NATURAL INQUIRER

THE WORLD'S FORESTS EDITION – NUMBER 15

FOREST SERVICE
US
DEPARTMENT OF AGRICULTURE

FAO
FIAT PANIS

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

Summer 2011

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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* was created is the Global Forest Resources Assessment 2010. It contains information from 233 countries and territories around the world. This is the second edition of the World's Forests *Natural Inquirer*. The first was published in 2008 and was based on the Global Forest Resources Assessment 2005.

Visit:

http://www.naturalinquirer.org
http://www.fao.org/forestry/fra/en
http://www.fao.org/kids/en/forestry.html
http://foris.fao.org/static/data/fra2010/mosaic.pdf

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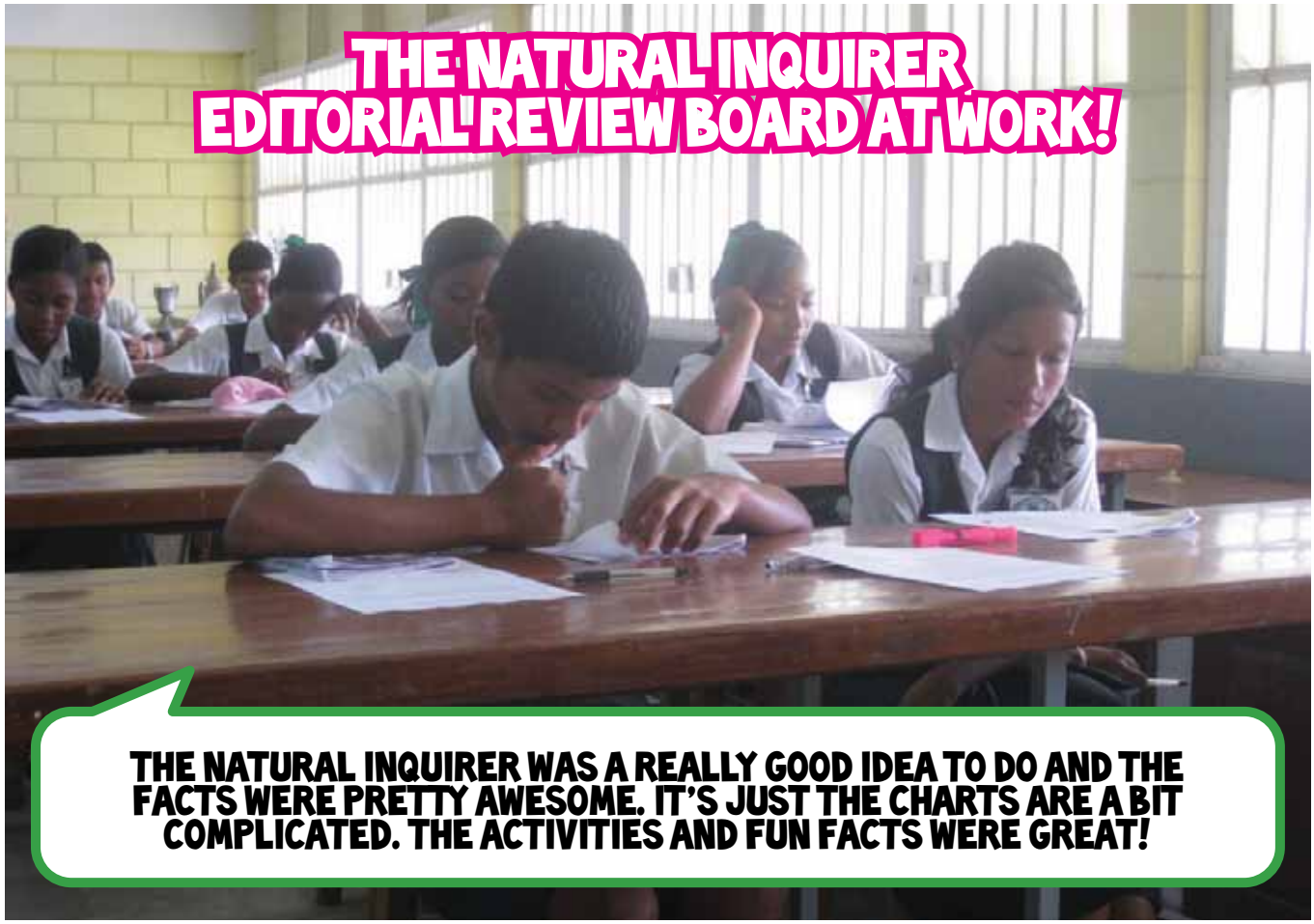
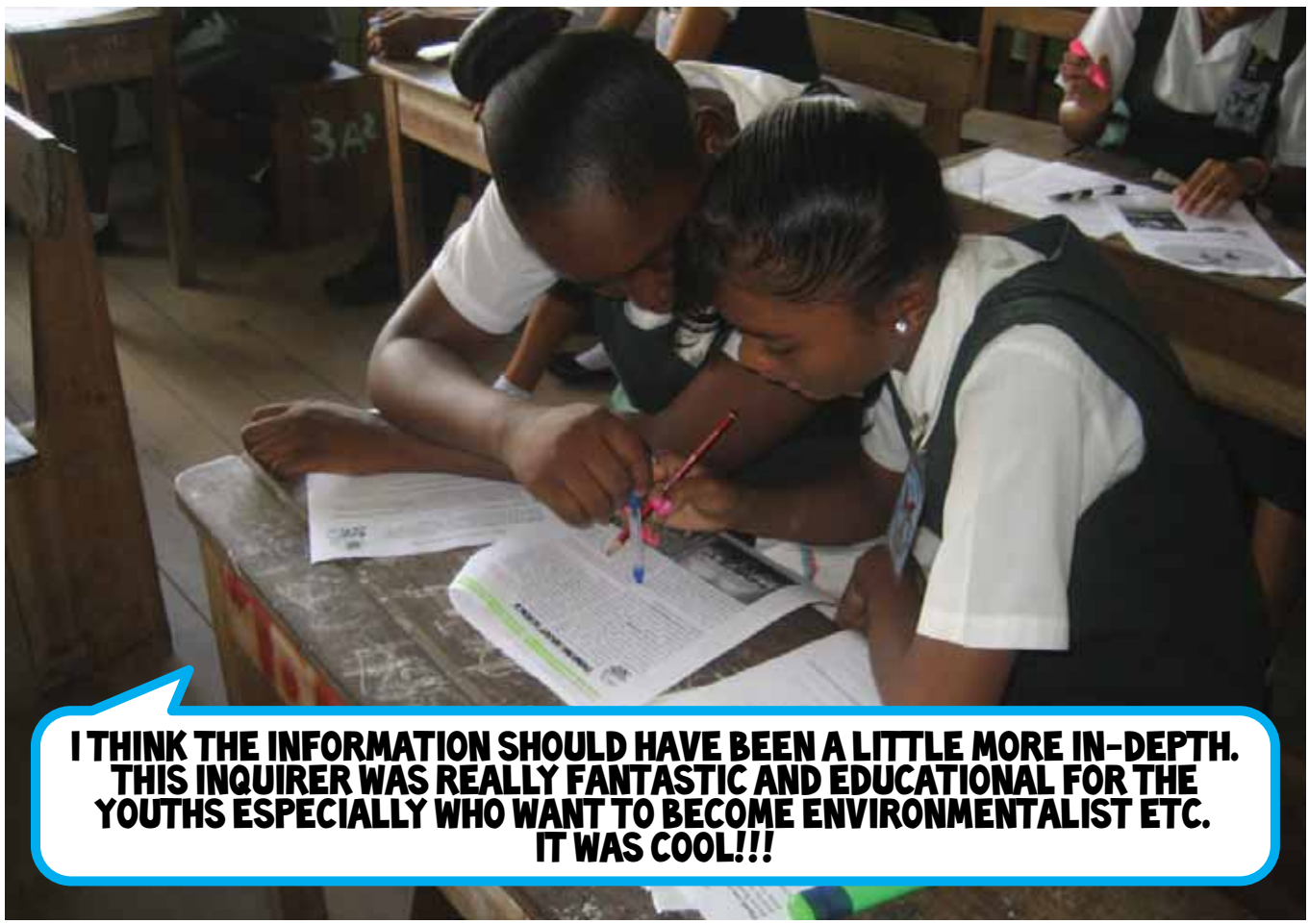
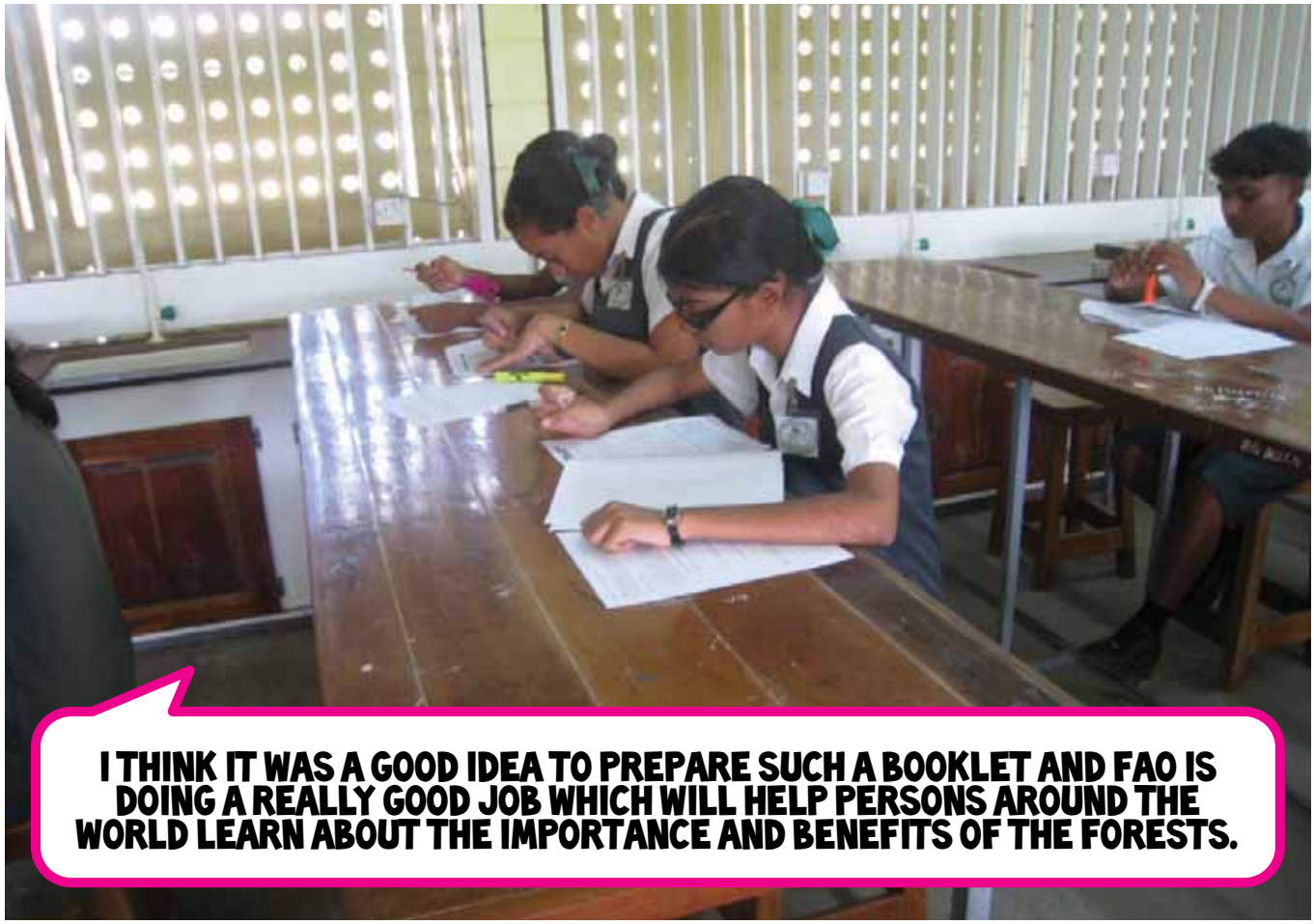
THE NATURAL INQUIRER EDITORIAL REVIEW BOARD AT WORK!

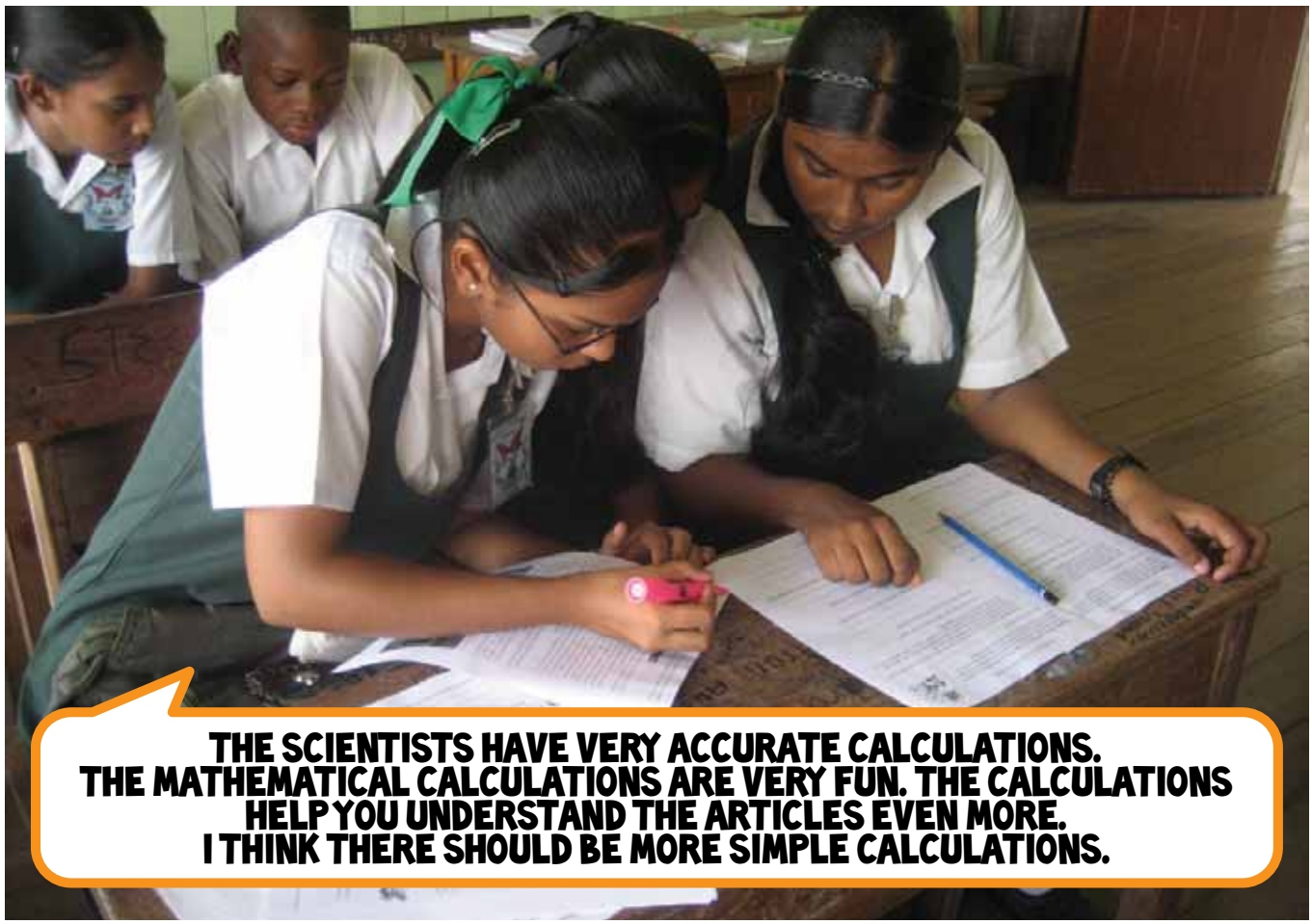


THE NATURAL INQUIRER WAS A REALLY GOOD IDEA TO DO AND THE FACTS WERE PRETTY AWESOME. IT'S JUST THE CHARTS ARE A BIT COMPLICATED. THE ACTIVITIES AND FUN FACTS WERE GREAT!

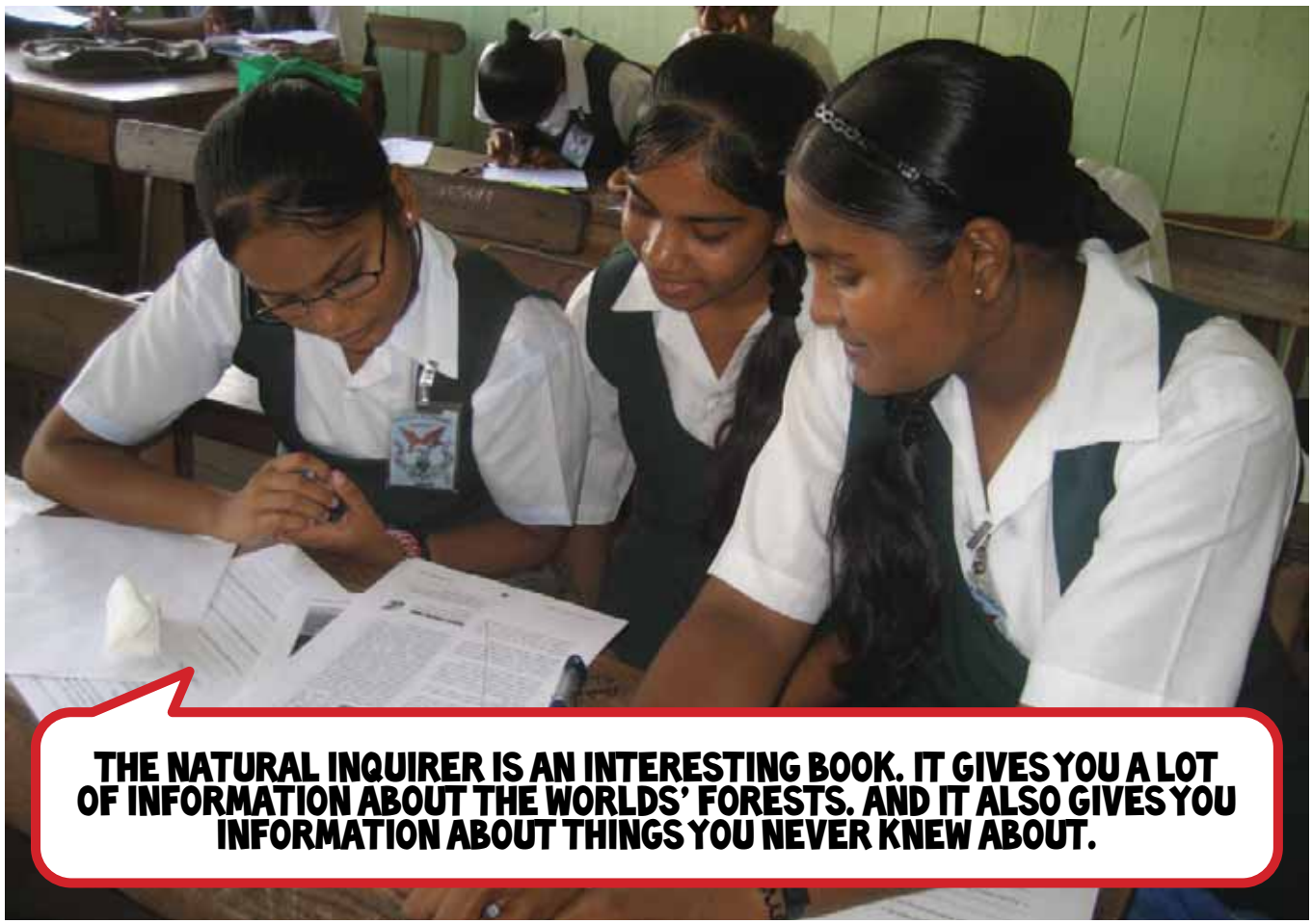


I THINK THE INFORMATION SHOULD HAVE BEEN A LITTLE MORE IN-DEPTH. THIS INQUIRER WAS REALLY FANTASTIC AND EDUCATIONAL FOR THE YOUTHS ESPECIALLY WHO WANT TO BECOME ENVIRONMENTALIST ETC. IT WAS COOL!!!


I THINK IT WAS A GOOD IDEA TO PREPARE SUCH A BOOKLET AND FAO IS DOING A REALLY GOOD JOB WHICH WILL HELP PERSONS AROUND THE WORLD LEARN ABOUT THE IMPORTANCE AND BENEFITS OF THE FORESTS.


THE SCIENTISTS HAVE VERY ACCURATE CALCULATIONS. THE MATHEMATICAL CALCULATIONS ARE VERY FUN. THE CALCULATIONS HELP YOU UNDERSTAND THE ARTICLES EVEN MORE. I THINK THERE SHOULD BE MORE SIMPLE CALCULATIONS.


I THINK THAT THE ARTICLE IN THE MAGAZINE WAS GOOD, EASY TO UNDERSTAND AND I LOVED THE PART ABOUT THE CLIMATE CHANGE AND GREENHOUSES GASES. I KNOW ANYONE WHO READ THIS MAGAZINE WOULD BENEFIT A LOT.


THE NATURAL INQUIRER IS AN INTERESTING BOOK. IT GIVES YOU A LOT OF INFORMATION ABOUT THE WORLDS' FORESTS. AND IT ALSO GIVES YOU INFORMATION ABOUT THINGS YOU NEVER KNEW ABOUT.

