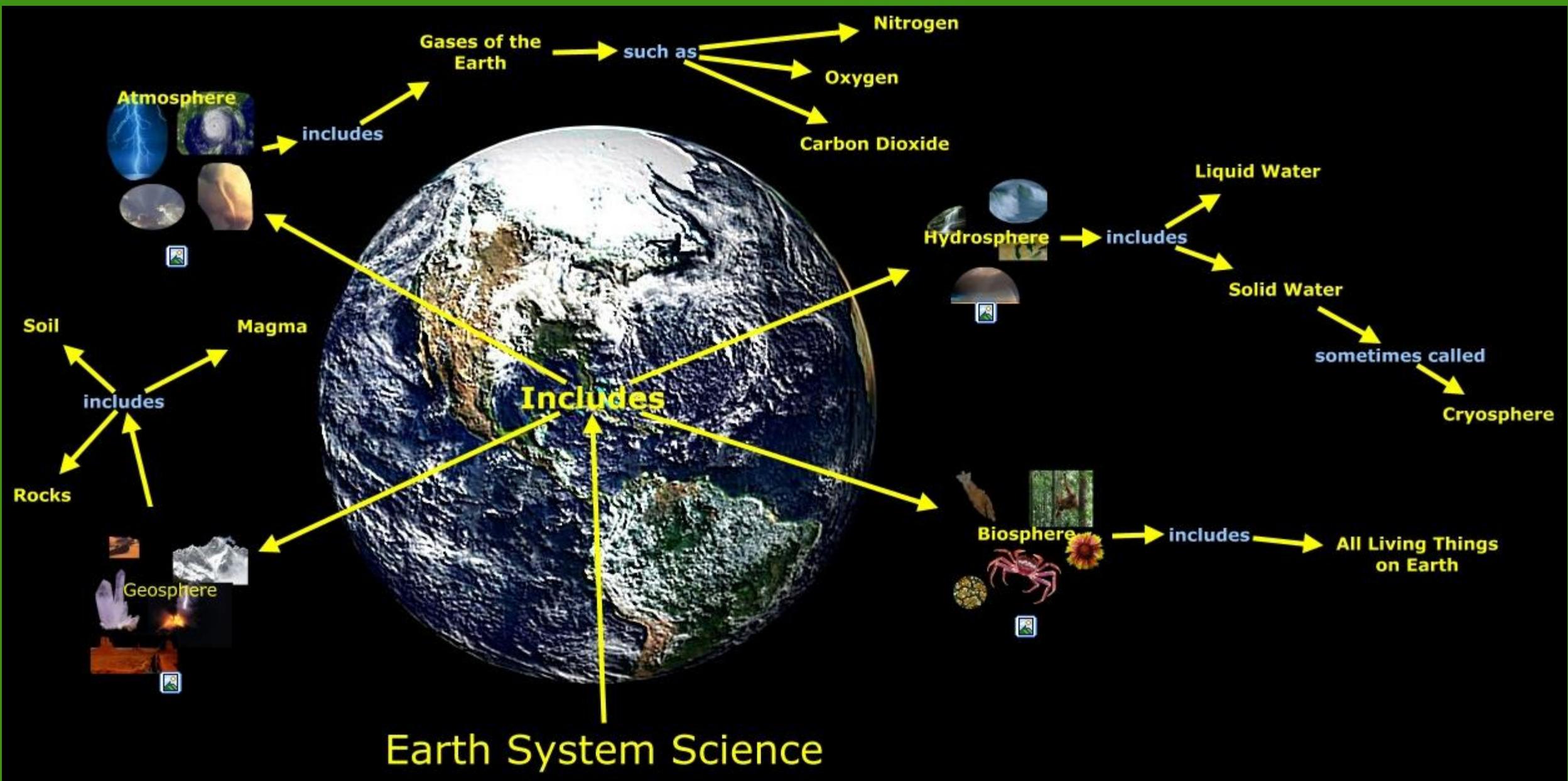


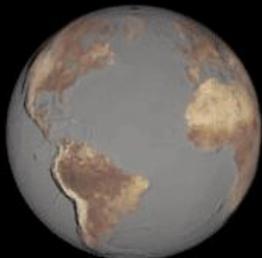
A world map where the landmasses are represented by a dense network of yellow and white lights, resembling city lights at night. The oceans are dark blue. The map is centered on the Atlantic Ocean, showing North and South America on the left, and Europe, Africa, and Asia on the right.

