Chapter 1

Science and the Environment

Section 1: Understanding Our Environment

What Is Environmental Science?

- **Environmental science** is the study of the air, water, and land surrounding an organism or a community, which ranges from a small area to Earth's entire biosphere.
- It includes the study of the impact of **humans on the environment**.

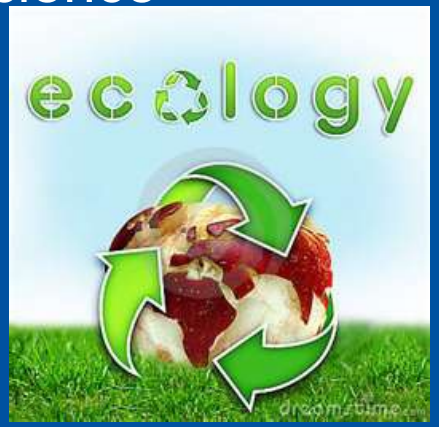
What is the Goal of Environmental Science?

- A major goal of environmental science is to **understand and solve environmental problems**.
- To accomplish this goal, environmental scientists study two main types of interactions between humans and their environment:

1) **How our actions alter our environment.**
2) **The use of natural resources like water, coal, and oil.**

Many Fields of Study

- Environmental science is an interdisciplinary science, which means that it involves many fields of study.
- Important to the foundation of environmental science is ecology.
- **Ecology** is they study of interactions of living organisms with one another and with their environment.
- **Biology** is the study of living things.
- **Chemistry** is the study of chemicals and their interactions.
- **Physics** is the study of matter and energy.



Many Fields of Study – Page 7 in Text

Major Fields of Study That Contribute to Environmental Science	
Biology is the study of living organisms.	**Zoology** is the study of animals. **Botany** is the study of plants. **Microbiology** is the study of microorganisms. **Ecology** is the study of how organisms interact with their environment and each other.
Earth science is the study of the Earth's nonliving systems and the planet as a whole.	**Geology** is the study of the Earth's surface, interior processes, and history. **Paleontology** is the study of fossils and ancient life. **Climatology** is the study of the Earth's atmosphere and climate. **Hydrology** is the study of Earth's water resources.
Physics is the study of matter and energy.	**Engineering** is the science by which matter and energy are made useful to humans in structures, machines, and products.
Chemistry is the study of chemicals and their interactions.	**Biochemistry** is the study of the chemistry of living things. **Geochemistry**, a branch of geology, is the study of the chemistry of materials such as rocks, soil, and water.
Social sciences are the study of human populations.	**Geography** is the study of the relationship between human populations and Earth's features. **Anthropology** is the study of the interactions of the biological, cultural, geographical, and historical aspects of humankind. **Sociology** is the study of human population dynamics and statistics.

Scientists as Citizens, Citizens as Scientists

- Governments, businesses, and cities recognize that studying our environment is vital to maintaining a healthy and productive society.
- Thus, environmental scientists are often asked to share their research with the world.
- However, the **observations of nonscientists** are the first steps toward addressing an environmental problem.

Our Environment through Time

- Wherever humans have hunted, grown food, or settled, they have changed the environment.
- For example, the environmental change that occurred on Manhattan Island over the last 300 years was immense, yet that period was just a “blink” in human history.

First Impact: Hunter-Gatherers

- **Hunter-gatherers** are people who obtain food by collecting plants and by hunting wild animals or scavenging their remains.
- Hunter-gatherers affect their environment in many ways:
  1) Native American tribes **hunted buffalo.**
  2) The tribes also set **fires to burn prairies and prevent the grow of trees.** This left the prairie as an open grassland ideal for hunting bison.

First Impact: Hunter-Gatherers

- In North America, a combination of rapid climate changes and overhunting by hunter-gatherers may have led to the disappearance of some large mammal species, including:

1) **giant sloths**
2) **giant bison**
3) **mastodons**
4) **cave bears**
5) **saber-toothed cats**

The Agricultural Revolution

- **Agriculture** is the raising of crops and livestock for food or for other products that are useful to humans.
- The practice of agriculture started in many different parts of the world over **10,000 years** ago.
- The change had such a dramatic impact on human societies and their environment that it is often called the **agricultural revolution**.

The Agricultural Revolution

- The Agricultural Revolution allowed human populations to grow at an unprecedented rate.
- As populations grew, they began to **concentrate in smaller areas placing increased pressure** on the local environments.

The Agricultural Revolution

- The agricultural revolution changed the food we eat.
- The plants we grow and eat today are descended from **wild plants**.
- However, during harvest season farmers collected seeds from plants that exhibited the qualities they desired, such as **large kernels**.
- These seeds were then planted and harvested again. Overtime, the domesticated plants became very different from their wild ancestors.

