DOCUMENT RESUME

ED 448 054 SE 064 351

TITLE	Global Change. Teaching Activities on Global Change for Grades 4-6.
INSTITUTION	Geological Survey (Dept. of Interior), Reston, VA.
PUB DATE	2000-00-00
NOTE	19p.; Poster not avilable from ERIC.
PUB TYPE	Guides - Classroom - Teacher (052)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	*Earth Science; *Ecology; Global Education; Intermediate Grades; Lesson Plans; Science Activities; Science Instruction; *Teaching Methods
IDENTIFIERS	*Geological Survey; *Global Change

ABSTRACT

This packet contains a series of teaching guides on global change. The series includes lessons on dendrochronology; land, air, and water; and island living. Included is information such as : laws of straws; where land, air, and water meet; and Earth as home. Each section provides an introductory description of the activity, the purpose of the lesson, materials needed, procedures, questions, extensions, and resources. Additional reading material, graphs, charts, and worksheets are also included. (SAH)

Global Change. Teaching Activities on Global Change for Grades 4-6.

U.S. Department of the Interior
U.S. Geological Survey

Teacher Guide

Global change is a relatively new area of scientific study using research from many disciplines to determine how Earth systems change, and to assess the influence of human activity on these changes.

This teaching packet consists of a poster and three activity sheets. In teaching these activities four themes are important: **time**, **change**, **cycles**, and **Earth as home**.

The poster

The front of the poster uses metaphor to invite students to think about the Earth as a whole and to respect its fragility. The back of the poster shows visible global change.

The **tree-ring** image can be used in the "Logs of Straws" activity. Have the students assume the tree was cut down in 1992. Have them calculate the age of the tree and measure the rings to see which years had favorable climatic conditions and which had unfavorable conditions.

The **Keeling curve** relates to the activity, "Where Land, Air, and Water Meet." It shows students how data can be visualized to detect patterns: both the upward trend in the atmospheric concentration of carbon dioxide, and cyclical fluctuations during the growing season.

The **greenness maps** depict the vigor of vegetation and allow scientists to see how vegetation changes over a growing season and from year to year. Because plants remove carbon dioxide from the atmosphere, such maps may be useful for describing how gases are transferred between the biosphere and the atmosphere.

In the final activity, "An Island Home," students can be asked: What happens to an ecosystem when much of the vegetation is removed? Satellite images such as those from **the Brazilian rainforest**, show human alteration of the landscape. How could the destruction of the rain forest affect the global environment?

Activities

Each of three activities, ("Logs of Straws: Dendrochronology," "Where Land, Air, and Water Meet," and "An Island Home") includes background material, an experiment, suggestions for further reading, and extensions. Activities can be presented in any order, but "An Island Home" could be used as a summary.

The four themes

Time

Looking back over the millions of years of the Earth's history, scientists have found evidence of times when climates were very different from today's. Scientists know from fossil records that certain pine trees growing today in Nova Scotia, Canada, once grew more than 1,500 miles farther north on an island near the Arctic Circle. Students will work with simulated tree rings to discover how records of natural phenomena are used to reconstruct past climates.

Change

One demonstrable variation in Earth's atmosphere has been the increase in concentration of carbon dioxide (CO_2) gas during the past century. "Where Land, Air, and Water Meet" introduces students to measurement in parts per million and concentration. This activity can lead to a discussion of the composition of the atmosphere and of how solar radiation, vegetation, and human activity could influence global warming.

Cycles

Many natural phenomena vary on a regular or periodic basis. An example of this is the changing seasons. Some of the images on the back of the poster demonstrate natural cycles. The concentration of CO_2 in the atmosphere fluctuates regularly with the seasons. Temperature records reveal a history of thermal cycles in the Earth's climate. Students should be asked to consider cycles and to discuss how cyclical change can be distinguished from change that moves in only one direction.

The Earth as home

"An Island Home" is an open-ended activity in which students consider how altering part of an ecosystem can cause changes to other parts of the system. This activity uses concepts developed in the other activities to help students look on the Earth as home, and encourage responsible stewardship.

Readings for teachers

The following books and articles are recommended for more information about global environmental change issues:

de Blij, H.J., editor, 1988, Earth '88—Changing geographic perspectives: Washington, D.C., National Geographic Society, 392 p.

Jastrow, W., Nierenberg, W., and Seitz, F., 1990, Scientific perspectives on the greenhouse problem: Ottawa, Illinois, Jameson Books, 250 p.

Levenson, Thomas, 1989, Ice time: New York, Harper and Row, 229 p.

Lins, H.F., Sundquist, E.T., and Ager, T.A., 1988, Information on selected climate and climate change issues: U.S. Geological Survey, Open-File Report 88-718, 26 p.

Lovelock, J.E., 1979, Gaia—A new look at life on Earth: Oxford, Oxford University Press, 157 p.

Revelle, Roger, 1982, Carbon dioxide and world climate: Scientific American, v. 247, no. 2, p. 35-43.

Schneider, Stephen H., 1989, Global warming—Are we entering the greenhouse century?: San Francisco, Sierra Club Books, 317 p.

