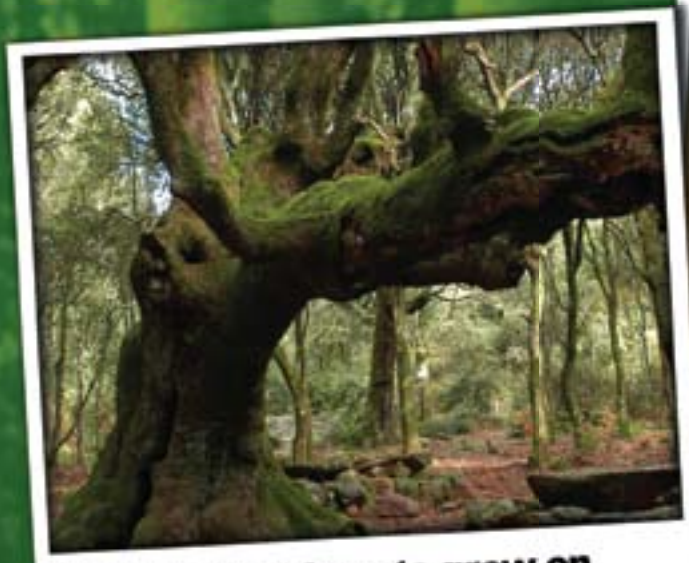
NATURAL INQUIRER

THE WORLD'S FORESTS EDITION - VOLUME XI / NUMBER 1



What kind of forests grow on Earth and how do they differ?

How well are we managing our forests worldwide?

How much carbon is being held by the world's forests?

How much of Earth's land is covered by forests?

FOREST SERVICE US DEPARTMENT OF AGRICULTURE

FAO FIAT PANIS

Welcome to the World's Forests edition of the *Natural Inquirer*!

Winter 2008

United States Forest Service

Jan Heino
Assistant Director-General
Forestry Department, FAO

Abigail Kimbell
Chief
US Forest Service, Washington, DC

Ann Bartuska
Deputy Chief for Research

Jim Hubbard
Deputy Chief for State and Private Forestry

With thanks to:

Safiya Samman
Staff Director
Conservation Education
US Forest Service

John Sebelius
Staff Director
Science Quality Services
US Forest Service

Alex Comfort
Executive Director
Cradle of Forestry In America Interpretive Association

Andrea Perlis, Laura Russo, Mette Wilkie
Forestry Department, FAO

Editor:
Babs McDonald
US Forest Service

Layout:
Giulio Tiberi

The *Natural Inquirer* is an integrated science education journal for students aged 11-14. In the United States where the journal was first published, the *Natural Inquirer* presents research from scientists working in the United States Department of Agriculture's Forest Service.

This edition of the *Natural Inquirer* presents the results of a worldwide effort to understand the world's forests, organized by the United Nations Food and Agriculture Organization, or FAO. The report from which this *Natural Inquirer* is written is the Global Forest Resources Assessment 2005. It contains information from 229 countries and territories around the world.

You can access the FAO report at http://www.fao.org/forestry/fra2005/

Visit:
http://www.naturalinquirer.usda.gov
http://www.fao.org/forestry/site/fra
http://www.fao.org/kids/en/forestry.html
for more information and
to find this journal online!

TABLE OF CONTENTS

EDUCATORS! Go first to the educator resources section on page 27.

WELCOME TO THE WORLD'S FORESTS EDITION OF THE *NATURAL INQUIRER*!

Have you heard of the United Nations? The United Nations (UN) is a world organization that was established in 1945. Today, nearly every nation in the world belongs to the UN. In total, 192 countries are members of the UN. These nations are working together for peace, human rights, freedom, and social progress.

YOU DO THE MATH:
How old is the UN today?

The Food and Agriculture Organization, or FAO, is a part of the United Nations. FAO helps developing countries and countries in *transition modernize* and improve agriculture, forestry, and fisheries practices. FAO also helps these countries provide good nutrition for all.

For many years, FAO has been collecting information about the world's forests. It may seem unusual for an organization concerned with food and agriculture to be studying forests. Trees, however, can be important for the nutrition of people. Trees have many links to agriculture. They help protect soil and water necessary for food crops. People use forests and plant trees for the many benefits trees provide, including food, energy, wood products, construction materials, and medicines. Trees also help protect the environment.

Trees are often planted in a manner similar to food crops, except that it takes many years for trees or their products to be ready for harvesting (Figure 1). The more knowledge FAO can collect about trees and forests, the more successfully it can help countries like yours grow and manage healthy forests. More information also helps your country take better advantage of forest benefits. These benefits improve the lives of all people.

In this edition of the *Natural Inquirer*, you will learn about the world's forests. Take a moment to think about the size of the planet. Because it is so large, you will learn about large areas of forests. FAO divided the world into regions and subregions (Figure 2). Most of the information in this journal is presented according to these regions or subregions. For example, Africa is considered one region. The three subregions of Africa include: Eastern and Southern Africa, Northern Africa, and Western and Central Africa. Take a moment to find the region and subregion where you live.

GLOSSARY:

transition: The act or process of passing from one condition, form, or place to another.

modernize: To make or become modern; to bring up to date.

Figure 1. A young forest plantation in the United States. Photo by Dave Powell, USDA Forest Service

Figure 2. Regions and subregions of the world

Forests are important to the lives of all people everywhere. Worldwide, people benefit from the world's forests, even if those forests are not found in their own community. Forests provide materials such as wood for building or for energy. Forests provide food for people and for animals. They provide *habitat* for many different kinds of plants and animals, which helps to maintain the *diversity* of life on Earth (Figure 3). Forests protect the quality of water and help keep the soil from *eroding*. Forests help keep the air clean and they provide places for people to live and play. In many places, forests provide jobs which help people and their families have a better life.

Note: Italicized words are defined on page 6.

GLOSSARY:

habitat: Environment where a plant or animal naturally grows and lives.

diversity: A measure of the differences between the types and numbers of living things in a natural area.

erode: To wear away.

average: The usual kind or amount. The number gotten by dividing the sum of two or more quantities by the number of quantities added.

unit of measurement: A standard quantity of a physical property, such as meters, degrees Celsius, or grams.

Northern Hemisphere: The half of Earth that is north of the equator.

correspondent: In the context of FRA 2005, a correspondent is a representative from each country who gathered and sent information to FAO.

Figure 3. Forests provide habitat for wildlife

THINKING ABOUT SCIENCE

When scientists want to learn something, they must collect information. Although you might not realize it, you do the same thing when you want to learn something. This information is called data, and it is often collected in the form of numbers. If scientists collect data in the form of numbers, they can add, subtract, multiply, or divide the numbers, and they can calculate new numbers like *averages*. Numbers help scientists compare information collected from different places or times. This is more complicated than it first appears. The numbers coming from different places or times must have the same *unit of measurement*. Otherwise, the calculations will be meaningless.

For example, let's say a scientist wants to calculate an average temperature for one month across the entire *Northern Hemisphere*. Some temperatures are reported in Celsius and some in Fahrenheit. Would an average of those measurements allow a meaningful conclusion? Of course not! The scientist would have to change each number to the same unit of measurement. Only then could an average temperature be calculated.

This same scientist has found that some countries, when reporting a daily temperature, used the highest temperature measured each day. Other countries used an average temperature, calculated over a 24-hour period. Would an average of these measurements allow a meaningful conclusion? Again, the answer is no. When numbers are intended to be combined in some way, they must represent the same thing or calculations done with them are meaningless.

The scientists in this study wanted to learn about forests across the globe. To collect accurate data, they worked with an individual

in each country, called a *correspondent* (Figure 4). The correspondent provided his or her country's data to FAO. Each correspondent worked with FAO to ensure the numbers being collected represented the same thing. This enabled the scientists to add the numbers from different countries. In this way, the scientists were able to create a report about the world's forests.

REFLECTION SECTION

What are some of the benefits forests provide to your community?

Mr. Brad Smith is the National Correspondent from the United States. We asked Mr. Smith what he likes best about this important job and he said: *"working closely with scientists from all over the world. I like discussing environmental issues and discovering new ways of thinking and solving problems. By working together, we improve our data gathering and reporting both at home and across the globe. I also liked discovering that some of the smallest countries have some of the most creative ideas."*

Figure 4. The country correspondents met to discuss their work

INTRODUCTION TO THE INQUIRIES

This journal contains four Inquiries. Each Inquiry represents a study done by FAO scientists and country correspondents to answer a specific question about the world's forests. By the time you complete all four Inquiries, you will know several new facts about forests across the world.

Each Inquiry builds on the previous Inquiry. It is best, therefore, to read the Inquiries in the order presented. As you read about FAO's work to collect data about the world's forests, think about the forests you have seen, visited, or read about. Although there are differences between forests around the world, many of the challenges and opportunities are the same wherever forests are found.

For each of the four Inquiries presented in this journal, FAO and the correspondents followed the same process to collect data. When the data were added together, it provided information about forests subregionally, regionally, and globally.

Next, we will take a look at the information collected by country correspondents and provided to FAO in these four Inquiries. If you want to learn more about the entire report about the world's forests, visit: **http://www.fao.org/forestry/fra2005**

INQUIRY 1: WHAT KIND OF FORESTS GROW ON EARTH AND HOW DO THEY DIFFER?

THE SITUATION: Across the planet, different types of forests are found. One reason different forest types exist is because they grow under different *climates* (Figure 5). Another reason is that human activities have changed some of the forests, for example through planting or felling of trees. To better understand the different types of forests found across Earth, the scientists had to decide what was most important about those forest differences to study. In other words, to study the differences between forests across the planet, FAO had to determine how they would *classify* forests.

Before we learn how FAO classified the world's forests, let's think about the place on which these forests grow. What is this place called?

If you guessed Earth, you are right! We know that Earth spins on its *axis* and revolves

GLOSSARY:

climate: The average condition of the weather over large areas, over a long time, or both.

classify: To arrange by putting into groups according to some system.

axis: A straight line about which a body or geometric figure rotates.

equator: An imaginary circle around the middle of Earth at an equal distance from the North Pole and the South Pole.

conserve: To avoid wasteful or destructive use of something.

latitude: Distance north or south of the equator.

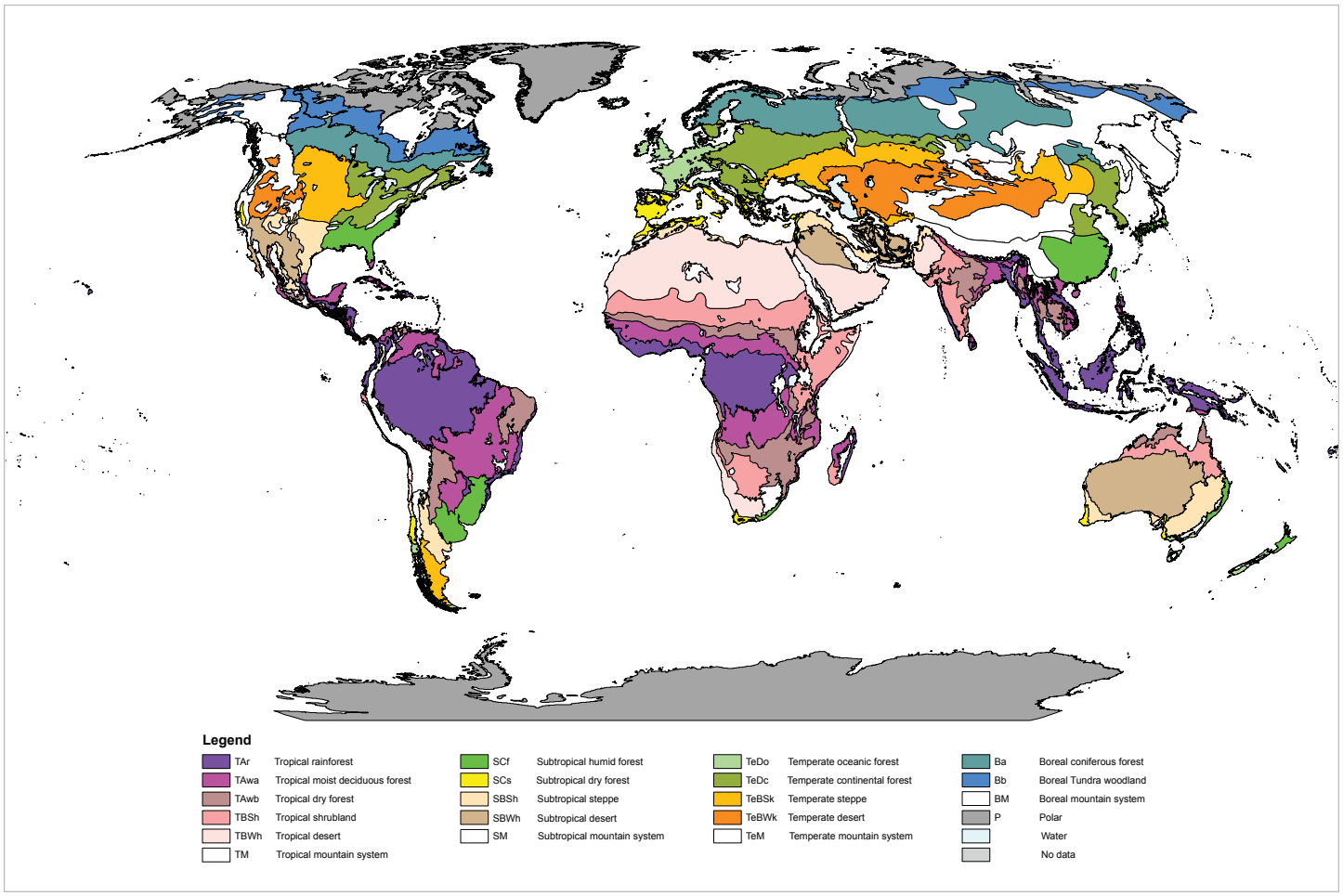


Figure 5. World ecozone map. An ecozone is a region with similar type of land cover. Notice that similar ecozones can occur on different continents

around the sun (Figure 6). The area near the equator is closest to the sun. Because of this, Earth is warmest near the *equator*, and coolest near the poles (Figure 7).