The Agricultural Revolution

- Many habitats were destroyed as grasslands, forests, and wetlands were replaced with farmland.
- Replacing forest with farmland on a large scale can cause **soil loss, floods, and water shortages**.

The Agricultural Revolution

- The **slash-and-burn** technique was one of the earliest ways that land was converted to farmland.
- Much of this converted land was poorly farmed and is no longer fertile.

YouTube!

Agriculture Revolution

The Industrial Revolution

- The Industrial Revolution involved a shift from energy sources such as **animals and running water to fossil fuels such as coal and oil**.
- This increased use of fossil fuels changed society and greatly increased the efficiency of **agriculture, industry, and transportation**.
- For example, motorized vehicles allowed food to be transported cheaply across greater distances.

The Industrial Revolution

- In factories, the large-scale production of goods became less expensive than the local production of handmade goods.
- On the farm, machinery reduced the amount of land and human labor needed to produce food.
- With fewer people producing their own food, the populations in urban areas steadily grew.

YouTube!

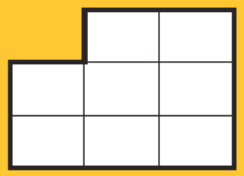
Industrial Revolution Clip

Graphic Organizer – page 616

Graphic Organizer

Comparison Table

Create the **Graphic Organizer** entitled "Comparison Table" described in the Appendix. Label the columns with "Hunter-Gatherers," "The Agricultural Revolution," and "The Industrial Revolution." Label the rows with "Characteristics" and "Effects on the Environment." Then, fill in the table with details about the characteristics and the effects on the environment of each historical period.



1. Draw a chart like the one shown. Your chart can have as many columns and rows as you want.
2. In the top row, write the topics that you want to compare.
3. In the left column, write characteristics of the topics in the appropriate boxes.

	Hunter-Gatherers	The Agricultural Revolution	The Industrial Revolution
Characteristics	Get food by collecting plants and hunting wild animals	Practiced growing food, breeding, and caring for plants	Started using fossil fuels such as coal and oil (Energy Shift)
Effects on Environment	Over-hunting caused extinction of some species	Habitats were destroyed because grasslands, forests, and wetlands were replaced with farmland.	Introduced artificial substances into the environment that cannot be recycled like plastic.

Chapter 1: Science and the Environment

Section 1: Understanding Our Environment

DAY 2

Our Environment Through Time Continued: Improving the Quality of Life

- The **Industrial Revolution** introduced many positive changes such as the light bulb.
- Agricultural productivity **increased**, and sanitation, nutrition, and medical care vastly **improved**.

Improving the Quality of Life

- However, the Industrial Revolution also introduced many new environmental problems such as **pollution and habitat loss**.
- In the 1900s, modern societies began to use **artificial substances** in place of raw animals and plant products.
- As a result, we know have materials such as **plastics, artificial pesticides, and fertilizers**.

Spaceship Earth

- Earth can be compared to a spaceship traveling through space as it cannot dispose of its waste or take on new supplies.
- Earth is essentially a **closed system**.
- This means that the only thing that enters the Earth's atmosphere in large amounts is **energy from the sun**, and the only thing that leaves in large amounts is **heat**.

Spaceship Earth

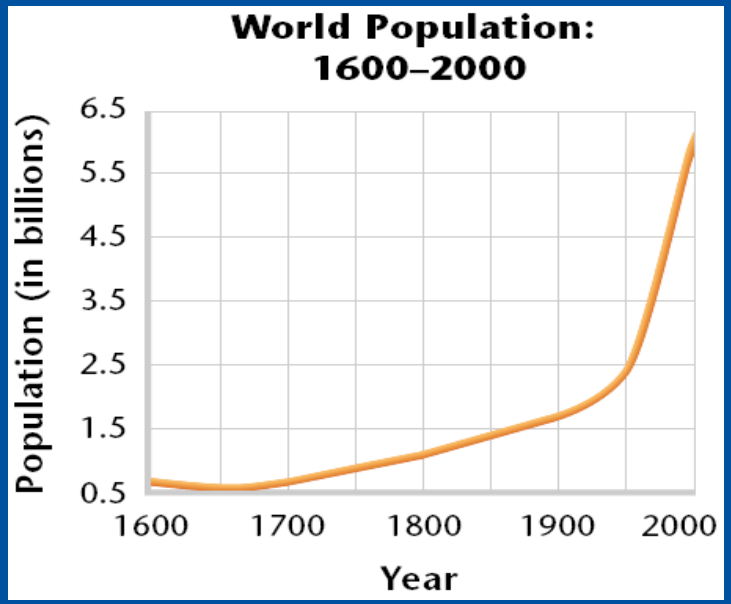
- This type of closed system has some potential problems.
- Some resources are limited and as the population grows, the resources will be used more rapidly.
- There is also the possibility that we will produce wastes more quickly than we can dispose of them.

