethic – A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise (Aldo Leopold, 1949).

Human Ecology

- Humans are part of the biosphere;
- We are living organisms like other animals in many respects, but
  - we have an advanced social organization, and
  - the ability to extract and use energy and resources that characterizes us and our impacts on the planet.
- That does not make us independent from the environment though

Tracing the chain of effects through ecosystems and human society

- anticipate the long-range environmental consequences of human actions
- avoid disastrous surprises from the environment
- generate ideas for dealing with environmental problems; and, in general
- maintain a liveable and sustainable relationship with the environment.

Are you hungry?

- Pick a food of your choice and draw a system diagram of how it interacts with you and the environment

Understanding SYSTEMS!

- A set of components or parts that function together to act as a whole