Land and people : Finding a Balance

Everglades

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

Introduction

The Everglades project in this curriculum packet ask students to consider the following focus question: The year is 2010. The National Weather Service has studied the last decade's rainfall rates and the storm patterns over the Atlantic Ocean and has produced an alarming forecast: over the next 5 years, the Everglades region will experience a 30-percent decrease in the amount of rainfall it receives. How will your group respond to this serious decrease in rainfall? Create an action plan that will minimize the damage the long period of dry weather will cause to human and ecological interests.

To develop an answer to these complex questions, students will need to:

- understand the concept of a water budget,
- predict characteristics of the Everglades region in the future, including the size of the watershed, the population, the amount of rainfall,
- learn how soils reveal chemical changes in an environment over time, and
- explore the unique geology of the Everglades.

At the end of this project, students should produce a plan for meeting the region's water needs in light of the upcoming drought. Their plan should address how they think the drought will affect the environment, residents, and agribusiness. They should also provide justification for their plan, based upon the data they received in the Student Packet, their understanding of the water budget, and the lessons they learned through calculation and experimentation.

Opening Session

Help students look through the Student Packet. Ask them to read through the tables of data and, in small groups, write generalizations about the Everglades region on the basis of the data. (In this packet, the Everglades region is defined as Broward, Dade, and Palm Beach Counties.) Post these generalizations and discuss them as a class.

Return to these generalizations as students complete the three activities in the Teacher Packet.

Activity 1
The Everglades Spending Plan — Water Budgets and the Hydrologic Cycle

Purpose

This activity will acquaint students with the hydrologic cycle and introduce watersheds and water budgets. Students will realize that water is a limited resource and that they will have to consider competing interests as they allocate this resources.

Materials

- 1/2-gallon clear plastic beverage bottle,
- roll of masking tape,
- marker,
- water, and
- graduated cylinder or beaker.

Procedure

1. Before beginning the activity, discuss the hydrologic cycle with students. (This information may be for review.) Ask students to make a sketch that explains the hydrologic cycle, then use the illustrations to review the components of the hydrologic cycle. Explain that water circulates continually in its three states — liquid, solid, or vapor — through the geosphere, atmosphere, hydrosphere, cryospohere, lithosphere, and the biosphere.

2. In small groups, have students discuss the meaning(s) of the term, "watershed." Provide dictionaries, encyclopedias, and textbooks. How many definitions can they find? Direct the discussion to the following definition of watershed: all of the land that drains into a particular body of water.

3. Have students brainstorm about the possible sources of water and various methods of drainage, such as rivers, streams, rainfall runoff, storm drains, gutters, and so forth. Have students

generate a list of ways that humans affect the watershed system. Revisit this topic as you introduce Activity 2, "How Big is the Watershed?"

4. Working in pairs, have students calibrate a clear plastic bottle in 50 mL graduations by placing a strip of masking tape along its length and marking the gradations. Have them pour 50 mL of water into the bottle and mark the water level, continuing this process until the bottle is full.

5. Tell students that the water in the bottle represents the amount of water in a model watershed, and that they are in charge of allocating water for a growing town of 1,000 households. Before the students begin allocating, have them make a list of uses for the water in the model watershed. (Use the following table as a guide.) Point out that there is a minimum volume of water required to sustain streamflow and that streamflow must be maintained. You may wish to assign mL of water use per household for each water use, or you may use the sample provided below.

6. Once the amount of water used for each purpose has been assigned, have the groups pour water from their 1/2-gallon bottles to represent each use for the 1,000 households in the town. Students should record the amount of water left after each withdrawal.

7. Have students devise a method to determine the maximum number of households the model watershed can support.

8. Once the activity is complete, lead students into a discussion of water budgets. (Use the information below as background for the discussion.) Ask them to revisit the Focus Question for the Everglades. How will the drought affect the water budget in general? What effects might the drought have on each of the interested parties?