Scientific American, 1989, Managing planet Earth: Scientific American, v. 261, no. 3, p. 47-190.

Stevens, P.R., and Kelley, K.W., 1992, Embracing Earth: San Francisco, Chronicle Books, 176 p.

Weiner, Jonathan, 1968, Planet Earth: New York, Bantam, 370 p.

Zaburunov, Steven A., 1992, As the world breathes—The carbon dioxide cycle: Earth, v.1, no.1, pp. 26-33.

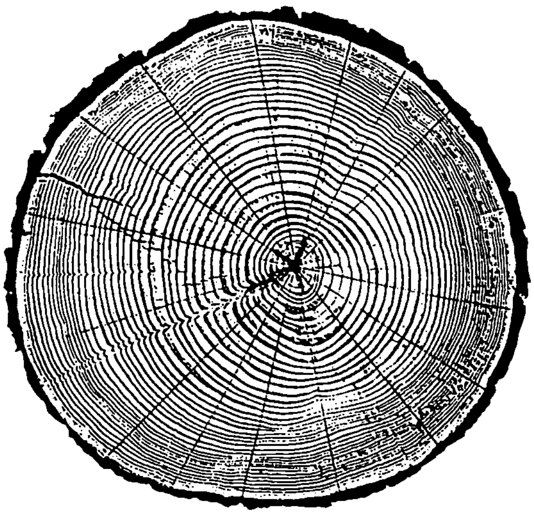
Acknowledgments:

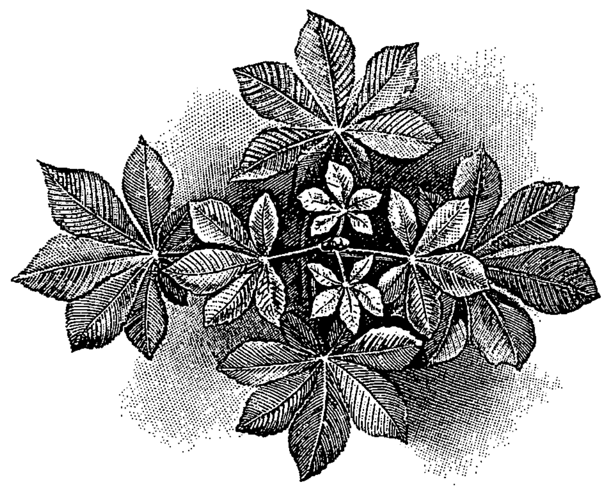
Technical assistance from the following scientists is greatly appreciated: Keith C. Clarke, Hunter College, New York; Richard. S. Williams, Jr., U.S. Geological Survey (USGS), Woods Hole, Massachusetts; and Michael D. Carr, John A. Kelmelis, David A. Kirtland, Harry F. Lins, Robert M. Hirsch, Richard Z. Poore, and Thomas M. Yanosky, USGS, Reston, Virginia.

For more information

To find out more about research being done on global change by the USGS or about other USGS educational materials call 1-800-USA MAPS.

Logs of Straws: Dendrochronology





Background

Trees are some of nature's most accurate timekeepers. Their growth layers, appearing as rings in the cross section of the tree trunk, record evidence of floods, droughts, insect attacks, lightning strikes, and even earthquakes.

Tree growth depends on local conditions, which include the availability of water. Because the water cycle, or hydrologic cycle, is uneven—that is, the amount of water in the environment varies from year to year—scientists use tree-ring patterns to reconstruct regional patterns of drought and climatic change. This field of study, known as dendrochronology, was begun in the early 1900's by an American astronomer named Andrew Ellicott Douglass.

While working at an observatory in his native Arizona, Douglass began to collect pine trunk cross sections to study their annual growth rings. He thought there might be a connection between sunspot activity and drought. Such a connection could be established, he believed, through natural records of vegetation growth.

Douglass was not the first to notice that some growth rings in trees are thicker than others. In the climate where Douglass was working, the varying widths clearly resulted from varying amounts of rainfall. In drier growing seasons narrow rings were formed, and in growing seasons in which water was more plentiful, wide rings occurred.

In addition to correlating the narrow rings to periods of drought and, in turn, to sunspot records, Douglass had to establish the actual year each tree ring represented. Because absolute ages can be determined through dendrochronology, the science has since proven useful far beyond the narrow study to which Douglass applied it.

Computer analysis and other methods developed since Douglass' time have allowed scientists to better understand certain large-scale climatic changes that have occurred in past centuries. Likewise, highly localized analyses are possible. Archaeologists use tree rings to date timber from log cabins and Native American pueblos by matching the rings from the cut timbers of homes to rings in very old trees nearby. Matching these patterns can show the year when a tree was cut and, thus, reveal the age of a dwelling.

To determine whether changes now occurring in climate are part of the Earth's normal pattern or are induced by human activity, scientists rely on the history of climatic changes both locally and globally as revealed by tree rings, ice cores, pollen samples, and the fossil record. Computers are used to detect possible patterns and cycles from these many sources. In dendrochronology, large data bases allow scientists to compare the ring records of many trees and to construct maps of former regional climates. The evidence collected so far suggests that climatic change is simply a part of life on Earth. The extent to which human activity affects the way the global climate is changing now is not yet fully understood.

