

Climate Educator Guide



- **Climate Basics**
- **The Carbon Cycle**
- **Trees and Carbon**
- **Forests of Guatemala**
- **Investments in Forest Carbon**

Activity 1

Climate Basics

Guatemala

Overview

The Earth's climate is changing due to an increase of carbon dioxide (CO₂) in the atmosphere. In this activity, students will explore the relationship between CO₂ and climate by graphing changes in atmospheric CO₂ over a 50-year period. They will also interview family members or neighbors to find out whether they have observed any climate changes in the area.

Objectives

- Students understand that gases in the Earth's atmosphere affect climate.
- Students will examine and analyze trends in CO₂ levels.
- Students will learn how an increase in temperature can affect humans and ecosystems.

Assessment

To assess their understanding of the relationship between CO₂ and climate, ask students to write a paragraph describing what they learned from the graphing activity and the interviews.

Subjects

- Science
- Math
- Social Studies
- Language Arts

Concepts (from PLT Conceptual Framework)

- Altering the environment affects all life forms, including humans, and the interrelationships that link them. (2.2)
- When the Earth is studied as an interacting ecological system, every action, regardless of its scale, affects the biosphere in some way. (4.3)
- Ecosystems change over time through patterns of growth and succession. They are also affected by other phenomenon such as disease, insects, fire, weather, climate and human intervention. (5.4)
- Our increasing knowledge of the Earth's ecosystems influences strategies used for resource management and environmental stewardship. (5.5)

Skills

- analyzing
- determining cause and effects
- discussing



- identifying relationships and patterns
- researching

Materials

- copies of student pages (optional)
- graph paper (optional)

Time Considerations

Preparation: 10 minutes

Activity: two to three 50-minute class periods

Background

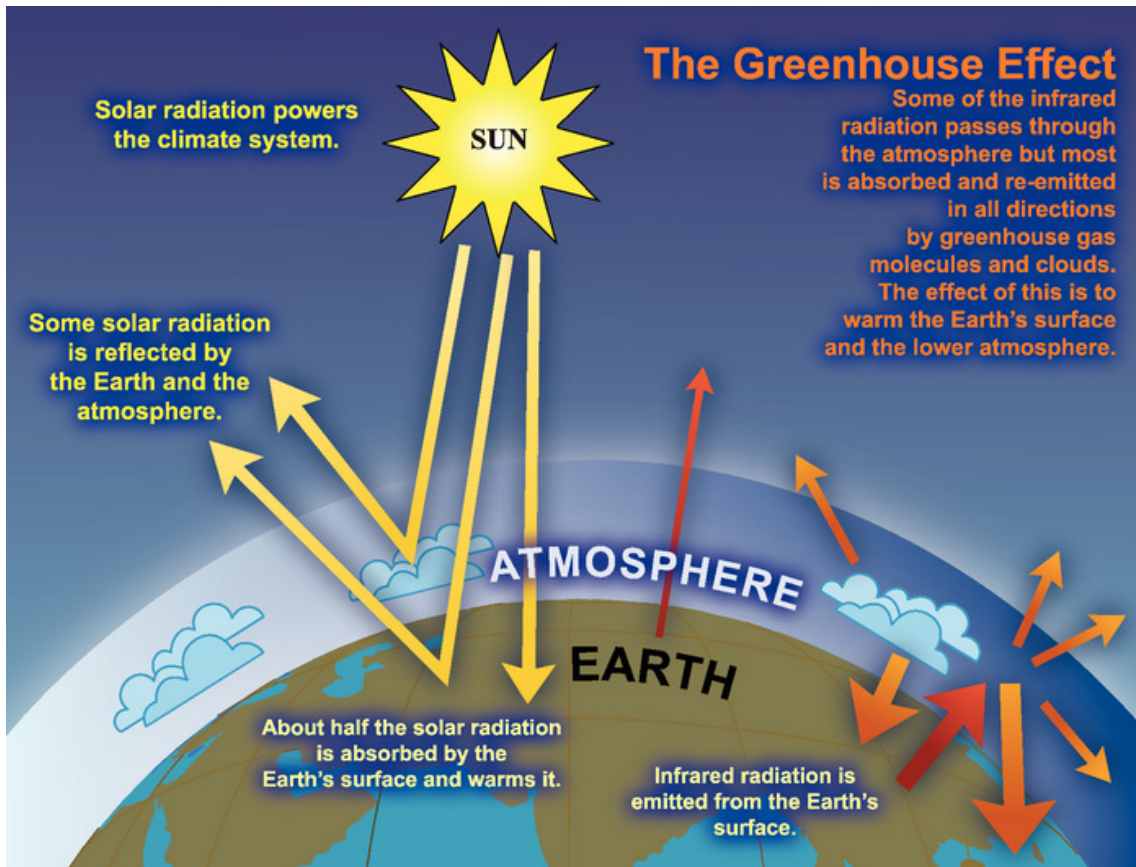
Beginning late in the 18th century, human activities have changed the composition of the atmosphere, influencing the Earth's climate. This is known as global climate change.

What's the difference between weather and climate?

Weather is what is happening outside at any particular moment in time. It may include daily or even hourly accounts of temperature, rainfall, cloud cover, humidity and other variables.

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Climate Basics



An idealized model of the natural greenhouse effect.

"Climate Change 2007: The Physical Science Basis." International Panel on Climate Change. www.ipcc.ch/publications_and_data/ar4/wg1/en/faq-1-3.html

In contrast, **climate** is what you might generally expect to happen based on long-term weather patterns. What is considered "normal" for the climate is often calculated using averages over a period of 30 years.

The Earth's climate system is complex. It is affected not only by what happens in the atmosphere (the air), but also what happens on land, in the oceans, in forests and other ecosystems, and in glaciers and ice caps.

What is carbon dioxide (CO₂)?

Carbon dioxide is a gas found in Earth's atmosphere. Each carbon dioxide molecule is made up of one part carbon (C) and two parts oxygen (O), thus it is often written CO₂.

What does CO₂ have to do with climate?

One important element of global climate is the amount of so-called greenhouse gases in the atmosphere. These gases include CO₂, nitrous oxide, methane and water vapor.

Greenhouse gases, such as CO₂, are a natural part of the atmosphere. In fact, they are necessary for life on Earth. Though they make up a small percentage of the Earth's atmosphere, they play an important role.

After the sun's radiation enters the atmosphere and warms up the Earth, these gases prevent some of the heat from escaping back into space, similar to the way that the glass panes of a greenhouse can trap heat. Without this "greenhouse effect," the planet would be too cold to support life as we know it.

Why is the level of CO₂ in the atmosphere a concern?

Levels of CO₂ in the Earth's atmosphere have been fairly stable for the past several thousand years at about 280 parts per million (ppm). Natural sources—like the decay of material in forests and grasslands—emit CO₂ into the atmosphere. In the past, these sources were balanced by natural processes—like plant growth and the dissolving of CO₂ in seawater—that removed CO₂ from the atmosphere.

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Climate Basics

Around 1860, at the beginning of the Industrial Revolution, the CO₂ levels began to rise. By 1958, CO₂ levels were up to 316 ppm from 280 ppm. In 2010, they topped 390 ppm for the first time—a 39 percent increase since 1860. Scientists say this increase in CO₂ is the main cause of rising global temperatures.

What has caused the increase in CO₂ in the atmosphere?

Most of the increase in atmospheric CO₂ is from burning fossil fuels for energy. These fuels include gasoline, kerosene and other petroleum products; coal and natural gas. When they are burned, they release CO₂, among other things.

Deforestation is another major source of CO₂. When forests are logged for lumber, pulpwood or fuel, and when new land is cleared for farming or pastures, CO₂ is emitted into the atmosphere.

Why is it called climate change?

The rising average world temperature is often called global warming, but scientists prefer to use the term climate change. That is because its impacts will be different in every region of the world and will involve changes in rainfall and other climate conditions, not just temperatures.

Related PLT Activities

- Waste Watchers (*PreK–8 Guide*)
- Energy Sleuths (*PreK–8 Guide*)

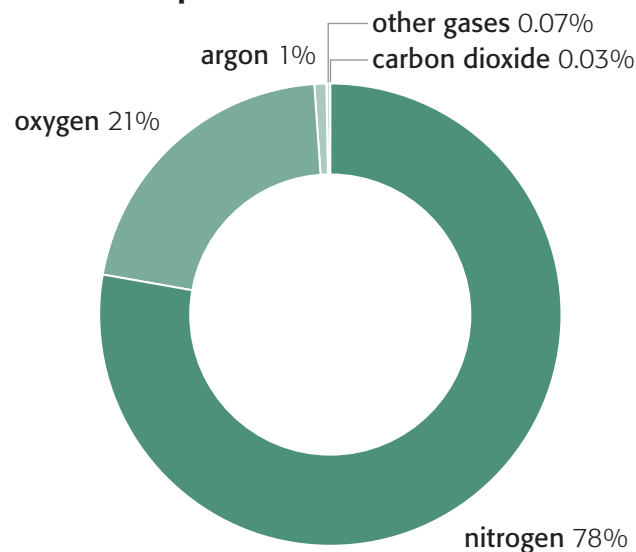
Getting Ready

Write the data from the "Atmospheric CO₂ Concentrations" student page on the board, or make copies of it.

Doing the Activity

1. Ask students whether they have heard the term "global climate change"? Ask them what they think this term means. What does global mean? What is climate? Is climate the same as weather? What change might this term refer to? How is climate change different from "global warming"?
2. Ask students whether their parents, grandparents or neighbors have ever mentioned any changes they have noticed in the climate. Invite students to interview someone in the community about changes they may have observed. They may use questions on the "Interview an Elder" student page, adding their own if they would like.
3. Have students share what they learned from the interviews. What changes have people noticed in the last 10–30 years? What might be causing these changes? How might these changes affect the community?
4. Ask students to name some of the gases found in air (nitrogen, oxygen, argon, carbon dioxide, water vapor, and rare gases such as helium, neon and radon). Ask them what portion of air they think nitrogen, oxygen, argon and carbon dioxide make up. (See the graph below. Air is about 78 percent nitrogen, 21 percent oxygen, 0.9 percent argon and 0.03 percent carbon dioxide. The rare gases together make up about 0.07 percent.) Explain that students will be examining CO₂ in the atmosphere over time to learn more about its relation to climate.
5. Read aloud the introduction on the "Atmospheric CO₂ Concentrations" student page. Help students understand that 0.03 percent (the approximate portion of air that CO₂) is equal to 300 parts per million (ppm).
6. Divide the class into teams and assign each team a five-to-10 year period to graph (there are 50 years of data). Direct the teams to create the x-axis (horizontal axis) and y-axis (vertical axis) so that the graphs will be uniform in scale. The x-axis should show the years and the y-axis should show values ranging from 310 to 400 ppm as in the following sample.

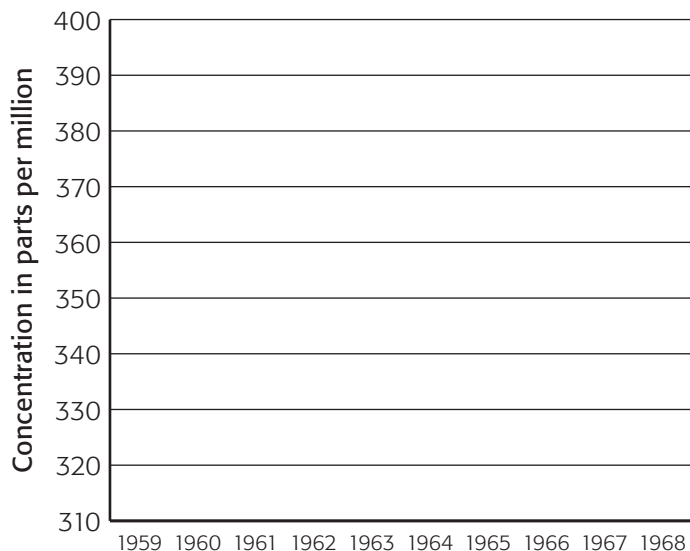
Earth's Atmosphere



Activity 1

Climate Basics

Annual Average CO₂ in the Atmosphere



7. Using the data for 1959 as an example, remind students how to plot a line graph. First they draw an imaginary vertical line from the place where the year 1959 would be on the x-axis, then an imaginary horizontal line from the place where 315.98 ppm would be on the y-axis. Where these two imaginary lines meet, they draw a point on the graph. To make a line graph, students will connect all the points after they plot them.
8. Have the teams graph their data points and then connect the points. Post the graphs in chronological order, linking them along the x-axis to make one large graph.
9. Ask students to share with the whole group their observations about the graphs. Discuss:
 - What pattern do you notice in the graph over 50 years?
 - How do the last five years of data compare to the first five years?

