New Directions in the Sciences - Sustainability Science

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Earth System Science

Includes

Gases of the Earth
such as
- Nitrogen
- Oxygen
- Carbon Dioxide

Hydrosphere
includes
- Liquid Water
- Solid Water (sometimes called Cryosphere)

Biosphere
includes
- All Living Things on Earth

Atmosphere
includes

Soil
includes

Magma
includes

Rocks
includes

Geosphere
The word cloud contains various terms related to the Humanities, including history, literature, philosophy, art, music, drama, and more. It highlights the interdisciplinary nature of the Humanities, encompassing fields such as classics, linguistics, musicology, and classical studies. The cloud also touches on themes of composition, stagecraft, and fine arts, reflecting the diverse range of interests within the Humanities.
HUMANS ARE THE MOST INTELLIGENT LIFE FORM

ACCORDING TO HUMANS
Triple Bottom Line

Interconnected and Interdependent Benefits

Environment  Economy  Society

Weak Sustainability

Economy  Society  Environment

Strong Sustainability

Source: Maureen Hart - Sustainable Measures
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)
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.
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
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

**ECOSYSTEM SERVICES**

- **Provisioning**
  - Food
  - Fresh water
  - Wood and fiber
  - Fuel
  - ...

- **Supporting**
  - Nutrient cycling
  - Soil formation
  - Primary production
  - ...

- **Regulating**
  - Climate regulation
  - Flood regulation
  - Disease regulation
  - Water purification
  - ...

- **Cultural**
  - Aesthetic
  - Spiritual
  - Educational
  - Recreational
  - ...

**LIFE ON EARTH - BIODIVERSITY**

**CONSTITUENTS OF WELL-BEING**

- **Security**
  - Personal safety
  - Secure resource access
  - Security from disasters

- **Basic material for good life**
  - Adequate livelihoods
  - Sufficient nutritious food
  - Shelter
  - Access to goods

- **Health**
  - Strength
  - Feeling well
  - Access to clean air and water

- **Freedom of choice and action**
  - Opportunity to be able to achieve what an individual values doing and being

- **Good social relations**
  - Social cohesion
  - Mutual respect
  - Ability to help others

**Source:** Millennium Ecosystem Assessment

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**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?