Spaceship Earth

- Environmental problems can occur on different scales: **local, regional, or global**.
  - A local example would be your community discussing where to build a **new landfill**.
  - A regional example would be a polluted river **1000 miles away affecting the region's water**.
  - A global example would be the **depletion of the ozone layer**.

Population Growth

- The Industrial Revolution, modern medicine, and sanitation all allowed the human population to **grow faster** than it ever had before.



Population Growth

- In the past 50 years, nations have used vast amounts of resources to meet the worlds need for food.
- Producing enough food for large populations has environmental consequences such as **habitat destruction and pesticide pollution**.

What are our Main Environmental Problems?

- Environmental problems can generally be grouped into three categories:

1) **Resource Depletion**
2) **Pollution**
3) **Loss of Biodiversity**

Resource Depletion

- **Natural resources** are any natural materials that are used by humans, such as, water, petroleum, minerals, forests, and animals.
- Natural resources are classified as either a **renewable resources or a nonrenewable resource**.

Resource Depletion

- **Renewable resources** can be replaced relatively quickly by natural process.
- **Nonrenewable resources** form at a much slower rate than they are consumed.

Renewable and Nonrenewable Resources

Renewable	Nonrenewable
energy from the sun	metals such as iron, aluminum, and copper
water	nonmetallic materials such as salt, sand, and clay
wood	fossil fuels
soil	
air	

Resource Depletion

- Resources are said to be **depleted** when a large fraction of the resource has been used up.
- Once the supply of a nonrenewable resource has been used up, it may take millions of years to replenish it.
- Renewable resources, such as trees, may also be depleted causing deforestation in some areas.

Pollution

- **Pollution** is an undesirable change in the natural environment that is caused by the introduction of substances that are harmful to living organisms or by excessive wastes, heat, noise, or radiation
- Much of the pollution that troubles us today is produced by **human activities and the accumulation of wastes**.

Pollution

- There are two main types of pollutants:
  - **Biodegradable pollutants**, which can be broken down by natural processes and include materials such as newspaper.
  - **Nondegradable pollutants**, which cannot be broken down by natural processes and include materials such as mercury.

Pollution

- Degradable pollutants are a problem only when they **accumulate faster** than they can be broken down.
- However, because nondegradable pollutants do not break down easily, they can build up to dangerous levels in the environment.

Loss of Biodiversity

- **Biodiversity** is the variety of organisms in a given area, the genetic variation within a population, the variety of species in a community, or the variety of communities in an ecosystem.
- The organisms that share the world with us can be considered natural resources.
- We depend on them for food, the oxygen we breathe, and for many other things.

Ticket out the Door

1. What are the three groups of environmental problems?
2. What is a renewable resource?
3. What is a nonrenewable resource?
4. What is pollution?
5. What is the difference between a biodegradable and non-biodegradable products?

Chapter 1

Science and the Environment

Section 2: The Environment and Society

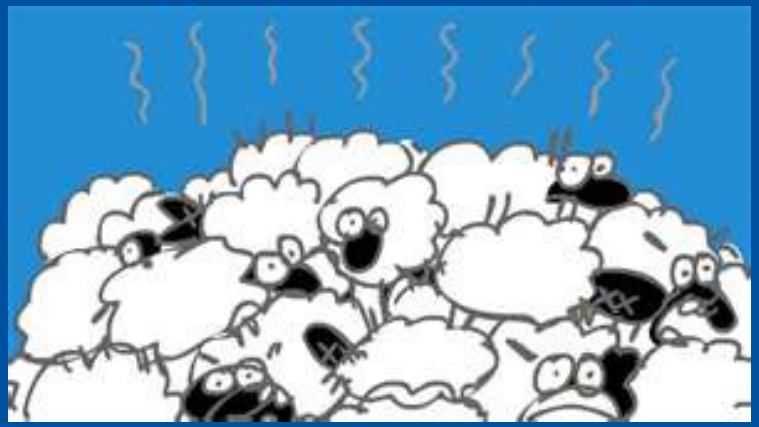
DAY 1

"The Tragedy of the Commons"

- In his essay, ecologist **Garrett Hardin** argued that the main difficulty in solving environmental problems is the conflict between the short-term interests of the individual and the long-term welfare of society.
- The example he used was the **commons**, or the areas of land that belonged to the whole village.