- The level of CO₂ in the year 1860 was approximately 280 ppm. How does the rise from 1860 to 1958 compare to that from 1958 to 2009?
 - What do you think caused the increase in CO₂?
 - Looking at the graph, what do you predict the CO₂ level will be in the year 2020? In the year 2050? What factors could influence these predictions?
 - How might the change in CO₂ affect people and other living things?
10. Using information from the Background, help students understand the causes of CO₂ change and the effects it may have for Guatemalans.

Enrichment

Help students visualize the thickness of the Earth's atmosphere by doing a simple demonstration. Using a piece of rope 13 meters long as a guide, help students stand in a 13-meter-diameter circle. Have them stretch out their arms, holding hands if possible. Explain to them that if this circle represents the diameter of the Earth, the width of their arms represents the thickness of the atmosphere where the Earth's greenhouse gases are found (the troposphere and stratosphere layers). Are they surprised at the thinness of the atmosphere? *This demonstration is based on the fact that the Earth's atmosphere is about 13,000 km in diameter, and the troposphere and stratosphere is about 50 km thick combined.*

Create a greenhouse effect using jars filled with equal amounts of water. Leave one jar open to the air, and cover the other jar with plastic. Put the jars in a sunny window and have students observe them over the course of the day or a week.

Activity 1

Student Resource Page: Interview an Elder

Ask a parent, grandparent, aunt, uncle or neighbor about changes they have observed that may be related to climate. You may add other questions, if you like.

How long have you lived in this area?

Climate is the weather patterns a place experiences over a long period of time. How would you describe this area's climate? (For example, what time of year is it usually warmest, coolest, rainiest, cloudiest, and so on?)

Have you noticed any changes in the climate pattern in the last 10 or 20 or 30 years? (For example, has it been warmer, cooler, windier, wetter, or drier than you remember in the past, or has there been a change in the timing of these things?)

Have you noticed any changes in garden or forest plants? (For example, do certain plants come into flower at a different time than you remember in the past?)

Have you noticed any changes related to animals? (For example, do migrating birds come or leave at a different time than in the past?)

If you have noticed any changes, what do you think may be causing them?

Activity 1

Student Resource Page: Atmospheric CO₂ Concentrations

Since 1958, scientists have measured the amount of CO₂ in the Earth's atmosphere from a site on the Mauna Loa volcano in Hawaii, a group of South Pacific islands. This site is one of the best locations in the world for measuring CO₂ because there are no plants or human activities nearby to influence the measurements (any volcanic venting of gas is excluded from the record). The Mauna Loa data are considered to be a precise record of the concentration of CO₂ in the region.

Using the data in the table, graph the annual average CO₂ concentrations from 1959 to 2016.

Atmospheric CO₂ Concentrations from 1959–2014

Year	Annual Average	Year	Annual Average	Year	Annual Average
1959	315.98	1979	336.85	1999	368.31
1960	316.91	1980	338.69	2000	369.48
1961	317.64	1981	339.93	2001	371.02
1962	318.45	1982	341.13	2002	373.10
1963	318.99	1983	342.78	2003	375.64
1964	319.62	1984	344.42	2004	377.38
1965	320.04	1985	345.90	2005	379.67
1966	321.38	1986	347.15	2006	381.84
1967	322.16	1987	348.93	2007	383.55
1968	323.05	1988	351.48	2008	385.34
1969	324.63	1989	352.91	2009	387.35
1970	325.68	1990	354.19	2010	389.78
1971	326.32	1991	355.59	2011	391.57
1972	327.45	1992	356.37	2012	393.82
1973	329.68	1993	357.04	2013	396.48
1974	330.25	1994	358.89	2014	398.65
1975	331.15	1995	360.88	2015	400.83
1976	332.15	1996	362.64	2016	404.21
1977	333.90	1997	363.76		
1978	335.51	1998	366.63		

Source

U.S. National Oceanic and Atmospheric Administration, Earth System Research Laboratory. "Trends in Atmospheric Carbon Dioxide." <http://www.esrl.noaa.gov/gmd/ccgg/trends/>

Activity 2

The Carbon Cycle

Guatemala

Overview

Earth has a fixed number of carbon atoms, which circulate among air, plants, animals, soil and minerals by way of the carbon cycle. This activity uses a game to introduce students to the carbon cycle, and will help them see how carbon in the atmosphere is connected to living things.

Objectives

- Students will describe the carbon cycle and the journey a carbon atom might take on its way through this cycle.
- Students will describe how trees help to store carbon.

Assessment

Look at students' carbon cycle stories and assess how well they explained the carbon atom's journey.

Subjects

- Science
- Social Studies
- Language Arts

Concepts (from PLT Conceptual Framework)

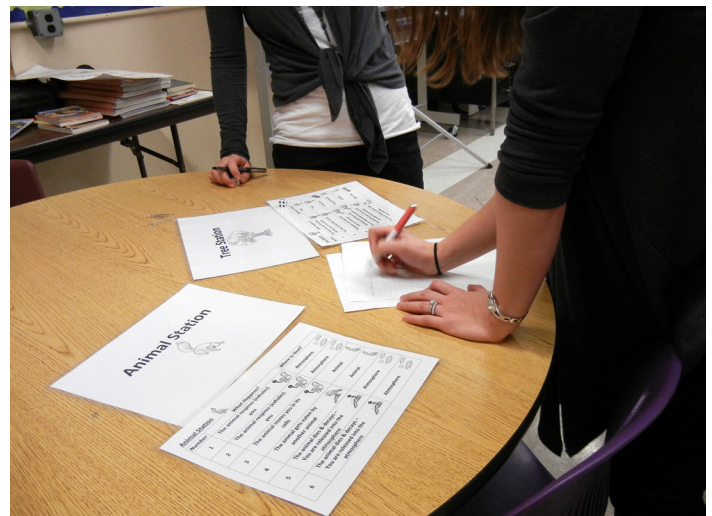
- Organisms are interdependent, and depend on nonliving components of the Earth. (2.1)
- In biological systems, energy flows and materials continually cycle in predictable and measurable patterns. (3.1)
- Conservation technology enables humans to maintain and extend the productivity of vital resources. (3.7)

Skills

- organizing information
- predicting
- comparing and contrasting
- inferring

Materials

- three or four different objects made of carbon (such as a leaf, a stick, a bone, a piece of charcoal, a corn kernel or other food item, or something made from cotton or wool)
- copy of the "Forest Carbon Cycle Stations" student page
- three pairs of dice (optional)
- student notebooks



Time Considerations

Preparation: 30 minutes

Activity: one or two 50-minute class periods

Background

Carbon is the fourth most abundant element on Earth and is essential for life. It is the basis for carbohydrates, proteins and nucleic acids, which living things need to live, grow and reproduce. It is also found in carbon dioxide (CO₂), limestone, wood, plastic, diamonds and graphite.

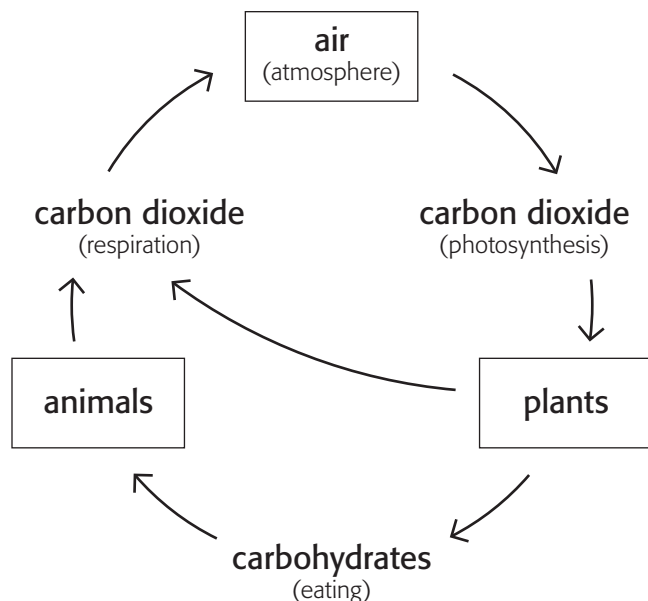
The total amount of carbon on the Earth is always the same. Through the **carbon cycle**, carbon atoms are continuously exchanged between living things and the environment, and are reused over and over again.

The basic carbon cycle of living systems (shown below) involves the processes of photosynthesis and respiration. Through photosynthesis, plants absorb carbon dioxide from the atmosphere and use it to make carbohydrates (sugars) with energy from the sun. As part of the cycle, animals eat plants (or other animals), taking in the carbohydrates for food. Then,

Activity 2

The Carbon Cycle

Basic Carbon Cycle of Living Systems



through respiration, both plants and animals break down carbohydrates, releasing carbon dioxide into the atmosphere. This process can be described through the following formulas:

Photosynthesis

6CO_2 (carbon dioxide) + $6\text{H}_2\text{O}$ (water) \rightarrow $\text{C}_6\text{H}_{12}\text{O}_6$ (glucose) + 6O_2 (oxygen)

Respiration

$\text{C}_6\text{H}_{12}\text{O}_6$ (glucose) + 6O_2 (oxygen) \rightarrow 6CO_2 (carbon dioxide) + $6\text{H}_2\text{O}$ (water)

Not all carbon atoms are constantly moving in the carbon cycle. As can be seen on "The Carbon Cycle" student page, carbon may become stored in trees, wood products, fossil fuels or other carbon stores or "sinks." Eventually, when the tree dies or if the products or fuels are burned, the carbon atoms will be released. They will then become an active part of the carbon cycle again.

Forests play an important role in the global carbon cycle. They absorb carbon dioxide during photosynthesis, and store the carbon in their trunks, branches and roots. Both the trees and wood products can continue to store this carbon as long as they remain intact.

- Soil Stories (*PreK–8 Guide*)
- Global Climate (*PreK–8 Guide*)

Getting Ready

1. Make one copy of the "Forest Carbon Cycle Stations" student pages.
2. On the board or using pen and paper, make a large label for each of the six stations: Air (Atmosphere), Tree, Firewood, Wood Product, Fallen Log and Animal.
3. Draw a basic carbon cycle on the board.
4. Optional: Make an enlarged drawing of the Carbon Cycle Poster either on the board or on a piece of cardboard.

Doing the Activity

1. Show students the objects you have brought in and ask what they all have in common. If students do not think of it, point out that all of the items are mostly made of carbon. Discuss carbon and why it is important. Ask for example:
 - What is carbon? (*Carbon is one of the most abundant elements on Earth, and is necessary for life*)
 - Why do we need carbon? (*Like all living things, we need carbon for the basic processes of life, including growth and reproduction*)
 - How do living things get carbon? (*There are two ways organisms can get the carbon they need. They either get it from the air—as plants do—or they get it by eating other living things. All of our food has carbon*)
 - Besides food, how else do people use carbon? (*We use carbon-based products like wood, cotton and wool, as well as plastics and other things made from petroleum. Fuels like gasoline and kerosene are also carbon-based*)
 - If every living things needs carbon, why isn't it all used up? (*Carbon gets reused over and over again in a process called the carbon cycle*)
2. Show students the basic carbon cycle you drew on the board. Explain how carbon dioxide (CO_2) in the air becomes part of plants through photosynthesis, a process that turns the CO_2 into food (carbohydrates). When animals eat plants or other animals, they ingest the carbon. Through respiration, carbon returns to the air as CO_2 .

