Floods
6–8

Flood Science

The Hydrologic Cycle

Floods can happen anywhere—along the Mississippi River, in New England or even in western deserts—and most communities in the United States experience some type of floods.

Key Terms and Concepts

arroyo
awash
coastal flood
condensation
crest
debris flow
evaporation
evapotranspiration
flash flood
flood stage
groundwater
hydrologic cycle
hydrosphere
ice jam
infiltration
precipitation
river flood
slurry
speed of flow
storm drain
streambed
surface runoff
transpiration
transport
urban flood
wash
water table
zone of aeration
zone of saturation

Purposes

To introduce the students to the hydrologic cycle

To help the students and their families assess the potential for different types of flood and to understand their causes

Objectives

The students will—

- Use *The Hydrologic Cycle* to discuss, illustrate and write about the hydrologic cycle.
- Explain to family members the assertion that they are drinking the same water the dinosaurs drank. (Home Connection)
- Tell the story of the hydrologic cycle based on maps of their own area. (Linking Across the Curriculum)
- Write science fiction based on hydrologic facts. (Linking Across the Curriculum)
- Design experiments to illustrate and analyze the transpiration process. (Linking Across the Curriculum)
- Use the hydrologic cycle to explain lake-effect snow. (Linking Across the Curriculum)
- Apply knowledge of the hydrologic cycle in "The Water Cycle Game." (Linking Across the Curriculum)
- Research the earth's rising sea level and create a model to explain the process to others. (Linking Across the Curriculum)
- Research and model the approximate distribution of surface water on the earth. (Linking Across the Curriculum)

American Red Cross

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Floods
6–8

LESSON PLAN 1

The Hydrologic Cycle

- Use *Types of Floods* to describe different types of floods and find the reasons they occur: geography, human influence or weather.
- Create a profile of the community to determine the types of floods most likely to occur.
- Interview older family and friends to discover past floods and gauge the danger of flooding and the community's awareness of flood control. (Home Connection)
- Write day-by-day imaginary diary entries or letters based on interviews and research into the history of floods in their community. (Linking Across the Curriculum)

Activities

"Explaining the Cycle"

"In Danger of Flood"

TEACHING NOTE To understand the science behind floods and flash floods, it is important for the students to understand the hydrologic cycle. The second activity in this lesson plan introduces flood risk in your community; Lesson Plan 3 provides models for flood control.

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Floods
6–8

LESSON PLAN 1

The Hydrologic Cycle

Materials

The Hydrologic Cycle, 1 copy per student

American Red Cross

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"Explaining the Cycle"

SET UP 15 minutes **CONDUCT** two 40-minute classes

Science: Earth Science; Social Studies: Geography; Language Arts: Research, Vocabulary and Writing

1. Write the following terms on the board and have the students copy the terms into their science journals:

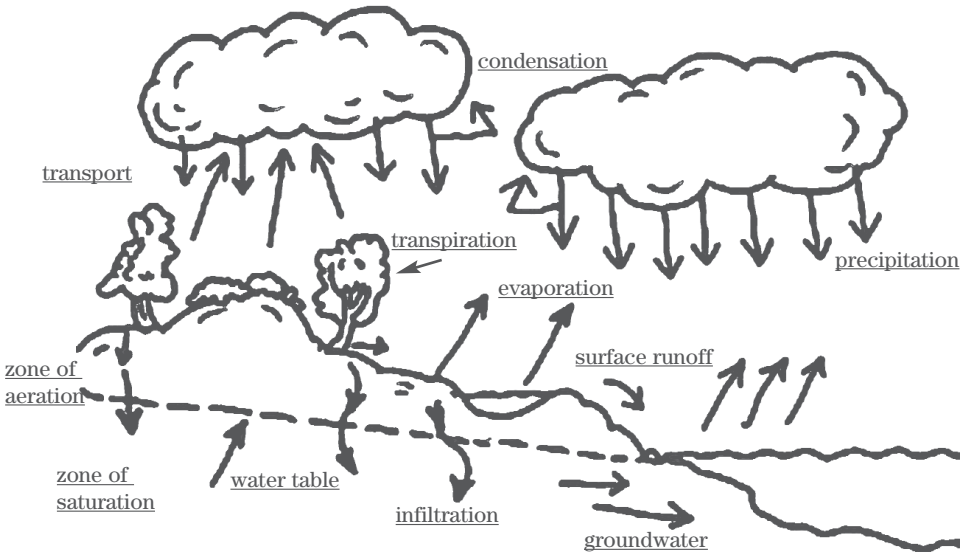
condensation	transport	precipitation
	Hydrologic Cycle	
transpiration	evaporation	surface runoff
infiltration	groundwater	water table
zone of aeration	zone of saturation	