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

Have you heard of the United Nations (UN)? The UN is a world organization established in 1945. Today, 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 UN. FAO's mission is to build a world where no one goes hungry. To do this, it helps developing countries and countries in **transition modernize** and improve agriculture, forestry, and fisheries practices. FAO also helps these countries provide healthy nutrition for all their citizens.

GLOSSARY:

Words in **bold** are included in the glossary on page 45. If you do not understand the word, be sure to use the glossary!

For many years, FAO has been collecting information about the world's forests. You may think it is unusual for an organization concerned with food and agriculture to be studying forests. Trees, however, are important for human nutrition and health.

Forests are a source of food, including fruits, nuts, mushrooms, herbs, spices, and animals. Forests provide wood that can be used to build houses, heat homes, and cooks meals. Forests provide fibres for building houses, making clothing, and for other building purposes. Trees provide resins that are used in many products. Trees also provide medicines. They help protect soil and water necessary for food crops. Trees also help protect the environment and they reduce the impact of climate change.

INTERNATIONAL YEAR OF FORESTS:

The United Nations General Assembly declared 2011 as the International Year of Forests to raise awareness on **sustainable** management, **conservation**, and sustainable development of all types of forests. The UN's International Year of Forests Web site is a global platform to celebrate people's action to sustainably manage the world's forests.

http://www.un.org/en/events/iyof2011/

The International Year of Forests 2011 logo conveys the theme of "Forests for People." The logo celebrates the central role of people in the sustainable management, conservation, and sustainable development of our world's forests. The elements in the design show some of the many values of forests. Forests provide shelter for people and **habitat** to support **biodiversity**. Forests are a source of food, medicine, and clean water. Forests play a vital role in maintaining a stable global climate and environment. The logo reminds us that forests are vital to the survival and wellbeing of people everywhere.

People use forests and plant trees for the many benefits trees provide.

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 to manage forests wisely. More information also helps your country take better advantage of forest benefits. These benefits improve the lives of all people. You will learn about the benefits provided by forests in Inquiry 3.

Figure 1. Eucalyptus trees planted in rows. Eucalyptus trees are often planted to be used in cleaning products, medicines, timber, foods, for fuelwood, and for many other purposes. Photo by Babs McDonald.

Every 5 years, FAO publishes a report about the world's forests. This journal was written from the Global Forest Resources Assessment 2010. It contains information about forests in 233 countries and territories. All together, these forests are the world's forests. No matter where these forests are located, they provide benefits for people and wildlife across the entire planet.

In this edition of the *Natural Inquirer*, you will learn about the world's forests. FAO divided the world into regions (Figure 2). Most of the information in this journal is presented according to these regions. Africa, for example, is considered one region. Take a moment to find the region where you live.

IS THIS THE FIRST WORLD'S FORESTS *NATURAL INQUIRER?*

This is the second World's Forests *Natural Inquirer*! More than 55 000 copies of the last edition were printed and distributed. FAO translated it into French, Chinese and Arabic, while other translated versions were made available thanks to national initiatives.
The Czech version was made available thanks to the Forest Management Institute (ÚHÚL) of the Czech Republic (***http://www.lesnipedagogika.cz***), the Spanish version was realized by the National Forestry Commission of Mexico (CONAFOR) (***http://ww.conafor.gob.mx:8080/biblioteca/ver.aspx?articulo=339***). Recently the publication has been translated into Mongolian by a FAO project working for the management and conservation of forests in Mongolia.

The Ocean in Arid Land Organization, an NGO based in Kenya, has a 5 year project aimed at planting 2.5 million trees through distribution of seeds and seedlings. As part of the project it distributes copies of the *Natural Inquirer* to increase awareness on the importance of the forest ecosystems.

All the translated versions of the first World's forests edition of the *Natural Inquirer* are available for download at:
http://www.naturalinquirer.org
http://www.fao.org/forestry/fra/en

If you are interested in having this new edition of *Natural Inquirer* translated in a different language please contact:
fra@fao.org

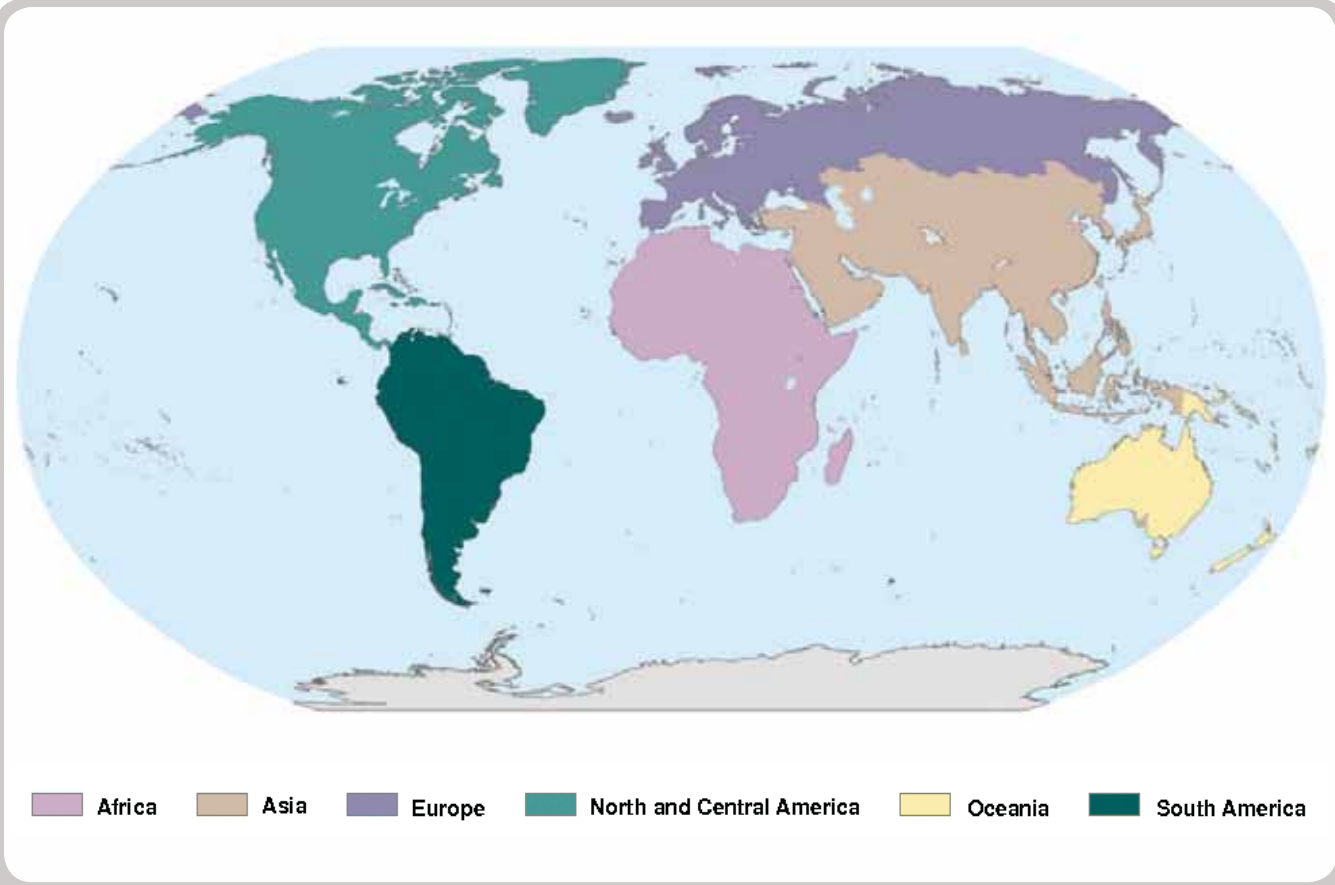


Figure 2. Regions of the world.

THINKING ABOUT THE WORLD'S FORESTS

Forests are important to the lives of people everywhere, 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. Forests also hold carbon on Earth, which helps to slow the rate of climate change.


Figure 3. Impala in Namibia, Africa often ***browse*** on ***vegetation***. Photo by Michael Bowker.

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. 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.

Let's say, for example, that a scientist wants to calculate an average temperature for one month across the entire Northern Hemisphere. Some temperatures are 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 by collecting data from individual countries. To collect accurate data, they worked with an individual in each country, called a National **Correspondent** (Figure 4). The National 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.

Figure 4. The National Correspondents met to share information and discuss their work together.

Mr Souleymane GUEYE is the National Correspondent from Senegal in West Africa. We asked Mr GUEYE what he likes best about this important job and he said:

"It is a very exciting and useful challenge at many levels. We are working in a national committee with experts from several national bodies. Together we can better analyze relations between forestry and other parts of the economy. We can coordinate the reporting between the Forest Resources Assessment National Committee and those in the country who are collecting data. At the regional level, the Forest Resources Assessment organized by FAO allowed us to profit from the framework of a successful regional network. We attended international meetings. This gave us the opportunity to discuss and exchange with scientists from all over the world for mutual benefit. This shows us that the world is a village and we have all to act in the same direction for the safety and sustainability of mankind."

REFLECTION SECTION:

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

Do you think it is helpful to get information about forests in different regions of the world? Why or why not?

INTRODUCTION TO THE INQUIRIES

Each Inquiry represents a study done by FAO scientists and National Correspondents to answer a specific question about the world's forests. By the time you complete all 5 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 5 Inquiries presented in this journal, FAO and the correspondents followed the same process to collect data. When the data were added together, they provided information about forests regionally and globally.

Next we will take a look at the information collected by National Correspondents and provided to FAO in these 5 Inquiries. If you want to learn more about the entire report about the world's forests, visit:
http://www.fao.org/forestry/fra2010/

DID YOU KNOW?

The raffia palm from tropical Africa has leaves up to 24 meters (80 feet) long.
http://waynesword.palomar.edu

INQUIRY 1: WHAT KINDS OF FORESTS GROW ON EARTH AND WHERE ARE THEY FOUND?

THE SITUATION: A forest is a natural **ecosystem** composed most notably of trees. Different types of forests are found across the planet. In one area, a forest may be dry with little vegetation. In another, a forest may contain large trees that grow quickly because of high rainfall. Different types of forests exist because they grow under different **climates** (Figure 5).

Another reason is that human activities have changed some of the forests. These activities include things like felling or planting 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 it 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 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 above sea level is called its elevation. At higher elevations, the climate is cooler (Figure 8).

Across Earth, different areas receive different amounts of rainfall. Plants need water to survive

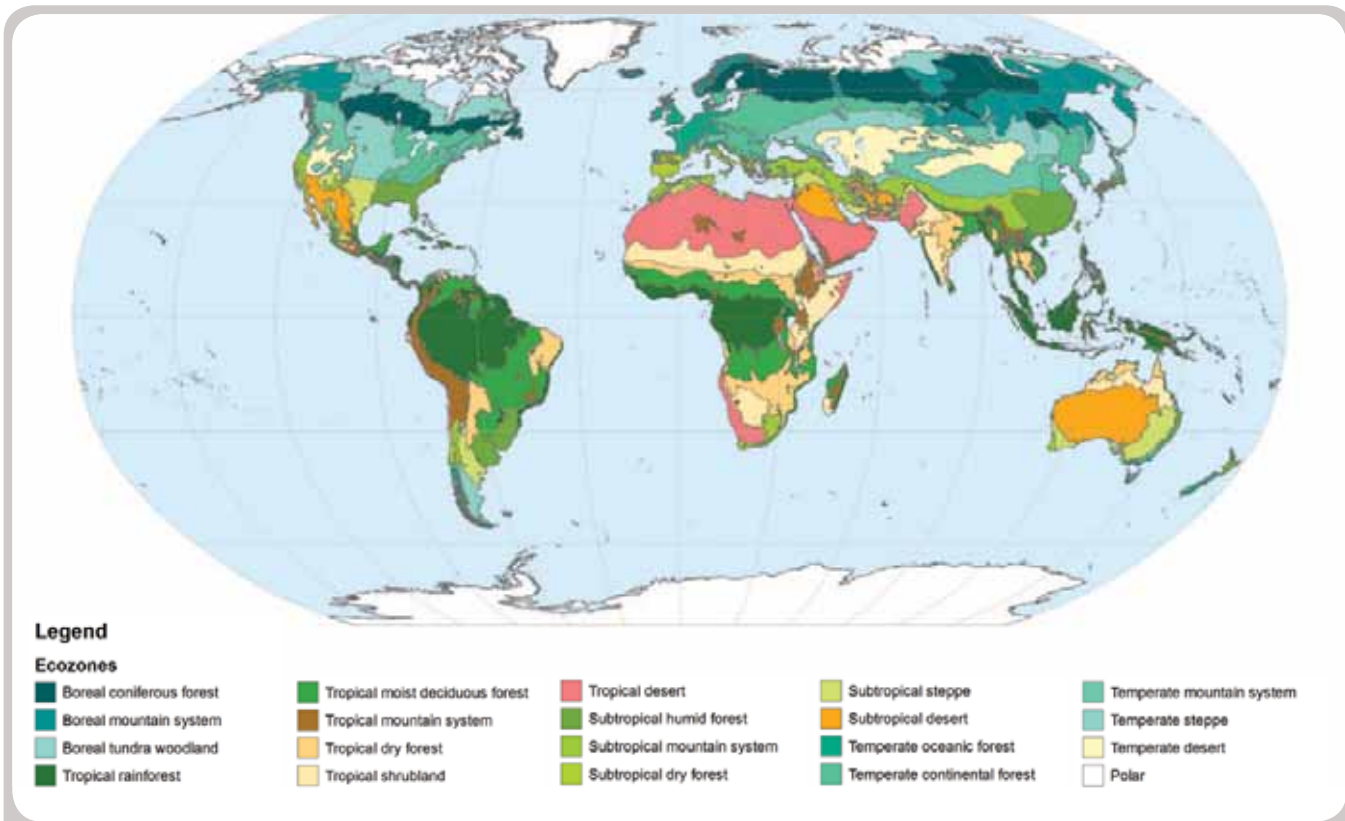


Figure 5. The world's ecozones. An ecozone is a region with similar type of land cover. Notice that similar ecozones occur on different continents where the climate is similar.

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 water they receive. Drier areas have fewer plants and trees. Some areas have no plants or trees at all.

The three things that we have just explored are latitude, elevation, and rainfall (Figures 7-10). These three things affect what kind of forest grows naturally in a particular area on Earth (Figures 9-11).

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?

If you guessed humans, you are right! FAO wanted to understand how forests are changing as a result of human activity. To understand how humans impact the world's forests, the scientists classified forests into three categories (Table 1).

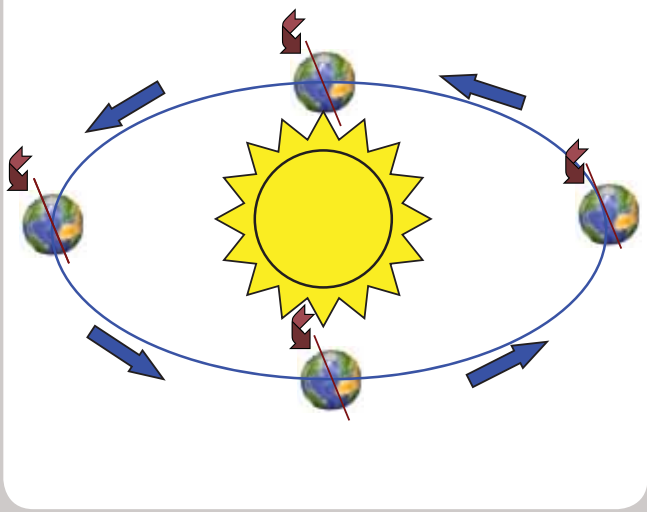


Figure 6. Earth spins on its axis and revolves around the sun.

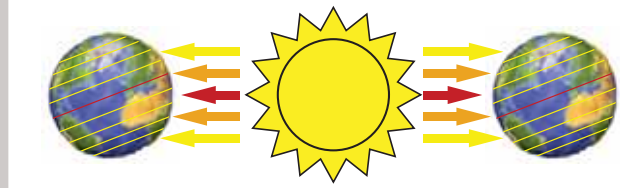


Figure 7. Earth is warmer near the equator, cooler near the poles.

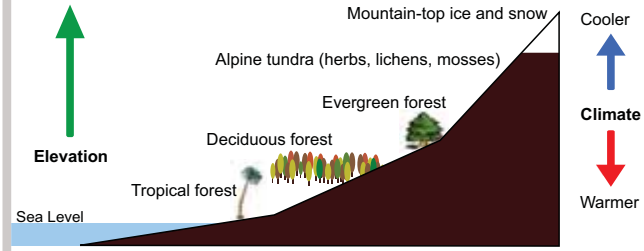


Figure 8. The higher the land's elevation, the cooler its climate.

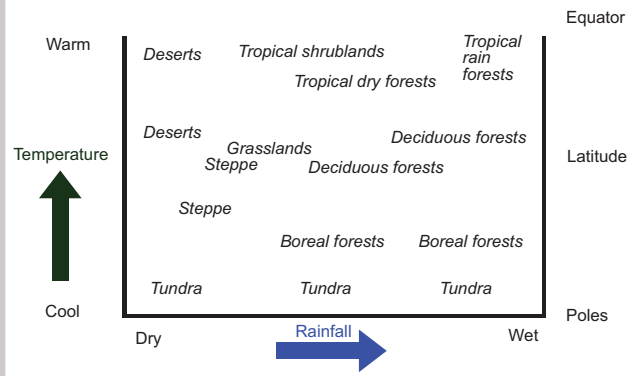


Figure 9. Vegetation types, rainfall, temperature, and latitude.

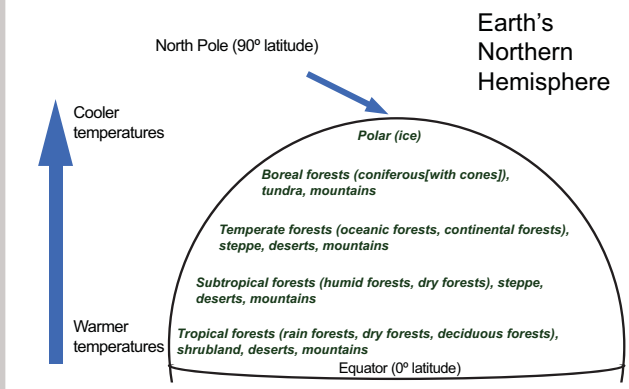


Figure 10. Vegetation types, temperature, and latitude.

Fig. 11 A. Hawai'i. Photo by Babs McDonald.

Fig. 11 B. Russian Federation. Photo by L. Vaschuk.

Fig.11 C. Chile. Photo by John Pye.

Fig. 11 D. Vietnam. Photo by Michael Bowker.

Fig. 11 E. Australia. Photo by Michael Bowker.

Fig. 11 F. Germany. Photo by Babs McDonald.

Fig. 11 G. Tanzania. Photo by Chuck Chappell.

Fig. 11 H. China. Photo by Robert Haack.

CATEGORY OF FOREST	DESCRIPTION
PRIMARY FORESTS	Forests with native tree species. Evidence of human activities is not visible and the forest's ecological processes are not widely disturbed.
OTHER NATURAL FORESTS	Forests growing naturally (without human assistance) but where there are visible signs of human activities. These forests may include both native and introduced tree species.
PLANTED FORESTS	Forests planted by man.

Table 1. Categories of forests studied in the Global Forest Resources Assessment 2010.

The scientists also wanted to estimate the area of forests being used to maintain a diversity of plant and animal species and the area of forests that are legally established and protected to maintain this diversity.

REFLECTION SECTION:

Compare and contrast the forests shown in Figure 11. What are their similarities? What are their differences?

WHAT FAO DISCOVERED: The world's forests cover about 31 percent of Earth's land area (Figure 12). This is a little more than 4 billion hectares (Figures 13 and 14). More than half of the world's forests are in the Russian Federation, Brazil, Canada, the United States of America, and China (Figure 15).

Of the world's forests, 36 percent are primary forests. Primary forests, and in particular wet tropical forests, are the world's most diverse forests. They have the greatest variety of plant and animal species.

The number of hectares of planted forests increased between 2000 and 2010. Planted forests now make up 7 percent of the world's forests, or 264 million hectares. Of all the world's forests, most are forests growing naturally without human assistance, but show signs of human

Figure 12. The location of the world's forest are shown in green.

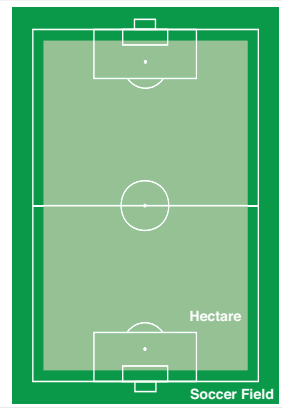


Figure 13. One hectare is a little smaller than a football (soccer) field.

activities. These forests make up 57 percent of the world's forests (Figure 16). Since 2000, about 13 million hectares of forest have been lost each year (Figure 17). While this is not good news, it is less than the rate of deforestation in the previous 10 years.

Forests are lost for a number of reasons. Trees are felled, for example, to clear land for agriculture or development. Extreme natural events such as tornados, hurricanes, volcanic eruptions and droughts also damage or destroy forests.

An area the size of Greece or Nicaragua is lost to deforestation every year. Not all countries, however, have fewer forests today than 10 years ago. Some countries have increased their forest areas and others have slowed the rate of forest loss.

