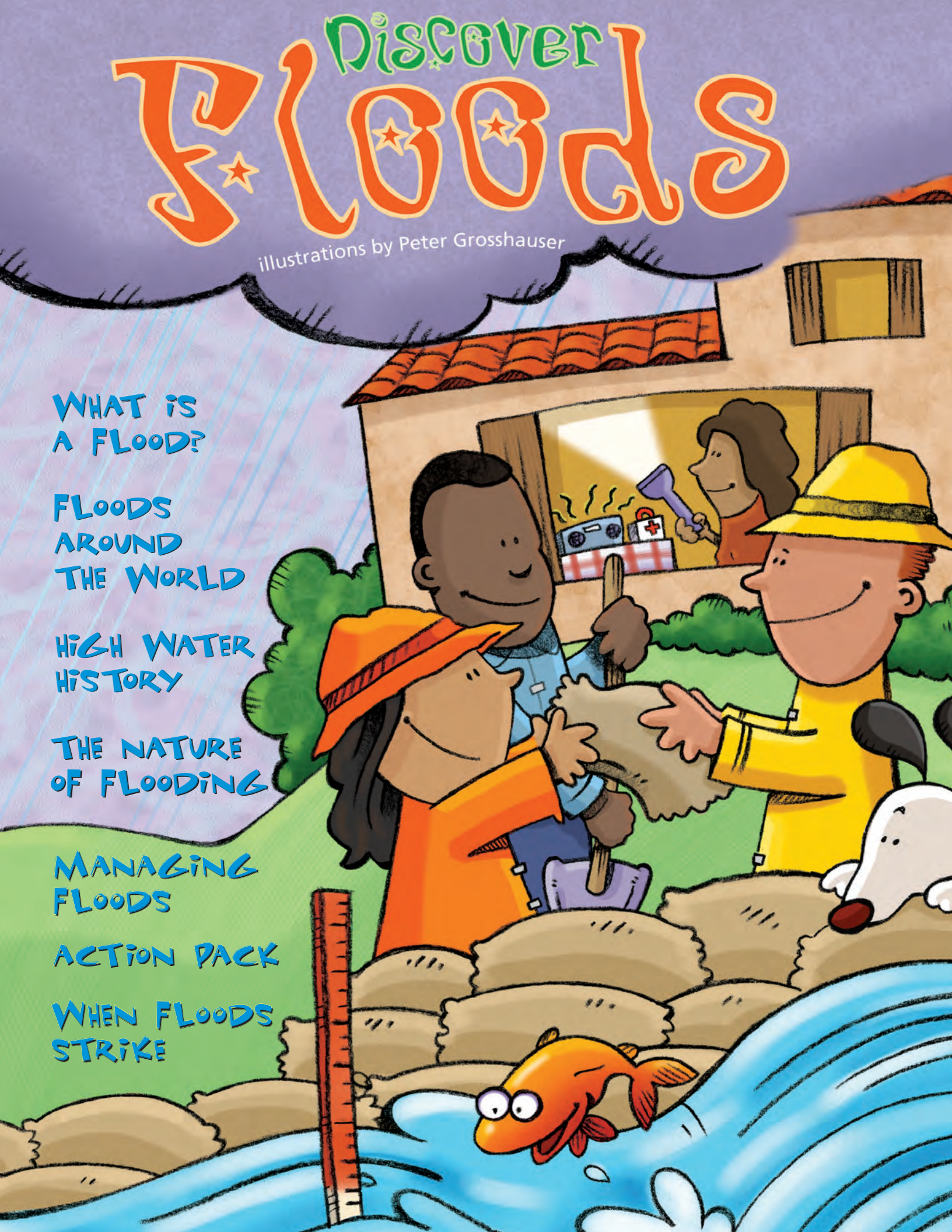
Discover Floods

illustrations by Peter Grosshauser



What is a Flood?

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.

Where in the Watershed?
Study the photos below for clues where these flooding events occurred in the **watershed** (all of the land area draining into a particular river or body of water). Circle the area and check your answers in the Key.

In each corner box, see a question that you will be able to answer once you complete this booklet. Based on whether you select true (T) or false (F), pick the letter associated with it. If you answer each question correctly, a life-saving message will emerge.

istockphoto/toemick

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FEMA/John Shea

When I see a flooded street, I should stay away from it.
a. T (pick letter F) b. F (pick letter Q)

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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.

