Introduction

Module objectives

In this module, students will

- identify questions regarding the use and management of global water resources;
- use technology and mathematics to improve their investigations of water resources;
- formulate and revise explanations for precipitation and water flow patterns using logic and evidence; and
- identify local, regional and global challenges of managing water resources.

Module overview

This module contains four units that examine the movement of water through the hydrologic cycle with an emphasis on factors controlling precipitation, surface flow, and ground water recharge, and the importance of wise water management.

Key concepts

Exploring Water Resources emphasizes these basic concepts:

- Water on Earth exists in several large global reservoirs and moves between these reservoirs through the various processes collectively called the hydrologic cycle.
- Fresh water comprises a very small percentage of Earth's water supply, and much of this fresh water is not easily accessible.
- Wind, weather fronts, convection, and topography determine where precipitation occurs.
- Topography and other characteristics of the land surface determine how surface water moves.
- Human-related and environmental factors influence our ability to utilize water resources.
- Wise water management is a crucial factor in sustaining the current and future global population.

Unit overviews

Unit 1 – Global Water Reservoirs

Unit 1 objectives

In this unit, students will

- understand the distribution of global water resources and the movement of water through the hydrologic cycle;
- estimate the volume of water contained in the three largest water reservoirs;
- explore technologies used to extract water resources; and
- relate how climatic changes would alter the distribution of water and impact the global population.

Students examine how the global water supply moves through the hydrologic cycle, estimate the size of important global water reservoirs, and explore methods of obtaining water from these reservoirs for human use. Using a scenario whereby global warming melts polar ice caps, students determine how changes in sea level affect human populations through the loss of habitable areas and croplands.

- 1.1 – **Global water sources.** Students identify global water reservoirs and predict the relative size and accessibility of each reservoir. Students also consider how these reservoirs are used and the challenges of maintaining a safe water supply in their community.
- 1.2 – **Measuring global water.** Students examine ocean bathymetry and estimate the volume of water held in three important water reservoirs: the oceans, ice caps, and the atmosphere.
- 1.3 – **Utilizing global water reservoirs.** Students are provided with a more complete understanding of the hydrologic cycle and an explanation of the technology used to obtain fresh water from the oceans, ice caps, and atmosphere.

- 1.4 – **What if the ice caps melted?** Students examine the potential effects of global warming on world population. They visualize how a change in sea level resulting from the melting of polar ice caps would impact densely populated coastal areas and croplands.
- 1.5 – **Comparing major reservoirs.** Students discuss the advantages and disadvantages of obtaining and using water from the oceans, ice caps, and atmosphere. They also use Internet resources to identify countries that could extract drinking water from these reservoirs.

Unit 2 – The Renewable Resource

Students investigate factors influencing global and regional precipitation patterns and examine the ecological and socioeconomic consequences. Students also examine the influence of topography and land characteristics on surface water flow. Finally, they examine the relationship between precipitation and discharge in important U.S. watersheds, and learn how biological processes interact with climate to affect runoff.

Unit 2 objectives

In this unit, students will

- examine how the movement of water through the hydrologic cycle generates weather that impacts society;
- explore patterns of precipitation and surface flow at various scales;
- discover how topography, winds, fronts, and convection influence precipitation; and
- identify factors driving local precipitation.

- 2.1 – **Too little, too much.** Students read historical accounts of severe droughts and floods in the U.S. and examine statistics detailing the monetary losses to illustrate the economic, ecological, and sociological effects of too little or too much precipitation.
- 2.2 – **Global precipitation patterns.** Students examine patterns of global precipitation and the role it plays in the formation of two important biomes, deserts and rainforests.
- 2.3 – **Moving air and water.** Students are given an in-depth explanation of how winds influence the formation of precipitation and how topography influences the movement of runoff.
- 2.4 – **U.S. precipitation patterns.** Students investigate how wind and topography influence precipitation. They compare average seasonal paths of the jet stream to precipitation trends, and use graphs to examine the relationship between topography and precipitation.
- 2.5 – **Surface water flow.** Students examine the influence of aspect on surface water flow in different regions of the U.S. They compare the mean precipitation and annual discharge for important U.S. watersheds in disparate climates, and calculate evapotranspiration and infiltration to determine the effect these processes have on runoff.
- 2.6 – **The local water picture.** Students use Internet weather resources to determine how uplift triggered by topography, weather fronts, winds, and convection have contributed to recent precipitation events in the U.S.

Unit 3 – Using Water Wisely

Students explore relationships between precipitation and water use patterns across the U.S. They investigate state and county water use in major economic sectors (domestic, agricultural, power, etc.), and gain an understanding of the critical importance of this resource and the complex issues that are involved in its management.

Unit 3 objectives

In this unit, students will

- understand how water is used in different economic sectors;
- investigate patterns in water use and consumption, and relate them to precipitation patterns;
- analyze agricultural practices in the U.S. in the context of water resource management; and
- identify local and regional challenges in water management and formulate potential solutions to these problems.

- 3.1 – **Water in your world.** Students contemplate the role of water in their everyday life by categorizing the ways in which water is used in their home and their community.
- 3.2 – **Water for many uses.** Students investigate water use and consumption patterns in the U.S. by major economic sectors, and examine relationships between these patterns and precipitation.
- 3.3 – **Water at work.** Students read about water use in the domestic, commercial, industrial, agricultural, mining, and power sectors and are introduced to the issues regarding conservation and sustainability of our water resources.
- 3.4 – **Feeding a nation.** Students examine patterns in precipitation and agricultural products and practices in the U.S. They explore relationships between crops, irrigation, surface water, and major ground water aquifers. Finally, they estimate the amount of water in the High Plains Aquifer, and calculate the number of years until its water supply is depleted if withdrawals continue at their current rate.
- 3.5 – **Meeting the challenge.** In this open-ended investigation, students use information learned in previous activities to discuss regional and local issues of water quality and quantity. Students evaluate how these issues affect them personally and formulate recommendations to address local and regional challenges.

Unit 4 – Water for a desert city

The activities in this unit focus on a local case study of the challenges of obtaining and providing water as well as the economic and environmental consequences of ground water removal in Tucson, Arizona.

Unit 4 objectives

In this unit, students will

- identify challenges regarding the use and management of water resources in arid environments;
- understand the characteristics of an aquifer and the physical and societal effects of ground water removal;
- conduct studies of ground water use, aquifer recharge, and the physical and economic impacts of ground water withdrawal; and
- examine potential conservation strategies and develop a plan to address future water needs.

- 4.1 – **Living in the desert.** Students are introduced to the challenges of managing water resources in desert communities, focusing specifically on Tucson, Arizona, a city in the Sonoran Desert of the southwestern United States.
- 4.2 – **Water in the balance.** Students investigate precipitation, stream discharge, and aquifer recharge of the Tucson area. They examine how precipitation, population growth, and water use interact and influence the amount of water withdrawn and recharged to the aquifer.
- 4.3 – **The Tucson Basin aquifer.** Students learn about the composition and structure of aquifers. They are introduced to potential physical and economic consequences of ground water withdrawal.
- 4.4 – **Impacts of ground water pumping.** Students examine current and predicted environmental and economic consequences of excessive ground water withdrawal from the Tucson Basin aquifer.
- 4.5 – **Conserving water.** Students investigate the amount of water used in daily activities, the cost of water, and the feasibility of harvesting rainwater to meet some of Tucson's water needs.
- 4.6 – **The voice of conservation.** In this open-ended investigation, students use knowledge gained in the activity to develop a conservation plan that addresses various aspects of Tucson's water supply problem.