Unit 8

Water Resources

Background

Introduction

Water resources are under major stress around the world. Rivers, lakes, and underground aquifers supply water for drinking and sanitation, while the oceans provide habitat for a large share of the planet's food supply. Today, however, damming, diversion, over-use, and pollution threaten these irreplaceable resources in many parts of the globe and scientists widely predict that global climate change will have profound impacts on the hydrologic cycle.

Essential Questions

Can we meet the basic human and ecological needs for water, improve water quality, eliminate the overdraft of groundwater, and reduce the risks of political conflict over shared water?

Can we develop a model to understand a watershed system in order to manage water resources?

Content

Unit 8 describes how the world's water supply is allocated among major reserves such as oceans, ice caps, and groundwater. It then looks more closely at how groundwater behaves and how scientists analyze this critical resource. After noting which parts of the world are currently straining their available water supplies, or will do so in the next several decades, the unit examines how humans are depleting freshwater supplies and the problems posed by salinization, pollution, and water-related diseases.

The video illustrates how scientists go about collecting and verifying field data to address hypotheses. It also shows how individuals become involved in a specific research area in science based on their background and interests. The first part of the video addresses water use and management in Florida by reviewing the research of Dr. Wendy Graham, specifically in the central part of the state in the Suwanee River Watershed, and then describes resource management issues in the Everglades. The second part of the video focuses on watershed issues in Arizona with Dr. Tom Maddock and his study of groundwater flow. Both segments of the video address the importance of the managing a regional water resource supply and extend the model to state, national, and international levels.

Background

Learning Goals

During this session you will have an opportunity to build understandings of the following.

a. Knowledge

   i. Water is a critical natural resource on Earth and is currently being stressed.

   ii. The world's water is found in several major reserves, namely the oceans, groundwater, and glaciers and polar ice caps, and through the hydrological cycle, connects all of Earth's systems.

   iii. Aquifers are important geological formations that serve as groundwater storage units and are being depleted faster than they can be recharged.

   iv. Water resources are governed by political and economic systems.

b. Skills

   i. It is more effective to study water-related issues at the watershed level.

   ii. Science helps explain current events about global water issues.

   iii. Scientists take a systems approach when studying watersheds and water issues.

c. Dispositions

   i. Access to clean water for drinking and sanitation purposes is a basic human right.

   ii. Water-related diseases need to be eradicated from developing countries.

   iii. The Clean Water Act (1972) and Safe Drinking Water Act (1974) have generally protected public health and enforced standards of high water quality.

Key Concepts

Aquifer	Permeable
Artesian	Point source
Capillary force	Pollution
Catchment area	Porous
Discharge	Recharge
Freshwater	Salinization
Groundwater	Sorption
Hydraulic head	Total Maximum Daily Load
Hydrological cycle	Valdose zone
Hypoxia	Watershed
Non-point source	Wetlands

FACILITATOR: These concepts correspond roughly to the sections of the unit. There are a number of other concepts that could be included. It is best to start with the author's major ideas and then ask for input from the study group for other concepts they would include.

Background

Misconceptions about Water Resources

Consider the following list of misconceptions as reported in the science and environmental education research literature.

- Many people believe that water originates from pipes, and not from watersheds, springs, and aquifers. There appears to be little understanding of the interconnections of the landscape and how water gets to a residence.
- It is a common misconception that wetlands are wastelands with no social or economic value to society. People tend to think of them as smelly and unproductive. Underlying basic ecological concepts of nutrients and productivity are little understood and the value of these transitional habitats is not recognized.
- Because people do not understand the interrelationships of the water cycle, they tend to believe that water flowing into the sea is wasted water. In fact this is an important connection in the hydrologic cycle.
- Because we seldom think about and never actually see groundwater, a number of misconceptions exist. Among them are:
  - Groundwater flows in underground rivers over great distances.
  - Groundwater is a non-renewable resource.
  - Groundwater is suitable for drinking without treatment.
- Seasonal changes in water resources and their ecological relationships are little understood. For example, many people believe that floods along rivers happen only after snow melts in the spring. (Recent news coverage of storm flooding may help correct related misconceptions.)
- A pervasive and interesting misconception is that all rivers flow "down" from north to south. This ignores the role of elevation and topography.
- Because the oceans are so vast, many people believe that oceans are a limitless resource. The also believe there are no political boundaries in the oceans. In fact, they are a limited and politically arbitrated natural resource.

