

Chapter One – Environmental Science

I. What is environmental science?

A. definition: the study of the air, water and land surrounding an organism or a community, which ranges from a small area to the Earth's entire biosphere; includes the study of the impact of humans on the environment

- 1. interdisciplinary or integrated science: involves many different fields of study; e.g. biology, chemistry, sociology, psychology, economics**
- 2. One of the most important and prevalent of these sciences is ecology.**
 - a. ecology: the study of the interactions of living organisms with one another and with their environment**

B. Three Main Areas of Environmental Science

- 1. conservation and protection of natural resources**
- 2. environmental education and communication**
- 3. environmental research**

C. Goal: Identify, Understand, and Solve environmental science problems

- 1. A very lofty goal, scientists study two main areas to try to achieve it:**
 - a. How do we use our natural resources?**
 - b. How do our actions impact or alter our environment?**
- 2. Yet keep in mind, problems in the environment are often first observed by regular citizens and**

are only brought to the attention of scientists and the government by active and persistent people, just like you.

Case in point: deformed frogs in Minnesota

II. Our Environment through Time

Since the beginning of humans populating the Earth, our impact on the environment has been far beyond any other organism's reach. That impact has changed drastically in the last few millennia.

A. Hunter-Gatherers

- 1. for most of human history, people were hunter-gatherers: obtain food by collecting plants and by hunting wild animals or scavenging their remains**
 - a. small sized groups**
 - b. migration from place to place according to food availability and the season**
 - c. still exist in such areas as Amazon rain forests**
- 2. Effects on Environment from hunter-gatherers**
 - a. massive destruction of vegetation for easier hunting of animals**
 - b. spread of plants to areas where they were not originally found**
 - c. possibly the elimination of large mammal species through over hunting, in conjunction with rapid climate changes**
e.g. giant sloths, giant bison, mastodons, saber-toothed cats

B. Agricultural Revolution

- 1. eventually, some hunter-gatherers collected the seeds of the plants they gathered and began to domesticate some of the animals in their environment**
 - a. agriculture: the practice of growing, breeding, and caring for plants and animals that are used for food, clothing, housing, transportation, and other purposes**
 - b. the practice of agriculture started in many different parts of the world about 10,000 years ago**
 - c. the change from hunter-gatherer societies to agricultural society had a HUGE impact**

2. Impacts of the Agricultural Revolution

- a. allowed human populations to grow at an unprecedented rate – the same amount of land now supported 500x more people!**
- b. concentrations of populations become higher – no longer nomadic, the human population caused far more strain on their environments simply because they stayed in one place for a long period of time**
- c. types of food – as humans used selective breeding, (choosing specific traits in the plants they grew and harvested), the plants that we were eating became drastically different from their wild ancestors**
- d. destruction of habitat: we replaced grasslands, forests, and wetlands with farmland**

- i. large scale replacement of forest with farmland can cause: soil loss, floods, water shortages**
- ii. much of the converted land was farmed poorly and is no longer fertile**
- iii. history of poor farming practices significantly contributed to the collapse of many early civilizations – Tigris-Euphrates River basin**

C. The Industrial Revolution

- 1. involved a shift from energy sources such as animal muscle and running water to fossil fuels like coal and oil**
 - started in the mid –1700's**
 - for the previous 10,000 years, tools were powered by humans or animals**
 - a. increased use of fossil fuels and machines greatly increased the efficiency of agriculture, industry, and transportation**
 - b. economic changes: large-scale or mass production of goods in factories became cheaper than the local production of handmade goods**
 - c. farms: machinery further reduced the amount of land and human labor needed to produce food**
 - d. food and other goods could be transported inexpensively across greater distances**

- 2. Positive Changes of the Industrial Revolution**
 - a. lots of inventions during this time – light bulb, steam engines, expansion of trains**
 - b. much more food was available to a greater number of people**
 - c. sanitation, nutrition, and medical care improved by leaps and bounds**

- 3. Negative Effects of the Industrial Revolution**
 - a. pollution (e.g. Pittsburgh in the late 1800's to early 1900's)**
 - b. habitat loss far more common as the size of farms and the land needed for larger cities and factories grew**