To help understand more about the world's forests' gains and losses, look at figures 18-21. Figure 18 is a map you should recognize. This is a map of the world that shows each country at its normal size. Find your own country on the map. Figures 19-21 are called cartograms. Each country size in these cartograms is **distorted** to show forest growth or loss. If the forest growth or loss were the same in each country, each country would be the same size. In each cartogram, find your own country.

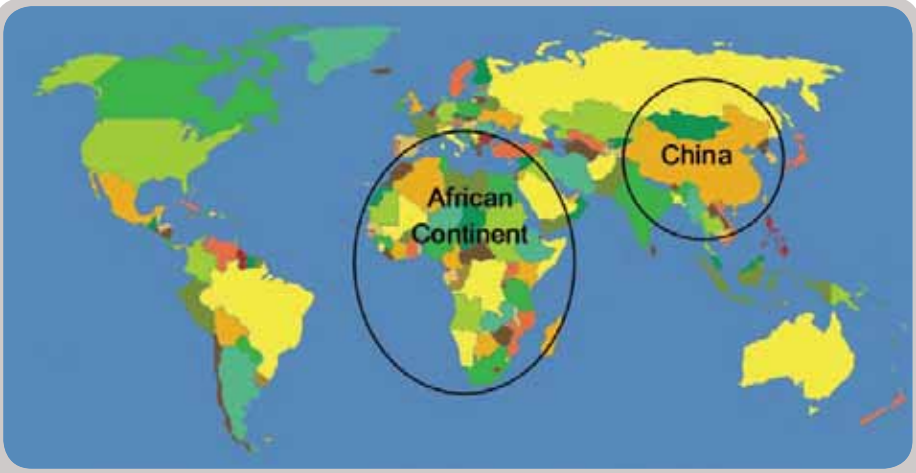


Figure 14. The area of forests worldwide is larger than the size of the African continent and China combined.
Map courtesy of www.ego.thechicagoschool.edu

Figure 15. This forest is located in the Siberian region of the Russian Federation. This area is far from the equator.
Photo by Leonid Vaschuk.

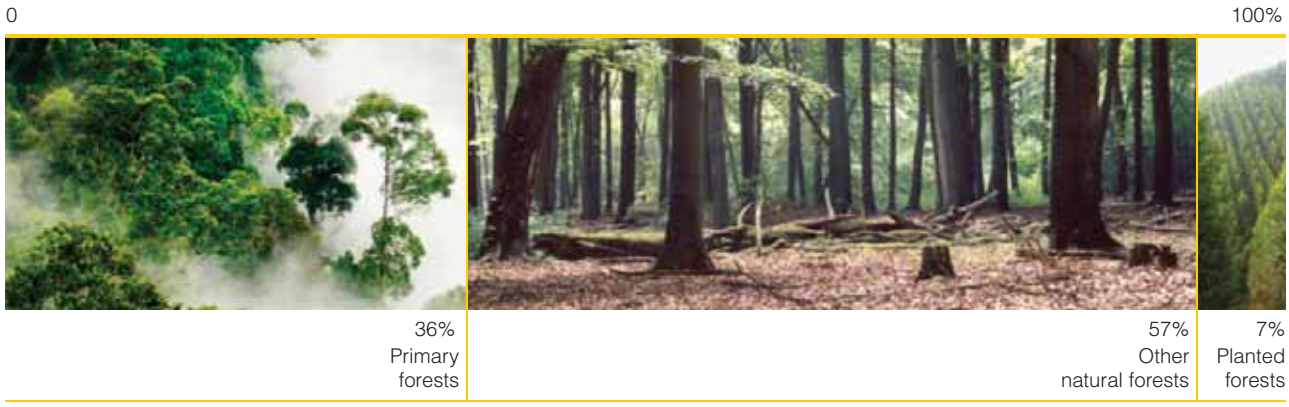


Figure 16. Most of the world's forests are in a category FAO called "other natural forests." These forests are growing without human assistance, but show signs of human activities.

Figure 17. This is what remained of a forest in Thailand after the trees were felled to grow maize. Photo by FAO / FO-0506 / M. Kashio.

REFLECTION SECTION:

Look at figures 19-21. What can you say about the change in your country's forests in the past 5 years?

What do you think about the changes in your country's forests over the past 5 years? Is this a change for the better or worse? Why?

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

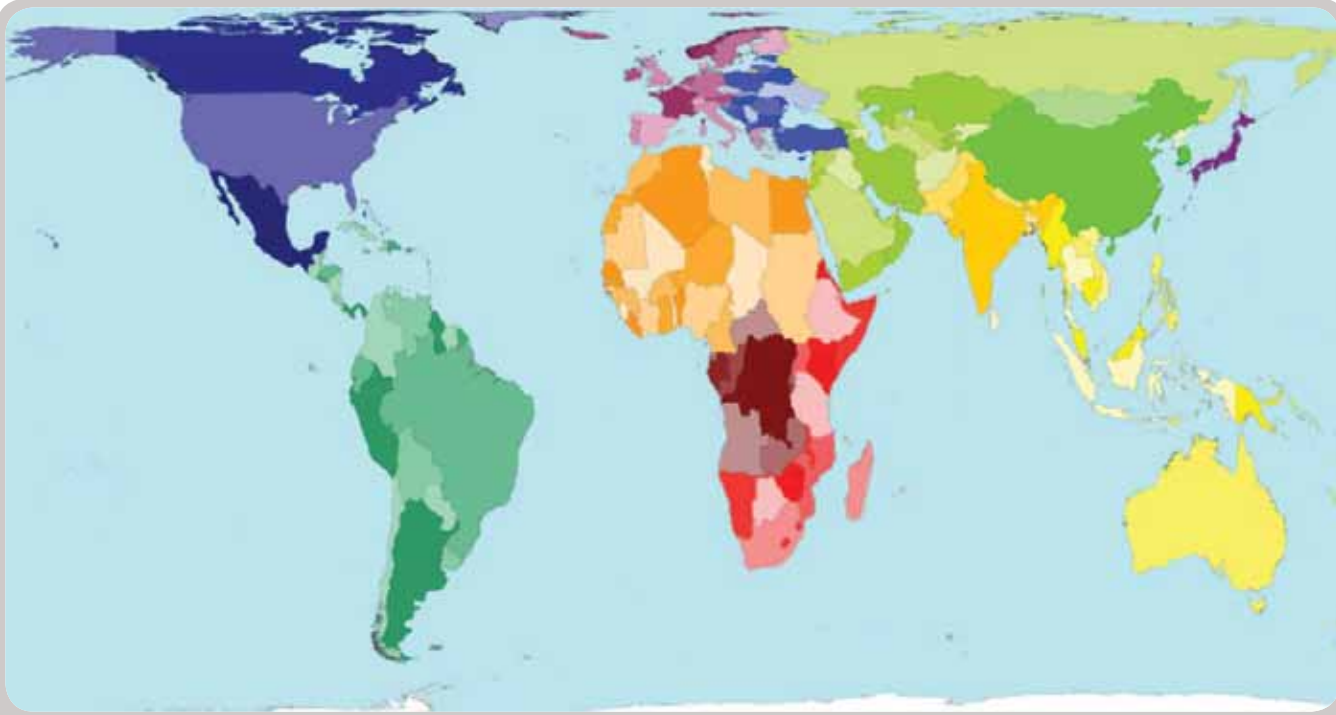


Figure 18. Land area of countries worldwide.
Map by Worldmapper, University of Sheffield, http://www.worldmapper.org.

FACTIVITY:

Using a map, atlas, globe, or the Internet, identify the latitude of your country. How far is your country from the equator and either the North or South Pole? What is your country's elevation above sea level? Using this information and the information in Figures 7-10, what kind of vegetation would you expect to find in your country? Compare this with the ecozone type for your region or country shown in Figure 5. Do they match? If they do not match, why do you think this is so?

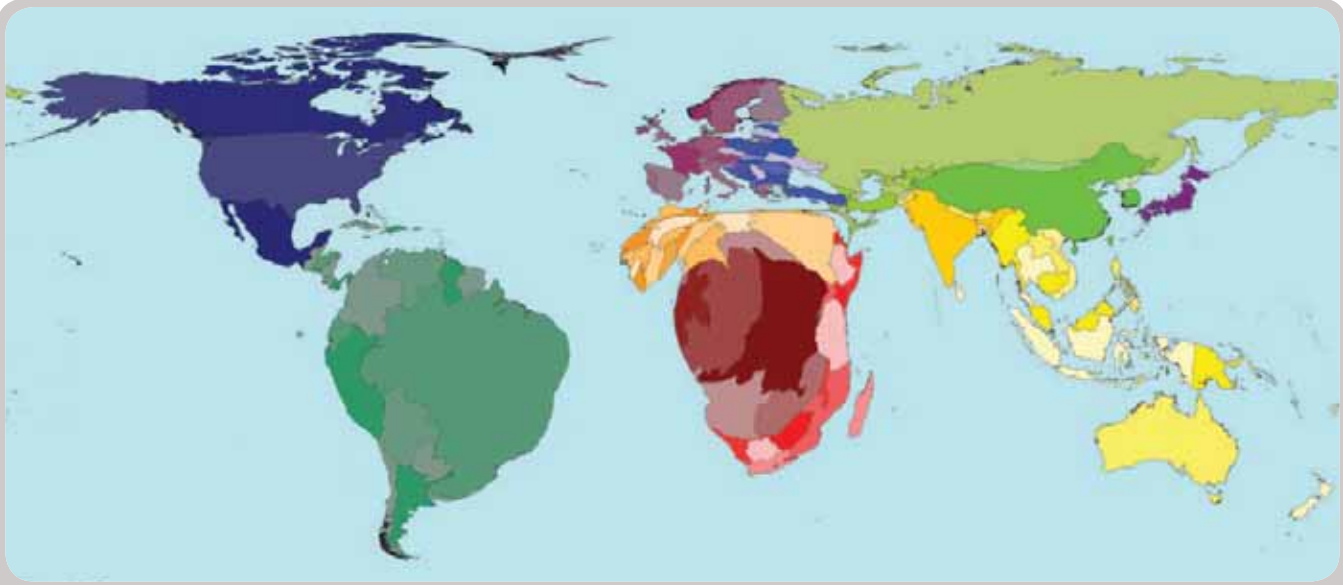


Figure 19. Amount of forest area in each country in 2010. Map by Worldmapper, University of Sheffield.

Figure 20. Amount of forest growth in each country between 2005 and 2010. Map by Worldmapper, University of Sheffield.

Figure 21. Amount of forest loss in each country between 2005 and 2010. Map by Worldmapper, University of Sheffield.

INQUIRY 2: BIODIVERSITY AND THE WORLD'S FORESTS

THE SITUATION: In Inquiry 1, you learned about the types of forests found across the planet. You also learned how much of Earth's land area is covered in forests, and where forest area is growing and shrinking. You also learned about primary forests.

Primary forests are those with native tree species and little evidence of human activities. Primary forests are usually rich in **biodiversity** (Figure 22). Biodiversity is the variety of life and life processes. When a natural ecosystem is diverse, it has a variety of living **organisms**.

Figure 22. Tropical rain forests contain a wide variety of plants and animals, such as this iiw'i. Photo by David Flaspohler.

FAO wanted to know how much biodiversity the world's forests contained in 2010. This can be complicated, because there are many ways to measure biodiversity. Biodiversity can be measured within an ecosystem, a plant or animal community, a species, a **population**, among individuals, and among genes. FAO decided to collect three pieces of information as an indication of a country's forest biodiversity. These 3 pieces of information included:

1. The number of hectares in primary forests.
2. The number of hectares of forests set aside to conserve the forest's biodiversity.
3. The number of hectares of forests in **protected areas**. Protected areas are areas set aside by law to conserve biodiversity and other natural and cultural resources.

FAO and the National Correspondents also planned to identify the number of hectares of forests affected by natural or human-caused disturbances.

REFLECTION SECTION:

Why do you think biodiversity is important to the world's forests?

How could knowing the number of hectares in each of the 3 categories help FAO to understand biodiversity in the world's forests?

WHAT FAO DISCOVERED: Worldwide, more than one-third of the world's forests are primary forests (Figures 16 and 23). This includes tropical rain forests, which are Earth's most diverse forests. FAO found that the percentage of primary forests has decreased yearly by 0.4 percent since 2000. This is about 40 million hectares, or the size of 12 football fields lost every minute. The decline was caused mostly by logging and other human disturbances. This does not mean that the forests had disappeared, however. It could mean that the primary forest had been

WHY IS GENETIC DIVERSITY IMPORTANT TO THE WORLD'S FORESTS?

Natural environments are always changing in some way. When something in the environment changes, plants and animals must adapt to the change if they are to survive. Some individuals can adapt and some cannot. This is because of slight differences in their genetic structure. If all individuals of a species had exactly the same genetic structure, the species may not be able to survive in a changing environment.

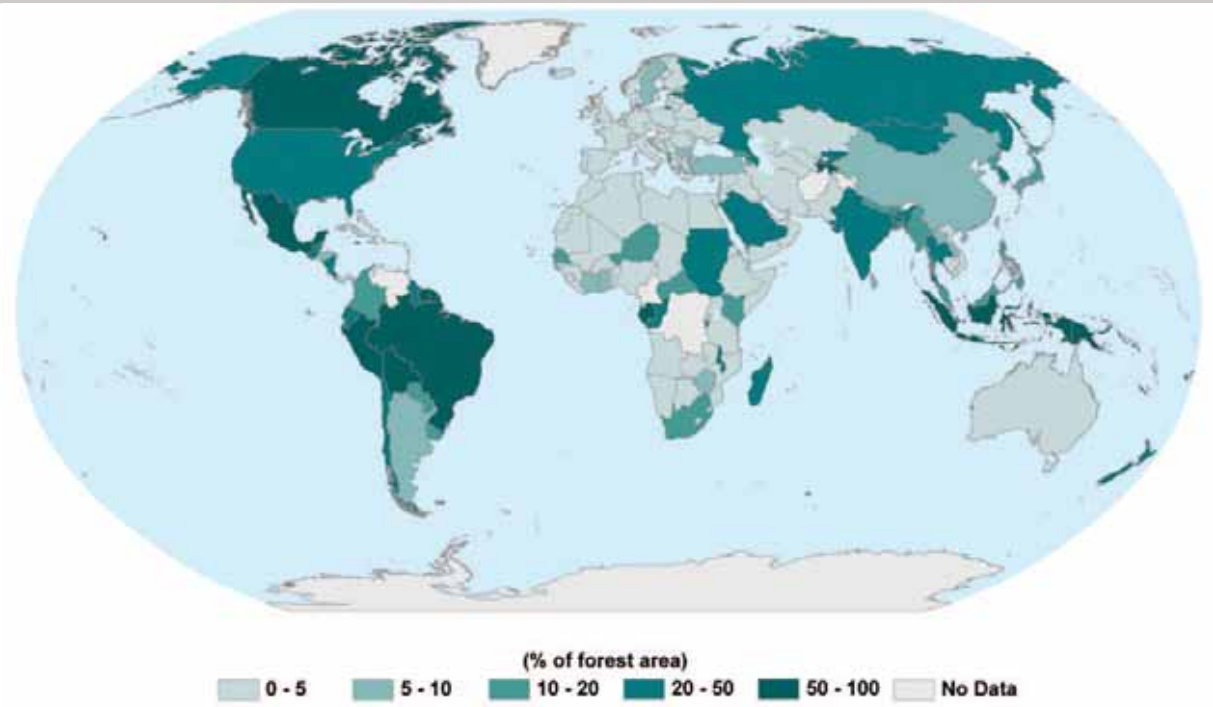


Figure 23. The percentage of forest land in each country classified as primary forest in 2010.

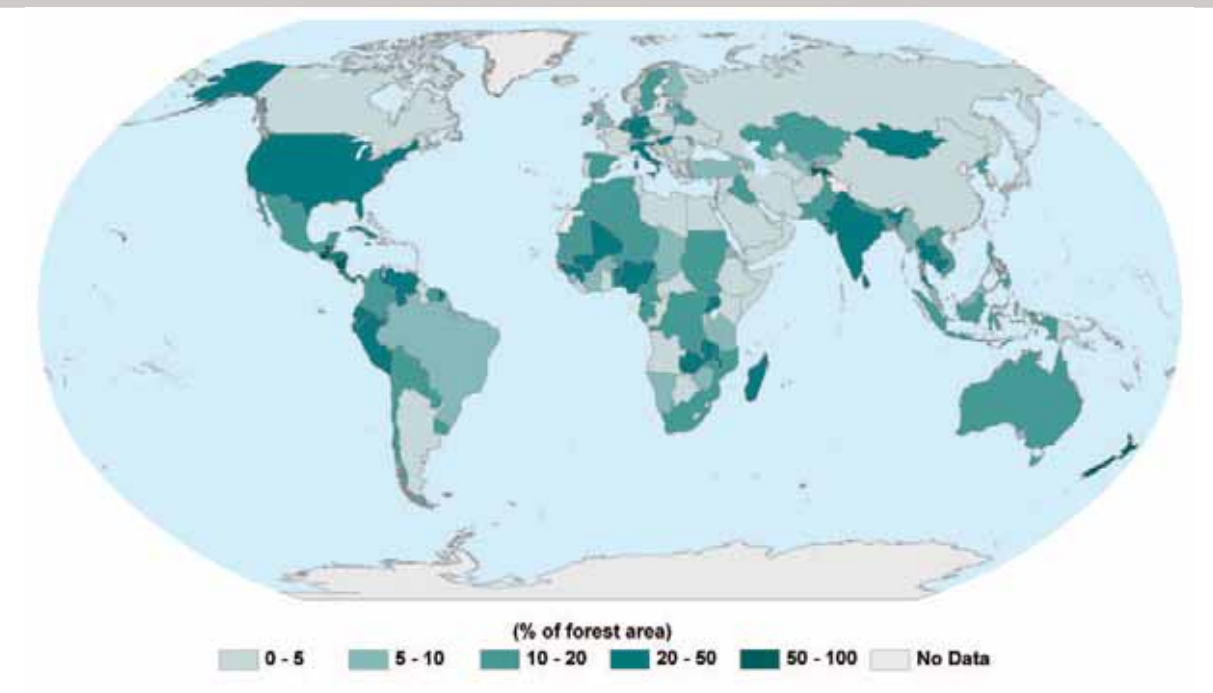


Figure 24. The percentage of forest land in each country set aside to conserve biodiversity, 2010.

modified by human activity so that it could no longer be classified as primary forest.

Almost twelve percent of the world's forests are set aside for the conservation of biodiversity (Figures 24 and 25 and Table 2). The area of these forests increased by 63 million hectares between 2000 and 2010.

Worldwide, 13 percent of the world's forests are located within protected areas (Figure 26). Since 1990, 94 million hectares of protected areas have been added globally. Two-thirds of these protected areas were added since 2000.

YOU DO THE MATH:

How many hectares of forests in protected areas were added between 2000 and 2010?

FAO found that over the past 20 years, more of the world's forests are being set aside to conserve biodiversity. On the other hand, it found that the area of primary forests worldwide has declined over this same period.

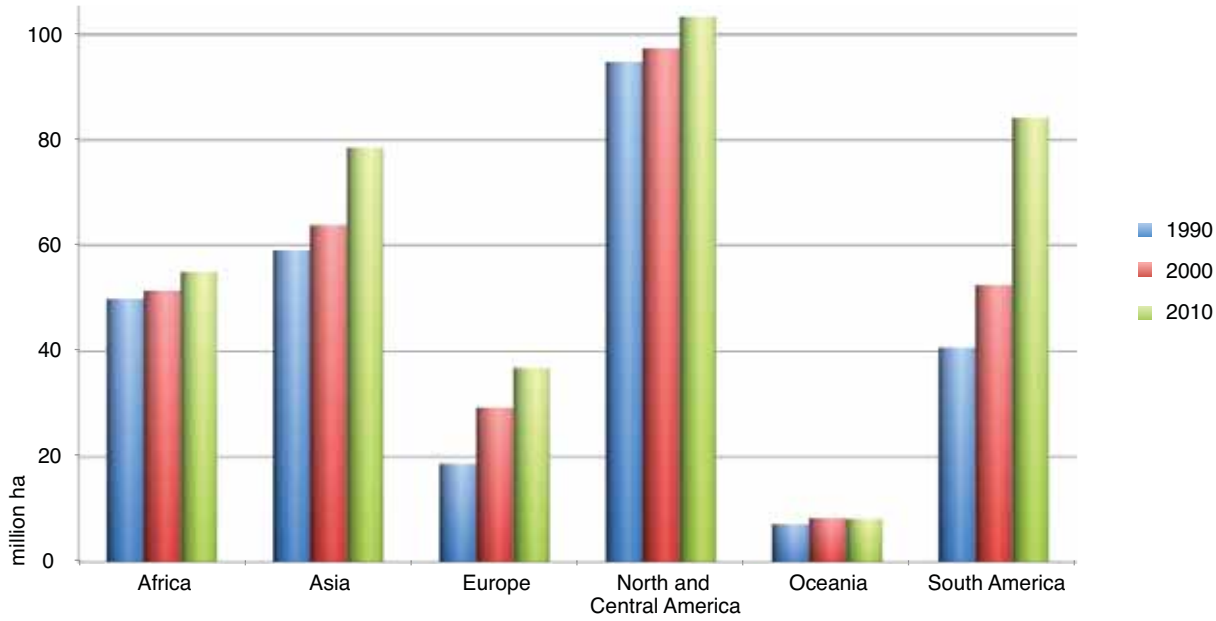


Figure 25. Number of hectares of forests set aside to conserve biodiversity by region, 1990-2010.

