

ENVIRONMENT

THE SCIENCE BEHIND THE STORIES

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Ch 1

An Introduction to Environmental Science

Part 1: Foundations of
Environmental Science

PowerPoint® Slides prepared by
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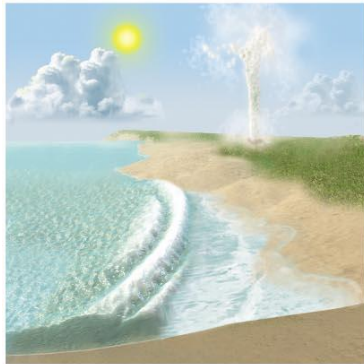
Third Edition

Environment: the total of our surroundings

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

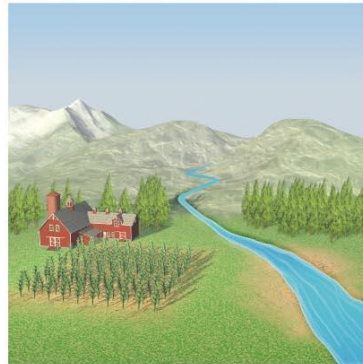
Natural resources: vital to human survival

Natural resources = substances and energy sources needed for survival



Renewable natural resources

- Sunlight
- Wind energy
- Wave energy
- Geothermal energy



- Agricultural crops
- Fresh water
- Forest products
- Soils



Nonrenewable natural resources

- Crude oil
- Natural gas
- Coal
- Copper, aluminum, and other metals

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

Garrett Hardin's Tragedy of the Commons

- Unregulated exploitation leads to resource depletion
 - Soil, air, water
- Resource users are tempted to increase use until the resource is gone
- 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 raw materials and to dispose/recycle waste
- **Overshoot:** humans have surpassed the Earth’s capacity



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

Environmental science

... can help us avoid mistakes made by past civilizations.

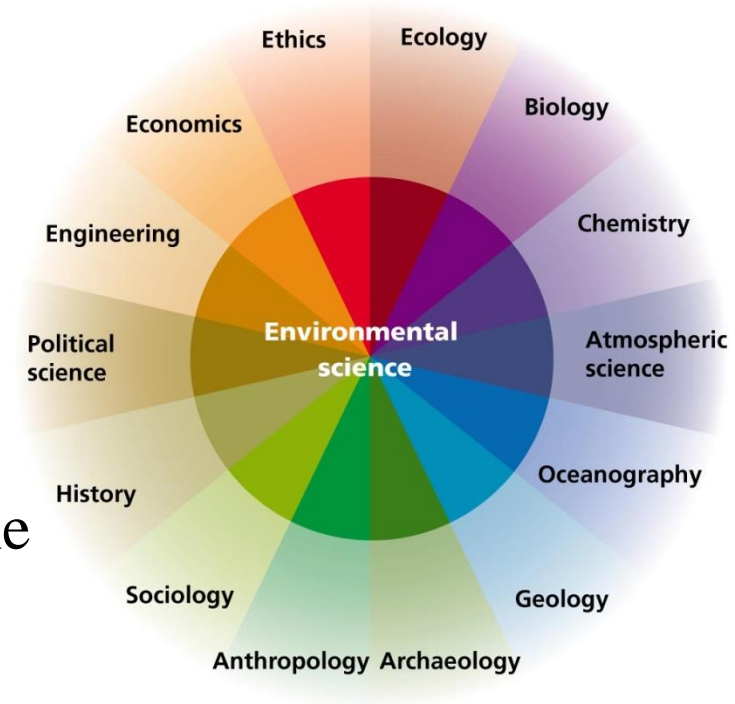


The lesson of Easter Island: people annihilated their culture by destroying their environment. Can we act more wisely to conserve our resources?

Environmental science: how does the natural world work?

