Discover
Floods

illustrations by Peter Grosshauser

What Is a Flood?
Floods Around the World
High Water History
The Nature of Flooding
Managing Floods
Action Pack
When Floods Strike
Floods have always been part of nature and our world. They can happen just about anywhere there is too much water in one place, at one time. The opposite of a flood is drought—a period of water shortage when lack of precipitation produces dry conditions lasting as long as several years.

During a flood, water in a stream crests (reaches its highest peak), usually for a short time, and then recedes (goes down) at a slower rate. In the United States, the term flooding is also used whenever water rises above its normal boundaries and spills onto normally dry land. Most other countries have a separate word for this type of flooding, called inundation.

Floods can be destructive, but they can also do a lot of good. They can leave behind important nutrients in floodplains (flat areas of normally dry land that are alongside many rivers, streams and lakes) that make them ideal for growing crops. They also bring water to wetlands (land that is often flooded), which is needed for many species of animals and plants to live.

Types of Floods
Riverine floods
When rivers or streams overflow their banks, these are called riverine floods. They can be caused by heavy and prolonged rains or when snowmelt (water from melting snow) happens too quickly in the springtime. They generally last for several days to weeks.

Flash floods
During a flash flood, water rapidly rises, then falls within a few hours. In many cases, water quickly rushes down slopes, which can be dangerous.

Urban floods
Flooding can happen in cities, also called urban areas, where pavement and rooftops prevent rainfall from soaking into the ground. Storm drains are made to carry the storm water away, but they can’t always keep up.

Coastal floods
When ocean water rises above a normal high tide and floods occur on the coast, it is called a coastal flood. Sometimes wind storms, such as typhoons and hurricanes, push a large volume of water toward the coast, which is called a storm surge.

Watch Out Below!
Flooding in hilly or mountainous areas can cause landslides (masses of rock and water-soaked earth that break free and slide downhill) and mudflows (similar to landslides but made of thick mud and debris). The roots of grass, shrubs and trees on mountain slopes can help hold the soil together and soak up some of the water to prevent these from happening.
Floods around the World

What’s a Hydrograph?
The amount of water in a river changes seasonally and year to year. Water managers measure the river’s streamflow (amount of water passing through) at gaging stations (measuring stations) and make hydrographs (charts). A hydrograph records the streamflow at one spot over a period of time in cubic feet per second (cfs) or cubic meters per second (cms).

Look at the hydrograph and answer the following questions:
1. In which month does each river have the highest flow?
2. For each river, what month has the lowest flow?
3. Name the river that flows the highest and the lowest.
4. At its highest point, how many liters of water are flowing in the river with the highest flow?

See the Answer Key. That’s a lot of water!

What Size is Your Cube?
How big is a cubic foot or cubic meter? See for yourself.

How many gallons would fit into a cubic foot, or liters in a cubic meter?

It takes about seven and one-half gallon jugs (7.48 to be exact) to fill a cubic foot. It would take 1,000 liters of water to fill a cubic meter.

Mississippi at Vicksburg
(1931-1999)
Mississippi at Phnom Penh
(1960-1973)
Rhine at Lobith
(1901-2006)
Amazon at Obidos
(1968-1996)
Congo at Kinshasa
(1963-1983)

*Data is gathered at gaging stations along a river as stream height and calculated as (cfs) in the United States and (cms) in the rest of the world. This graph represents the average flow for each month for the life of the gaging station (the years in parenthesis). Rainfall and stream gaging stations help water managers forecast floods.

Mississippi River Basin, North America
The Mississippi River Basin begins as a small brook in northwestern Minnesota in the United States and empties into the Gulf of Mexico. Many things came together to produce the Great Flood of 1993: saturated soils from the previous year’s rainfall, high snowmelt and spring rains, several summer storms and heavy rainfall, in addition to many failed levees.

Rhine River Basin, Europe
Starting in the Alpine Mountains of Switzerland, the Rhine River winds its way through Germany, France and the Netherlands (Holland) to the North Sea. Although there are dikes (long banks built alongside rivers), flooding remains a challenge for all the countries that share the river basin.