Related PLT Activities

- Water Wonders (*PreK–8 Guide*)

Activity 2

The Carbon Cycle

3. Point out that in an ecosystem, like a forest, the process is more complex than this simple drawing. Show students "The Carbon Cycle" student page (or your drawing of it on the board), which describes the carbon cycle in a forest. Talk through the different parts of this cycle.
4. Point out that the carbon cycle is a simplified model for looking at the journey of a carbon atom. Explain that students will play a game to learn more about the forest carbon cycle. In this game, they will each be a carbon atom.
5. Divide the class among the different stations to begin. Place the station cards in different locations around the room, and place one die (if using) at each station.
6. Have each student roll the die or choose a number between one and six, and then read the statement at their station corresponding to that number. They should write in their notebooks the current station, what happens to them based on their number, and where they will go next.

Sample Notebook Entry













<u>Station</u>	<u>What Happens?</u>	<u>Where to Next?</u>
Tree	The tree is hit by a storm, falls over and dies.	Dead matter
7. When you call out "cycle," students should go to the next station as directed on the card. If the directions have them stay at the same station, the student should either roll the die again or choose again a number between one and six.
8. Repeat Steps 6 and 7 about 10 more times or until most students have cycled through Tree Station at least once.
9. Ask students to write a brief story from a carbon atom's point of view that describes the journey they just took through the carbon cycle. For example, a student might start a story, "I was a carbon atom in a tall tree. One day a fierce storm came, and knocked the tree over. It lay for a long time on the forest floor. As it decayed, I was released into the atmosphere..."
10. Discuss the following:
 - At which station did you spend the most time? At which station did you spend the least time?
 - While each of your journeys was different, was there anything similar about them?
 - At which stations can carbon be stored? At which stations is carbon released into the atmosphere?
 - What are the different paths carbon might take after becoming a tree? Which paths release carbon quickly into the atmosphere, and which store carbon for a long period of time?
 - How does the carbon cycle help us understand the relation between forests and global climate change?

Enrichment

Look at "The Carbon Cycle" student page and consider if there are any parts of the carbon cycle not included in the game. How might you add them?








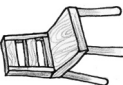




Activity 2

Student Resource Page: Forest Carbon Cycle Stations

Atmosphere (Air) Station		
Number	What Happens?	Where to Next?
1	A tree takes you in through photosynthesis. 	Tree 
2	A tree takes you in through photosynthesis. 	Tree 
3	You stay in the atmosphere. 	Atmosphere 
4	You stay in the atmosphere. 	Atmosphere 
5	You stay in the atmosphere. 	Atmosphere 
6	You stay in the atmosphere. 	Atmosphere 







Activity 2

Student Resource Page: Forest Carbon Cycle Stations

Tree Station		Where to Next?	
Number	What Happens?		
1	The tree uses you to grow, storing you in its trunk. 	Tree 	
2	You stay in the tree's trunk. 	Tree 	
3	Someone cuts down the tree for firewood. 	Firewood 	
4	Someone cuts down the tree to make wood products. 	Wood Product 	
5	You become part of a nut and are eaten by an animal. 	Animal 	
6	The tree is hit by a storm, falls over and dies. 	Fallen Log 	





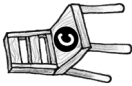
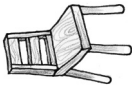

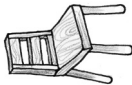




Activity 2

Student Resource Page: Forest Carbon Cycle Stations

Firewood Station		
Number	What Happens?	Where to Next?
1	The wood is burned. You are released into the atmosphere.	 Atmosphere
2	The wood is burned. You are released into the atmosphere.	 Atmosphere
3	The wood is burned. You are released into the atmosphere.	 Atmosphere
4	The wood is burned. You are released into the atmosphere.	 Atmosphere
5	The wood is burned. You are released into the atmosphere.	 Atmosphere
6	The wood is burned. You are released into the atmosphere.	 Atmosphere













Activity 2

Student Resource Page: Forest Carbon Cycle Stations

Wood Product Station		
Number	What Happens?	Where to Next?
1	You stay stored in the wood product. 	Wood Product 
2	You stay stored in the wood product. 	Wood Product 
3	You stay stored in the wood product. 	Wood Product 
4	The product breaks and is repaired. You stay stored in it. 	Wood Product 
5	The product breaks and is burned. You are released into the atmosphere. 	Atmosphere 
6	The product starts to decay. You are released into the atmosphere. 	Atmosphere 



















Activity 2

Student Resource Page: Forest Carbon Cycle Stations

Fallen Log Station		
Number	What Happens?	Where to Next?
1	<p>You stay stored in the fallen log.</p> 	 <p>Fallen Log</p>
2	<p>You stay stored in the fallen log.</p> 	 <p>Fallen Log</p>
3	<p>You stay stored in the fallen log.</p> 	 <p>Fallen Log</p>
4	<p>The fallen log decays. You are released into the atmosphere.</p> 	 <p>Atmosphere</p>
5	<p>The fallen log decays. You are released into the atmosphere.</p> 	 <p>Atmosphere</p>
6	<p>The fallen log decays. You are released into the atmosphere.</p> 	 <p>Atmosphere</p>

Activity 2

Student Resource Page: Forest Carbon Cycle Stations

Animal Station		Where to Next?	
Number	What Happens?		
1	The animal respire (exhales) you. 	Atmosphere 	Atmosphere 
2	The animal respire (exhales) you. 	Atmosphere 	Atmosphere 
3	The animal stores you in its cells. 	Animal 	Animal 
4	The animal gets eaten by another animal. 	Animal 	Animal 
5	The animal dies and decays. You are released into the atmosphere. 	Atmosphere 	Atmosphere 
6	The animal dies and decays. You are released into the atmosphere. 	Atmosphere 	Atmosphere 

Student Resource Page: The Carbon Cycle



Activity 3

Trees and Carbon

Guatemala

Overview

Forests store more carbon than any other land-based ecosystem. Tropical rainforests like Guatemala's Petén region have the potential to store even more. In this activity, students will measure a tree to estimate the amount of carbon stored in it.

Objectives

- Students will explain how to measure a tree's height and diameter.
- Students will understand that taller and larger trees store more carbon.

Assessment

Evaluate the students' understanding by having them write a paragraph or draw a diagram explaining how to measure a tree to find out the amount of carbon in it.

Subjects

- Science
- Math
- Social Studies

Concepts (from PLT Conceptual Framework)

- Organisms are interdependent, and depend on nonliving components of the Earth. (2.1)
- Populations of organisms exhibit variations in size and structure as a result of their adaptation to their habitats. (4.1)
- Our increasing knowledge of the Earth's ecosystems influences strategies used for resource management and environmental stewardship. (5.5)

Skills

- observing
- comparing and contrasting
- analyzing
- translating

Materials

- student notebooks
- ruler and large ball of string or measuring tape
- ruler or stick for each pair of students

Time Considerations

Preparation: 20 minutes

Activity: one or two 50-minute class periods



Background

As trees grow, they absorb carbon dioxide from the atmosphere and store the carbon in their trunks, branches and roots. Because they store more carbon than they release, forests are known as a carbon "sink."

Forests are among the world's most important carbon sinks. They store some 289 million metric tons (tonnes) of carbon in the trees and plants alone. The total carbon stored in forests—including the trees, plants, deadwood, litter and soil—is more than all the carbon in the atmosphere. Forests store more carbon than any other land-based ecosystem, and more carbon than all of the world's remaining oil stocks.

By storing carbon, forests slow the rate that carbon dioxide accumulates in the atmosphere. One way people hope to reduce or reverse the build-up of CO₂ in the Earth's atmosphere—and global climate change—is to increase the amount of carbon stored in forests.

In tropical rainforests like the Petén, trees grow more rapidly than in other types of forests. These forests lock in as much as 15 metric tons (tonnes) of carbon

Activity 3

Trees and Carbon

per hectare per year. Planting trees in tropical rainforests can remove large amounts of CO₂ from the air within a relatively short time.

The amount of carbon an individual tree can store depends on the species of tree, how large it is, and how old it is. In general though, the larger the tree, the more carbon it can store. Also, the faster-growing the tree, the more quickly it will add carbon to its stores.

Related PLT Activities

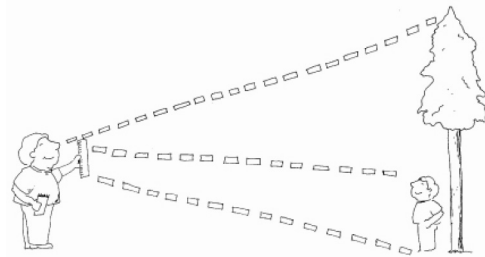
- Adopt a Tree (*PreK–8 Guide*)
- Tree Cookies (*PreK–8 Guide*)
- To Be a Tree (*PreK–8 Guide*)

Getting Ready

Before doing the activity, select one or more trees for students to measure.

Doing the Activity

1. Remind students of the carbon cycle in Activity 2, and ask:
 - Where in the carbon cycle is carbon stored? (*Trees and wood products*)
 - How much carbon do you think might be stored in a single tree?
 - Do you think bigger trees store more or less carbon than smaller trees? Why do you think so?
2. Explain that since forests contain lots of trees, they are one of the world's biggest stores of carbon. Students will learn how to measure a tree, and then use that information to find out how much carbon is stored in it.
3. Take students outside to measure the tree or trees you have chosen. Have students bring their notebooks for recording the measurements.
4. Ask students to estimate the circumference of the tree (how big around it is) in centimeters, recording their estimates in their notebooks.
5. Point out that foresters always measure the width of a tree at 1.4 meters above the ground (they call these measurements Diameter at Breast Height [DBH] or Circumference at Breast Height [CBH]). To see why this is an important standard, help students measure the tree's circumference using a piece of string and ruler, or a tape measure, at 0.5 meters, 1 meter and 2 meters from the ground. Ask students what would happen if everyone measured at different heights of the tree (everyone would get different results).
6. Help students measure the circumference at 1.4 meters, recording their measurements in their notebooks (see the "Sample Data Sheet" student page). Ask students to compare their actual measurements to their estimates.
7. Divide the class into pairs, and ask each pair to calculate the height of the tree using the following method:
 - Student A stands at the base of the tree.
 - Student B holds a ruler or pencil at arm's length a distance away from the tree.
 - Student B lines up the top of the bottom of the ruler or pencil with Student A's feet, and places a thumb on it to mark the place where it lines up with Student B's head. This length represents the scaled height of Student A.
 - Student B moves the ruler or pencil to see how many scaled heights of Student A it takes to reach the top of the tree.
 - Student B measures Student A's actual height and multiplies it by the previous result. For example, if Student A's height is 140 cm and it takes six scaled heights to reach the top of the tree, then the height of the tree would be $140 \text{ cm} \times 6 = 8.4 \text{ m}$.
8. Students may record their measurements in their notebooks using the "Sample Data Sheet for Recording Tree Measurements" student page. Have pairs compare their calculations for the tree height. How similar are they? What might explain any differences?
9. Help students use the "About How Much Carbon is in a Tree?" student page to determine the approximate amount of carbon stored in the tree.



Activity 3

Trees and Carbon

10. Ask the class to think about how their tree compares to others:
 - How does this tree measure up to other trees in the area?
 - Does it have more or less carbon?
 - Looking at the chart on the student page, which dimension—height or circumference—has a greater effect on the amount of carbon in the tree (using the chart, compare your tree to trees that are the same circumference, but taller and the same height, but wider)?
 - How might the trees in this forest compare to trees in other forests around the world?

Enrichment

Help students use a field guide to identify the species of the tree you measured. In general, how does this tree species compare in size to other trees described in the guide?

Find out how forest workers in your community measure trees and what they use the tree measurements for.

Resources

Forests and Climate Change: A Convenient Truth. A multilingual DVD on the connection between forests and climate change. <http://www.fao.org/forestry/52980/es/>

Activity 3

Student Resource Page: Sample Data Sheet for Recording Tree Measurements

Circumference of Tree

What is the circumference of the tree?

Estimate (in centimeters): _____ cm

Circumference of tree at breast height (1.4 meters above ground): _____ cm

Circumference of tree at breast height (in meters): _____ m

Height of Tree

Hold ruler or pencil away at arm's length with one end lined up with friend's feet. Mark with your thumb the place where your friend's head lines up.

Number of pencil/ruler lengths it takes to reach from bottom to top of the tree: _____

Actual height of friend: _____ cm

Height of tree = number of lengths x height of friend: _____ cm

Height of tree (in meters): _____ m

Activity 3

Student Resource Page: How Much Carbon is in a Tree?