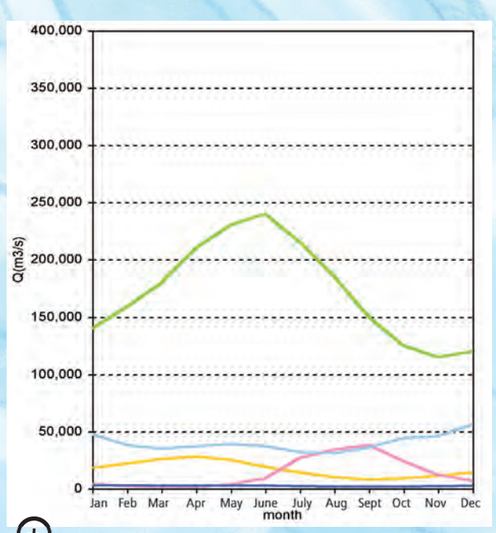
Coastal floods
When ocean water rises above a normal high tide and floods occur on the coast, it is called a **coastal flood**. Sometimes wind storms, such as typhoons and hurricanes, push a large volume of water toward the coast, which is called a **storm surge**.

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.

To be prepared, my family should have an emergency plan.
a. T (L) b. F (T)

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**).



- Mississippi at Vicksburg (1931-1999)
- Mekong at Phnom Penh (1960-1973)
- Rhine at Lobith (1901-2006)
- Amazon at Obidos (1968-1996)
- Congo at Kinshasa (1903-1983)

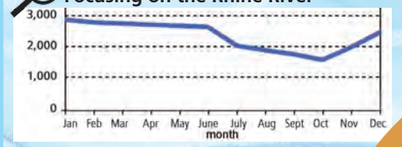
*Data is gathered at gaging stations along a river as stream height and calculated as (cfs) in the United States and (cms) in the rest of the world. This graph represents the average flow for each month for the life of the gaging station (the years in parenthesis). Rainfall and stream gaging stations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

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 shows the largest difference between high and low flow.
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!

Focusing on the Rhine River

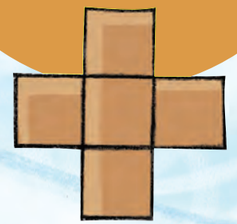


How many gallons would fit into a cubic foot, or liters in a cubic meter?

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.

What Size is Your Cube?

How big is a cubic foot or cubic meter? See for yourself. Draw one-foot by one-foot or one-meter by one-meter square in the middle of a large piece of cardboard. Then, on each of the four sides, draw the same size squares. Now, carefully cut out the five squares in the shape of a cross. Fold the ends up and tape them together. There's your cubic foot or meter.



Two feet of moving water is enough to float a car or truck and take it away.
a. T (O) b. F (F)

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.

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.

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.

The Mekong River Basin, Asia
Flooding occurs in this basin so regularly that the people have adapted by sometimes moving to higher ground during the flood season. Though damage can be costly in cities, floods provide water for crops and leave behind **sediment** (tiny pieces of rock and other material carried by water) that makes the soil fertile for raising crops.

The Mississippi River Basin, North America
The Mississippi River starts as a small brook in northwestern Minnesota in the United States

The Amazon River Basin, South America
Originating high in the Andes Mountains and flowing into the Atlantic Ocean, it contains 20% of the world's fresh water. Each year during the rainy season, the Amazon River rises over 30 feet (nine meters) and inundates bordering forests, which enriches the soil and allows freshwater fish to feed on fruits fallen from the trees.

The Congo River Basin, Africa
Critical to transportation, the Congo River has been named Central Africa's "highway." An

ACTIVITY
Draw a line from the name of the river basin to its location on the map.

If I hear official warnings about flooding, I should take them seriously.
a. T (O) b. F (L)

HIGH WATER HISTORY

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.