Environment ← impacts → Humans

- It has an applied goal: developing solutions to environmental problems
- An interdisciplinary field
 - Natural sciences: information about the world
 - Environmental Science programs
 - Social sciences: values and human behavior
 - Environmental Studies programs



Environmental science is not environmentalism

•Environmental science

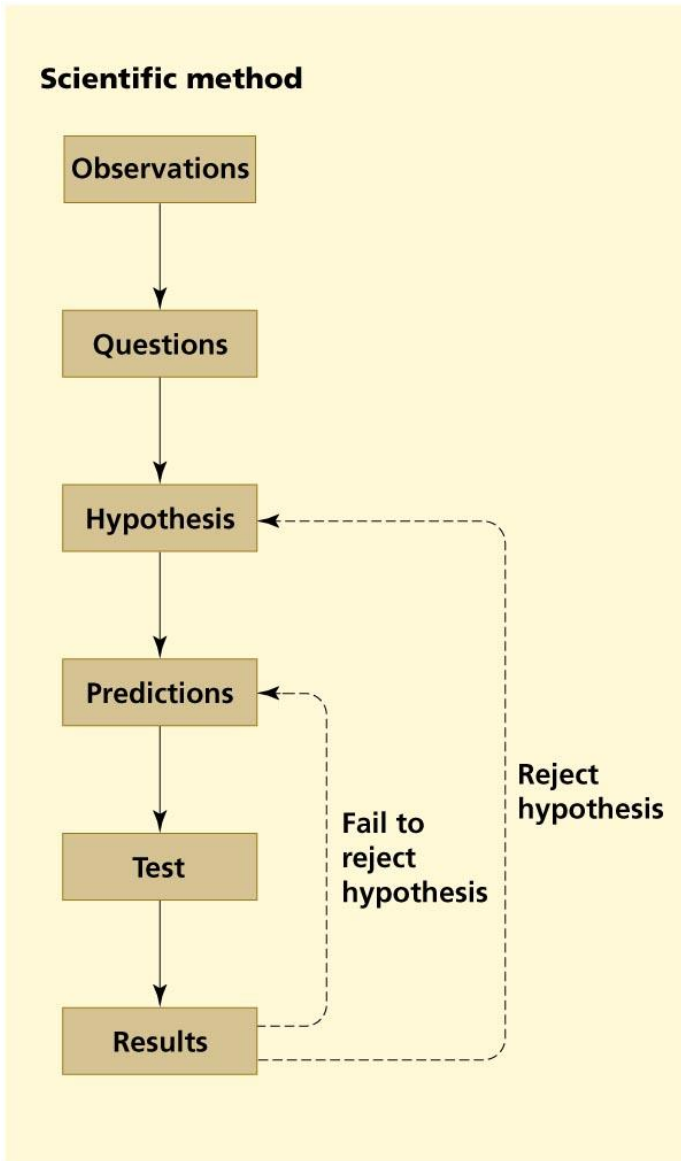
- The pursuit of knowledge about the natural world
- Scientists try to remain objective

•Environmentalism

- A social movement dedicated to protecting the natural world



The scientific method

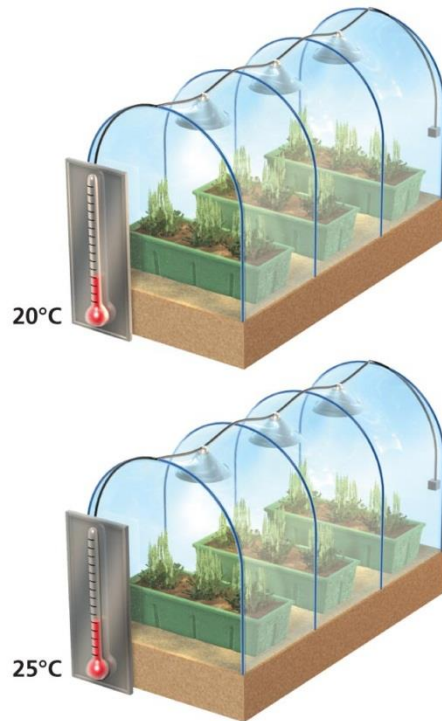


- A scientist makes an **observation** and asks **questions** of some phenomenon
- The scientist formulates a **hypothesis**, a statement that attempts to explain the scientific question.
- The hypothesis is used to generate **predictions**, which are specific statements that can be directly and unequivocally **tested**.
- The test **results** either support or reject the hypothesis