Getting Ready (45 minutes)

Activity One: Assessing Prior Knowledge, Questions, and Related Experiences

FACILITATOR: Participants are given three index cards. On the first card, they should indicate something they know about watersheds or groundwater. On the second, they should write one question about either watersheds or groundwater. And finally on the third card, they should describe an experience they have had that relates to a watershed or groundwater. Examples of comments and questions might be:

- All drinking water is derived from surface water.
- What is the status of groundwater in our region or state?
- Are we vulnerable to a shortage of freshwater for drinking, bathing, etc.?

Getting Ready

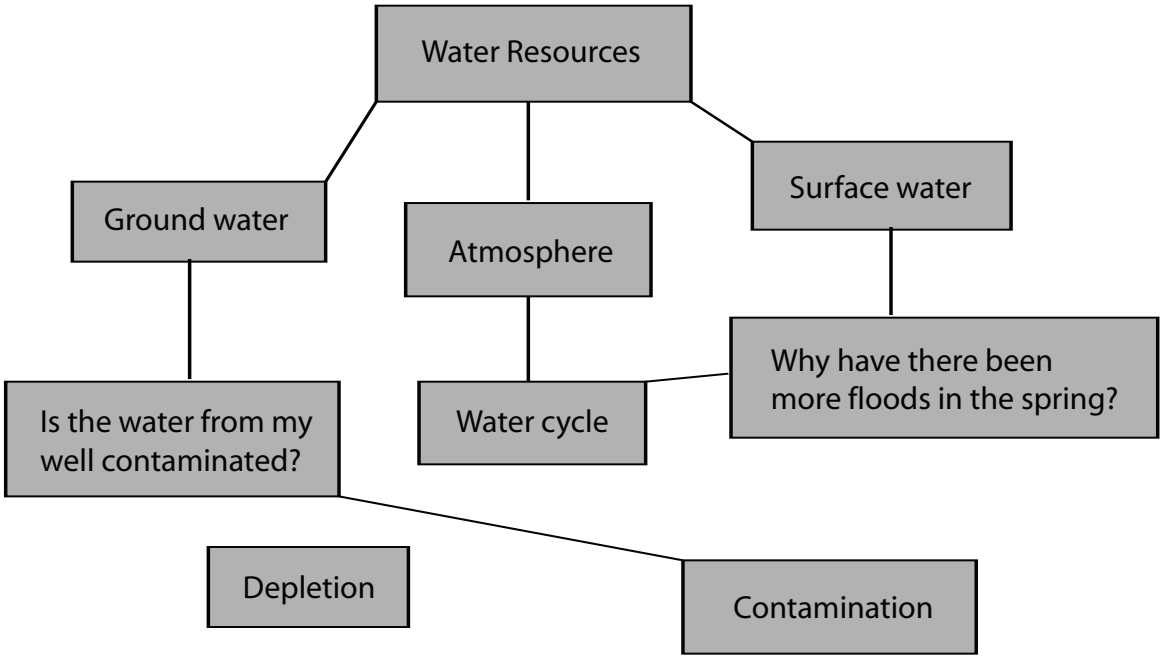

Figure 8.1 An example of a study groups' idea collection, with major subjects identified and the addition of the major focus ideas of the video. This activity links individual pre-existing knowledge with that of other members of the group and the unit content.

