

Chapter 1

An Introduction to Environmental Science

This lecture will help you understand:

- 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.
- The fundamental insight of environmental science is that we are part of the natural world.
 - Our interactions with its other parts matter a great deal.

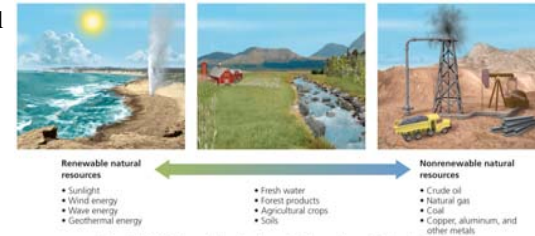
Humans and the world around us

- 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.

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Natural resources: vital to human survival

Natural resources = substances and energy sources needed for survival



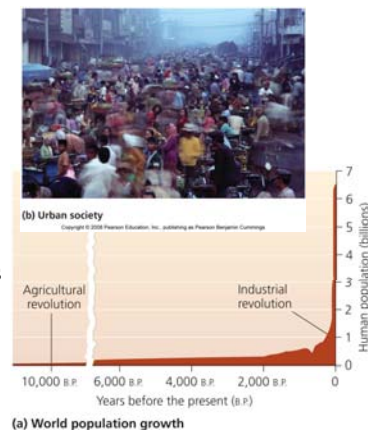
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- **Renewable resources:**
 - Perpetually available: sunlight, wind, wave energy
 - Renew themselves over short periods of time: timber, water, soil
 - These can be destroyed
- **Non-renewable resources:** can be depleted
 - Oil, coal, minerals

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Global human population growth

- More than 6.7 billion humans
- Why so many humans?
 - Agricultural revolution
 - Stable food supplies
 - Industrial revolution
 - Urbanized society powered by fossil fuels
 - Sanitation and medicines
 - More food



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Thomas Malthus and human population

- Thomas Malthus
 - Population growth must be controlled, or it will outstrip food production.
 - Starvation, war, disease
- Neo-Malthusians
 - Population growth has disastrous effects.
 - Paul and Anne Ehrlich, *The Population Bomb* (1968)
 - Agricultural advances have only postponed crises.



(a) 18th-century London, England



(b) Thomas Malthus

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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?

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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 are available on a sustainable basis!

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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.



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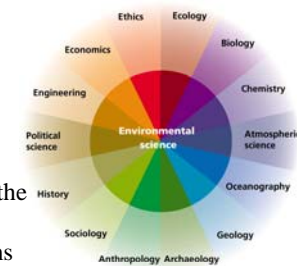
The lesson of Easter Island: people annihilated their culture by destroying their environment. Can we act more wisely to conserve our resources?

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Environmental science: how the natural world works

Environment ← impacts → Humans

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



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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



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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

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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

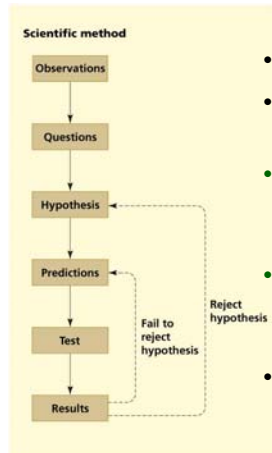
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Scientists test ideas

- 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

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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.

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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 that is generally quantitative (numerical)

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Experiments test the validity of a hypothesis

- **Manipulative experiments** yield the 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 (i.e., 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

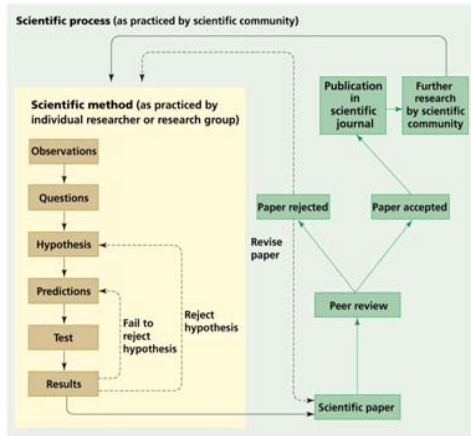
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The scientific process is part of a larger process

- **Peer-review**: other scientists provide comments and criticism
 - Guards against faulty science
- Conference presentations improve the quality of the science
 - Scientists interact with their colleagues
- Grants and funding come from private or government 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 doctor the results.

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The scientific community



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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.

