UNDERSTANDING

BASIC ECOLOGICAL CONCEPTS

Third Edition

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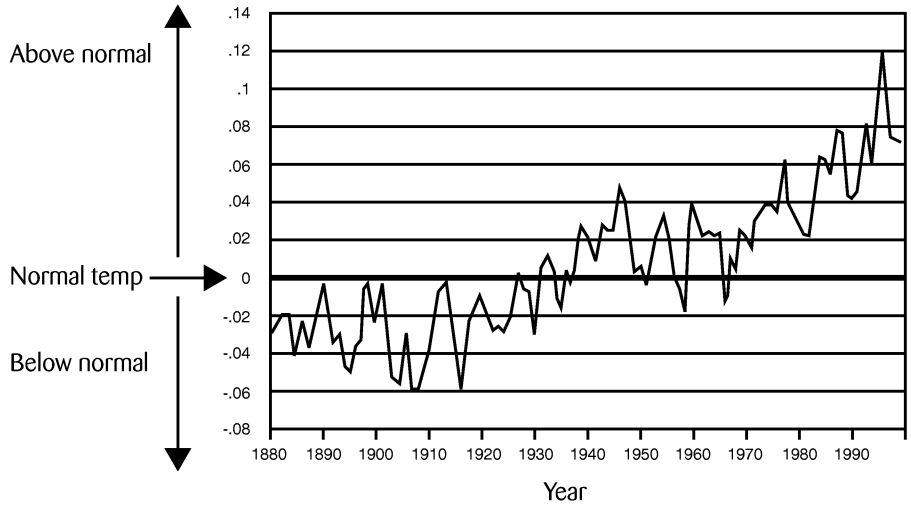
CONTENTS

GLOBAL WARMING 9

There is no doubt that our earth's atmosphere is warming up. The hottest year on record was 1998. The next year, 1999, was cooler, but it still was the sixth hottest year. The graph below demonstrates that global warming is really happening.

AVERAGE YEARLY GLOBAL TEMPERATURE DEVIATION (°F)



Let's take a closer look at this graph in order to understand what it tells us. First, you may be wondering why the title uses the word *deviation* rather than *actual global temperatures.* This is because an absolute global temperature is very hard to determine. The absolute temperature would change quickly as you climbed up a mountain or down into a valley. It is easier to use the change (temperature deviation) from year to year. In the years between 1951 and 1980, the global mean temperature is 13.9 °C. That figure is still being used today.

What is that temperature in degrees Fahrenheit? _____

The global mean temperature has gone up 0.6 °C since the 1880s. That may not seem like much, but the graph shows how the temperature has deviated *above* the mean in recent decades. Now let's look a little more closely at the graph.

In what way is the *X* axis unusual? _____

_____

_____

What was the temperature deviation in the year 1900? _____ What does this mean?

_____

_____

_____

Approximately when did the warming trend begin? _____

What were the three coldest years in the twentieth century? _____

_____

Compare the temperature deviation of the 1950s to that of the 1980s.

_____

_____

_____

_____

_____

You may wonder why there should be such a fuss about the average surface temperature going up less than one degree Celsius. What can such a small change do? Let's see what has happened thus far because of the temperature change, and what may happen if this trend is not stopped or reversed.

THE EFFECTS OF GLOBAL WARMING

The earth's northern regions have already become greener by more than 10 percent since 1980. Not only are more square kilometers greener, but the plants stay greener longer. Spring comes at least a week earlier and fall arrives later, so the growing season is about 15 days longer. This doesn't sound bad. More food can be grown. So far, so good for the northern latitudes. However, in the southern regions of the United States and in those areas close to the equator, the soil will dry out more quickly due to the heat. Therefore, food production will decrease in these regions.

The ice cap of Mount Kilimanjaro in Tanzania has lost 82 percent of its ice since it was first measured in 1912. Mountain glaciers have been melting all over the world. The same is true of the polar ice cap at the North Pole. Polar bears are in danger of starvation as melting ice eliminates solid surfaces to walk on and keeps them from their food.