Mekong River Basin, Asia
The Mekong River Basin’s diverse fish, critical to transportation, the aquatic food chain and nourish the flooded forests move into the tropical forests; nutrients from the flooded forests move into the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooded forests move into the tropical forests; nutrients from the flooding remains a challenge for all the countries that share the river basin.

The World
Central Africa’s “highway.” An amazing five to eight feet (1.5 to 2.5 meters) of rain fall each year in the Congo Basin. Flooding enriches the floodplain and tropical forests; nutrients from the flooded forests move into the aquatic food chain and nourish the Congo Basin’s diverse fish.

If I hear official warnings about flooding, I should take them seriously.

a. T (O) b. F (L)

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The reasons to live in an area with a history of flooding can often outweigh the risks. Rivers are a source of water for drinking, irrigation, fishing, power generation and recreation. Waterways (bodies of water that boats can use) make it easy for shipping goods to market and travel. Also, floodplains usually have rich soil, which is good for growing crops.

What's a 100-Year Flood?
By its name you might think that a 100-year flood is one that happens once every 100 years. Actually, it means that historic measurements show that the likelihood that a river will reach a certain flood level, in any given year, is just 1% (or 1 in 100).

Floods are labeled as 10-year, 100-year or 500-year floods. Think of these as big, bigger and biggest. The lower the number, the more likely it is that a flood of that size will happen. Flood hazard maps show how far flood waters spread during these floods and serve as a guide to where houses and roads should be located. Each flood is measured in feet or meters above msl (mean sea level). Sea level is zero msl.

**ACTIVITY**

One in Ten
Number spaces on a lined sheet of paper from one through 10, representing 10 years. Cut another sheet of paper into 10 pieces. Write the word “flood” on just one of them. Put the pieces in a container, mix them up and draw one out. Record whether you drew a “blank” or “flood” on the line for the first year. Return the paper back into the container and draw again. Repeat and record your results until you’ve completed all 10 years. You may have no floods for 10 years. Or you may have floods every year. Either way, your chance of a “flood” is exactly the same, every time: one in 10!
When floods happen in nature, land, trees and other plants help absorb extra water like a sponge. When the land is saturated (too full to absorb any more water), the water becomes runoff that flows to the lowest point. Wetlands (land covered with shallow water) act like nature’s reservoirs (storage areas for water). They retain water from the wet season for use during dry times.

When land is covered with asphalt and concrete, water is prevented from being absorbed into the soil. Storm drains may carry water away from urban areas, but all this extra water can sometimes add to problems downstream.

When flood waters recede, mud, debris (rubble or wreckage), polluted water and damaged homes are often left behind. Diseases can spread. Crops may be destroyed, leading to food shortages. However, most farmland (land on which crops are grown) in the long-term is enriched from the added nutrients that floods deposit.

See the Difference
The effects of a flood in a natural setting are different from an urban one. Some forests in the Amazon basin are flooded twice a year with 20 to 23 feet (6-7 m) of water! Big fish, pacu, swim in and feed on fruit that falls from the trees. Manatees graze in submerged grasses. Caiman wait under tropical trees for high, low or average water year on the Red River?

Fall  Winter  Spring
below avg. snow pack 0 above avg. snow pack 1  late spring snow melt 1
average snow pack 0 avg. spring snow melt 0 avg. spring temperature 0
below avg. snow pack 1 early spring snow melt -1 below avg. spring temp. -1
average snow pack 0 below avg. spring precip. 1 below avg. spring precip. -1

Flood Indicators
Hydrologists (people who study water) watch indicators (clues) that may predict floods and drought.

Flood Indicators, the Ganges River
The Ganges River, Ganga in most Indian languages, begins in a number of glaciers high in the Himalayas. After it leaves the highlands, most of its 1,560 mile (2,510 kilometers) journey is across the broad plain of India where it is joined by several large tributaries from Nepal until it empties into the Bay of Bengal south of Bangladesh.

When rivers flow through many countries, it is important that people upstream warn downstream dwellers of high rainfall and swollen rivers — indicators that a flood may be coming. Weather and water experts need to work together to prepare a flood forecast that is shared with downstream forecasting centers, water management institutions and emergency services. Forecasts can be quickly communicated through satellite-based systems to authorities who alert people at risk to move families, belongings and livestock to higher, safer ground.