"The Tragedy of the Commons"

- It was in the best interest of the individual to put as many animals in the commons as possible.
- However, if too many animals grazed on the commons, they destroyed the grass.
- Once the grass was destroyed, everyone suffered because no one could raise animals on the commons.



"The Tragedy of the Commons"

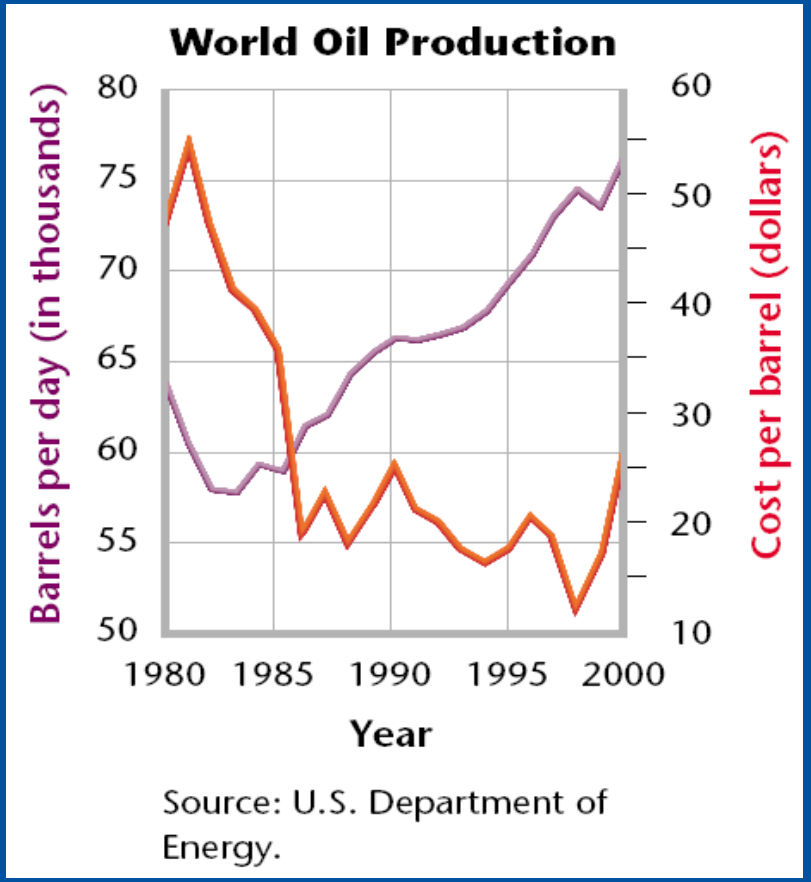
- The commons were eventually replaced by **closed fields owned by individuals.**
- Owners were now careful not to put too many animals on their land, because overgrazing wouldn't allow them to raise as many animals next year.
- Hardin's point being that **someone or some group must take responsibility for maintaining a resource or it will become depleted**.

"The Tragedy of the Commons"

- Hardin's point can be applied to our modern commons, natural resources.
- Humans live in societies, and in societies, we can solve environmental problems by **planning, organizing, considering the scientific evidence, and proposing a solution**.
- The solution may be to override the short-term interests of the individual and improve the environment for everyone in the end.

Supply and Demand

- **The Law of Supply and Demand** is a law of economics that states as the demand for a good or service increases, the value or the food or service also increases.
- An example is the world **oil production**.



Source: U.S. Department of Energy.

Costs and Benefits

- The cost of environmental solutions can be high.
- A **cost-benefit analysis** balances the cost of the action against the benefits one expects from it.
- The results depend on who is doing the analysis.
- For example, pollution control may be too costly to an industry, but to a nearby community, the price may well be worth it.
- Often, environmental regulations are passed on to **the consumer or taxpayer**.

Risk Assessment

- One of the costs of any action is the risk of an undesirable outcome.
- **Risk assessment** is a tool that helps us create cost effective ways to protect our health and environment.
- To come up with an effective solution to an environmental problem, the public must perceive the risk accurately.

Developed and Developing Countries

- The unequal distribution of wealth and resources around the world influence the environmental problems and solutions a society can make.
- **Developed countries** have higher incomes, slower population growth, diverse industrial economies, and stronger social support.
- **Developing countries** have lower average incomes, simple agriculture-based communities, and rapid population growth.