Use this table to find a rough estimate of the amount of carbon stored in a tree, based on the tree's circumference at breast height and its height. The estimated amount of carbon is in kilograms.

Circumference at Breast Height (in meters)

	0.25	0.5	0.75	1.0	1.25	1.5	1.75	2.0	2.25	2.5	2.75	3.0	3.25	3.5	3.75	4.0	4.25	4.5
2	10	14	19	26	36	48	61	77	95	115	138	162	189	217	248	281	316	353
4	11	18	28	43	62	86	113	145	181	221	266	315	368	425	486	552	622	696
6	13	22	38	60	89	124	165	213	267	327	394	467	547	633	725	823	928	1040
8	14	26	48	77	115	162	217	281	353	433	522	620	726	840	963	1095	1235	1383
10	15	31	57	94	142	200	269	349	439	539	651	773	905	1048	1202	1366	1541	1727
12	16	35	67	111	168	238	321	416	525	645	779	925	1084	1256	1440	1638	1848	2070
14	14	39	76	128	195	276	373	484	610	751	907	1078	1263	1464	1679	1909	2154	2414
16	18	43	86	145	221	315	425	552	696	857	1035	1231	1443	1672	1917	2180	2460	2757
18	19	48	95	162	248	353	477	620	782	963	1164	1383	1622	1879	2156	2452	2767	3101
20	20	52	105	179	274	391	529	688	868	1069	1292	1536	1801	2087	2394	2723	3073	3444
22	21	56	114	196	301	429	581	756	954	1175	1420	1688	1980	2295	2633	2994	3379	3787
24	22	60	124	213	327	467	633	823	1040	1281	1549	1841	2159	2503	2872	3266	3686	4131
26	23	64	133	230	354	505	685	891	1126	1387	1677	1994	2338	2710	3110	3537	3992	4474
28	24	69	143	247	380	544	737	959	1211	1493	1805	2146	2517	2918	3349	3809	4298	4818
30	25	73	152	264	407	582	789	1027	1297	1599	1933	2299	2697	3126	3587	4080	4605	5161
32	26	77	162	281	433	620	840	1095	1383	1705	2062	2452	2876	3334	3826	4351	4911	5505
34	27	81	172	298	460	658	892	1163	1469	1811	2190	2604	3055	3541	4064	4623	5217	5848
36	28	86	181	315	486	696	944	1231	1555	1917	2318	2757	3234	3749	4303	4894	5524	6192
38	29	90	191	332	513	734	996	1298	1641	2023	2446	2910	3413	3957	4541	5166	5830	6535
40	31	94	200	349	539	773	1048	1366	1727	2129	2575	3062	3592	4165	4780	5437	6137	6879
42	32	98	210	366	566	811	1100	1434	1813	2235	2703	3215	3772	4373	5018	5708	6443	7222
44	33	103	219	382	592	849	1152	1502	1898	2341	2831	3368	3951	4580	5257	5980	6749	7565
46	34	107	229	399	619	887	1204	1570	1984	2448	2960	3520	4130	4788	5495	6251	7056	7909
48	35	111	238	416	645	925	1256	1638	2070	2554	3088	3673	4309	4996	5734	6522	7362	8252

Height (in meters)



Rainforest Alliance

Note: These estimates are based on the assumptions that V (volume of tree) = 0.0567 x 0.5074 x (CBH/π)² x H; that D (density of the wood) = 0.6 g/cm³; that water makes up 45% of the tree's mass; that M (mass of the wood) = 0.55 x V x D; and that the mass of carbon in the wood is 0.5% of the mass of the wood.

Activity 4

Forests of Guatemala

Guatemala

Overview

Students learn about the distribution of forest and humans around the world, and then analyze maps of the Maya Biosphere Reserve to determine recent changes in forest cover and to consider the causes of these changes.

Objectives

- Students will graph and describe changes over time in two areas of the Maya Biosphere Reserve.
- Students will identify causes of forest change in Guatemala.

Assessment

Have students list three conclusions they can reach from the graphs of forest change they created in the activity.

Subjects

- Science
- Math
- Social Studies
- Language Arts

Concepts (from PLT Conceptual Framework)

- Governmental, social and cultural structures and actions affect the management of resources and environmental quality. (4.9)
- Ecosystems change over time through patterns of growth and succession. They are also affected by other phenomena such as disease, insects, fire, weather, climate and human intervention. (5.4)

Skills

- analyzing
- classifying and categorizing
- interpreting
- graphing

Materials

rope
measuring tape
tape
copies of student pages
overhead transparencies
student notebooks
graph paper (optional)



Time Considerations

Preparation: 30 minutes

Activity: one or two 50-minute class periods

Background

Trees and forests are natural carbon “sinks.” They absorb CO₂ and convert carbon into trunks, leaves, stems and roots. But when a forest is cut down and converted to another use, carbon is released back into the atmosphere—either slowly through decay, or quickly through burning.

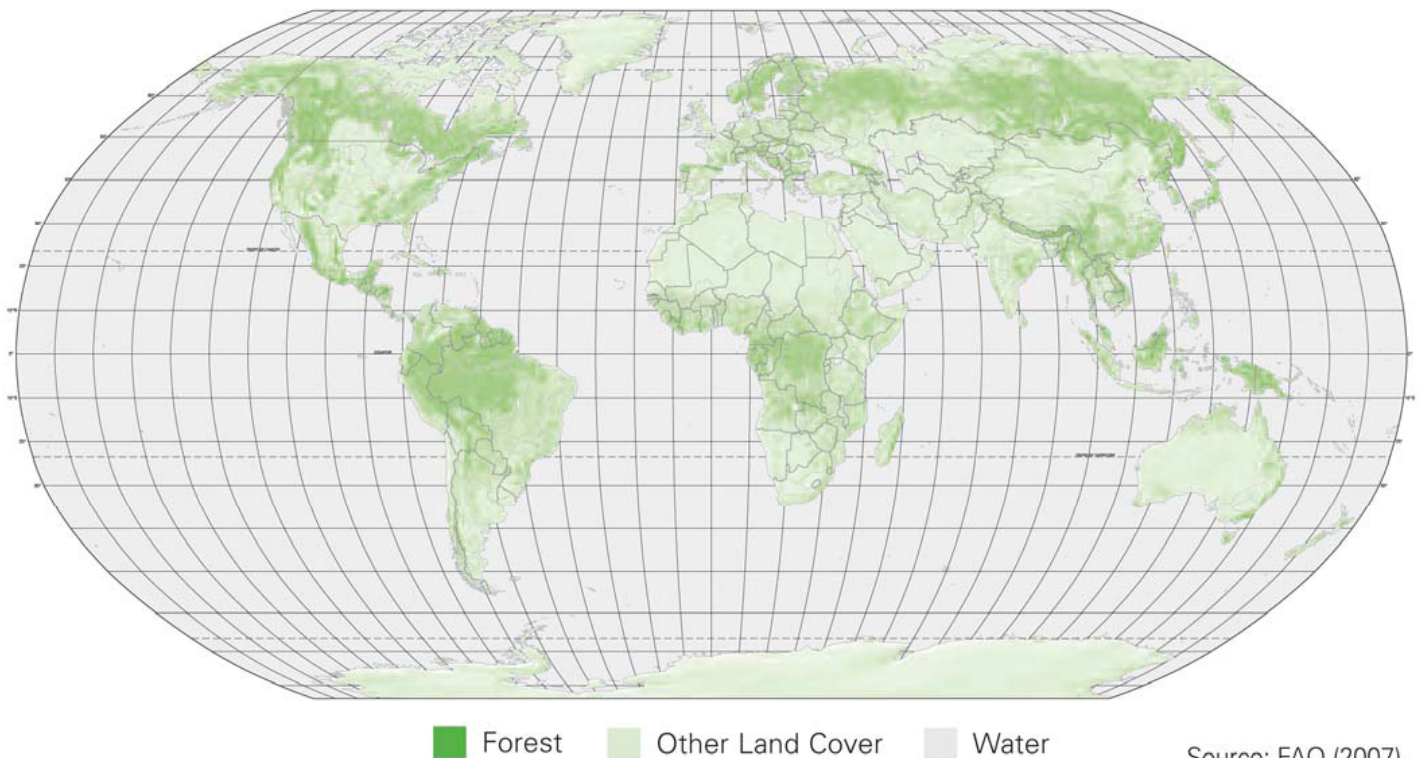
Globally, around 13 million hectares of forests were lost each year between 2000 and 2010. This represents a total area lost in just one decade of almost 200 times the size of the Petén. In Guatemala, more than 73,000 hectares of forest are lost each year. With such huge losses of forest land, deforestation contributes a significant amount to increased CO₂ in the atmosphere. In the tropics alone, deforestation releases an estimated 1.5 billion metric tons (tonnes) of carbon annually.

Forests account for more than a quarter of the land area of the Earth, and they store a vast amount of

Activity 4

Forests of Guatemala

The Forest Planet



carbon—more than three-quarters of the carbon in all land plants. Avoiding deforestation can play a key role in reducing future CO₂ and other greenhouse gas concentrations.

In addition to complete deforestation, forest degradation also contributes to carbon emissions. Forest degradation occurs when forest cover decreases by any amount up to 90 percent.

In order to avoid deforestation and forest degradation, it is helpful to understand what causes these things in the first place. The causes or “drivers” of deforestation are different depending on the region. In mainland Asia, for example, commercial timber is the dominant driver of deforestation and degradation. But in Africa, the collecting of fuel wood, increased human populations and unclear land rights are dominant factors.

The primary drivers of deforestation and degradation in the Petén of Guatemala are 1) migration of new people into the area, 2) farming and cattle ranching, 3) drug trafficking, and 4) oil and gas exploration. It is important to keep in mind that these factors are not

isolated, but are related to one another. For example, migration means more people need to farm or ranch, and access roads for oil and gas exploration allow more agriculture, ranching and drug farming within the forest.

Related PLT Activities

- Tropical Treehouse (*PreK–8 Guide*)
- Rain Reasons (*PreK–8 Guide*)
- Mapping the World's Forests (*Forests of the World*)
- Analyzing Patterns of Forest Change (*Forests of the World*)

Getting Ready

1. Cut rope into the following lengths, labeling each with a piece of tape that has the name of the continent written on it:
 - Africa – 7.5 meters (25 feet)
 - Australia – 2.1 meters (7 feet)
 - Eurasia – 14.4 meters (48 feet)
 - Central and South America – 4.8 meters (16 feet)
 - North America – 6.3 meters (21 feet)

Activity 4

Forests of Guatemala

	Percentage of World's Forest Cover	Number of Students to Represent Forest Cover Distribution*	Percentage of World's Human Population	Number of Students to Represent Population Distribution**
Africa	13%	3	14%	4
Australia	5%	1	1%	0
Eurasia	47%	12	71%	18
Central and South America	20%	5	9%	2
North America	15%	4	5%	1

* Each student represents approximately 16 million hectares (40 million acres) of forest.

** Each student represents approximately 265 million people.

- Have available a globe, a world map or a copy of the map on the previous page.
- Have copies of the “Maya Biosphere Reserve Maps” student pages. Also have copies of the “Square Dot Matrix” student page copied on overhead transparencies.
- Read over the “History of the Maya Biosphere Reserve” teacher page, and be prepared to convey some of the information to your students during the activity.
- Ask the students which continent they think has the most people and which the least people. Using the chart above, move students among the continents so that they represent the population distribution within the different continents.
- Ask students: How does the distribution of forests compare to the distribution of people around the world? (*students may notice that the forests and the people are not equally distributed, and that the forests are not always located where the people are*) What challenges or issues might these differences present? (*students may have different ideas, but might suggest that places with high populations might experience more clearing of forests or that people must find a way to move forest products from one place to another*)
- Explain to students that they will look at maps of the Maya Biosphere Reserve to learn about possible changes in the forest there. Ask students what they know about the history of the Petén and the Maya Biosphere Reserve. How has the Petén changed in the last 70 years? What is the Maya Biosphere Reserve? Why was it created? How has the forest area changed since it was created? Use information from the “History of the Maya Biosphere Reserve” teacher page to clarify any questions.
- Divide the class into groups, and give each group a set of maps and a square dot matrix transparency. Explain to students that the maps are of two different sections within the Maya Biosphere Reserve between 1986 and 2007. One section is the area

Activity 4

Forests of Guatemala

around Carmelita and the other section is the land north of Lake Petén-Itza.