# New Directions in the Sciences - Sustainability Science

Jason Hamilton  
Dept. of Environmental Studies & Sciences  
Ithaca College



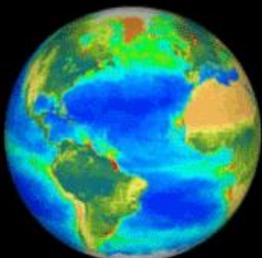




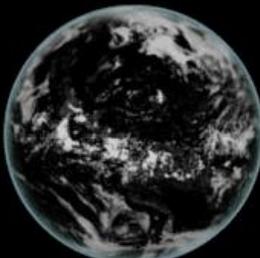
Geosphere



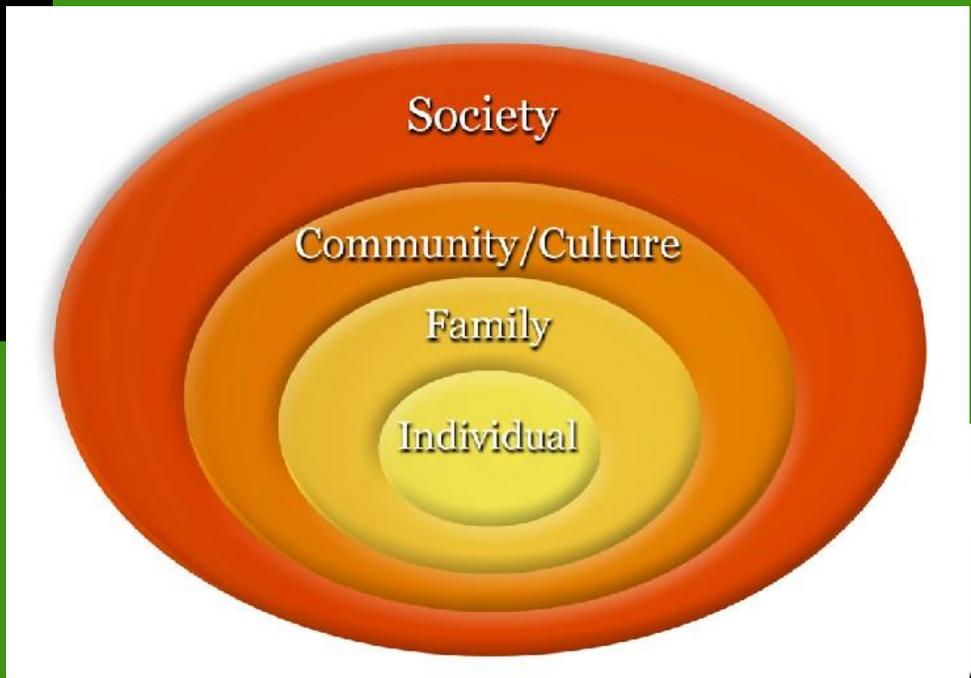
Hydrosphere

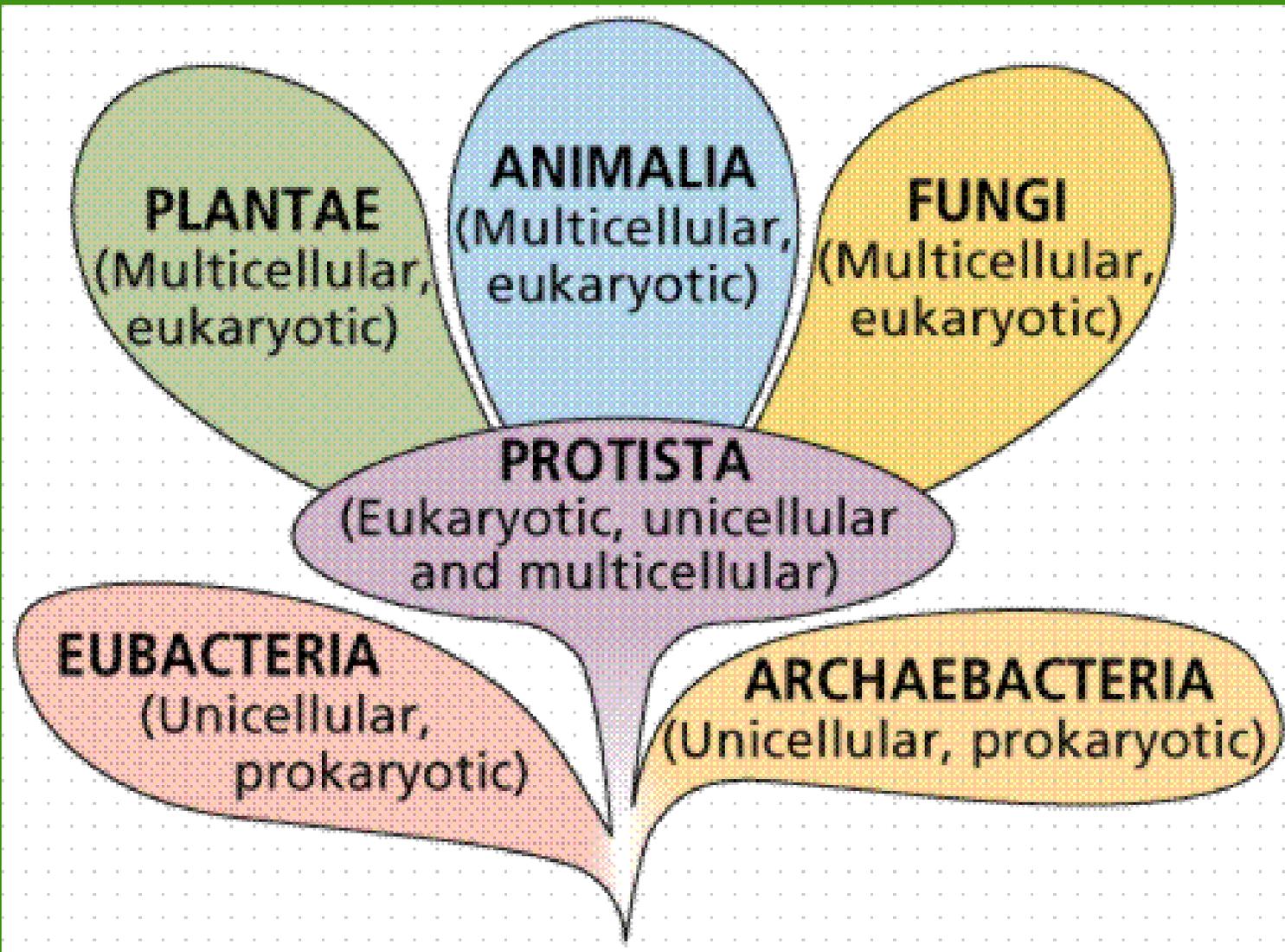


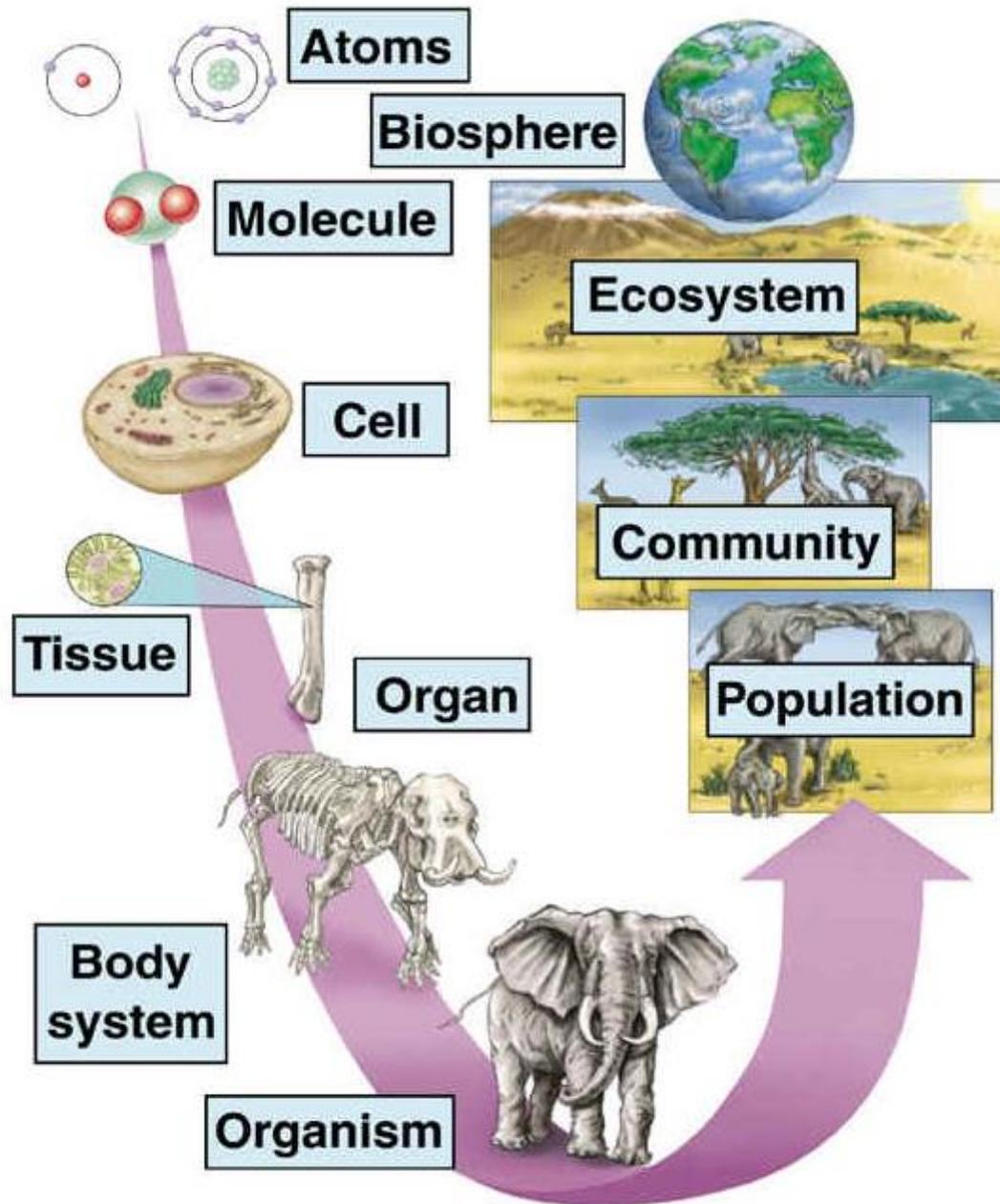
Biosphere



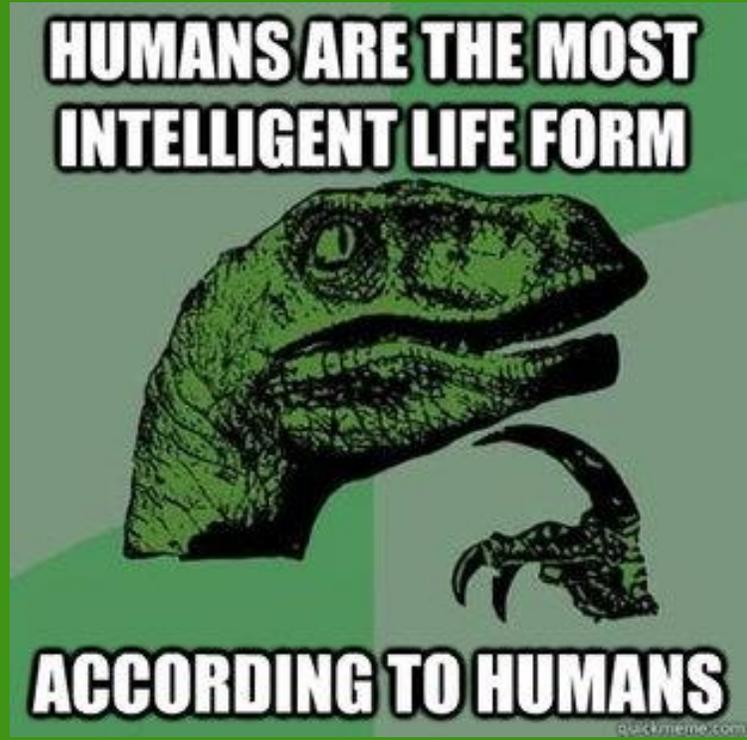
Atmosphere

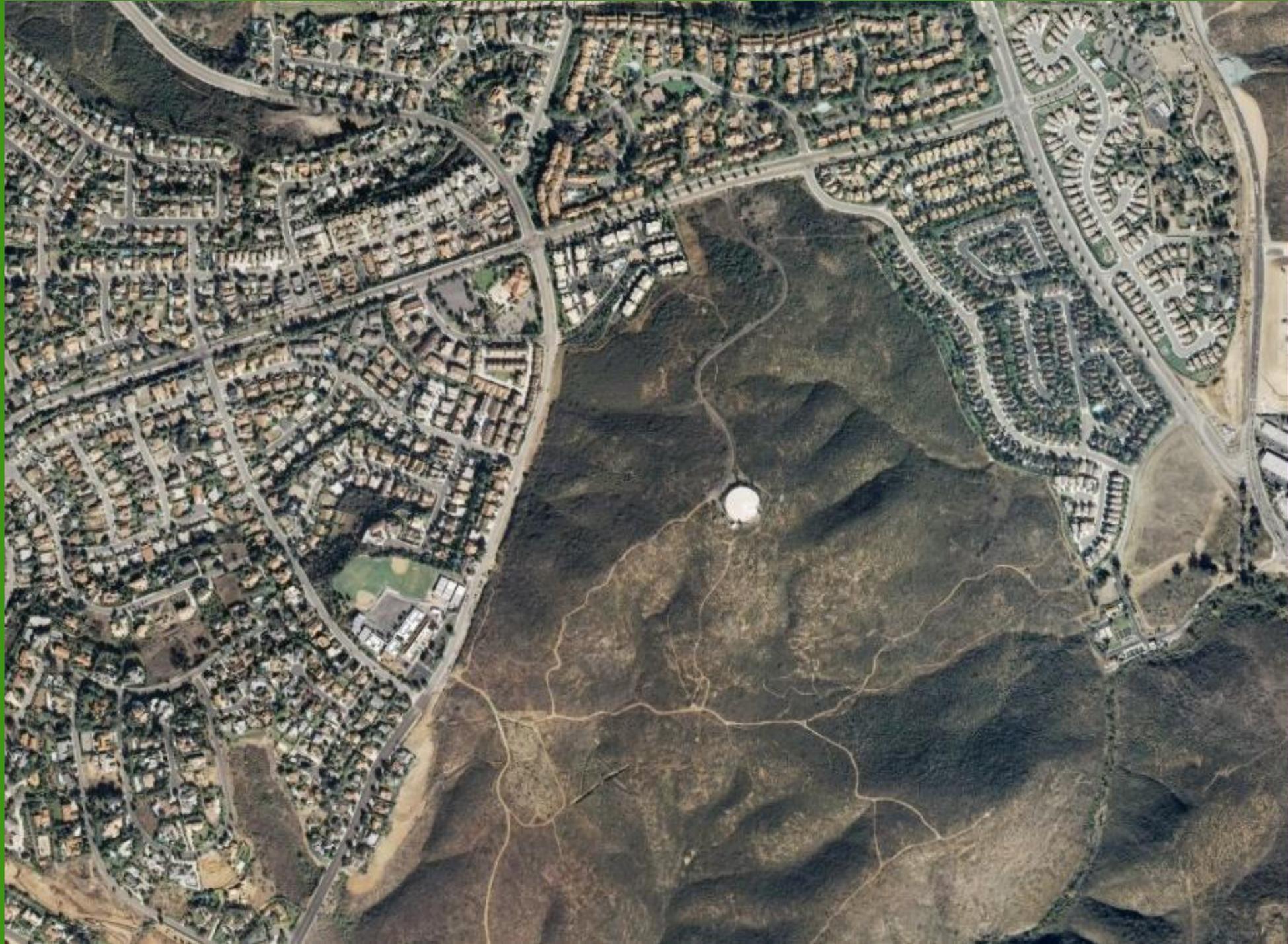






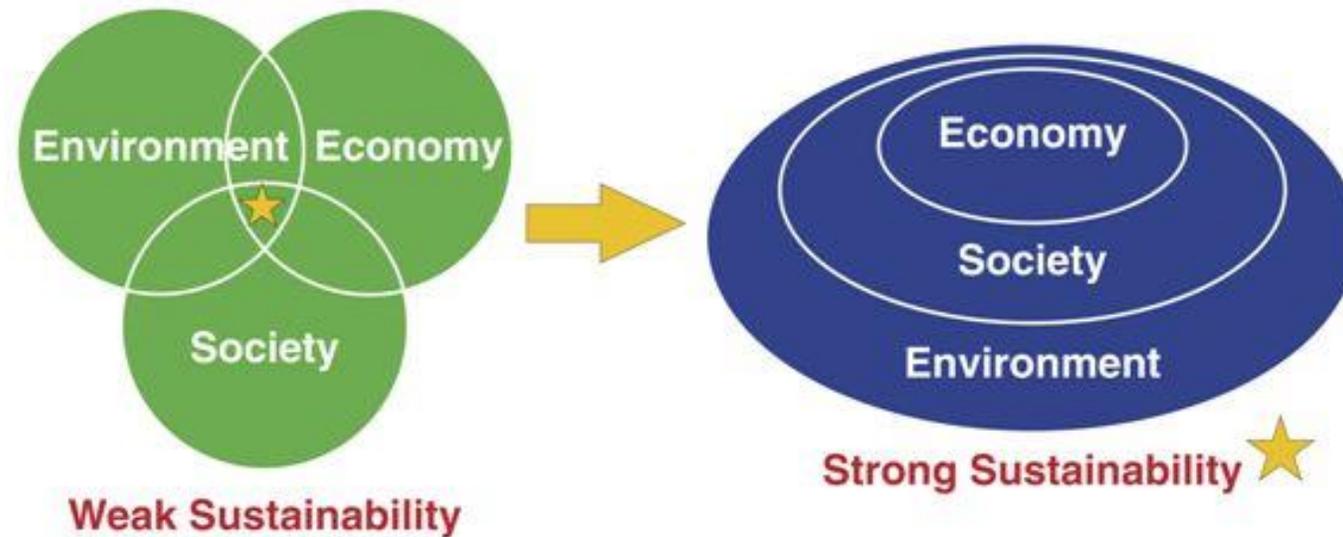




