

An Introduction to Environmental Science

What this class is all about:

- The meaning of the term environment
- The importance of natural resources
- That environmental science is interdisciplinary
- The scientific method and how science operates
- Some pressures facing the global environment
- Sustainability and sustainable development



Environment: the total of our surroundings

- All the things around us with which we interact:
 - Living things
 - Animals, plants, forests, fungi, etc.
 - Non-living things
 - Continents, oceans, clouds, soil, rocks
 - Our built environment
 - Buildings, human-created living centers
 - Social relationships and institutions

Humans exist within the environment

- **Humans exist within the environment and are part of nature.**
 - Our survival depends on a healthy, functioning planet.
- **We are part of the natural world.**
 - Our interactions with its other parts matter a great deal.
- **This idea is fundamental to environmental science and conservation biology**

Humans and the world around us

- **Humans depend completely on the environment for survival.**
 - Enriched and longer lives, increased wealth, health, mobility, leisure time
- **But natural systems have been degraded**
 - Pollution, erosion, and species extinction
 - Environmental changes threaten long-term health and survival.
- **Environmental science is the study of:**
 - How the natural world works
 - How the environment affects humans and vice versa
- **With environmental problems come opportunities for solutions.**

Natural resources: vital to human survival

substances and energy sources needed for survival



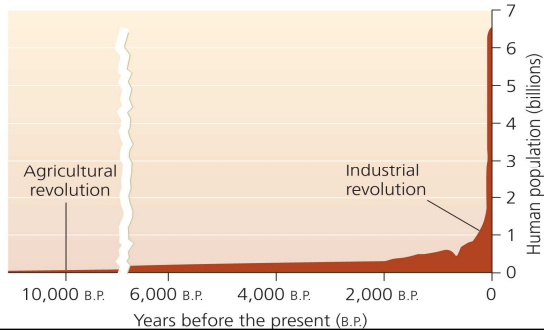
- | | | |
|---|----|--|
| Renewable natural resources <ul style="list-style-type: none">• Sunlight• Wind energy• Wave energy• Geothermal energy | ←→ | Nonrenewable natural resources <ul style="list-style-type: none">• Fresh water• Forest products• Agricultural crops• Soils• Crude oil• Natural gas• Coal• Copper, aluminum, and other metals |
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- **Perpetually available:** sunlight, wind, wave energy
- **Renewable over short periods of time:** timber, water, soil, wildlife?
 - These can be destroyed
- **Non-renewable resources:** Oil, coal, minerals
 - These can be depleted

Global human population growth

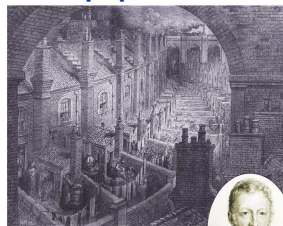
- More than 6.7 billion humans
- Why so many humans?



Thomas Malthus and human population

• Thomas Malthus

- Population growth must be controlled, or it will outstrip food production.
- Starvation, war, disease



(a) 18th-century London, England



(b) Thomas Malthus

• Neo-Malthusians

- Population growth has disastrous effects.
- Paul and Anne Ehrlich, *The Population Bomb* (1968)
 - Agricultural advances have only postponed crises.

Resource consumption exerts impacts

- Garret Hardin's "tragedy of the commons" (1968)
 - Unregulated exploitation causes resource depletion
 - Grazing lands, forests, air, water
 - No one has the incentive to care for a resource.
 - Everyone takes what he or she can until the resource is depleted.
- Solution?
 - Private ownership?
 - Voluntary organization to enforce responsible use?
 - Governmental regulations?

The “ecological footprint”

- The environmental impact of a person or population
 - Amount of biologically productive land + water
 - For resources and to dispose/recycle waste
- Overshoot: humans have surpassed the Earth’s capacity to support us



We are using 30% more of the planet’s resources than is available on a sustainable basis!

Environmental science

- Can help us avoid mistakes made by past civilizations
 - Human survival depends on how we interact with our environment.
 - Our impacts are now global.
 - Many great civilizations have fallen after depleting their resources.

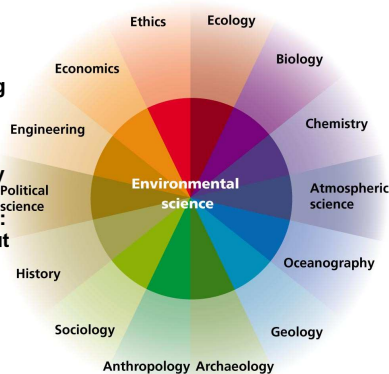


The lesson of Easter Island: people annihilated their culture by destroying their environment. Can we act more wisely to conserve our resources?