7. Point out that the green on the maps shows forested areas and the red shows non-forested areas. Using the dot matrix and the maps, students will see whether the amount of forest in each section changed from 1986 to 2007.
8. To estimate the percentage of forested area on each map, students should place the square dot matrix over the map, line up the corners of the dot matrix with the marks on the map, and count the number of dots that fall within the green forested areas. They then should divide that number by three to calculate the percentage (each dot represents 1/3 of a percent of the entire area shown on the map).
9. Have students repeat this procedure for each map, recording their findings in their notebooks. To check their work, they should then count the dots that partially or completely fall within the red non-forested areas on each map and calculate the percentage of non-forested area (the two percentages for a given map should add up to close to 100 percent). Have each group make a graph showing the change in forested area over time around Carmelita and around Lake Petén-Itza.
10. Ask students to compare and contrast the maps for each area. Is more forest being lost in one area than in another? What do you think might be going on? If they don't already know, explain to students that the Maya Biosphere Reserve is split into different zones (described in the student page), in which the Guatemalan government allows different types of activities. Explain that the community and surrounding area of Carmelita is in the "multiple use zone," and the land surrounding Lake Petén-Itza is in the "buffer zone." Ask:
 - How does this information help you understand what is shown on the maps?
 - From these maps, what might you infer are the causes of deforestation in the Petén?
 - What else would you want to know to determine the causes of deforestation?

Additional Resources

Slide show about Guatemala developed by the Rainforest Alliance at www.rainforest-alliance.org/pictures/guatemala-kids.

Activity 4

Teacher Page: History of the Maya Biosphere Reserve



The Petén region of northern Guatemala is home to an astounding diversity of plant and animal life, including 54 species of mammals, 333 species of birds and thousands of species of insects. Once the birthplace of the Maya civilization, today the region is mostly rural, with residents making their living off the land through agriculture and logging, and by collecting and selling goods from the forest.

The Petén has changed a lot in the last 70 years. In 1941, there were only 11,000 people living in the region, most of them farmers using traditional methods to grow their crops. Some of the people also worked for international companies that harvested forest products, including *chicle*, rubber, and cedar and mahogany woods.

In the 1950s, the Guatemalan government began to encourage people to move to the Petén, hoping that more people would mean a more secure border with Mexico. New settlers were offered parcels of land for agriculture, raising cattle and logging. With this enticement, many people did move to the Petén from other parts of Guatemala, and by 1990, nearly 500,000 people lived there.

This change in population—from 11,000 to almost half a million—also had a big impact

on the land. People cut down trees to create ranch land and cornfields. They build roads into the jungle, making it possible for loggers to clear large areas of forest. They hunted wildlife for food and to sell as pets and fur.

As more and more of the forest and its resources disappeared, it became clear that steps needed to be taken to protect it. So in 1990, the Guatemalan government established the Maya Biosphere Reserve in the northern part of the Petén. The Reserve has special rules meant to keep people and companies from completely clearing the forest. And because so many people in the Petén depend on the land, the Reserve also allows farming, ranching and logging in certain areas.

The Maya Biosphere Reserve is made up of three different zones to meet these different needs. The first zone is called the "national park zone," and all human activities are illegal here except for research and some tourism. The second zone, the "multiple-use zone," allows people to live and to harvest wood and other forest products, as long as they do so in a way that preserves the forest; farming and ranching are not allowed in this zone. The third zone, the "buffer zone," allows individuals and companies to own

Sources

Call, Wendy. "Seeing the Forest, Not Just the Trees: A Guatemalan Village and Conservation." Terrain.org: No. 14. www.terrain.org/articles/14/call.htm

Herron, Scott. "The Economic Botany of *Manilkara zapota* (L.) Van Royen." Ethnobotanical Leaflets International Web Journal. www.ethnoleaflets.com/leaflets/zapota.htm

"The Maya Biosphere Reserve." Global Perspectives: A Remote Sensing and World Issues Web Site. www.cotf.edu/earthinfo/camerica/maya/MBtopic5.html

Activity 4

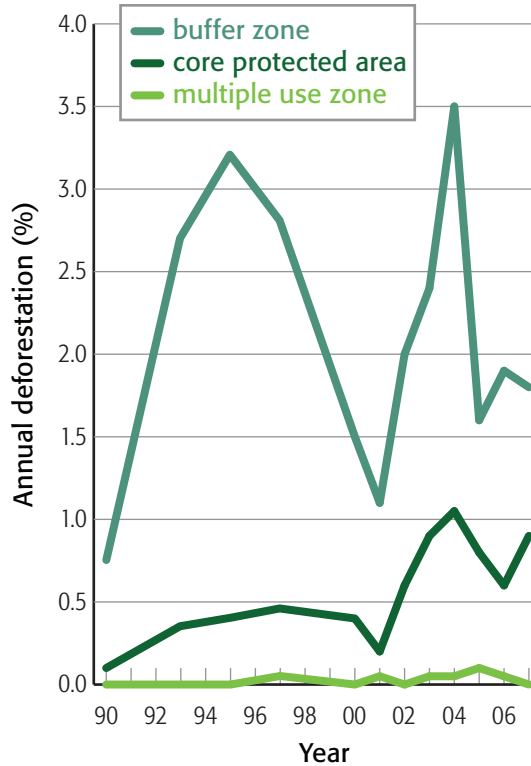
Teacher Page: History of the Maya Biosphere Reserve

land and to live, farm, have cattle or log on that land.

While creating the Maya Biosphere Reserve has slowed the rate of deforestation in the Petén, it continues in many areas. As the graph above shows, the highest rate of deforestation is in the buffer zone, where people can legally clear forest land. In remote protected areas of the national park (core protected area) where it is difficult to patrol, some people continue to cut the forest illegally. The lowest rate of deforestation is in areas of the multiple-use zone with FSC-certified concessions.

In Carmelita, for example, the villagers harvest FSC-certified sustainable products from the forest. They collect allspice and *xate* palm leaves, cut vines and weave them into wicker furniture, and selectively log mahogany trees, selling the lumber and keeping the twigs and leaves to fertilize the forest floor. These activities provide income for the community without harming the forest.

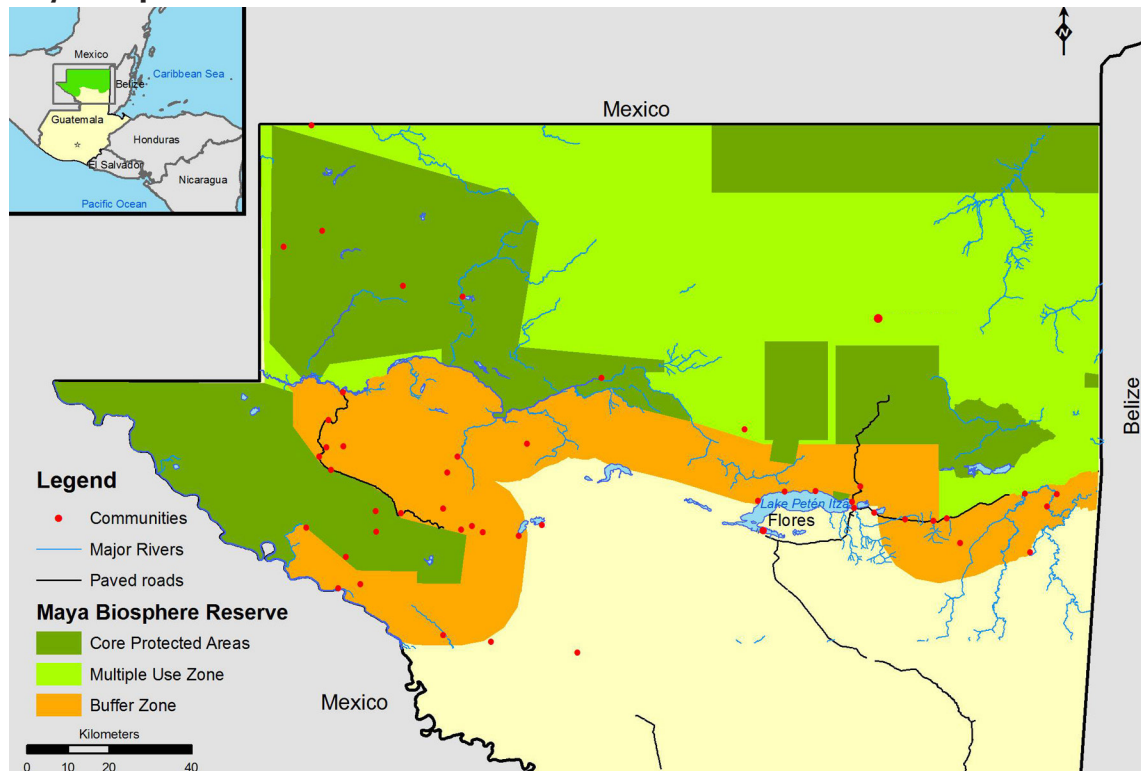
Deforestation by Land Use Zone



[Chart Source](#)

"Impact of FSC Certification on Deforestation and the Incidence of Wildfires in the Maya Biosphere Reserve." Figure 2. Comparison of annual deforestation rates by land use zones in the MBR from 1990 to 2007. Rainforest Alliance. February 2008.