REGION	NUMBER OF HECTARES	% OF FOREST AREA
Africa	92 529 000	13.7
Asia	78 513 000	13.3
Europe	37 150 000	3.7
North and Central America	108 969 000	15.5
Oceania	30 640 000	16.0
South America	115 613 000	13.4
World	463 415 000	11.5

Table 2. Number of hectares and percent of forest area set aside to conserve biodiversity by region in 2010. Round off to the nearest whole percentage each of the percentages in the third column.

Biodiversity can be threatened by invasive insects and some kinds of forest fires. Nearly 35 million hectares of forest land were damaged by insects worldwide (Figure 27). In particular, the mountain pine beetle attacked over 11 million hectares of forest in Canada and the western United States (Figure 28).

Largely because of the increase in worldwide trade, insects are moving from country to country. The changing global climate has also made many areas more favorable for insects. This has caused an increase in damage from insects worldwide. Unfortunately, many countries did not collect information about damage from insects.

One percent of all forests were affected by forest fires in 2010 (Figures 29 and 30). This

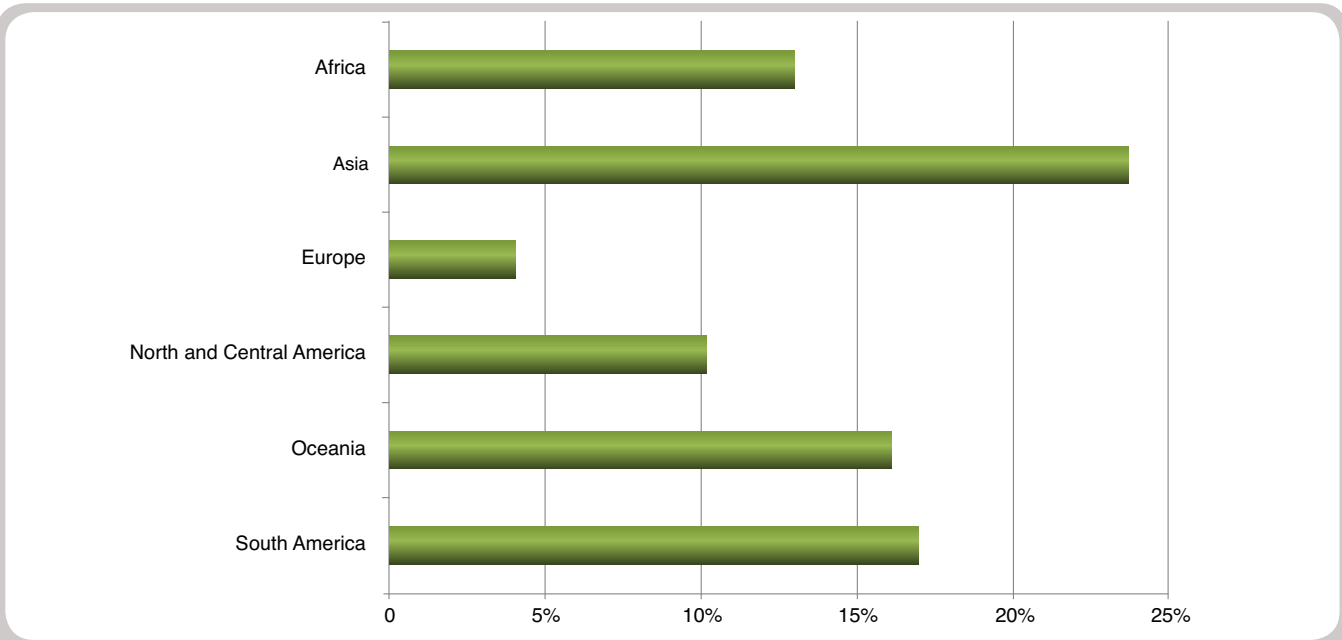


Figure 26. The percentage of forest area in protected areas by region, 2010.

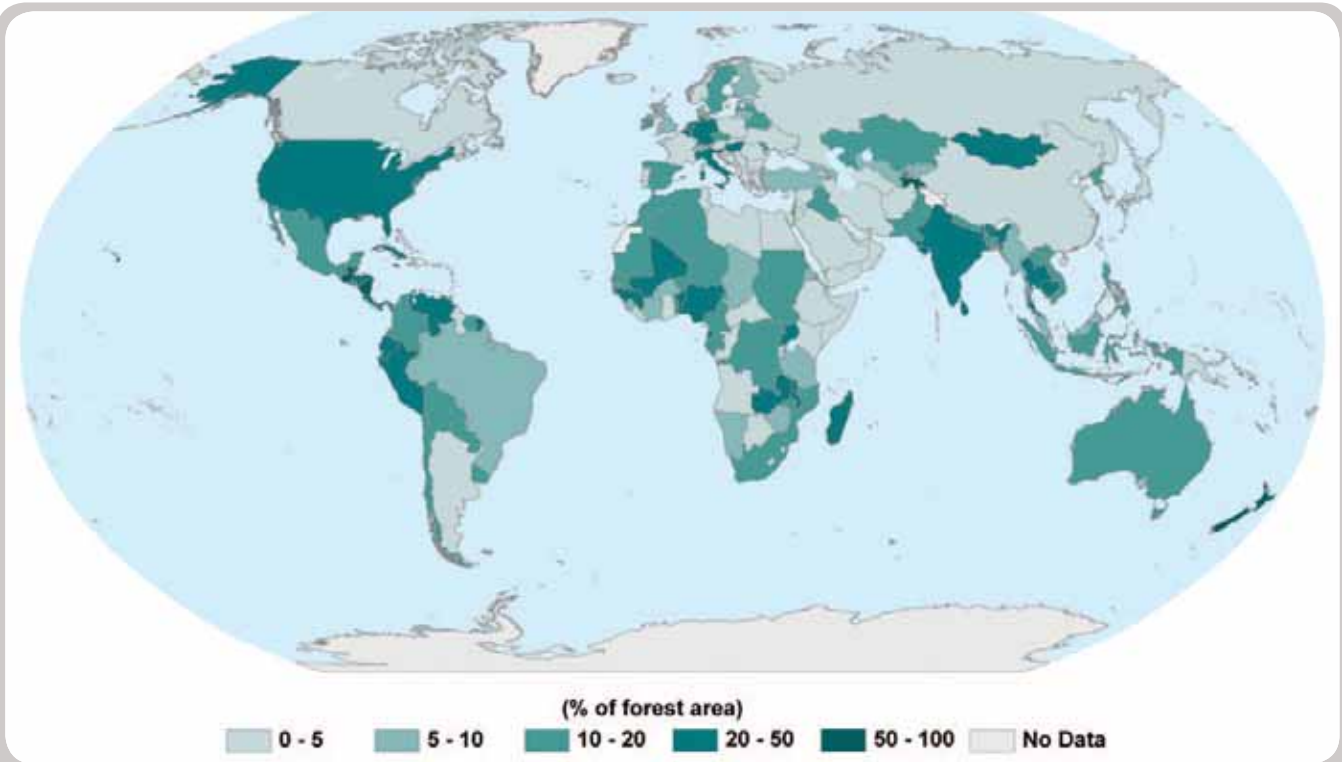


Figure 27. Average area of forest damaged by insects yearly by country, 2005

estimate may be low, however, as only 78 out of 233 countries reported information about forest fires. Events such as fire, drought, wind, snow, ice, and floods are usually considered natural disturbances. As the global climate changes, the number and strength of these disturbances have been increasing. This has resulted in a greater threat to forest biodiversity in these areas.

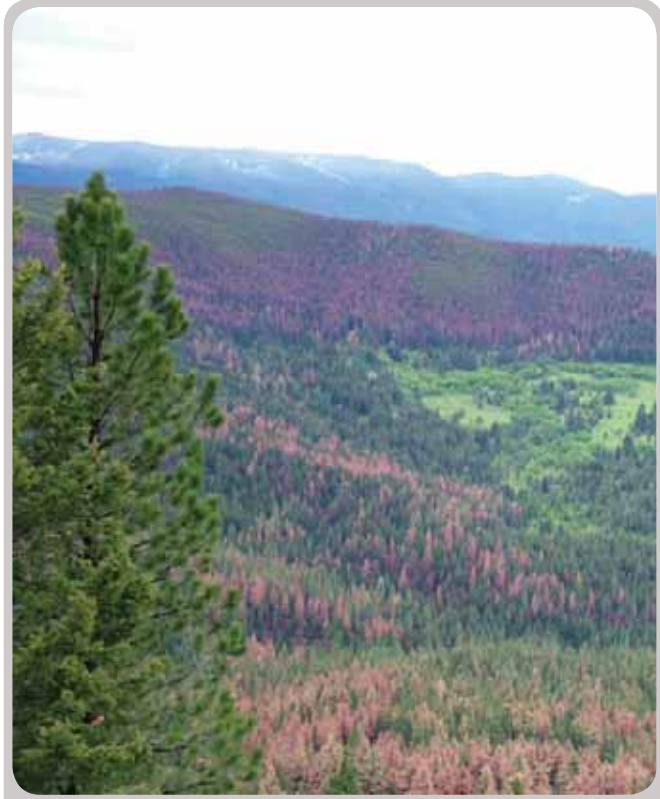


Figure 28. The mountain pine beetle is destroying large areas of forest in the North American West. Photo by Barbara Bentz.

REFLECTION SECTION:

Based on FAO's findings, would you say that the biodiversity of the world's forests is increasing or decreasing? Why?

Is it important to protect the biodiversity of forests? Why or why not?

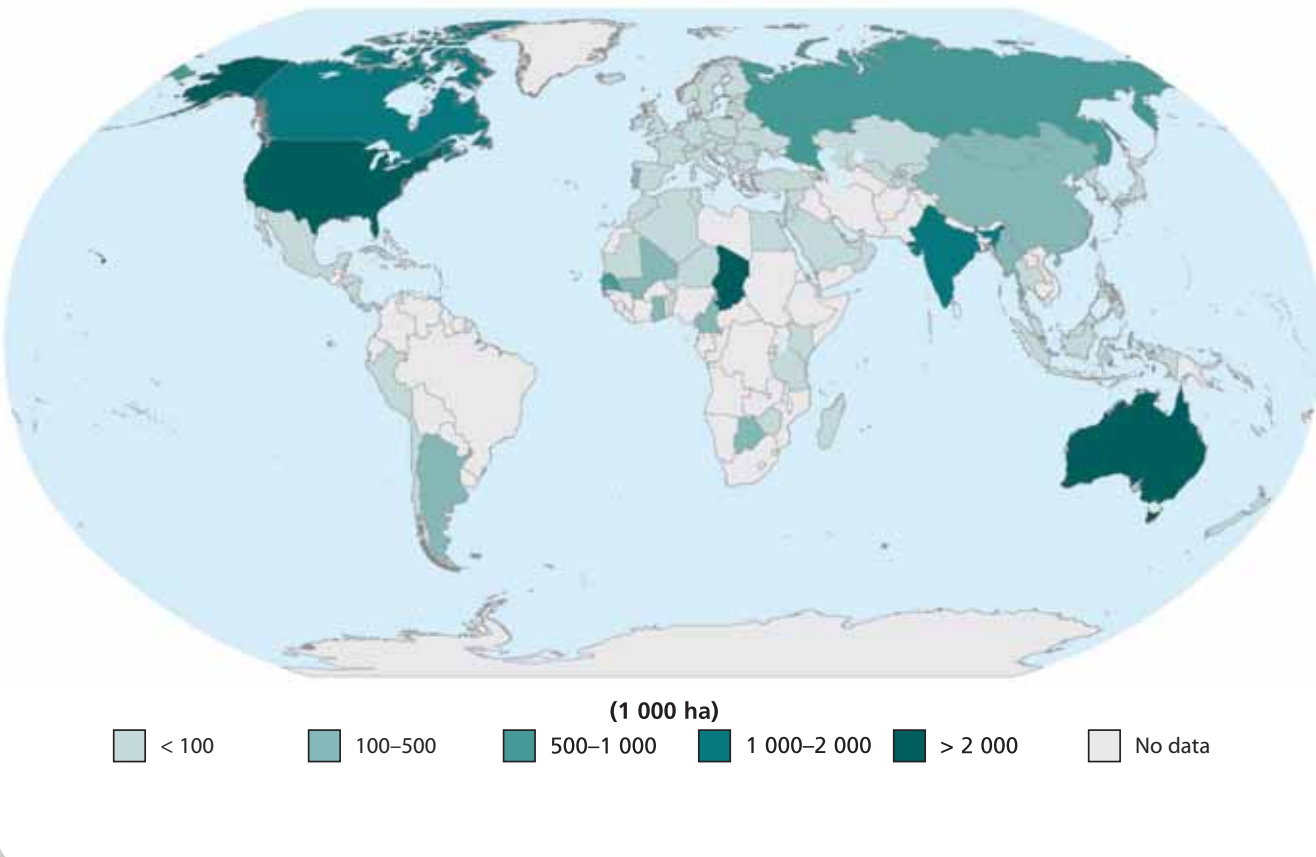


Figure 29. Average area of forest damaged by fire yearly by country, 2005.

Figure 30. A forest fire destroyed this forest in Chile. Photo by John Pye.

ARE FOREST FIRES ALWAYS A BAD THING FOR FORESTS?

FAO used the area of forest damaged or destroyed by fire to evaluate the health and vitality of the forests. For some forests, however, occasional fire is needed. In these forests, trees are adapted to withstand fires that burn across the ground. The trees are not killed. Some trees need fire to break open their seeds so they can germinate. Some trees depend on fire to keep other trees from growing in the area. So while many forest fires damage or destroy forests, it is important to remember that some types of forests need ground fires to conserve their biodiversity. When these fires occur, they typically do not destroy the forest.

FACTIVITY:

Forests are not the only places to find diversity. Diversity can be found everywhere! To prove this, take a look at either your classroom or your school. In a classroom discussion, identify the diversity that you observe. If you are examining your classroom, you might focus on diversity among students. If you are examining your school, you might also observe diversity among teachers and classroom appearance. All observations about diversity should be done respectfully. Now hold a class discussion about how diversity improves your classroom or your school. What are the advantages of having diversity in your community?

DID YOU KNOW?

The heaviest woods in the world come from flowering trees that are called “ironwoods”. This unusual wood sinks in water!
http://waynesword.palomar.edu

DID YOU KNOW?

One of the world’s softest and lightest woods is from the American balsawood tree.
http://waynesword.palomar.edu

INQUIRY 3: WHAT DO FORESTS DO FOR THE WORLD'S ENVIRONMENT AND ITS PEOPLE?

THE SITUATION: It is important to know where the world's forests are located and where they are expanding and shrinking in size. This was the topic of Inquiry 1. It is also important to understand whether the world's forests are helping to conserve biodiversity. This was the topic of Inquiry 2. Forests provide a range of benefits to people and to the environment. Understanding these benefits is the topic of Inquiry 3.

FAO identified three broad ways that forests provide benefits. The first is called productive because it focuses on the products people take from forests. People take wood for timber and fuelwood, they take food such as nuts, fruits, berries, mushrooms, edible plants, and bushmeat from forests, and people allow livestock to browse in forests. People use plant materials for medicines and dyes, and they take wildlife for a number of purposes.
Forests also provide protective benefits. Examples of protective benefits include protecting soils from wind and water erosion, protecting coastal areas, and controlling **avalanches**. Forests also provide a benefit by filtering the air and water. Filtering rain water helps to keep water supplies clean.

Forests provide social and economic benefits to people and to communities. Social benefits include providing places for people to play and to get away from an increasingly urban life. Forests provide beautiful landscapes and reduce the effects of noise. They provide a place for people to learn about nature and themselves, and they provide inspiration. Forests also provide a living laboratory for scientists to study nature.

Forests are an important source of economic benefits. Many people work in the forest sector, enhancing either the productive, protective, or social benefits of forests. Examples include work in the timber industry or in the outdoor recreation industry. Some people make their living managing forests for conservation purposes. Forests are an important source of livelihood for people all over the world. FAO and the National Correspondents collected information about how much forest land is set aside in each country to provide these benefits.

REFLECTION SECTION:

If the area of the world's forest decreases, what will happen to the amount of benefit forests provide to people? What does this suggest about how we should manage our forests?

Do you think that anywhere forests are located on Earth they provide productive, protective, social, and economic benefits? Why or why not?

REGION	NUMBER OF HECTARES	% OF FOREST AREA
Africa	205 037	30
Asia	232 754	30
Europe	526 646	52
North and Central America	101 781	14
Oceania	11 656	6
South America	118 295	14
World	1 196 168	30

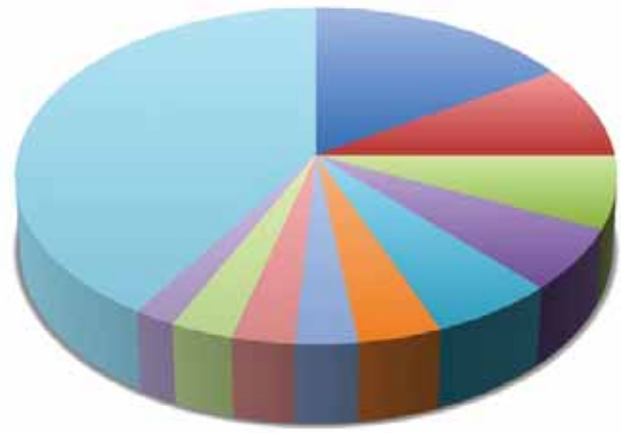
Table 3. Area in hectares and percentage of forest area used primarily for the production of forest products by region, 2010.

WHAT FAO DISCOVERED: PRODUCTIVE FOREST BENEFITS

Thirty percent of the world's forests are used primarily to produce forest products for people (Table 3 and Figure 31). Another 24 percent of the world's forests are used for the production of products along with other benefits. When forests are used for multiple purposes, it is called "multiple use." FAO found that the amount of forest land used primarily to produce products had decreased slightly in the past 20 years.

Worldwide in 2005, about half of the wood removed from the world's forests was used for fuel. In Africa, more than 90 percent of removed wood is used for fuelwood. Most of this is used for cooking food. The United States of America led the world in the volume of wood removed (Figure 32). Wood products include, for example, lumber for building houses and furniture, and paper made from trees. China led the world in the removals of non-wood forest products. The Chinese collected a large amount of plant products such as oil, seeds, nuts, and bamboo. As you can see, forests provide products that people use every day.

Figure 31. Some forests are used primarily to produce products. Here, trees were felled to create lumber for building. Photo by Babs McDonald.



United States	16%
India	9%
Brazil	7%
Canada	6%
Russian Federation	6%
China	4%
Ethiopia	3%
Indonesia	3%
Sudan	3%
Democratic Republic of the Congo	2%
Remaining Countries	41%

Figure 32. Ten countries with the largest volume of wood removed by percentage, 2005.

PROTECTIVE FOREST BENEFITS

In the past, FAO concentrated its research on the productive benefits of forests. To better understand the protective benefits of the world's forests, FAO focused on soil and water conservation (Figure 33). When soil and water is protected in an area, the entire ecosystem is healthier. FAO found that soil and water conservation was the primary focus for 8 percent of the world's forests (Figure 34).

This is about 330 million hectares of forest.

An important part of soil conservation is concerned with stopping the spread of sand

into areas that once had plants or trees. When trees are felled or plants are removed and drought occurs, sand can spread into an area. These areas can become like deserts. When an area becomes like a desert, a number of other things can happen. Less land may be available for grazing animals, less water may be available for people and wildlife, and people's livelihoods may be affected. Forests help to protect areas from the spread of sand. People living in **arid** places use plants and trees to help stabilize desert areas (Table 4 and Figure 35).

Figure 33. This forest in China helps to protect water quality and conserve water and soil. Photo by Robert Haack.

COUNTRY	FOREST AREA DESIGNATED FOR PROTECTION OF SOIL AND WATER %
Libyan Arab Jamahiriya	100
Bahrain	100
Kuwait	100
Jordan	98
Turkmenistan	97
Kenya	94
Uzbekistan	93
Azerbaijan	92
Wallis and Futuna Islands	87
Iraq	80

Table 4. Ten countries with the highest percentage of forest area managed to protect soil and water, 2010. You can see that all of these countries, except Wallis and Futuna Islands, are located in arid regions. The countries are found in the Middle East near the Red Sea, the Persian Gulf, and the Caspian Sea. The Wallis and Futuna Islands are located east of Australia in the South Pacific Ocean (Figure 35).

