Louisiana Public Broadcasting

ENVIRO•TACKLE BOX™

Teacher's Guide

Module 4: Forces in the Environment

Rebirth in Fire
Force of Floods
The Earth: Work in Progress
Erosion: On the Move
Glaciers: Movers & Shapers

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ENVIRO-TACKLE BOX™

Module 4

Forces in the Environment

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Enviro-Tacklebox™

Module 4

Forces in the Environment

Funding for this module of Enviro-Tacklebox™ was provided in part from a 5-year Star Schools grant to the Satellite Educational Resources Consortium (SERC) from the U.S. Department of Education under contract R203A970032.

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Enviro-Tacklebox™ Overview

Enviro-Tacklebox™ Project Overview

Background Information

What is the Enviro-Tacklebox™ Project?

The Enviro-Tacklebox™ is a program directed toward middle school students that focuses on environmental education topics. The project is being developed by Louisiana Public Broadcasting working as a sub-grantee of the Satellite Education Resource Consortium. Enviro-Tacklebox™ is funded through a five year U. S. Department of Education Star Schools grant.

The goals of the project are to:

- Develop thematic modules that focus on environmental issues and promote student interest and the attainment of critical thinking skills that will support decision making;
- Enhance student learning by using the environment as an integrating theme;
- Engage and support community outreach efforts through workshop presentations at science conferences at the state, regional and national level; and
- Increase the level of awareness and understanding of K-12 teachers about environmental education issues.

The Enviro-Tacklebox™ includes the following components:

1. A series of five thematic modules, each of which consists of five tele-lessons and accompanying teacher guides with student activities. An interactive web site complements each module.

2. Professional development teleconferences, delivered by satellite, that address topics of national interest to all formal and informal educators involved in environmental education.

3. Workshops presented at professional conferences, in school districts and other appropriate educational settings to raise the awareness of the Enviro-Tacklebox™ project.

Topics for each module were selected in response to a national survey of middle school teachers and were developed by a curriculum design team of educators. Materials from each module have undergone extensive review at the state and national levels. All materials reflect the ***National Science Education Standards*** and the North American Association for Environmental Education's ***Excellence in Environmental Education-Guidelines for Learning (K-12).***

There are five student video lessons in each module, with the exception of Module II, which has four student video lessons and one teacher professional development video. This "how to" video for educators is not for student viewing but instead provides the instructor with a model for teaching decision-making strategies.

For information concerning purchase of the Enviro-Tacklebox™ materials contact:

GPN
P.O. Box 80669
Lincoln, NE 68501-0669
1-800-228-4630
http://gpn.unl.edu

Louisiana teachers interested in broadcast dates or purchasing information should contact:

Louisiana Public Broadcasting
7733 Perkins Road
Baton Rouge, LA 70810-1009
225-767-4206
http://www.lpb.org

Module 4

www.envirotacklebox.org

Rebirth in Fire

ACTIVITY GUIDE

REBIRTH IN FIRE

Background Information

Wildland fire is a natural process in the environment, much like floods, tornadoes, etc., and natural processes cannot always be controlled. Some debate occurs over whether wildland fire should be controlled, since it is so beneficial to the natural forest environment. However, as humans have encroached on the natural forest, fire has become a "hot topic." Some wildland fires are allowed to burn only to a certain point; others are actively extinguished as soon as possible. And, in some areas, forest managers use prescribed burns to maintain the healthy forest environment. In order for people to appreciate the role of fire as a technique for resource management, they must understand that fire can be beneficial under the right conditions.

Fuel + Heat + Oxygen must be present for a fire

In order for fire to occur, three elements must be present: heat, oxygen, and fuel. These three elements form a "fire triangle."

Heat can be transferred in three ways:

1. **Radiation** - a ray or wave; heat energy in the form of invisible light called infrared radiation; transferred through empty space. Radiation can dry surrounding fuels and sometimes ignite them.
2. **Convection** - heat is transferred through liquids and gases by means of up-and-down movements called convection currents. As temperature rises, convection increases as molecules move faster and become less dense. An example of this is a smoke column above the fire or smoke rising up a chimney. Hot gases and embers from it can dry and ignite other fuels.
3. **Conduction** - heat is transferred through the fuel, or from one fuel to another by direct contact of molecules.

Characteristics of Fuel:

1. **Moisture** - how well a fuel will ignite and burn is dependent upon its moisture content or chemical composition.
2. **Size and shape** - light fuels such as shrubs, grasses, leaves and pine needles burn rapidly but are easily extinguished. Heavy fuels such as logs and limbs burn more slowly.
3. **Fuel loading** - the quantity of fuels in an area which is available for combustion
4. **Horizontal continuity and vertical arrangement** - the manner in which fuels are spread over a certain area.

Characteristics of Weather:

1. **Temperature** - fuel and ground temperatures are primarily due to direct radiation from the sun
2. **Wind** - encourages combustion and the spread of fire
3. **Relative Humidity** - low humidity takes moisture from fuels; fuels, in turn, take moisture from the air when humidity is high
4. **Precipitation** - fuel moisture is affected by the amount and also the duration of the precipitation

Characteristics of Topography:

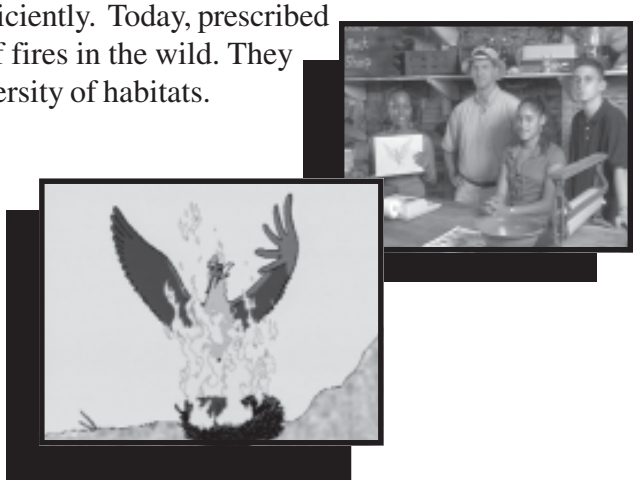
1. **Aspect** - the direction in which a slope faces relative to the sun
2. **Slope** - the amount of degree of incline of a hillside. The steeper the slope, the faster the fire burns up or down (depending on wind direction)
3. **The shape of the country** – box canyons, narrow canyons, and other rugged topographic features can influence the wind's speed and direction.

In order to properly manage resources, natural resource managers sometimes start fires or permit naturally occurring fires to burn under very specific conditions. In addition to protecting life and property, a chief concern among resource managers is public reaction. It is essential that the public understand appropriate fire management policies, and that fire is a necessary part of ecological succession in many forested areas. In other forests, fire is used to maintain existing growth conditions. Succession occurs when one plant and animal community is gradually replaced by another. For example, when new and hardier varieties of plants are introduced, more animals are enticed to the habitat because food is plentiful. Fire enriches the soil, reduces insect pests and diseases and allows the germination of some plant species.

Removal of fire from an area may save some residential and business areas, but it can be very detrimental to the forest habitat. For example, woody debris, pine needles, dead leaves and ground cover will begin to accumulate on the forest floor and the mineral nutrients in the wood are then returned more slowly to the soil during decomposition. When fires do finally occur, they may be especially hot, and thus more destructive, because of the extra fuel.

Some plants that require fire for reproduction may be endangered by the absence of fire. These plants exhibit *serotiny*; they store a large number of seeds over a period of years. When the heat of a fire cracks the resin bonds of the cone scales, the seeds are then dispersed. After a fire occurs, the successional areas which grow out of the burned habitat support species such as berries which produce food for animals. In tree savannas such as longleaf pine, fire removal may result in woody species invasion that chokes out herbaceous species.

Controlled or prescribed burning has existed for the past 12,000 years in North America, when the first Native Americans used it to clear land and herd buffalo. Fire was used to drive animals from cover so that hunting could be accomplished more efficiently. Today, prescribed burning is used to resynthesize the natural pattern of fires in the wild. They burn in a patchwork pattern which helps create a diversity of habitats.



The objectives of prescribed burning are:

1. fuel reduction
2. preparation of seedbeds for regeneration of wind-disseminated species which become established most readily on bare mineral soil
3. control of competing vegetation
4. improvement of grazing
5. management of wildlife by allowing species that they feed on to grow
6. recreation management to maintain a park-like appearance
7. thinning of saplings
8. control of pests

During the past several decades, prescribed burning has become an accepted management practice for many areas in North America. Problems occur when the public is misinformed about forest fires and fear and alarm take hold. Fires in the wildland /urban interface pose a special set of problems, as firefighters are often trained to deal with either urban, structural fires or rural forest fires, but not both. The key idea that needs to be stressed to the general public is that often it is most efficient to "fight fire with fire;" that is, to set fires deliberately so as to avoid larger and more destructive fires in later years.

REBIRTH IN FIRE

Lesson 1 Activity: Fireproof Plants

Lesson Overview:

Students will research and discuss different types of plant adaptations to fire. Using their research, they will compile a list of known adaptations, then add any others that they think might help a plant to survive. Using this list, students will then design their own fire-resistant plants.

National Science Education Standards:

Content Standard A: Science as Inquiry
Abilities necessary to do scientific inquiry
Content Standard C: Life Science
Regulation and Behavior
Diversity and Adaptations of Organisms

Excellence in EE — Guidelines for Learning:

Strand 1: Questioning and Analysis Skills
F. Working with models and simulations
Strand 2: Knowledge of Environmental Processes and Systems
2. The Living Environment
A. Organisms, populations, and communities

Key Concepts:

1. Many plants and animals have adaptive mechanisms that allow them to survive a wildfire.
2. Plants that have morphological adaptations and animals that have behavioral adaptations to survive in habitats frequented by fire live in *fire communities*.

Objectives:

Students will

- list possible adaptations of plants to fire.
- incorporate some of these adaptations into designing a model fire-resistant plant species.

Cross-Curricular Connections:

Art
- Make a three-dimensional model of the plant and label it.

Language Arts
- Write a description of the plant's survival of a wildfire.

Social Studies
- Research the history of fire in the local area and discover which plants survived.