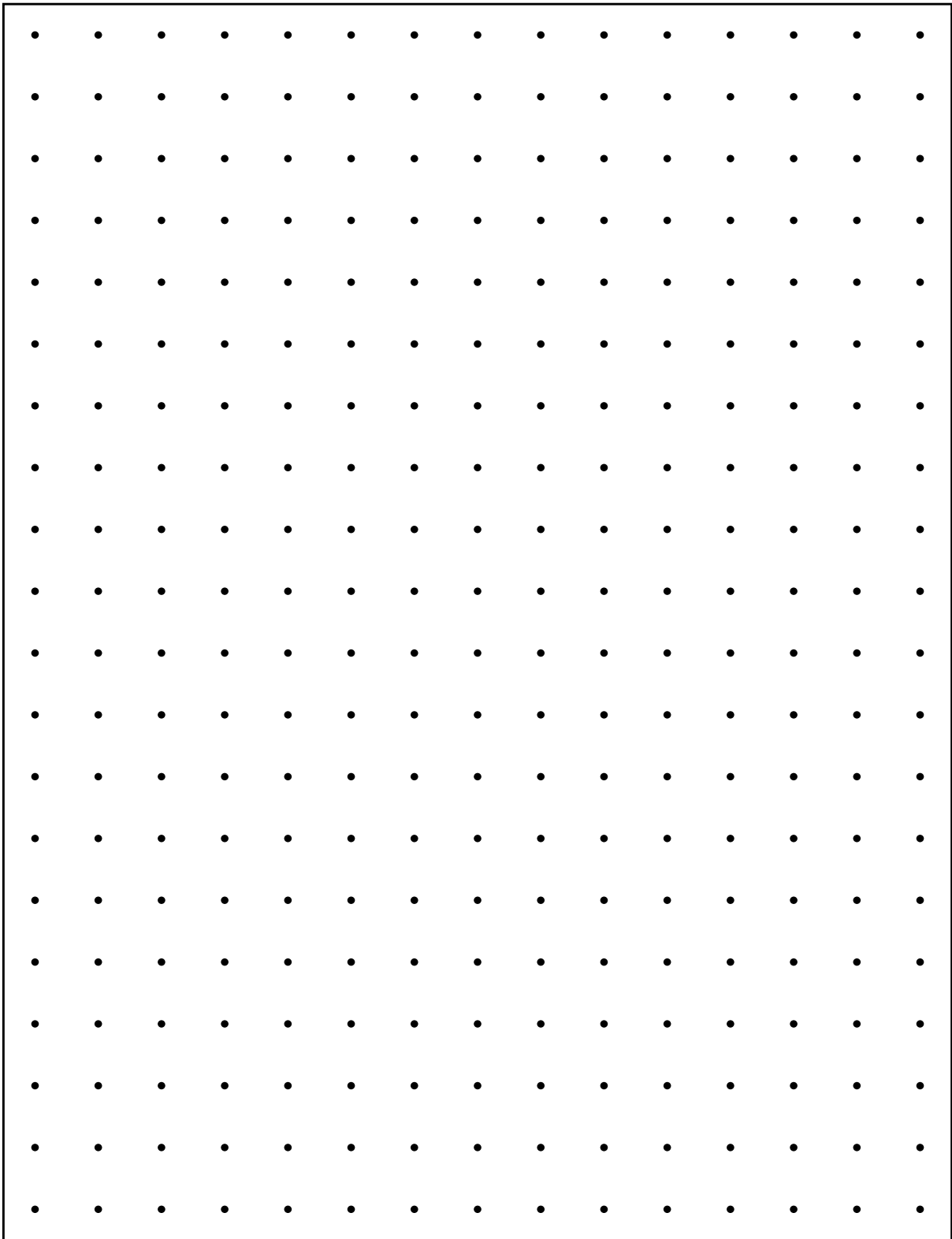
Maya Biosphere Reserve



Activity 4

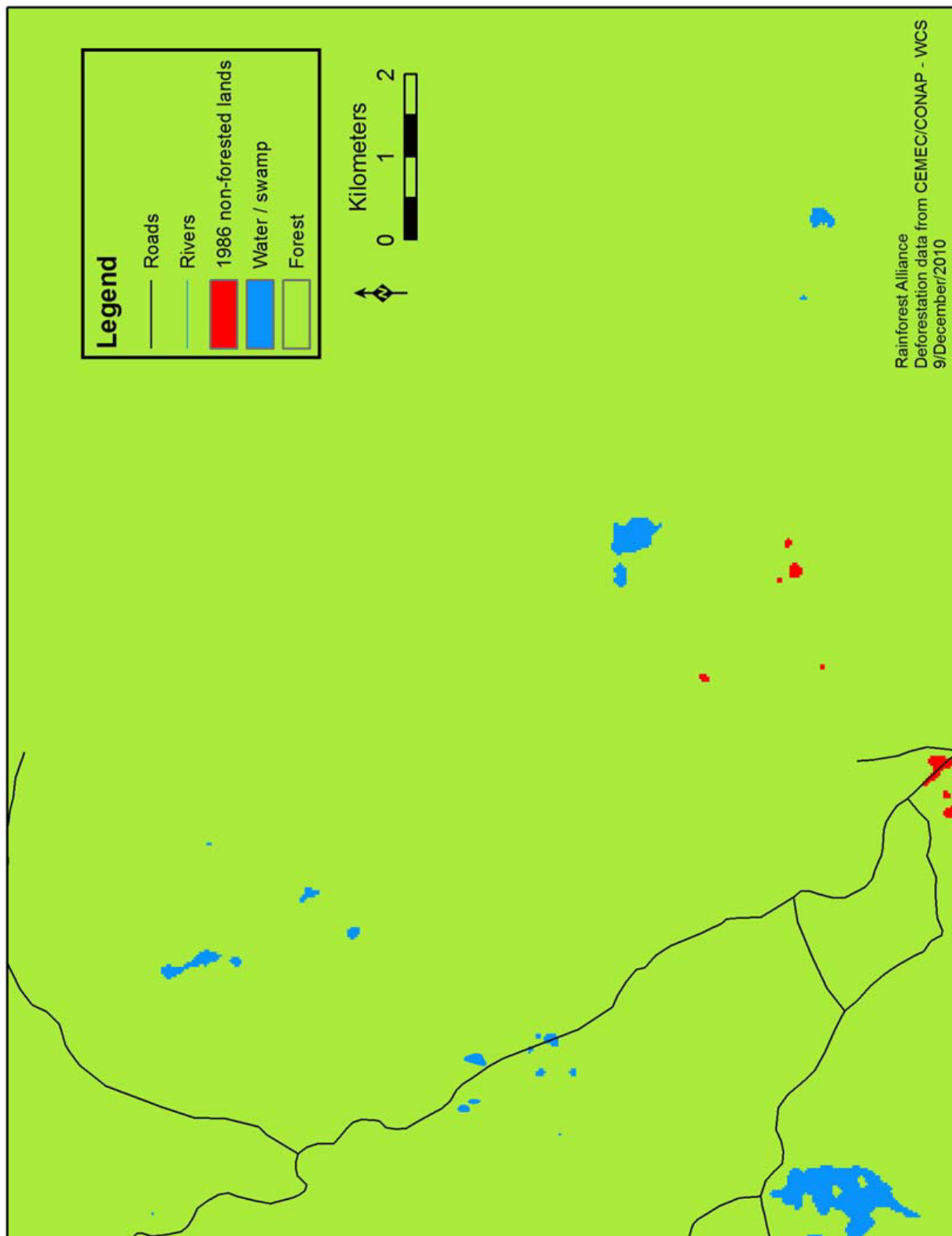
Student Resource Page: Square Dot Matrix

Note: This Square Dot Matrix should be the same size as the following maps.



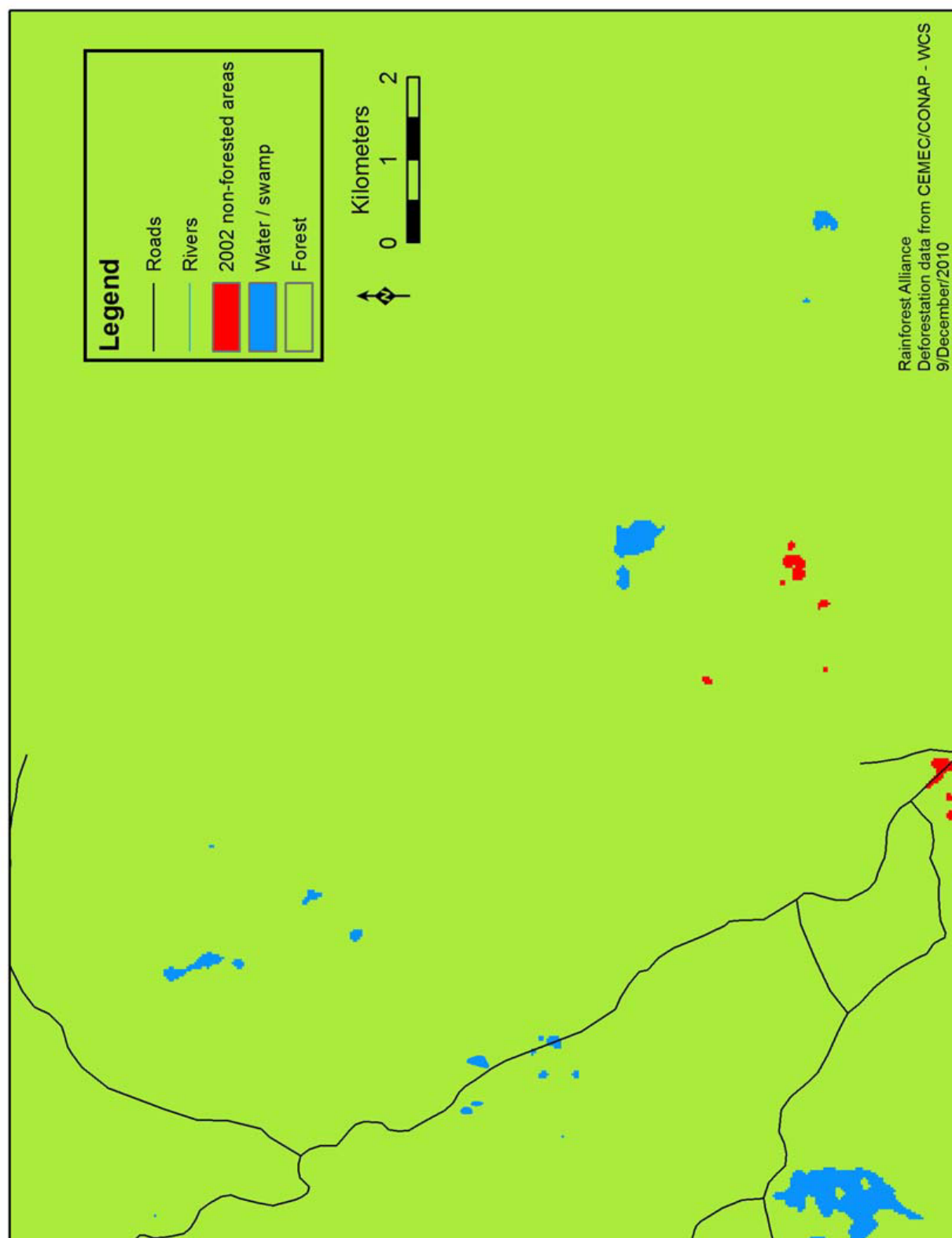
Activity 4

Student Resource Page: Forest Cover for Carmelita (1986)



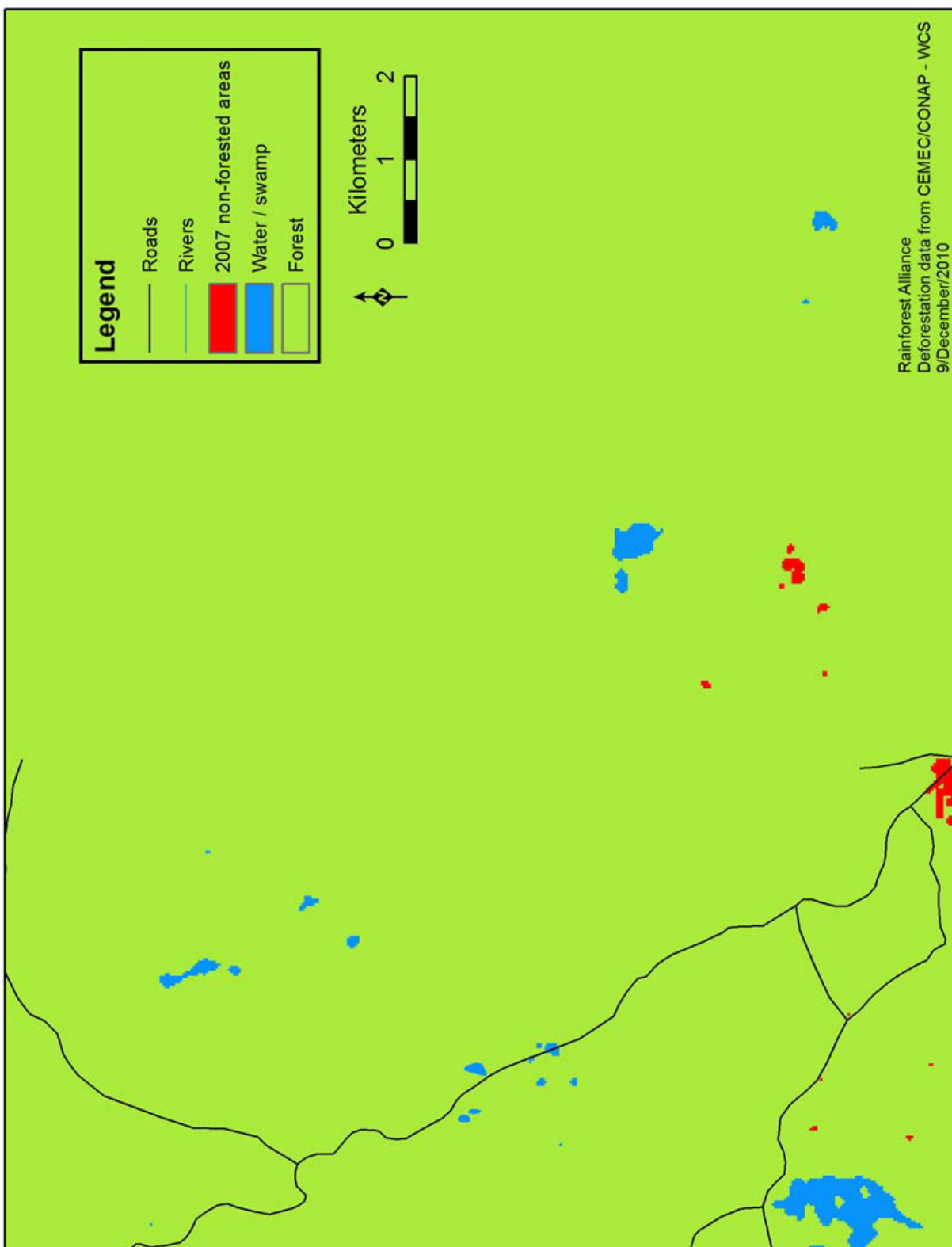
Activity 4

Student Resource Page: Forest Cover for Carmelita (2002)