Experiments test the validity of a hypothesis

Manipulative experiments yield the strongest evidence

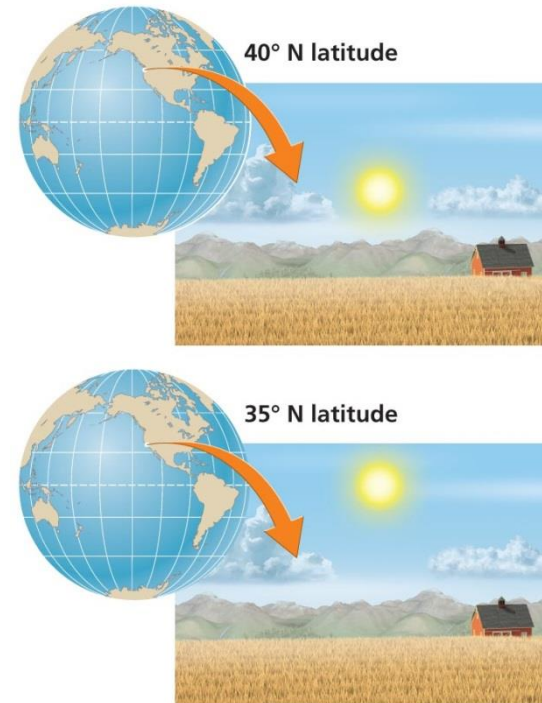
- But, lots of things can't be manipulated



(a) Manipulative experiment

Natural or correlational tests show real-world complexity

- Results are not so neat and clean, so answers aren't simply black and white



(b) Natural experiment, or correlational study

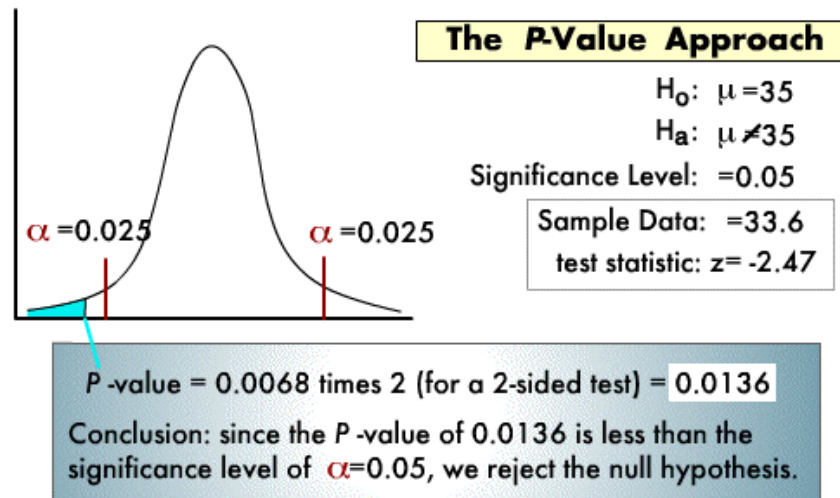
Experimental Design

- Every experiment whether manipulative or observatory must have the following components:
 - Hypothesis
 - Independent and Dependent Variable
 - Control Variables
 - Materials
 - Method of measurement
 - Analysis of data
 - Conclusion



Analysis of Data

- Statistics are used to determine if results from an experiment are significant
 - A t-test uses averages to determine if the results were random or by chance
 - The results of a test are p-values.
 - If the p-value is less than 0.05 the results are significant



Experimental Design

- The citizens of Lexington notice that one area of Ellis Lake has fewer fish than other areas. The decreased fish population is near a power plant where lake water at 65 °F is pumped out of the lake to cool equipment and returned at 75 °F. An experiment was conducted in which water from the lake was collected along with fish and divided equally into several large experimental aquariums. Each aquarium was maintained at a different temperature between 67 °F and 76 °F. The mortality rate of the fish population in each aquarium was monitored for several weeks. The fish were found to survive at the highest rate in the aquarium with 67 °F water and at the lowest rate in the 76 °F water.
- What is the independent variable?
- What is the dependent variable?
- What conclusion can be drawn from this experiment?