About 71 percent of Earth is covered with water, and most of this is ocean. The top level of any ocean is called sea level. The height of the land compared with sea level is called elevation. At higher elevations, the climate is cooler (Figure 8).

Across Earth, different areas receive different amounts of rainfall.

Plants need water to survive and have adapted over time to live with varying amounts of rainfall. Some plants, such as those in tropical rain forests, must have a lot of water to survive. Other plants, like those in deserts, do not need much water to survive. Desert plants have adapted to *conserve* the amount of water they receive. Drier areas have fewer plants and trees. Some areas have no plants or trees at all. The 3 things that we have just explored are *latitude*, elevation, and rainfall (Figures 7-10). They affect what kind of forest grows naturally in a particular area on Earth (Figures 9-10 and 12).

In addition to latitude, elevation, and rainfall, there is another influence on Earth's forests. This influence is changing Earth's forests, no matter where on Earth the forests are located. It was this influence FAO was most interested in understanding. What influence did the scientists want to understand?

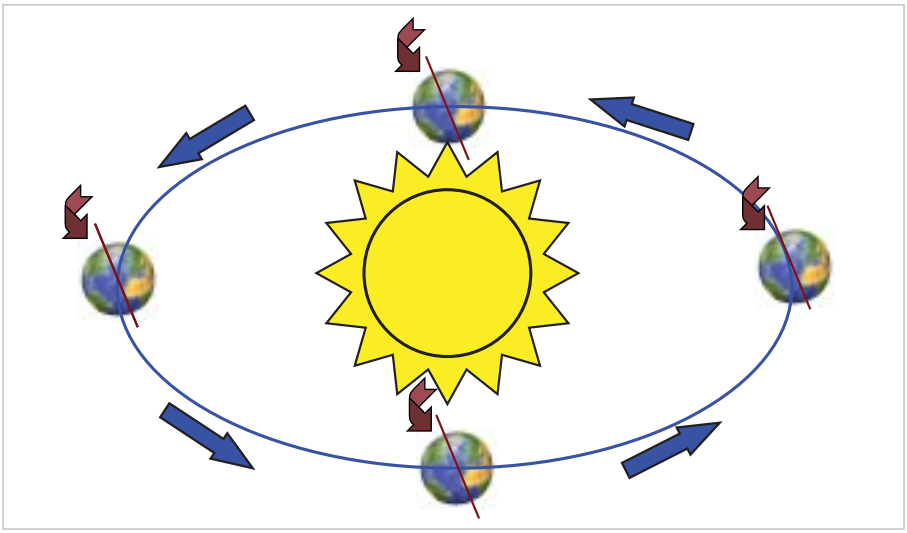


Figure 6. Earth spins on its axis and revolves around the sun

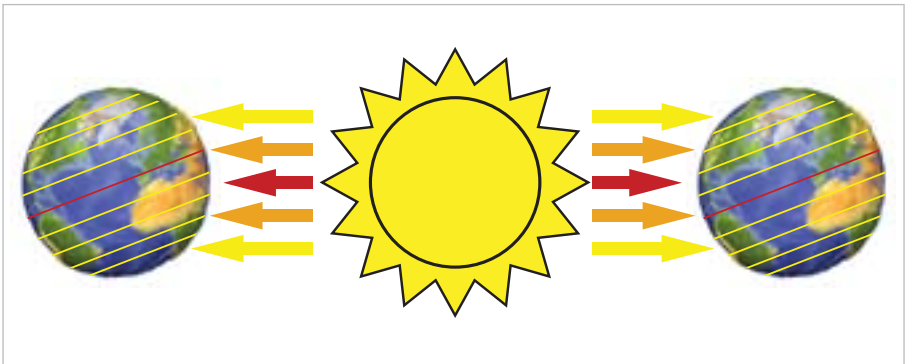


Figure 7. Earth is warmer near the equator, cooler near the poles

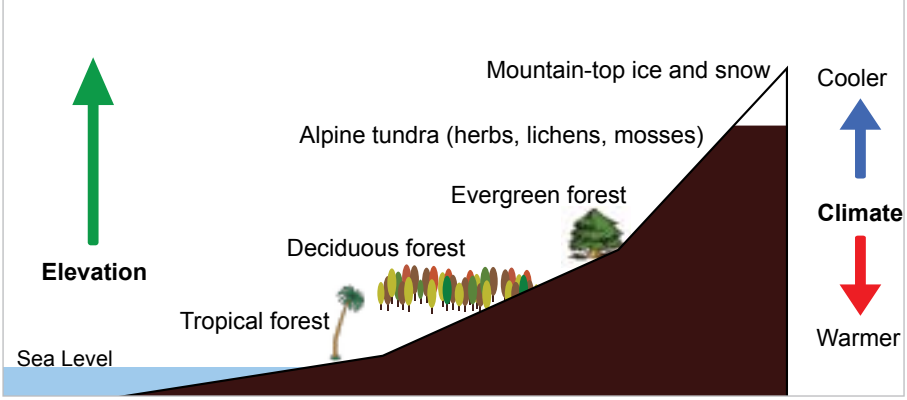


Figure 8. The higher the land's elevation, the cooler its climate

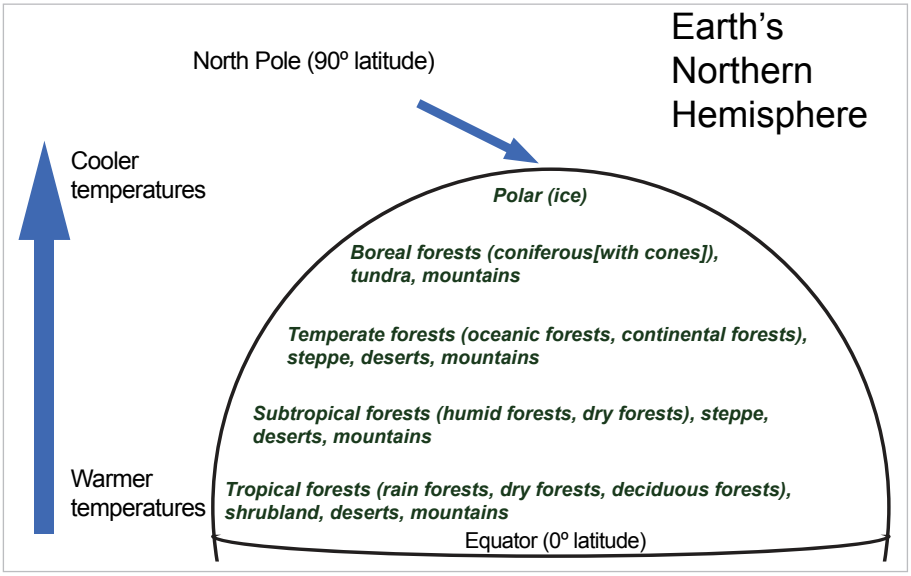


Figure 9. Vegetation types, temperature, and latitude

If you guessed humans, you are right! FAO wanted to understand how forests are changing as a result of human activity. To study the influence of humans on forests, the scientists classified forests into five categories (Table 1, page 11). These categories were based on how much humans have changed the forest.

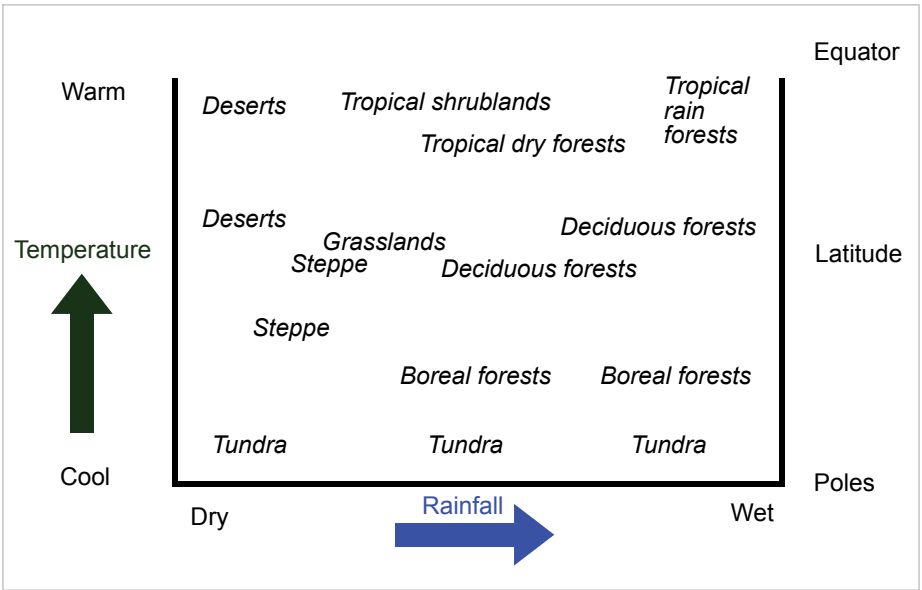


Figure 10. Vegetation types, temperature, and rainfall

If humans have not changed a forest much at all, that forest is made up of *native* plant and tree species. Native species are those that are found in the area naturally (Table 1, page 11 and Figure 12 , page 12).

Not all forests are made up of native species, and not all forests get their start naturally. Trees are planted by people for many reasons. People plant trees to harvest timber in the future and for other wood products such as pulp for making paper. When people plant trees for these kinds of products, the resulting forests are called productive plantations.

Of course, trees are also planted for food products such as fruits and nuts, but the result of these plantings are mostly fruit orchards. Fruit orchards were not included among the forest categories by FAO.

People also plant trees to achieve environmental benefits. Trees may be planted to protect streams and rivers and to keep soil from eroding, a practice called soil and water *conservation*. When people plant trees to conserve water quality and soil, the resulting forests are called protective plantations.

After FAO had classified forests according to human activity, they were ready to discover how humans were influencing the world's forests. They asked each country correspondent to provide information about the characteristics of their country's forests according to the categories in Table 1 for the years 1990, 2000, and 2005.

GLOSSARY:

native: Naturally occurring in an area.

species: Groups of organisms that resemble one another in appearance, behavior, chemical processes, and genetic structure.

ecological: Having to do with ecology, the study of organisms and their relationship with their environment.

environmental services: The collection of environmental processes that provide benefit to life on Earth.

conservation: The care and protection of natural resources such as forests and water.

ecosystem: A community of organisms living in an environment as an interdependent system.

WHAT THEY DISCOVERED: In 2005, slightly more than half of all forest area worldwide was classified as modified natural forest (Figure 11). Remember that modified natural forests contain native tree species that have grown naturally but show some signs of human activity.

In 2005, more than one-third of the world's total forest area was classified as primary forest showing no signs of human activity.

The largest area of primary forest was in the Amazon region of South America. Seven percent of the world's forests were semi-natural. Productive and protective plantations only made up 3.8 percent of total forests worldwide. Of this 3.8 percent, 3 percent was in productive plantations.

Between 1990 and 2005, the areas of primary forest and modified natural forest were decreasing worldwide. The areas of semi-natural forest and forest plantations increased over the same period. Each year since 1990, about 6 million hectares of primary forest have been lost or modified. About 2.8 million

Table 1. Categories of forests identified by FAO

CATEGORY OF FOREST CHARACTERISTICS	DESCRIPTION OF FOREST WITHIN EACH CATEGORY
Primary forest	Forests with native tree *species*. Evidence of human activities is not visible and the forest's *ecological* processes are not widely disturbed.
Modified natural forest	Forests with native tree species that have grown naturally. There is evidence of human activities in a modified natural forest. An example is an area where some trees were cut in the past.
Semi-natural forest	Forests with native tree species that have grown because humans have either sown seeds or planted small trees, or have otherwise assisted the growth of native tree species.
Productive forest plantation	Man-made forests with mostly non-native (and in some cases native) tree species. These forests have been purposely planted by humans for the production of wood products or non-wood forest products. People create a productive plantation by sowing seeds or planting small trees.
Protective forest plantation	Man-made forests with mostly non-native (and in some cases native) tree species that have been purposely planted by humans for *environmental services*.

You Do the Math:
What percentage of forest land worldwide was classified as either modified natural forest or primary forest?

You Do the Math:
How many hectares of productive plantations are added every year? How many hectares of protective plantations are added every year?