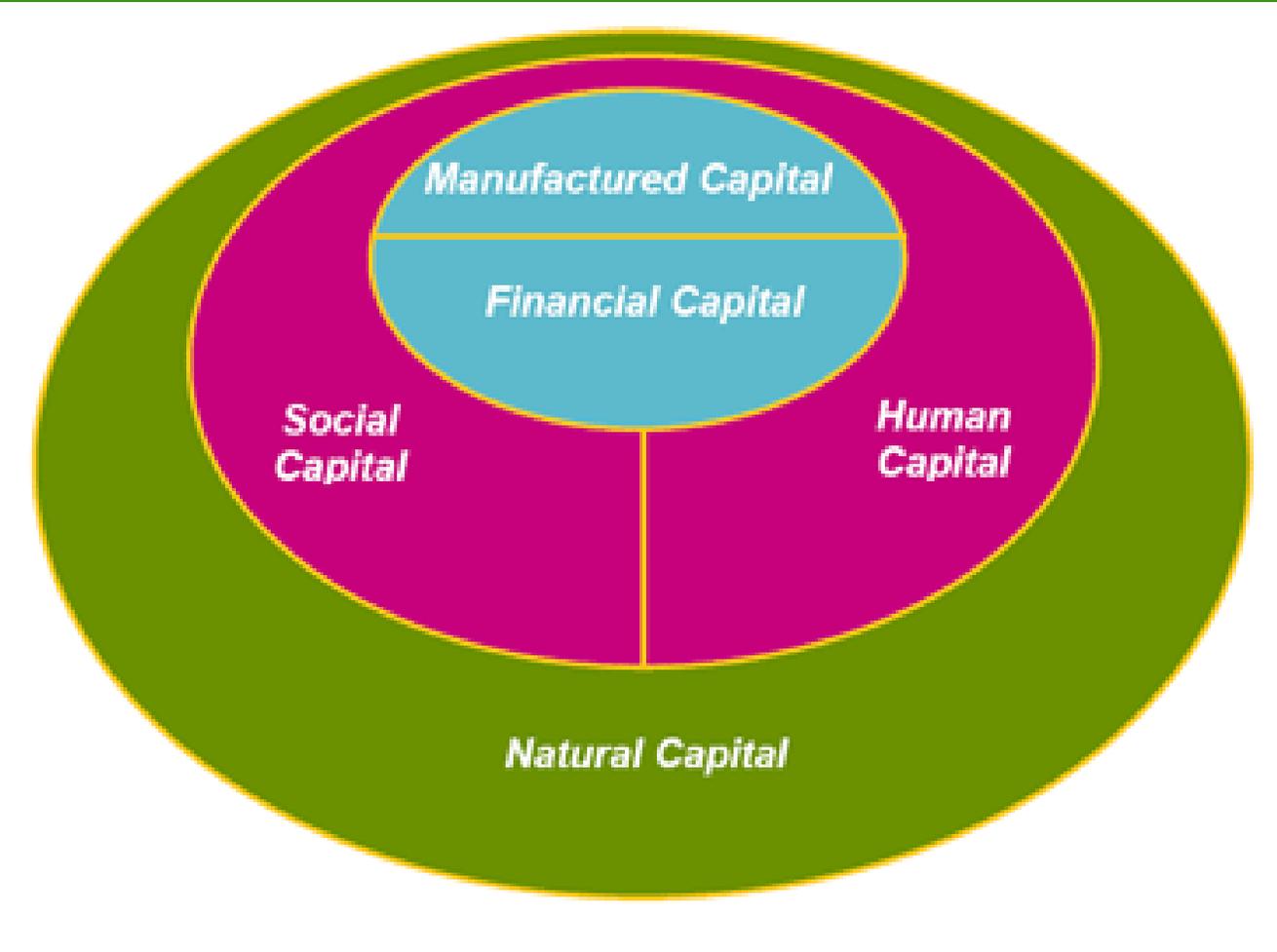


# Triple Bottom Line

*Interconnected and Interdependent Benefits*



Source: Maureen Hart - Sustainable Measures



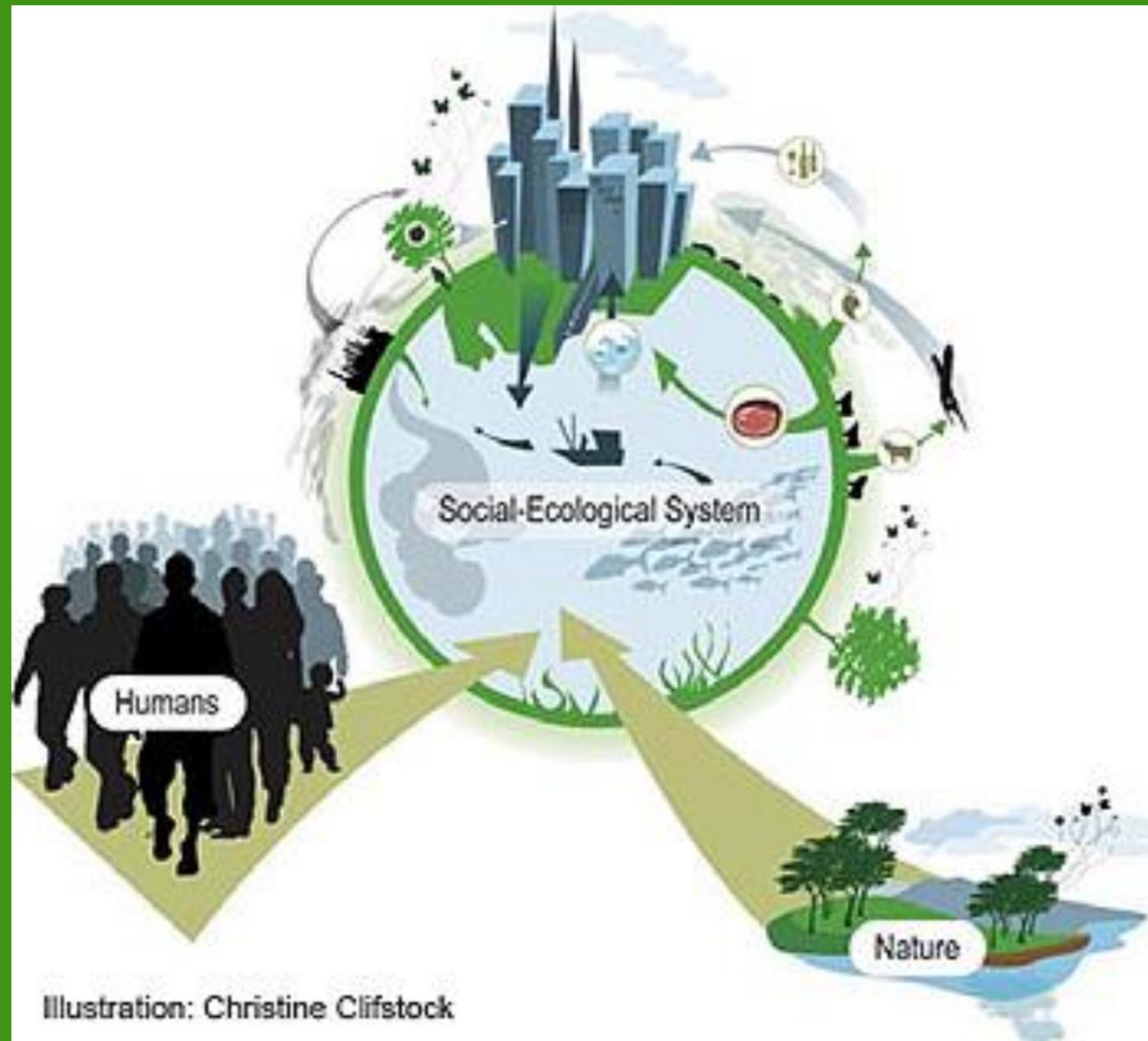


Illustration: Christine Clifstock

# Sustainability: From Word to Concept

## Definition: Sustainability

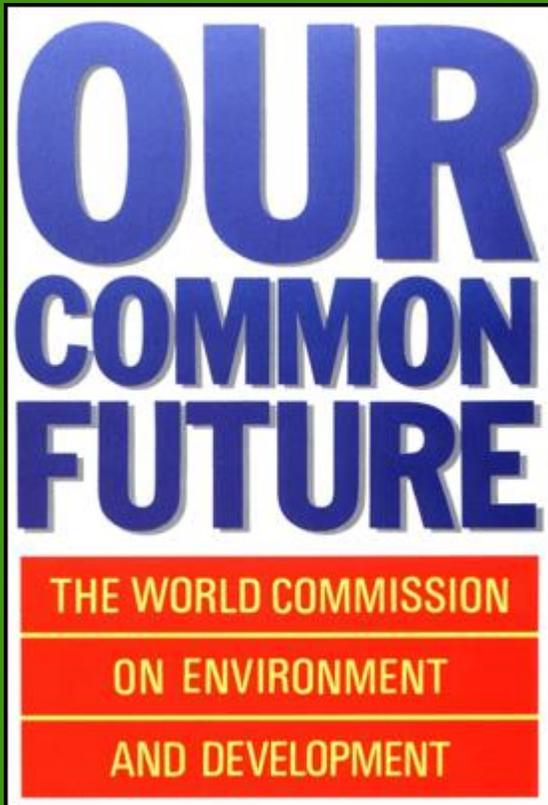
Capable of being sustained



# Developing the Concept of Sustainability: What Is Being Sustained?

Report of the World Commission on Environment  