Lesson 1 Activity: Fireproof Plants

Process Skills:

Communicating
Interpreting
Inferring
Modeling

Materials:

Per Student

- paper
- pencils
- crayons or markers

Optional

- assorted materials such as clay, paint, buttons, pipe cleaners if students wish to make a 3-D model of their plant

Suggested Time Frame:

One 50 minute class period

Procedure:

1. Introduce the concept of fire ecology by explaining that many plants survive wildfires, and that some even need fire in order to survive.
2. Using books and Internet sources on fire ecology, students research various types of plant adaptations to fire.
3. When research is completed, students make a list of all the plant adaptations discovered, then brainstorm a list of possible additional adaptations that may make survival of a wildfire possible.
4. Using the list as a guide, students will work in pairs to design and label a plant which is fire resistant. They will present their plant to the class and explain why its unique qualities will enable it to survive a wildfire.
5. *Optional:* Students may construct a three-dimensional model of their plant.

Suggested Discussion Questions:

- What are some reasons that fire is good for an ecological area?
- What is serotiny?
- What species of plants in your area are fire-resistant?
- Could the adaptations these plants have developed against fire also help them survive other environmental disasters? How?

Further Investigations:

- Contact your local forestry department or park ranger to see about arranging a tour of an area which has been subjected to fire recently.
- Interview forest rangers who use prescribed burning to discover the reasons it is helpful to plants.
- Obtain seeds or pine cones from plants that need heat to open them up and test them under different heat conditions such as an oven, in a heated beaker, or on asbestos screen gauze under a Bunsen burner.

Lesson 1 Activity: Fireproof Plants

Career Opportunities:

Biologist
Botanist
Firefighter
Forester
Park Ranger

Assessment Procedures:

- Each group of students will explain the choices they made in designing their plant and describe its fire-resistant abilities
- Students will discuss the various ideas and evaluate some of the best plants by writing in their science journal.

Additional Resources:

Ecological Communications Lab. Fire ecology resource management education unit. Columbus, Ohio. (no date given.)

Louisiana Department of Agriculture and Forestry. (1996). ***A Teacher's Guide to Fire Ecology in the Southeastern United States.***

Smith, D. (1986). ***The Practice of Silviculture.*** Eighth edition. John Wiley & Sons

Temperate Forest Foundation. ***Eco-Link: fire ecology booklet.*** Vol. 4, No. 4

Wenger, K. (1984). ***Forestry Handbook.*** John Wiley & Sons

Temperate Forest Foundation. Fire Ecology. http://www.forestinfo.org/Products/eco-links/fire-ecology.htm 1998 (accessed May, 2002)

U.S. Department of Interior. The National Park Service Fire Management Program Center. http://www.nps.gov/fire/ August 20, 1998 (accessed May, 2002)

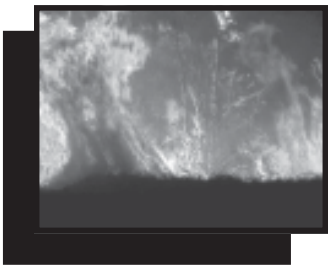
Arboretum: The University of Central Florida. Fire Ecology. http://pegasus.cc.ucf.edu/~arbor/fire.html October 26, 1999 (accessed May, 2002)

REBIRTH IN FIRE

Lesson 2 Activity: The Wildland/Urban Interface Dilemma

Lesson Overview:

People are affected by wildland fire in varying degrees, and as a result have differing opinions about it. Many people see fire as dangerous because they have been taught by parents, teachers, and even "Smokey the Bear" that forest fires are destructive. On the other hand, foresters and wildlife managers know that fire can be an essential part of an ecosystem's life. It ensures biological diversity by providing for a wide range of vegetative growth. This lesson will enable students to learn about all sides of the issues surrounding wildland fire.



National Science Education Standards:

Content Standard A: Science As Inquiry
Abilities Necessary to do Scientific Inquiry
Content Standard F: Science in Personal and Social Perspectives
Natural Hazards

Excellence in EE — Guidelines for Learning:

Strand 1: Questioning and Analysis Skills
G. Developing Proposed Explanations
Strand 2: Knowledge of Environmental Processes and Systems
3. Humans and their Societies
A. Individuals and Groups
4. Environment and Society
B. Human/environment interactions
Strand 3: Skills for Understanding and Addressing Environmental Issues
1. Skills for Analyzing and Investigating Environmental Issues
B. Sorting out the consequences of issues

Key Concepts:

1. Fires in the wildland/urban interface pose special problems to both resource managers and homeowners. Proper understanding of the use of fire is essential if this interface is to be maintained harmoniously.
2. As human populations grow, more people have a chance of being impacted by wildfires because city and suburban boundaries have expanded to meet the forest boundary.

Objectives:

Students will

- list positive and negative effects of wildland fire.
- analyze the issues involved in living in the wildland/urban interface and use decision-making skills to determine the best alternatives.

Lesson 2 Activity: The Wildland/Urban Interface Dilemma

Cross-Curricular Connections:

Arts

- Draw or paint a picture of an ecosystem that needs wildfire to survive.
- Create a poster to illustrate position taken during debate.

Mathematics

- Compare the cost of living in the wildland with that of living in the city or suburb.
- Consider such factors as housing costs, availability of resources, and travel time/costs to work and/or school.

Social Studies

- Research some famous wildland fires of the last 100 years and describe their impact on the local population.

Process Skills:

Identifying variables
Interpreting
Hypothesizing
Investigating

Materials:

Per Group

Index cards for notes
Poster board for visual aids in presentation
Markers, crayons, or colored pencils

Suggested Time Frame:

Two 50 minute class periods.

Procedure:

1. Begin the lesson by listing both the positive and negative effects of wildland fire.
2. Assign each group of students a role to play in the upcoming debate about land use:
   a. Park/forest manager
   b. Homeowner in the interface area
   c. An animal in the grazing area
   d. Timber company that wants to harvest lumber from the area that is burning
   e. Small insects that live in and eat dead wood
   f. Firefighter from an urban area
   g. Forest firefighter
   h. Land developer who wants to build in the wooded area
3. Tell students that a fire has started in the forest area, and they must meet with their group and decide what their position is with respect to this fire. When they have decided on a position, they will prepare a presentation to make before the local governing body.
4. Students will present their positions on wildland fire to their classmates, and a discussion will follow which analyzes the issues involved.

Lesson 2 The Wildland/Urban Interface Dilemma

Suggested Discussion Questions:

- How does each of these groups feel about a fire in their area? Would they feel differently if it was caused by lightning or by humans?
- What is a prescribed burn?
- Explain succession.
- Why are wildland fires useful? Why are they not useful?
- What are some fire dependent ecosystems?

Further Investigations:

- Talk to local firefighters about techniques they use to combat forest fires. Investigate times when they may have let fires burn for ecosystem management.
- Contact the local forestry department about prescribed burning in the area. How often is it done, and why is it important?
- In order to show how nutrients return to the soil, place some soil in a pan and test it for nutrients, especially phosphorus (kits are inexpensive from seed and feed stores). Let sit for a few days and water (to help the leeching).Then test again for nutrients.

Career Opportunities:

Forester
Land Manager
City Planner
Biologist
Botanist
Firefighter

Assessment Procedures:

- Students will write a paper that summarizes their group's position on the issue of wildland fire.
- Use a rubric or checklist to analyze each group's presentation

Additional Resources:

National Fire Protection Association. ***Fire Behavior in the Wildland-Urban Interface*** Boise Interagency Fire Center. Boise, Idaho.

National Interagency Fire Center. ***Introduction to Wildland Fire Behavior*** (May, 1994)

Temperate Forest Foundation. (1996) "Two Sides of Fire" video. Beaverton, OR.

United States Department of Agriculture. (1989) ***A Guide for Prescribed Fire in Southern Forests.***

Arboretum: The University of Central Florida. Fire Ecology. http://pegasus.cc.ucf.edu/~arbor/fire.html October 26, 1999 (accessed May, 2002)

Florida Division of Forestry. Fight Fire with Fire. http://www.prescribed-fire.org 1998 (accessed May, 2002)

Rodriguez, Rose. Tall Timbers Research Station. http://www.ttrs.org/feco.html November 23, 1999 (accessed May, 2002)

Force of Floods

ACTIVITY GUIDE

FORCE OF FLOODS

Background Information

In the United States there is hardly a place where natural disasters do not occur. No matter where you live, there is always the threat of a natural disaster. Through recorded history we have accounts of disasters created by volcanoes such as Mt. Vesuvius and Krakatau. Storm chasers have brought us dramatic video footage of disastrous tornadoes and hurricanes. The nightly news seems to regularly feature disastrous floods from over flowing rivers that follow large accumulations of rain or the thawing of ice and snow.

Of all the natural disasters floods are the most costly in terms of human hardship and economic loss. Most communities in the United States do experience some kind of flooding. In the United States the floods of 1889 (Johnstown), 1927 (Mississippi River), 1976 (Big Thompson River near Denver), 1993 (Mississippi River), and 1997 (Western Tributary System of the Mississippi River) are well known and documented disasters. Globally the most significant flood in terms of loss of human life is the Huang He River in China where approximately 3.7 million people were killed in 1931. In 1939 the same river flooded again, killing 500,000 people. In 1970 a cyclone and a seismic wave in the Bay of Bengal killed 266,000 people. These serve as terrible reminders that floods may be devastating.

Floods can be slow or fast but generally develop over a period of time. This range in time depends on the type of flood. The most common types of floods are:

1. **Coastal Flood** – May be brought on by hurricanes and tropical storms, seismic waves or tsunamis, or astronomically driven high flood tides.
2. **Flash Flood** – This is the most dangerous of flooding situations because this type of flood comes as a surprise. It generally occurs after a heavy rain and the natural or municipal drainage system is overwhelmed. The failure of a dam is another type of flash flood.
3. **Urban Flood** – The concrete and asphalt sprawl of a city reduces drainage areas. Water has nowhere to go after a heavy rain.
4. **River Flood** – Flooding along rivers is a natural event. The encroachment of urban and suburban development in the floodplains of rivers turns a natural event into a natural disaster.

Floodwaters can be extremely dangerous. The force of six inches of swiftly moving water can knock people off their feet. Flash floods move at very fast speeds and can roll boulders, tear out trees, destroy buildings, and wipe out bridges. Cars can be swept away in just 2 feet of water.