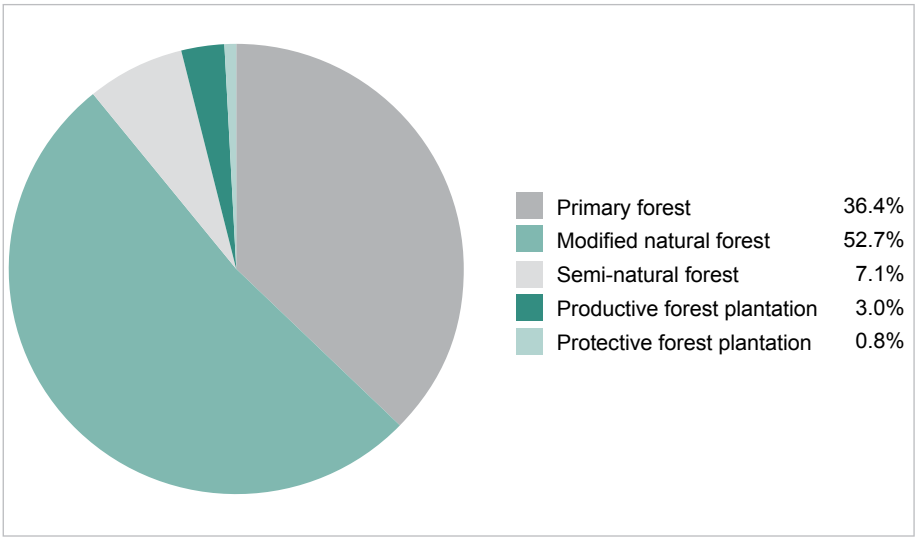


Figure 11. Forest characteristics: percent worldwide in each category

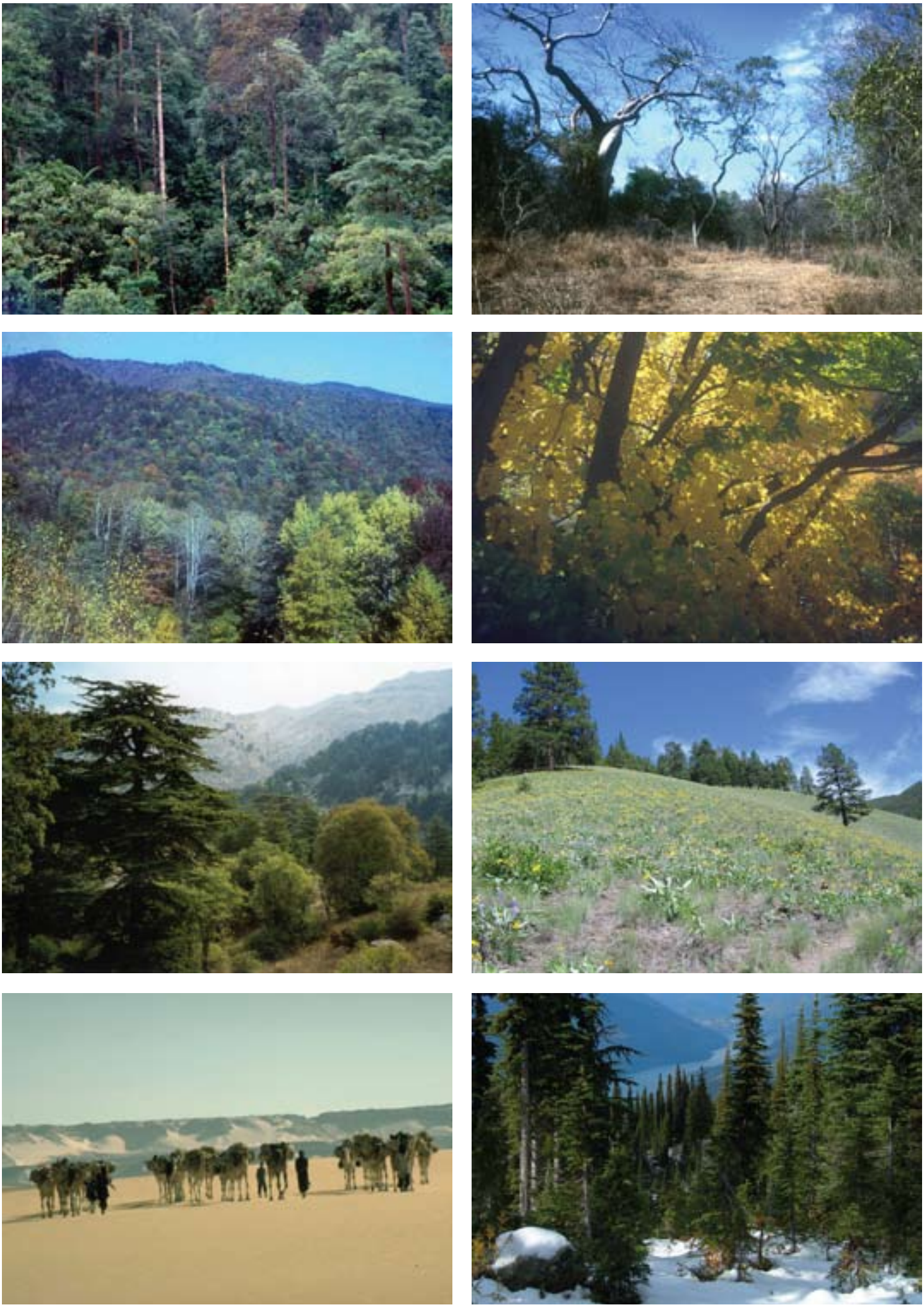


Figure 12. Some native ecosystems

hectares of forest plantations are added every year. Of these, 87 percent are productive plantations (Figure 13).

REFLECTION SECTION

Describe the majority of forests worldwide. You can either use one or two categories to do this.

What are two major trends in the categories of forests?

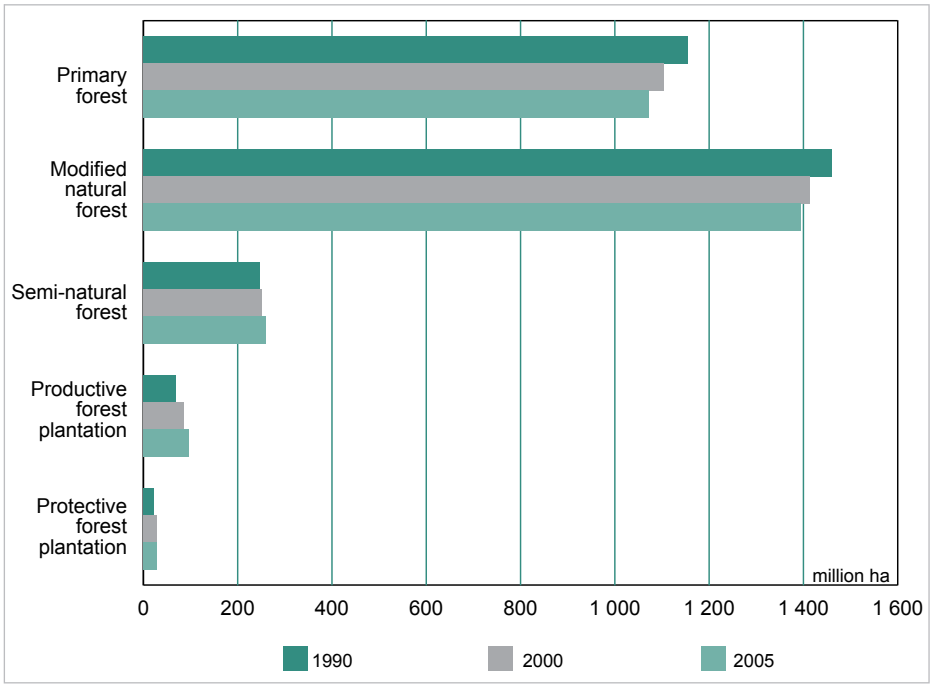
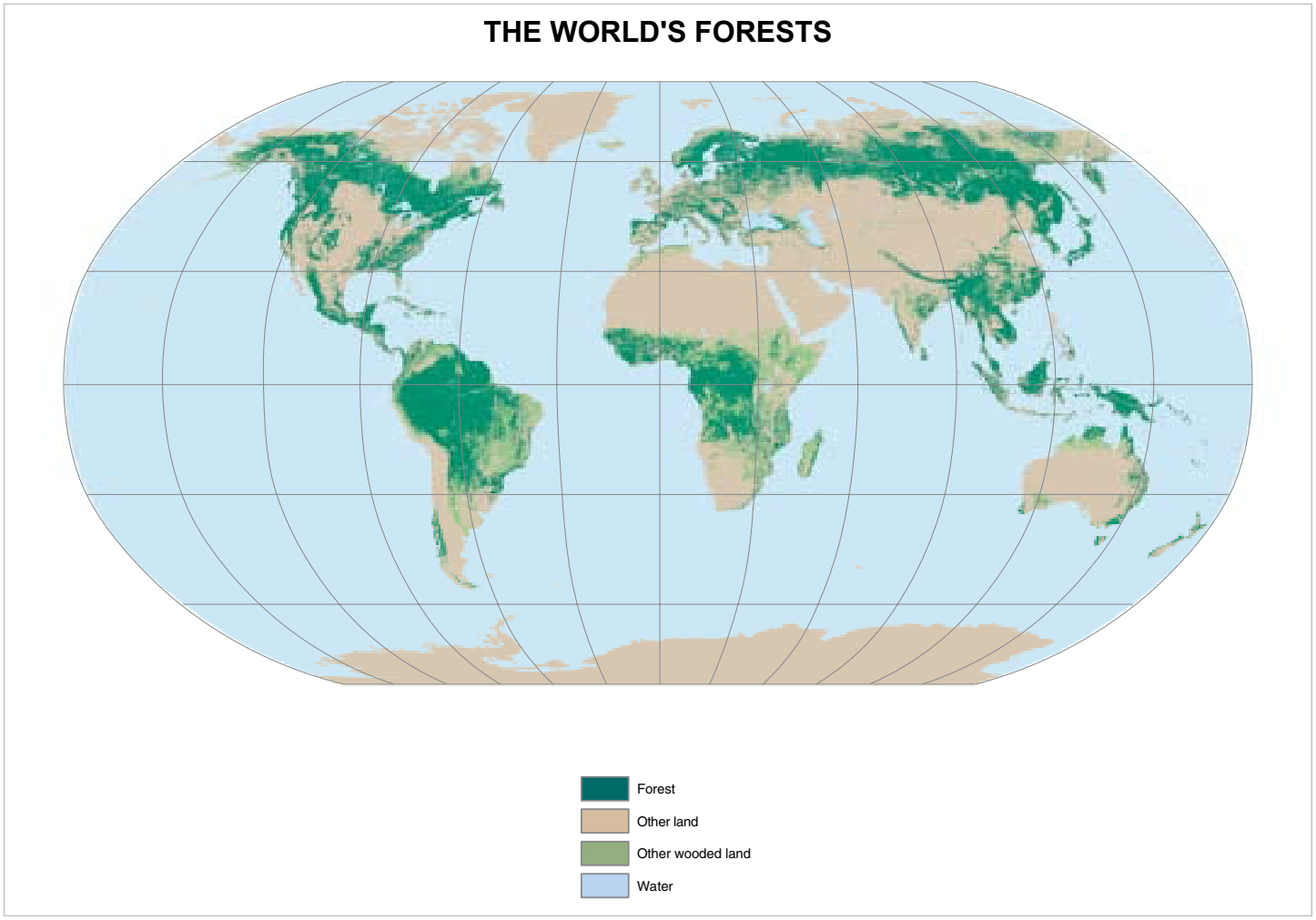


Figure 13. Changes in different categories of forests from 1990 to 2005 (million hectares)



INQUIRY 2: HOW MUCH OF EARTH'S LAND IS COVERED BY FORESTS?

THE SITUATION: You have learned about the benefits forests provide to people and other animals. (If you have not read "Thinking about the Environment," please do so now.) In Inquiry 1, you also learned that people are changing the world's forests. What you did not learn, however, is whether the world's forests are growing or shrinking in size overall.

Throughout history, humans have cut down trees and planted trees to meet their needs (Figure 14). This is one of the benefits of trees! If humans remove more trees than they plant, however, the size of the forest will shrink.

FAO wanted to know whether Earth is losing, gaining, or keeping about the same amount of forests over time. To do this, they asked each country correspondent to provide information for the years 1990, 2000, and 2005. The information they collected included the total amount of forests in all categories for each correspondent's country.

REFLECTION SECTION

Do you think FAO found that Earth is gaining, losing, or keeping about the same amount of forests over time?

If more forests are lost than are being planted, what will happen to the benefits provided by forests?

WHAT THEY DISCOVERED: In 2005, the total amount of forests worldwide was just under 4 billion hectares. This is equal to about 30 percent of the land area on Earth. If every person on Earth were given an equal piece of forest, each person would have 0.62 of a hectare, which is about the size of a soccer field (Figure 15).

Some countries have a large population and a small amount of forest. For those countries, each person might be given an area smaller than 0.1 hectare (about 1/6 of a soccer field). In other countries, there is a large amount of forest compared with the population. In the largest of these countries, each person might be given over 5 hectares of forest, or about 8 soccer fields. You can see that the amount of forests across Earth is not evenly distributed among the world's human population.

Figure 14. Young man watering trees to stabilize sand dunes

The removal of trees and conversion of the land to another use is called deforestation. Most deforestation happens because people remove trees and plant food crops for people and for livestock (Figure 16). Worldwide, 13 million hectares of forests are lost to deforestation every year.

Fortunately, people are also planting trees and helping forests grow back. In addition, some forests have naturally spread over a larger area without help from people.

Because some forests were expanding but more were being lost worldwide, about 7.3 million hectares of forests - an area about the size of Sierra Leone or Panama - were lost every year between 2000 and 2005. While this is not good news, it is better news than in the past. Between 1990 and 2000, about 8.9 million hectares of forests were lost every year.

You Do the Math:
How many fewer hectares of forest land were being lost each year between 2000 and 2005 compared with the decade between 1990 and 2000?

There are 100 hectares in a square kilometer (km^2). How many km^2 did Earth lose per day during 2000-2005?

REFLECTION SECTION

Why is it important to understand whether the amount of forest area worldwide is shrinking, growing, or staying about the same?