2. Distribute *The Hydrologic Cycle*.

3. Have the students conduct research to label the steps within the cycle and the role each process or section plays in maintaining the cycle.

4. After discussing their diagrams to ensure accuracy, have the students write an explanatory paragraph that describes the hydrologic cycle using the terms above.

Answers to *The Hydrologic Cycle*



Floods 6–8

LESSON PLAN 1

The Hydrologic Cycle

The hydrologic cycle is the vertical and horizontal transport of water in all its states between the earth, the atmosphere and all bodies of water. There is a finite amount of water within the earth and the atmosphere. This water is in a liquid or frozen form in precipitation as snow or ice, rivers, streams, lakes, groundwater and seas. It becomes a gas as it evaporates from the waters on the earth or transpires through the leaves of plants on the earth. It condenses to form clouds and then falls to the earth again as precipitation. Water infiltrates the soil and becomes part of the groundwater or runoff and then begins the cycle once more.

Wrap-Up

Have the students use their illustrations to explain how the net amount of water in the hydrosphere, the region that contains all the moisture in the atmosphere and on the earth, remains the same at all times. Discuss—
(For all discussion questions, answers will vary, but might include ideas within parentheses below.)

- What would happen if one part of the hydrologic system stopped functioning? Explain for each part of the cycle. (If water no longer evaporated, then the groundwater would continue to rise; rivers would flood their banks; and oceans would rise above the shoreline. If there were no precipitation, the atmosphere would stay moist, but eventually the waters on the earth would evaporate and not be replenished. If ice did not melt, rivers and oceans would shrink; some rivers would dry up; new snow and ice would accumulate (not melt) throughout the years; and we could have another ice age.)

- What would happen if more water were suddenly added to the system? Could the hydrologic cycle keep the system stable? What would need to occur? (If more water were added to the system, there would be flooding and rising oceans unless the evaporation and transpiration part of the cycle also increased in efficiency, and the atmosphere could hold more water for a longer period of time.)

- What would happen if water suddenly disappeared from the system? What would be the long-term effect? (If water disappeared, there could be short- and then long-term drought—not enough precipitation and a lowered water table. Worldwide drought could cause a global food shortage, could devastate rain forests and eventually could eliminate living things on the earth.)

- What would happen if the polar ice caps melted? (Rivers, groundwater and oceans would rise, changing and erasing shorelines and landmasses.) If the ice caps melted, the amount of water in the system would not change, but the state of the water would change. Could the hydrologic cycle keep water levels stable? (Melting polar ice caps would mean a warmer earth which could mean greater evaporation. However, water vapor would still condense and fall to earth as rain, causing even higher water levels.)

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Floods
6–8

LESSON PLAN 1

The Hydrologic Cycle

- What would happen if we drain and contaminate more and more of our freshwater from lakes, rivers and groundwater? Or clear away greater amounts of vegetation? Would this affect the hydrologic cycle? Can people survive in a diminished or poisoned hydrologic system? (Since our water supply is finite, destroying our freshwater or fouling parts of the system would certainly affect how people live. Without vegetation, there would be no transpiration; greater runoff could cause flooding. The saturation of the ground from flooding could keep high levels of contaminated water from infiltration which would help filter some of the contamination. Further, the contaminants could also pollute the soil, killing more vegetation. Waters would be foul and unusable, but would continue to evaporate, condense, transport and spread contamination all over the world.)