We face challenges in agriculture

- Expanded food production led to increased population and consumption
- It's one of humanity's greatest achievements, but at an enormous environmental cost
 - Nearly half of the planet's land surface is used for agriculture
 - Chemical fertilizers
 - Pesticides
 - Erosion
 - Changed natural systems

We face challenges in pollution

- Waste products and artificial chemicals used in farms, industries, and households



Each year, millions of people die from pollution

We face challenges in climate

- Scientists have firmly concluded that humans are changing the composition of the atmosphere
- The Earth's surface is warming
 - Melting glaciers
 - Rising sea levels
 - Impacted wildlife and crops
 - Increasingly destructive weather

Since the Industrial Revolution, atmospheric carbon dioxide concentrations have risen by 37%, to the highest level in 650,000 years

We face challenges in biodiversity

- Human actions have driven many species extinct, and biodiversity is declining dramatically
 - We are at the onset of a mass extinction event



Biodiversity loss may be our biggest environmental problem; once a species is extinct, it is gone forever

Sustainable solutions exist

We must develop solutions that protect both our quality of life and the environment

- Organic agriculture
- Technology
 - Reduces pollution
- Biodiversity
 - Protect species
- Waste disposal
 - Recycling
- Alternative fuels



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Are things getting better or worse?

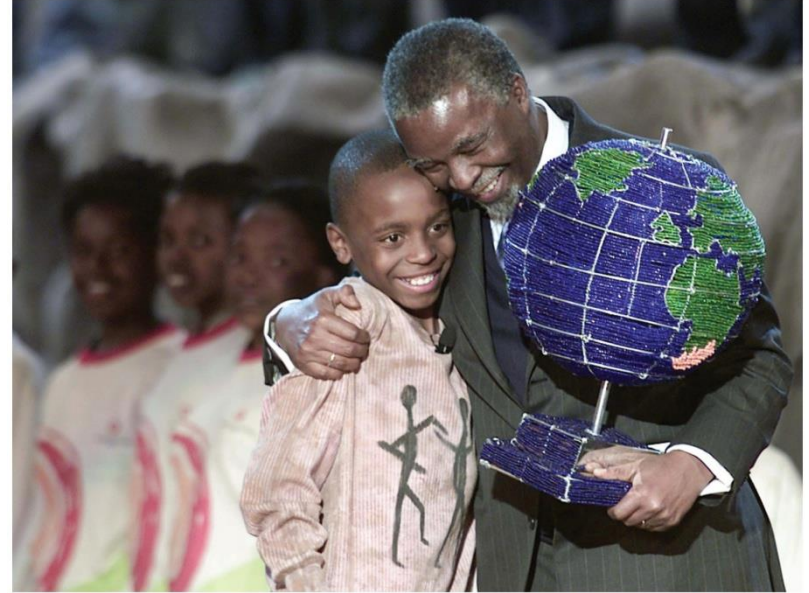
- Many people think environmental conditions are better
 - **Cornucopians:** Human ingenuity will solve any problem
- Some think things are much worse in the world
 - **Cassandras:** predict doom and disaster
- How can you decide who is correct?
 - Are the impacts limited to humans, or are other organisms or systems involved?
 - Are the proponents thinking in the long or short term?
 - Are they considering all costs and benefits?

Sustainability: a goal for the future

- How can humans live within the planet's means?
 - Humans cannot exist without functioning natural systems
- **Sustainability**
 - Leaves future generations with a rich and full Earth
 - Conserves the Earth's natural resources
 - Maintains fully functioning ecological systems
- **Sustainable development:** the use of resources to satisfy current needs without compromising future availability of resources

Will we develop in a sustainable way?

- The **triple bottom line**: sustainable solutions that meet
 - Environmental goals
 - Economic goals
 - Social goals
- Requires that humans apply knowledge from the sciences to
 - Limit environmental impacts
 - Maintain functioning ecological systems



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