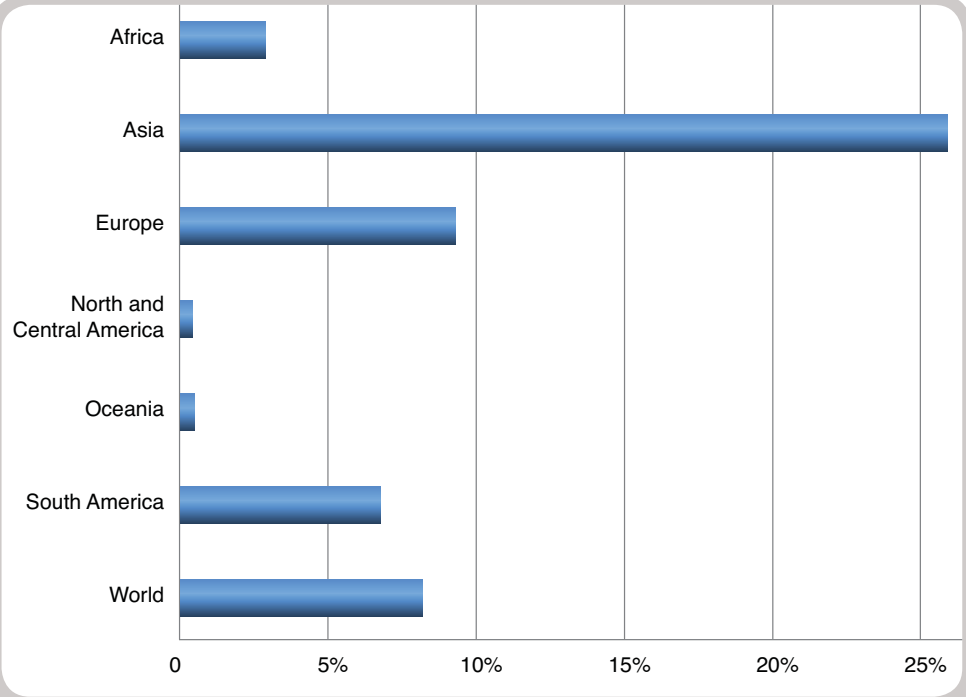


Figure 34. Percent of forest area managed primarily for the protection of soil and water by region, 2010.

Notice the small percentages for North and Central America and Oceania.

Why do you think these percentages are low? For a hint, reread the first paragraph on page 26 under "Protective Forest Benefits." Then read the first two paragraphs on page 28.

Sometimes, a graph, table, or chart may not tell the whole story! In reality, a large proportion of land in North and Central America and Oceania is managed for many benefits, including soil and water conservation.

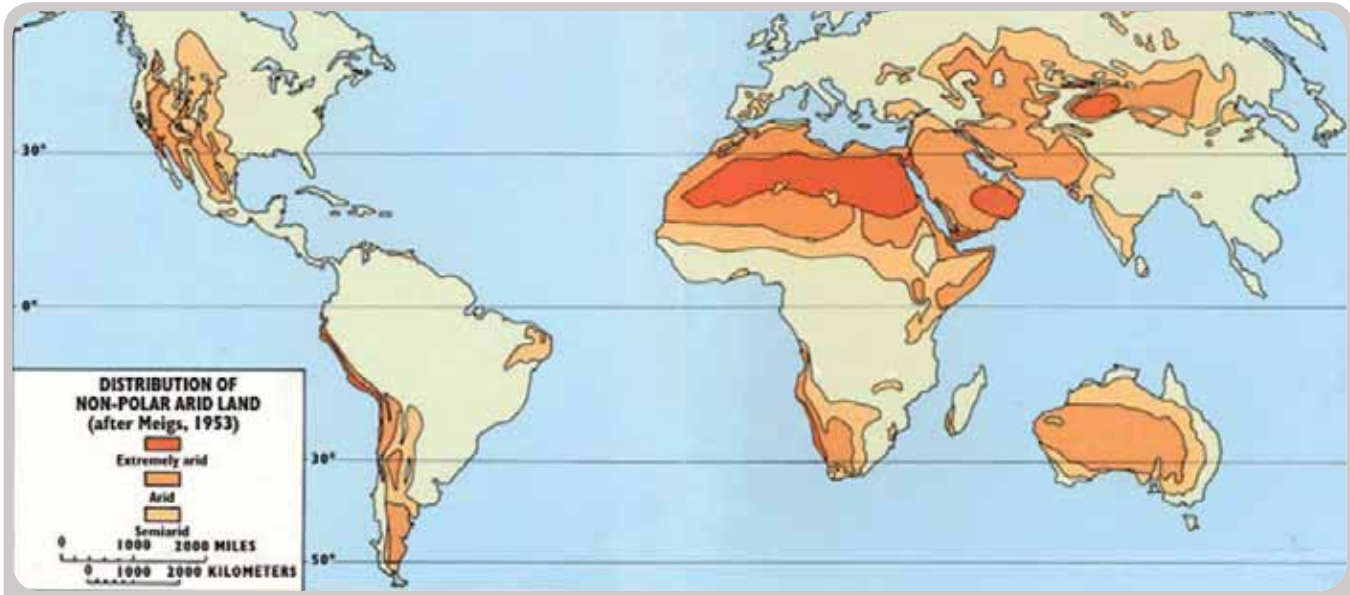


Figure 35. Earth's arid regions. Adapted from ***http://www.cartage.org***

SOCIAL AND ECONOMIC BENEFITS

People receive social benefits when they use forests for outdoor recreation, tourism, education, research, and for the appreciation of cultural or spiritual areas (Figures 36 and 37). Although most countries have recognized the importance of these social benefits, few manage forests for social benefits alone. A country might, for example, manage a forest to protect soil and water but also allow people to camp and hike in the forest.

FAO found that some countries do not identify the number of forest hectares providing social benefits. Instead, these countries consider such forests as being "multiple use" forests. FAO, therefore, feels that the number of forest hectares providing these benefits could be much larger than was reported. The United States of America, for example, did not report many forest hectares for the social benefits they offer (Table 5). At least 134 million hectares of United States forest land are however open for public use and enjoyment as "multiple use" forests.

FAO found that 80 percent of the world's forests are owned by governments on behalf of their citizens.

FAO was also interested in economic benefits. The amount of money received from wood removals changes from year to year. In some years it is high and in some years it is low. In the period between 2003 and 2007, the removal of wood brought an average of over US$100 billion every year.

FAO found that it is difficult to estimate the value of non-wood forest products. Food, such as mushrooms, berries, fruit, and nuts, accounted for 51 percent of non wood forest products removed from forests. Other plant products accounted for 17 percent of the benefit, and wild honey and beeswax accounted for another 11 percent. In 2005, non-wood forest products brought about US$18.5 billion. FAO, however, believes that this estimate is low. It is difficult to identify and report the use of non-wood forest products because many people collect these for their own use.

Worldwide, almost 11 million people worked in forest management or conservation in 2005 (Figure 38). Most of these people worked producing forest products, and about 338 000 people helped to manage protected areas.

REGION	PERCENT OF FOREST AREA
AFRICA	0.1
ASIA	1.6
EUROPE	1.9
NORTH AND CENTRAL AMERICA	0.1
OCEANIA	0
SOUTH AMERICA	13.8
WORLD	3.7

Table 5. Percent of forest managed for social benefits by region, 2010.

Figure 36. People enjoy the view of this German forest. Photo by Babs McDonald.

Figure 37. One social benefit of forests is the information learned from research. Here, a scientist shows his assistant how to identify a small fish in a tropical forested stream. Photo by Babs McDonald.

Figure 38. People around the world make their living working in the forest sector. Photo by Susan Cordell.

Forests are used for education around the world. The Gombe School of Environment and Society, for example, lies in the heart of Tanzania's Kitobe Forest. This school inspires African students to work towards environmental stewardship, community self-reliance, and economic sustainability. The Gombe School uses its surrounding forest as a "school without walls" to provide social and economic benefits to the community (Figure 39).

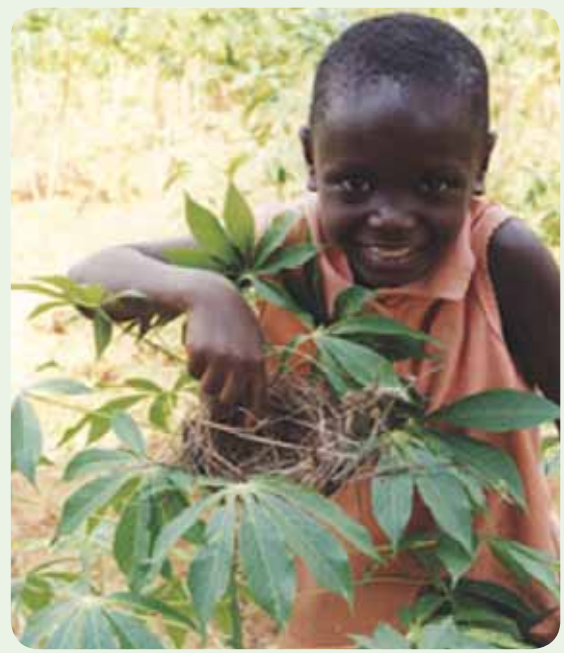


Figure 39. This child has found a bird's nest near the edge of Kitobe Forest. Photo by Yared Fubusa.

YOU DO THE MATH:

According to the International Labour Office, about 3 billion (3 000 000 000) people were employed in 2009. Assume that 11.4 million (11 400 000) people worked in forest management or conservation. What percentage of the world's employed was working in and for the world's forests?

REFLECTION SECTION:

Why the protection of soil and water important to the world's citizens?

What are some of the social benefits you enjoy from visiting forests?

FACTIVITY:

You have learned a lot about the benefits provided by forests. Go back to page 7 and look at the logo developed by the United Nations for the International Year of Forests. Each item in that logo refers to a benefit provided by forests. Think about the benefits provided to you and your community by forests. Create your own International Year of Forests logo just for your community. Share your logo with your class and post the logos on the wall. If you can scan your logos into a computer, you may send them to ***Jessica@naturalinquirer.org*** and we will place them on the *Natural Inquirer* Web site. Please include your first name, your age, your school name, and your country name

DID YOU KNOW?

The world's oldest tree is a spruce tree thought to be 9 550 years old and was discovered in Sweden in 2008.
http://www.sciencedaily.com

DID YOU KNOW?

A 2 000-year old seed from a date palm was found in the ruins of an ancient palace near the Dead Sea. The seed germinated and the date palm that grew from it is named "Methuselah."
http://waynesword.palomar.edu.

INQUIRY 4: WHAT DO THE WORLD'S FORESTS HAVE TO DO WITH CLIMATE CHANGE?

THE SITUATION: Is the climate changing over time? You probably have heard many different opinions about climate change. In the past few years, most scientists have agreed on at least one thing about climate change. They have agreed that measured and recorded changes in Earth's climate over the past 100 or more years point to a warming of Earth's surface greater than they would have expected from normal cycles.

Earth's average temperature depends on how much of the sun's energy comes through the atmosphere to Earth's surface, and how much escapes back into space. About 90 percent of the sun's energy is trapped by gases in the atmosphere, including carbon dioxide, methane, and nitrous oxide. This trapped energy is sent back to Earth in all directions, warming the planet. This warming is called the greenhouse effect, and the gases are called greenhouse gases. Without these gases, humans and other forms of life would not be able to survive on our planet.

During the past 150 years, however, the amount of greenhouse gases in the atmosphere has risen sharply (Figure 40). This increase has been happening since the beginning of the Industrial Revolution in the mid-1700s. The amount has been increasing even more over the past 100 years. Scientists believe the sharp rise in greenhouse gases is caused by an increase in the burning of fossil fuels, such as oil, coal, and natural gas. These higher levels of greenhouse gases in the atmosphere trap more of the sun's heat that is reflected off of Earth's surface. This additional trapped heat leads to increasing temperatures on Earth.

Carbon dioxide is one of the greenhouse gases. Carbon dioxide naturally occurs in our

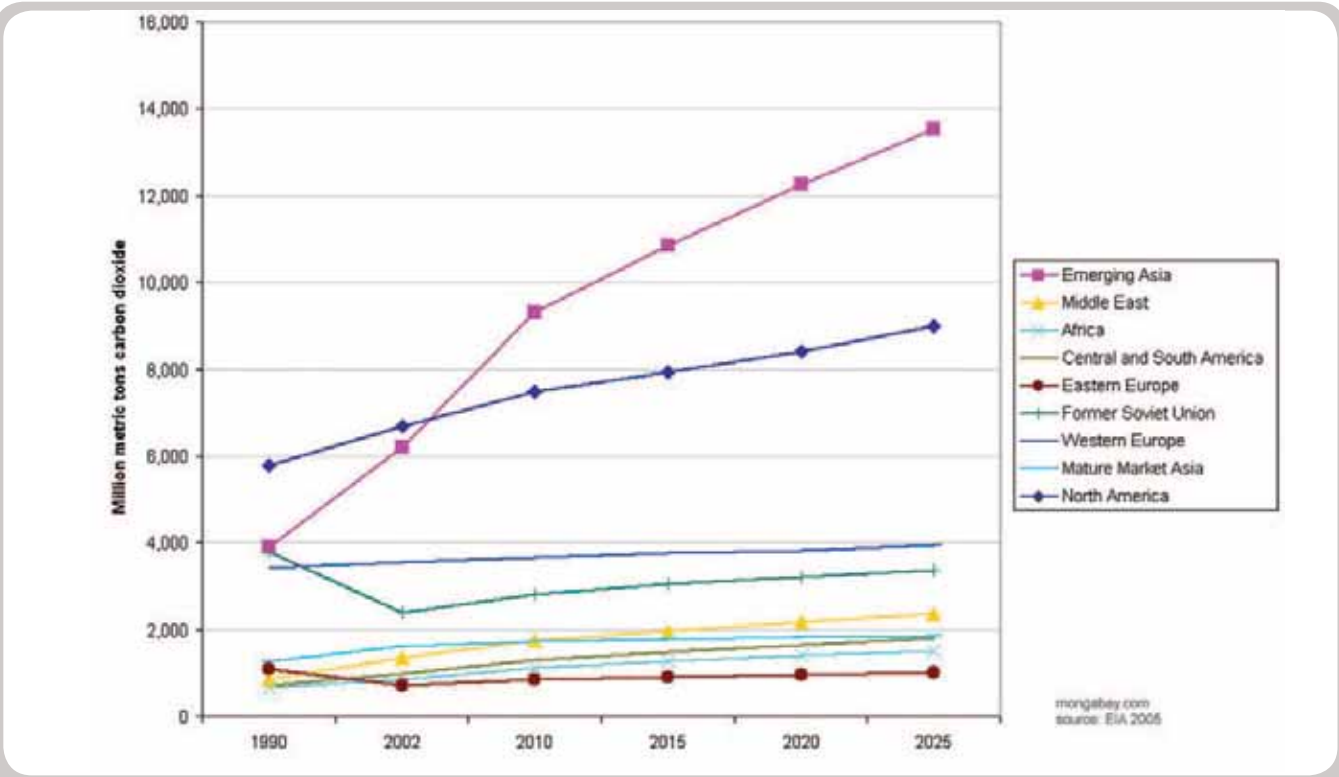


Figure 40. Increase in the world's carbon dioxide emissions, 1990-2025. Carbon dioxide is a greenhouse gas. Source: The United States Energy Information Administration.

atmosphere and a certain amount is necessary to keep Earth warm enough for life to continue. When too much carbon dioxide is **emitted** into the atmosphere, however, Earth's surface continues to get warmer. As Earth's surface warms beyond its normal temperatures, plants and animals are affected.

Carbon is present in rocks, oceans, and the air. Every living thing and once-living thing contains carbon, including all plants and animals. Carbon is always moving around. You can see how it moves in what is called the carbon cycle (Figure 41). Since a tree is a living thing, it also contains carbon. As a tree grows, it absorbs carbon from the air and stores it in its wood (Figure 42). The world's forests are related to Earth's climate because they hold large amounts of carbon on Earth. The carbon stored in the world's forests does not get emitted into our atmosphere unless the trees are felled and burned or when they die and decay. As you can see, the world's forests play a role in helping to reduce the effects of global climate change.

FAO and the National Correspondents wanted to know how much carbon is held on Earth by the world's forests. They also wanted to know whether this number is staying the same, increasing, or decreasing over time.

The amount of carbon in a tree is closely related to the weight of its living material, minus any water. Some scientists estimate that half of a tree's dry weight is carbon. Others estimate that about 45 percent of a tree's dry weight is carbon. FAO, used an estimate of 47 percent to calculate the amount of carbon being held by the world's forests.

WHAT FAO DISCOVERED:

The National Correspondents and FAO used three measures of carbon storage. First, they estimated the amount of carbon being held in trees growing in the forests. Recall that carbon is also present in once-living things.

FAO and the correspondents, therefore, also estimated the amount of carbon in the litter

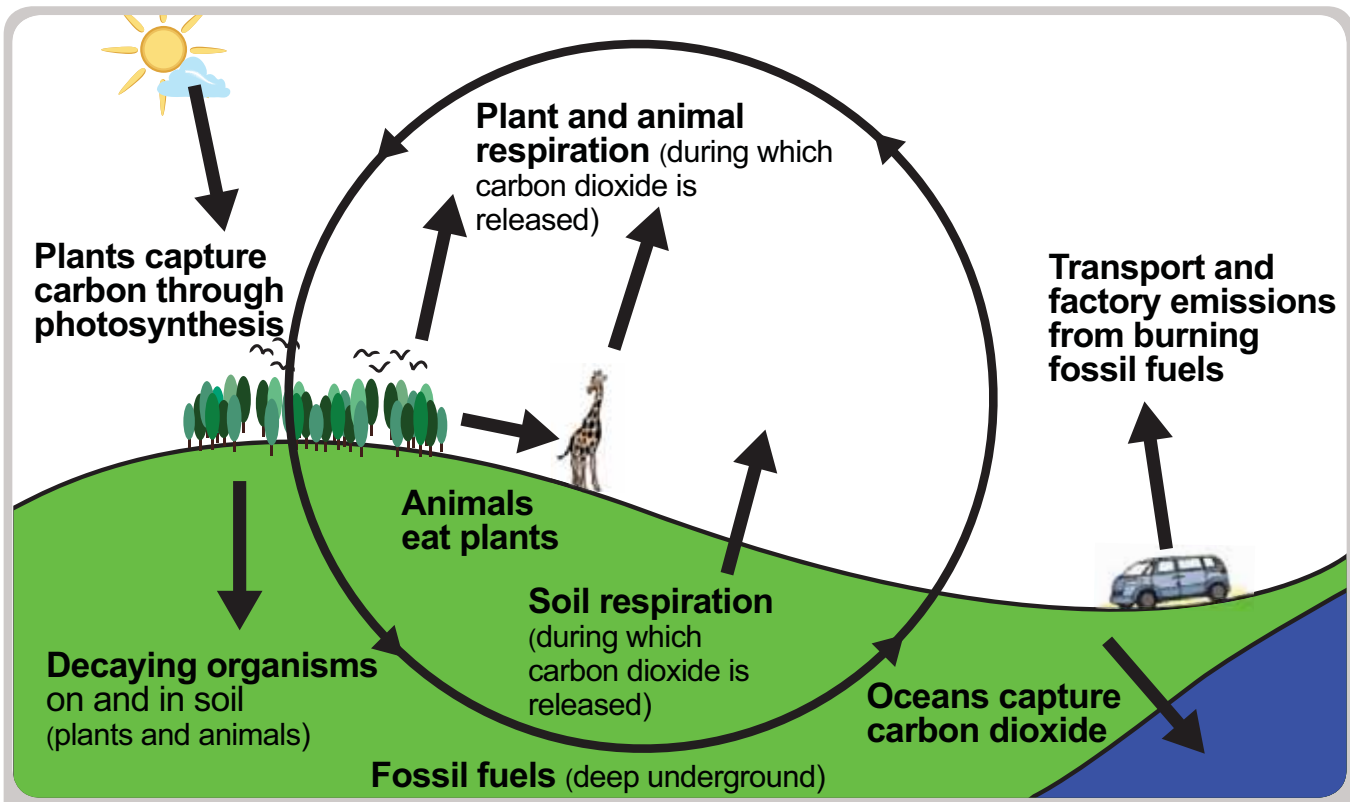


Figure 41. The carbon cycle.

and deadwood lying on the forest floor. Litter includes leaves that have fallen from the trees (Figure 43). Deadwood is the remains of fallen branches and trees that have died (Figure 44). The third measure of carbon was an estimate of the amount of carbon held in the world's forests soils. Because soil contains living beings such as microbes and once-living material, it also contains carbon. Trees also release carbon into the soil (See Figure 42).

The amount of carbon being held in the world's forests' trees was estimated to be 289 Gigatonnes, or Gt (Figures 45 and 47). One Gt is equal to 1 billion tonnes. One tonne is equal to 1 000 kilograms, or 2 205 pounds.

The amount of carbon in the forests' litter and deadwood was estimated to be 72 Gt, or 17.8 tonnes per hectare. Compare this with the amount of carbon held in the soil, which was estimated at 292 Gt or 72.3 tonnes per hectare. One of the questions FAO wanted to answer is what is happening over time to the amount of carbon being held by the world's forests.

When FAO estimated the amount of carbon being held by the world's forests' trees per hectare, it discovered something surprising (Table 6).

AMOUNT OF CARBON	
YEAR	TONNES/HA
1990	71.8
2000	71.9
2010	71.6

Table 6. Amount of carbon held by the world's forests' trees per hectare between 1990 and 2010.