Look at Figure 17. Find the region where your home is located.

How does your region compare with the rest of the world?

Why do you think that is?

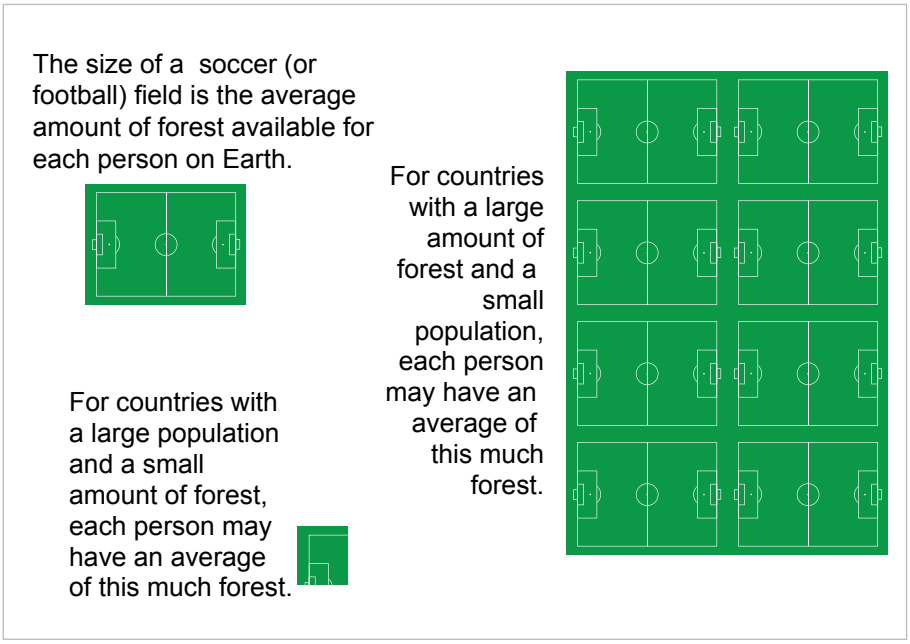


Figure 15. Average amount of forest for every person on Earth and the range of forest from the smallest amount per person to the largest amount per person

Figure 16. Land planted for food crops

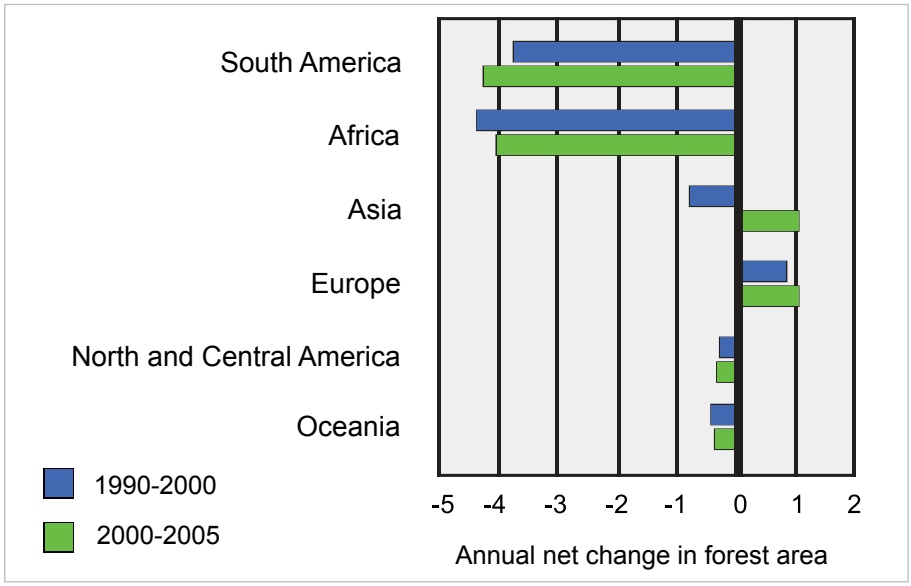


Figure 17. Changes in the amount of forest area by region (million hectares per year)

Between 2000-2005 South America lost more hectares of forests than any other region (Figure 17). Africa also lost a large amount of forests. On the other hand, Asian forests grew by one million hectares every year between 2000 and 2005. Asia's increase in forests was the result of a planned effort to plant trees in that region. Most of the trees were planted in China.

Figures 18-21 show four world maps. The first map (Figure 18) is easy to recognize, because each country is its normal size and shape. The countries within each region are similarly colored. Find your own country and region on this world map. What general color is the region in which your country is located?

The maps in Figures 19-21 are called cartograms. In cartograms 19-21, the country size and shape is *distorted* to show the country's forest area, forest growth and forest loss in relation to the country's size. In Figure 20, the cartogram shows forest growth in

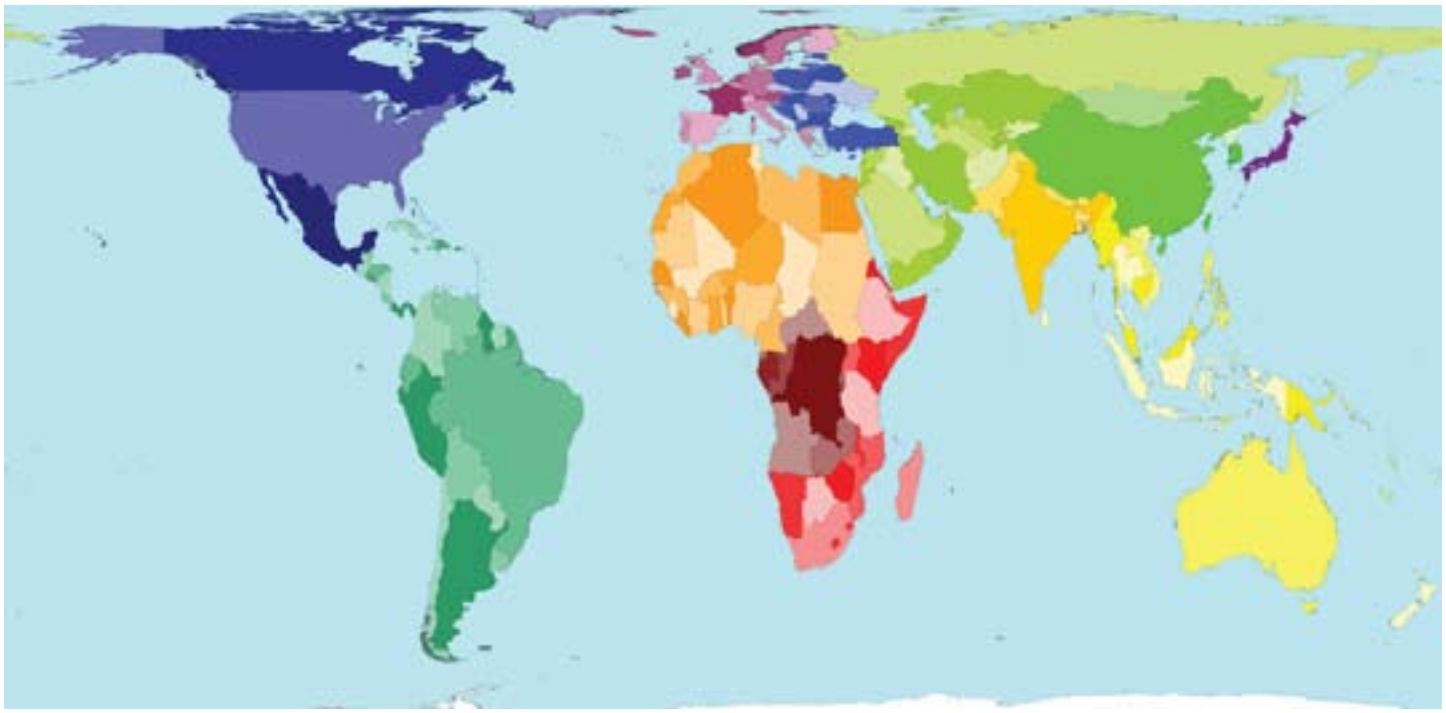


Figure 18. Land area of countries across the world. Map by Worldmapper

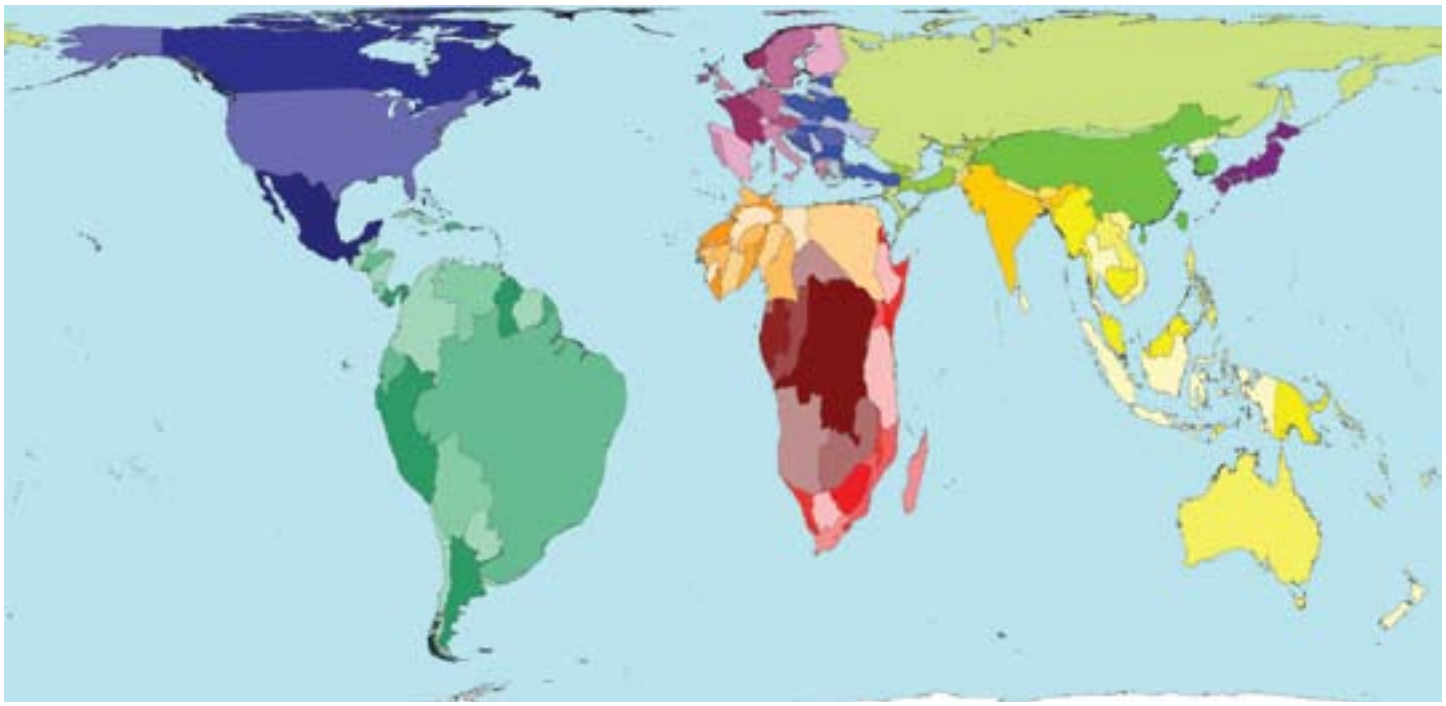


Figure 19. Amount of forest area in each country in 2005. Map by Worldmapper

square kilometers between 1990 and 2005. Compared with their normal size and shape, the larger countries and regions experienced more forest growth during that period.

In Figure 21, the cartogram shows forest loss in square kilometers between 1990 and 2005. Compared with their normal size and shape, the larger and more distorted countries experienced more forest loss. Find your country and region in the cartograms in Figures 20 and 21. Did your country gain or lose forests? Did your region gain or lose forests? Now compare these cartograms with the blue and green bars in Figure 17. What do Figures 17, 20 and 21 tell you about the forests in Asia?

GLOSSARY:

distort: To twist out of a normal shape.