Home Connection

Have the students take their diagrams home and use them to explain to family members why the water they drink at their dining room table is the same water dinosaurs drank from prehistoric rivers.

Linking Across the Curriculum

Geography: Mapping; Language Arts: Research and Writing

Have the students use scientific terms to tell the story of the hydrologic cycle based on maps of their own area. For example:

"Runoff transports down _____ River, a tributary of _____ , which flows into the _____."

"The _____ trees in the _____ mountains access the groundwater."

"Today, the _____ clouds transport moisture on the winds blowing to the _____."

"On this very sunny, windy day, there is a great deal of evaporation from Lake _____ ."

Language Arts: Writing

Have the students turn their Wrap-Up discussion of the hydrologic system into science fiction stories based on scientific, hydrologic facts. Critique the stories for scientific accuracy as well as creativity.

Science: Biology

Have the students conduct research online and in local media sources to design experiments that illustrate the transpiration process. Is transpiration necessary for plants to live? How does it affect the hydrologic cycle? What would happen if the students alter the conditions: greater winds, warmer air and more light? Does this affect the transpiration process? Would it affect the weather? Would it affect plant life? Explain.

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Floods
6–8

LESSON PLAN 1

The Hydrologic Cycle

Extension: Why might some scientists use the term "evapotranspiration" and combine two of the hydrologic processes?

Science: Meteorology

Challenge the students to use the hydrologic cycle to explain lake-effect snow. (Winds blowing from shore, evaporation from warmer surface waters, quick condensation into ice crystals in the cold air above, transport toward the opposite shore, ice crystals become too heavy and snowfall on shore.)

Science: Physical Science

Put students' knowledge of the water cycle to work. Set up student teams at computer stations to study the directions and play "The Water Cycle Game" at *http://response.restoration.noaa.gov/book_shelf/1064_Watercycle_instructions.pdf*.

Science: Physical Science

Tell the students that global warming is predicted to cause a significant rise in sea level over the course of the twenty-first century. Does that mean that there is a new source of water for the earth? Why or why not? Ask students to search the Internet and other media sources to discover the source of water that is lifting the sea level and what that may mean for coastal cities around the world. Challenge them to create a model, either individually or in teams, to demonstrate what is happening to lift the sea levels and then use their model to explain the rising sea level in a short presentation to the class.

Mathematics: Calculation; Science: Earth Science

Challenge students to follow the directions found at the Internet site entitled "Water Cycle," *http://www.msichicago.org/ed/env/envsample.html*, to build a model of the hydrologic cycle. With further research online, they can discover the approximate distribution of water on the planet among the oceans; surface and ground water; ice caps and glaciers; and the atmosphere. Ask them to consider their model of the hydrologic cycle. If they added 8 ounces (250 milliliters) more water in their model, what do they think is the mathematical distribution of the water in the model? How would that change if the model had included a small glacier and an ocean?

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Floods
6–8

LESSON PLAN 1
The Hydrologic Cycle

Materials

Types of Floods, 1 copy per student

American Red Cross

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"In Danger of Flood"

SET UP 10 minutes **CONDUCT** two or three 40-minute classes

Science: Earth Science; Social Studies: Geography, Community and History

1. Have students discuss why they think floods occur based on their work with *The Hydrologic Cycle*.

2. Distribute *Types of Floods* and ask the students to consider each picture and try to figure out the cause for each type of flood.
   Answers to *Types of Floods*
   Flash flood: Flooding that develops very quickly on streams and river tributaries usually as a result of thunderstorms. Sometimes the onset of flash flooding comes before the end of heavy rains. There is little time between the detection of flood conditions and the arrival of the flood crest. Swift action is essential to the protection of life and property.

   River flood: Flooding that usually occurs on rivers after a flash flood has occurred on streams and tributaries. River floods develop and reach their peak more slowly than flash floods. In many cases the river flood peak occurs after the rain has ended.