- 4. Use of Artificial Substances**
 - a. 1900's saw a huge increase in the replacement of raw plant and animal products with artificial substances**
 - b. plastics, fertilizers, pesticides are just a few**
 - c. these products were convenient and often easier to use, but we are just now beginning to understand the long term effects**

- 5. Population Growth**
 - a. one major result of the agricultural and industrial revolutions is unprecedented population growth**
 - b. modern medicine, sanitation, and generally improved quality of life also contributed**

- c. human population has grown at an exponential rate (see the graph on page 13)**
- d. supporting this population with enough food and the consequent consumption of resources has caused major problems for almost all ecosystems**
- e. as the population increases, so will the pressure put on our ecosystems**

D. Spaceship Earth and the Gaia Hypothesis

There have been a lot of comparisons of Earth to a ship traveling through space.

1. Earth is a closed system.

- a. The only thing that enters in large amounts is energy from the sun and the only thing that leaves in large amounts is heat.**
- b. There is no “away.” You can’t throw something away when you view the Earth as a complete and closed system. Pollution that occurs in one area can affect a community hundreds, even thousands of miles from the original source.
e.g. acid rain in PA from the air pollution in the Midwest**

2. The Gaia Hypothesis

- a. Proposed by James Lovelock, a NASA scientist, and detailed in his book Gaia: A New Look at Life on Earth published in 1979**
- b. States that Earth is a living organism; can be taken literally or as an analogy**

- c. The Gaia idea is just one way to try to understand and approach environmental problems**

III. What Are Our Main Environmental Problems?

Generally, environmental problems can be grouped into 3 categories: resource depletion, pollution, and loss of biodiversity

A. Resource Depletion

- 1. natural resource – any natural material that is used by humans**
- 2. Natural resources can be categorized as either renewable or nonrenewable.**
 - a. renewable resource – can be replaced relatively quickly by natural processes**
ex. Fresh water, air, soil, trees, and crops
 - b. nonrenewable resource – forms at a much slower rate than the rate at which it is consumed**
ex. Minerals, fossil fuels
Once it is used up, it takes millions of years to replenish it.
- 3. Depletion – a resource is said to be depleted when a large fraction of the resource has been used up**
 - a. both renewable and nonrenewable resources can be depleted**

B. Pollution

- 1. definition: 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**
- 2. Most pollution that is a problem today is a result of human activities.**
- 3. Two main types of pollutants – biodegradable and nondegradable**
 - a. biodegradable: pollutants that can be broken down by natural processes**
examples: Human sewage, newspapers - become a problem when they accumulate faster than they are broken down
 - b. nondegradable: cannot be broken down by natural processes; difficult to break down at all**
examples: mercury, lead, some plastics easily and quickly build up to dangerous levels

C. Loss of Biodiversity

- 1. biodiversity: the variety of organisms in a given area; the genetic variation within a population; the variety of species in a community**
- 2. Millions of species have existed on Earth, past and present, with only a fraction of those species existing on the Earth today**
 - a. Extinction is a natural process.**
 - b. There have been several mass extinctions in Earth's history, one of the more recent**

occurring at the end of the Permian period (250 million years ago).

- c. It is estimated that as much as 95% of all species became extinct at that time.**

3. Problem: we have very limited information and understanding about how modern extinction rates compare with those of other periods in Earth's history.

- a. Other organisms are natural resources, and they are nonrenewable. Considering the interdependency of organisms on each other and the lack of understanding we have of the complex relationships of ecosystems, loss of a species can be considered a serious consequence.**
- b. One of the most common debates in trying to create environmental policy is determining the worth of a species. There are countless examples; one of the most known is the spotted owl.**

How does anyone determine which is more important: the jobs and economic health of a community or the existence of a species?