and Development: Our Common Future

(1987; the “Brundtland Report”)



# Developing the Concept of Sustainability: What Is Being Sustained?

Sustainability should be the “central guiding principle of the United Nations, Governments and private institutions, organizations and enterprises. . .”

United Nations General Assembly (Resolution 42/187)

# OUR COMMON FUTURE

THE WORLD COMMISSION

ON ENVIRONMENT

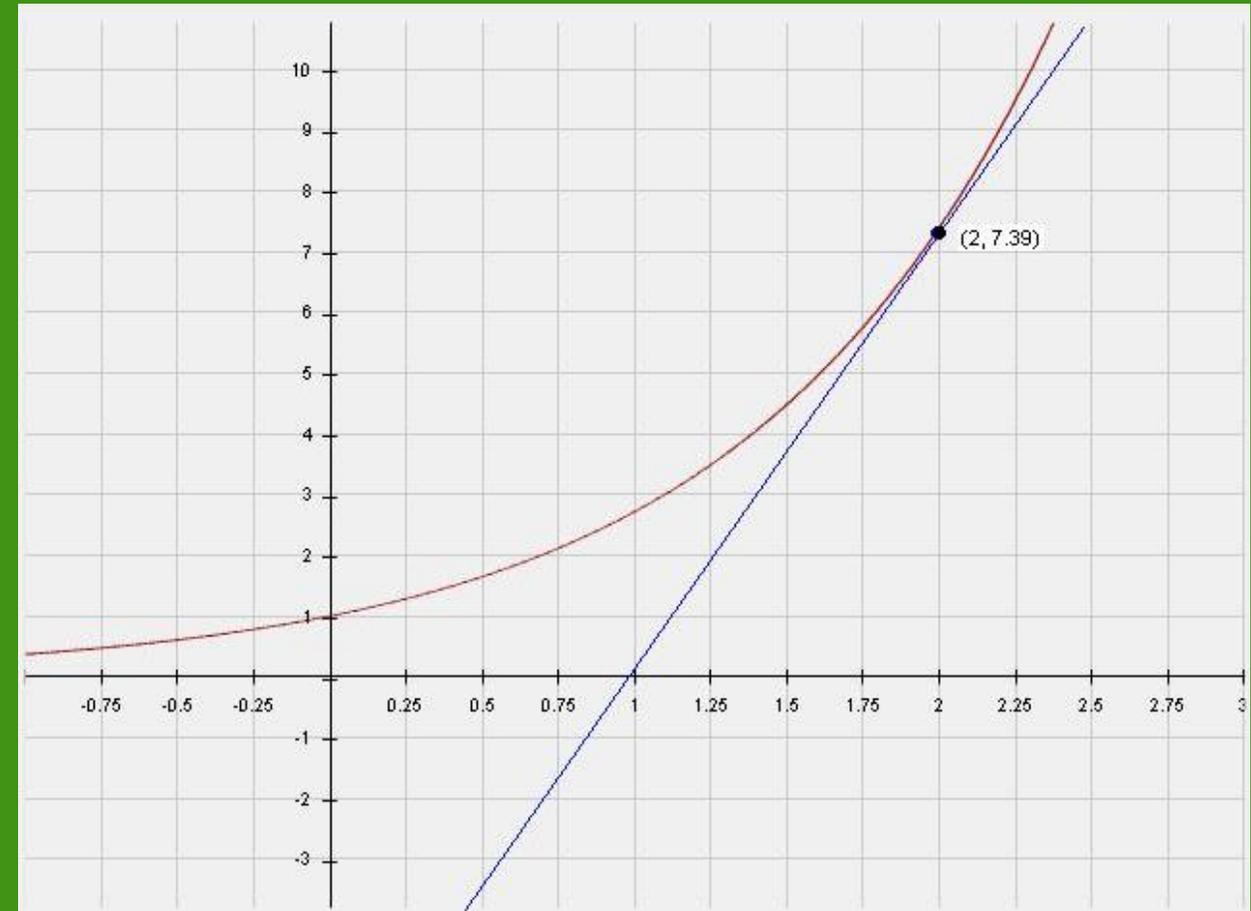
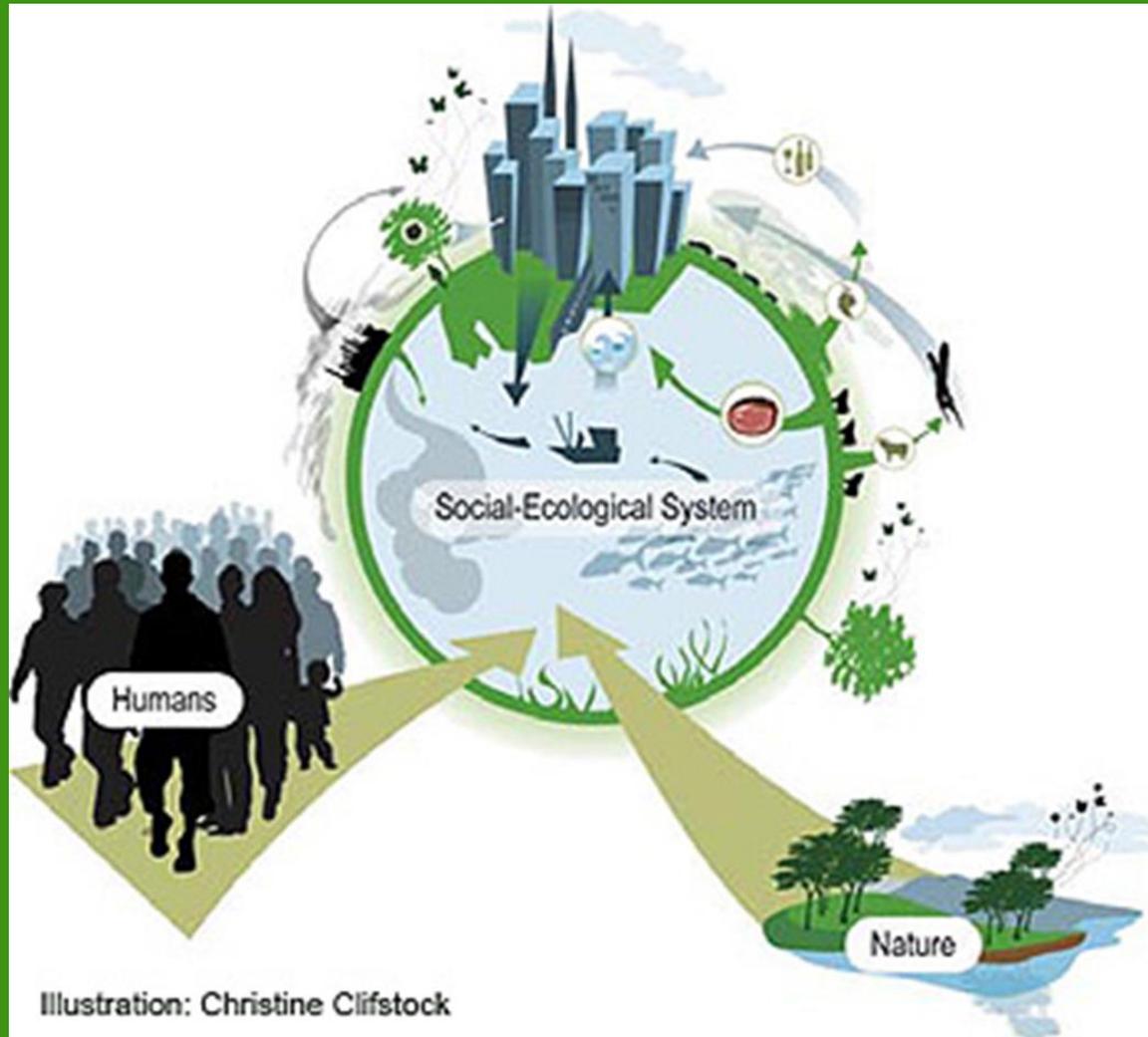
AND DEVELOPMENT