Activity (Allow 45-60 minutes)

In this activity straws will be used to simulate tree-ring core samples. Using the straws, students will work in groups to reconstruct a 50-year climatic history. Students will record this chronology on a 3-meter time line designed to highlight significant social, personal, and scientific events covering the same period.

Dendrochronologists seldom cut down a tree to analyze its rings. Instead, core samples are extracted using a borer that is screwed into the tree and pulled out, bringing with it a straw-size sample of wood about 4 millimeters in diameter. The hole in the tree is then sealed to prevent disease.

Materials

For each group of four students:

- One set of white straws marked with ring patterns (see illustration below). Markings can be produced with permanent black marker on paper or plastic straws
- One 3-meter strip of adding machine tape for each group
- Colored pencils for each group
- Colored markers for each group
- A notebook for recording results (optional)
- Reference material such as almanacs that provide students with the dates of social and scientific events over the last 4 decades.

Prior to the activity the teacher should construct sets of straws similar to the set shown in the illustrations.

Group students in teams of four. The following information on the straw samples can be recorded on the blackboard or copied and handed out. Review with the students some of the tips on reading tree rings found in the boxed section.

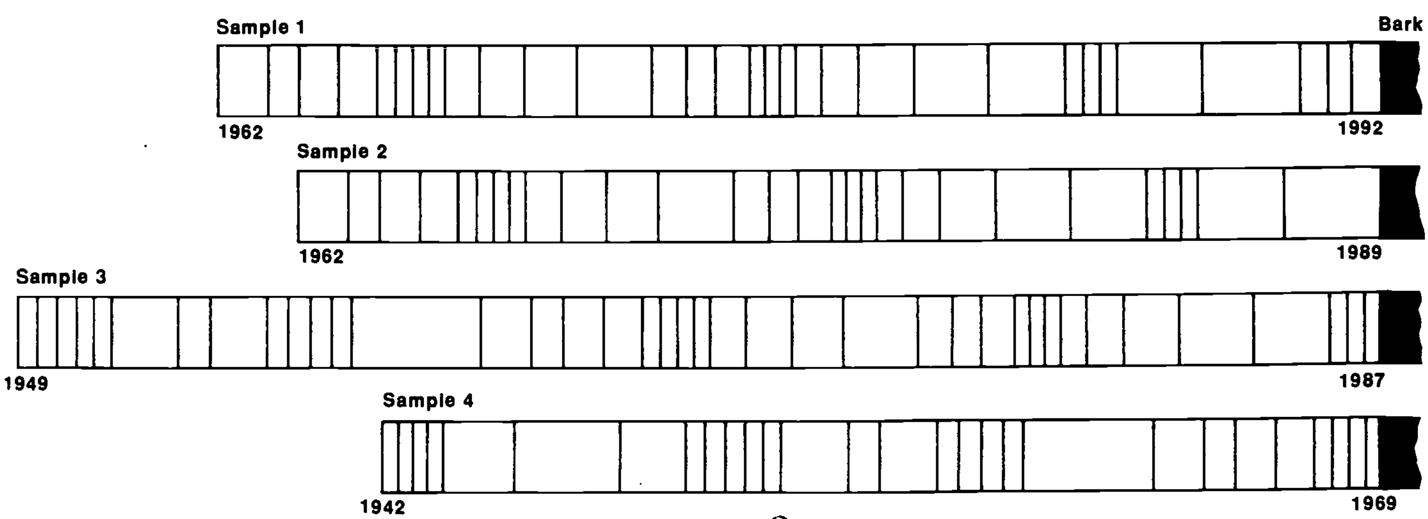
Reading Tree Rings

Core sample 1 is to be used as a standard against which to compare the others, because a bore date of 1992 has been established. Notice the varying patterns of ring widths in sample 1; look for similar patterns in other samples.

Core sample patterns are alternating dark and light lines. The darker lines of a core sample represent the end of a growing season. The light-toned space between the two darker lines represents one growing season.

Tree rings are formed from the center of the tree outward. The ring closest to the bark is the youngest and final growth ring. The ring closest to the center of the tree is the oldest growth ring. Neither the outer layer of bark nor the central pith layer of a sample is counted when determining the age of a sample.

Similar ring patterns are found between trees growing under the same conditions. The most obvious feature of these patterns is varying widths. Widening of a ring indicates good growing conditions, while narrowing indicates poor ones. Conditions can include climatic factors such as temperature and moisture as well as factors such as erosion, fire, landslides, etc.



Procedure

Imagine you have core samples from four trees:

Sample 1. From a living tree, July 1992, Pinetown Forest.

Sample 2. From a tree from the Pinetown Christmas Tree Farm.

Sample 3. From a log found near the main trail in Pinetown Forest.

Sample 4. From a barn beam removed from Pinetown Hollow.