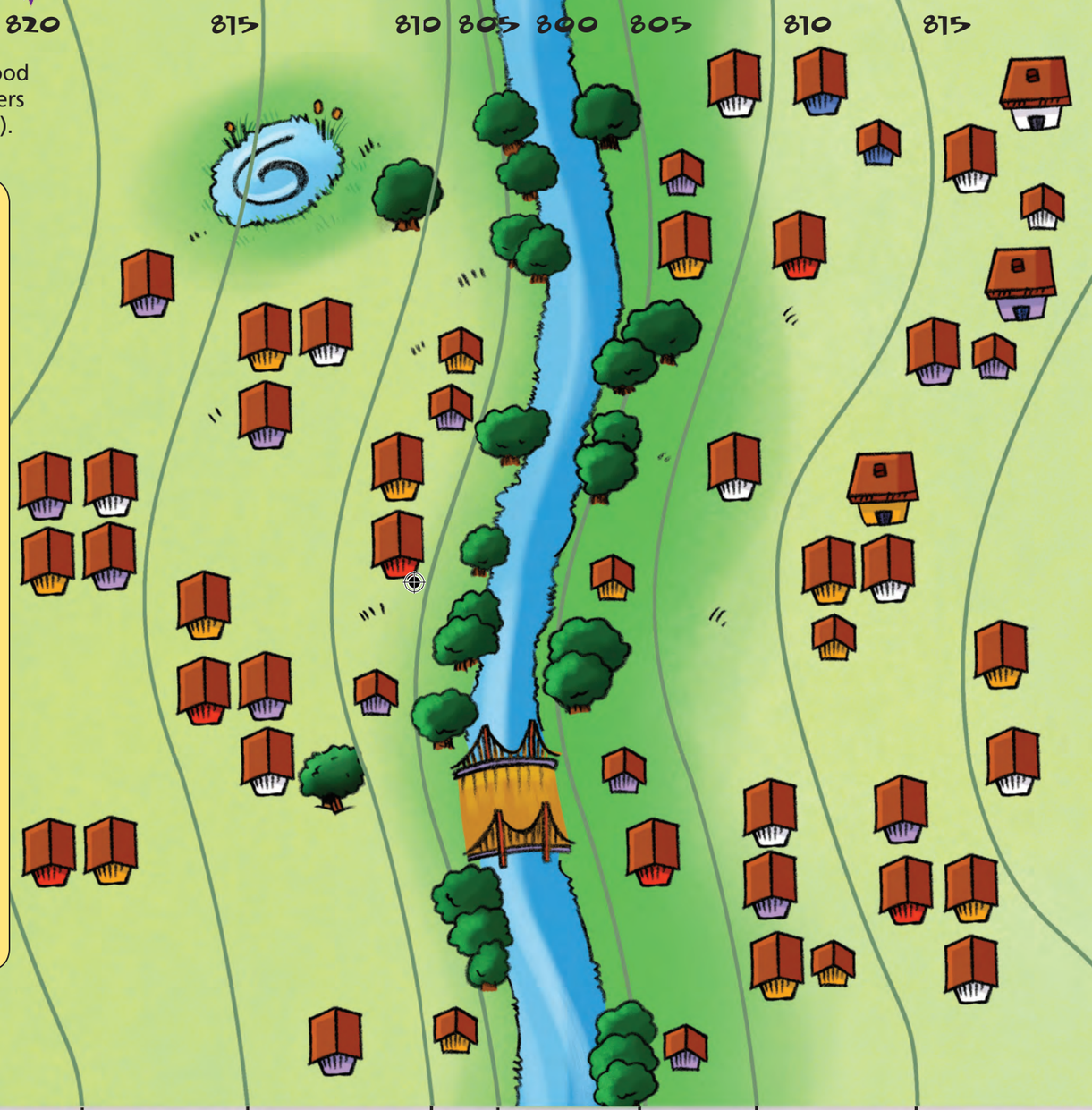
What's a 100-Year Flood?
By its name you might think that a 100-year flood is one that happens once every 100 years. Actually, it means that historic measurements show that the likelihood that a river will reach a certain flood level, in any given year, is just 1% (or 1 in 100).

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!



DATA FOR A HYPOTHETICAL RIVER

Average winter flow 800 ft msl (mean sea level) (non-flood level)

Bank full	805 ft msl
Minor flooding (water slightly over river banks)	806 ft msl
10-year flood	810 ft msl
100-year flood	815 ft msl
500-year flood	820 ft msl

One way to determine the **extent** (area flooded) of a 10-, 100-, or 500-year flood is to locate the elevation shown on maps as contour lines, located on both sides of the river. Let's say we want to determine how many buildings will be flooded at the hypothetical site during a 10-year flood. First find the contour lines of a 10-year flood (810 feet msl) on both sides of the river. Carefully shade in all the land between those two lines in red.

Everything shaded is impacted by flood waters. Use different colors to shade flooded areas during 100- and 500-year floods. Record the number of buildings flooded.