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Environmental science: how the natural world works

- Its goal: developing solutions to environmental problems
- An interdisciplinary field
 - Natural sciences: information about the natural world
 - Social sciences: study human interactions and behavior



Environmental science is not environmentalism

- Environmental science
 - The pursuit of knowledge about the natural world
 - Scientists try to remain objective
- Environmentalism
 - Environmental activism
 - A social movement dedicated to protecting the natural world



The nature of science

- Science:
 - A systematic process for learning about the world and testing our understanding of it
 - The accumulated body of knowledge that results from a dynamic process of observation, testing, and discovery
- Science is essential:
 - To sort fact from fiction
 - Develop solutions to the problems we face

Applications of science

Policy decisions and management practices



(a) Prescribed burning

Technology



(b) Methanol-powered fuel-cell car
Energy-efficient methanol-powered fuel cell car from DaimlerChrysler

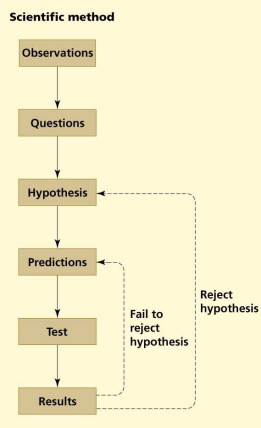
Restoration of forest ecosystems altered by human suppression of fire

Scientists test ideas

- **Scientists examine how the world works by observing, measuring, and testing**
 - Involves critical thinking and skepticism
- **Observational (descriptive) science: scientists gather information about something not well known or that cannot be manipulated in experiments**
 - Astronomy, paleontology, taxonomy, molecular biology
- **Hypothesis-driven science: research that proceeds in a structured manner using experiments to test hypotheses through the scientific method**

The scientific method

- **A technique for testing ideas**
- **A scientist makes an observation and asks questions of some phenomenon.**
- **The scientist formulates a hypothesis, a statement that attempts to answer the question.**
- **The hypothesis is used to generate predictions: specific statements that can be tested.**
- **The results support or reject the hypothesis.**



Testing predictions

- **Experiment:** an activity that tests the validity of a hypothesis
- **Variables:** conditions that can be manipulated and/or measured
 - **Independent variable:** a condition that is manipulated
 - **Dependent variable:** a variable that is affected by the manipulation of the independent variable
- **Controlled experiment:** one in which all variables are controlled
 - **Control:** the unmanipulated point of comparison
 - **Treatment:** the manipulated point of comparison
- **Data:** information (more correctly facts) that is (are) generally quantitative (numerical)

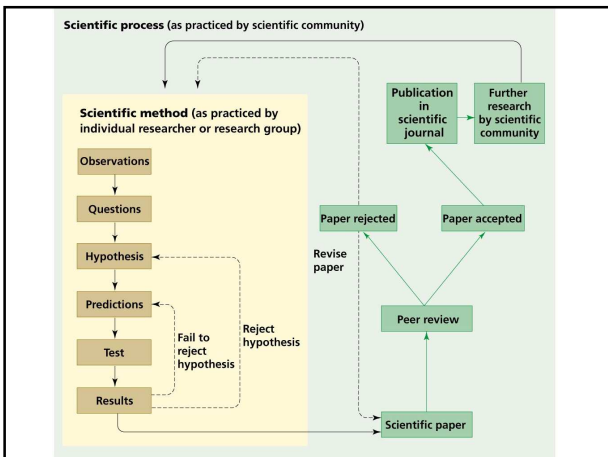
Experiments test the validity of a hypothesis

- Manipulative experiments = strongest evidence
 - Provides the strongest type of evidence
 - Reveal causal relationships: changes in independent variables cause changes in dependent variables
 - But many things can't be manipulated: long-term or large-scale questions (e.g., global climate change)
- Natural experiments show real-world complexity
 - Only feasible approach for ecosystem or planet-scale
 - Results are not so neat and clean, so answers aren't simply black and white

The scientific process is part of a larger process

Peer-review: publication requirement demanding other scientists provide comments and criticism

- Guards against faulty science – reject/accept
- Conference presentations improve the quality of the science and generate ideas when scientists interact with their colleagues
- Grants and funding from private or govt. agencies.
 - Can lead to conflict of interest if the data show the funding source in an unfavorable light
 - The scientist may be reluctant to publish or tempted to doctor the results – NOT ethical



Theories and paradigms

- A consistently supported hypothesis becomes a theory, a widely accepted explanation of one or more cause-and-effect relationships
 - Has been extensively and rigorously tested, so confidence in a theory is extremely strong
 - Darwin's theory of evolution, atomic theory, cell theory, big bang theory, plate tectonics, general relativity
 - Differs from the popular meaning of theory, which suggests a speculative idea without much substance
- With enough data, a paradigm shift — a change in the dominant view — can occur.