# Developing the Concept of Sustainability: What Is Being Sustained?

***A vision of development*** that encompasses populations, animal and plant species, ecosystems, natural resources – water, air, energy – and that integrates concerns such as the fight against poverty, gender equality, human rights, education for all, health, human security, intercultural dialogue, etc.

(UNESCO 2005)

# Moving Toward Sustainability:



# The Foundational Premises of Sustainability

## Premise #1:

The current state of human existence is not an acceptable endpoint of societal development.



# The Foundational Premises of Sustainability

## Premise #2:

Humans have reached a state where we are negatively impacting the ability of future generations to meet their needs and aspirations.



# The Foundational Premises of Sustainability

Human activity is putting such strain on the natural functions of Earth that the ability of the planet's ecosystems to sustain future generations can no longer be taken for granted. The provision of food, fresh water, energy, and materials to a growing population has come at considerable cost to the complex systems of plants, animals, and biological processes that make the planet habitable. . . . Nearly two thirds of the services provided by nature to humankind are found to be in decline worldwide. In effect, the benefits reaped from our engineering of the planet have been achieved by running down natural capital assets. In many cases, it is literally a matter of living on borrowed time. (MEA 2005a)

# The Foundational Premises of Sustainability

## Premise #3:

The major types of problems facing humanity have to be addressed simultaneously: There is no ranking of importance among social, environmental, and economic issues.



# The Foundational Premises of Sustainability

Premise #4:

The complex, coupled social-ecological system of humans and the earth requires fundamental restructuring.

Or

The system isn't broken

# The Foundational Premises of Sustainability

## Premise #4: The Central Law of Improvement

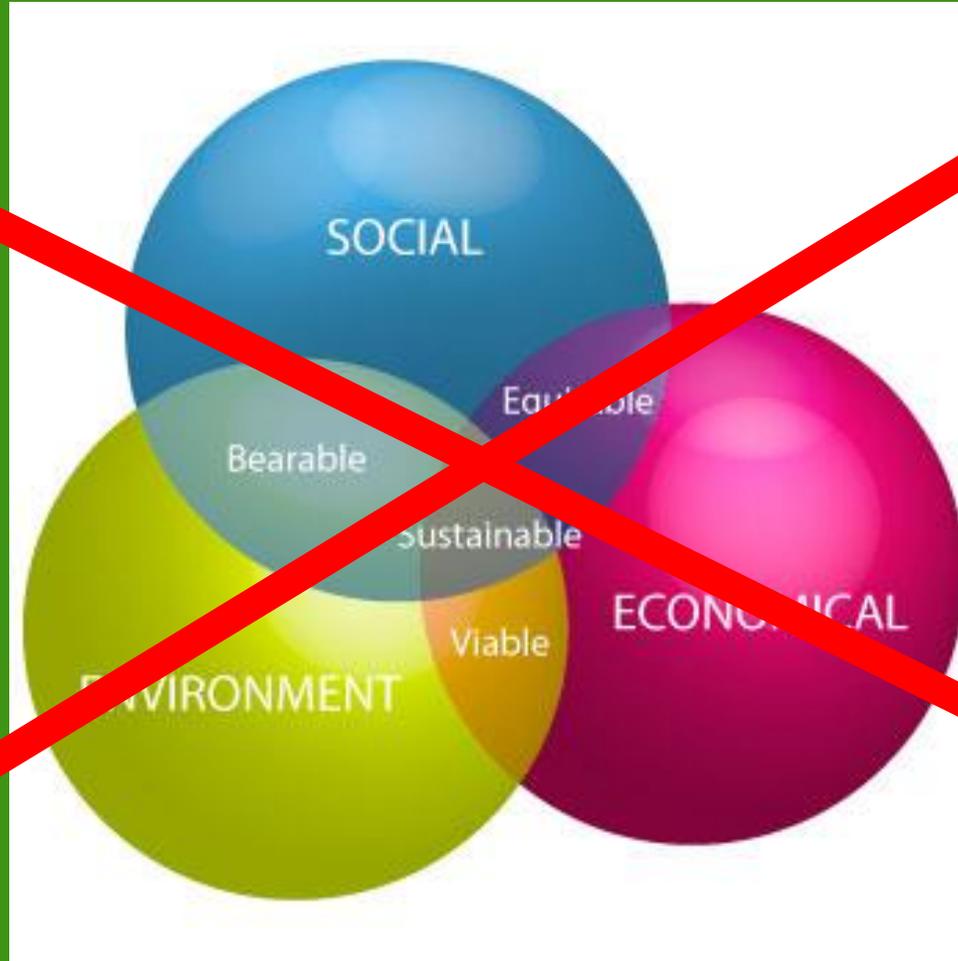
Every system is perfectly designed to achieve the results it achieves



