1

An Introduction to Environmental Science

Chapter Objectives

This chapter will help students:

Define the term *environment*

Describe natural resources and explain their importance to human life

Characterize the interdisciplinary nature of environmental science

Understand the scientific method and describe how science operates

Diagnose and illustrate some of the pressures on the global environment

Evaluate the concepts of sustainability and sustainable development

Lecture Outline

I. Our Island, Earth

A. Our **environment** is the sum total of our surroundings.

1. It includes both living and nonliving things.

2. The fundamental insight of environmental science is that we are part of the natural world and we are dependent on a healthy, functioning planet.

B. **Environmental science** explores interactions between humans and our environment.

1. Environmental science is the study of how the natural world works, how our environment affects us, and how we affect our environment.

2. Our actions modify the environment.

3. Many actions enrich our lives, but they have also degraded the natural systems that sustain us.

C. **Natural resources** are vital to our survival.

1. Natural resources are the various substances and forces we need in order to survive.

2. **Renewable natural resources** are perpetually available or can be replenished by the environment over short periods of time.

3. **Nonrenewable natural resources** are in finite supply and are not replenished or are formed much more slowly than we use them.

4. Some renewable resources may turn nonrenewable if we deplete them too drastically.

D. Human population growth has shaped our resource use.

1. The **agricultural revolution** occurred around 10,000 years ago as humans transitioned from a hunter-gatherer lifestyle to an agricultural way of life.

2. The **industrial revolution** began in the mid-1700s, shifting from a rural, agricultural life to an urban society powered by **fossil fuels**, which are nonrenewable energy sources such as oil, coal, and natural gas.

3. **Thomas Malthus** and population growth

   a. Malthus claimed that unless population growth was controlled, the number of people would outgrow the food supply.

   b. He argued that a growing population would eventually be checked by starvation, disease, or war.

4. Paul Ehrlich and the “population bomb”

   a. Ehrlich predicted that a rapidly increasing human population would bring widespread famine and conflict.

   b. He claimed that population control was the only way to avoid starvation and war.

   c. Although his predictions have not come true yet, many who support his ideas predict a global food crisis in the near future.

E. Resource consumption exerts social and environmental impacts.

1. Garrett Hardin and "The Tragedy of the Commons"

a. Hardin said resources that are open to unregulated exploitation, the "commons," will eventually be depleted.

b. He disputed economic theory that individual self-interest, in the long term, serves the public.

c. He said that if no single person has ownership, there is no incentive to take care of a commons; everyone takes as much as they can until it is depleted.

2. Wackernagel, Rees, and the **ecological footprint**

a. The ecological footprint expresses the environmental impact of an individual or a population in terms of the cumulative amount of land and water required to provide the raw materials consumed, and recycle the waste produced.

b. The ecological footprint totals the amount of Earth's surface "used" once all direct and indirect impacts are totaled.

c. Using these calculations, it is clear that we are depleting our resources 30% faster than they are being replenished.

F. Environmental science can help us avoid mistakes made by past civilizations.

II. The Nature of Environmental Science

A. Environmental science provides interdisciplinary solutions.

1. Environmental science aims to comprehend how Earth's natural systems function, how systems influence people, and how people influence systems.

B. Environmental science is an interdisciplinary pursuit addressing environmental problems to produce effective and lasting solutions.

1. Environmental science is especially broad because it encompasses not only the **natural sciences**, but also the **social sciences**.

2. Programs incorporating the social sciences often use the term **environmental studies** to describe their academic umbrella.

Environmental science programs focus predominantly on the natural sciences as they pertain to environmental issues.

C. Environmental science is not the same as **environmentalism**.

1. Environmentalism is a social movement dedicated to protecting the natural world from undesirable changes brought about by human choices.

2. Environmental science is the pursuit of knowledge about the environment, how it works, and our interactions with it.

III. The Nature of Science

1. Modern scientists describe **science** as a systematic process for learning about the world and testing our understanding of it.

2. Environmental science is a dynamic yet systematic way of studying the world, and it is also the body of knowledge accumulated from this process.

A. Scientists test ideas by critically examining evidence.

1. The **scientific method** is a traditional approach to scientific research.

2. It is a technique for testing ideas with observations and involves several assumptions and a series of interrelated steps.

3. The assumptions are:

   a. The universe functions in accordance with fixed natural laws.

   b. All events arise from some cause and cause other events.

   c. We can use our senses and reasoning abilities to detect and describe natural laws.

4. The steps of the scientific method are:

   a. Make observations.

   b. Ask questions.

   c. Develop a **hypothesis**. A hypothesis is an educated guess that explains a phenomenon or answers a scientific question.

   d. Make **predictions**. A prediction is a specific statement that can

be directly and unequivocally tested.

e. Test the predictions. An **experiment** is an activity designed to test the validity of a hypothesis; it involves manipulating **variables**, or conditions that can change.