1. Determine the age of each tree (how many years it had been growing) by counting the rings. Record your answers in your notebook or in the first column on the chart below:

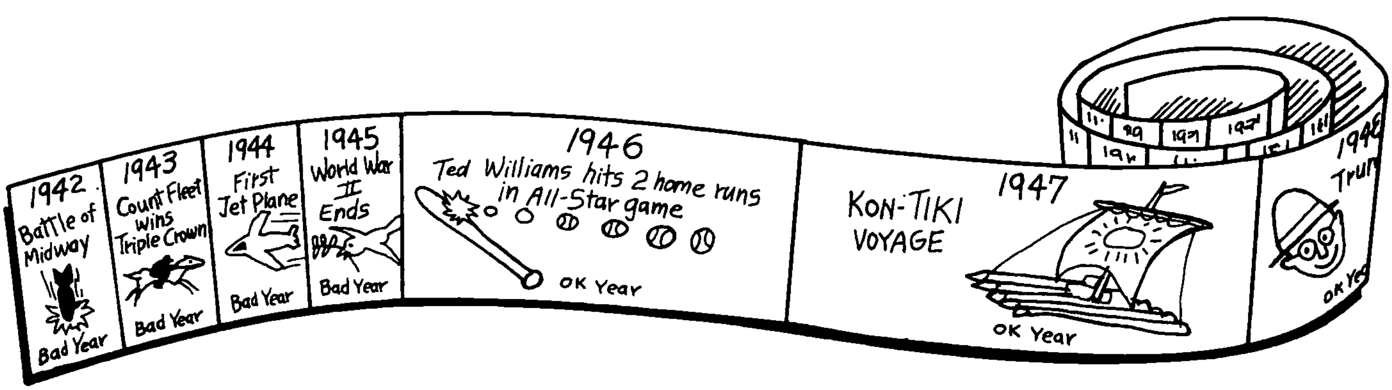
	Age of tree	Year tree was cut	Year growth began
Sample 1			
Sample 2			
Sample 3			
Sample 4			

2. Look for patterns in the rings. Patterns in this exercise match well, but actual ring patterns will vary among different species of trees. Once a ring pattern has been discovered, line up all the samples. Because you know that Sample 1 was cut in 1992, you can match the patterns of all the other samples and determine when all the other trees were cut or cored and also when they began to grow. Record this information in your notebook or fill in the chart above.

3. Make a time line. Spread out the adding machine tape. Beginning at the left end of the tape, record each year from the earliest year identified on the tree-ring samples through 1992. After the years are recorded on the strip, identify years that were good growing years for the trees in Pinetown, and years that were poor. Think of other events that might have happened during this time period such as your birthday, Presidential elections, important scientific discoveries, or record-setting sports achievements. Fill them in on the time line. You can color the time line and illustrate it with drawings, photographs, or newspaper clippings.

Questions

Which ring on each tree represents your birth year? What kind of growing season existed that year in Pinetown? In which years did droughts occur in Pinetown? Is there a pattern to the droughts? What buildings in your areas were built during the lifetime of these trees?



Extensions

Measure the tree rings in the photograph on the back of the poster. Assume the tree was cut in 1992. How old is the tree? Can you determine good and bad years for growth?

Find and map the locations of some of the oldest known trees in your neighborhood. Sketch what you think a core from one of these trees might look like.

Contact your local forestry service or science museum and obtain some actual cross sections of trees that have been cut in your area. Use the techniques applied during this activity to "read the tree." If a tree has been cut in your neighborhood recently, look at the tree rings on the stump or ask if you can keep a small piece of the trunk.

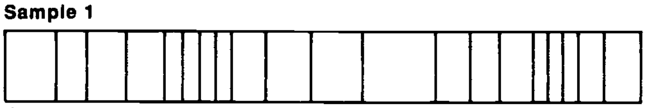
Create some simulated core straws of your own for another group to analyze and report about.

For the Teacher

Aligning the samples

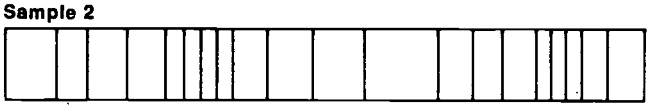
The following illustration shows how samples 1 and 2 can be aligned. Have the students align all four samples so that the patterns match, and determine the years when each tree was cut and when it began to grow. Have them count all the rings from the oldest samples as they are aligned with the younger samples to determine the total amount of time represented by the rings. Count aligned rings that appear on several samples only once.

Sample 1



1962 **1981**

Sample 2



1962 **1981**

Charts

The charts should be completed as follows:

	Age of tree	Year tree was cut	Year growth began
1	31	1992	1962
2	28	1989	1962
3	39	1987	1949
4	28	1969	1942

The total time covered by the tree rings is 50 years, from 1942 to 1992.

Answers to questions

The answers to some of the questions in the activities will depend on the individual class—for example, when they were born or when buildings in their area were built. In looking at the climate record as revealed in the tree rings, notice that there is a significant period of poor growing conditions in each of the four decades covered by the tree samples. This pattern, which can be graphed, is the type of pattern scientists might look for when studying climate change.

Classroom Resources

Angier, Natalie, Warming?—Tree rings say not yet: New York Times, Tuesday, December 1, 1992, p. C-1, C-4.