It is difficult to predict a flood, especially a flash flood. Several factors must be considered, such as current river levels and the amount of recent of precipitation. The frequency of flooding is often stated as a statistical chance. This chance is stated as the number of floods per one hundred years. For example, a certain area floods about every thirty-three years. Then there is a one in thirty-three chance of it flooding there. This is stated as a 33-year flood or the 33 percent chance of flooding. It is based on historical records and surrounding topography. The highest or largest flood that may occur in an area is considered to have a 1% chance of occurring in 100 years.

This type of flood is called a 100-year flood. It doesn't mean that there will only be an extreme flood every 100 years. It means there is a 1% chance of having such a flood anytime. One of the interesting questions about floods is why are we seeing a greater occurrence of 100-year floods over larger areas, such as the 1927, 1993, and 1997 floods of the Mississippi River system.

People once had the option of settling in the best protected areas, but are now forced into less than desirable areas. As people live and build in floodplains, coastal zones, and dry washes they must assess their risk of flooding. How much risk is acceptable? Should you consider living in a house that is subject to 10-year flooding or 50-year flooding? Likewise, when living along the coast do you live in an area that is subject to 10-year storms or 100-year storms? How do you weigh the risk to human life? It seems that any life-threatening event should be considered too much risk. However, people continue to live and build in areas susceptible to flooding. Another consideration is the economics of living and working in a flood plain. What level of loss can one tolerate before going broke? How much should the federal government pay in disaster relief to people and businesses located in flood zones? These are all very tough questions to try to answer. What do you think?

The great advances in engineering and science that came with the turn of 19th century made us believe we could control rivers and stop excessive flooding along with improving navigation. The Army Corps of Engineers built levees, diversion outlets, and dams to control rivers. For a period of time, that seemed to be the answer, but what happens when a levee or dam fails? Were the levees built to 100-year flood heights? Did human activities alter the hydrology of a local area so that 100-year floods are now coming every 10-years? The use of diversion outlets is controversial because of potential environmental problems such a diversion may create.

Since it would be impossible to move people and businesses out of all the floodplains, a better warning system needs to be developed. Several government agencies are working on plans to reduce the occurrence of national disasters. This planning is called the U.S. National Disaster Reduction Initiative. The major activities associated with this initiative are to: (1) provide the best possible warning and information to prevent damage and allow escape from harm, and (2) provide information and techniques to lower the vulnerability and increase the resiliency of people and property after floods. The United States Geological Survey is developing new GIS (Geographic Information System) materials that allow planners to model flood scenarios. One thing they can do with these models is identify which roads or bridges may be cut off by flood waters and suggest alternative escape routes. These agencies will also make recommendations as to the type of construction that should occur in certain areas and work with local governments to create zones for various business activities. For example, having a ballpark in a flood zone would be less risky than having a hospital in a flood zone.

It is clear that the government cannot continue to subsidize disaster. It is important for citizens to recognize risks associated with floods and plan and prepare wisely. Further research is necessary in order to gain a better understanding of climate and global change. Hopefully, new and better technologies will evolve to help us with our predictive abilities to recognize when the **water is on the rise.**

FORCE OF FLOODS

Lesson 1 Activity: Dynamic River Model

Lesson Overview:

This activity will allow students to create a model river system and manipulate variables such as rate and volume of water. Through this exercise students will develop the concepts of flood stage, levees, floodplain, and the dynamics of river flooding. Students will construct river models and test various flow rates and volumes. Students will report any patterns they observe relative to river flooding.

National Science Education Standards:

Content Standard F: Science in personal and social perspectives
Natural Hazards

Excellence in EE—Guidelines for Learning:

Strand 1: Questioning and Analysis Skills

Key Concepts:

1. A river researches a critical phase called flood stage.
2. Levees are built as flood protection devices.
3. The broad flat areas adjacent to rivers are characterized as being a flood plain.

Objectives:

Students will:

- design model river systems.
- model river dynamics.
- manipulate variables relative to river dynamics.
- explain river dynamics using their observations and conclusions of their experiments.
- propose ideas that will reduce the risk of floods.

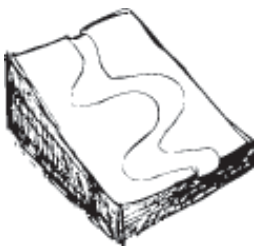
Cross Curricular Connections:

Mathematics:

- Graph and chart results.

Social Studies:

- Research the history of major floods.
- Investigate flood insurance issues.



Process Skills

Observing	Identifying variables	Modeling
Graphing	Controlling variables	

Lesson 1 Activity: Dynamic River Model

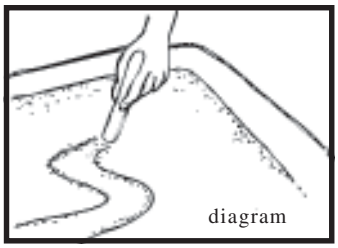
Materials:

Per Group

Stream table
Craft sticks (Popsicle sticks)
Camera (digital, Polaroid, or whatever is available)
Butcher or craft paper that overlaps or fits the size of the stream table
Marking pens
Soil
Sand
1 and 2-liter bottles or any containers that will hold a measured amount of water (containers must all be the same)
Nail or anything that can punch holes in the bottom of the above containers

Suggested Time Frame:

Two 50 minute class periods



diagram

Procedure:

1. Have each group fill a stream table with wet soil and sand mixture.
2. Have one student use the craft stick to create an S-shaped river course down the lower two-thirds of the stream table. Then using wet soil make a Y-shaped dam or levee that connects to the river. (See the diagram)
3. Direct another student to gently pat down the extra soil that was excavated by the craft stick to form a levee.
4. Another student should place a small block of wood under the non-drain side of the stream table. Pieces of 1/4-inch plywood work well for this.
5. Instruct the group to tape over or plug the drainage hole and fill the river with water so that it does not overflow the banks.
6. Have a group member place a line on the craft stick every 5 millimeters. Place the craft stick into a mid-river location and record the height of the water. This will be the river's normal level.
7. Instruct the group to create a river flow that does not exceed the normal height of the river by unplugging the drain and creating rain within the Y-shaped part of the stream table. Students will have to manipulate the number of holes in their water containers and record the height reached on the craft stick after each trial. (1, 2, 3, 4 holes, etc.) A student should be designated as a timer and record the time (rate) of the flow.
8. The recorder needs to record the amount of flow necessary to keep the river a normal level. (For example, 1 liter per minute.) Recheck.
9. Then allow the students to systematically manipulate two variables: (1) the elevation and (2) the volume and observe when overflow or flooding conditions occur.
10. Show the students there are several ways to record data about their stream table experiment: (a) capture it on camera, (b) make a full scale drawing using butcher or craft paper, (c) scale drawings using graph paper, (d) craft stick measurements, (e) verbal descriptions.

11. Ask the students to devise a method for showing the area that floods when the river overflows its banks.
12. Have the students make a prediction about what will happen when they change a variable.

Suggested Discussion Questions:

- What conditions caused the greatest flooding? Why?
- If these were inhabited areas, how much warning do you think residents would need to evacuate?
- If you had the job to prevent flooding in this area, what would you do?

Further Investigations:

- Visit the web sites for the following agencies and see what resources they have about flooding:
  1. Federal Emergency Management Agency (FEMA) http://www.fema.gov
  2. US Geological Survey (USGS) http://www.usgs.gov
  3. Army Corp of Engineers (ACOE) http://www.usace.army.mil
- Research personal accounts of flood victims or interview flood survivors in your area.

Career Opportunities:

County, City, or State Planner
Hydrologist
Geologist
Engineer

Assessment Procedures:

- Students' written records of observations, predictions, data collection, data presentation (graphs and charts), and conclusions should be assessed via predetermined rubrics.
- Written or oral justifications of flood plain management.

Additional Resources:

Barry, J. M., (1997). ***Rising Tide: The Great Mississippi Flood of 1927 and How It Changed America***. New York: Simon & Schuster.

Seeking an End to a Flood of Claims. (1999, June-July). **National Wildlife**.

Gorman. J. (1999, Jan.). ***The River Wild***. **Discover**, 20, 64.

China: Aftermath of 1998 Flood. (1998). **Life**, 21(11), 24

Krautwurst, T. (1998, June). ***I Survived the Johnstown Flood: A Real Life Experience of a Disaster Survivor in Pennsylvania.*** **National Geographic World**, (274), 12-17.

Henry, H. (1998, June). ***Red River Rising***. **Readers Digest**, 152(914), 114-140.

Chua-Eoan, H. G. (1993, July 12). ***Mississippi Rising: Continuing Flooding Along the Mississippi River***. **Time**, 142(2), 36-38.

Dale, D. (1989). ***When 20 Million Tons of Water Flooded Johnstown: Terror, Heroism and 2,209 Deaths***. **Smithsonian**, 20(2), 50-60.

Federal Emergency Management Agency (FEMA) http://www.fema.gov (accessed May, 2002)

US Geological Survey (USGS) http://www.usgs.gov (accessed May, 2002)

Army Corp of Engineers (ACOE) http://www.usace.army.mil (accessed May, 2002)

FORCE OF FLOODS

Lesson 2 Activity: Can You Control Floods?

Lesson Overview:

Students will assume the role of an engineer or planner. As an engineer or planner they must come up with ideas that can be put into place to control floods. The ideas will be generated through brainstorming and then developed through a research and design phase that creates a working model of flood control.

National Science Education Standards:

Content Standard F: Science in personal and social perspectives
Natural Hazards

Excellence in EE—Guidelines for Learning:

Strand 1: Questioning and Analysis Skills

Key Concepts:

1. Engineering can provide some solutions to alleviating natural hazards.
2. Controlling river flooding requires an understanding of hydrology.
3. There are limits to engineering solutions.

Objectives:

Students will:

- generate a list of ideas on how to control flooding
- test the above ideas by creating working models
- evaluate the flood control measures

Cross Curricular Connections:

Geography:

• Identify population settlement patterns in the U.S. influenced by natural features.

Social Studies:

• Research the need to be near water for industry, agriculture, and community development.

Process Skills:

Experimenting Modeling Applying

Lesson 2 Activity: Can You Control Floods?