Polar bears on ice. (Corel CD)

The result will be higher sea levels all over the world. The sea level has risen somewhere between 10 and 20 cm over the past century, and scientists predict a rise of up to 100 cm in the current century. This projected rise of one meter will cause coastal flooding and beach erosion all over the world. Many countries will have to build sea walls for protection or force people to evacuate beach areas. In addition, German scientists recently reported that the seas are getting rougher with higher waves. They have matched the increase in wave height to increased air temperatures near the earth's surface.

Melt pool and iceberg. (Corel CD)

Global warming will increase the rate of evaporation from the land, causing drier soils and more deserts. Water will be exchanged faster between the oceans, the atmosphere, and the land, resulting in more frequent floods and droughts. This trend may already have started; in the early 1990s there were two severe floods in the Midwest in a five-year period.

Health is an important concern in relation to global warming. First, severe heat waves will be more frequent. In 1995, Chicago recorded 495 deaths due to heat stress. As the earth grows warmer, what will happen to the number of deaths from heat stress? Warmer weather equals fewer "killing frosts," so there will also be a spread of mosquitoes and other insects.

Name three diseases that are transmitted by insect bites. _____

_____

_____

Since warmer air will produce more mold spores and pollen in the atmosphere, cases of asthma and other plant allergies will also be on the increase.

Forest and grassland changes due to global warming will affect the organisms in most ecosystems. In the following table, describe what changes might occur in each of the listed ecosystems.

Ecosystem	Change
Tundra	
Desert	
Mountain regions	
Wetlands	

Causes of Global Warming

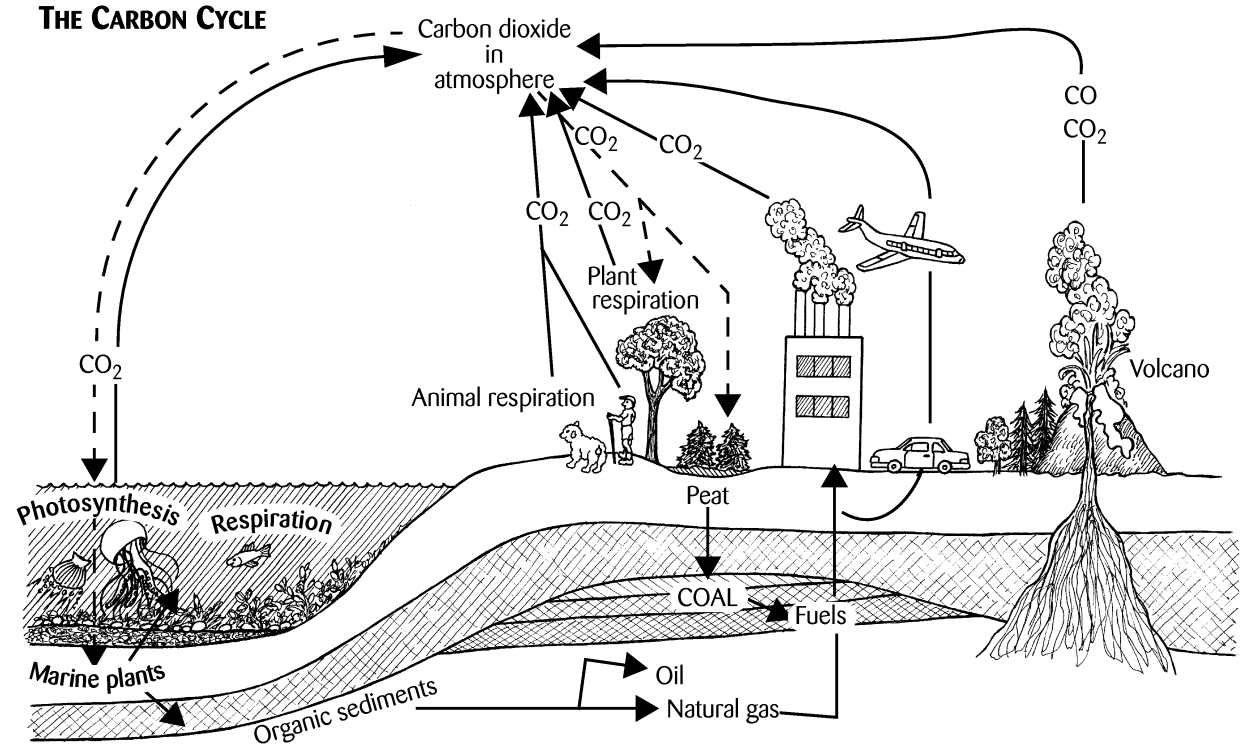
Currently, there are three theories about why global warming is taking place. However, most scientists believe that the cause is an increase in the **"greenhouse gases."**

