Read Case Study: Environmental Problems, their Causes, and Sustainability

1. Describe exponential growth.

2. What do you think sustainability means?

3. What does exponential growth have to do with environmental science?

4. What is the global problem his article is discussing?

5. How could this affect us?

1 Environmental Problems, Their Causes, and Sustainability

CORE CASE STUDY

Living in an Exponential Age

Two ancient kings enjoyed playing chess. The winner claimed a prize from the loser. After one match, the winning king asked the losing king to pay him by placing one grain of wheat on the first square of the chessboard, two grains on the second square, four on the third, and so on, with the number doubling on each square until all 64 squares were filled.

The losing king, thinking he was getting off easy, agreed with delight. It was the biggest mistake he ever made. He bankrupted his kingdom because the number of grains of wheat he had promised was probably more than all the wheat that has ever been harvested!

This fictional story illustrates the concept of **exponential growth**, by which a quantity increases at a *fixed percentage* per unit of time, such as 2% per year. Exponential growth is deceptive. It starts off slowly, but after only a few doublings, it grows to enormous numbers because each doubling is more than the total of all earlier growth.

Here is another example. Fold a piece of paper in half to double its thickness. If you could continue doubling the thickness of the paper 42 times, the stack would reach from the earth to the moon—386,400 kilometers (240,000 miles) away. If you could double it 50 times, the folded paper would almost reach the sun—149 million kilometers (93 million miles) away!

Because of exponential growth in the human population (Figure 1-1), in 2007 there were almost 6.7 billion people on the planet. Collectively, these people consume vast amounts of food, water, raw materials, and energy and in the process produce huge amounts of pollution and wastes. Unless death rates rise sharply, there will probably be 9.2 billion of us by 2050 and perhaps as many as 10 billion by the end of this century (Figure 1-1).

The exponential rate of global population growth has declined some since 1963. Even so, each day we add an average of 225,000 more people on the earth. This is roughly equivalent to adding a new U.S. city of Los Angeles, California, every 2 months, a new France every 9 months, and a new United States—the world's third most populous country—in less than 4 years.

No one knows how many people the earth can support, and at what level of resource consumption, without seriously degrading the ability of the planet to support us and other forms of life and our economies. But there are some disturbing warning signs. Biologists estimate that by the end of this century, our exponentially increasing population and resource consumption could cause the irreversible loss of one-third to one-half of the world's known species.

There is growing evidence and concern that continued exponential growth in human activities such as burning fossil fuels and clearing forests will change the earth's climate during this century. This could ruin some areas for farming, shift water supplies, and disrupt economies in parts of the world.

Great news. We have solutions to these problems that we could implement within a few decades, as you will learn in this book.

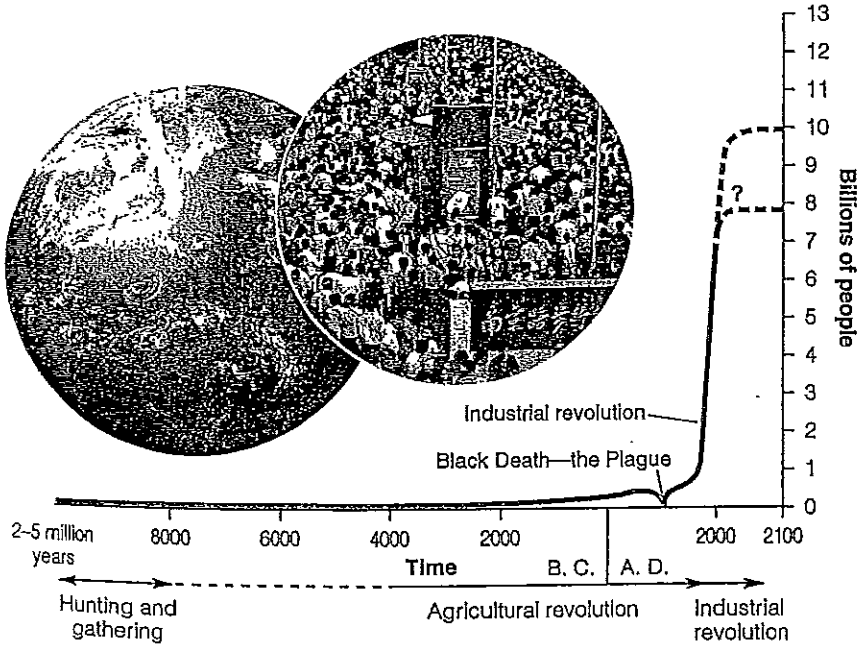

Figure 1-1 *Exponential growth:* the *J*-shaped curve of past exponential world population growth, with projections to 2100 showing possible population stabilization. (This figure is not to scale.) (Data from the World Bank and United Nations; photo of street in China by L. Yong/UNEP/Peter Arnold, Inc.)