U.S. Geological Survey, 1991, Tree rings—timekeepers of the past: Reston, Virginia, USGS, 15 p.

Where Land, Air, and Water Meet

Background

The Earth is often compared to a gigantic greenhouse. Energy in the form of sunlight passes through the planet's atmosphere. Some of the energy that strikes the land and water is reflected back into space. Most of the rest is absorbed by the land and water, converted to heat, and radiated back into the atmosphere. This radiated energy is mostly absorbed by carbon dioxide (CO_2) and other atmospheric gases, which act much like the glass in a greenhouse, warming the atmosphere.

Since the middle 1800's, scientists have wondered about the importance of CO_2 as a "greenhouse gas" in the regulation of Earth's climate. According to the "greenhouse effect" theory, increasing levels of CO_2 in the atmosphere will trap more and more heat, raising the planet's overall temperature and affecting regional climates, sea levels, distribution of arable land, animal and human habitats, and more.

The widespread burning of fossil fuels—coal, oil, and natural gas—releases greenhouse gases, including CO_2, into the atmosphere. Concern about the possible climatic effects of increasing atmospheric CO_2 levels was voiced in 1957 by Roger Revelle, then director of the Scripps Institute of Oceanography in La Jolla, California. He wrote, "... human beings are now carrying out a large-scale geophysical experiment of a kind that could not have happened in the past nor be reproduced in the future. Within a few centuries we are returning to the atmosphere and oceans the concentrated organic carbon stored in sedimentary rocks over hundreds of millions of years."

In the late 1950's scientific information on the levels of CO_2 in the atmosphere was sketchy. So Revelle and others commenced an international effort to monitor CO_2 concentrations in the atmosphere from stations in Alaska, Antarctica, and Hawaii, where measurements would not be affected much by nearby sources of greenhouse gases such as factories.

The Mauna Loa, Hawaii, station has been operating since November 1958. The record compiled there over more than 30 years reveals some interesting insights into the global carbon cycle. A chart of changing CO_2 patterns is reproduced on the back of the poster. Notice two patterns: a sawtooth pattern of seasonal variations of CO_2 of about 5 parts per million [ppm] superimposed over a long-term increase of about 1.3 ppm per year.

This long-term increase in CO_2 levels raises new questions. What are the sources of this "new" CO_2? How much comes from burning fossil fuels? How much may be caused by the clearing and burning of forests? What are the "sinks," or storage places, for the "excess" CO_2, and how big are they? Is the increase in atmospheric CO_2 changing the global climate?

Such new tools as computer simulation models and satellite images are used to better estimate the sources and sinks of the carbon cycle. CO_2 dissolves readily in sea water, where it is absorbed by microscopic plants known collectively as phytoplankton. When phytoplankton die, some are incorporated into the ocean bottom sediments, trapping their carbon for millions of years. Sensors borne on satellites can measure electromagnetic energy reflected from the Earth, providing images of the extent and vigor of plant growth. These satellite images are being used to map phytoplankton activity at the ocean's surface and estimate the role of the oceans as a sink for atmospheric carbon.

On land, plants absorb and store CO_2. A large part of the carbon that is fixed in the leaves of plants, as they grow, is released back into the atmosphere when the plants die and decay. During the growing season, plants take in CO_2 and give off oxygen. In the dormant winter months, no CO_2 is taken in. This causes a seasonal oscillation of CO_2 levels in the atmosphere, with maximum concentrations in early spring and minimum ones in the fall. In the longer term, carbon is stored either as wood, as humus in soil, or in certain rocks. Satellite sensors can be used to better delineate the world's forests and grasslands as both sources and sinks for CO_2.

All this information is being integrated into computer models to help scientists simulate how the oceans, the biosphere, and the atmosphere interact in the global carbon cycle. The idea is to learn more about effects of human activity on carbon levels and, thus, on climate.

Activity (Allow 30-45 minutes)

To develop an understanding of parts per million as a concept, teams of students will create successive dilutions of a solution to reach a parts-per-million concentration.

The atmosphere is a mixture of gases. Similarly, the world's oceans and fresh waters contain dissolved chemicals. Many substances dispersed in air or water are measured in parts per million. Some of these substances are colorless, odorless, and tasteless, yet even in small quantities they can be toxic.

Materials

For each group of three students:

- One eyedropper
- Supply of water
- A cylinder with 10-milliliter graduations
- Three 12-ounce clear plastic cups
- Masking tape
- Marking pen
- One bottle of food coloring (darker colors will work best)
- A calculator (optional)
- One box of crayons, pastels, or colored chalk
- A notebook for recording results.

The procedure can be copied and handed out to students.

Procedure

Before beginning the activity, put a piece of masking tape on each cup and label them "Sample 1," "Sample 2," and "Sample 3."

Sample 1.

1. Put 99 drops of water in the graduated cylinder. Record the volume of this amount of water in the notebook. (You will need this measurement later to avoid having to measure another 99 drops.) Pour the water from the 99 drops into the cup marked "Sample 1."

2. Add one drop of food coloring to sample 1. Stir the water. Record the color in your notebook using crayons, pastels, or chalk.