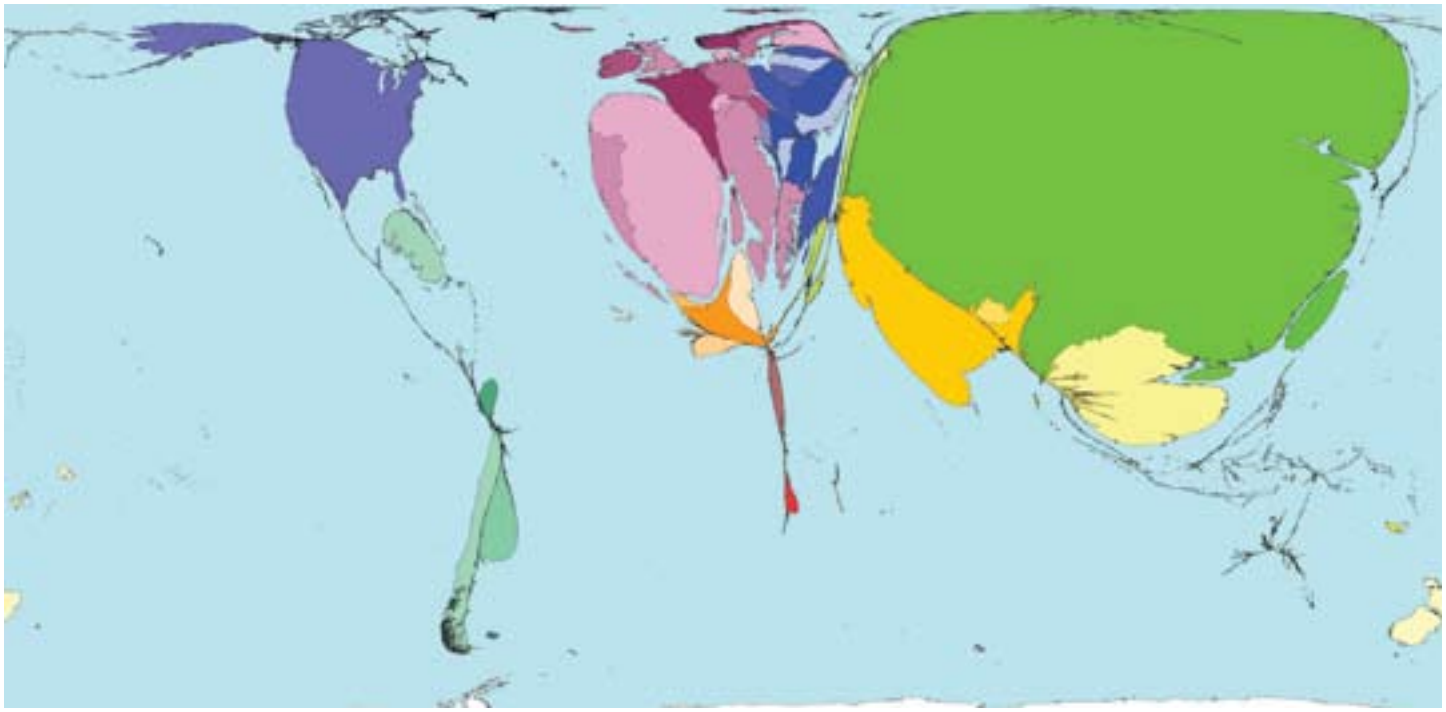


Figure 20. Amount of forest growth in each country between 1990 and 2005. Map by Worldmapper

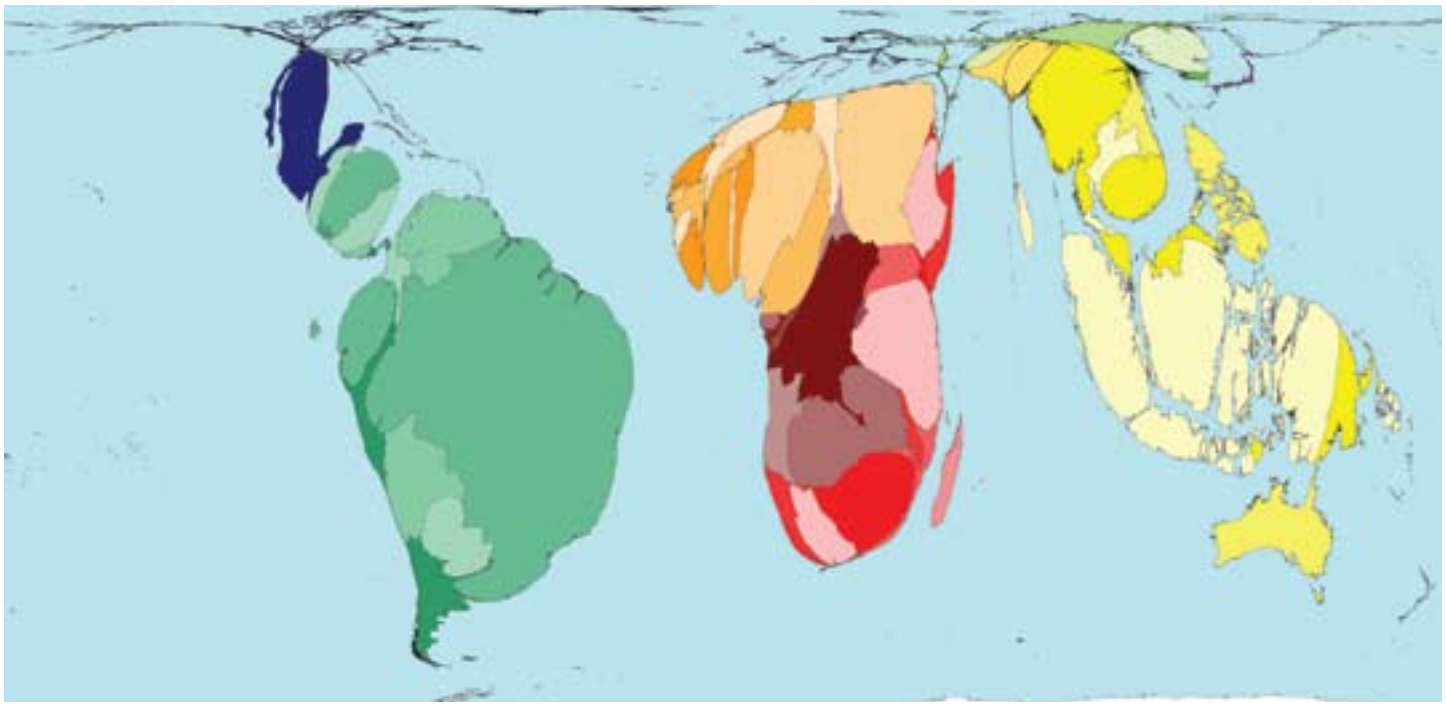


Figure 21. Amount of forest loss in each country between 1990 and 2005. Map by Worldmapper

INQUIRY 3: HOW MUCH CARBON IS HELD BY THE WORLD'S FORESTS?

THE SITUATION: Carbon dioxide is a gas that is made up of carbon and oxygen. Carbon dioxide has always been present in Earth's atmosphere. Carbon dioxide plays an important role in regulating Earth's climate through a process called the carbon cycle (Figure 22). Earth will cool if the carbon cycle removes too much carbon dioxide from the atmosphere. If the carbon cycle generates too much carbon dioxide, Earth will warm. As you can see from the carbon cycle, carbon is both held on Earth and released into the atmosphere as carbon dioxide.

Since the end of the last ice age, the amount of carbon dioxide in the atmosphere has remained fairly constant. In recent years however, the amount of carbon dioxide in the atmosphere has been rising. The rising amount of carbon dioxide may be related to the increase in some types of human activity, such as burning *fossil fuels*.

From Figure 22, you can see that trees and forests play an important part in the carbon cycle. As a tree grows, it absorbs carbon dioxide from the atmosphere. The carbon becomes a part of the living tree, including its roots. Most of the carbon stays in the tree until the tree is destroyed by fire or decay (Figure 23). Other plant matter in forests also contains carbon. Examples include fallen leaves, fallen dead wood (Figure 24), and shrubs. The soil also contains carbon.

Scientists believe that higher levels of carbon dioxide in the atmosphere are causing the world's climate to change. Since trees absorb carbon dioxide when they grow and other material in forests contain carbon, forests help reduce the amount of carbon dioxide being released to the atmosphere. FAO wanted to discover how much carbon is held by forests worldwide. The amount of carbon held in a tree is equal to about half the tree's weight after all water has been removed. The amount of carbon, therefore, can be calculated if the number and size of trees and

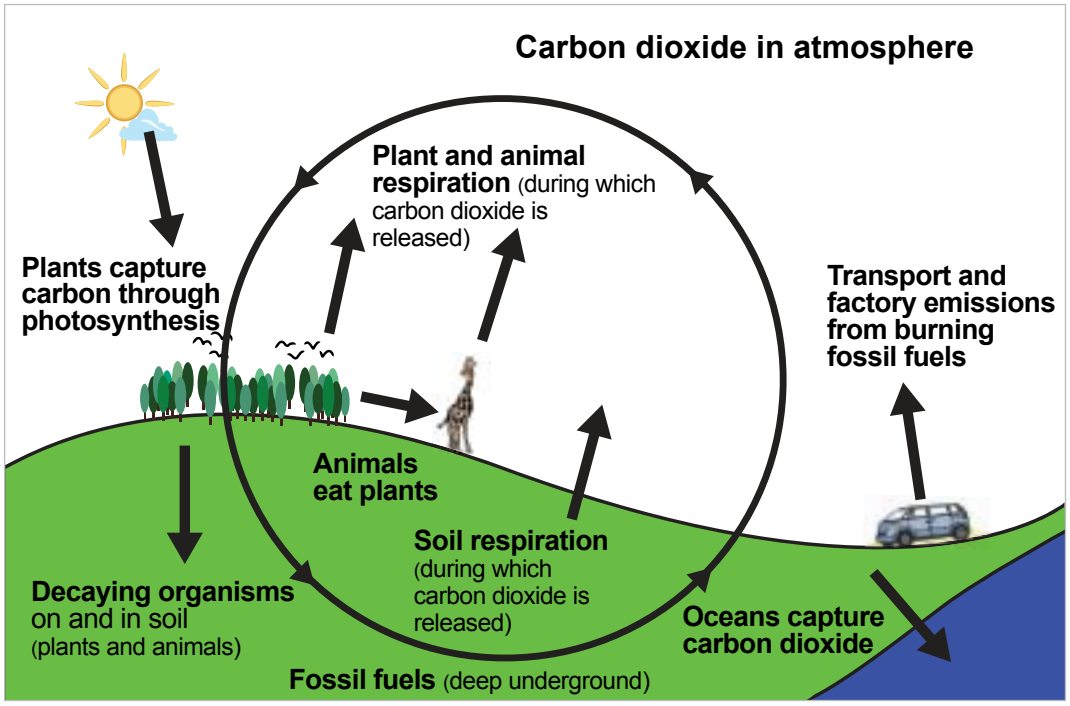


Figure 22. The carbon cycle

GLOSSARY:

fossil fuel: Fuel, such as coal, petroleum, or natural gas, formed from the fossilized remains of plants and animals.

REFLECTION SECTION

Do you think Earth's climate could be changing due to human activity? Why or why not?

the amount of water held in different sizes of trees can be estimated.

WHAT THEY DISCOVERED:

Of the 229 countries and territories reporting to FAO, 151 countries provided estimates of the amount of carbon contained in their forests. This accounted for 80 percent of the world's forests. Based on this information, FAO estimated the amount of carbon being held by the remaining 20 percent of the world's forests.

Then they added all of the information together. The amount of carbon is measured in gigatonnes, and is written Gt. One Gt is equal to 1 billion tonnes. One tonne is equal to 1,000 kilograms or 2,205 pounds. In 2005, the total amount of carbon in forests was estimated to be 638 Gt (Figure 25).

This is more than the total amount of carbon in the entire atmosphere! This figure includes all forest vegetation, roots, dead wood, and the carbon contained in the soil. Worldwide, there was a slight decline in the amount of carbon in the world's forests from 1990 to 2005.

