

1 Chapter 1

An Introduction to Environmental Science

2 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

3 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

4 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.

5 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.









6 Natural resources: vital to human survival










- 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








7 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

- 8  **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.
- 9  **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?
- 10  **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
- 11  **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.
- 12  **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
- 13  **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
- 14  **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

- 15  **Applications of science**
Restoration of forest ecosystems altered by human suppression of fire
- 16  **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
- 17  **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.
- 18  **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)
- 19  **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
- 20  **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.
- 21  **The scientific community**
- 22  **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.
- 23  **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
- 24  **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
- 25  **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
- 26  **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
- 27  **Expanding ethical consideration**
- 28  **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.
- 29  **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.
- 30  **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.
- 31  **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
- 32  **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.
- 33  **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
- 34  **Sustainability**
- We are increasing our burden on the planet each year.
 - Population growth, affluence, consumption
 - Natural capital: the accumulated wealth of Earth
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- 35  **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.
- 36  **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.
- 37  **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.
- 38  **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

39  **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

40  **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.