   Coastal flood: Flooding that usually occurs along an open coast, bay or inlet, and is caused by a storm surge and, in some instances, wave action caused by storms, wind or seismic forces.

   Urban flood: Flooding occurring in an urban area where there is little natural terrain, such as fields and woodlands, to absorb precipitation. Instead, the water runoff from paved surfaces increases two to six times more than what would normally occur. An urban flood can fill basements or other low-lying areas with water and transform streets into raging rivers.

   Ice jam: Sudden and uncontrolled flooding that occurs when the ice in a frozen river begins to break up, causing an ice jam in a narrow section of the river. When the jam finally breaks from the pressure of water backing up behind the ice, a huge and very rapid surge of water overflows the banks of the river.

   Debris flow: Flooding that is characterized by a mixture of sediment and water where the flow becomes slurry, similar to wet concrete. In steep canyons debris flows can achieve high velocities and transport large boulders.

3. Have the students share their hypotheses and determine a class list of essential factors for flooding. (Rainfall intensity, rainfall duration, urbanization that converts natural terrain into roads and parking lots, changes made to a river's flow or direction, unseasonable weather, storm surges, tsunamis, wildfire in the past five years.)

Floods
6–8

LESSON PLAN 1

The Hydrologic Cycle

Wrap-Up

As a class, create a profile of your community:

- Proximity to waterways, lakes and wetlands
- Distance to the seacoast
- Locations of dams and bridges
- Urbanization
- Low-lying areas
- High ground
- Potential for intense or prolonged rains (seasonal?)

Based on this profile, which type(s) of floods is the community most likely to experience? Explain.

Extension: Have the students understand the flood potential of your community through stream table exercises that model specific areas of the community. Based on topographic or physical maps or specific descriptions of the land, have the students create a simulation to test the potential for floods and flash floods caused by long-lasting or intense rainfall. Use this exercise to answer the question: Which type(s) of flood will most likely affect your community? Were student projections correct?

Home Connection

Ask the students to test their projections for community flooding. Have them interview older family members and friends about their memories of a past flood.

- What type of flood occurred?
- When did it occur?
- What effects did it have on the community?
- Did it affect them personally? Explain.

In class, have the students share their interviews. Was there a consensus of flood memories? Were some people more affected than others? Why?

Discuss the following topic: Has urbanization increased the potential for flooding in your community? In what ways has the community acted to decrease the potential?

Linking Across the Curriculum

Language Arts: Writing

Have the students turn flood interviews and research into day-by-day journal entries or letters to friends in other areas.

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Language Arts: Research and Media; Social Studies: History and Community

Have the students use local newspaper archives, public records or online resources to find out more about past floods in the area.

- Was their community prepared?
- Could the damage have been less?
- Were lives lost?

Considering past floods and the potential for future floods, have the students create a list of commendations for a job well done or action items for needed improvements.