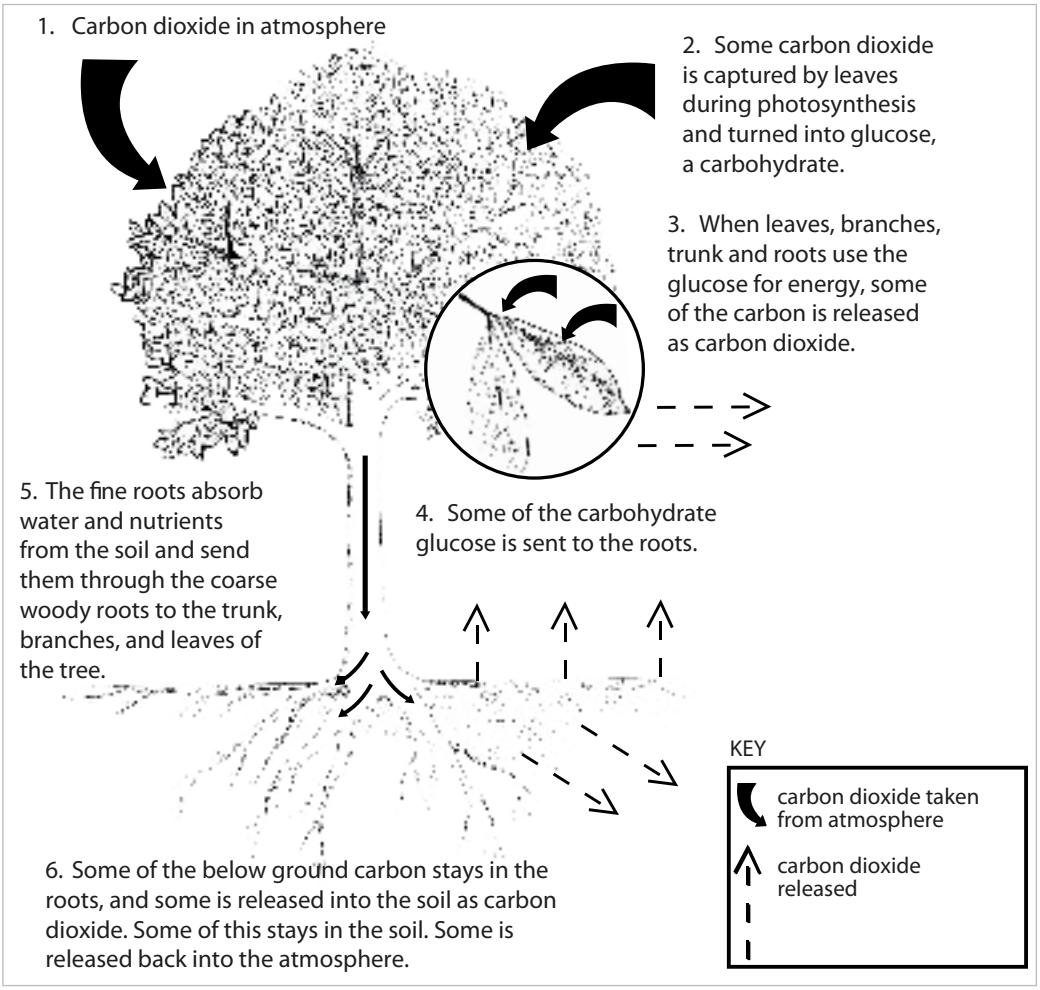


Figure 23. Trees absorb, hold, and release carbon

Fig 24. Plant matter found on the forest floor contains carbon

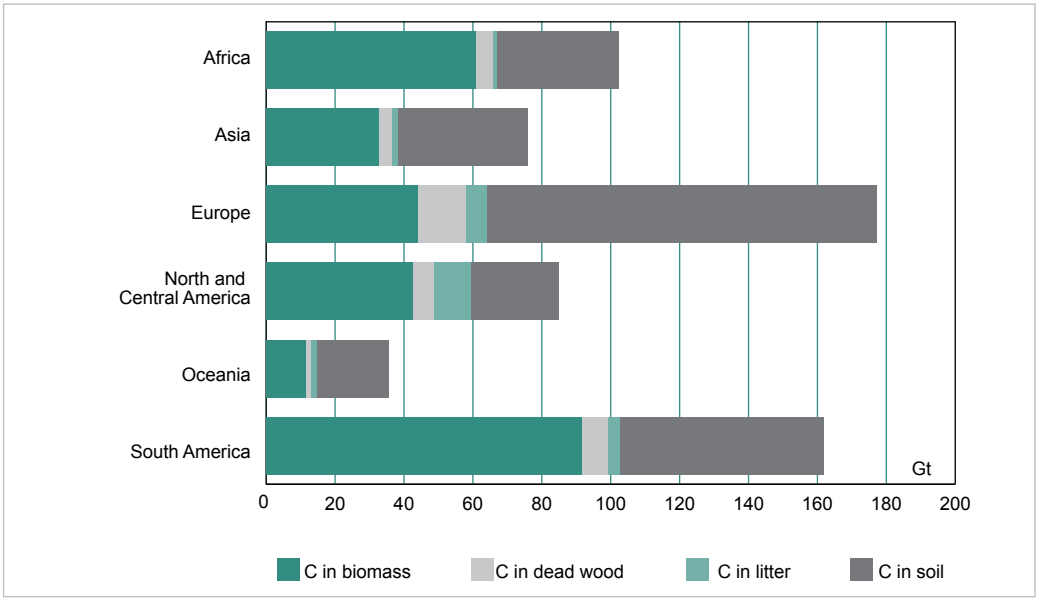


Fig 25. The total amount of carbon in forests by region in 2005 (Gt)

You Do the Math:

Although elephants vary in size and weight, let's say the average weight of an elephant is four tonnes (Figure 26).

How many elephants would it take to equal one Gt?

To calculate this, divide 1,000,000,000 by 4.

How many elephants would it take to equal the weight of carbon in all of the world's forests?

Fig 26. The average elephant weighs about four tonnes

REFLECTION SECTION

In Inquiry 2, you learned that more forests are being lost than are gained each year. Now read the last sentence on page 19. Does that sentence make sense in light of what you know about the loss of forests? Why or why not?

FAO scientists found that the amount of forests worldwide is declining. They also found the amount of carbon held by forests is declining. If, as most scientists believe, climate change is caused largely by an increasing amount of carbon dioxide in the atmosphere, what conclusion might you reach about the need for a greater or lesser amount of forest land?

INQUIRY 4: HOW WELL ARE WE MANAGING OUR FORESTS WORLDWIDE?

THE SITUATION: As you know, forests provide many benefits to people and other animals. For forests to provide these benefits, however, they must be managed so that they remain healthy and *sustainable*. Although there are many ways to identify what makes forests healthy and sustainable, FAO selected 6 *criteria* (Figure 27).

Extent of forest resources
Biological diversity
Forest health and vitality
Productive functions of forests
Protective functions of forests
Socioeconomic functions of forests

Figure 27. The 6 criteria of sustainable forest management used by FAO

For each of the 6 criteria, FAO identified information that served as indicators of sustainable forest management. Sustainable forest management is management that keeps forests healthy now and into the future. An *indicator* is a representation of something else. For example, when you complete a school assignment, you receive a grade or other assessment of your work. The grade or assessment is an indicator of your school achievement, but it is not the achievement itself. Indicators are the many ways a teacher has to assess how well you have done. In the same way, FAO identified ways to measure how well we are doing globally to manage our forests. Table 2 describes the indicators of sustainable forest management used by FAO in their study, according to the 6 criteria.

Fig 28. Forests that retain their biological diversity are more sustainable

GLOSSARY:

sustainable: The quality of surviving or being maintained over a specific time period.

criteria: Standards on which a judgment or decision may be based.

biological diversity: A measure of the differences between the types and numbers of living things in a natural area.

socioeconomic: Of, relating to, or involving a combination of social and economic factors.

indicator: Something that measures or shows something.

medicinal: Being or acting like a medicine.

social service: A process or service, usually sponsored by a government, that benefits humans.

fodder: Coarse food for cattle, horses, or sheep, etc., like straw or hay.

CRITERIA	INDICATORS
Extent of forest resources	Area of forest in hectares. Area of other wooded land in hectares. Total volume of wood in all trees of a minimum size. Measured from the ground to a particular diameter of the trunk. Amount of carbon in the living part of the forest in tonnes.
Biological diversity	Area of primary forest in hectares. Area of forest in hectares designated primarily for the conservation of biological diversity. Total forest area in hectares, excluding area of productive forest plantations.
Forest health and vitality	Area of forest in hectares affected by fire. Area of forest in hectares affected by insects, diseases, and other disturbances.
Productive functions of forests	Area of forest in hectares designated primarily for production. Area of productive forest plantations in hectares. How much wood is produced for wood products, measured by the total volume of trees and how much of that volume is designated for wood products. How much wood is harvested every year, measured by volume. How much of non-wood forest products is collected or harvested each year, measured by volume.
Protective functions of forests	Area of forest identified primarily for protection of soil and water in hectares. Area of protective forest plantations in hectares.
Socioeconomic functions of forests	Value of total wood removed, measured in United States dollars ($). Value of total non-wood forest products removed, measured in United States dollars ($). Total employment having to do with forest production, measured in number of people employed. Area of forest under private ownership measured in hectares. Area of forest designated primarily for *social services* measured in hectares.

Table 2. Criteria and indicators of sustainable forest management used by FAO

REFLECTION SECTION

What characteristic do all of the indicators listed in Table 2 have in common? Hint: The common characteristic has something to do with their ability to be compared across regions.

You learned about the extent of the world's forests in Inquiry 2. If forests are to be sustainable into the future, they must not continue to shrink in size. Therefore, the extent of the world's forests, at the subregional, regional, and global levels, is a measure of forest sustainability.

Biological diversity is a measure of the differences between the types and numbers

of living things in a natural area. For example, if an area has more types of plant species than another area, it is more biologically diverse in plant life. Areas that have kept their natural level of biological diversity are usually considered healthier and are better able to withstand threats now and into the future. Therefore, biological diversity is a measure of forest sustainability (Figure 28, page 21).

Forest health and vitality is also a measure of forest sustainability. This was measured by how much forests were negatively affected by fire, diseases, or insects (Figure 29).

If a forest is productive, it provides useful products to people. These products include timber, fuelwoods, foods (fruits, mushrooms, bushmeat), *medicinal* plants, *fodder*, and other products (glossary on page 21). If a forest is to provide these products now and into the future, it must be carefully managed so that it remains healthy. The amount of land that is managed to provide forest products over time provides a measure of its productivity and its sustainability.

If a forest is managed for protective benefits, it must be safe from a range of threats and uses. Protective benefits include environmental benefits, such as clean water, clean air, and healthy soil. The amount of land being managed for these benefits over time is another measure of forest sustainability (Figure 30).

Forests also provide financial and social benefits to people. One measure of sustainable forest management is the amount of employment provided by forests over time. This employment may be in or away from the forest. Social benefits include things like education, recreation, and inspiration. If a forest is managed for these benefits over time, FAO considered it to be a positive indicator of sustainable forest management (Figure 31).

Using these 6 criteria and 21 indicators of sustainable forest management, FAO scientists assessed the world's forests by

Figure 29. Forests negatively affected by fire are less sustainable

Figure 30. Forests managed to provide environmental benefits over time, such as clean water, are more sustainable

Figure 31. Forests that provide recreation for people over time are more sustainable

region and subregion. When they were finished, they had an idea of how well forests are being managed so they will be sustainable now and into the future.

REFLECTION SECTION

Think about a forest that is near you or that you have visited. Based on FAO's criteria and indicators, would you say this forest is sustainable? Why?

Themes and variables

- ● Positive change (greater than 0.5% per year)
- △ No major change (between -0.5% and 0.5% per year)
- ■ Negative change (less than -0.5% per year)
- \- Information not available

NWFP = Non wood forest products

Themes and variables	Africa			Asia			Europe	North and Central America			Oceania	South America
	Eastern and Southern	Northern	Western and Central	East	South and Southeast	Western and Central		Carribbean	Central	North		
Extent of forest resources												
Area of forest	■	■	■	●	■	●	△	●	■	△	△	△
Area of other wooded land	■	△	△	■	●	△	△	△	●	△	-	△
Growing stock of forests	■	■	△	●	■	△	△	●	■	△	-	■
Carbon stock per hectare in forest biomass	△	△	△	△	△	△	△	●	-	-	-	△
Biological diversity												
Area of primary forest	△	■	■	△	■	●	△	△	■	△	△	■
Area of forest designated primarily for conservation of biological diversity	△	■	●	●	●	●	●	●	●	●	-	●
Total forest area excluding area of productive forest plantations	■	■	■	●	■	△	△	●	■	△	△	△
Forest health and vitality												
Area of forest affected by fire	-	-	-	■	■	■	■	■	-	△	-	■
Area of forest affected by insects, diseases and other disturbances	-	-	-	△	■	■	■	-	-	■	-	■
Productive functions of forest resources												
Area of forest designated primarily for production	△	■	■	△	■	△	△	●	■	△	-	△
Area of productive forest plantations	●	△	●	●	●	●	●	●	●	●	●	●
Commercial growing stock	■	△	△	●	■	△	■	●	■	△	-	■
Total wood removals	●	●	●	■	■	■	■	△	●	△	●	■
Total NWFP removals	-	-	-	●	●	●	△	●	-	-	-	■
Protective functions of forest resources												
Area of forest designated primarily for protection	■	△	●	●	△	●	●	●	■	●	-	△
Area of protective forest plantations	△	●	●	●	●	●	●	●	△	●	●	●
Socio-economic functions												
Value of total wood removals	-	●	-	■	■	■	-	●	●	●	-	■
Value of total NWFP removals	-	●	-	-	●	■	●	■	-	●	-	■
Total employment	●	●	●	■	■	△	■	●	●	△	●	-
Area of forest under private ownership	■	△	●	△	●	△	●	■	■	△	-	-
Area of forest designated primarily for social services	△	●	△	●	●	■	■	△	△	△	-	●

Table 3. Trends in progress toward sustainable forest management for regions and subregions of the world

WHAT THEY DISCOVERED: At first, FAO examined the information by regions. Then they looked at areas smaller than regions, called subregions. The researchers found that when they looked at subregions, the picture was sometimes different than when they looked at an entire region. For example, a national effort to plant trees in China showed an overall increase in forests in Asia, but not all subregions of Asia had an increase in forests. FAO wanted to know if subregions showed positive or negative trends in sustainable forest management. The scientists found both positive and negative trends across the world (Table 3, page 24).

FAO also compared trends in forest management in rural areas of the world experiencing the highest poverty levels. They found a higher proportion of negative trends in sustainable forest management for the poorest rural areas of the world.

As you can see, FAO found that the answer to their question is not clear. In some areas, progress is being made. In others, progress is not being made. Table 3 tells whether the trends are positive (●), negative (■), or about the same (▲) in each region or subregion of the world.

REFLECTION SECTION

Do you think it is important to consider subregions of the world when trying to understand progress toward sustainable forest management? Why or why not?

Using Table 3, consider the indicators of forest sustainability for your own subregion or region. For which indicator is your subregion or region doing well? What should it improve?

EDUCATOR RESOURCES

Note to Teachers

EDUCATOR RESOURCES
Note to Teachers

The *Natural Inquirer* is an integrated science education journal for students aged 11-14. In the United States where the journal was first published, the *Natural Inquirer* presents research from scientists working in the United States Department of Agriculture's Forest Service. This edition of the *Natural Inquirer* presents the results of a worldwide effort to understand the world's forests, organized by the United Nations Food and Agriculture Organization, or FAO. The report from which this *Natural Inquirer* is written is the Global Forest Resources Assessment 2005. It contains information from 229 countries and territories around the world.

You can access the FAO report at http://www.fao.org/forestry/fra2005/.

This journal is organized into four Inquiries. Each Inquiry presents a category of findings from the Global Forest Resources Assessment 2005. Each Inquiry builds on the previous inquiry's information, and each should be considered a separate lesson. A lesson plan for each Inquiry follows this "Note to Teachers". The educational concepts, which immediately follow the "Reflection Answer Guide", summarize suggested key learning objectives for the journal.