Number of Buildings

10-Year _____

100-Year _____

500-Year _____

Little streams and rivers can become deep and dangerous quickly in a flash flood.
a. T (D) b. F (S)

A flood is always a bad thing.
a. T (O) b. F (R)

THE NATURE OF FLOODING

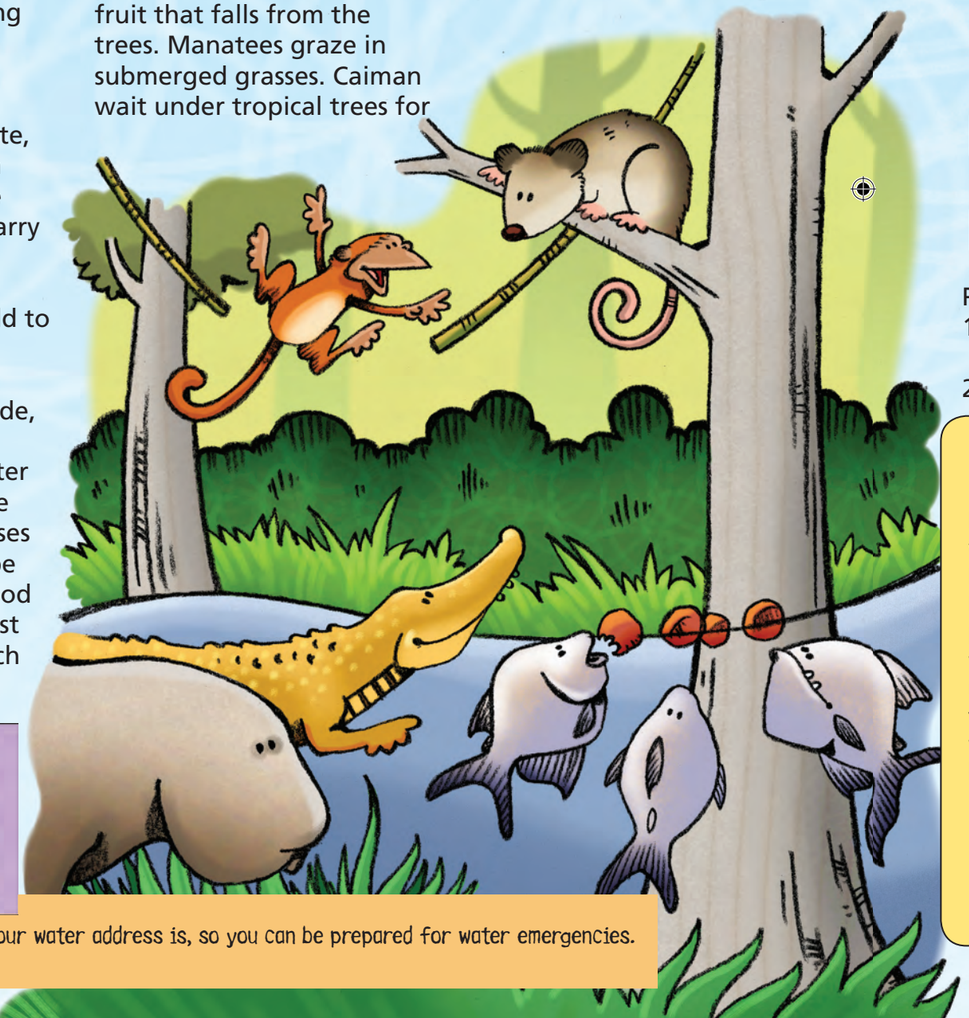
When floods happen in nature, land, trees and other plants help absorb extra water like a sponge. When the land is **saturated** (too full to absorb any more water), the water becomes runoff that flows to the lowest point. Wetlands (land covered with shallow water) act like nature's **reservoirs** (storage 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.

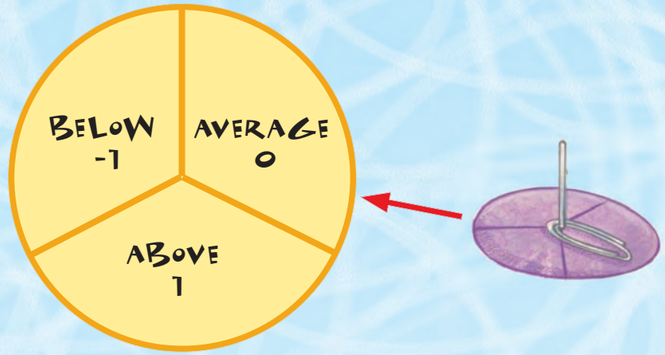
When flood waters recede, mud, **debris** (rubble or wreckage), polluted water and damaged homes are often left behind. Diseases can spread. Crops may be destroyed, leading to food shortages. However, most **farmland** (land on which crops are grown) in the long-term is enriched from the added nutrients 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 an opossum to slip and fall while red howler monkeys play in the canopy. The flood waters add nutrients to the forest and the forest provides nutrients to the river.