Materials:

Per Group

topographic map(s)
stream table
graph paper
drawing materials (pens and pencils)
soil mixture (sand, slit, & clay)

Suggested Time Frame:

Two 50 minute class periods

Procedure:

1. Provide each cooperative group with a topographic map or maps of a river system that is subject to flooding (local systems if available).
2. Instruct each group to brainstorm a list of possible solutions to prevent flooding in the populated areas on the map(s).
3. If students are having a hard time thinking up solutions you may suggest that they consider large levees, levee enhancement, diversions, or holding areas.
4. Instruct the students to build working models of their solutions using the stream tables provided.
5. Ask the students to evaluate what method they think was best and why.

Suggested Discussion Questions:

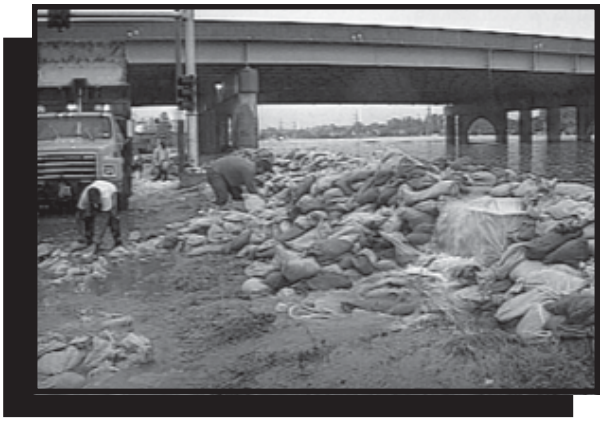
- What criteria did you use to evaluate your flood control method?
- What solution would be the most economical?
- Did you consider moving any of the population out of the flood zone? Why? Why not?
- What limits are there to engineering solutions?

Further Investigations:

- Research to see if any insurance companies offer incentives for people to move out of flood zones.
- See FEMA web site for the government's response to minimizing flood damage.

Career Opportunities:

Engineer
Hydrologist
Geologist
Planner



Lesson 2 Activity: Can You Control Floods?

Assessment Procedures:

- Each group presents a clear rationale for selecting a flood prevention measure to test.
- The group justifies the use of flood prevention procedures. For example, using a nearby water body for diversion.
- The group assesses the flood control procedure in terms of rate of success, possible limitations, economic costs, human displacement etc.

Additional Resources:

Barry, J. M., (1997). ***Rising Tide: The Great Mississippi Flood of 1927 and How It Changed America***. New York : Simon & Schuster.

Seeking an End To a Flood of Claims. (1999, June-July). **National Wildlife**.

Gorman. J. (1999, Jan.). ***The River Wild***. **Discover**, 20, 64.

China: Aftermath of 1998 Flood. (1998). **Life**, 21(11), 24

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Dale, D. (1989). When 20 Million Tons of Water Flooded Johnstown: Terror, Heroism and 2,209 Deaths. S**mithsonian**, 20(2), 50-60.

Federal Emergency Management Agency (FEMA) http://www.fema.gov (accessed May, 2002)

US Geological Survey (USGS) http://www.usgs.gov (accessed May, 2002)

Army Corp of Engineers (ACOE) http://www.usace.army.mil (accessed May, 2002)

The Earth: Work in Progress

ACTIVITY GUIDE

THE EARTH: WORK IN PROGRESS

Background Information

A natural hazard is an event in nature that produces environmental change and negatively impacts human beings and/or the environment.

Environmental change is a naturally occurring phenomenon. We are constantly reminded through our own life experiences and the media that changes in our environment are inevitable. While environmental change can be the direct result of human impact, it also occurs as a result of the natural life-sustaining activity of the dynamic nature of Earth systems.

Change is critical to maintaining a healthy environment. Devoid of human interaction, environmental change creates long-term benefits. For example, some plants do not reproduce unless their seed pods are opened during the intense heat of a fire. Floods, while life-threatening to humans and animals, are necessary to replenish nutrients in soil and build new land in delta regions. Volcanic eruptions create new habitats for plants and animals. These changes, while devastating to the environment initially, produce far reaching, positive results in the long term.

The environment is very capable of recovering from these natural events, especially in those areas that have had little human impact. However, environmental degradation by humans severely limits the Earth's capacity to overcome naturally occurring events such as storms, fires, and floods. In areas that have little degradation, the rate of recovery is much greater.

When environmental change and humans are involved, loss of life and property become important issues. Advances in technology and early reporting of impending danger have helped control losses considerably, but the Earth is governed by complex forces of nature that cannot be restrained. These powerful forces are always at work in a variety of ways.

Responding to Meteorologic and Geologic Changes

Rather than fighting the changing nature of the environment, there is a need to find creative methods of coping with change and insulating ourselves from the impact of meteorologic and geologic changes. Some of these changes are slow and incremental, while others are dramatic and swift. Usually, changes that occur quickly are in response to a catastrophic natural hazard.

Natural hazards are so pervasive that no one can escape the risks they pose. Not only can death and injury occur because of natural hazards, but also there can be tremendous financial losses. As the population and economic activity increase so do the costs. Financial costs of natural disasters in the United States have skyrocketed because individuals are becoming increasingly vulnerable to their impact due to the trends in society rather than trends in nature.

Since most natural disasters occur in areas of acknowledged high risk such as barrier islands, flood plains, and fault zones, we would expect individuals to proceed with caution when locating homes and

businesses in these areas. However, there has been little interest in prevention. More attention has been paid to development of hazard-prone areas and subsequently providing assistance to those who have been affected by natural disasters. Instead of offering incentives that would encourage responsible land use, legislated insurance rate controls and federal aid programs actually subsidize development in high-risk areas. Sometimes there seems to be more political interest in providing economic and humanitarian relief than in preventing loss of life and property in the first place.

Understanding the Forces of Nature is Key to Prevention

Natural hazards and environmental change are inevitable, but loss of life and property can be greatly lessened through education and appropriate response.

Understanding the natural perils will help reduce the risks involved:

- **where and how often they occur;**
- **what causes them;**
- **what factors increase their severity; and**
- **the efficacy of preventative measures.**

While little can be done to stop natural hazards from occurring, their subsequent impact can be ameliorated to reduce losses. One important consideration is limiting use of areas that are prone to experiencing natural hazards. This is not easy, especially when demographic movement is often toward those areas that hold the greatest risks. Technological advances and a growing population have encouraged building homes and businesses in areas that should be off-limits to permanent human development, e.g., on hillsides, around coastal areas, and in wetland areas that historically have held flood waters. Individuals living in these regions face greater risks of experiencing problems due to natural hazards.

The impact of natural hazards has as much to do with society's reaction to them as the actual events themselves. These actions will help prevent loss of life and property:

- **Responsible land use decisions**
- **Building and construction practices that withstand hazards**
- **Emergency preparedness**
- **Early warnings to evacuate or take precautions**
- **Post-disaster recovery**
- **Public education and awareness**

THE EARTH:
WORK IN PROGRESS

Lesson 1 Activity: Natural Disaster Lists

Lesson Overview:

Many people do not know or understand the types of natural disasters they may face during their lifetimes. Travelers who are not familiar with the natural disasters of the local area are often hurt or killed because they do not react to signs of natural disasters that locals know and often take for granted. Students will use newspapers, periodicals, the Internet, and historical data to produce a list of the natural disasters that have occurred in their community, county or parish, and state over at least the past 25 years (most areas now have about 100 years of records and you may chose to divide the research into 25 year intervals).

National Science Education Standards:

Content Standard F: Science in Personal and Social Perspectives
Natural hazards

Excellence in EE —Environmental Guidelines for Learning:

Strand 2: Knowledge of Environmental Processes and Systems

2. *The Living Environment*
4. *Environment and Society*

Key Concepts:

1. Knowledge about local and other natural disasters allows individuals and communities to plan how to react in advance of and in the aftermath of a natural disaster
2. Knowledge about natural disasters allows individuals to understand the impact natural disasters can have on humans and the environment.

Objectives:

Students will:

- identify past natural disasters and investigate the preparations and precautions that were taken during that natural disaster.
- describe current preparations and precautions that are taken for possible natural disasters.

Cross-Curricular Connections:

Language Arts

- Record information about natural disasters and document recovery efforts.

Mathematics

- Measure time (when and how long), severity and quantity of the damage, estimating the amount of time required for recovery.

Social Studies

- Describe the history of natural disasters in an area.
- Detail the social, societal and environmental impact of the natural disaster on the history of the communities affected.

Lesson 1 Activity: Natural Disaster Lists

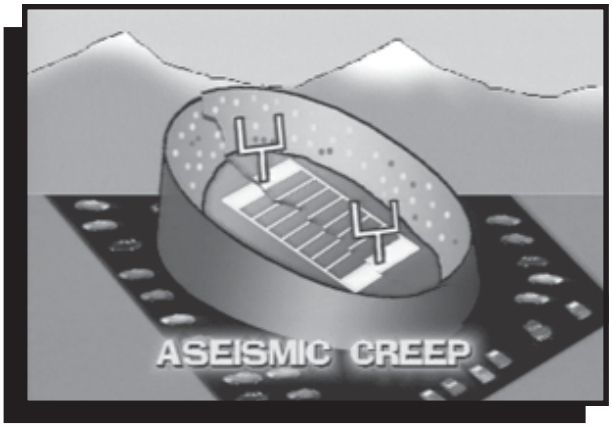
Process Skills:

Communicating	Predicting	Inferring
Interpreting	Modeling	Investigating

Materials:

Per Class

- Internet access
- Computers
- Telephones
- Libraries with past periodicals



Suggested Time Frame:

Two 50 minute class periods

Procedure:

1. During the first class present the concept of natural disasters or show ***The Earth: Work in Progress*** video to students and discuss what they know about the topic. Assign individual students or groups of two students to research specific natural disasters and their impact on humans and the environment for either the last 25 years or a certain period of time during the last 100 years.
2. As students work on their research the teacher should provide a time each day to answer questions and redirect students' efforts. A couple of minutes in one class could be set aside during the research period for some groups to share what they have learned.
3. During the second class have students report their findings and use a computer to develop a timeline of natural disasters. Then have students use the timeline to predict possible natural disasters for the next 25 to 100 years for different locales.
4. The last 10 minutes should be reserved for drawing conclusions from the information given by students and to develop an action plan for what to do before, during and after a natural disaster.