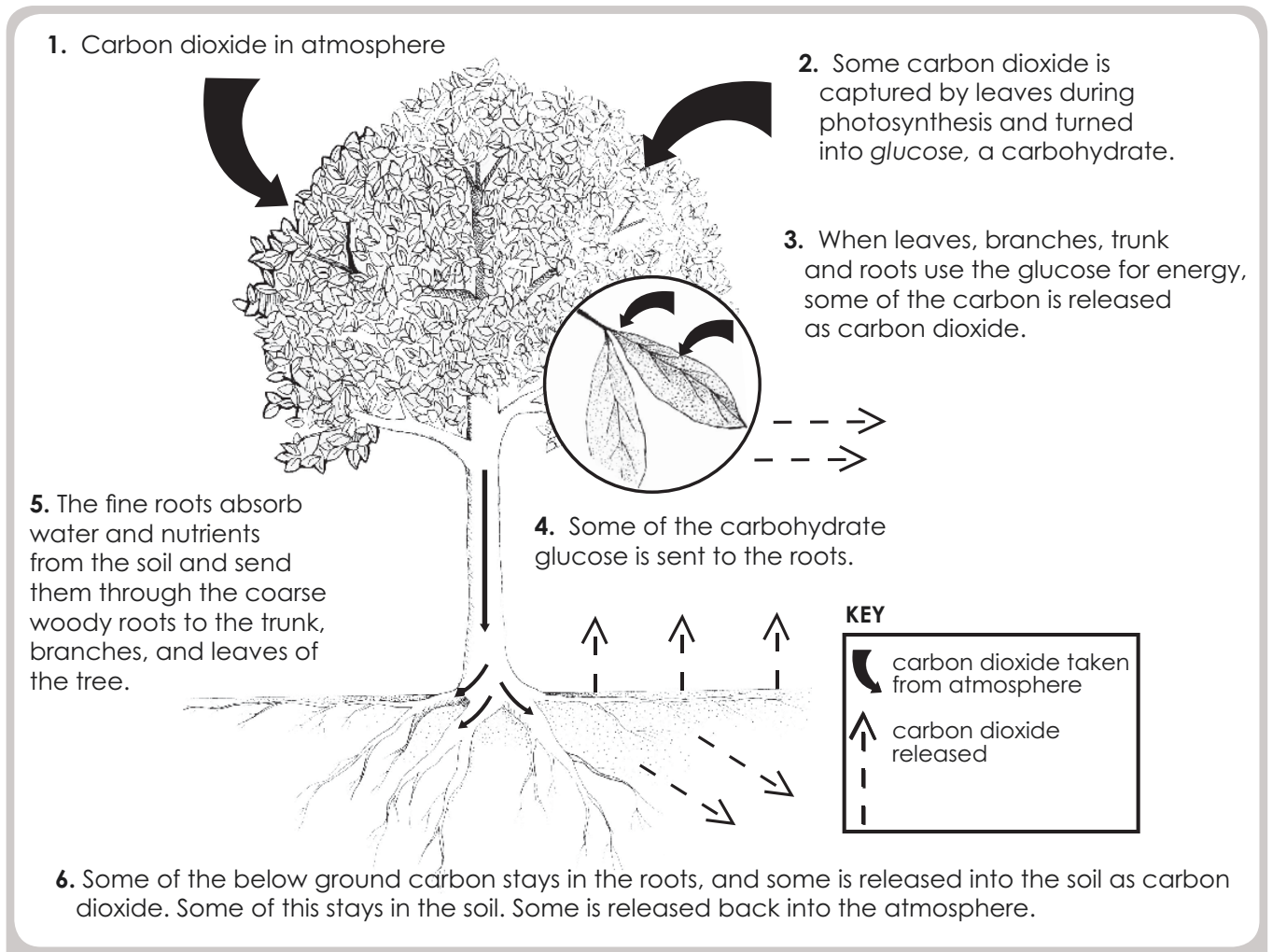


Figure 42. Trees absorb, hold, and release carbon.

Figure 43. Litter is composed of dead and **decomposing** leaves on the forest floor. Photo by Babs McDonald.

YOU DO THE MATH:

Although elephants vary in size and weight, let's say the average weight of an elephant is four tonnes (Figure 46). How many elephants would it take to equal one Gt?

To calculate this, divide 1 000 000 000 by four. How many elephants would it take the equal the weight of carbon in all of the world's forests?

Figure 44. The remains of fallen trees and branches are called deadwood. Photo by Babs McDonald.

Figure 46. African elephant. Photo by Chuck Chappell.

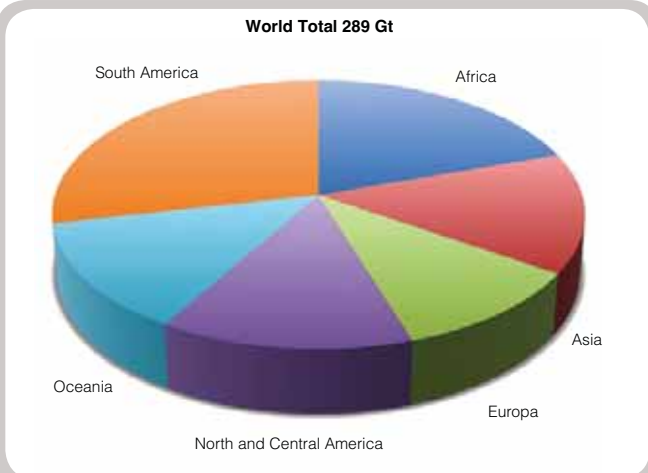


Figure 45. The amount of carbon in the world's forests' trees in Gt by region, 2010.

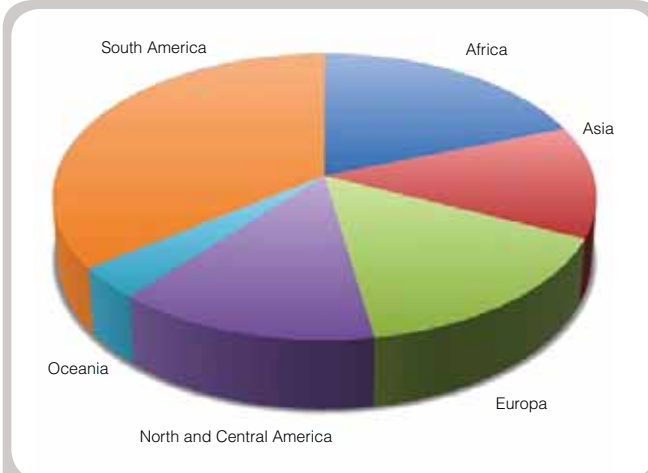


Figure 47. The amount of carbon in the world's forests' trees per hectare by region, 2010.

REFLECTION SECTION:

Do you think that humans contain carbon? Why or why not?

Why should we care whether the world's forests are holding the same amount, more, or less carbon over time?

Over the past 10 years, the average amount of carbon held by a hectare of forest has changed very little. The decrease in carbon held by the world's forests over the past 20 years (Figure 48) is due to the decrease in forest area worldwide (See Inquiry 1).

The United Nations Intergovernmental Panel on Climate Change, or IPCC, is interested in better understanding carbon and its role in climate change. In 2007, the IPCC reported that 17.4 percent of the world's greenhouse gases come from the forest sector. Most of these emissions come from the loss of forests in developing countries (Figure 49).

REFLECTION SECTION:

How do forests help to reduce the impact of climate change?

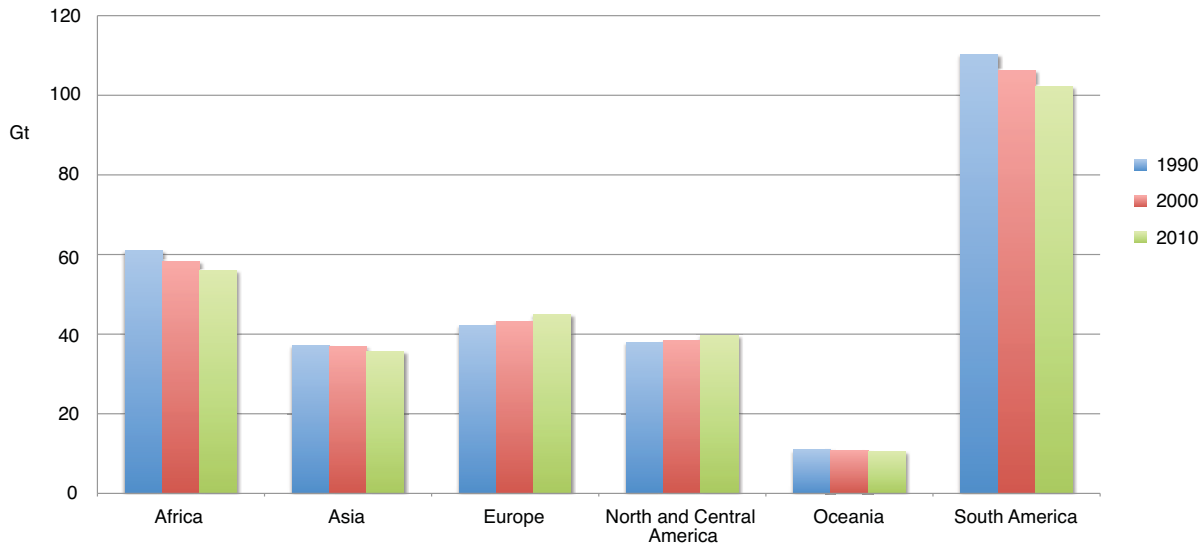


Figure 48. The amount of carbon, in Gt, held in the world's forests' trees between 1990 and 2010 by region.

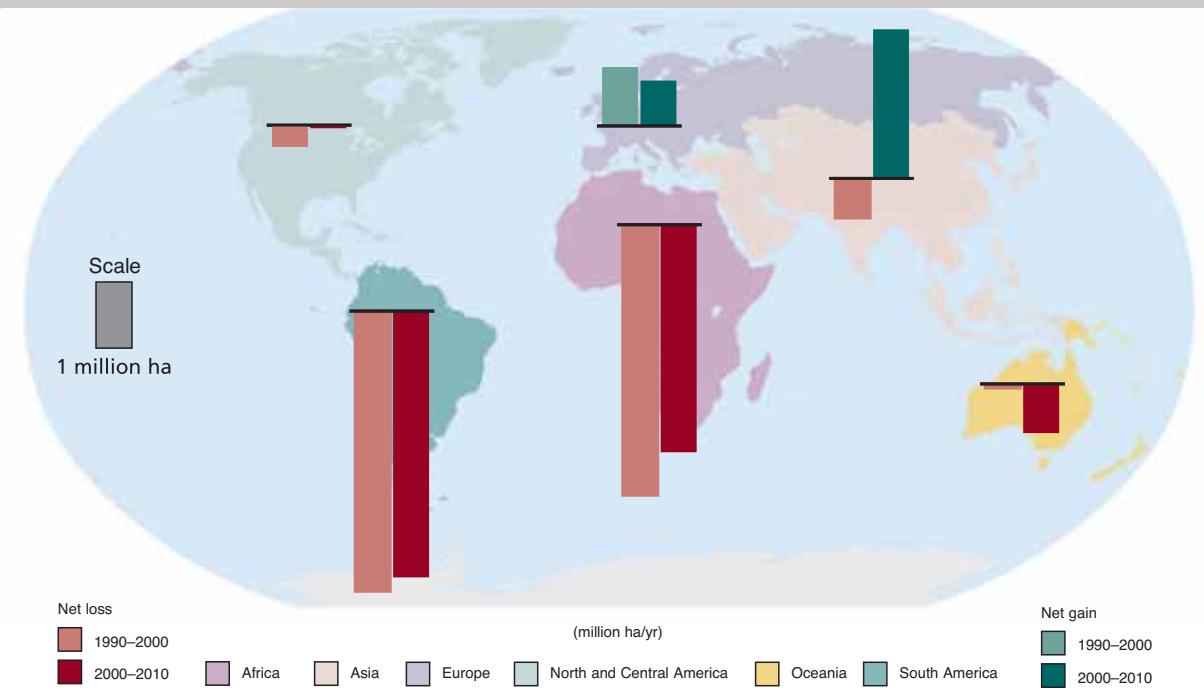


Figure 49. In some regions of Earth, the loss of forests is increasing carbon emissions into the atmosphere.

ACTION ON CLIMATE CHANGE

The United Nations has recognized the importance of taking action to reduce climate change. It developed an effort to reduce the amount of greenhouse gas emissions from deforestation and **degradation** in developing countries. This effort is known as REDD (**R**educe **e**missions from **d**eforestation and forest **d**egradation). In December 2010, the United Nations took another step forward. The new effort, known as REDD+, includes the following actions.

REDD+

Reduce emissions from deforestation
Reduce emissions from forest degradation
Manage forests sustainably
Conserve the carbon contained in forests
Enhance the carbon contained in forests

Under REDD+, developing countries will receive money if they successfully complete one or more of these actions. This money can be used to cover some of their costs.

The United Nations views REDD+ as an investment that will help countries to reduce the impact of climate change.

Recognizing that the carbon held on Earth within forests helps to address climate change has created a number of opportunities and challenges. People now recognize carbon **sequestration** as a benefit of having forests. This is in addition to other forest benefits that we explored in Inquiry 3. When thought of this way, you can see that by holding carbon, forests provide a service that has value. A government or a business may decide that maintaining forests for the carbon they hold is worth more than felling forests for fuelwood, agriculture, or for other reasons.

The United Nations also recognized that when forest managers work sustainably, they help people and forests worldwide adapt to a changing climate. As the climate changes, forest management will play an important role in maintaining the health and wellbeing of the world's citizens.

REFLECTION SECTION:

Countries are beginning to manage some of their forest areas primarily for the protection of soil and water (Inquiry 3). In the same way, do you think countries may begin to manage their forests primarily for the protection of carbon resources? Why or why not?

Look at the list of actions that make up REDD+. Compare the first two with the last three. How are the last three different than the first two?

FACTIVITY:

Two ways to address climate change are to take care of the trees and vegetation we have now and to plant more trees and other plants. Working with your teacher, identify 2 actions that your class can take now to address climate change. You may think of many other actions, such as decreasing the amount of energy you use or writing letters to your community leaders. Set a time line for when these actions will be taken and who will do what.

INQUIRY 5: HOW WELL ARE WE MANAGING OUR FORESTS WORLDWIDE?

THE SITUATION: In the previous 4 Inquiries, you learned many new things about the world's forests.

- You learned how much of the world's land area is covered in forest according to 3 forest categories (Inquiry 1).
- You learned about biodiversity and the world's forests (Inquiry 2).
- You learned about the benefits provided by the world's forests (Inquiry 3).
- In Inquiry 4, you learned about the role of the world's forests in addressing climate change.

FAO and the National Correspondents collected all of this information to learn something important about the world's forests. They wanted to know how well the world's forests are being managed. They were interested in whether we are making progress towards managing the world's forests **sustainably**.

As you know, forests provide many benefits to people and to the environment. For forests to provide these benefits into the future, 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 7 **criteria** and 18 **indicators** (Table 7). The indicators were the **variables** that were measured by FAO and the National Correspondents. Up to three indicators per criterion were identified. (Criterion is the singular form of criteria.)

CRITERION	INDICATOR 1	INDICATOR 2	INDICATOR 3
Extent of Forest Resources	Area of forest in hectares	Volume of trees growing per hectare in cubic meters of wood (Figure 50).	Total carbon being held in the forest in Gt
Biological Diversity	Area of primary forest in hectares	Area of forests managed for the conservation of biological diversity in hectares	Area of forest in protected areas in hectares
Forest Health and Vitality	Area of forest damaged by fire in hectares	Area of forest affected by insect pests in hectares	
Productive Benefits	Area of forest being managed for productive purposes in hectares	Area of planted forests in hectares	Total wood removals in cubic meters (Figure 50)
Protective Benefits	Total area managed primarily for the protection of soil and water in hectares		
Social and Economic Benefits	Area of forest in private ownership in hectares	Employment in the primary production of forest goods and related services in numbers of full time jobs	Total value of wood removals in US dollars
Legal and Policy Framework	Area of forest with a management plan in hectares	Level of employment in public forest organizations in numbers of full time jobs	Number of university students graduating in forestry each year

Table 7. The 7 criteria and 18 indicators used by FAO to evaluate sustainable forest management.

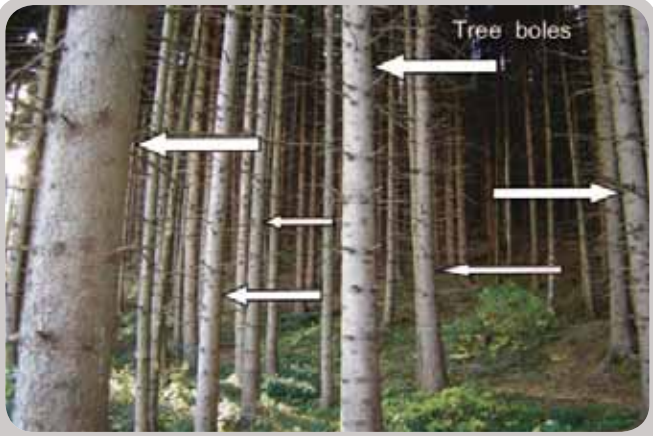


Figure 50. How are cubic meters of wood measured? A tree trunk is called a bole. A bole is essentially a long cylinder. When the volume of a tree is calculated, the branches and twigs are not included. Foresters estimate the amount of wood contained in the tree's bole using a formula based on the bole's diameter and length.

Do you think the volume of wood in a forest is estimated or is an exact figure? Why?

YOU DO THE MATH:

Let's say you are taking a walk in one of the world's forests. You have found a log that is 5 meters long with a diameter of 0.5 meter. What is the volume of the log in cubic meters?

The formula to calculate the volume of a cylinder is $V=\pi*r^{\wedge 2}*L$

where V=Volume, π is pi or 3.14, r=radius (which is one-half of the diameter), ^ = approximate calculation, 2 = squared (r*r), L= Length. (Note: * means to multiply.) You cannot calculate exactly how much wood is in this log. When you calculate the volume of a cylinder, it is close but not exact.

REFLECTION SECTION:

Look at the indicators in Table 7. What is similar about every one of the indicators?

Look at the last indicator of Social and Economic benefits. FAO calculated the value of wood removals in United States dollars. What did it have to do with the information from each country before it could report this figure?

WHAT FAO DISCOVERED: Progress toward sustainable forest management is different across the planet. In some regions and subregions, progress is positive; in others more work is necessary (Tables 8 and 9).

FAO and the National Correspondents are committed to collecting and reporting information about how the world's forests are being managed. The world's forests provide important benefits to Earth's citizens and its environment. With information, people can do a better job of sustainably managing the world's forests.

CRITERION	INDICATORS	HOW MUCH INFORMATION WAS AVAILABLE?***	1990 2000	2000 2010
Extent of Forest Resources	Area of forest in hectares	H	▲	▲
	Volume of trees growing per hectare in cubic meters of wood	H	▲	▲
	Total carbon being held in the forest in Gt	H	▲	▲
Biological Diversity	Area of primary forest in hectares	M	▲	▲
	Area of forests managed for the conservation of biological diversity in hectares	H	●	●
	Area of forest in protected areas in hectares	H	●	●
Forest Health and Vitality	Area of forest damaged by fire in hectares	M	●	●
	Area affected by insect pests in hectares	L	●	●
Productive Benefits	Area of forest being managed for productive purposes in hectares	H	▲	▲
	Area of planted forests in hectares	H	●	●
	Total wood removals in cubic meters	H	▲	●
Protective Benefits	Area of forest managed primarily for the protection of soil and water in hectares	H	●	●
Social and Economic Benefits	Level of private forest ownership in hectares	H	●	●
	Total value of wood removals in US$	M	▲	●
	Employment in the primary production of forest goods and related services in numbers of full time jobs	M	●	▲
Legal and Policy Framework	Area of forest with a management plan in hectares	M	●	●
	Level of employment in public forest institutions in numbers of full time jobs	L	■	▲
	Number of university students graduating in forestry each year	L	●	●

Table 8. How well are we managing the world's forests? You can see that the indicators are made up of information collected by FAO and the National Correspondents. The third column tells whether there was a high, medium, or low amount of information available. The fourth and fifth columns tell whether the change has been positive (●), negative (■), or little change has occurred (▲).

***** HOW MUCH INFORMATION WAS AVAILABLE?**

H= High (Reporting countries represent 75-100 percent of total forest area)
M=Medium (Reporting countries represent 50-74 percent of total forest area)
L=Low (Reporting countries represent 25-49 percent of total forest area)

REFLECTION SECTION:

Look at Table 8. Find the column labeled, "HOW MUCH INFORMATION WAS AVAILABLE?" Why is this important? Compare and contrast the meaning of findings for which little information was available with the meaning of findings for which much information was available.

Look again at Table 8 Change in "Forest Health and Vitality," "Protective Benefits," and "Social and Economic Benefits" has been positive. If these positive trends continue, what might you predict for the future of the world's forests?