To be most effective, the Inquiries should be presented in the order outlined in the journal. At the beginning of the journal, three sections set the context for learning. "Welcome to the World's Forest Edition of the *Natural Inquirer*!" provides an introduction to the journal. "Thinking about the Environment" presents benefits of forests and sets the stage for why it is important to understand forests at a global scale. "Thinking about Science" presents the method used by FAO to gather the information presented in the Inquiries. To be most effective, students should read these sections before they begin the Inquiries. A short lesson plan for these sections is presented on page 29.

Each Inquiry is comprised of 2 main sections: "The Situation" and "What They Discovered." "The Situation" introduces the question asked by FAO. This section also presents background information that leads to the research question. Whenever there is a scientific question to be answered, there is a situation that led to the development of the question.

"What They Discovered" presents the answer to the research question. This section includes tables and photographs as well as text. Embedded within this section are "Reflection Sections," which ask questions aimed at encouraging students to think critically about what they are reading. You may use these questions to check student comprehension. In some instances, a "You Do the Math" section provides an opportunity for students to integrate math with their scientific learning.

Before beginning any of the Inquiries, have your students read "Welcome to the World's Forests Edition of the *Natural Inquirer*! " This section introduces the journal and provides opportunity for students to begin thinking about the world's forests within their own subregion, region, and as a part of the global landscape. Students should only have to read this section once. Before they leave this section, have them locate their own region and subregion of the world.

Lesson Plan Welcome to the World's Forests Edition of the *Natural Inquirer*!

Have your students read the first paragraph. (When students read this journal, they may read silently or you may select students to read paragraphs out loud.) Next, have students "do the math" and give the answer. (In 2008, the UN was 63 years old.)

Students should then read the next paragraph. Then hold a discussion about the meaning of the word "improve." What does it mean to them? What might improvement mean to a country in transition and modernization?

Students should read the next paragraph. Ask them to identify the main idea of the paragraph.

The next paragraph begins with "Trees are often planted..." Have students read this paragraph and follow up with a class discussion. Questions to get you started: "How is your life improved by forests?" "What do you think is the topic of this journal?"

Examine Figure 1. Has anyone seen a forest plantation? Have them tell about it.

Have students read the next paragraph in preparation for examining Figure 2. Have them locate their region and if appropriate, their subregion.

Lesson Plan for Thinking About the Environment

Have students read the first paragraph. Questions to generate discussion include: "What is the main idea of the paragraph?" "Who or what benefits from forests?"

Examine Figure 3. What does the photograph show?

Now do the Reflection Section on page 7. Students may read silently and write a list of benefits. Their lists should be shared with the class, where a master list can be created. As your class reads through the journal, add to the list of benefits.

Lesson Plan for Thinking About Science

Read first the paragraph. Ask students to think of a time in the last 3 days when they collected information. This can be numeric or non-numeric. Challenge students to think of numeric data recently collected. For example, they may have checked the temperature, the cost of something, or the distance to a location.

Read the next paragraph. Check for student comprehension by asking questions about using a standardized unit of measurement. (When you come to an italicized word, check to make sure all students understand its meaning).

The following 2 paragraphs will also explain standardized units of measurement. After students read the paragraph, ask someone to explain the main idea of the paragraphs.

The final paragraph in this section introduces country correspondents. After students read this paragraph, have them clarify the role of the country correspondent in relation to FAO scientists.

Lesson Plan for Introduction to the Inquiries

Have students read this entire section silently. After they have finished, check comprehension by asking them if the correspondents used the same unit of measurement as FAO. If students understand the term, they will know that the same unit of measurement was either necessary, or FAO had to be able to transform any data received into a standardized unit of measure.

Lesson Plan for Inquiry 1

Before beginning Inquiry 1, have students read "Thinking About the Environment" and "Thinking About Science". This will give students an introduction to the importance of global forests and to FAO's effort to understand the world's forests.

Need: Journal, paper, pencils, a globe or world map with lines of latitude, internet or library access, and copy of the Table on page 31.

Have students read the title and first paragraph of "The Situation". Check comprehension by asking the difference between weather and climate. Ask students to identify the two ways that FAO could have classified forests, based on the information in this paragraph. Check comprehension of the word classify. It is important for students to fully understand classification before continuing.

Have students read and answer the question in the next paragraph.

After reading the paragraph that follows, have students examine Figures 6 and 7. Explain latitude, especially as it relates to the equator and Earth's climate. Now do the activity below to determine your latitude

DETERMINING LATITUDE.
Using a globe or a world map, have students identify where on Earth they are located. Primarily, have them identify their latitude, or distance from the equator. Some maps may show latitude in degrees, minutes, and seconds. Others may only show degrees and minutes, or just degrees. Have them identify the closest degree of latitude to their geographic location. After they have located their latitude, determine how far between the equator and one of the poles their location is. (Latitude is 0 degrees at the equator, 90 degrees at the poles.)
Students should read the paragraph that begins, "About 71 percent of Earth....". After reading the paragraph, they should examine Figure 8.

After reading the next paragraph, ask students to identify the paragraph's main idea. Then, ask them to describe the natural area close by. How much rainfall does it receive? Ask students to describe the trees and vegetation growing close to home.

Students should read the next paragraph, then examine Figures 9, 10 and 12.

Next, have students do research in the library or on the internet to discover their elevation and amount of annual rainfall. Elevation is the height of the land above sea level. Using Figures 9, 10 and 12, have them identify what kind of forest, if any, should naturally grow nearby.

Using the picture of the distribution of the world's forests on page 13, you can further check the understanding of the students by asking them to explain why they think that there are no forests in North Africa.

Now, using Figure 5, have students identify into which ecozone forests close to home should be placed.

Read the paragraph beginning with "In addition to latitude,..." Hold a class discussion based on the last sentence in the paragraph. Then read the next paragraph.

Using Table 1, hold a class discussion on the closest forest to their home. Into which FAO category would they place this forest? Explore the advantages and disadvantages of each forest type. Students can work in small groups to do this. Do plantation forests look different than more natural forests? How? Do students think different animals might live in different types of forests? Why or why not? What evidence do they have to support their answer?

The next four paragraphs should be read by students, and a short class discussion should be held between each paragraph. This will

bring students to the end of The Situation. Some ideas for discussion include:

Paragraph 1: How many of the 5 categories contain trees planted by humans? Is this a surprise? Why or why not?

Paragraph 2: Do you think fruit orchards should have been included by FAO in their study? Why or why not?

Paragraph 3: Discuss the difference between primary forests and protective plantations.

Paragraph 4: Discuss the idea of understanding trends and examining trend data.

WHAT THEY DISCOVERED

Read the entire section. Use your globe, a world map, or Figure 2 to locate the Amazon area of South America. Read the next paragraph and examine Figures 11 and 13. Ask students to identify which category of forest is comprised of the least amount of land. Have them "do the math (first problem only)." Students can use Figure 11 to do this calculation. Ask a student to explain what this means about the current character of most of the world's forests. Have students "do the math" (second problem) and briefly discuss the meaning of the results.

REFLECTION SECTION:

In small groups, have students discuss the two "questions" and appoint a representative to make a short presentation to the class. You can use this presentation as an informal assessment of student comprehension.

EXTENSION:

Kenya's Green Belt Movement (www.greenbeltmovement.org) has developed a program to reforest Kenya. The program suggests what types of trees should be planted for what purposes and where. Using the Table below (developed by the Green Belt Movement), have students identify into which of FAO's 5 categories of forests each type of planting should be placed. Remember that in every case and in the Table below, humans are planting trees. Therefore, none will be categorized as primary forest or modified natural forest.

PURPOSE	BEST SUITED SPECIES	PRIMARILY PLANTED IN	FAO CATEGORY
Environmental conservation	Native	Public places	
Household needs	Fast growing non-native	Farms	
Fodder	Fast growing non-native	Farms	
Medicine/herbs	Native	Public places	
Food security	Non-natives and fruit trees	Farms	
Shade	Native	Farms	
Increase biological diversity	Native (to support birds, animals, and plants)	Public places	
Protecting cultural sites	Native	Public places	

Lesson Plan for Inquiry 2

Before beginning Inquiry 2, have students read "Thinking About the Environment" and "Thinking About Science" if they have not yet done so. These sections will give students an introduction to the importance of global forests and to FAO's effort to understand the world's forests.

Need: Journal, pencils, paper, copy of the Table below.

Read paragraph 1. Ask students: What is the main idea from this paragraph? (The main idea is that we have not yet learned whether forests are growing or shrinking in size worldwide.)

Read paragraph 2. Hold a class discussion about the idea of renewable resources. Here are some questions to get the discussion started. "What are renewable resources, and what makes forests renewable?" "What are some other renewable resources?" "What are some non-renewable resources?" "What is the advantage of using renewable resources?"

Examine Figure 14. Ask if any students have planted trees. If so, ask them to share their experiences.

Have a student read the next paragraph, beginning with "FAO wanted to know..." Then hold a class discussion using the Reflection Section. This may also be done in small groups.

Ask students to read the first 2 paragraphs in "What They Discovered" and examine Figure 15. Using the Table below, have students calculate the amount of forest per person for each region. Have students compare their region with other regions. Order the regions from the most forest per person to least forest per person.

Now hold a class discussion based on these questions:

1. Where is my region on the list? Is it near the top or bottom, or near the middle?
2. How does my region compare with other regions in the world?
3. What are some of the reasons my region is ranked where it is on the list?
4. How might the country I live in compare with my region as a whole? (If you have access to the internet, visit and download the FRA 2005 Global Tables in excel from the main

REGION	POPULATION (2004)	FOREST AREA (HECTARES)	AMOUNT OF FOREST PER PERSON
Africa	868 182 000	635 412 000	
Asia	3 837 943 000	571 577 000	
Europe	723 495 000	1 001 394 000	
North and Central America	508 064 000	705 849 000	
Oceania	32 764 000	206 254 000	
South America	364 668 000	831 540 000	

page. Table 1 contains population Figures and Table 3 the area of forest. Using these resources, your students can calculate an estimated amount of forest per person for any country included in the report.)

Have students read the remaining paragraphs and examine Figure 17. After examining Figure 17, have your students look at Figures 18, 19, 20 and 21. You may have to explain these maps to your students. For more information about these maps, visit **http://www.worldmapper.org/about.html.** Have them "do the math" to determine how many fewer hectares are being lost now than in the past. Hold a class discussion about these numbers. What do they tell us? Is this good news? Why or why not? (Students may break into small groups for these discussions.)

Have students read the last paragraph and examine figures 17, 20 and 21 and answer the questions. (Refer to page 37 for answers). Hold a class discussion based on the reflection questions. Here are some additional questions to get the discussion started:

1. What is happening in our region or subregion that is leading to the loss or gain of forests?
2. Do you think this trend might change in the future? Why or why not?
3. What might happen to cause a change in the trend?

Hold small group discussions about whether your current regional or subregional trend is desirable or should be changed. Remember that not all deforestaion is bad. Some forests may have to be converted to agriculture to provide enough food or to provide land for roads, houses and ports. In these groups, have students identify 3 advantages and disadvantages to the current trend. Have each group develop 2 action items that will either support or try to change the trend. Each group will identify a spokesperson to present their action items and rationale to the class.

As a class, identify any action items that can be taken by the students.

EXTENSION: The Green Belt Movement Using the internet, visit: **http://www.greenbeltmovement.org.** Have students research this site and others to discover how one African woman has made a difference by planting trees. If possible, explore options for planting trees near your school or in your community.

Lesson Plan for Inquiry 3

Before beginning Inquiry 3, have students read "Thinking About the Environment" and "Thinking About Science" if they have not yet done so. This will give students an introduction to the importance of global forests and to FAO's effort to understand the world's forests.

Need: Journal, pencils, and paper.

Have students read the first paragraph and ask them to study the carbon cycle (Figure 22). Discuss the carbon cycle in your classroom. Before moving forward, make certain your students understand that all living things contain carbon, and that carbon moves from the atmosphere, through living matter, into the soil and water, and is released again into the atmosphere.

Ask students to read the next paragraph. Ask them to identify the main idea of the paragraph.

Now have them read the next paragraph (beginning with "From Figure 22") and examine Figures 23 and 24. Ask students if they can guess why FAO wanted to estimate the amount of carbon held by the world's forests. To do this, your students must connect information from the previous paragraphs. The logical conclusion should be that forests absorb and hold carbon, and therefore may help address climate change.

Have students read the next paragraph. That paragraph should confirm the conclusion made in the previous exercise.

Have students read the next paragraph beginning with "Scientists believe...". Check their understanding by emphasizing that after all water is removed from a tree's living parts, about half of the remaining weight is carbon. Ask students if they think humans have carbon in them as well. (This question will allow you to check their comprehension.) About 18 percent of a human body is carbon. Remind your students that carbon is the most abundant element on Earth, because all living things contain carbon.

Using the Reflection Section on page 18, hold a class discussion about the evidence for climate change. Students may have differing opinions on this, and they should examine their own reasons for believing as they do. What evidence are they using? Is that evidence credible? How do they know?

Have students read all paragraphs in "What They Discovered" and look at Figure 25. Ask them if they can guess what "biomass" is. For the purposes of this graph, biomass is the living material of trees. (Biomass usually refers to living and once-living material.) Ask students if they can guess why South America has more carbon in biomass than other regions of the world. (South America contains a large area of rain forest, which contains a massive amount of leafy green biomass).

Now have students "do the math." Considering how many elephants it would take to equal the amount of carbon in the world's forests, ask them if they think there is more carbon in plant or in animals on Earth. Earth's human population is almost 7 billion, but your students must consider that other animals live on Earth as well. (After comparing the numbers and considering the size of other animals, students should conclude that worldwide, plants must contain more carbon than animals.)