Population and Consumption

- Almost all environmental problems can be traced back to two root causes:
  - **The human population in some areas is growing too quickly for the local environment to support.**
  - **People are using up, wasting, or polluting many natural resources faster than they can be renewed, replaced, or cleaned up.**

Local Population Pressures

- When the population in an area grows rapidly, there may not be enough natural resources for everyone to live a healthy, productive life.
- In severely overpopulated regions, forests are stripped bare, topsoil is exhausted, and animals are driven to extinction.
- In these areas, malnutrition, starvation, and disease can be constant threats.

Local Population Pressures

- In **developing countries**, millions of people are starving.
- Yet these human populations tend to grow the fastest.
- Food production, education, and job creation cannot keep pace with the population growth, so each person gets fewer resources as time goes by.

Consumption Trends

- To support the higher quality of life, **developed countries** are using much more of Earth's resources.
- Developed nations use about **75** percent of the world's resources, although they make up only **20** percent of the world's population.
- This rate of consumption creates more waste and pollution per person then in developing countries.

Consumption Trends

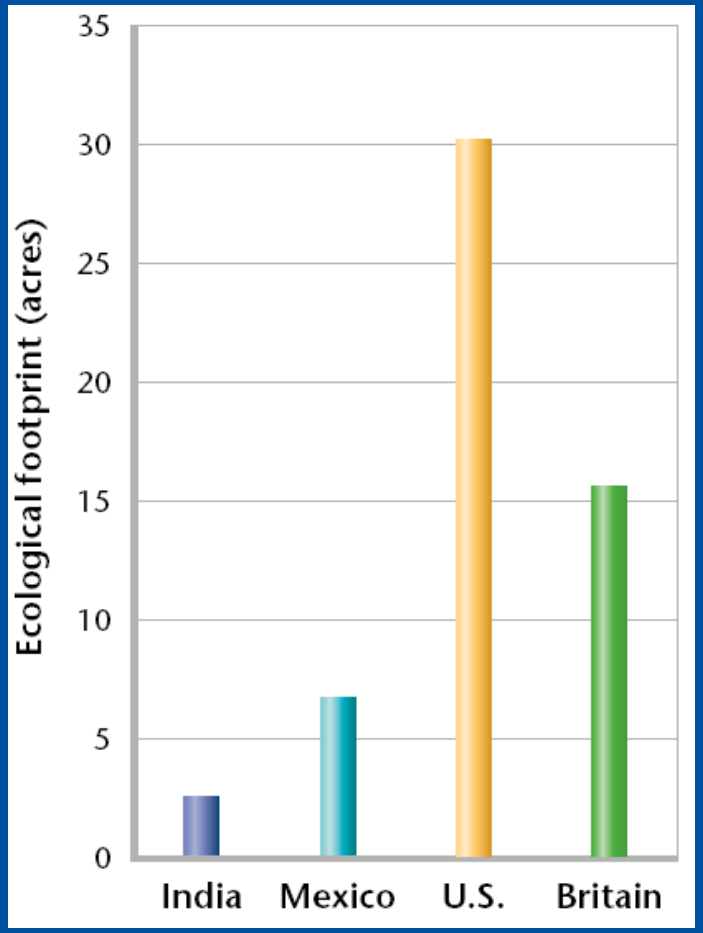
Indicators of Development for the United States, Japan, Mexico, and Indonesia					
	Measurement	U.S.	Japan	Mexico	Indonesia
Health	life expectancy in years	77	81	71.5	68
Population growth	per year	0.8%	0.2%	1.7%	1.8%
Wealth	gross national product per person	$29,240	$32,350	$3,840	$640
Living space	people per square mile	78	829	133	319
Energy use	per person per year (Btu)	351	168	59	18
Pollution	carbon dioxide from fossil fuels per person per year (tons)	20.4	9.3	3.5	2.2
Waste	garbage produced per person per year (kg)	720	400	300	43

Ecological Footprints

- **Ecological footprints** are calculations that show the productive area of Earth needed to support one person in a particular country.
- An ecological footprint estimates the land used for **crops, grazing, forests products, and housing**.
- It also includes the ocean area used to harvest seafood and the forest area needed to absorb the air pollution caused by fossil fuels.

Ecological Footprints

- An ecological footprint is one way to **express the differences in consumption between nations**.



Critical Thinking and the Environment

- Remember a few things as you explore environmental science further:
  - **First, be prepared to listen to many viewpoints over a particular issue.**
  - **Second, investigate the source of the information you encounter.**
  - **Third, gather all the information you can before drawing a conclusion.**

A Sustainable World

- **Sustainability** is the condition in which human needs are met in such a way that a human population can survive indefinitely.
- Sustainability is a key goal of environmental science.