CRITERION/INDICATOR	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 in hectares	■	▲	▲	●	▲	▲	▲	●	■	▲	▲	▲
Volume of trees growing per hectare in cubic meters of wood	▲	▲	▲	▲	▲	▲	▲	▲	▲	●	-	▲
Total carbon being held in the forest in Gt	■	▲	▲	●	■	●	▲	●	■	▲	-	▲
Biological diversity												
Area of primary forest in hectares	■	▲	■	▲	▲	▲	-	▲	■	▲	■	▲
Area of forests managed for the conservation of biological diversity in hectares	●	▲	●	●	●	●	●	●	■	●	-	●
Area of forest in protected areas in hectares	●	-	●	●	●	●	●	●	-	●	-	●
Forest health and vitality												
Area of forest damaged by fire in hectares	■	-	-	■	●	●	●	●	-	■	-	-
Area affected by insect pests in hectares	-	-	-	■	-	●	●	-	-	■	-	-
Productive benefits												
Area of forest being managed for productive purposes in hectares	■	▲	■	■	▲	▲	▲	●	■	●	▲	●
Area of planted forests in hectares	●	●	●	●	●	●	●	●	●	●	●	●
Total wood removals in cubic meters	●	●	●	▲	▲	▲	●	▲	▲	▲	●	●
Protective benefits												
Area of forest managed primarily for the protection of soil and water in hectares	■	▲	■	●	▲	▲	▲	●	■	●	-	▲
Social and economic benefits												
Level of private forest ownership in hectares	■	●	▲	●	▲	▲	●	■	■	▲	-	●
Total value of wood removals in US$	-	●	●	●	●	●	-	●	-	●	-	●
Employment in the primary production of forest goods and related services in numbers of full time jobs	●	-	-	■	●	■	■	-	●	■	■	-
Legal and policy framework												
Area of forest with a management plan in hectares	●	-	●	●	●	●	▲	●	-	●	-	●
Level of employment in public forest institutions in numbers of full time jobs	●	●	●	▲	▲	●	-	-	-	-	-	-
Number of university students graduating in forestry each year	●	■	●	●	■	●	-	■	■	●	-	●

Table 9. Progress toward sustainable management by region and subregion, 1990-2010.

● 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

FACTIVITY:

You can use your own criteria and indicators to assess the health of your own school yard. First, you have to identify the size of the land area you will assess. If you know the size in acres, multiply that amount by 0.405 to calculate the number of hectares. Next, complete the table below. You will have to estimate the percentages. If you can count the number of trees in your school yard, you will be able to calculate exact percentages.

CRITERION	INDICATOR	SCORING	SCORE
Extent of forest resources	Number of hectares included in the school yard	1-2 hectares = 1 3-5 hectares = 2 6-10 hectares = 3 More than 10 hectares = 5	
Extent of forest resources	Percentage of school yard planted in trees	None = 0 1-10 percent = 1 11-20 percent = 3 21-30 percent = 5 More than 30 percent = 7	
Biological diversity	Percentage of native trees growing in school yard	None = 0 1-10 percent = 2 21-30 percent = 5 More than 30 percent = 8	
Forest health and vitality	Percentage of trees damaged by insects, lightning, diseases, or other visible damage	None = 7 1-10 percent = 3 More than 10 percent =	
Productive benefits	Percentage of trees used for productive purposes, such as for nuts, fruits, or other products	None = 0 1-5 percent = 1 More than 5 percent = 2	
Protective benefits	Percentage of trees with evidence of wildlife or for which the area around the trunk is protected from erosion	None = 0 1-10 percent = 2 11-20 percent = 5 21-30 percent = 8 More than 30 percent = 12	
Social and economic benefits	Percentage of trees included in play areas or recreation areas	None = 0 1-5 percent = 1 6-10 = 5 More than 10 percent = 7	
Legal and policy framework	Does your school have a plan for taking care of the trees?	No = 0 Yes = 2	

Total points:	
Assessment:	

Assessment:
40-50 points = [green circle]
25-40 points = [yellow triangle]
Under 25 = [red square]

As a class, discuss your findings. What can your class do to help make your school yard healthier? Write your planned actions with a time line and who will do which action.

WORLD'S FORESTS PHOTO CHALLENGE!

Match the caption on the left to its photograph on the right. Using a pencil, write the caption number next to its photograph. Note that these photos have not yet appeared in the World's Forest edition!

1. Biodiversity is an important characteristic of forests and the plants and animals that make forests their home.

2. Forests protect environmental values.

3. Forests provide economic benefits to people.

4. Forests provide non-wood products like mushrooms and berries as well as wood products.

5. One social benefit of forests is what we can learn from research.

6. Primary forests may sometimes be replaced by a planted forest.

7. Trees hold a lot of carbon in their wood, helping to address climate change.

8. Forest biodiversity can be lost through natural and human-caused disturbances.

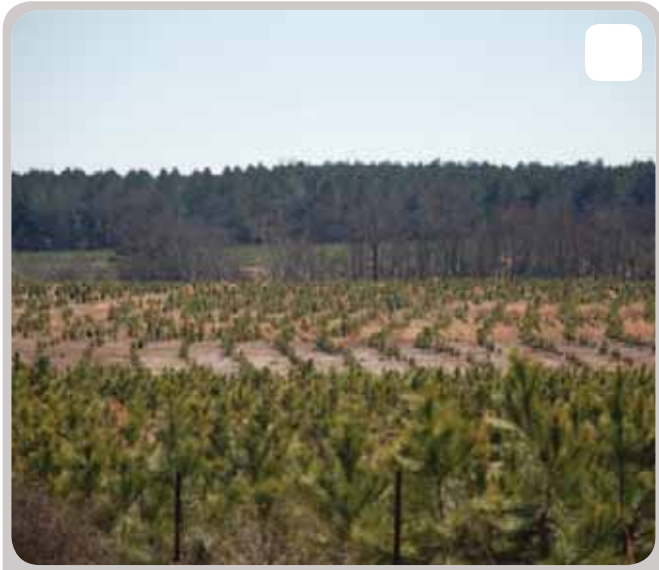
David Flashpohler

US Forest Service

Babs McDonald

Babs McDonald

Susan Cordell



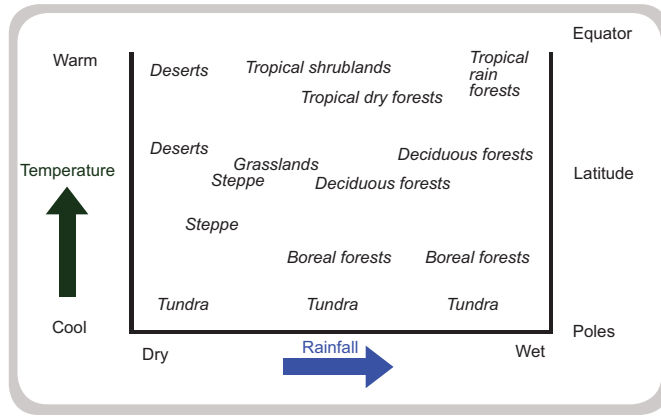
Babs McDonald

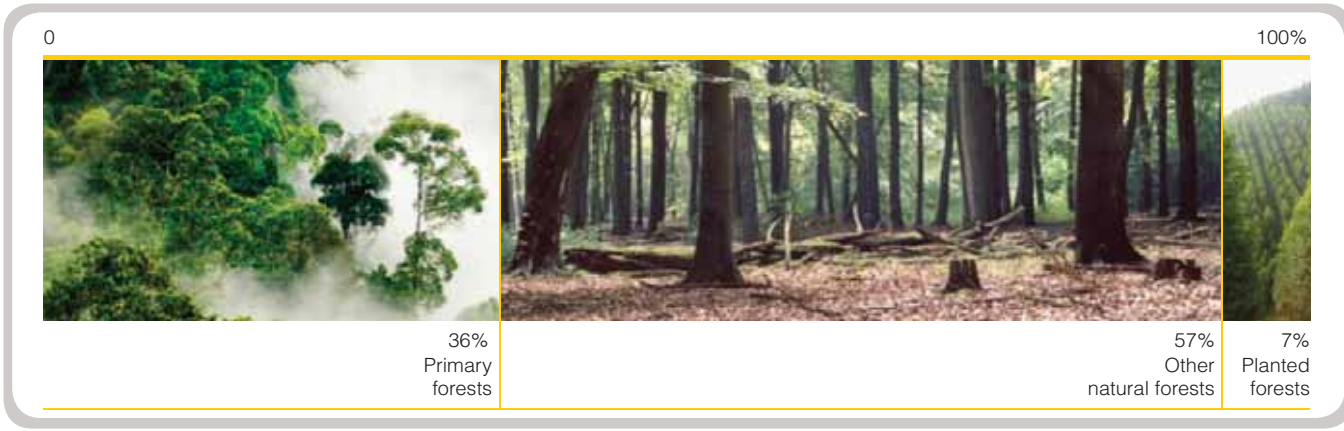
Babs McDonald

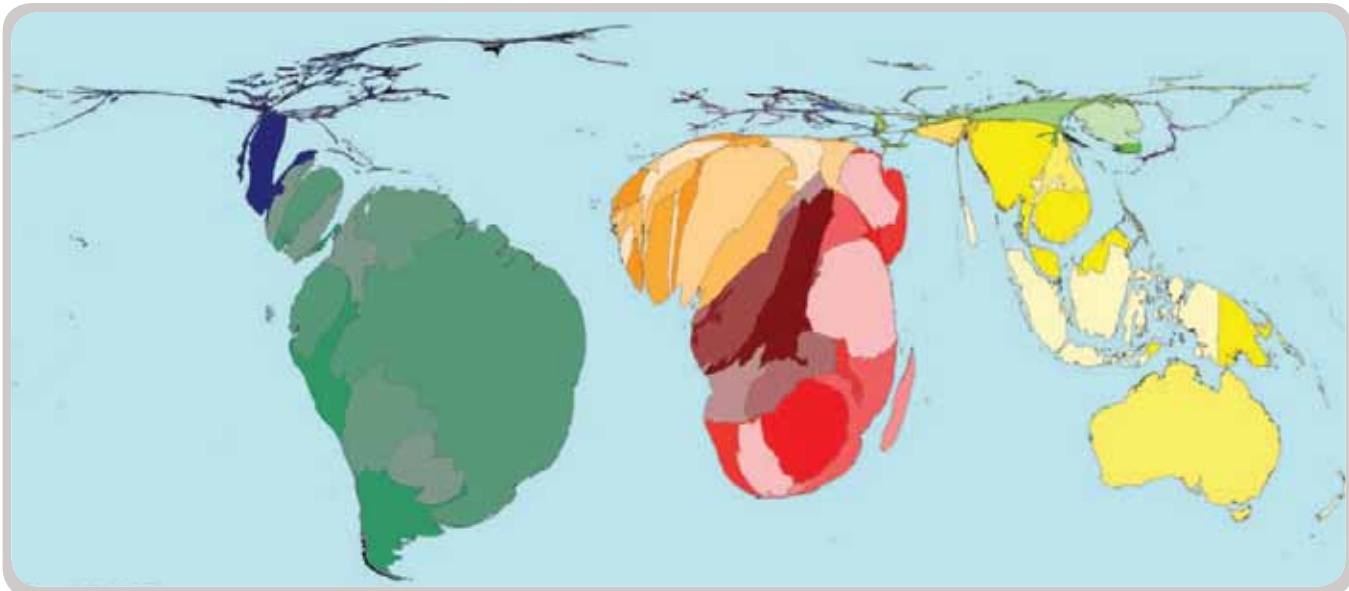
Research Scotland

FIGURE IT OUT!

Have students explain what each figure represents. Each of these photos have appeared in the journal. If desired, you may encourage students to discuss their understanding in more depth.







GLOSSARY

Arid: Not having enough rainfall to support agriculture.

Avalanche: A large mass of snow, ice, earth, rock, or other material in swift motion down a mountainside.

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

Axis: In the context of this report, an imaginary straight line about which Earth rotates.

Biodiversity: The state of having a variety of life forms including plants and animals, including a variety of genetic information among members of the same plant and animal species.

Browse: To graze. Browsing often refers to grazing on low shrubs or tree branches.

Bushmeat: The meat of land-based wild animals.

Classify: To assign to a category.

Climate: The average condition of the weather at a place usually over a period of years.

Conservation: Protection of something; especially the planned management of a natural resource to prevent exploitation, destruction, or neglect.

Conserve: To avoid wasteful or destructive use of.

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

Criterion (criteria is plural): A standard on which a judgment or decision may be based.

Decompose: To decay or rot.

Deforestation: The action or process of clearing of forests. Deforestation happens when a forest is destroyed and the area previously occupied by the trees is used for other purposes.

Degradation: The act of impairing or bringing to a lower level of quality. When a forest experiences degradation, it does not always mean that the area of forest is reduced. It may mean that the forest's natural processes have been disturbed. The result is that the forest is less productive than it could be.

Distort: To twist out of a natural, normal, or original shape or condition.

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

Drought: A period of dryness lasting a long time.

Ecological: Having to do with a branch of science concerned with the interrelationship of organisms and their environments.

Economic: Of, relating to, or based on the production, distribution, and consumption of goods and services.

Ecosystem: A set of relationships among the living resources, habitats, and residents of an area.

Equator: A great circle of Earth that is everywhere equally distant from the two poles and divides Earth's surface into the northern and southern hemispheres.

Erode: To wear away.

Genetic: Having to do with genes; the hereditary material of living things.

Germinate: To cause to sprout or develop.

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

Indicator: A pointer toward something.

Introduced: A tree species that is not native to the area in which it is growing.

Invasive species: A plant or an animal whose presence in an area causes harm or destruction to the native plants or animals.

Latitude: Distance north or south from Earth's equator, measured from 0 degrees (at the equator) to 90 degrees (at the poles)

Manage: To look after and make decisions about.

Modernize: To bring conditions to the present or the immediate past.

Native: Living or growing naturally in a particular region.

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

Organism: A living being.

Population: The total of individuals occupying an area or making up a whole.

Protected area: In the context of this report, a protected area is legally established for the purposes of protecting the area's natural resources and values.

Revenue: The total income produced by a given source.

Sequestration: The act of holding.

Social: Of or relating to human society.

Species: A class of individuals having common attributes and designated by a common name.

Stabilize: The act of firmly establishing or putting into a condition of having no change.

Sustainable: Of, relating to, or being a method of using a resource so that the resource is not depleted or permanently damaged.

Sustainably: Of, relating to, or being a method of using a resource so that the resource is not depleted or permanently damaged.

Transition: Change; passage from one state, stage, subject, or place to another.

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

Variable: A quantity that may assume any one of a set of values.

Vegetation: Plant life.

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 2010. In contains information from 233 countries and territories around the world.

You can access the FAO report at:
http://www.fao.org/forestry/fra/fra2010/en/.

This journal is organized into 5 Inquiries. Each Inquiry presents a category of findings from the Global Forest Resources Assessment 2010. Each Inquiry builds on the previous Inquiry's information, and each should be considered a separate lesson. A lesson plan for each section and Inquiry follows this "Note to Teachers."

The educational concepts, which immediately follow the "Reflection Section 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, 3 sections set the context for learning. "Welcome to the World's Forests Edition of the *Natural Inquirer*!" provides an introduction to the journal.

"Thinking About the World's Forests" presents the 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 included 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 50.

Each Inquiry is comprised of 2 main sections: "The Situation" and "What FAO Discovered." "The Situation" introduces the question asked by FAO. This section also presents background information that led 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 FAO Discovered" presents the answer to the research question. This section includes tables, figures, 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 and stimulate discussion. Possible answers to the Reflection Questions can be found on page 58.

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 forests within their own country and region 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 on the map on page 9.

Note that the first occurrence of glossary words is given in bold. The glossary is on page 44 and the words are presented in alphabetical order.

LESSON PLANS INTRODUCE THE NATURAL INQUIRER

Tell your students that they are going to be learning about the world's forests. If possible, give each student a copy of the journal. Have them look at the cover and read the 5 topics the journal addresses. Have them examine the cover photos associated with each topic. In a rapid fire format, have students share what they currently know about each of these topics. If possible, write a list of what students currently know about each of these 5 topics on the blackboard or whiteboard. Save this list for later. Note that the first occurrence of glossary words is given in bold. Glossary words are defined on page 45.

WELCOME TO THE WORLD'S FORESTS 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 2011, the UN was 66 years old.)

Students should read the next paragraph. Hold a discussion about the meaning of the word "improve." What does it mean to them? What might improvement mean to people in a country that is 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?"

LOGO SIDEBAR:

Have students read the International Year of Forests sidebar and compare the text with the logo. How have people and forest benefits been shown by the logo? What does the logo say to them?

Examine Figure 1. Has anyone seen a forest planted specifically to produce products? Have them tell about it. If not, what do they imagine such a forest might look like?

Have students read the next 2 paragraphs in preparation for examining Figure 2. Have them locate their region and subregion.

Read the next paragraph, beginning with "Every 5 years…" At the end of the paragraph in rapid fire format, have students say what they think are benefits provided by the world's forests. Write this list on the blackboard or whiteboard and save it.

Read the next paragraph and then, using Figure 2, have students find the region where they live.

LESSON PLAN FOR "THINKING ABOUT THE WORLD'S FORESTS"

Have students read the paragraph. Compare this list of benefits given in this paragraph with the student-generated list created above. Hold a class discussion about whether students were surprised at some of the benefits provided by forests. Can they think of any additional benefits?

Look at Figure 3. What are some of the forest benefits illustrated by this photograph?

LESSON PLAN FOR "THINKING ABOUT SCIENCE"

This section provides the background for how FAO collected information about the world's forests. Begin by asking students if they can imagine how FAO collected information about forests all over the world. After students provide some ideas, have them read the first 2 paragraphs. Hold a discussion about the first and second paragraphs, then read and discuss the third paragraph. Check student understanding of the term, "unit of measurement."

After students read paragraph 4, have them read the statement from Mr Souleymane GUEYE. By asking questions, make sure that students understand that each National Correspondent was responsible for working with others in his or her country to collect and report information to FAO. Each correspondent also worked with other National Correspondents to share information about their country.

Discuss what Mr GUEYE might have meant when he said, "...the world is a village and we have all to act in the same direction for the safety and sustainability of mankind." Ask students to discuss other thoughts they have in about Mr GUEYE's statement.

You may then direct their attention back to the purpose of the data collection and ask the reflection questions.

LESSON PLAN FOR "INTRODUCTION TO THE INQUIRIES"

As an educator, read this section in advance. You may paraphrase the information in this section without having students read each paragraph. It is most important for students to understand that each Inquiry builds on the previous one. It is important, therefore, to present them in order.

LESSON PLAN FOR INQUIRY 1

THE SITUATION:

Have students read the first paragraph. Have students examine Figure 5 and identify their country's ecozone type. Have them identify another area of the world with a similar ecozone. Ask them if they think the two areas look similar.

Why or why not? They should guess that the areas look somewhat similar in vegetation cover if they are in similar ecozones, because an ecozone describes an area's land cover.

In the next number of paragraphs, students will explore Earth's climate zones and associated vegetation cover. Have students read a paragraph and then examine the associated figure, through Figure 10. Make sure that students understand what each figure is showing about Earth and its relationship to a particular climate zone.

Now look at Figure 11. Have students do a comparison of these photographs. Students may work in pairs or individually. Have students make a list of the similarities and differences between any two of the photographs. If students can find the approximate country location on a world map, have them identify the photograph's ecozone by referencing Figure 5.
Using this information, have students describe what the photographs reveal about the vegetation in different ecozones. Students can summarize their results for the Reflection Question.

Read the next two paragraphs, answering the question in the first paragraph before moving to the second. Look at Table 1. Make sure that students understand the 3 categories of forests studied by FAO before moving to the next section.

WHAT FAO DISCOVERED:
Have students read the first paragraph and examine Figures 12-14. If desired, students can calculate the area in acres by using the following formula:

Acres = hectares*2.47

If you are in the United States of America, remind students that soccer is called football across the rest of the world. Have them note some characteristics of the Siberian forest in Figure 15.

Read the next paragraph. Ask students to define a primary forest. Look at Figure 16. Have them compare the photographs. What are the similarities and differences? Ask them to explain why they think the differences exist.

Ask students to calculate the percentage of primary forest covering Earth's entire surface. (Multiply 36 percent by 31 percent.) Do they think this is a lot of forest area? Why or why not? (Students will have individual answers to this question. The important thing is for them to provide a reason for their answer.)

Now have students go back and examine Figure 12. Ask them to identify where most of the world's forests are located on Earth.

Have students read the next paragraph (beginning with "The number of hectares of planted forests…"). Have them examine Figure 16. Ask them to summarize what the findings in this paragraph and figure tell us about the world's forests.

Have students read the next paragraph about deforestation and examine Figure 17. Have them explain the cause of deforestation in this photo.

Have students read the next paragraph (beginning with "To help understand…"). Have students study Figure 18. This shows the world's countries and their real areas. Have them identify their own country and any other countries. The following maps, called cartograms, show the countries distorted in size according to a statistic about forest gain or loss (Figures 19-21).

Now, students can work in small groups, in

pairs, or individually. Have them examine each cartogram and study their own country in relation to other countries. After they have examined all of the cartograms, hold a discussion based on the reflection question that begins with, "Look at Figures 19-21…"

Next, have students discuss their answers to the remaining reflection questions.

Optional: Do the FACTivity.

LESSON PLAN FOR INQUIRY 2

THE SITUATION:

Have students read the first paragraph. Before going to paragraph 2, make sure that students understand what biodiversity is.

Have students read paragraph 2. Hold a discussion about the various levels of biodiversity. (Biodiversity is literally a diversity of life.) Note that an area can be biologically diverse at the genetic level up to the level of plant and animal communities.

Have students read to the "Reflection Section." Have students state in their own words the three things FAO measured to better understand biodiversity in the world's forests. Then, hold a class discussion based on the reflection questions.

WHAT FAO DISCOVERED:

Have students read the first paragraph and examine Figure 23. Have students examine their own country. Hold a class discussion about whether students have visited any primary forests. If they have, have them share their experience with the class. What did they observe about these forests? What did they like or dislike? Does their country have any birds that look similar to the bird in Figure 22? What do they think the bird in the figure eats? (The bird eats nectar from tropical flowers. Its beak is uniquely adapted for this purpose.)