Now ask students to consider the reflection questions. This may be done in small groups. For the first question, students should conclude that the two pieces of information are compatible. That is, as more forest land is lost than is gained, it makes sense that the amount of carbon in the world's forest should be declining. Ask students to discuss the second question in small groups and report their conclusion to the class.

Based on this Inquiry, students should identify the holding of carbon as another benefit of forests. This benefit should be added to the classroom list of forest benefits.

Lesson Plan for Inquiry 4

Before beginning Inquiry 4, have students read "Thinking About the Environment" and "Thinking About Science" if they have not yet done so. This will give students an introduction to the importance of global forests and to FAO's effort to understand the world's forests.

Need: Journal, pencils, paper.

Have students read the first sentence under "The Situation". Have them read the definition of sustainable. Hold a class discussion about what sustainability means. Some ideas you can use include:

1. Have students brainstorm words, phrases, or concepts that mean sustainability to them. This could be things like regular meals, going to school, being a member of a family, etc.
2. Now challenge students to think about environmental sustainability. What does environmental sustainability mean to them?
3. Have students review the definition of criteria. Make certain students understand what criteria means before continuing.
4. Examine Figure 27. Have students guess what each of these terms might mean.

Now have students read the paragraph following Figure 27. Discuss the term "indicator" with them. In small groups, have students identify 3 criteria and two indicators for each criteria. The criteria can be something from their own life. Examples of criteria might include maturity, human intelligence, good farming weather, etc. For each of the criteria identified, ask students to identify 2 indicators that can be measured. Measurable indicators are ones to which you can apply a specific number and a unit of measurement.

Before continuing, make certain students understand what criteria and indicators are.

Have students examine Table 2 (page 22) and answer the reflection question. Then, ask students if any of the indicators are not measurable. Ask students to think about whether FAO researchers could determine how sustainable the world's forest management is today if the indicators were not measurable. Hold a discussion about measurement in science. Although most science is based on measurement, not all scientific studies use measured evidence. At the scale of the planet, or even regionally and subregionally, however, it would be difficult to determine sustainability without consistent measurement.

Have students break into 6 small groups. Assign one of the next 6 paragraphs to each group. Each of these paragraphs describes in more detail one of the FAO's criteria for sustainability. Each group will read and discuss their paragraph, then explain the criteria to the class. The first paragraph begins with "You learned about the extent..." The last of the six paragraphs begins with "Forests also provide financial..." As an extension, students may use the internet or library to do additional research about their criteria. For the criterion on forest health, note that not all forest fires are negative. Some forest types, for example, depend on occasional fire to remain healthy. Emphasize that this criterion is focused on threats to forest health, not on all forest fires.

Read the next paragraph ("Using these 6 criteria..."). Ask students if they agree with the FAO's criteria for sustainable forest management. Ask students to contribute any additional criteria for sustainable forest management.

Have students complete the reflection question on page 24. You may do this as a class, or use the six small groups from the

previous exercise. If there are no forests nearby, select a forest type with familiar characteristics.

Have students read the first paragraph after What They Discovered. Students should refer to Table 3 on page 24. Ask students if, based on what they have read so far, they are surprised that scientists found both positive and negative trends across the world. Why or why not?

Read the next paragraph. Hold a class discussion about rural poverty and forest sustainability.
Discuss the implications of this finding.

Have students read the remainder of the article, including an examination of Table 3. Using Table 3, have students identify their own region or subregion (if applicable). Have them look down the column at the indicators for their region or subregion. In small groups, have students develop a method to compare columns. Have each group share their assessment with the class.

Hold a discussion about forest sustainability in their region or subregion. Include the reflection questions in the discussion. Does their analysis suggest that something needs to be done? If so, discuss options for action. Are there any actions that individual students or the class can take?

EXTENSION: If the class has identified any actions that can be taken, give students time to plan and implement their action. For example, they might write letters to the government in support of reforestation. They might decide to plant trees in their community. They might start a Green Belt Movement in their community. Any action taken should be carefully considered for its practicality, keeping available resources in mind.

Reflection Answer Guide

Note: The reflection questions are meant to encourage students to think critically about what they have read. There are no right or wrong answers.

THINKING ABOUT THE ENVIRONMENT

What are some of the benefits forests provide to your community?

Students should answer this based on their own experience. Students may do this in groups or individually, or you may hold a class discussion. Students should think not only of nearby forests, but should also consider the benefits gained from forests more distantly located from the community.

INQUIRY 1

Describe the majority of forests worldwide. You can either use one or two categories to do this.

Just over half of forests worldwide are modified natural forests. These forests have native trees that have grown naturally. There is evidence of human activity in these forests, even though they have native trees that have grown naturally. A little over one-third of forests worldwide are primary forests. These forests also have native trees that have grown naturally and there is no visible sign of human activity in these forests. Therefore, over 80 percent of forests worldwide are made up of native trees that have grown naturally, and most of these forests show signs of human activity.

What are two major trends in the categories of forests?

The amount of forest with naturally-growing native trees is decreasing. The amount of forest worldwide that has been planted by humans is increasing.

INQUIRY 2

Do you think FAO found that Earth is gaining, losing, or keeping about the same amount of forests over time?

This question can be discussed as a class or in small groups. Whatever answer students give, they should be able to back up their answer with logically-constructed arguments for why they answered as they did.

If more forests are lost than are being planted, what will happen to the benefits provided by forests?

The amount of benefit provided by forests will be reduced.

Why is it important to understand whether the amount of forest land world wide is shrinking, growing, or staying about the same?

Because forests provide benefits to people and other living beings. If we know that forests are shrinking in size worldwide, we can take action to stop that trend.

Look at Figure 17. Find the region and subregion where your home is located. How does your region or subregion compare with the rest of the world? Why do you think that is?

This must be answered individually by each classroom, group of students, or individual student. When giving reasons, the student should be able to support his or her claim with logical thinking.

Now compare cartograms 20 and 21 with the blue and green bars in Figure 17. What do Figures 17, 20 and 21 tell you about the forests in Asia?

Figure 17 shows that Asia lost forests from 1990-2000 (blue bars) but gained forests from 2000-2005 (green bars). This Figure doesn't say in which countries these changes have occurred. Cartograms 20 and 21 show that the greatest increase in forests has occurred in China, while many other countries in Asia are still losing forests.

INQUIRY 3

Reflection Section: Do you think Earth's climate could be changing due to human activity? Why or why not?

Students should be aware that the burning of fossil fuels by humans is causing the amount of carbon dioxide in the atmosphere to rise.

This rise in carbon dioxide is believed to be one of the major causes of global climate change. While most scientists believe this to be the case, some people believe the recent changes in weather patterns are not caused by an increase in carbon dioxide. Therefore, students should state what they think and be able to support their claim with a logically-constructed argument.

In Inquiry 2, you learned that more forests are being lost than are gained each year. Now re-read the last sentence on page 19. Does that sentence make sense in light of what you know about the loss of forests? Why or why not?
It should make sense to students that if the amount of forests worldwide is decreasing, the amount of carbon held in the world's forests would be declining as well.

FAO scientists found that the amount of forests worldwide is declining. They also found the amount of carbon held by forests is declining. If, as most scientists believe, climate change is caused largely by an increasing amount of carbon dioxide in the atmosphere, what conclusion might you reach about the need for a greater or lesser amount of forest land?
Students should recognize that trees and forests play a role in holding carbon on Earth and keeping some of it out of the atmosphere. They should conclude, therefore, that if would be wise to protect our current forests and if possible, increase the amount of forests.

INQUIRY 4
What characteristic do all of the indicators listed in Table 2 have in common? Hint: The common characteristic has something to do with their ability to be compared across regions.
They can all be measured.

Think about a forest that is near you or that you have visited. Based on FAO's criteria and indicators, would you say that forest is sustainable?
This is an individual question and must be answered individually. Students should be able to support their answer with logical reasons.

Do you think it is important to consider subregions of the world when trying to understand progress toward sustainable forest management? Why or why not?
This question can be answered individually, within a small group, or in a class discussion. Students should be able to support their answer with logic. Since subregions are smaller and more homogeneus than regions in general, students should realize the importance of examining sustainable management at a subregional level.

Using Table 3, consider the indicators of forest sustainability for your own subregion or region. For which is your subregion or region doing well? What should it improve?
This answer will depend on the geographic location of the student.

Educational Concepts Addressed by the Inquiries

Note: These educational concepts have been adapted from the North American Association for Environmental Education's *Excellence in Environmental Education: Guidelines for Learning,* and focus on learning by students aged 11-14.

Inquiry Skills:

Questioning Skills
Learners are able to identify, develop, or explain inquiry questions based on personal experience, discussion, or reading.
Learners are able to summarize environmental problems or situations based on personal experience, discussion, or reading.

Data Collection Skills
Learners are able to understand and/or use measurement tools or metrics.
Learners are able to choose and synthesize materials from second-hand sources, such as books, journals, newspapers, and the internet.

Data Organization Skills
Learners are able to read and explain data summarized in tables, charts, graphs, or maps.
Learners are able to draw conclusions and develop explanations based on data or information.
Learners are able to distinguish between description and explanation.
Learners are able to propose explanations and evaluate the strengths and weaknesses of these explanations.
Learners are able to compare and contrast data representing different geographic locations.

Knowledge of Earth Systems and Processes:

Earth As a Physical System
Learners understand and are able to describe the following physical Earth processes:
- global carbon cycling
- carbon cycling in trees
- climate change (its cause and potential effects)
- latitude and its relation to tree species
- elevation and its relation to tree species.

Environment and Society:

Human/Environment Interactions
Learners understand and can explain how human-caused changes to forests have consequences: immediately and in the future, and locally, regionally, and globally.

Natural Resources (forests)
Learners understand that natural resources (forests) are unevenly distributed across the planet.
Learners understand and can describe the multiple benefits offered by forests.
Learners understand that forests can change because of natural and man-made activity.
Learners understand that a variety of forests exist on Earth, and this variety may be created naturally or may be man-made.

Technology
Learners understand the increasing human ability to shape and control the environment as a function of the development and use of technology.

Environmental Issues
Learners understand that environmental issues occur at all scales, and that people in other places in the world experience environmental issues similar to the ones they are concerned about locally.

Skills for Understanding and Addressing Environmental Issues:

Understanding and Addressing Environmental Issues
Learners are able to apply their knowledge of ecological and human processes and systems to identify the consequences of specific environmental issues.
Learners understand the nature of trade-offs, and are able to analyze the risks and benefits of human environmental actions.
Learners are able to predict the consequences of inaction or failure to resolve an environmental issue.
Learners are able to identify and evaluate solutions and courses of action to address environmental issues.

Decision-making and **Citizenship Skills**
Learners are able to identify, justify, and clarify their views on environmental issues.
Learners are able to evaluate the need for citizen action and decide whether they should or could be involved.
Learners are able to set realistic goals for action.

WHAT DOES FAO DO?

FAO's Member Nations have given the Organization the task of helping them create a world where no one goes hungry.
So what exactly is FAO doing to help build a world without hunger? Its work can be divided into four main activities:

Information

First and foremost, the world needs reliable information about how many people are hungry, who they are and where they live. To help bring an end to hunger, countries need to have up-to-date and trustworthy information about all sorts of things: food production, prices and trade, land use, nutrition levels, food aid and population. FAO is the world's leading source for this sort of information and has been so for more than 50 years.
Find out more about how FAO provides the world with information (http://www.fao.org/kids/en/information.html).

Advice

Having mountains of information is essential. But you also need to know how to make sense of all this data to put it to practical use. When governments request assistance, FAO's experts offer advice on how to establish policies on agriculture, forestry, fisheries and rural development that can truly benefit the hungry.

A meeting place

Individual countries working on their own can't bring an end to world hunger. It's a global problem that requires international cooperation on many issues, including agriculture, fisheries, forestry, trade and the environment. FAO provides the common ground where rich and poor countries can come together to reach international agreements that can help the world's hungry.

Field work

FAO also helps countries bring technical knowledge and expertise directly to farmers to the field. The Organization coordinates thousands of field projects throughout the world. It mobilizes and manages millions of dollars provided by industrialized countries, development banks and other sources to make sure these projects are effective.

A great many of these projects are carried out in response to humanitarian emergencies arising from natural disasters or armed conflict. Find out more about FAO's work in emergencies (http://www.fao.org/kids/en/emergencies.html).

A broad range of expertise

To get an idea of some of the specific topics that FAO deals with, visit the links below. We guarantee you'll come across some surprises.

Forestry	http://www.fao.org/kids/en/forestry.html
Fisheries	http://www.fao.org/kids/en/fisheries.html
Food forever	http://www.fao.org/kids/en/forever.htm
Emergencies	http://www.fao.org/kids/en/emergencies.html
Clean energy	http://www.fao.org/kids/en/energy.html
Social justice	http://www.fao.org/kids/en/socialjustice.html
AIDS	http://www.fao.org/kids/en/aids.html
Global warming	http://www.fao.org/kids/en/gw.html
Poverty	http://www.fao.org/kids/en/poverty.html
Globalization	http://www.fao.org/kids/en/globalization.html
Food safety	http://www.fao.org/kids/en/safety.html
	http://www.fao.org/kids/en/

Notes:

EDITORIAL REVIEW BOARD

The *Natural Inquirer* Editorial Review Board is made up of students between the ages of 12 and 13. The Editorial Review Board reads an early copy of the *Natural Inquirer* and makes suggestions for improvement. This is Mrs Ashley Potter's 7th grade Science class, Morgan County Middle School, Madison, Georgia, USA.