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



It's important to know what your water address is, so you can be prepared for water emergencies.
a. T (E) b. F (A)



FALL	WINTER	SPRING	SPRING	SPRING
above avg. fall precip. 1	above avg. snow pack 1	late spring snow melt 1	high spring temperature 1	above avg. spring precip. 1
average fall precip. 0	average snow pack 0	avg. spring snow melt 0	avg. spring temperature 0	average spring precip. 0
below avg. fall precip. -1	below avg. snow pack -1	early spring snow melt -1	below avg. spring temp. -1	below avg. spring precip. -1

Player
1 _____ _____ _____ _____ _____

2 _____ _____ _____ _____ _____

ACTIVITY

The Indicator Game

Rivers have different indicators. The Red River of the North watershed is shared between Canada and the United States. Discover indicators of high and low water flows in the Red River. First, make a spinner by straightening part of a paperclip and pushing it through the center of the circle from behind. Place another paperclip over that "post" and use it as the arrow. Record your number and season for each turn. Each player takes turns spinning and moves through fall, winter and spring. Based on your indicators, will it be a high, low or average water year on the Red River?

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 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.

The Ganges floods every year; these events are usually considered beneficial unless they are unusually long-lasting or widespread. Flood indicators include both heavy monsoon rains (June-September) in the Himalayan foothills and the plains that generate high river discharges and high tides.

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.

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

Managing Floods

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.

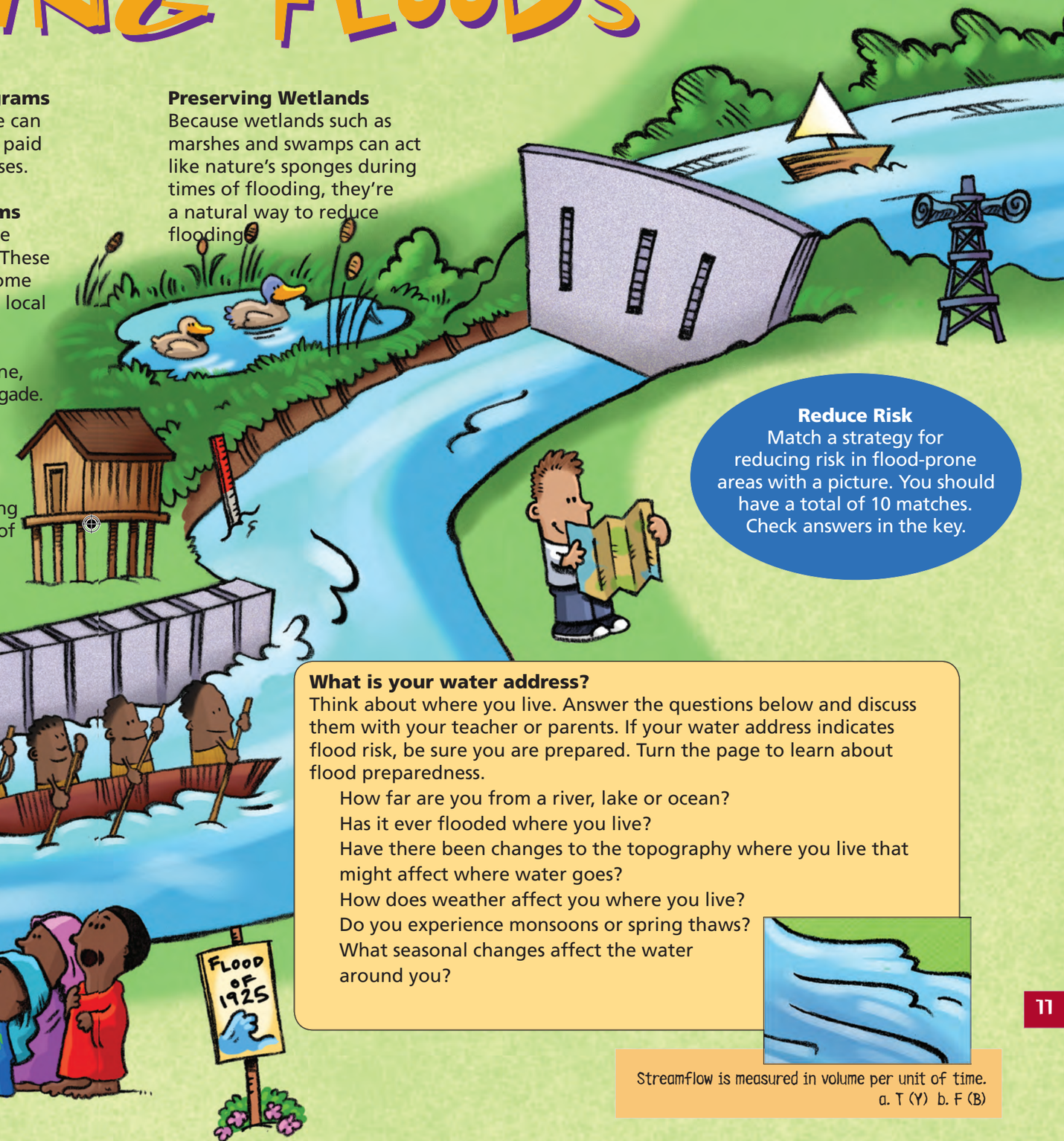
Flood Hazard Map
This map indicates flood-prone areas within a community or region.