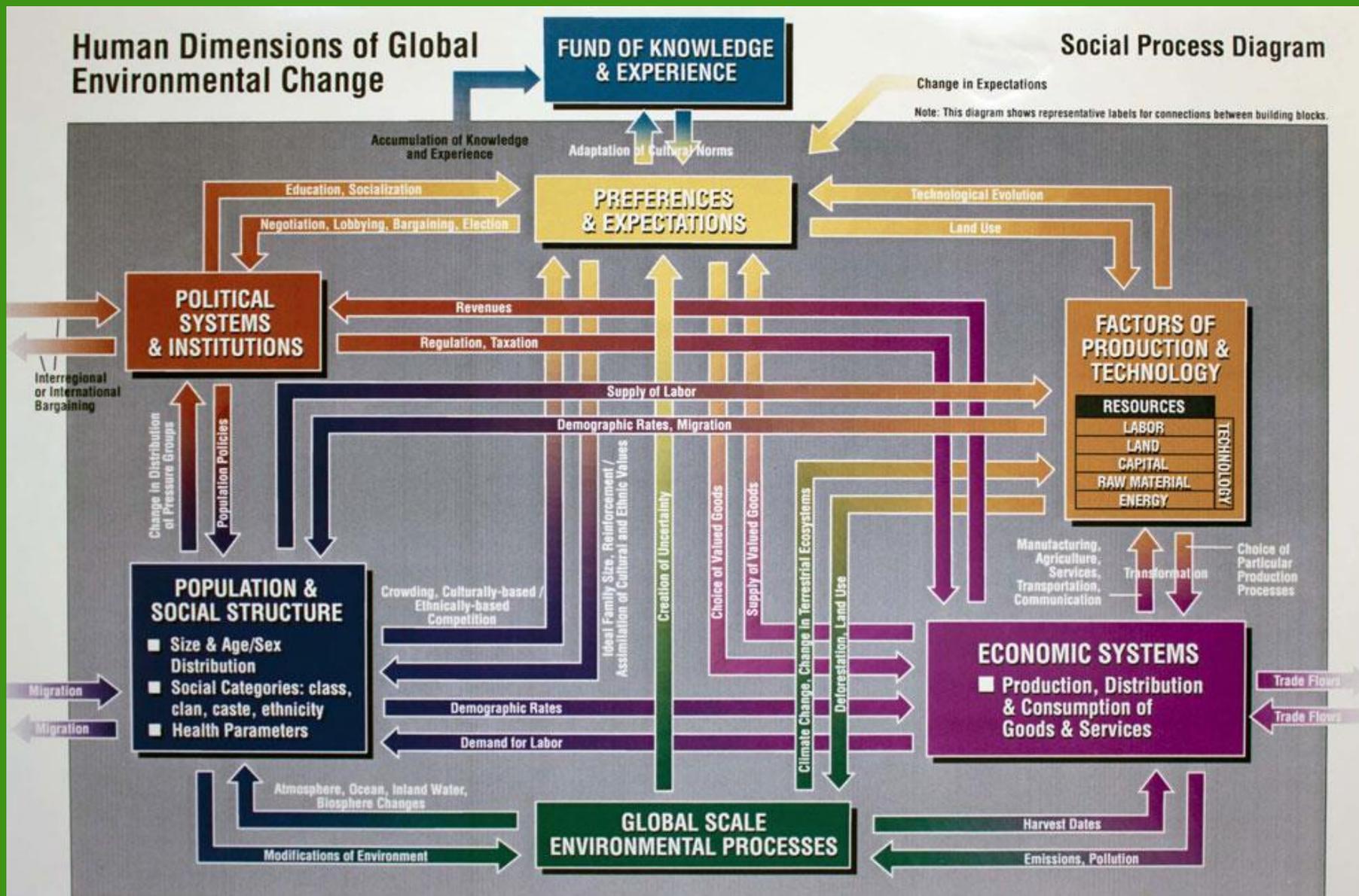
# Operationalizing Sustainability



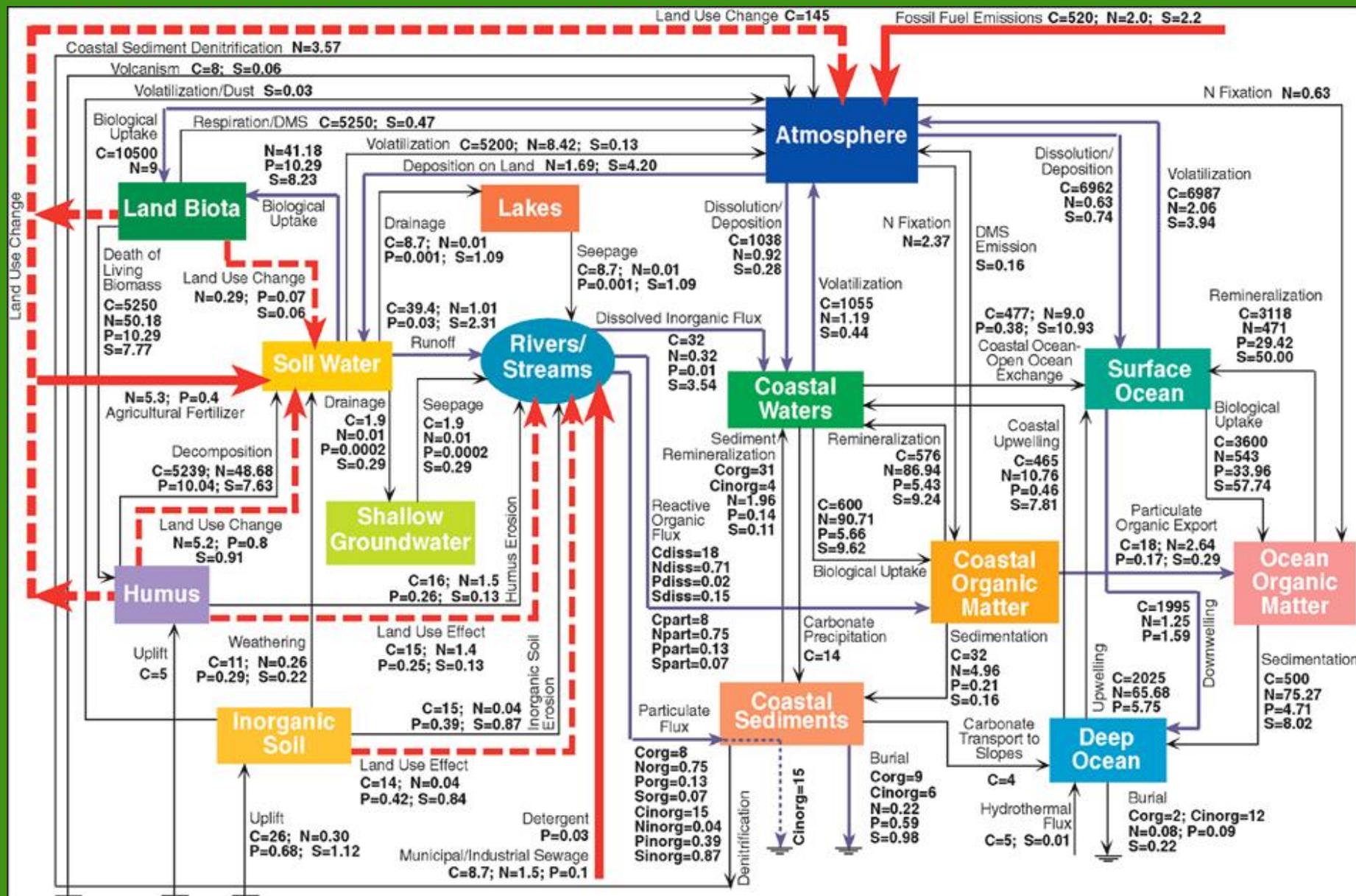
# Operationalizing Sustainability



# Operationalizing Sustainability



# Operationalizing Sustainability



# Operationalizing Sustainability

## ECONOMICS

Production & Resourcing  
Exchange & Transfer  
Accounting & Regulation  
Consumption & Use  
Labour & Welfare  
Technology & Infrastructure  
Wealth & Distribution

## ECOLOGY

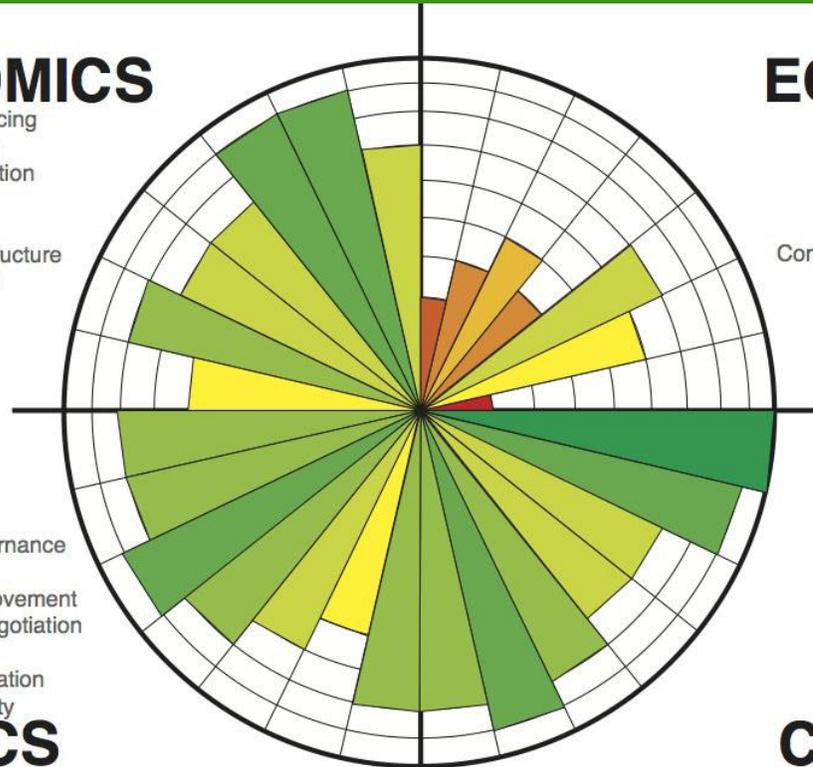
Materials & Energy  
Water & Air  
Flora & Fauna  
Habitat & Food  
Place & Space  
Constructions & Settlements  
Emission & Waste

Organization & Governance  
Law & Justice  
Communication & Movement  
Representation & Negotiation  
Security & Accord  
Dialogue & Reconciliation  
Ethics & Accountability

## POLITICS

Engagement & Identity  
Recreation & Creativity  
Memory & Projection  
Belief & Meaning  
Gender & Generations  
Enquiry & Learning  
Health & Wellbeing