It's important to know what your water address is, so you can be prepared for water emergencies.

a. T (A)  b. F (E)

Rushing water is stronger than I am.
a. T (A)  b. F (E)

One of the most destructive Red River floods in the last 100 years happened in 1997. All the indicators were right for a big flood. Imagine landing on the number one box from fall through spring—five high water indicators in a row!
Flood Management
People often choose to live in a floodplain because of the many advantages (e.g., fertile soil for farming, water for irrigating crops, transportation of goods on the river). To protect themselves and their property, there are many things that people can do to be safer living in flood-prone areas.

Monitoring Systems and Evacuation
Using technology, scientists can monitor rainfall amounts and water levels upstream to predict when and where floods may occur, so that people can be prepared. They can warn people to evacuate (temporarily move away from an area).

Oral Tradition
In areas of 100- or 500-year floods, community members may never have experienced one. Through oral tradition (telling stories which often become lessons passed down from generation to generation) people can be warned about flood-prone areas.

Migration
Every year, the people of Barotseland in Western Zambia travel from the Barotse floodplain to higher ground. After the floods recede, the people move back to take advantage of the rich soil deposits.

Human-made Barriers
A levee is a human-made barrier built to prevent a river from overflowing its banks or ocean water from inundating a coast.

Dams are barriers that hold water and control the amount of water that travels downstream. They can serve many purposes, including flood control, water storage for towns and cities, crop irrigation and power generation.

Secure Homes
Some people prevent flood damage to their homes by raising them on stilts so that flood waters pass beneath them or building on an elevated area.

Flood Insurance Programs
After a flood, insurance can help people, who have paid for policies, recover losses.

Early Warning Systems
Many communities have early warning systems. These may include: a siren, home telephone notification, local radio station messages, police broadcasting warnings via megaphone, visits by volunteer fire brigade.

Water Mark
To help a community recognize flood risk, standard signs or flooding marks remind residents of the water level of past floods.

Preserving Wetlands
Because wetlands such as marshes and swamps can act like nature’s sponges during times of flooding, they’re a natural way to reduce flooding.

Flood Hazard Map
This map indicates flood-prone areas within a community or region.

What is your water address?
Think about where you live. Answer the questions below and discuss them with your teacher or parents. If your water address indicates flood risk, be sure you are prepared. Turn the page to learn about flood preparedness.

- How far are you from a river, lake or ocean?
- Has it ever flooded where you live?
- Have there been changes to the topography where you live that might affect where water goes?
- How does weather affect you where you live?
- Do you experience monsoons or spring thaws?
- What seasonal changes affect the water around you?

Streamflow is measured in volume per unit of time.
- a. T (Y) b. F (B)
Wetlands are like sponges and can soak up extra water.

a. T (O)  b. F (A)

Action Pack

Flooding is a natural part of our world and one that we continue to learn to live with. Our ability to predict floods is improving as we increase our knowledge about their causes. And new technology is giving us better systems to warn people about possible flooding.

Still, flash floods can happen so quickly that sometimes people can’t be warned in time. That’s why it is important to be aware of the risk of flooding wherever you are, and to be prepared.

Action Pack

You should always include a can opener in your emergency supply kit.

a. T (O)  b. F (A)

FLOOD & FLOODING.indd   12
02/12/09   2:39:35 PM

FLOOD & FLOODING.indd   13
02/12/09   2:39:39 PM
In a 100-year floodplain, floods happen only once every 100 years.

a. T (M)  b. F (W)

Military personnel support government agencies and assist relief organizations.

Medical professionals tend to the injured and inoculate people against disease.

Contractors repair or rebuild buildings and roads destroyed by flooding.

When severe flooding happens, help comes flooding in, too, from many sources. It takes a lot of people with different skills working together to manage the situation and to help lessen the dangers.

Scientists forecast the severity of flooding in order to warn people. Local, state and federal government agencies in addition to elected leaders work together to coordinate emergency efforts.

Engineers look for ways to repair damage done to levees and dams.

Media outlets such as television and radio stations broadcast public service announcements about ways to stay safe.

Emergency response personnel respond to life-threatening situations.

Disaster relief workers bring safe drinking water and food to flood victims.

Utility company crews work to restore power, gas and water.

Citizens clean their homes to prevent mold.