Activity Two: Current Events

Participants will share an article that they have found that relates to the week's topic. All members of the group will share their headlines for the articles. The leader should ask a few people to summarize their articles and ask for comments from others with related articles. As the group discusses the articles, a participant should record key concepts and make a list. (Participants may choose to bring in a cartoon or an editorial related to the week's topic instead of an article.)

Activity Three: What is a Watershed?

In this activity, you will build a watershed model, then refer to a topographic map to note similarities between your model and the map to begin to understand the characteristics of a watershed.

Getting Ready

Part 1. Build Your Own Watershed

Materials

Stream table, children's pool, or large plastic container

Crumpled newspaper

Saran wrap

Spray bottle

Blue colored water

Clear acetate sheet for each participant

Erasable markers

Procedure

1. Build your watershed in a stream table, child's pool, or large plastic storage container.
2. Crumple some newspaper into a mountain-like form and tape to the bottom of container.
3. Using Saran wrap, cover the watershed/mountain structure, making sure to fit the wrap into the "nooks and crannies."
4. Using a spray bottle, squirt blue colored water over the watershed/mountain structure and make note where the water accumulates and runs down the watershed and makes streams and rivers to the base level.
5. Draw a diagram of your watershed and label the identified watershed components.

Part 2. Topographic Maps, Aerial Photographs, and Watersheds

1. Using a topographic map of the local area, identify the boundaries of the watershed in this area.
2. Place a clear, acetate sheet over a section of the topographic map and using an erasable marker, trace the boundary of the watershed, the path of the streams and rivers in the watershed, and any other important feature of the watershed.
3. Locate an aerial photo for this area using an appropriate Web site.

NOTE: There are many Web resources to locate watershed photos, topographic maps, etc. However we recommend using Google Earth since it is likely to be a common resource for most participants. Search for your own community and expand the Earth view to include all the water bodies associated with your watershed.

Discussion

1. What is the geographic area of your watershed and how does it compare to other watershed in your region?
2. Where are the main water bodies that store water for future use?
3. How does the population distribution of your community correspond to the distribution of water?
4. How are communities in your region connected by their watersheds?

Video (45 minutes)

Activity Four: Watch the Video

As you watch the video, think about the following focus questions.

1. Describe the watershed systems studied by the principal researchers.
2. How does modeling play a role in understanding these watershed systems?
3. What do the scientists researching the various watersheds do with the hydrological models they develop?
4. Describe the importance of the riparian zone to the watershed as a whole.
5. Why is the process of evapotranspiration important to the understanding of the hydrological cycle in a region?
6. How do various chemicals identified as pollutants impact the overall aquifer?
7. Using the karst topography of central Florida as an example, describe the relationship of geology to the watershed.
8. How do you balance agricultural needs with human water use needs?

Activity Five: Discuss the Video

1. How far can you stress the watershed system before you cause ecological collapse?
2. Are there any examples in your watershed that are obvious stressors on the system?
3. What are some competing uses of water in your community?
4. Are there any current events that relate directly to the watershed you live in? Explain them and discuss public opinion regarding any problems or solutions.

FACILITATOR: Refer back to the misconception section and Activity One: Assessing Prior Knowledge. Has the video contributed to the participants' new understanding of concepts? Are there any changes the participants would make about the arrangement of their cards from Activity One?

Going Further (60 minutes)

Activity Six: Community Water Resources

Have you considered where your water supply originates or where water goes after it is used? In this activity, you will research water resources in your local community. Sources of information can be your home water bill, if available; the United States Geological Survey (USGS website http://waterdata.usgs.gov); your town or city website; or your state department of environmental services or related agency.

FACILITATOR: If a computer with internet access is not available, print out data concerning local water use, supply, problems, etc., from the USGS water web site.

Going Further

Research answers to the following questions and share your answers with other members of the group.