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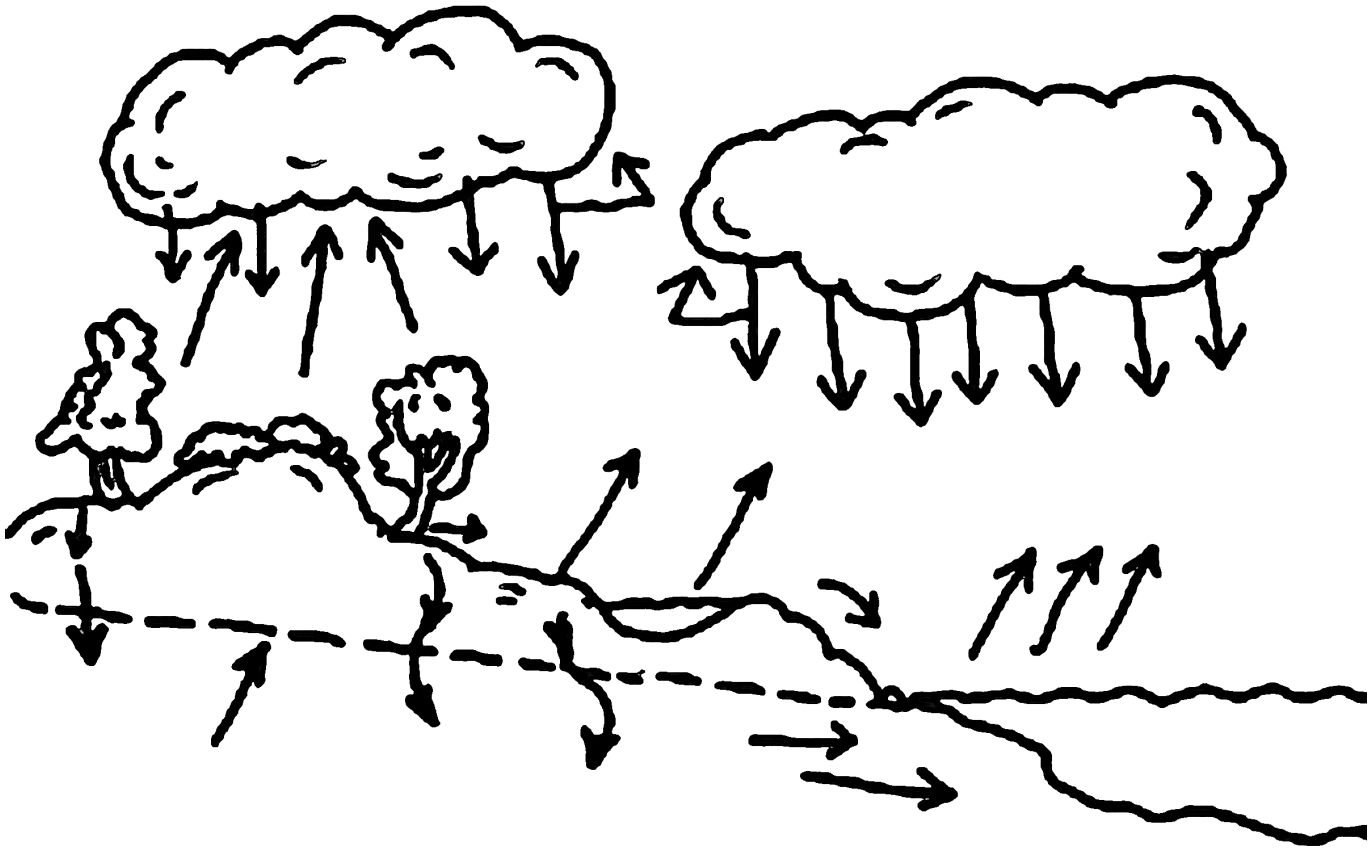
The Hydrologic Cycle

Name _____

Directions: The hydrologic cycle consists of the processes that change and move water through the earth's system. Use the terms below to label the hydrologic cycle.

precipitation
transpiration
transport
zone of aeration
evaporation
infiltration
groundwater
zone of saturation
condensation
surface runoff
water table



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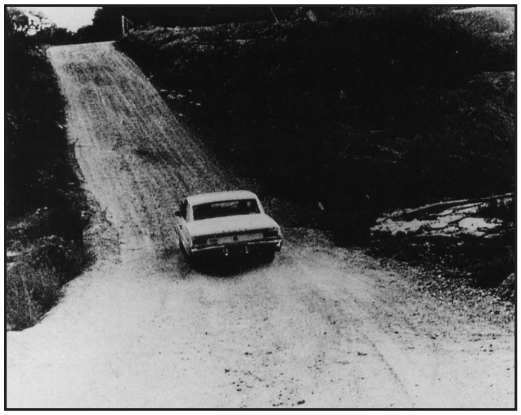
Types of Floods

Name _____

Directions: Consider each of the pictures below and hypothesize why this type of flooding occurs.



Flash Flood

_____
_____
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River Flood

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Coastal Flood

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Types of Floods

Urban Flood

Ice Jam

Debris Flow

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