What’s Your Strategy?
There are many strategies that people use to work together quickly and efficiently before, during and after a flood. Write down those strategies that helped your team to successfully move the container of water. For example, people working in groups need to communicate to express their needs and concerns. See if you can unscramble the syllables of the words below and discover seven strategies for working together. A capital letter indicates the beginning of a word. Compare your answers to those in the Answer Key.

Com ni mu tion ca

ten Lis ing

pro mise Com

a ti go Ne tion

work Team

er op a Co tion

spect Re

In a 100-year floodplain, floods happen only once every 100 years.

a. T (M)  b. F (W)

Activity
Moving as One
Work together the way people during a flood must do. Gather eight friends. Each one can represent a different profession (scientist, newscaster, government employee, etc.).

Riverine Flood
Group moves the can over string held two feet above the floor.

Coastal Flood
Group moves the can through string with paper strips.

Urban Flood
Group moves the can under string held three feet above floor.

Now, tie eight strings evenly around a rubber band that snugly encircles a can ¾-full of water. Try to lift the can together and move it around the challenges, representing different kinds of floods.

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The World Meteorological Organization (WMO) is a specialized agency of the United Nations. It is the UN system’s authoritative voice on the state and behavior of the Earth’s atmosphere, its interaction with the oceans, the climate it produces and the resulting distribution of water resources. The vision of (WMO) is to provide world leadership in expertise and international cooperation in weather, climate, hydrology and water resources and related environmental issues and thereby contribute to the safety and well-being of people throughout the world and to the economic benefit of all nations. www.wmo.int

The Associated Programme on Flood Management (APFM) is a joint initiative of the World Meteorological Organization (WMO) and the Global Water Partnership (GWP). The mission of the APFM is to support countries in the integrated management of floods within the overall framework of integrated water resources management. The programme has been financially supported by the Governments of Japan and Switzerland. www.apfm.info

The mission of Project WET is to reach children, parents, educators and communities of the world with water education. Project WET’s Kids in Discovery series (KIDs) is designed to help kids discover the scientific, natural, cultural and historical wonders of their world. www.projectwet.org

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**Discover Floods Brought to You By:**

**Strategy**

**Action**

- Monitoring System
  - Measuring stick for water level
- Oral Tradition
  - Storyteller/elder
- Migration
  - Canoe with rowers
- Human-made barrier
  - Levee (wall lining river bank)
- Human-made barrier
  - Dam
- Secure Home
  - House on stilts
- Flood hazard map
  - Person viewing map
- Early warning system
  - Tower with siren
- Water mark
  - Measuring stick with flood notice
- Preserving wetlands
  - Wetland with ducks and cattails

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**Page 2**

A. circle the city
B. circle any area on the coast
C. circle a steep area on the mountain with houses

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**Page 4**

<table>
<thead>
<tr>
<th>Month of Highest Flow</th>
<th>Month of Lowest Flow</th>
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<td>September</td>
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<td>January</td>
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<td>October</td>
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<tr>
<td>Amazon: June</td>
<td>November</td>
</tr>
<tr>
<td>Congo: December</td>
<td>August</td>
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#4 240,000 cubic meters X 1,000 liters = 240,000,000 liters of water (Amazon)

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**Page 5**

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<thead>
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<th>A. Mississippi River Basin</th>
<th>B. Amazon River Basin</th>
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<tr>
<td>C. Mekong River Basin</td>
<td>D. Congo River Basin</td>
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<tr>
<td>E. Rhine River Basin</td>
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</tbody>
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**Page 7**

#1 Month of Highest Flow
1. Mississippi: April
2. Mekong: September
3. Rhine: January
4. Amazon: June
5. Congo: December

#2 Month of Lowest Flow
1. Mississippi: September
2. Mekong: January
3. Rhine: October
4. Amazon: November
5. Congo: August

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**Page 11**

<table>
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<th>Answer Key</th>
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**Page 15**

<table>
<thead>
<tr>
<th>Syllable Search Answers:</th>
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</thead>
<tbody>
<tr>
<td>Communication, Listening</td>
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<tr>
<td>Compromise, Negotiation</td>
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<tr>
<td>Teamwork, Cooperation, Respect</td>
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If readers answer each question correctly, they will spell: Flood Ready Now!