Discussion of water budgets

When discussing the concept of a water budget (the freshwater available for plant, animal, and human use plus the water necessary to maintain stream flow), you many want to begin by discussing the distribution of water in the hydrosphere:

97.30% in the ocean (saltwater),
2.14% frozen into glaciers,
0.54% ground water,
0.02% in streams, rivers, freshwater and saltwater lakes, and soil moisture.

To determine a region's water budget, hydrologists consider "deposits" to be water from precipitation, and "withdrawals" to include water lost to the atmosphere through evaporation and transpiration, water which runs off to rivers, streams, and lakes, and water that seeps underground. Humans also make withdrawals from the water account. Although much of this water is recycled back into the system, only a small portion of water used in agriculture is returned to the account. When the account is overdrawn, humans rely on water supplies stored in aquifers.

For the continental U.S., about 3.8 trillion gallons of water are credited to the water account annually through precipitation. Sixty-six percent is returned to the atmosphere through evapotranspiration, 31percent runs off and 3 percent enters the ground-water supply. South Florida's water budget differs from the national water budget. To highlight south Florida's unique water budget, refer students to the inflow and outflow pie charts in their Student Packets.

Adapted from "Watershed Wisdom." Ellen Pletcher Metzger, *Journal of Geological Education,* 1993, v.41, p. 508.

Activity 2
Disappearing Drainage — the Incredible Shrinking Everglades Watershed

Purpose

This activity will introduce students to the drastic changes in the Everglades watershed. They will use their understanding of the historic changes in the watershed to help them predict what the Everglades watershed will be like in 2010. This activity will also introduce them to changes in land use in the Everglades watershed area.

Sample Table of Water Use in the Model Town and Amount Needed

USE	WATER NEEDED
minimum streamflow	550 mL
household use	50 mL/1,000 households
industrial use	25 mL/1,000 households
agricultural use	50 mL/1,000 households
hydroelectric use	25 mL1,000 households

Materials

- original and present Everglades watershed maps (see Student Packet),
- string,
- rulers,
- graph paper,
- tag board or cardboard for mounting,
- cutouts of historic and present day Everglades watershed, and
- balance.

Procedure

1. Ask students to examine the two watershed maps provided in the Student Packet. Ask them to compare the maps, then list changes in the Everglades watershed from the original to the present day. Changes include the decline in watershed area, the addition of agriculture, the loss of wetlands, and the introduction of Water Conservation Areas.

2. Open a discussion of the changes in the watershed configuration and how these changes might be results of the impact of human settlement on the Everglades. Have the students brainstorm reasons why the watershed configuration has been changed.

Note: Hold this discussion before students read the Student Packet text about the history of the Everglades.

3. Tell students that their next task will be to determine the change in area of the Everglades watershed. Have students brainstorm about ways they can calculate the difference in the areas of the original and present watershed. Once they have generated a list of methods for calculating the areas, have students work in pairs or small groups to determine the change in watershed area. Have each group try a different technique from the list.

Possible methods for determining the change in the area of the watershed include the following:

- Use string to create shapes within the watershed that students will be able to calculate the area for.
- Put the graph paper on top of the watershed map. Trace the outlines of the current and historic watersheds. Count the squares within the traced outlines. Compare the numbers of squares.
- Cut out each of the historic and current day maps. Mount each of these on cardboard. Weigh the two pieces of cardboard. Compare the weights.
- By using two copies of the map, overlay the present watershed on the original watershed. Find the area of the difference in the two watersheds, then weigh the difference (as suggested above) or use graph paper to count the squares within the difference.

4. Once the students have completed their measurements, have each group report their results. (The difference is less than 25 percent) Have the students suggest why different techniques might yield different results. Ask students which techniques they believe yield the best results.

Extension

In addition to changes in the watershed caused by the extensive water-management system, other land-use changes have affected the movement of water in south Florida. Draining and filling in wetlands for agricultural use and paving for extensive urbanization have increased runoff and the risk of flood.