Carbon dioxide (CO_2)is a major greenhouse gas in the atmosphere. In fact, without any carbon dioxide in the atmosphere, the earth would be a much colder place to live. The global mean temperature would be below 0 °C instead of being close to a comfortable 14 °C. Most carbon dioxide comes from the decomposition of dead plants and animals and the respiration of living animals and plants. For thousands of years there was no problem with this, because the oceans absorbed much of this CO_2, taking it out of the atmosphere. Plants carrying on photosynthesis also absorbed a great deal of the atmospheric carbon dioxide.

Everything was fine until people began to release huge quantities of additional carbon dioxide into the atmosphere, beginning in the late nineteenth century and increasing dramatically up through the early twenty-first century. Auto engines, power plants, industrial mills, and home and business heating systems burn coal, oil, or natural gas. This accounts for 98 percent of the CO_2 added to the atmosphere. The other 2 percent is due to increased deforestation and mining. To understand how carbon dioxide builds up in the atmosphere, we can take another look at the carbon cycle.

During the period 1981–1990, 7.1 billion metric tons (BMT) of carbon dioxide was released worldwide. Of that amount, 5.5 BMTs were the result of the burning of fossil fuels. An additional 1.6 BMTs came from the destruction of tropical forests and other forms of vegetation, respiration, and decomposition.

1.8 BMTs were removed from the atmosphere by existing plants (land and aquatic) through photosynthesis. Another 2.0 BMTs were absorbed by oceans, lakes, etc. Both of these sources of CO_2 removal are known as **sinks.** However, *3.3 BMTs of carbon dioxide remained in the atmosphere.*



Be sure to read the text in the upper left corner of the diagram. It explains how carbon dioxide is added to the atmosphere. Then read all the text in the diagram, and follow the arrows. When you have finished, answer the following questions.

1. Name three sources of carbon dioxide _____

_____

2. Which ones can we control? _____

_____

3. What do carbon dioxide sinks do? _____

_____

4. Explain why carbon dioxide tends to build up in the atmosphere. _____

_____

_____

Methane (CH_4) is another of the major greenhouse gases. Methane molecules trap 20 times more heat than carbon dioxide molecules. Methane is released from wetlands, decomposing wastes in landfills, rice paddies, the stomachs of cows and sheep, and termites. It also leaks out of coal mines and natural-gas deposits. There are about two *billion* cows and sheep on the earth today, each belching up 200 grams of methane or more each day!

In the last few years, the amount of methane being added to the atmosphere has been decreasing. Scientists are not positive why this is so. One theory is that global warming is causing the wetlands—the number one methane source—to dry up, resulting in a reduction of methane production. Another possibility is that since the outbreak of "mad cow" disease and hoof-and-mouth disease in Europe, less beef has been sold; thus, fewer cows have been raised. In the United States, beef consumption is also down, but for a different reason. Many Americans have cut down on their consumption of hamburgers and other meat products that are high in fat content in an effort to lose weight or cut their cholesterol levels.

Next in order of importance of the greenhouse gases is nitrous oxide (N_2O). This gas is added to the atmosphere when bacteria break down human and animal waste products. Nitrogen fertilizers breaking down in the soil also release nitrous oxide into the atmosphere. The burning of oil, coal, and natural gas also creates nitrous oxide. Since the mid-1700s, nitrous oxide content in the earth's atmosphere has increased by more than 7 percent. A molecule of nitrous oxide absorbs 270 times more heat than a carbon dioxide molecule!

Some gases of minor importance, such as sulfur hexafluoride, also contribute to global warming. These gases are not included in the table below, which shows greenhouse gas concentrations in the atmosphere at the beginning and the end of the twentieth century.

Major Greenhouse Gas	**Concentration in the Atmosphere in 1900**	**Concentration in the Atmosphere in 2000**
Carbon dioxide	300 parts/million	375 parts/million
*Methane	900 parts/billion	1,800 parts/billion
Nitrous oxide	275 parts/billion	325 parts/billion

*Since 1980, the rate of increase of methane in the atmosphere has been negative. That is, each year less methane is added.