Genetic Diversity Sidebar: Have students read the sidebar. Hold a discussion about diversity and adaptation. Ask students to consider what would happen if all humans had the same genetic makeup. Ask them to consider if that would be a good thing for humans. Have them state their reasons for their answers.

Have students read the next paragraph and examine Table 2. What do they think stands out in the percent of forest area column? (Europe has a low percentage of area set aside for biodiversity compared with the rest of the world.)

Have students examine Figures 24 and 25. Ask students what they can learn from those figures about the possible future of biodiversity in their own country's and region's forests.

Have students read the next paragraph. What do they think is the most important sentence in that paragraph and why? (Students will have individual answers to this question. Their answers can be used to stimulate a class discussion about protected areas.)

Have students examine Figure 26. Have them discuss how their region compares with other regions in the percentage of protected forest areas.

Have students "do the math." Ask them whether this is a good or a bad sign for the future of forests

worldwide and why. (Multiply 94 000 000 by 0.66)

Have students read the next paragraph (beginning with "Biodiversity can be threatened…"). First, have students compare the number of hectares damaged worldwide with the number damaged in North America. About what percentage of insect damage has occurred in North America? Hold a discussion about the increase in damage from invasive insects. There are two main reasons given for the increase in insect damage. Ask students to identify those two reasons.

Have students examine Figure 27. What do they notice about insect damage worldwide and in their own country? What reactions do they have to the amount of damage shown in Figure 28?

Have students read the next paragraph. Ask students what is similar about the quality of the information between reports of fire damage and insect damage? (Not many countries kept records of this kind of damage.)

Have students examine Figures 28 and 30. Do they think the forest in Figure 30 has a high level of biodiversity? Why or why not?

Have students read the sidebar. Hold a discussion about whether or not students were aware that fire can be a good thing for some forests. Now have students reflect on why FAO used the occurrence of fire as an indication that a forest might not have biodiversity. (FAO had to use just a few measures to determine whether a forest had biodiversity. Although some forests need occasional fires, if a forest is destroyed by a fire, it mostly likely no longer has biodiversity.)

Hold a class discussion based on the two reflection questions.

Optional: Do the FACTivity.

LESSON PLAN FOR INQUIRY 3

THE SITUATION:

Have students read the first paragraph. Ask students to recall that they had earlier created a list of forest benefits. Bring this student list to their attention and see if they can add any new benefits to the list.

Have students read the next paragraph. On the student-generated list of benefits, have the class say which they believe are productive benefits. Do this for each of the next three paragraphs, identifying which benefits from the list are protective, social, and economic. Some of the benefits might fit into more than 1 category. Have students read the next paragraph before considering the reflection questions.

WHAT FAO DISCOVERED:

Have students read the first paragraph. Discuss what might be meant by the term "multiple use." (Multiple use means that forests are used for more than one purpose. For example, forests might provide products and social benefits at the same time.)

Have students examine Table 3. Hold a class discussion about why European forests might have such a high percentage of area in productive forests. Now have students examine Figure 31.

Ask students to share their experience of a productive forest. If none of your students have an experience with a productive forest, ask them to imagine what one might look like. You may, if you have time, give students the opportunity to

draw their vision of a productive forest.

Have students read the next paragraph and examine Figure 32. Hold a class discussion about wood products. Ask students if they can identify any wood products around them.
Also discuss the idea of non-wood forest products. From Figure 32, have students explain why they think these countries have the largest volume of wood removed by percentage. These include food, botanicals for medicines, grasses for weaving, and other non-wood products.

Have students read the first paragraph under "Protective Forest Benefits." Discuss soil and water conservation. In a class discussion, have students explore why soil and water conservation provide overall protection for forests. Have students compare regions in Figure 34. What do they think stands out about soil and water conservation by region? Have students examine Figure 33. How do they think forests help to conserve soil and water?

Have students read the paragraph about desertification. Have them compare Table 4 with Figure 35. Do students know the location of the countries listed in Table 4? If not, have them use an atlas, encyclopedias, or the Internet to identify the location of each country. Then they can compare each country's location with the map in Figure 35.

Students should now read the first paragraph under "Social and Economic Benefits." Hold a class discussion about what social benefits are. Have them consider whether people in their country enjoy social benefits from forests. Hold a class discussion about these benefits.

Have students compare and contrast Figure 36 with Figure 37. Have students identify and discuss the differences in the social benefit being described by each photograph.

Students should read the next paragraph, beginning with "FAO found that some countries…" Have students consider the idea of "multiple use." Have them reflect on whether classifying forests as multiple use forests causes some of the particular forest benefits to be forgotten. Also have them consider whether managing forests for multiple uses is a good idea. Have them identify advantages and disadvantages of managing forests for multiple uses.

Have students examine Table 5. Have them identify what stands out about the information given in Table 5. Discuss whether they think Oceania's forests offer any social benefits and why.

Now students will read about economic benefits. Have students read the first 2 paragraphs. Hold a class discussion about whether students agree with FAO that non-wood forest products have a much higher value than was discovered in this research. Have students give reasons for their position.

Have students read the next paragraph and examine Figure 38. As a class, identify different kinds of jobs related to the forest sector. Remind students that many of these jobs might be done in an office. If any students have met an individual who works in the forest sector, have them share what they know about this person and their job.

Now have students "do the math." Hold a class discussion about whether that seems like a large or a small percentage. Challenge students to think of all of the different kinds of jobs people can have as they consider the percentage of people working in the forest sector. Examples are education, healthcare, business, retail,

construction, manufacturing, (non-forest) agriculture, and travel.

Now have students consider the reflection section. Hold a class discussion to explore each of these questions.
Read the sidebar. What social benefit is highlighted in the paragraph? What social benefits are shown in Figure 39?
Optional: Do the FACTivity.

LESSON PLAN FOR INQUIRY 4

THE SITUATION:

Have students read the first paragraph. Hold a class discussion about whether students agree that the climate has been changing more than one would have expected from normal cycles. Ask students to point to any evidence that they have. Explore whether the evidence can be trusted and why.

Have students read the next paragraph. Before moving on, test student knowledge to make sure that they understand what the greenhouse effect is and that it is vital to regulating temperatures on Earth so that life can exist on Earth.

Have students read the next paragraph and examine Figure 40. Hold a class discussion about the rising level of greenhouse gases in the atmosphere. Have students explain what they understand from examining Figure 40. Have students explore whether this figure supports the position that greenhouse gases are rising more than should be expected from normal cycles.

Have students read the next paragraph, beginning with, "Carbon dioxide is one of the…" Check to make sure that students understand (1) that atmospheric carbon dioxide is necessary for life to exist on Earth and (2) that it is only when too much carbon dioxide gets into the atmosphere that plants and animals are affected.

Have students read the next paragraph and examine Figures 41 and 42. Check to make sure that they understand the carbon cycle and that trees (and therefore forests) play a role in the carbon cycle by absorbing and holding carbon on Earth.

Have students read the next 2 paragraphs. Ask students if they think that carbon is present in high amounts in trees. (Students should conclude that if half of a tree's dry weight is carbon, that carbon is present in high amounts in trees.)

Have students do the reflection questions. Hold a class discussion about each of these questions.

WHAT FAO DISCOVERED:

Have students read the first paragraph and examine Figures 43 and 44. Ask students if they have seen litter and deadwood in forests, either in person or in photographs. If they have, have them compare and contrast the litter and deadwood they have seen with Figures 43 and 44.

Have students read the next short paragraph and examine Figure 45 and 47. Ask students to compare and contrast the pie charts. Ask which region's forests hold the most carbon. Why do they think this is so?

Have students "Do the math." Ask them to give their reactions to the weight of the carbon in all of the world's forests.

Have students read the next paragraph, beginning with, "The amount of carbon in the forests' litter…" Ask students if they are surprised at the comparison between the amount of carbon in litter and deadwood, compared with the amount of litter in the soil. Ask students to explain their reaction.

Have students read the next sentence and examine Figure 48. Ask students what they notice about this bar chart. (Students should notice that the amount of carbon being held has gone down in all but 2 regions.)
Have students read the next sentence and examine Table 6 on page 33. Ask them what they notice about the amount of carbon being held by the world's forests per hectare. Then have them read the next short paragraph.

Do the reflection question on page 35 and hold a class discussion about the role of forests in reducing the impact of climate change.

Have students read the paragraph about the IPCC and examine Figure 49. Ask students why the loss of forests may be increasing carbon emissions into the atmosphere.

ACTION ON CLIMATE CHANGE

Students should read the paragraphs about the United Nations work with REDD and REDD+, and then read the action items associated with REDD+. Ask students how they can tell that the first 2 action items are a part of REDD.

Read the next paragraph. Discuss the use of money to encourage action to address climate change. Do students agree that this is a good idea? What are the advantages and disadvantages of using money to encourage action?

Now have students read the paragraph about carbon sequestration. Make sure that students understand how carbon sequestration compares with other forest benefits. Check their knowledge concerning the value of carbon sequestration.

Have students read the next paragraph, beginning with, "The United Nations also recognized…" Hold a class discussion about how forest management can help maintain the health and wellbeing of the world's citizens.

Do the reflection questions and hold class discussions about each question.

Optional: Do the FACTivity.

LESSON PLAN FOR INQUIRY 5

THE SITUATION:

The first 2 paragraph introduces the idea of criteria and indicators for healthy and sustainable forest management, as defined by FAO. Have your students read this paragraphs and check to make sure that they understand what the words "criteria" and "indicators" mean. Have your students examine Table 7.

Have them take time to explore this figure. Check to make sure that they understand each set of indicators, when taken together, provide evidence regarding the criterion to which the set of indicators is associated.
Before doing the math, have students examine Figure 50 and check their understanding of cubic meters of wood.

Then "do the math." This math problem relates to the second indicator of the first criterion (cubic meters of wood). As an extension, get a cylinder (such as a pencil or a can), measure

its diameter and length, and calculate its approximate volume.

Compare the cylinder with the photo of tree boles. What is one difference between a tree bole and the cylinder?
If students need a hint, show them a cup that has a smaller diameter at its base than at its top. Ask students to guess why the calculation of a tree bole's volume is not exact.

Do the reflection questions. Hold a class discussion about each question.

WHAT FAO DISCOVERED:
Have students read the first paragraph. In small groups, have them examine Tables 8 and 9. Their examination of Table 9 should focus on comparing their subregion with their region; and their region with the rest of the world.

What can students say about sustainable forest management worldwide and in their subregion and region? Ask them how their subregion compares with the rest of the world. If students had the opportunity to speak with forest managers in their own subregion or country, what would they recommend?

As an extension, have students write letters to their country's forestry division with recommendations for forest management, based on FAO's study about the world's forests. Have students read the last paragraph and then do the reflection questions. Hold a class discussion about these questions.

Challenge students to compare the positive signs with some of the less positive findings presented in this journal. Overall, what do they see in the future of the world's forests?

Optional: Do the FACTivity.

Summary Exercise:
Have students divide into 5 small groups. Each group will take one of the Inquiries and create a poster to summarize the information in their Inquiry. Display the posters in the school.
As an alternative, have each group create a 5-10 minute verbal summary of their Inquiry. Present these summaries in order, for a total of 25-50 minutes, to other students (and parents). Invite local forestry professionals if possible.

WORLD'S FORESTS PHOTO CHALLENGE!

These are new photos that the students have not yet seen. They should match each photo with its caption by numbering the photos according to the correct caption. Hold a class discussion about the photos and explanations.

FIGURE IT OUT!

Students should examine each of the images on this page and in small groups or as a class, explain the meaning of the image based on what they have learned in the Inquiries.

REFLECTION SECTION
ANSWER GUIDE

REFLECTION SECTION 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 SCIENCE

What are some of the benefits forests provide to your community? *Students should be able to identify at least 3 of the following benefits: wood products, homes for wildlife, clean water, clean air, places to live and play, food, and energy. Students may also know that forests hold carbon on Earth, reducing the impact of climate change; and they may know that forests help to slow or stop soil erosion.*

Do you think it is helpful to get information about forests in different regions of the world? Why or why not? *Students will answer individually to this question and should back up their answer with logic. They should realize, however, that it is helpful to get information about regions so that regions can be compared.*

INQUIRY 1

THE SITUATION:

Compare and contrast the forests shown in Figure 11. What are their similarities? What are their differences? *Students should identify at least 2 similarities and 2 differences and explain what these similarities and differences are. For more challenge, have students imagine why the forests they compared are different.*

What do you think about the changes in your country's forests over the past 5 years? Is this a change for the better or worse? Why or why not? *Each student will have individual answers to these questions. You can use this question to start a class discussion about your country's forest resources, their value, and forest management.*

WHAT FAO DISCOVERED:

Look at figures 19-21. What can you say about the change in your country's forests in the past 5 years? *Each student, depending on their location, will have a different answer. Students in the same classroom should come to similar conclusions about changes in their country's forests over the past five years.*

Why is it important to understand whether the amount of forest area worldwide is shrinking, growing, or staying about the same? *Individual students will have different answers to this question. This question can be used to begin a discussion about the value of forests to people and the planet.*

INQUIRY 2

THE SITUATION:

Why do you think biodiversity if important to the world's forests? *Students will have individual answers to this question. They should be able to back up their answers with logical reasons.*

Some possible answers include:

1. *Biodiversity creates a variety of places for animals to live.*
2. *Biodiversity protects species from becoming endangered.*

3. *Biodiversity ensures a variety of forest products.*
4. *Biodiversity allows species to adapt over time.*
5. *Biodiversity provides insurance against one species using too many resources.*

How could knowing the number of hectares in each of the 3 categories help FAO to understand how healthy those forests were in 2010? *Primary forests are forest with native tree species and with little evidence of human activities. In primary forests, the ecological processes are not much disturbed. Because of this, primary forests indicate healthy forests.*

WHAT FAO DISCOVERED:

Based on FAO's findings, would you say that the health of the world's forests is increasing or decreasing? Why? *Students will have individual answers to this question, but they should look at the evidence given and be ready to discuss their thinking. Based on the findings about primary forests, it appears that the health of the world's forests is decreasing.*
Based on the findings about the number of hectares of forests set aside for either biodiversity or other ecological functions, it appears that the health of the world's forests is increasing.

Due in part to climate change, damage from insects, disease, fire, and other disturbances may increase in the future. This would negatively affect the health of forests worldwide. FAO, therefore, found both positive and negative indicators of forest health.

Is it important to protect the biodiversity of forests? Why or why not? *Students will have individual answers to this question. Students should be able to back up their answer with logic.*

One of the most important reasons to protect biodiversity is that biodiversity is considered to be the most important indicator of forest health. It is important to keep forests healthy so that they can continue to offer benefits to people and wildlife into the future.

INQUIRY 3

THE SITUATION:

If the size of the world's forest decreases, what will happen to the amount of benefit forests provide to people? What does this suggest about how we should manage our forests?
Students should realize that if the size of a forest decreases, the amount of benefit it can provide will decrease as well.

Students should realize that if we want to continue to enjoy the benefits forests provide, we will have to manage forests so that they can be sustained into the future.

Do you think that anywhere forests are located on Earth they provide benefits in all four of FAO's categories? Why or why not? *Students will have individual answers to this question.*
They should realize, however, that forests everywhere provide benefits in all four of FAO's categories. In your classroom, you can have a discussion about the benefits of nearby forests and contrast this with possible benefits of a forest far away.

WHAT FAO DISCOVERED:

Why are the protection of soil and water important to the world's citizens? *Students will have individual answers, but they should realize that healthy soil is necessary for agriculture and that clean water is necessary for all life.*

What are some of the social benefits you enjoy from visiting forests? *Students will have individual answers to this question.*
Remind them of what social benefits are: outdoor recreation, tourism, education, research, and the existence of cultural or spiritual areas. Some of the benefits could include health and wellbeing, fitness, time with family and friends, learning, and inspiration.

INQUIRY 4

THE SITUATION:
Do you think that humans contain carbon? Why or why not? *Students should realize that since humans are animals, they contain carbon. (About 18 percent of a human body's weight is carbon, and carbon is the second most prevalent element in a human behind oxygen.)*

Why should we care whether the world's forests are holding the same amount, more, or less carbon over time? *Each student will have an individual answer to this question. Students should be able to back up their answer with logic. Students should conclude that we can better manage the world's forests for reducing the effects of climate change if we know over time how much carbon is being held by those forests.*

WHAT FAO DISCOVERED:
How do forests help to reduce the impact of climate change? *They absorb and hold carbon on Earth.*

Countries are beginning to manage their forests primarily for the protection of soil and water (Inquiry 3). In the same way, do you think countries may begin to manage their forests primarily for the protection of carbon resources? Why or why not? *Students will have individual answers to this question. This question asks students to imagine how forest management priorities might change in the future as the climate continues to change. Use this question as a discussion about current and future benefits of forests, and the role of forests in mitigating climate change.*

Look at the list of actions that make up REDD+. Compare the first two with the last three. How are the last three different than the first two? *The first two describe an effort to reduce carbon emissions. The last three go much farther and involve a greater effort to actively manage forests so that carbon is not just lost, but so the service provided by forests when they hold carbon can be enhanced into the future.*

INQUIRY 5

THE SITUATION:
Look at the indicators in Table 7. What is similar about every one of the indicators? *Students may need a hint with this answer. Every indicator can be measured.*

Look at the last indicator of Social and Economic benefits. FAO calculated the value of wood removals in United States dollars. What did it have to do with the information from each country before it could report this figure? *The value of wood removals in each country's currency had to be recalculated to its value in United States dollars. This was done so that the same unit of measurement was used. In "Thinking About Science," students learned the importance of*

using the same unit of measurement.

WHAT FAO DISCOVERED:

Look at Table 8. Find the column labeled, "HOW MUCH INFORMATION WAS AVAILABLE?" Why is this important? *Compare and contrast the meaning of findings for which little information was available with the meaning of findings for which much information was available. The more information available, the more confidence FAO can have in its findings. For those indicators where little information is available, FAO cannot be as confident that the findings reflect the true situation. Where a lot of information is available, FAO can be much more confident that the findings reflect the true situation.*

Change in "Forest Health and Vitality", "Protective Benefits" and "Social and Economic Benefits" has been positive. If these positive trends continue, what might you predict for the future of "Forest Health and Vitality?" *Although no one can know the future, if "Protective Benefits" continues to change in a positive direction, "Forest Health and Vitality" may become more positive in the future. On the other hand, if the amount of forest land continues to decline, we may find fewer forests on Earth, even if they offer a greater amount of protective benefits.*

EDUCATIONAL CONCEPTS ADDRESSED BY THE INQUIRIES

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 geographical 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 does FAO do to help build a world without hunger? Its work is divided into 4 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 by visiting ***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.

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 will 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.html***
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***
Digital divide ***http://www.fao.org/kids/en/divide.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***
Home page for kids ***http://www.fao.org/kids/en/***

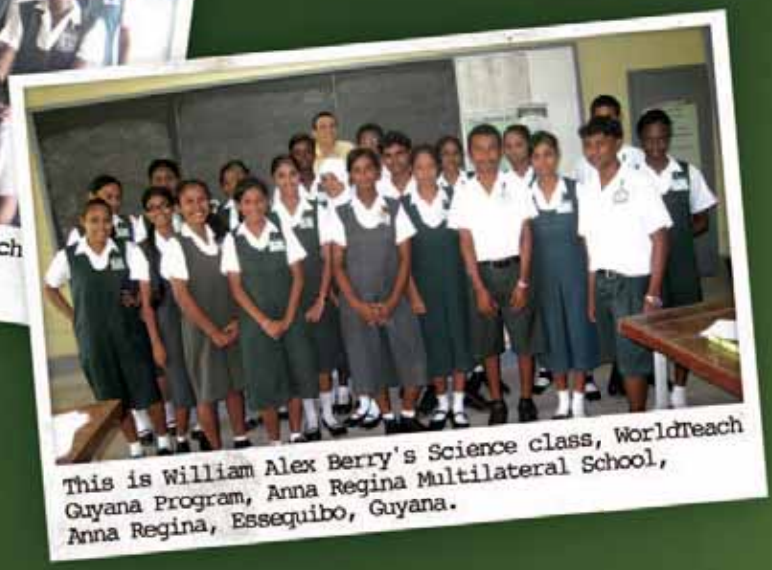
WHAT IS THE USDA FOREST SERVICE?

The United States Department of Agriculture – Forest Service is an organization of people who manage, teach about, and study the forests and ranges in the United States and worldwide. The Forest Service publishes ***Natural Inquirers*** on a variety of topics, such as climate change, bioenergy, invasive species, and tropical forests. The Forest Service worked with FAO to create the ***Natural Inquirer*** World's Forest edition so that students worldwide can learn about the forests that sustain life on Earth. For more information and to order ***Natural Inquirers***, visit http://naturalinquirer.org.

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 Sarah Frei's Science class, WorldTeach Guyana Program, Patentia Secondary School, Patentia, West Bank Demerara, Guyana.



This is William Alex Berry's Science class, WorldTeach Guyana Program, Anna Regina Multilateral School, Anna Regina, Essequibo, Guyana.

Internet Resources:
United Nations: http://www.un.org
Food and Agriculture Organization: http://fao.org
Natural Inquirer: http://www.naturalinquirer.org
International Year of Forests: http://www.un.org/en/events/iyof2011/
FAO for Kids: http://fao.org/kids/en
Forest Service for Kids: http://www.fs.fed.us/kids/
Global Forest Resources Assessment 2010: http://www.fao.org/forestry/fra/fra2010/en/
Member States (countries) of the United Nations: http://www.un.org/en/members/index.shtml