## CULTURE



# CIRCLES OF SUSTAINABILITY

# The Development of Sustainability Science

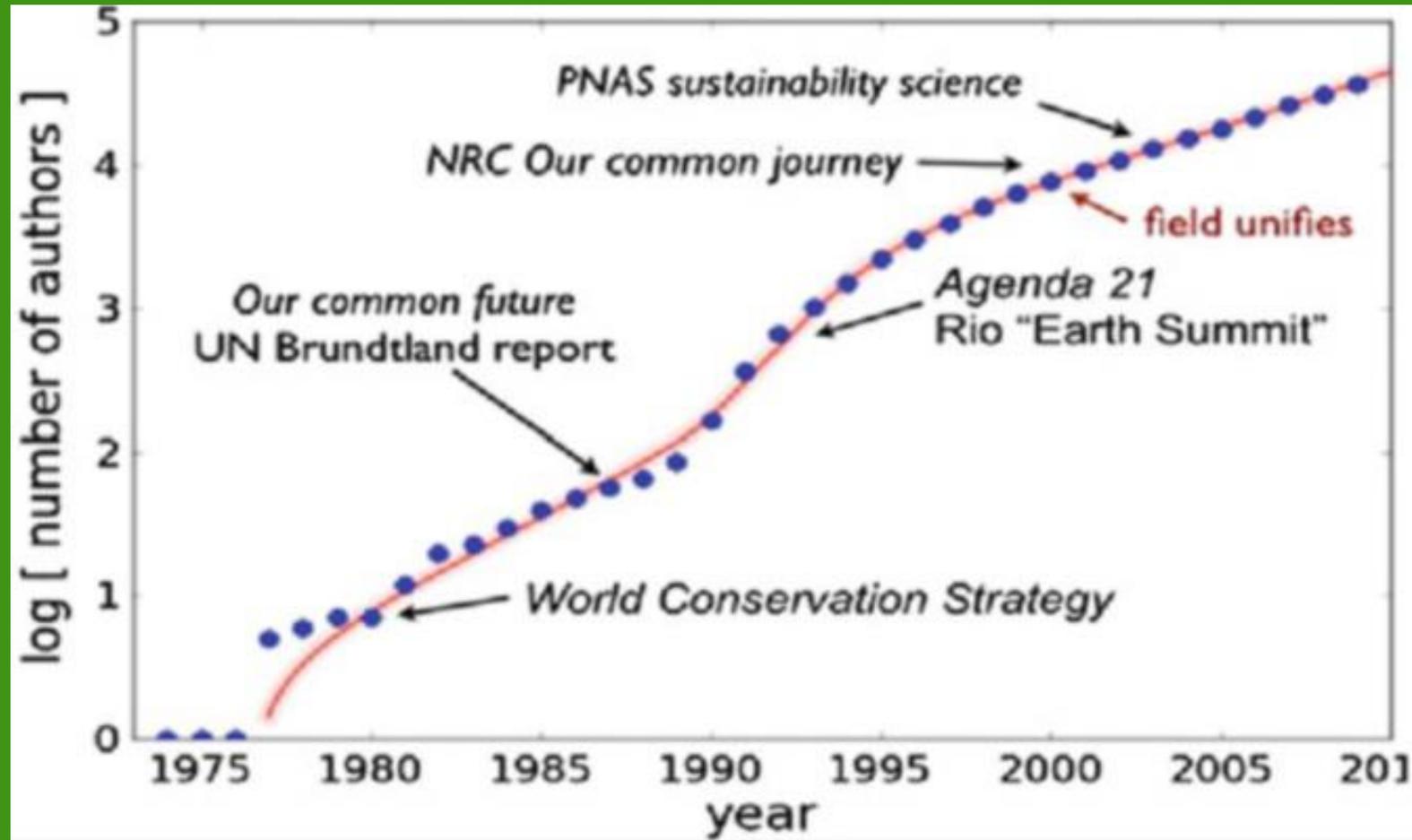
An emerging field of research dealing with the interactions between natural and social systems, and with how those interactions affect the challenge of sustainability: meeting the needs of present and future generations while substantially reducing poverty and conserving the planet's life support systems.

(<http://sustainability.pnas.org/page/about>)

# Sustainability Science: A New Conceptual Model for the World

The “new” insight is that the very concept of a human/nature system (a dichotomy between humans and the rest of the natural world) is, in fact, the problem.

# The Development of Sustainability Science



(From Bettencourt and Kaur (2011))

# The Development of Sustainability Science

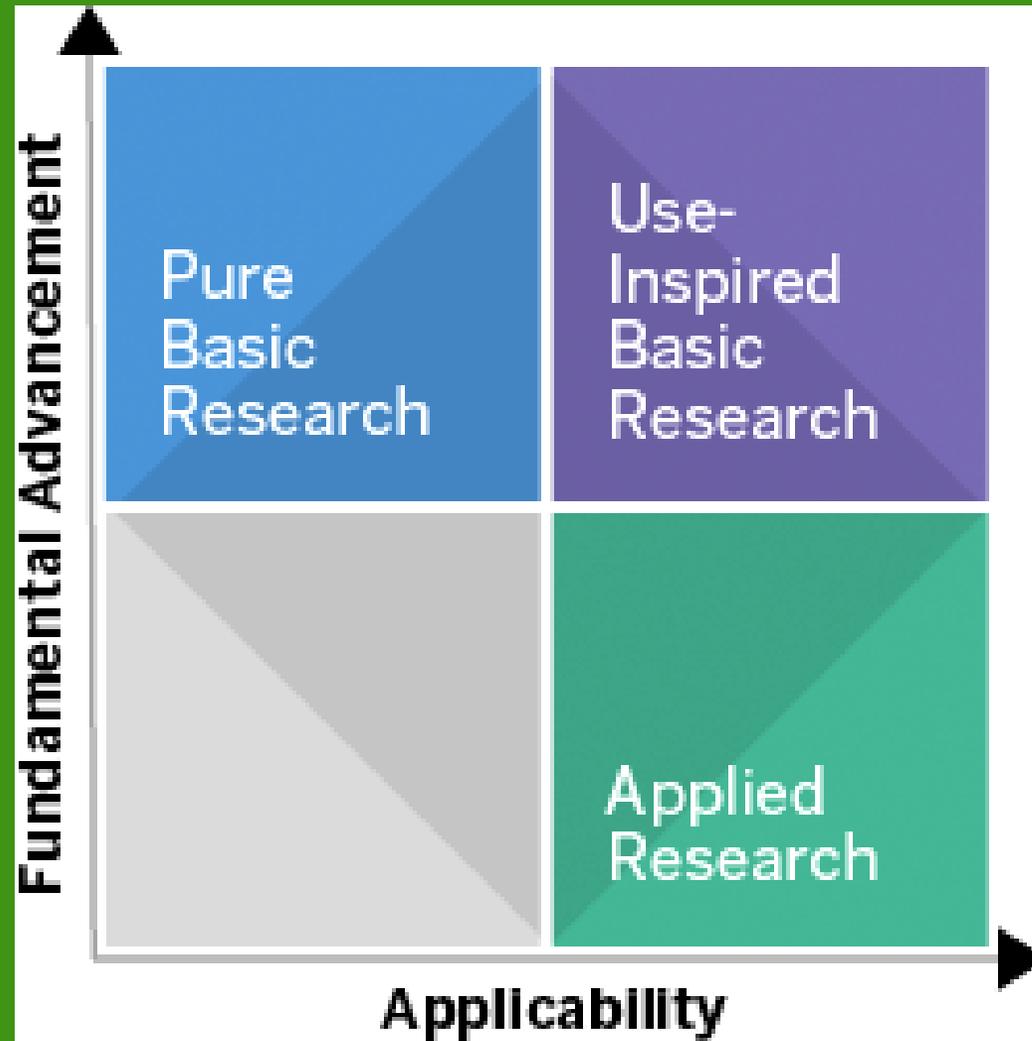
Essential questions that underlie much of the scientific enterprise:

(1) What is the optimal balance between pure and applied research?

(2) What is the appropriate role of science in society?

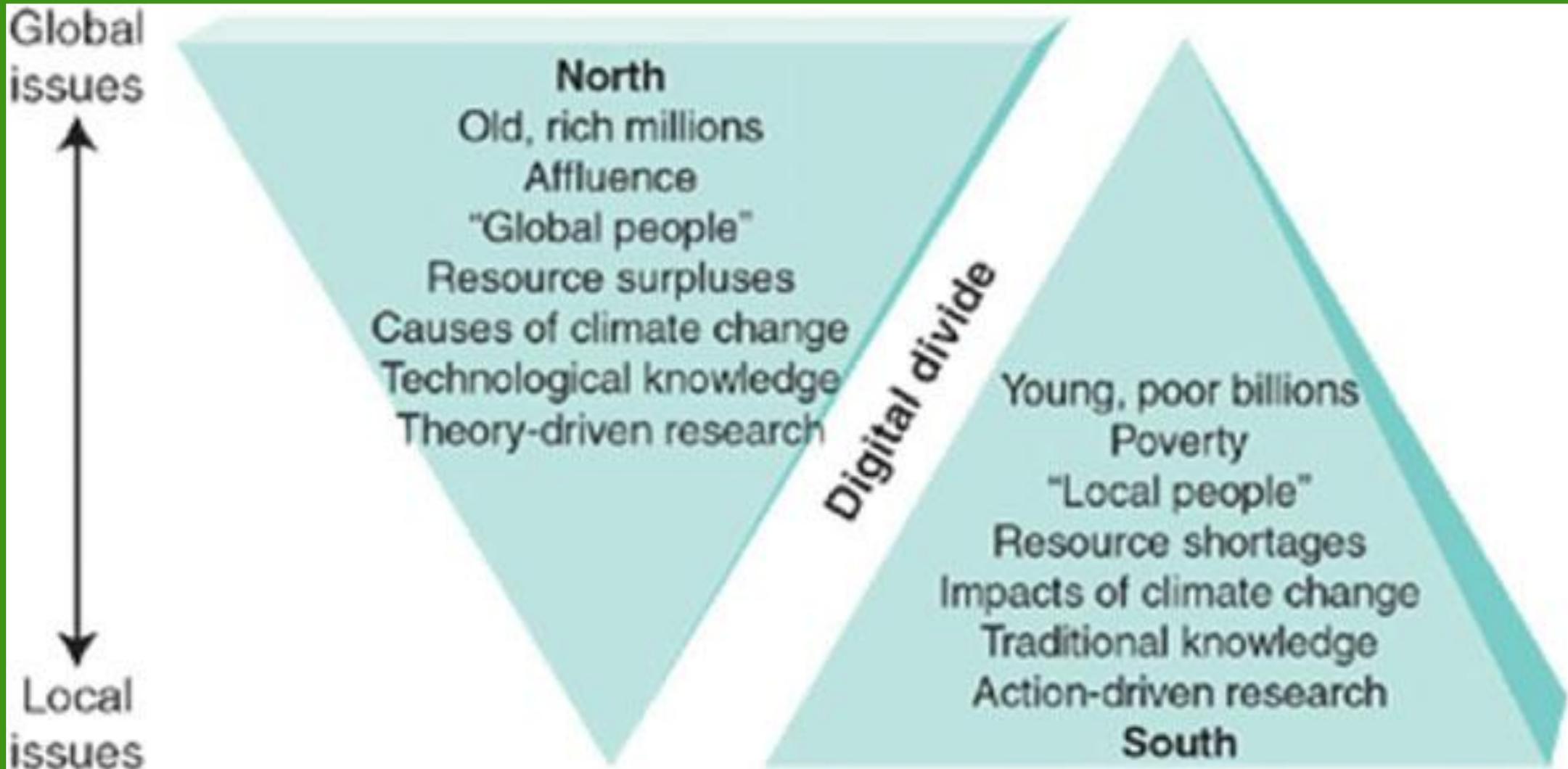
(3) How much support should society give science and scientists and what is appropriate to expect in return?