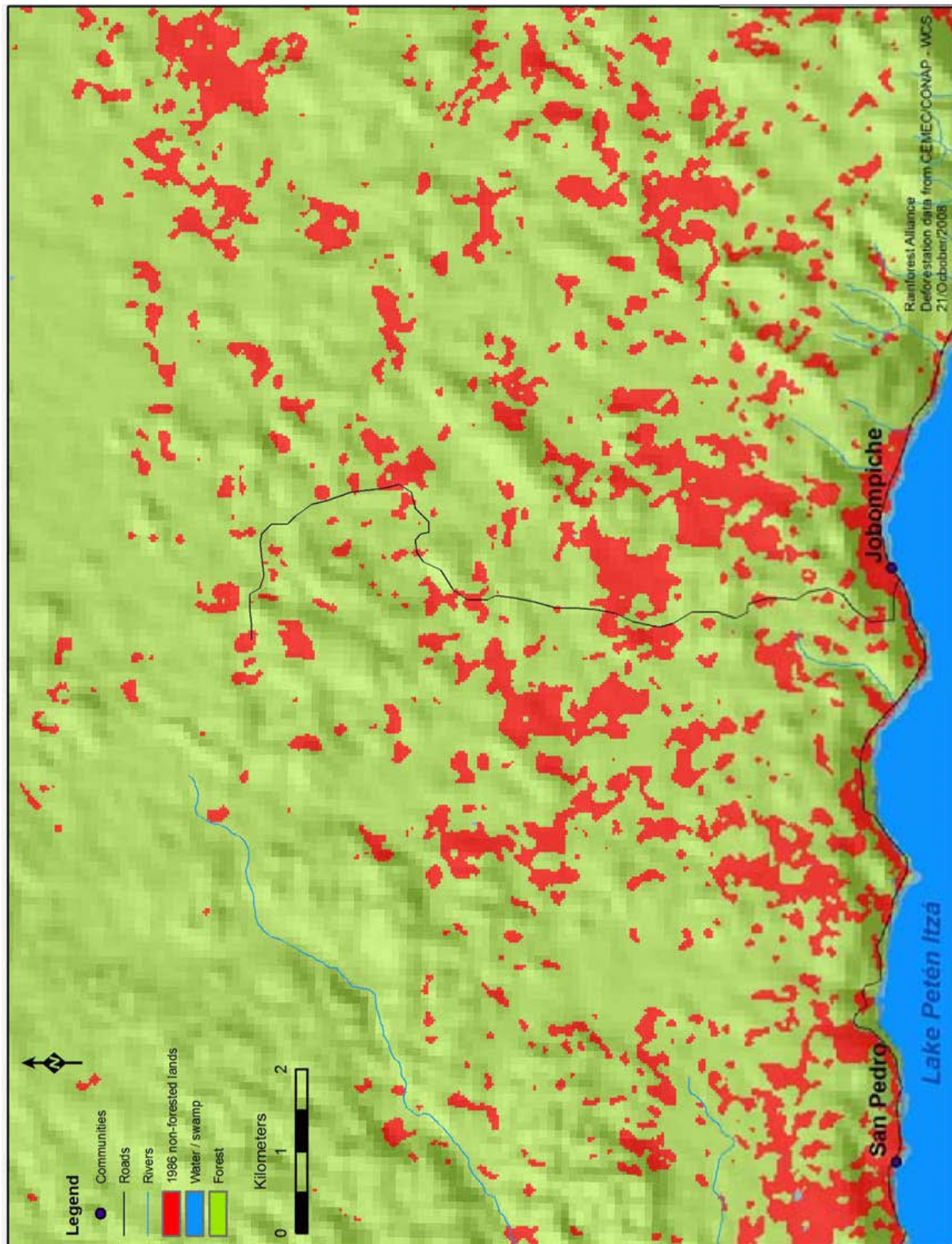
Activity 4

Student Resource Page: Forest Cover for Carmelita (2007)



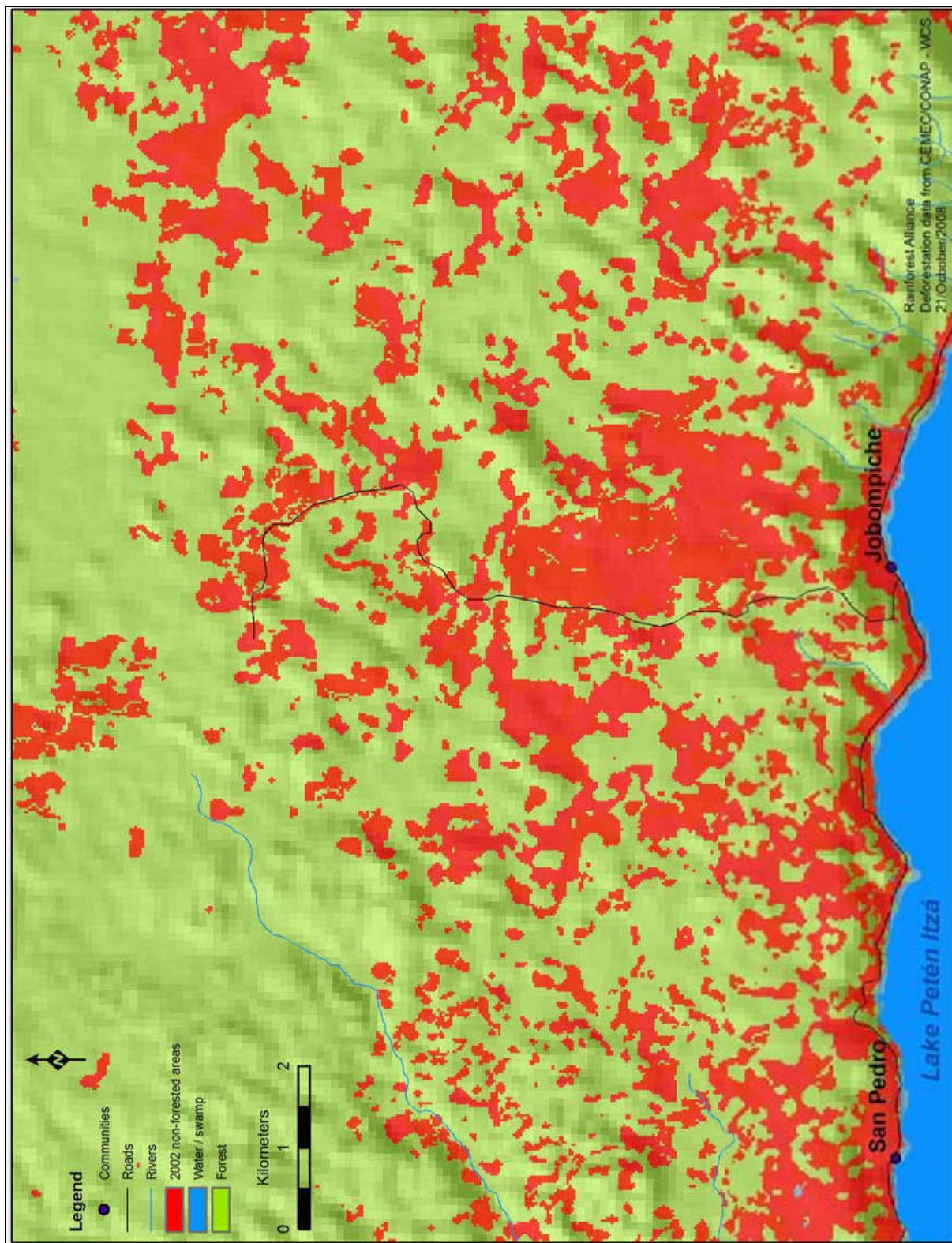
Activity 4

Student Resource Page: Buffer Zone Forest Cover (1986)



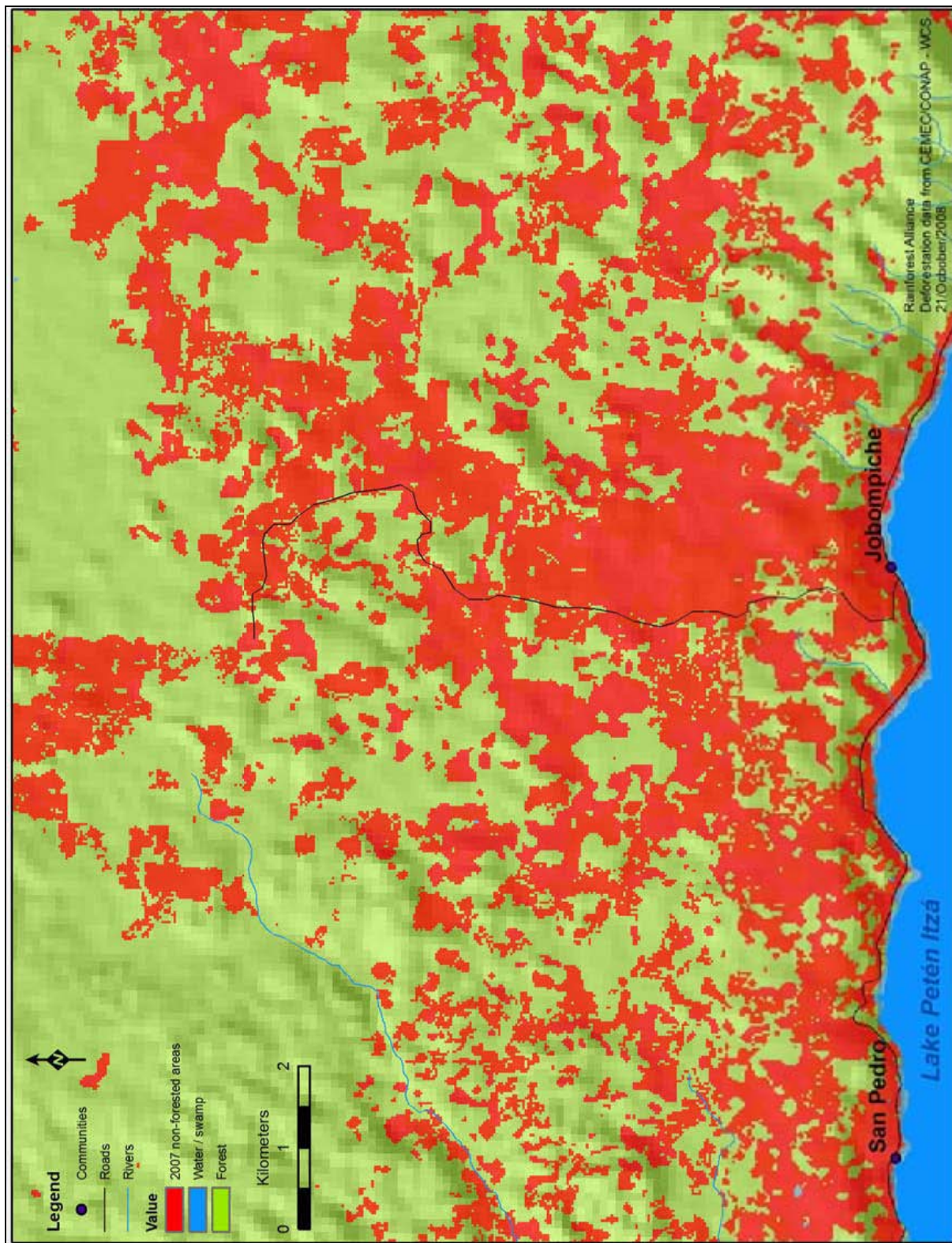
Activity 4

Student Resource Page: Buffer Zone Forest Cover (2002)



Activity 4

Student Resource Page: Buffer Zone Forest Cover (2007)



Activity 5

Investments in Forest Carbon

Guatemala

Overview

Students consider what makes the forest valuable to people, and then read a case study about a community in the Petén gearing up to sell carbon credits based on carbon sequestered in the community's forests.