Which greenhouse gas is most prevalent in the atmosphere today?

Using the data in the table, explain why carbon dioxide is the most important greenhouse gas.

ACTIVITY 22 Demonstrating the Greenhouse Effect

In this activity, you will create two models of the earth's atmosphere. Then you will determine how light is transformed into heat in each model.

Materials

Two 1-liter soda bottles made of clear plastic with paper labels removed
Gas burner
Phillips head screwdriver
Safety goggles
Two metric thermometers
Transparent tape

Procedure

Note: The first two steps must be done under adult supervision while wearing goggles.

1. Lay one of the soda bottles on the tabletop. Heat the tip of the screwdriver using the gas burner. The screwdriver need not get red hot. While holding the soda bottle by its neck, use the heated screwdriver tip to melt seven holes in a line down one side of the bottle as shown in Diagram A.

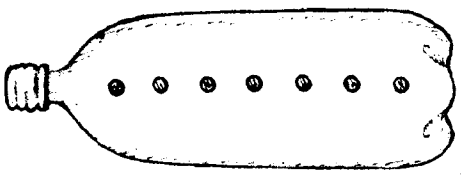


Diagram A

2. Repeat the first step, only this time, prepare 13 holes as shown in Diagram B.

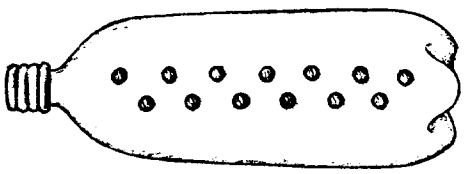


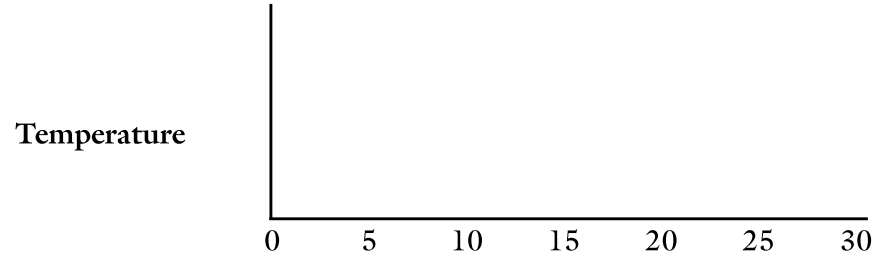
Diagram B

3. Set the plastic bottles on their sides so that the holes are facing up. Indoors, place them on a tabletop that is in the sun. If you are doing this outdoors, be sure that there is little or no wind. Insert a thermometer in the middle hole in each bottle. Use two thin books to keep the bottles from rolling around. Use the transparent tape to hold the thermometers in place. Be sure that the thermometer tips are near the middle of the inside of the bottles and are not touching the plastic on the side of the bottle that is resting on the flat surface.
4. Record your initial temperatures. Record the data in the table on the next page.

5. Continue to take readings for 30 minutes, recording your data.

Reading	7-Hole Bottle	13-Hole Bottle
Initial	°C	°C
5 minutes	°C	°C
10 minutes	°C	°C
15 minutes	°C	°C
20 minutes	°C	°C
25 minutes	°C	°C
30 minutes	°C	°C

6. Graph your data in a line graph. Use different colored ink for each bottle's temperature.



Analysis

1. What conclusions can you reach from comparing the data for each bottle?

2. How do you explain the differences in the data for each bottle?

3. The bottles are models of the atmosphere. (The plastic acts like glass when it comes to light and heat.) Which part of the model represents the greenhouse gases?

4. Which model represents an atmosphere with the most greenhouse gases in it?

5. Why would your results *not* be valid if you did this outside on a windy day?

CHAPTER 9 REVIEW | Global Warming

1. Explain why global warming is a serious problem to you and to future generations.

_____

_____

_____

2. Why might replacing all gasoline engines with hydrogen fuel cells reduce global warming? _____

_____

_____

3. What is the greenhouse effect? _____

_____

_____

4. State and explain three ways by which carbon dioxide emissions could be reduced.

_____

_____

_____

5. What are the sources and sinks of carbon dioxide? _____

_____

_____