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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
 - People use criteria, standards, or rules when making judgments.
 - Different cultures or worldviews lead to different values, which lead to different actions.
- **Relativists:** ethics vary with social context
- **Universalists:** right and wrong remains the same across cultures and situations

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Ethical standards

- **Ethical standards:** criteria that help differentiate right from wrong
 - Classical standard = virtue
 - The golden rule: treat others as you want to be treated
 - **Utility:** something right produces the most benefits for the most people

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Environmental ethics

- **Environmental ethics:** application of ethical standards to relationships between human and non-human entities
 - Hard to resolve; depends on the person's ethical standards
 - Depends on the person's domain of ethical concern

Should we conserve resources for future generations?

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

Should we drive other species to extinction?

Is it OK for some communities to be exposed to excess pollution?

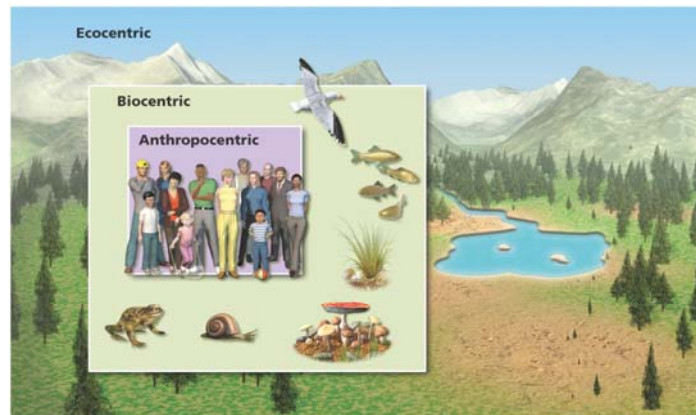
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Three ethical perspectives

- **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

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Expanding ethical consideration



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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.

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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.

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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.

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Ecofeminism

- In the 1960s and 1970s, feminist scholars saw parallels in how people treated nature and how men treated women.
 - Degradation, social oppression
- Ecofeminism: a patriarchal (male-dominated) society is a root cause of both social and environmental problems
 - Female worldview: interrelationships and cooperation
 - Male worldview: hierarchies, competition, domination, and conquest

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Environmental justice (EJ)

- Involves the fair treatment of all people with respect to the environment, regardless of race, income, or ethnicity
- The poor and minorities are exposed to more pollution, hazards, and environmental degradation.
 - Despite progress, significant inequalities remain.



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The U.S. has still not ratified the Basel Convention, which prohibits the international export of 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

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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
- **Natural capital** = the accumulated wealth of Earth
 - We are withdrawing our planet's natural capital 30% faster than it is being produced.

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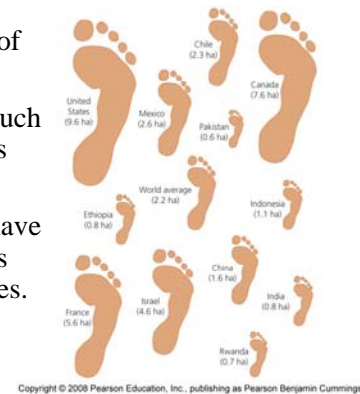
We are increasing our burden on the planet

- Human population growth amplifies all environmental problems
 - *The growth rate has slowed, but we still add over 200,000 people to the planet each day.*
- Our consumption of resources has risen even faster.
 - Life has become more pleasant for us so far.
 - However, rising consumption increases the demands we make on our environment.
 - The rise in affluence has not been equal. The gap between rich and poor has doubled in the past 40 years.

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Ecological footprints are not all equal

- The ecological footprints of countries vary greatly.
 - The U.S. footprint is much greater than the world's average.
 - Developing countries have much smaller footprints than developed countries.



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The 2005 Millennium Ecosystem Assessment

- The most comprehensive scientific assessment of the condition of the world's ecological systems
- Major findings:
 - Humans have drastically altered ecosystems.
 - These changes have contributed to human well-being and economic development, but at a cost.
 - Environmental degradation could get much worse.
 - Degradation can be reversed, but it requires work.

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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.

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Will we develop in a sustainable way?

- Sustainable solutions must meet:
 - Environmental goals
 - Economic goals
 - Social goals
- Requires that humans limit our impact while promoting economic well-being and social equity
 - Apply science to solve problems



The single most important question we face is: "Will we develop sustainably?"

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Conclusion

- Finding ways to live sustainably on Earth requires a solid ethical grounding and scientific understanding of our natural and social systems.
- Environmental science helps us understand our relationship with the environment and informs our attempts to solve and prevent problems.
- Identifying a problem is the first step in solving it.
- Solving environmental problems can move us toward health, longevity, peace, and prosperity.
 - Environmental science can help find balanced solutions to environmental problems.

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