Suggested Discussion Questions:

- How can knowledge of past natural disasters affect the way you plan and react to impending threats of natural disasters?
- How does knowledge of past natural disasters allow you or your community to plan for future natural disasters?

Further Investigations:

- Research any natural disaster that has affected either areas the students live in or travel to visit.
- Students could develop an action plan for natural disasters.
- Read or research past and recent natural disasters and their impact on the environment.

Lesson 1 Activity: Natural Disaster Lists

Career Opportunities:

Meteorologist
Vulcanologist
Seismologist
Fire fighter
Natural disaster response planner or team member

Assessment Procedures:

- Assess the presentations using a rubric (collaboratively decided upon by teachers and students) giving points for quality of research and quality of presentation (oral presentation, quality of visual aids, extras).
- Have students describe and explain the environmental impact of a natural disaster.
- Have students design an action plan for what to do before, during, and after a natural disaster.

Additional Resources:

United States Department of the Interior, United States Geological Survey. (1996) ***USGS Response to an Urban Earthquake***, Publication 96-263.

United States Department of the Interior, United States Geological Survey. ***Volcanoes of the United States***, U.S. Government Printing Office.

Federal Emergency Management Agency (FEMA)
http://www.fema.gov
(accessed May, 2002)

Local and National Red Cross
http://www.urbanecology.org
(accessed May, 2002)

Weather Bureau
http://www.sustainable.doe.gov
(accessed May, 2002)

Assessing Student Understanding

While the following assessment is specific to hurricanes, the format can be adapted to address other natural hazard events.

News Flash!

You are a _____reporter stationed in _____. You have been tracking a tropical storm for ___ days that originated in _____. The storm gathered strength during the past ___ hours while moving over the _____. The storm has grown into a hurricane that has the potential to cause great harm to the surrounding area. You know that what you say on the air will be extremely important. The information you provide will help save lives. As you think about what you will say you realize that many people depend upon you to guide them to make the safest decisions. You are preparing your report as follows:

Hurricane _____'s coordinates are ____N , ____W. The National Weather Center has just upgraded it to a Category _____ hurricane. It is moving _____ at _____ miles per hour, packing winds in excess of _____. This is a killer hurricane and all precautions should be made to protect life and property. Hurricane _____ is expected to make landfall within the next ___ hours.

Remember to _____

_____

_____

_____

_____

Name _____ **Date** _____

THE EARTH:
WORK IN PROGRESS

Lesson 2 Activity: Natural Disaster Interview

Lesson Overview:

Each student chooses a relative or friend to interview about their experiences during a natural disaster that directly impacted their lives. After students have done at least one interview, they should report their finding to the class. The class can use these findings to construct a profile of local storms. The more severe the natural disaster the more likely that students will be able to uncover multiple stories stories about its impact.

National Science Education Standards:

Content Standard A: Science as Inquiry
Think Critically
Content Standard F: Science in Personal and Social Perspectives
Natural Hazards

Excellence in EE — Guidelines for Learning:

Strand 2: Knowledge of Environmental Processes and Systems
4. Environment and Society

Key Concepts:

1. Knowledge about local and other natural disasters allows individuals and communities to plan how to react in advance of and in the aftermath of a natural disaster.
2. Knowledge about natural disasters allows individuals to understand the impact natural disasters can have on humans and the environment.

Objectives:

Students will

- identify natural disasters that have occurred in certain areas in the past.
- identify the possible natural disasters that people might have to deal with during their lives.

Cross-Curricular Connections:

Language Arts
- Record information found through research with individuals.
- Communicate information gathered.

Mathematics
- Compare and contrast different natural disasters: their effect on the environment and the dates on which they occurred.

Social Studies
- Investigate the history of natural disasters.
- Detail the societal and environmental impact of the natural disaster.

Lesson 2 Activity: Natural Disaster Interview

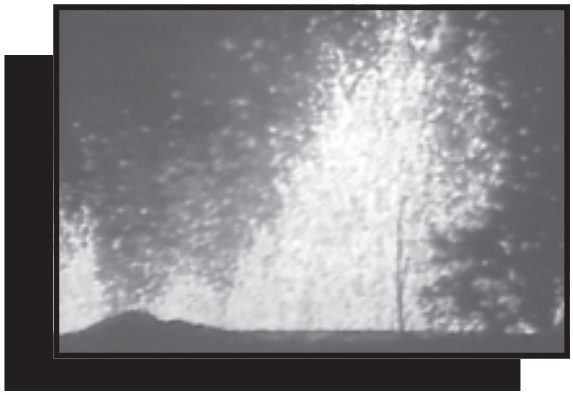
Process Skills:

Communicating Interpreting Investigating

Materials:

Per Student

Paper
Pencil
Someone to interview



Suggested Time Frame:

Two 50 minute class periods

Procedure:

1. The first class is to set the stage so students understand their assignment. As students identify a friend or relative to interview the teacher should provide a little time each day to answer questions and redirect students' efforts.
2. It is generally easiest if you have students brainstorm the questions they should all ask and then prioritize the top five or more questions that all students should include when they conduct their interviews.
3. All community plans should include one major highway, a railroad, and a river or lake. In addition, students may want to consider drawing a buffer zone between residential and commercial areas.
4. A full class (if research is well done this may take two classes) should be set aside for student reports. The last 10 minutes should be reserved for students to make a timeline of the natural disasters described and develop an action plan about how they might react to a natural disaster.

Suggested Discussion Questions:

- How often do natural disasters occur and are there regular intervals?
- Should a community have plans for natural disasters?
- Should a family or an individual have a plan for what to do during a natural disaster?

Further Investigations:

- Over a period of time have students develop a booklet detailing different generations' (grandparents, parents, brothers and sisters) memories of natural disasters.
- Create a timeline of natural disasters as reported from the interviews.
- Discuss the types of natural disasters that might be experienced if people move from one part of the country to another.

Lesson 2 Activity: Natural Disaster Interview

Career Opportunities:

News reporter
Historian
Meteorologist
Climatologist
Geologist (specialist in volcanoes, earthquakes)
Firefighter
Natural disaster response planner or team member
Hydrologist

Assessment Procedures:

- Use an essay question to have students describe their interview with a relative/friend who has experienced a natural disaster.
- Have students describe what they learned from conducting the interview.
- Design a plan for what to do during natural disasters that might occur locally.

Additional Resources:

Local newspapers
Local periodicals
Local Red Cross
Local or state Civil Defense

The International Council for Local Environmental Initiatives.
http://www.iclei.org/la21/onestop.htm
(accessed May, 2002)

American Planning Association.
http://www.planning.org
(accessed May, 2002)

Center for Livable Communities.
http://www.lgc.org/center/
(accessed May, 2002)

Erosion: On the Move

ACTIVITY GUIDE

EROSION: ON THE MOVE

Background Information

So WHAT About Soil?

Erosion is an important concept for students to learn about because the loss of soil/land affects their lives in many ways:

- loss of productive land to grow food, timber, fiber for clothing.
- runoff into water bodies degrading water quality for fishing and swimming.
- loss of coastal land as habitat and for recreation.
- loss of a future resource.

Soil is formed by the weathering of rocks over long periods of time. Weathering is the mechanical (physical disintegration) and chemical (decomposition) wearing away of rocks by air and water. Soil is a mixture of tiny particles of inorganic minerals and rocks, decaying organic matter, water, air, and living organisms.

The soil profile is composed of different layers called soil horizons. See Figure 1.

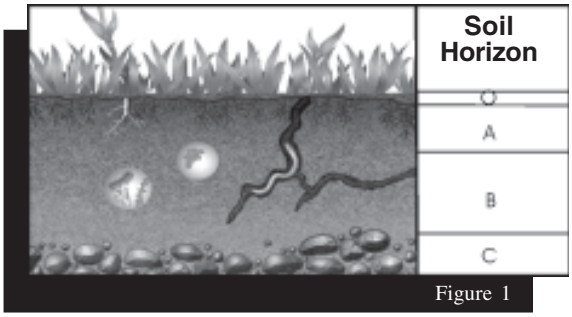


Figure 1

The thin layer of soil – ranging up to several feet thick – on the Earth's surface helps provide the food most living things depend on for their survival, the natural fibers used to make clothes, the paper used for writing and packaging, and the lumber used to build houses and furniture.

While soil is technically a renewable resource, the average rate of erosion throughout the world greatly exceeds the rate at which soil is being formed. Erosion is caused by air and water moving over weathered material. After the material is loosened and moved, it is deposited when the air and water lose their carrying power. For example, when a river slows down as it meets the sea, the sand it carries is deposited near the mouth, becoming part of a layer of sediment. Because of flooding, the Mississippi River has been leveed so it no longer overflows its banks. This also prevents sediment from the river being deposited to replenish soils and build coastal lands. Instead the sediment is being dumped off the continental shelf at the Gulf of Mexico. Forces of air and water that erode soil include flooding, waves, wind, and ice. During the 1930's wind erosion caused the Dust Bowl in the Great Plains region of the United States. Soil erosion was so extensive that farmers lost their lands and had to relocate. Over 9 million acres of farmland were destroyed and 80 million acres were severely damaged.

Other causes of erosion are human-induced, such as clearing away vegetation to build houses or other structures, farming, and overgrazing. When vegetation is removed, the soil is left exposed to rain and wind. This causes sedimentation runoff, a type of nonpoint source pollution that gets washed into water bodies, clogs them and adds excess nutrients leading to eutrophication (the process by which a body of water becomes either naturally or by pollution rich in dissolved nutrients, such as nitrates and phosphates, causing a deficiency in dissolved oxygen).

So what can be done about erosion? There are many conservation techniques used by resource managers and landowners to combat erosion:

- Conservation tillage farming techniques - instead of plowing and leaving the soil exposed, the soil is disturbed as little as possible (ex. the no-till method plants seeds and adds fertilizers and weed killers at the same time with almost no disturbance of the soil).
- stream bank restoration – ex. stabilizing the stream slope with terraced banks and revegetating the banks to hold the soil in place.
- revegetation of coastal areas – planting marsh grasses on areas of the coast that have been damaged by waves.
- Best Management Practices (BMPs) for new residential and commercial developments – using sediment fences, bales of hay or grassed-swales to collect any sediment that would runoff from a construction site into local water bodies.
- Local sediment ordinances that developers must follow to eliminate sediment runoff – developers must implement prescribed BMPs such as the ones stated above.
- Join the NRCS's Earth Team, a student volunteer program.