IV. The Environment and Society

A. The Tragedy of the Commons

- 1. "The Tragedy of the Commons" is the title of an essay written by ecologist Garrett Hardin and published in 1968.**

- a. addressed the issues concerning the sharing of common resources such as the ocean
 - b. the essay became essential to the environmental movement
2. Hardin argued that the main challenge in solving environmental problems was the conflict between the short-term interests of the individual and the long-term welfare of society.
 - a. used the concept of the commons to illustrate this point
 - b. commons – areas of land that belonged to a whole village; anyone was allowed to graze their animals on this land
3. short-term interest of an individual – greatest benefit was to put as many animals as possible on the commons
 - a. If I don't use this resource, someone else will.
 - b. The harm caused by my animals is of little consequence.
 - c. But too many animals grazing would destroy the grass, and then everyone suffered: no one could raise animals on the commons.
4. Commons were eventually replaced by individually owned closed fields.
 - a. Owners were very careful not to overcrowd and overgraze their land because overgrazing meant that fewer animals could be raised on the land the next year.
 - b. The focus had shifted to long-term concerns rather than short-term gains.

- 5. Point: Someone has to take responsibility for maintaining a resource. If no one does, the resource can be overused and depleted.**
- 6. What is the modern equivalent of the commons?
Our natural resources.**

B. Economics and the Environment

- 1. Law of Supply and Demand – a law of economics that states that as the demand for a good or service increases, the value of the good or service also increases**
- 2. cost-benefit analysis – balances the cost of the action against the benefits one expects from it**
 - a. results are often influenced by who is performing the analysis**
 - b. costs of pollution control vs. benefits of improved community relations, health**
 - c. often lots of difficulty in equating something to a number of dollars**
- 3. risk assessment – used in cost benefit analysis; looks at the risk of an undesirable outcome**
 - a. tool used to create cost-effective ways to protect public health and environment**
 - b. risk must be perceived accurately to be useful, which doesn't always happen**
ex. Nuclear power technology

C. Developed and Developing Countries

- 1. The wealth and resources of the world are unequally distributed and this greatly influences the environmental problems a society may face and the choices it can make.**
- 2. The UN (United Nations) classifies nations as developed or developing.**
 - a. Developed: higher average incomes, slower population growth, diverse industrial economies, and stronger social support systems - United States, Canada, Japan, Western Europe**
 - b. Developing: lower incomes, simple and agriculture based economies, rapid population growth**
 - c. There are some countries that are in between: Mexico, Brazil, etc.**

D. Population and Consumption

- 1. Local Population Pressures**
 - a. The population of the Earth is growing – reached 6 billion people in 2005 – and it tends to grow most rapidly in developing nations. There aren't enough natural resources and forests get stripped bare, land becomes agriculturally exhausted, and organisms can be driven to extinction.**
 - b. Result: malnutrition, starvation, disease**
 - c. Of the 4.5 billion people in developing countries, fewer than half have access to enough food, safe drinking water, and proper sanitation.**

2. Consumption Trends

- a. Life in the other extreme is better than ever. The population has stabilized or is growing slowly and there is even better access to the needs and resources of the people.**
- b. Supporting this type of lifestyle is difficult though, and developed nations are using much more of the Earth's resources than the developing nations.**
- c. 75% of the Earth's resources are used by the 20% of the population living in developed nations.**
- d. Result: more waste and pollution per person in the developed countries than in developing countries**

3. Ecological Footprint

- a. Definition: a calculation that shows the productive area of Earth needed to support one person in a particular country**
- b. Estimates the land used for crops, grazing, forest products and housing; the ocean area used to harvest seafood; and the forest area needed to absorb the air pollution caused by fossil fuels**
- c. Examine figure 18 on page 19**

4. A Sustainable World

- a. sustainability: the condition in which human needs are met in such a way that a human population can survive indefinitely**
- b. Currently, we are nowhere near sustainability.**
- c. To reach sustainability, it will require the cooperation of all parts of society – individual people, industry, and government to name just a few.**

5. Keep in Mind

- a. Environmental issues are hot topics in politics and in the media.**
- b. There are lots of different sources of information and facts on these issues, and often data is misrepresented or distorted to suit a specific (and often biased) agenda.**
- c. Economics almost always plays a role in environmental policy, and often the different aspects are oversimplified. Most environmental issues are extremely complex in their possible impacts.**
- d. Think carefully and critically about these issues before you form an opinion, and there is never a shortage of opinions on these issues!**