1. In your community:
   a. What are the major sources of the water supply?
   b. How is water use divided among agricultural, industrial, power plant cooling, and public uses?
   c. Who are the biggest consumers of water?
   d. What has happened to water prices in the past 20 years?
   e. What water supply problems are projected?
   f. How is water being wasted?
2. Identify any floodplain areas in your community. Develop a map showing these areas and the types of activities found on these lands. Evaluate the management of such floodplains in your community and come up with suggestions for improvement.
3. In your community:
   a. What are principal non-point sources of contamination of surface water and groundwater?
   b. What is the source of drinking water?
   c. How is drinking water treated?
   d. Has pollution led to fishing bans or warnings not to eat fish from any lakes or streams in your region?
   e. Is groundwater contamination a problem? If so, what has been done about it?
   f. Is there a vulnerable aquifer or critical recharge zone that needs protection to ensure quality of groundwater?

Activity Seven: Return to Essential Questions

The facilitator should draw the attention of the participants back to the essential questions posed in the Background Section of this unit guide. Discuss how the participants' ideas may have changed in regard to the questions. Discuss the most logical and complete answers to the questions.

Activity Eight: Discuss Classroom Supplementary Activities

If the participants in the study group are teachers, the facilitator should draw the participants' attention to supplementary classroom activities located at the end of this unit. Discuss how teachers would implement these activities in their classrooms and how they would relate them to the topics in this unit.

Between Sessions

Next Week's Topic Overview

Read Unit 9 before the next session. In Unit 9, the decline of Earth's biological diversity will be considered. Subtopics will examine the gene pool, ecosystem structure, and endangered species.

Read for Next Session

For the next session be sure to read the Unit 9 Professional Development Guide background section. Consider the essential questions as you read the text. The misconceptions section will give you some insight into what misunderstandings people may have about biodiversity decline. Consider discussing the topic with your friends or students and discussing common misconceptions.

Current Events

Bring in a current event article or cartoon related to biodiversity decline.

Supplementary Classroom Activity 1

A Long-term Watershed Study

This activity is a web-based study of one of the most influential, long-term watershed studies in the United States. The intent of this exercise is to introduce students to the nature of watershed and forest ecology research studies that provide data to understand the processes and mechanisms of watersheds and cycling of water through forests. The Hubbard Brook Experimental Forest (HBEF) is part of the White Mountain National Forest, located in central New Hampshire in the town of West Thornton. It is part of the Long Term Ecological Research program (LTER) funded by the National Science Foundation. The data from the Hubbard Brook Experimental Forest (HBEF) is now used in many environmental science, biology, and chemistry textbooks as a source for acid precipitation data, watershed dynamics, and nutrient and water cycling in forests, as well as an example of one of the longest forest ecology studies in the United States.

You can simulate these studies in local areas by using sampling protocols from watershed or aquatic sampling manuals and forest ecological methods references. The activities are designed to teach basic ecological principles and inquiry skills and to make students aware of the value of long-term research as a basis for conservation management and regional planning decisions.

Materials

Computer with Internet access and printer

Supplementary Classroom Activity 1

Procedures

Go to http://www.hubbardbrook.org

Click on the Students and Teachers button; then from the pull down menu click on the 6–12th Grade Educational Resources; and finally Teacher and Student Resources.

Once at the Teacher Resource page, you can access various activities, databases, and information that relate to the research at Hubbard Brook.

A series of activities can be downloaded and used in your schoolyard, laboratory, or classroom. These activities are related to the science and research conducted at the HBEF and contain actual data, protocols similar to those used at HBEF, and suggestions for research projects. Topics include an introduction, a watershed deforestation experiment, and forest ecology.

There are links in the left hand column to handouts for the virtual tour. These handouts are written at different levels of difficulty depending on the nature of the content covered and student abilities. National Science Education Standards can also be accessed and adapted to your specific state suggestions. Finally, a series of activities can be accessed from the Long Term Ecological Research link (Teacher's Manual of Classroom Activities).

Procedures and discussion questions are included with each activity in these sites.

Notes