# Focusing Where Knowledge Is Most Needed



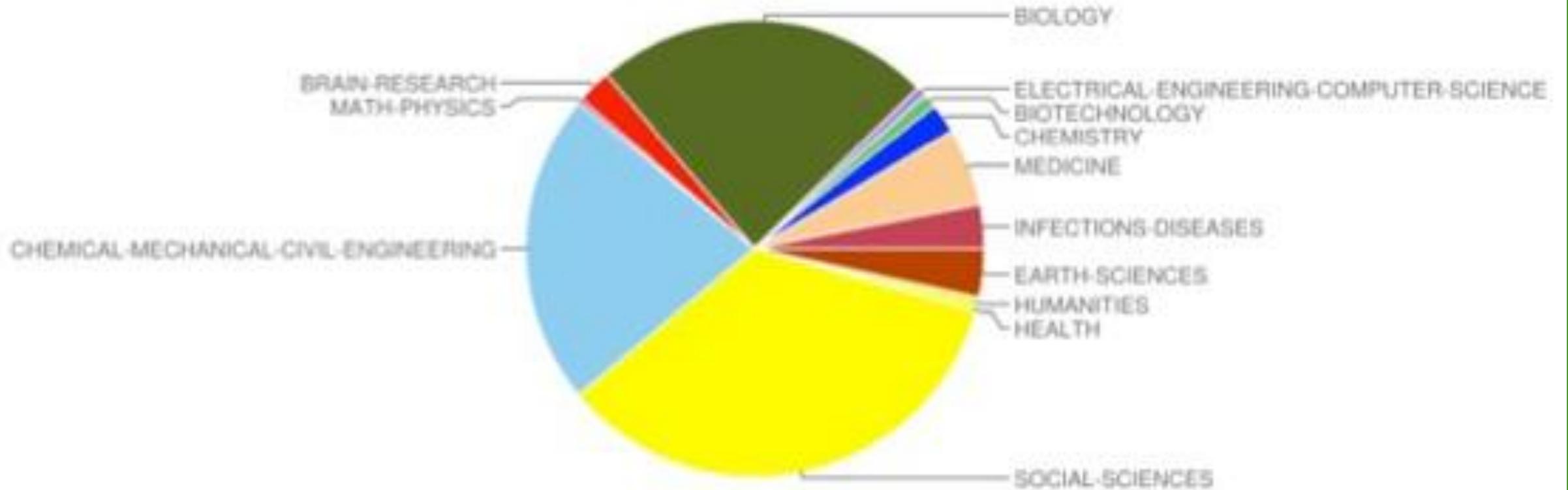
(Pasture's Quadrant, Donald Stokes 1997)

# Focusing Where Knowledge Is Most Needed



From Kates et al. (2001)

# Sustainability Science: Future Directions



Bettencourt and Kaurc (2011)

# Focusing Where Knowledge Is Most Needed

- What shapes the long-term trends and transitions that provide the major directions for this century?
- What determines the adaptability, vulnerability, and resilience of human–environment systems?
- How can theory and models be formulated that better account for the variation in human–ecosystem interactions?
- What are the principal trade-offs between human well-being and ecosystem states and processes?

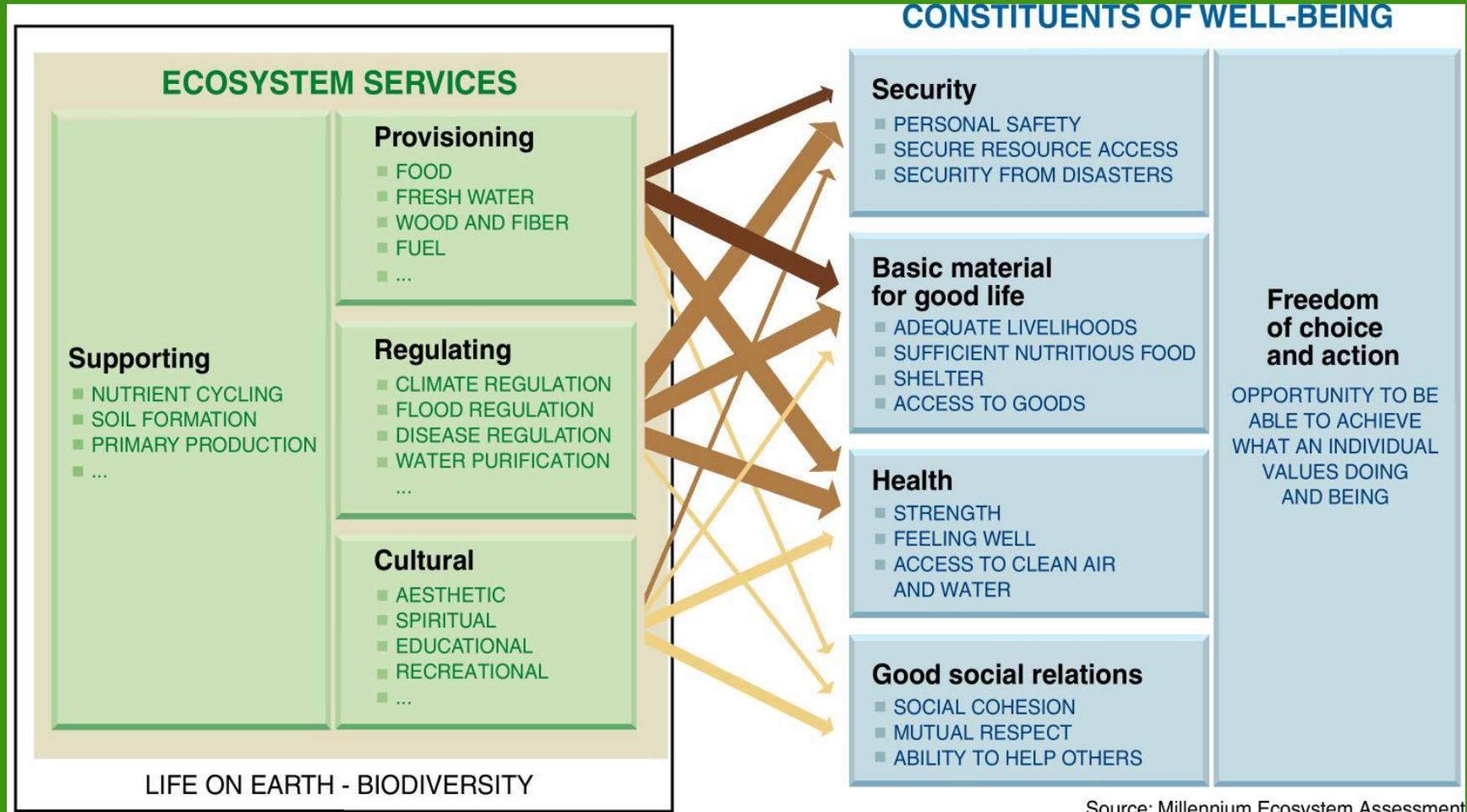
From Kates (2011)

# Focusing Where Knowledge Is Most Needed

- Can scientifically meaningful “limits” be defined that would provide effective warning for instabilities or tipping points in human–ecosystem interactions?
- How can society most effectively guide or manage human–ecosystem interactions toward a sustainability transition, reversing degradation in the condition of both human societies and natural ecosystems?
- How can the “sustainability” of alternative pathways of environment and development be evaluated?

From Kates (2011)

# Sustainability Science: The Millennial Assessment



Source: Millennium Ecosystem Assessment

**ARROW'S COLOR**  
Potential for mediation by socioeconomic factors

- Low
- Medium
- High

**ARROW'S WIDTH**  
Intensity of linkages between ecosystem services and human well-being

- Weak
- Medium
- Strong

# Sustainability Science is the Study of *The Social-Ecological System*

A system is an interconnected set of elements that is coherently organized in a way that achieves something...a system must consist of three kinds of things: elements, interconnections, and a function or purpose.

Meadows 2008

# Sustainability Science: The Social-Ecological System

Ultimately Sustainability Science is just a conversation, perhaps the most important conversation we can have:

What is the purpose of our social-ecological system?