Ethics

- Ethics: the study of good and bad, right and wrong
 - The set of moral principles or values held by a person or society that tells us how we ought to behave
 - Will save most of this discussion for the end of the semester

Environmental ethics

Should we conserve wildlife for future generations?

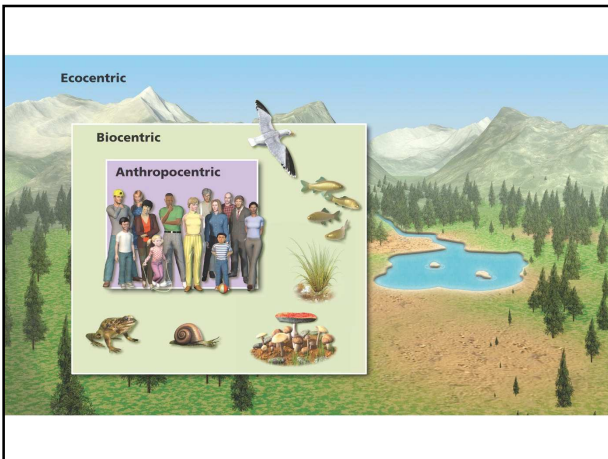
Is it OK to destroy a forest to create certain jobs for people?

Should we drive other species to extinction to maintain economic growth?

Is it OK to hunt or trap animals?

Three ethical perspectives or viewpoints

- **Anthropocentrism:** only humans have rights
 - Costs and benefits are measured only according to their impact on people
 - Anything not providing benefit to people has no value
- **Biocentrism:** certain living things also have value
 - All life has ethical standing
 - Development is opposed if it destroys life, even if it creates jobs
- **Ecocentrism:** whole ecological systems have value
 - Values the well-being of species, communities, or ecosystems
 - Holistic perspective, stresses preserving connections



The preservation ethic

- Unspoiled nature should be protected for its own inherent value.
 - We should protect our environment in a pristine state, because it promotes human happiness and fulfillment.
 - John Muir (*right, with President Roosevelt at Yosemite National Park*) had an ecocentric viewpoint.





The conservation ethic

• Use natural resources wisely for the greatest good for the most people

- A utilitarian standard that calls for prudent, efficient, and sustainable resource extraction and use
- Gifford Pinchot had an anthropocentric viewpoint.

The land ethic

- Healthy ecological systems depend on protecting all parts.
 - Aldo Leopold believed that humans should view themselves and the land as members of the same community.
 - We are obligated to treat the land ethically.
 - The land ethic will help guide decision making.



Ecofeminism

- Female worldview: interrelationships and cooperation
- Male worldview: hierarchies, competition, domination, and conquest
- Perhaps males need to consider the female perspective when attempting to conserve nature

Environmental justice (EJ)

- The poor and minorities are exposed to more pollution, hazards, and environmental degradation.
 - Despite progress, significant inequalities remain.

The U.S. exports waste, particularly to poor nations.



Sustainability

- A guiding principle of environmental science
- Living within our planet's means
 - The Earth can sustain humans AND other organisms for the future
 - Leaving our descendents with a rich, full world
 - Developing solutions that work in the long term
 - Requires keeping fully functioning ecological systems

Sustainability

- We are increasing our burden on the planet each year.
 - Population growth, affluence, consumption
- Natural capital: the accumulated wealth of Earth
 - We are withdrawing our planet's natural capital 30% faster than it is being produced



Sustainable solutions abound

- Sustainable development: using resources to satisfy current needs without compromising future availability of resources
- Sustainability involves:
 - Renewable energy sources
 - Soil conservation, high-efficiency irrigation, organic agriculture
 - Pollution reduction
 - Habitat and species protection
 - Recycling
 - Fighting global climate change

Humanity's challenge is to develop solutions that further our quality of life while protecting and restoring the environment.

Will we develop in a sustainable way?

This is the single most important question we face.