The importance of soil in our everyday lives is not recognized by many people. Because it takes so long to create soil, humans must find ways to conserve the soil that is left. Students can play a role by being "soil-aware" and getting involved in their local areas.

EROSION: ON THE MOVE

Lesson 1 Activity: The Eroding School Yard

Lesson Overview:

A demonstration project will be designed and installed by students to learn about the processes of soil erosion.

National Science Education Standards:

Content Standard A: Science as Inquiry
Understandings About Scientific Inquiry
Content Standard D: Earth and Space Science
Structure of the Earth System
Content Standard F: Science in Personal and Social Perspectives:
Populations, Resources, and Environments
Natural Hazards

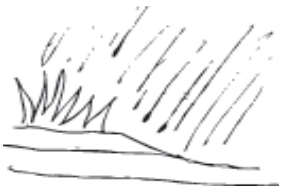
Excellence in EE—Guidelines for Learning:

Strand 1: Questioning and Analysis Skills
Strand 2: Knowledge of Environmental Processes and Systems
1. *The Earth as a Physical System*
4. *Environment and Society*

Strand 3: Skills for Understanding and Addressing Environmental Issues
1. *Skills for Analyzing and Investigating Environmental Issues*

Key Concepts:

1. The loss of soil due to erosional processes is increased with removal of vegetation.
2. Rain is a natural soil erosion process.
3. Soil erosion rates vary in relation to amounts of rain.



Objectives:

Students will:

- choose an appropriate demonstration site.
- observe and measure the effects of rain on their demonstration site.

Cross-Curricular Connections:

Language Arts:
- Write a report of their findings.

Mathematics:
- Use statistical procedures to record, display and analyze rates of erosion.

Visual Arts:
- Provide graphics in the report.

Lesson 1 Activity: The Eroding School Yard

Process Skills:

Observing	Modeling	Graphing
Measuring	Experimenting	Predicting

Materials:

Per Group

Rain gauge
Easy-installation pole (wood), if needed
Roll of plastic liner that can be cut to fit
Tent stakes
Large measuring cup with ounces and milliliters

Suggested Time Frame:

One semester or full year:

- *Several class periods to introduce topic of erosion using the video "Erosion..." and additional resources.*
- *After students have been spilt into groups, choose appropriate number of class sessions for planning, preparing plots, observing, measuring, and reporting.*

Procedure:

1. Divide the class into 4 cooperative groups.

2. Have each group select an area on the school grounds and fence it off as a study site. If unable to have a site for each group, just use at least 2 sites and assign different tasks to each group. *See NOTE on page 42 if unable to use school grounds.*

3. Each group will measure off their two plots of equal size (recommended size = 4x4 feet or 1.2m x1.2m) and clear one of the plots of vegetation, leaving the other plot vegetated. If both plots chosen currently have no vegetation, lay squares of grass on one plot (you can get grown grass in mats called sod from a plant nursery). See diagram A.

4. Place the rain gauge in a secure and stable manner between or near the two plots. (It can be affixed to the pole with screws. There are easy-installation poles available at most garden centers, usually in the bird feeder section).

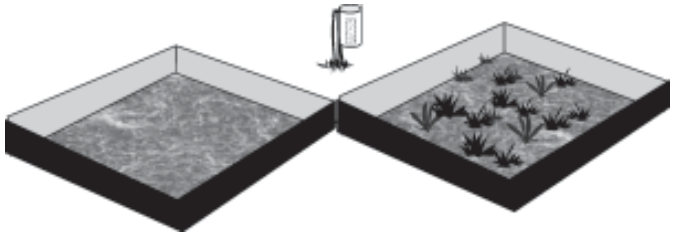


Diagram A

5. Use sediment fencing (plastic mesh strips) or hay bales and place completely around each plot to help catch all sediment. Dig a trench completely around the plot on the inside of the sediment-trapping device. Place a plastic liner inside the trench allowing the sides of plastic to come up to the lip of the highest part of the trench wall so the liner can be held in place with tent stakes. See diagram B.

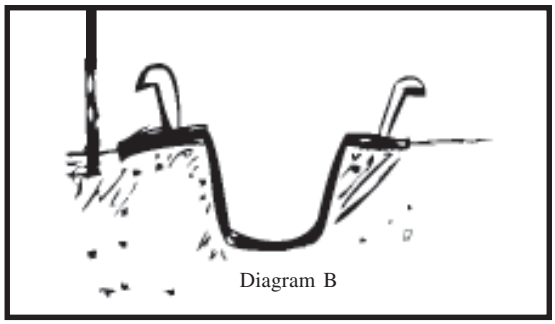


Diagram B

6. Begin observation period and use the data sheet provided (see page 48) for all measurements. Data can be recorded as frequently as daily but should be at least once per week.

7. At the end of the observation period (towards the end of the semester), students should compile the data using graphs, tables, frequency distributions, and summary statistics; analyze the data; make conjectures; and communicate information in a convincing way in their final report.

NOTE: *If school grounds are not available for plots, create plots as follows:*

1. *Pour soil into 2 large containers of equal size, same dimensions as plots above if possible (i.e., plastic, shallow tubs or build shallow boxes using plywood and 2x4's).*
2. *Plant grass or other ground cover in one of the containers and allow time to grow.*
3. *Place containers outside, on the school grounds, in an open area. Put fencing around them as well as a Do Not Disturb sign.*
4. *Build a wooden platform to affix a pole to and mount the measuring instrument. Place this apparatus between or near the two containers.*

Suggested Discussion Questions:

- Which plot, the vegetated or non-vegetated, had the highest rate of erosion? Why?
- How much were each group's rates of erosion?
- What conclusions can you draw based on this data?

Further Investigations:

- Compare each of the group's sites and rates of erosion. What were some physical factors that may have caused differences/similarities?
- What conservation techniques could be used to reduce rates of erosion?

Career Opportunities:

Soil Scientist
Geomorphologist
Agriculutural Scientist
Statistician

Assessment Procedures:

- Rubric-scored evaluation of plot design and development (meeting design criteria such as proper dimensions; durability; health of vegetation, etc).
- Properly filling-out data sheets and following directions.
- Final reports.

Additional Resources:

Strahler, A. and A. Strahler. 1989. ***Elements of Physical Geography***, John Wiley and Sons, New York.

Natural Resources Conservation Service. 1999. ***A Geography of Hope***, NRCS, Washington, D.C.

Natural Resources Conservation Service
http://www.nrcs.usda.gov
(accessed May, 2002)

USDA
http://www.usda.gov
(accessed May, 2002)

The Academy of Natural Sciences
http://www.acnatsci.org/research/kyc/sediments.html
(accessed May, 2002)

EROSION: ON THE MOVE

Lesson 2 Activity: Class Conservation Corps (CCC)

Lesson Overview:

Students will investigate how the loss of soil, a valuable natural resource, affects their lives through loss of productive land to grow food, loss of coastal land mass, and poor water quality from runoff. Students will design a conservation project to help protect soil from eroding.

National Science Education Standards:

Content Standard D: Earth and Space Science
Structure of the Earth System
Content Standard F: Science in Personal and Social Perspectives
Populations, Resources, and Environments
Natural Hazards

Excellence in EE—Guidelines for Learning:

Strand 1: Questioning and Analysis Skills
Strand 2: Knowledge of Environmental Processes and Systems
1. *The Earth as a Physical System*
4. *Environment and Society*

Strand 3: Skills for Understanding and Addressing Environmental Issues
1. *Skills for Analyzing and Investigating Environmental Issues*

Key Concepts:

1. Soil/land is an important natural resource that must be conserved.
2. Soil erosion is a serious threat to this natural resource.
3. A variety of conservation methods or BMPs (Best Management Practices) are employed to combat soil erosion.
4. Many BMPs are very simple and cheap to use.

Objectives:

Students will:

- identify local soil/land erosion problems in their community.
- investigate the causes of this problem.
- State some solutions to the problem.
- design and possibly implement a conservation plan.

Lesson 2 Activity: Class Conservation Corps (CCC)

Cross Curricular Connections:

Geography

- Provide maps of the area that is the site of the conservation plan.

Language Arts

- Write a conservation plan.

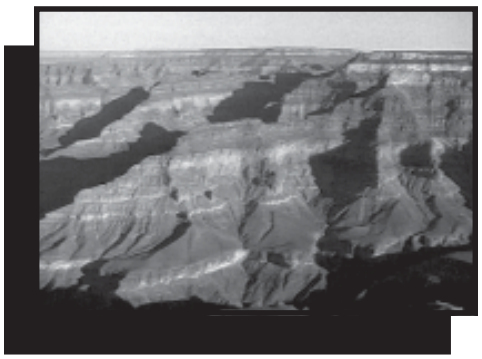
Visual Arts

- Prepare schematic drawings and other graphics in the conservation plan.

Processes and Skills:

Classifying	Estimating	Defining Operationally
Communicating	Predicting	Investigating

Materials:



Per Group

Internet access
BMP reference books
Soil conservation maps of area
Graphics capabilities (computer or manual)

Per Class

Video: **Enviro-Tacklebox™** ***Erosion: On the Move***

Suggested Time Frame:

One semester: Provide enough class time to do research and write plan.

Procedure:

Students will work in cooperative groups on one site with each group in charge of a specific task(s):

1. Students will begin research by contacting their local NRCS office and ask the Earth Team Coordinator for information on erosion problems, solutions and volunteer opportunities in their community.
2. Based on this information and other resources, students choose a site to design a conservation plan.
3. If possible, a field trip should be planned to the site with an NRCS representative. Remember, the site chosen may be under private ownership and you will need permission from the land owner. If a field trip is not possible, gather enough information from maps and other sources.
4. Once the information has been gathered, students should state the erosion problem they want to solve and include it at the beginning of their planning document.
5. Students then research the best management practices (BMPs) they think will solve the problem and describe them in the plan using text, maps, graphics and schematics (blueprints) as to how they should be installed.
6. Students can present the conservation plan to the NRCS and the land owner and ask them if it would be possible for the groups to help implement the plan.