In the past, wetland areas were like sponges, storing great quantities of water and serving as a flood control. How does replacing the wetland with agricultural land or cities increase flood hazards? Students can model the three, land-use wetlands — foam rubber, sponge, or a premium paper towel; farmland — mix of sand and potting soil; urban area — smooth hard surface like a clipboard or coated cardboard (cereal box). Have students design experiments where they can investigate the characteristics of surface water on wetlands, farmlands and urban areas by simulating runoff over models of each surface.

Activity 3
The Everglades — A Geology All Its Own

Purpose

This exercise will acquaint students with the physiographic and geologic characteristics of the south Florida region. They will also speculate on how the geology of the region influences topography and land use.

Materials

- geologic map of south Florida (in Student Packet),
- geologic column of rock units in south Florida (in Student Packet),
- rock samples (optional),
- fossiliferous limestone (marine),
- freshwater limestone,
- peat,
- sandstone, and
- marl.

Background

Much of south Florida is underlain by limestone. The surface topography reflects the underlying geology. Low areas associated with limestone erosion allow for water to pond, thus supporting the wetlands environments necessary for peat deposition. The sequence of freshwater and marine limestones provide a record of sea-level rise and fall over the geologic history of the Everglades. Also, the Everglades themselves lie in a basin that was most likely an ancient atoll-like structure that formed a lagoon. The higher regions that allowed for the development of the

Everglades wetlands are fossil reefs.

The process of limestone deposition in the area began about 5 million years ago. During the last 5 million years, the sequence of marine and freshwater limestones preserved the record of seawater inundation of south Florida. About 5,000 years ago, post-glacial rise in sea level slowed enough to allow the build-up of coastal structures, which impounded freshwater in the lowlands that are not the Everglades. The Everglades have evolved since then as a result of the deposition of peats and marls (mixture of 35-65 percent clay and 65-35 percent calcium carbonate formed under marine or freshwater conditions known as calcitic muds.)

Just as geologists use limestone to determine past conditions in the south Florida region, they also use peat cores to reconstruct the more recent history of the region. Peat is a chemical filter that holds a number of cations and anions. Scientists have used these peat cores to document the build-up of pollutants in the Everglades over the past 100 years.

Procedure

1. Refer each group to the geologic map of south Florida in the Student Packet and provide a copy of the geologic column. If students are unfamiliar with geologic maps, explain that geologic maps show the surface distribution of rock formations in the area. Have students use the geologic column to identify the oldest and youngest formations in the area. Ask them to identify which geologic formations border the Everglades and which formations underlie the Everglades.

2. Ask what kinds of rocks and unconsolidated deposits are represented on the geologic maps. (Show samples of these rocks if you have them.) Do they have any experience with these rock types? Have them speculate on what the difference is between marine and freshwater limestones. How did these rocks, which form underwater, end up on dry land? How did marine limestones, which are deposited in seawater, end up associated with the freshwater Everglades?

Use these discussions to introduce the concept of sea-level rise and fall related to the retreat and advance of continental ice sheets.

3. Have students use the geologic map and column to reconstruct the history of the Everglades region by relating marine and freshwater limestones to sea-level rise and fall. Ask them if they can determine the last time the region was under seawater? What has happened to the region since then?

Now would be a good time to discuss the use of peat cores in determining the environmental health of the Everglades. See the Discussion of Peat Cores below.

4. Have the students compare the land uses on the watershed map to the geologic units which occur in the area. What conclusions can they draw about distribution of rock types and present day land use?

Discussion of Peat Cores

USGS scientists are using peat cores to study peat accumulation rates and the change in peat chemistry from 1961 to the present. They have sampled two sites in Water Conservation Area 2. The first area shows a shift from saw-grass to cattail vegetation due to the increased nutrient input it receives from canal water. Peat accumulation near the canal has nearly doubled in this area. The second area, with near-pristine, low-nutrient conditions, shows slower rates of peat accumulation. The differences in these areas are recorded in peat cores as differences in preserved plant material and differences in peat chemistry.

Since 1961, peat chemistry shows increases in phosphorous, sulfur, copper, and zinc that probably originated from agricultural activities where they have been applied as fertilizer.