3. Answer the questions in the question section. You can use a calculator. Write the answers on the sheet or copy the information into your notebook.

Sample 2.

1. Pour an amount of water equal to 99 drops into the graduated cylinder. Pour this into the cup marked "Sample 2."

2. Add one drop of sample 1 to sample 2.

3. Stir and record the resulting color.

4. Answer the questions in the question section.

Sample 3.

1. Pour an amount of water equal to 99 drops into the graduated cylinder. Pour this into the cup marked "Sample 3."

2. Add one drop of sample 2 to sample 3. Stir and record the color of the solution.

3. Answer the questions in the question section.

Questions

What is the concentration of food coloring in sample 1?____________________

Can you see the food coloring in sample 1? ____________________

Suppose the food coloring was a harmful substance, how would you "clean" the water?__________

____

What happened to the color of the water in sample 2? Describe and explain._______________

____

What is the concentration of food coloring in sample 2?____________________

What is the concentration of food coloring in sample 3?____________________

Can you see the food coloring in sample 3? ________Explain why or why or why not. __________

____

How could a parts-per-billion solution be made?____________________

____

Extensions

Once the students are familiar with the procedure required to create a parts-per-million solution of a pollutant, have a selection of substances available for them to dilute and observe. Encourage the students to create experimental tests for determining if other substances are observable in the part-per-million concentration. Some suggested substances to experiment with are detergent and acid (vinegar). You can ask:

Are the new substances observable in any way? (Do they form a film, or foam, or is there discoloration?)

Has there been a change in a Ph test for the acid or base? (Use litmus paper to test the solutions.)

Answers will vary.

Discussion note—is a diluted substance "gone" just because it is no longer visible? How can these ideas be transferred from a liquid to a gas like CO_2?

For the Teacher

Answers to questions: Sample 1: Because you have added one drop of food coloring to 99 drops of water, the concentration is one part per hundred, which can also be expressed as 1/100 or 1 percent. A calculator can be used to visualize the answer. Divide 1 by 100. The answer is 0.01. The color should be visible.

Students might answer that filtering the water through a substance like sand or through paper might "clean" it, but filtering will not remove a chemical solution. The teacher might use this question as an opportunity to discuss the removal of CO_2 from the atmosphere. Just as no such simple process as filtering the water will remove food coloring, no simple process will remove excess CO_2 from the atmosphere. Reducing the amount of CO_2 emitted by human activity reduces the need to remove it later.

Sample 2: To 99 drops of new water, you add a drop of the solution from sample 1, which consists of .99 parts water and .01 part food coloring. Because you have now diluted the .01 drop of food coloring in a total of 100 drops of solution, divide .01 by 100 on the calculator. Your answer is .0001. This means you now have 1 part food coloring in ten thousand, or 1/10,000. Depending on the color used, the food coloring in sample 2 should be faintly visible.

Sample 3: Again you have 99 drops of new water and one drop from the solution in sample 2. The one drop is .9999 parts water and .0001 parts food coloring. To calculate the concentration of food coloring in sample 3 divide .0001 by 100 (the total number of drops in the solution). The answer is 0.000001 or one part food coloring in one million (1/1,000,000). The food coloring will not be visible at this concentration.

Making a parts-per-billion sample: Continue the procedures described above. Begin with 99 new drops of water. Use one drop of the parts-per-million solution. You will get 0.00000001 parts food coloring or one part food coloring in one-hundred million (1/100,000,000). For the final step, take nine new drops of water and add to it one drop of the previous solution. This yields 0.000000001 or one part per billion.

Classroom Resources

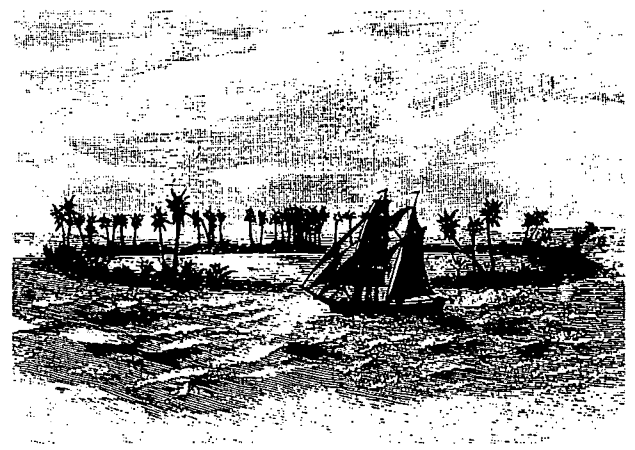
Hocking, C., Sneider, C., Erickson, J., and Golden, R., 1990, Global warming—The greenhouse effect: Berkeley, California, Lawrence Hall of Science, 171 p.

Johnson, R. L., 1980, The greenhouse effect—Life on a warmer planet: Minneapolis, Minn., Lerner Publications, 112 p.

Morrison, Philip, and Morrison, Phylis, 1982, Powers of ten: Redding, Conn., Scientific American Library, 150 p.

Schwartz, David M., 1985, How much is a million?: New York, Lothrop Lee and Shepard, 40 p.