1) An **independent variable** is the variable that the scientist manipulates, while the dependent variable is the one that depends upon the first variable.

2) Use **controlled experiments** by managing the variables. Have an unmanipulated point of comparison, called a **control**, and a manipulated **treatment**.

f. Analyze and interpret results. **Data** are collected from experiments.

g. If experiments refute a hypothesis, it will be rejected and a new hypothesis developed. If experiments fail to refute a hypothesis, this lends support to the hypothesis but does not prove it is correct.

B. We can test hypotheses in different ways.

1. A manipulative experiment is an experiment in which the researcher actively chooses and manipulates the independent variable.

2. When variables cannot be manipulated, a natural experiment is performed to search for correlations or statistical associations among data.

C. The scientific process does not stop with the scientific method.

1. **Peer review**. When other scientists examine and comment on an experiment, it is an essential part of the scientific process.

2. Conference presentations. Scientists frequently present their work at professional conferences.

3. Grants and funding. Research scientists spend large portions of their time writing grant applications requesting money to fund their research. Competition is often intense. This reliance on funding sources can lead to potential conflicts of interest, particularly if the data show a funding source in an unfavorable light. When assessing a scientific study, try to find out where the researchers obtained their funding.

4. Repeatability. Sound science is based on repeatability rather than on one-time occurrence.

5. Theories. If a hypothesis survives repeated testing by numerous research teams, it may be incorporated into a **theory**.

6. A theory is a widely accepted, well-tested explanation of one or more cause-and-effect relationships that has been extensively and rigorously tested.

D. Science goes through "paradigm shifts."

1. A **paradigm** is a dominant view regarding a topic, based on the facts and experiments known at that time.

2. Thomas Kuhn stated that science goes through periodic revolutions in which one dominant view is abandoned for another, as more information becomes available.

IV. Environmental Ethics

1. The field of **ethics** involves the study of good and bad, of right and wrong.

2. People of different cultures or with different worldviews may differ in their values; therefore some ethicists are **relativists**, believing that ethics vary with social context.

3. Some ethicists are **universalists**; they maintain that there are objective notions of right and wrong that are standard across all cultures and situations.

4. **Ethical standards** are the criteria that help differentiate right from wrong.

A. **Environmental ethics** pertains to humans and the environment.

1. The application of ethical standards to relationships between humans and nonhuman entities is known as environmental ethics.

2. **Anthropocentrism** is a human-centered view of our relationship with the environment; it denies or ignores the rights of any nonhuman entity, and measures costs and benefits of actions solely according to their human impact.

3. **Biocentrism** ascribes values to actions, entities, or properties on the basis of their effects on all living things or on the integrity of the biotic realm in general.

4. **Ecocentrism** considers actions in terms of their benefit or harm to the

integrity of whole ecological systems.

B. **Conservation** and **preservation** arose at the start of the 20th century.

1. **John Muir** was an advocate for the preservation of untouched wilderness.

2. **Gifford Pinchot** is associated with the conservation ethic that emphasizes that humans should put natural resources to use, but should manage them wisely.

C. Aldo Leopold's land ethic inspires many people.

1. **Aldo Leopold** came to see that healthy ecological systems depended on the protection of all their interacting parts, including predators as well as prey.

2. He argued that humans should view themselves and "the land" as members of the same community, and that people are obliged to treat the land in an ethical manner.

D. **Environmental justice** seeks fair treatment for all people.

1. Environmental justice is defined by the U.S. Environmental Protection Agency as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies."

2. A protest in the early 1980s by African Americans in North Carolina against a toxic waste dump in their community is widely seen as the beginning of the environmental justice movement.

3. Hurricane Katrina fueled the ongoing need for environmental justice as those affected most by the storm and its aftermath were poor and nonwhite.

V. Sustainability and our world's future.

1. Does the present generation have an obligation to conserve resources for future generations? This ethical question is at the core of the notion of sustainability, living within our planet's means. This means that the Earth and its resources can sustain us, and the rest of Earth's living things, for the foreseeable future.

A. Population and consumption drive environmental impact.

1. Humans are placing a great burden on Earth's ecosystems with 200,000 people added to the planet each day.

2. The **Millennium Ecosystem Assessment**, completed by over 2,000 of the world's leading environmental scientists in 2005, makes it clear that our degradation of the world's environmental systems is having negative impacts on all of us—but most of these trends can be turned around.

B. Sustainable solutions abound.

1. Sustainability need not require great sacrifice. The goal of **sustainable development** is the use of resources for economic advancement in a manner that satisfies current needs without compromising the future availability of resources.

VI. Conclusion

1. Finding effective ways of living peacefully, healthily, and sustainably on our diverse and complex planet will require a thorough scientific understanding of both natural and social systems.

A. It is important to keep in mind that identifying a problem is the first step in devising a solution to it.

B. Science in general, and environmental science in particular, can aid us in our efforts to develop balanced and workable solutions to the many environmental dilemmas we face today and to create a better world for ourselves and our children.