Lesson 2 Activity: Class Conservation Corps (CCC)

Suggested Discussion Questions:

- What are the most common causes of soil/land erosion in your community?
- What, if any, conservation practices are being used to combat these problems? Who is implementing these practices?
- What practices work the best?
- How expensive are these practices to implement for the land owner?
- What environmental impacts does erosion cause in your community?

Further Investigations:

- What is the estimated economic impact of soil/land loss in your community?
- If the erosion is allowed to continue unabated what will your community look like in 25 years? (Environmentally, economically.)

Career Opportunities:

Land Use Planner
Soil Scientist
Agricultural Scientist
Farmer
Land Manager

Assessment Procedures:

- Have students develop portfolios related to their research.
- Rubric-scored evaluation of conservation plan (ex. Do students use graphics, communicate ideas well, sequence tasks logically).

Additional Resources:

Strahler, A. and A. Strahler. 1989. ***Elements of Physical Geography***, John Wiley and Sons, New York.

Natural Resources Conservation Service. 1999. ***A Geography of Hope***, NRCS, Washington, D.C.

Natural Resources Conservation Service
http://www.nrcs.usda.gov
(accessed May, 2002)

Earth Force
http://earthforce.org engages young people in national environmental campaigns and offers practical activities that can help improve their communities. (accessed May, 2002)

Student Environmental Action Coalition
http://www.seac.org/ provides additional information on other projects.
(accessed May, 2002)

Give Water a Hand, Univ. of Wisconsin
http://www.uwex.edu/erc/gwah
provides youth/teacher action guides.
(accessed May, 2002)

Lesson 2 Activity: Class Conservation Corps (CCC)

Saving the Cape Hatteras Lighthouse...an attempt to stop environmental change

An example of the complex interaction among forces in nature is found on the shores of the Atlantic Ocean in North Carolina. The summer of 1999 marked the movement of the world-famous Cape Hatteras Lighthouse from its precarious perch in the ocean to 1600 feet from shore (moved a total of 2900 feet) in an effort to protect it and preserve its historical value. Completed in 1870, the lighthouse was first built 1500 feet from shore. By 1919, only 300 feet of land remained between the ocean and the lighthouse. Despite extraordinary efforts to save it in its original location, including constructing a seawall, moving 1.8 million cubic yards of sand to create barrier sand dunes, installing steel sheet pile groins, and gravel filled tubes linked to an underwater sandbar, human intervention was unsuccessful. The natural occurrence of beach subsidence had taken its toll on the lighthouse and threatened this historic landmark. After many years and millions of dollars spent toward beach nourishment and other extraordinary measures to protect it, the only way the lighthouse could be saved was to move it far from shore.

Moving 9.6 million tons was a major feat-engineers built a rolling platform to support the structure and locate it 1600 feet inland.

While many people have chosen to build homes and businesses on beautiful coastal beaches with million dollar views, beach migration is a normal process. Coastal beaches and barrier islands naturally shift in response to environmental conditions. Despite all efforts to protect them, these structures are placed in precarious positions and many will eventually succumb to the sea.

Lesson 2 Activity: Soil Erosion Survey Data Form

Class: _____

Teacher: _____

Group: _____

Date: _____

Time: _____

Plot #1 Vegetated: Measurements can be done in English or metric.

Rainfall: _____ inches/mm (Was gauge emptied 24 hours before reading?)

Soil Amount: _____ ounces/mL

Plot # 2 Non-vegetated

Rainfall: _____ inches/mm (Was gauge emptied 24 hours before reading?)

Soil Amount: _____ ounces/mL

NOTE: Make enough copies of this data form for each weekly recording. Have students create a spread sheet on which to enter all data collected for analysis.

Glaciers: Movers & Shapers

ACTIVITY GUIDE

GLACIERS: Movers & Shapers

Background Information

Glaciers are large masses of moving ice that are often called rivers of ice. They form slowly and some take over 100 years to reach their maximum size. Glaciers form because the annual snowfall in an area does not melt completely in the summer, and accumulates over time. As the snow accumulates, it slowly compresses under its own weight into a huge mass of ice. When a glacier's size reaches about 18 meters thick, its weight and the pull of gravity cause it to move slowly over land changing the land's surface features. Valley glaciers are found on land that slopes and flow downhill, while continental glaciers are on flat land and move out from their edges.

Glaciers either retreat or advance depending upon the amount of snow accumulation and melting. The rate of glacial movement can be slow or glaciers may move several hundreds of feet in a season resulting in a glacial surge. Glaciers are heard cracking and grinding as they move. Photographs of a glacier taken over a period of time show the rate of its advance or retreat. As glaciers move they pick up rocks and debris underneath them and carry them along, eroding the landscape. Glaciers can either wear down the earth's surface or build up new landforms by depositing debris as they move.

Glaciers are usually found at higher elevations and latitudes. They are found in mountainous areas, on islands, near the equator, and along some coastlines. Glaciers can become natural hazards if they melt during the warmer season and cause flooding in surrounding areas. These glacial melts can endanger the environment, wildlife, people, and property. Changes in Mt. Rainier glaciers in Washington state illustrate how glaciers can be hazards. Glaciers cut into headwalls and valley walls making the slopes unstable, often resulting in rockslides. On unusually hot or rainy days, cavities within the glacier may suddenly release water, causing glacial outburst floods. Outburst floods often roar rapidly along carrying rocks and debris (debris flow) and may suddenly and without warning cause a rapid rise in water level in the valley.

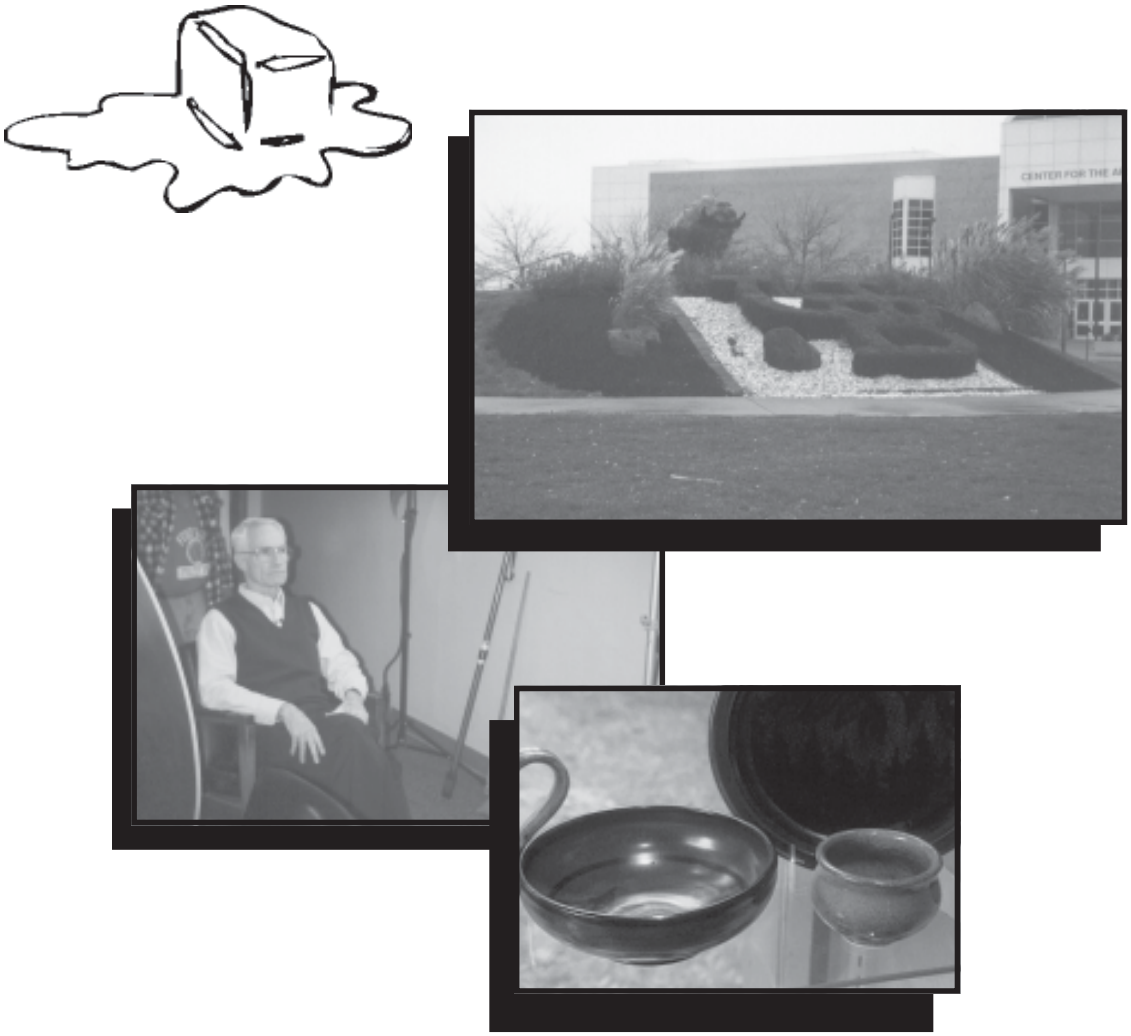
Tidal glaciers along coastlines can break off into icebergs during a process called calving. Often massive in size, icebergs can float into shipping channels and endanger ships. The U.S. Coast Guard has, since 1913, worked with the International Ice Patrol to monitor iceberg danger in the North Atlantic Ocean. The dangerous mix of icebergs, fog, severe storms, fishing vessels and busy trans-Atlantic shipping lanes could result in tragedy. The *Titanic* disaster in 1912, which resulted in 1517 deaths, and the loss of the *S.S. Hanshedtoft* in 1959 are proof of the danger of icebergs.

Several glacial studies research projects have examined glacial change. Scientists have mapped the locations of the world's glaciers and monitored glacial changes to better understand climate change and global warming. Scientists drill and extract ice core samples from glaciers around the world. These samples

suggest that the concentrations of greenhouse gases such as carbon dioxide and methane are increasing in the atmosphere. The burning of fossil fuels and deforestation contribute to these increases and could cause possible global warming. Some scientists have predicted that global warming will melt glaciers, resulting in a global sea level rise of disastrous proportions.