An Island Home



Suddenly from behind the rim of the Moon . . . there emerges a sparkling blue and white jewel, a light, delicate sky-blue sphere laced with slowly swirling veils of white, rising like a small pearl in a thick sea of black mystery. It takes more than a moment to fully realize this is Earth . . . home.

Edgar Mitchell
astronaut, USA, 1971

Background

Since the Soviet Union launched the tiny satellite called Sputnik in 1957, hundreds of men and women and thousands of electronic "eyes" have looked back at Earth, capturing images that reveal certain effects of human activity on the Earth's natural systems. People have increased the use of air, water, and other natural resources by a factor of 10 in the last 200 years. This activity has in turn affected the atmosphere, the water cycle, and the climate, and has altered ecological systems. Scientists have begun to monitor these effects both from the ground and from space, to identify problems, as well as to predict the future health of the planet.

Earth is surrounded by a delicate envelope of air, part and product of life on the planet. Human beings have changed the composition of this atmosphere. Tons of carbon dioxide and methane, among other compounds, are added annually to the atmosphere from the burning of fossil fuels. These and other chemical pollutants raise concerns about the effects a changing atmosphere may have on life.

Most life on Earth owes its existence, directly or indirectly, to photosynthesis, the "greening" process by which plants convert sunlight, carbon dioxide, and soil nutrients to energy. Green plants cover much of Earth's land area, and microscopic plants known as phytoplankton inhabit its waters. More than 35 percent of the planet's surface is used, at least indirectly, for harvesting food and other materials.

Grazing, agriculture, and timber harvesting disturb topsoil, increasing soil erosion. More than 75 million tons of soil are blown or washed into the oceans each year. Natural ecosystems shrink in the face of society's need to use land. Fragmentation of many ecosystems has created a series of ecological "islands." Some species, unable to survive in such reduced areas, become extinct.

Life requires water. On land, the amount and frequency of rainfall determine the success of crops, as well as the survival of natural ecosystems. It takes about 10 days, on average, for a drop of water that becomes airborne vapor in one place to return to Earth's surface as rain or snow in another. Precipitation varies by both season and geographic area. As one result, highly specialized ecosystems have developed, from deserts to rain forests.

In the event of global warming, regional rainfall patterns may shift. Similarly, the removal of forest cover may alter rainfall distribution because of reduced evaporation of water from plants. Changes in patterns of precipitation could have dramatic effects, positive or negative, on all life on Earth.

Throughout most of the Earth's history, Earth's systems have functioned unmonitored, but not unrecorded. Climate records can be found in the types of pollen in lake-bottom sediments; in the patterns of tree-ring growth; in air bubbles frozen in glaciers; in the growth rings of coral; and in many other places.

These records indicate that significant environmental changes have occurred throughout Earth's history. Even moderate changes in global temperature can freeze or melt significant amounts of fresh water, building or shrinking glaciers and the polar ice caps. This affects sea levels.

Inasmuch as 50 percent of the world's people live within 50 kilometers of the sea, the effects of even a moderate rise in sea levels, on the order of a meter or less, would be significant. This is one reason why understanding past climate changes, and their effects on plant and animal life, is crucial. Studies of past climates, then, can help determine what processes may have caused changes, giving us some clues as to which human activities might induce similar changes.

The environments surrounding marshes, dunes, and reefs can be unbalanced by many human activities such as fishing, building, highway construction, and the use of chemical fertilizers. Ecosystems weakened by such activity may not withstand major storms. Although occupying just 8 percent of the Earth's surface, these coastal environments produce 90 percent of the world's seafood.

Global environmental change concerns us all. Scientists are using instruments borne on satellites to gain new perspectives on previously unknown linkages between the Earth's land, air, and water. Monitoring, however, can only show that changes are taking place. Halting or reversing changes, if necessary, will test the will and the ingenuity of humankind.

Activity (Allow 45 to 60 minutes for 2 or 3 days)

This activity is designed to help students understand some of the effects people have on their natural environment.

The students will act as owners and developers of a lush, 14-square kilometer tropical island. Groups of students will select the forms and extent of development on their island by considering the benefits of the development and the risks their actions pose for the island and the planet.

The activity is best scheduled over 2 or 3 days, depending on the level of sophistication in student planning and the extent to which each team will report to the entire class upon completion of the project.

Materials

For each group of three to five students:

- Large physical map of the world
- Graph paper
- Drawing paper
- Colored pencils
- Reference materials on rain forests and coral reefs (see classroom resources)

Procedures

1. Say this to the class:

Congratulations. You have just been awarded ownership of a tropical island in recognition of your concern for the environment and your wisdom in management. As owners of this island, you have some responsibilities.

First, it is important to create jobs for your fellow citizens. There is a native population living in thatch-roofed huts and subsisting on fish, fruit, and nuts. Second, you must develop your island as a model environment for business **and** for natural habitats.

The island is covered by virgin rain forest and is surrounded by well-developed coral reefs. Both of these types of ecological systems are in danger all over the world. The island is in your care. Consider your actions carefully.