Objectives

- Students understand that forests provide a number of valuable benefits, including carbon sequestration.
- Students understand that businesses and other people value carbon sequestration in the Petén's forests, and are willing to pay money for it.

Assessment

Use the team lists from Steps 2 and 3 of the activity to assess students' understanding of ways people value forests.

Subjects

- Math
- Social Studies
- Language Arts

Concepts (from PLT Conceptual Framework)

- International cooperation directed toward conserving resources and protecting environmental quality is beneficial to human health and the well-being of other life forms. (2.6)
- Our increasing knowledge of the Earth's ecosystems influences strategies used for resource management and environmental stewardship. (5.5)

Skills

- analyzing
- evaluating
- critical thinking
- identifying relationships and patterns

Materials

student notebooks

Time Considerations

Preparation: 10 minutes

Activity: one 50-minute class periods



Background

Forests provide a number of benefits—or ecosystem services—on which people depend. Forests protect watershed by anchoring the soil and preventing soil erosion. Their leaves, twigs and bark decay into rich humus that nourishes plants. They convert sun energy to chemical energy that can be stored and transferred through the food web. Through this process, they absorb carbon dioxide and produce oxygen. Forests also give shade, cool the air, modify local climates and provide habitat for plant and animal species.

Forests are also crucial to the world economy. They provide wood-based goods such as lumber and paper, as well as non-wood products such as *chicle* and other gums, *xate*, medicines, oils and spices.

One ecosystem service that is gaining interest around the world with global climate change is “carbon sequestration.” This is the long-term storage of carbon in trees and other carbon “sinks.”

When trees grow, they take in carbon dioxide (CO₂), which is made up of one part carbon and two parts

Activity 5

Investments in Forest Carbon

oxygen. They use the carbon to build new wood and other tissues, and release the oxygen back into the air. Through this process, growing forests reduce the amount of carbon dioxide in the atmosphere, and keep the carbon locked or “sequestered” in their wood.

Too much carbon dioxide in the atmosphere can cause climate change. Because all countries of the world are concerned about the severe negative impacts that climate change can have, they are looking for ways to stop the emission of greenhouse gases, including carbon dioxide. Countries are working under the United Nations to develop a way to Reduce Emissions from Deforestation and forest Degradation and increase carbon sequestration in forests. This initiative, called REDD+, is a plan to save forests, fight climate change and help local communities all at the same time. The details of REDD+ are not final at the international level, but already people are taking actions in this area.

The idea of REDD+ is that countries will measure how much forest they have at a certain moment in time, predict how much forest will be lost in the future and identify the sources of the deforestation. Then these countries will take actions to stop deforestation and degradation of the forest, which can occur little by little and still have a large impact. The countries that reduce their rates of deforestation, thereby conserving carbon that would otherwise have been emitted, will receive payments for their efforts. If local forest communities participate in stopping deforestation, then they could be paid for the amount of carbon dioxide their existing forests remove from the atmosphere and store as new wood.

The people who invest in carbon sequestration or avoiding emissions are typically governments, companies, other organizations and individuals whose activities emit lots of carbon dioxide into the atmosphere. They have an interest or a legal requirement to compensate for (balance) their greenhouse gas emissions with avoided greenhouse gas emissions or carbon sequestration.

Some investors might choose to support carbon sequestration or avoided emissions in forests by giving money to governments to improve policies or practices, such as penalizing those who cut down forests illegally or improving the management of protected areas. Other investors might want to support carbon sequestration or avoided emissions through a project

that aims to change practices at a specific site, for example, by routing a new road through existing agricultural land instead of through forest.

When a country or project does something to permanently stop the release of carbon into the atmosphere or to increase sequestration, it can sell a credit equivalent to the amount of carbon that is permanently stored. The process of selling and buying carbon credits known as carbon trading, and there is a market for carbon credits just as there is a market for timber. Unlike a town market, in the carbon market the buyer doesn't actually take carbon from the seller. Instead, buyers receive the carbon credit, which is usually equal to one metric ton (tonne) of carbon dioxide. The carbon stays in the forest and the forest itself does not change owners.

In order to sell carbon credits, an avoided deforestation project must demonstrate that without the project, the forest would have been cut down. It also must prove that the size of the forest has remained the same from the start of the project to the current time. A reforestation project, on the other hand, must prove that trees would not have been planted without the project and that the specified number of trees really do grow to maturity. An outside organization is used to confirm that these claims are true. The process of checking a project's plan to ensure that it meets certain standards is called validation and the act of checking what has actually happened since the start of the project is called verification.

Investments in forest conservation for carbon sequestration and avoided emissions are good for local communities, as they can provide income to help people manage the forest more sustainably, like allowing trees to grow to maturity before cutting them down or restoring degraded areas of the forest. Such investments are also good for the global community because they lead to a reduction in the amount of carbon dioxide in the atmosphere, which is the leading cause of global climate change.

In December 2010, countries under the United Nations agreed to establish a mechanism that would manage investments in forest conservation for carbon sequestration and avoided emissions. Developing countries that intend to participate will need to develop a national strategy, a national forest reference emission level or forest cover reference level and a national forest monitoring system. If a community or country wants

Activity 5

Investments in Forest Carbon

to use this “carbon financing” for forest conservation, it must think through the activities and commitments from start to finish and involve in the planning government, potential investors, and anyone expected to be impacted by the project.

Getting Ready

Look over the “Carbon Market Case Study: Carmelita” student page and be prepared to read or describe the information presented in it.

Doing the Activity

1. Ask students, “What does it mean to value something? In what ways do you think people value our forests?”
2. Divide the class into teams of three or four students. Tell them that they will work together to list different products or benefits people get from the forest. Encourage them to list as many things as possible that they can think of.
3. After they have made their lists, have teams put a star next to the three things on their list they think are the most valuable. They should decide among their team members which ones to star.
4. Point out that one way people show what they value is to pay money for it. Ask, “Besides paying money, what are other ways people might show they value something?” Have students circle any items that they think people might pay money for.
5. Have teams share the most valuable items on their list. Also, have them share some of the items they think people might pay for. Ask, “Are the things you starred and the things you circled the same? Why might that be?”
6. Ask students whether their team included carbon storage on their list. Remind them how forests taking carbon dioxide and undergoing photosynthesis leads to the trees storing carbon in their trunks, branches and roots. This carbon sequestration removes carbon dioxide from the atmosphere and stores it in trees. Explain to students that with global climate change, people are willing to pay for long-term storage of carbon in forest trees.
7. Read aloud the “Carbon Market Case Study: Carmelita” student page or describe what is happening in Carmelita. Lead a discussion about the case study, asking:
 - How do the carbon investments work? How is this system the same or different from a town market?
 - How might the carbon investments help reduce carbon dioxide in the atmosphere?
 - How might they help communities like Carmelita?
 - What challenges might there be with this system?
 - What do you think of people being able to “buy” credits to offset their own carbon emissions?

Additional Resources

“Introduction to REDD.” Global Canopy Programme. www.youtube.com/watch?v=4Z4TIC1ObUI&feature=player_embedded. This three-and-a-half-minute video introduces REDD.

“In Forests: The Challenge of Climate Change and Poverty.” *Living on Earth*. Air date: week of April 23, 2010. www.loe.org/shows/segments.html?programID=10-P13-00017&segmentID=4. An interesting radio program on a REDD pilot project in Indonesia.

Activity 5

Student Resource Page: Carbon Market Case Study: Carmelita



Source

Adapted from “Working with Communities in Guatemala to Combat Global Climate Change.” Rainforest Alliance.

The 75 families living in Carmelita, deep in northern Guatemala's Petén region, share their forest home with raucous howler monkeys, stealthy jaguars, and brilliantly feathered scarlet macaws. Since 1997, when the government awarded the community the rights to manage 132,938 acres (53,798 hectares) of land, members have been working to conserve their forest by sustainably harvesting *xate*, *chicle* and wood.

Beneath the majestic kapok trees of the Maya Forest is the most biologically diverse ecosystem in Central America, extending from Guatemala through Belize into Mexico. It is the largest uninterrupted tropical forest north of the Amazon, a densely-forested habitat for an amazing array of plant and animal life, including 54 species of mammals, 333 species of birds and thousands of different insect species.

The Rainforest Alliance has certified Carmelita's forestry operations and helped the community find international buyers for its wood products. This arrangement has meant increasing income for the community, allowing it to build a new school, a health center and a soccer field. But it has not been enough to keep away illegal loggers, drug runners and other threats to the forest.

“In many cases, after extracting wood illegally, these invaders burn the forests,” explains Carlos Federico Barrios, manager of the Baren Commercial Plant, a leading manufacturer of certified wood products in the Petén. “With a dry summer, the fires can spread and destroy more forest. This process of turning a lush forest into a burnt area is happening every day here and we must stop it.”

To provide Carmelita and other communities with a greater incentive to conserve their forestlands, the Rainforest Alliance is spearheading Payments for Environmental Services in the Maya Biosphere Reserve. This project will help to avoid emissions of carbon due to deforestation into the Earth's atmosphere. By stopping deforestation and carbon emissions, Carmelita can help to slow down climate change.

At the same time, the project is expected to create a new source of income for communities in the Petén: Carmelita's citizens will sell “carbon credits”—the difference between current levels of carbon emissions and future levels of emissions—to people who cannot reduce their own emissions but want to compensate for them. With more money, the communities will be able to invest in conservation and meet pressing social needs.

Activity 5

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“We understand that climate change is caused by pollution and deforestation,” reflects Beneditin Garcia, president of the Management and Conservation Organization located in nearby Uaxactún. “With this project, we believe we are halting deforestation and maintaining the equilibrium of the forest. This will not only help to maintain our health, but it also has social, ecological and economic benefits.”

The Multiple Use Zone within the Maya Biosphere Reserve has the potential to offset an estimated 0.8 million tons (726,000 metric tons) of carbon dioxide per year through avoided deforestation or approximately 16 million tons (14.5 metric tons) of carbon dioxide over 20 years.

As Jeffrey Hayward, manager of the Rainforest Alliance's climate initiative, explains, “Deforestation accounts for between 12 and 15 percent of global greenhouse gas emissions. By giving communities the incentive to stop deforestation, we're helping to sequester carbon gases. At the same time, we're conserving biodiversity and helping to provide economic and social benefits in these areas.”

Under the terms of the project, the government and communities in the Petén hope to be able to sell credits on the international carbon market. But laying the groundwork for the project has been a lengthy three-year process that is still ongoing. It's important that communities like Carmelita and other legitimate stakeholders have their rights to the carbon fairly established.

Carmelita community members are currently immersed in preparing their baseline for monitoring emissions. They are also working to analyze the causes of deforestation and to identify ways to prevent further deforestation within their concession.

The community is eager to finalize a deal and move ahead with its conservation plans. “The communities

need more money to look after the forests. Management comes at a high cost,” observes Marcedonio Cortave, executive director of the Association of Forest Communities of the Petén. “Forest certification means that you have to pay for audits, annual improvements, and do all the activities that certification requires.” Projects designed to avoid carbon emissions have similar costs.

To qualify for payment, Carmelita will have to prove that the trees are actually still standing year after year for at least 20 years. In order to reduce the deforestation rate in the project area, Carmelita plans to invest in activities that will help sustain the forest so that it will continue to provide for future generations. These activities include:

- fire prevention
- increasing forest guards
- improving forest management
- improving harvest of non-timber products, like *xate* and *ramón* nuts
- monitoring and evaluation
- improving access to education and health care

“For me, education is crucial,” notes president of the Carmelita concession Carlos Crasborn. “Sadly, most of the children in our community leave to study elsewhere at the age of 15 because we don't have the facilities or teachers to educate children up to 18 years. We want children to stay in the community. Educating them here will be a step towards achieving that.”

Cortave believes that with enough financial incentive and support, the most qualified people to protect the forestlands are the community members themselves. “The people from the community are key to the vigilance of the forests. By having a direct interest in the forests, they are more likely to care for and protect them,” says Cortave. For a citizen of Carmelita, “the forest is crucial to his livelihood—it's his fountain of life.”