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.



Reduce Risk
Match a strategy for reducing risk in flood-prone areas with a picture. You should have a total of 10 matches. Check answers in the key.

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?

Rivers around the world flood at the same time of year.
a. T (S) b. F (D)

Streamflow is measured in volume per unit of time.
a. T (Y) b. F (B)

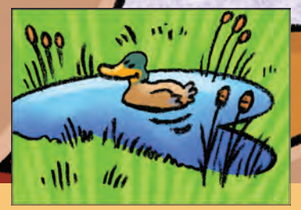
ACTION PACK

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.

WHAT YOU CAN DO

- ✔ Prepare a supply kit.
- ✔ Put special treasures and memorabilia in a waterproof container.
- ✔ Have a family disaster plan. Know where to go and where your family will meet.
- ✔ Know the safest route to higher ground.
- ✔ Have your pets and your personal items ready, so if you are told to evacuate, you can go immediately.
- ✔ Listen to warnings on the radio and TV. Follow instructions.
- ✔ Make those around you aware of a possible flood event.
- ✔ If you are on vacation, be aware of your surroundings.
- ✔ Pay attention to the weather and think about what it might mean for you and your activities.
- ✔ Stay away from rushing water, storm drains and rising rivers.
- ✔ Stay out of flood water. Never drive through flood water in a vehicle.
- ✔ Understand weather patterns in your area.



Wetlands are like sponges and can soak up extra water.
a. T (N) b. F (S)

PACK YOUR SUPPLY KIT

Circle what you might need just in case a flood happens to you.
Jugs/bottles of water
drinking water may be polluted
Flashlight
power may be out
Battery-powered or hand-crank radio to hear warnings and updates
Batteries
to power the radio and flashlight
First aid kit
for minor scratches/injuries
Rain gear
to keep you dry in a storm
Canned food
fresh food may be contaminated by flood waters
Can opener
to open canned food
Emergency cooking supplies
sources of power with which to cook may be unavailable
Pet food, water
they need basic essentials, too
Medicine
anything you need to stay healthy
Emergency phone numbers
you may need to call for help if you are separated from your family

You should always include a can opener in your emergency supply kit.
a. T (O) b. F (A)

Working Together When Floods Strike

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.

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.

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.).

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.

START

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.

FINISH

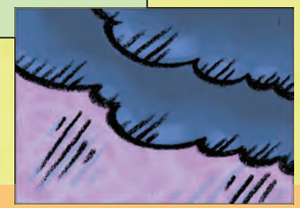
Urban Flood
Group moves the can under string held three feet above floor.

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)



Monsoons are seasonal winds that bring rain.
a. T (!) b. F (+)

ANSWER KEY

PAGE 2

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

PAGE 4

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

#3 Amazon

#4 240,000 cubic meters X 1,000 liters = 240,000,000 liters of water (Amazon)

PAGE 5

A. Mississippi River Basin
B. Amazon River Basin
C. Mekong River Basin
D. Congo River Basin
E. Rhine River Basin

PAGE 7

Number of Buildings Flooded
10-year = 13
100-year = 29
500-year = 50

PAGE 11

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

PAGE 15

Syllable Search Answers:
Communication, Listening
Compromise, Negotiation
Teamwork, Cooperation, Respect

If readers answer each question correctly, they will spell: *Flood Ready Now!*

DISCOVER FLOODS BROUGHT TO YOU BY :

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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