2. As a class, brainstorm the possible range of businesses that could be developed on a tropical island. A few suggestions to get the class thinking:

Scuba diving resort

Timber company

Pharmaceutical research station

Golf resort

Naval base

These and other suggestions can be written on the board for students to select a topic of interest.

3. Discuss the ways the outcomes of this project could be presented. Use the list below for possibilities:

A scale map of the island using graph paper

A physical map of the island using white drawing paper

A brochure, with a map, advertising the company and island

A group report about the island and its efforts to protect the environment.

4. Form interest groups of three to five students. Provide resources from the suggested list or from your school library for discussions about the importance of rain forest and coral reef ecosystems. Discuss rain forest destruction. What is the benefit? What are the immediate and long-term costs? Who pays?

5. Once the students have discussed some characteristics of a rain forest and coral reef, focus the students' thoughts on the business opportunities these environments offer and the risks associated with these enterprises in a fragile environment. Have students complete the third column on the following chart as they explore the impacts of their particular businesses. The chart can be duplicated to hand out.

6. Have each team report on the specific solutions that they propose to counter the risks presented by their development plans.

Considerations	Risks	Solutions
Clearing of land	Loss of habitats	______
	Loss of ability of land to filter water	______
	Increased impact of storms	______
	Increased erosion with loss of topsoil and loss of water clarity	______
	Extinction of species	______
Buildings and roads	Need for natural resources for building materials	______
	Need for air conditioning and refrigeration, requiring power plants	______
	Vulnerability to natural hazards	______
Water supplies	High demand	______
	Loss of quality	______
	Intrusion of salt water and contaminants into groundwater aquifers	______
Electricity	Need for power plants: coal, oil, or nuclear	______
	Pollution from the burning of fossil fuels	______
	Hazard from handling nuclear material	______

Considerations	Risks	Solutions
Automobile traffic	Air pollution	______
	Noise	______
	Road requirements	______
Solid and liquid waste disposal	Pollution	______
	Space limitations	______
Marine life	Overfishing	______
	Damage by people and boats	______
	Death of coral, changing food sources and modifying water flow patterns	______
	Need to import food if fish populations decline	______
Shore and land plants and animals	Destruction of beaches and dunes	______
	Introduction of nonnative species	______
	Extinction of plant and animal species	______
Indigenous culture	Cultural change	______
	Changes in social relationships	______
	Exploitation	______
	Loss of traditions	______
	Social unrest	______

Extensions

1. This exercise can be done using other environments including wetlands, deserts, polar regions, etc. Adjust the text of the story and the project requirements accordingly.

2. Ask teams of students what components would be necessary to create a habitable environment on another planet. What unique equipment and risks would have to be considered for such a project? For example, what would it take to transform an area on the planet Mars to make it acceptable for human habitation? (Mars has no oceans and four times the land area of the Earth.)

3. Groups of students can create a model of their island.

Classroom Resources

Landau, Elaine, 1990, Tropical rain forests around the world: New York, Franklin Watts, 64 p.

Arnold, Caroline, 1988, A walk on the Great Barrier Reef: Minneapolis, Carolhoda Books, Inc., 48 p.

U.S. Department of the Interior
U.S. Geological Survey

Evaluation of Teaching Packet on Global Change

So that we can improve our educational products, we would appreciate your filling out this evaluation sheet.

Please return to:
Branch of Publications
National Mapping Division
U.S. Geological Survey
508 National Center
Reston, VA 22092

Name (optional) ______________________

School address (optional) ______________________
____
____

My school is:

☐ urban ☐ suburban ☐ rural

Grade level of class ________

Number of students in class ________

Check all that apply; elaborate if desired in spaces provided.

Design of poster and activity sheets

☐ well designed
☐ did not like design because

____
____
____
____

Concepts

☐ presented clearly
☐ not presented clearly
☐ appropriate
☐ too difficult because

____
____
____
____

Instructions

☐ excellent
☐ adequate
☐ inadequate
☐ other ______________________

Activities

☐ the activities worked well
☐ did not work well because

____
____
____
____

☐ favorite activity was

____
____

☐ least favorite activity was

____
____

Time

☐ appropriate
☐ too short to present concepts adequately
☐ too long to keep students' attention

Questions

☐ excellent
☐ adequate
☐ inadequate
☐ other ______________________

Extensions

☐ used some of these ideas
☐ didn't have time

Resources

☐ easy to find and useful
☐ hard to find or could not use well

For more information about educational publications of the U.S. Geological Survey, call 1-800-USA-MAPS.

We'd like to hear more about what you thought of these activities, how they were used, or how they could be improved. Please use the space below, and continue on the back if necesssary. Thank you.

NOTICE

Reproduction Basis

- [ ] This document is covered by a signed "Reproduction Release (Blanket)" form (on file within the ERIC system), encompassing all or classes of documents from its source organization and, therefore, does not require a "Specific Document" Release form.

- [x] This document is Federally-funded, or carries its own permission to reproduce, or is otherwise in the public domain and, therefore, may be reproduced by ERIC without a signed Reproduction Release form (either "Specific Document" or "Blanket").

EFF-089 (3/2000)