Since 1974, scientists at the Vostok Station in Russia have examined ice core samples from Antarctica. Scientists have identified trapped bacteria, fungi, pollen grains, and algae that are almost 4,000 years old. Glaciers have also preserved fossil remains, such as those of whales, in the state of Maine. The 5,000-year-old "ice man" found in the Austrian/Italian Alps and a 550-year-old Canadian are providing information about human evolutionary and cultural history.

Throughout the history of the Earth glaciers have increased and decreased in size. Analyzing glacial changes helps us better understand the complex relationships between climate, the environment, and living things.

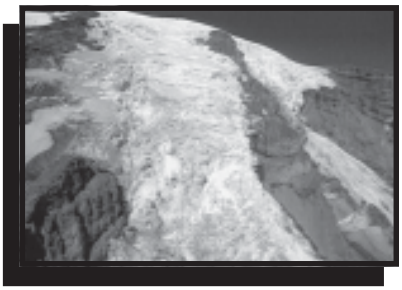


GLACIERS:
Movers & Shapers

Lesson 1 Activity: Glacial Change

Lesson Overview:

The glacier video will be used to introduce students to glaciers and glacial change. Students will research the ways in which scientists study glaciers and glacial change. They will interpret real time data and calculate the estimated global sea level rise potential. They will also graph the percent of land area that is covered by a glacier in a specific location and compare it with the total global area covered by glaciers.



National Science Education Standards:

Content Standard F: Science in Personal and Social Perspectives:
Natural Hazards

Excellence in EE—Guidelines for Learning

Strand 1: Questioning and Analysis Skills

Key Concepts:

1. Glaciers are produced by climatic processes and can become natural hazards.
2. Glacial change is being monitored by scientists and can serve as an indicator of global change.

Objectives:

Students will:

- investigate how scientists monitor glacial change.
- determine how glaciers can become natural hazards.
- analyze data and predict the effects of glacial change.

Cross-Curricular Connections:

Geography:

- Construct a glacier volume map of the world.

Language Arts:

- Collect and organize information and communicate it orally.

Mathematics:

- Interpret data collected by the USGS and calculate the projected maximum global sea level rise.
- Graph and interprete collected data.

Process Skills:

Inferring	Predicting	Observing
Modeling	Communicating	Analyzing

Lesson 1 Activity: Glacial Change

Materials:

Per Group

USGS data table of Estimated Present-Day Area and Volume of Glaciers and Maximum Sea Level Rise Potential (*May be accessed at the USGS website: http://pubs.usgs.gov/factsheet/fs133-99/gl_vol.html)*

Graphing paper or computer access to spreadsheet program

Calculators

Suggested Time Frame:

Three 50-minute class periods

Procedure:

1. Show the **Enviro-Tacklebox™** video, ***Glaciers: Movers & Shapers,*** to introduce the concept of glaciers and the effects of glacial change on the environment. Start and stop the video appropriately while encouraging students to think about:
   a) glaciers as potential natural hazards,
   b) how scientists study glaciers,
   c) the interrelationship between glaciers, global climate change, and possible sea level rise,
   d) the effects on the local environment.
2. Assign students in groups to research methods that scientists use to study glacial change including:
   a) NASA image data from earth-orbiting satellites [Landsat multispectral scanner (MSS) and thematic mapper (T M)]
   b) Smithsonian Institute's information on the discovery of "Ice Man" preserved in a glacier
   c) Vostok ice core studies and Greenland Ice Core Project
   d) National Snow and Ice Data Center
   e) Various countries that have glaciers, such as Greenland, Canada, Peru, even Africa
   f) Fieldwork and expeditions - Admiral Richard Byrd, SHEBA (Surface Heat Budget of the Arctic Ocean), *Live from Antarctica*, National Science Foundation's Office of Polar Programs, Rice University's *Glacier in Your Classroom*
   g) Computer modeling

   Several Internet sites provide information resources.
3. Ask the students to present their information to the class. This should include an overview of how the data is collected and what it tells us about glacial change and its effects on the environment. Visual representations should be a part of their presentation. Actual satellite images and photographs of early explorers on the glaciers are examples.
4. Hand out the USGS data table on Sea Level Rise Potential. Ask the students to calculate the maximum sea level rise potential (in meters) if all the world's glaciers were to melt.
5. Ask students to graph the percent by volume of the glaciers in each geographic region and make comparisons.
6. Have students construct a worldwide glacier volume map on butcher paper to visually display and compare these geographic regions.

Lesson 1 Activity: Glacial Change

Suggested Discussion Questions:

- Describe some of the ways that glaciers are natural hazards. Can any of these effects be controlled or prevented? (flooding, avalanches, icebergs)
- How are glaciers, climate, and sea level rise possibly related?
- If global sea level rises as it has been predicted, what will be the effects on human life and property?
- Discuss the ways that scientists collect information and make predictions about the effects of glacial change.
- Should scientists exercise care when interpreting this data? Explain your answer.

Further Investigations:

- Students can explore other sources of information about glaciers using the Internet sites provided.
- Have students look up the elevations of various U.S. cities and compare how each would be affected by a maximum sea level rise potential of 80.59m.
- The class can interview a glaciologist via email.
- Students can investigate the interaction of glaciers, volcanoes, and climate ("fire and ice").
- Students can research and propose what steps can be taken to spare human life and property if global sea level rise reaches its maximum potential.

Careers Opportunities:

Glaciologist
Meteorologist
Climatologist
Geologist
Geomorphologist

Assessment Procedures:

- Evaluate student graphs, maps, and calculations.
- Evaluate student oral presentations and visual representations.

Additional Resources:

Roberts, D. (1993, June). ***Ice man***. **National Geographic**,183(6), 36-67.

Stiefel, C. (1999, February 8). ***The Big Chill: Join Scientists on a Ship Stuck in Ice for One Year.*** **Science World**. 13 - 15.

Woods, R. K. (1994, October). ***Stimulating Interest in Geology***. **Science Scope**, 11-13.

National Snow and Ice Data Center
http://nsidc.org/cryosphere/index.html?GLACIERS/
(accessed May, 2002)

Antartica in the Classroom
http://www.glacier.rice.edu/
(accessed May, 2002)

University of Colorado, Polar & Cryospheric Research http://www.nsidc.colorado.edu
(accessed May, 2002)

GLACIERS:
Movers & Shapers

Lesson 2 Activity: Glaciers Leave Their Imprint

Lesson Overview:

Students will study various types of glaciers and the landforms they can create. Working in pairs, students will research a type of glacial landform and construct a calendar page illustrating and describing it. The pages will be compiled to create a class calendar.

National Science Education Standards:

Content Standard F: Science in Personal and Social Perspectives:
Natural Hazards

Excellence in EE—Guidelines for Learning

Strand 2: Knowledge of Environmental Processes and Systems
1. Processes That Shape the Earth

Key Concepts:

1. Moving glaciers carve and erode the landscape.
2. Glaciers also carry rocks and soil and deposit them in new areas.
3. These geological processes are slow and may even take thousands of years.

Objectives:

Students will:

- identify and illustrate the various landforms left by the imprint of glaciers.
- explain the processes by which these landforms were made.

Cross-Curricular Connections:

Fine Arts:
- Illustrate specific glacial landforms and use them to create a class calendar.

Language Arts:
- Communicate their information to others both orally and in writing.

Geography:
- Locate glacial regions on a map and construct a glacial volume map.
- Identify landforms that are the result of glacial action.

Process Skills:

Observing	Communicating
Classifying	Inferring

Lesson 2 Activity: Glaciers Leave Their Imprint

Materials:

Per Pair of Students

DIAGRAM (Calendar, page 58)
Drawing paper (11" X 17") that has the calendar copied onto bottom half
Library and/or computer resources
Art supplies

Suggested Time Frame:

Two 50-minute class periods.

Procedure:

1. Assign glaciers and landforms to student pairs to research and illustrate for a class calendar. These may include:

Glaciated Valleys	Mountain Glaciers	Ice Sheets	Loesses
Fjords	Ice Shelves	Ice Caps	
Cirques	Piedmont Glaciers	Tidewater Glaciers	
Moraines	Ice Aprons	Drumlins	
Horns	Kames	Kettle Lakes	
Erratic Boulders	Crevasses	Terraces	

2. Give students a page for their calendar that has been folded in half with the dates on the lower half. Students should place their glacier illustrations and descriptions in the blank space that is the top half. Illustrations may include enlarged computer images, photographs, and colored drawings. A one or two sentence description of the glacier or landform and how it is formed should be used to label the illustration.
3. Students should present their calendar page to the class and explain its glacial landform.

Suggested Discussion Questions:

- What geological processes helped to shape your landform?
- Can you estimate how long it might take a glacier to create your landform?
- Where in the world is your landform located?
- Is land still being imprinted by glacial action?
- What natural disasters could possibly result in the areas of these glaciers if the glaciers melted or shifted suddenly?
- How might these landforms impact the environment, wildlife, and humans in a positive way?

Further Investigations:

- Create a bird's eye view or topographic map of your landform.
- Design an amusement park ride that incorporates the landform and its surroundings (Example - Matterhorn in Disneyland).
- Describe how the landform has influenced the people and culture of the area in which it is located (Example - New York Finger Lakes region).

Career Opportunities::

Geologist
Cartographer
Glaciologist

Assessment Procedures:

- Evaluate the calendar illustration and description.
- Student presentation to the class.
- Concept map showing relationships between glaciers, landforms and the environment.

Additional Resources:

Bennett, M. R. & Glasser, N. F. (1996). ***Glacial Geology: IceSheets and Landforms***. New York: John Wiley & Sons.

Gallant, R. A. (1999). ***Glaciers (*****First Books: Earth and Sky Science)***. New York: Franklin Watts Press.

Patchett, L. (1994). ***Glaciers*** **(Our Planet).** New York: Troll Books.

Landforms
http://vathena.arc.nasa.gov/curric/land/landform/landform.html
(accessed May, 2002)

University of Colorado, Polar & Cryospheric Research
http://www.nsidc.colorado.edu
(accessed May, 2002)

USGS Water Science for Schools
http://ga.water.usgs.gov/edu/
(accessed May, 2002)

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY

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