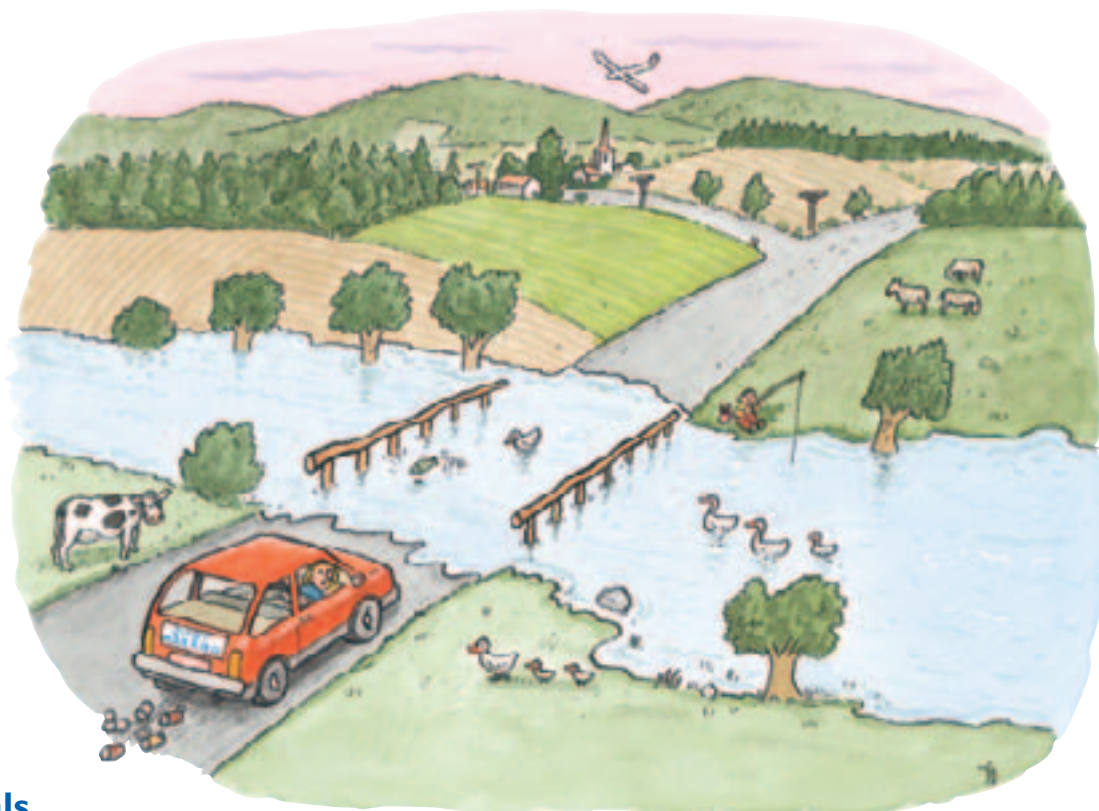


Activity 4

Severe Weather Hazards: Flash Floods



Goals

In this activity you will:

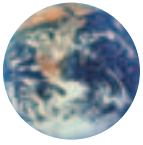
- Determine the flow of surface water using a topographic map.
- Examine factors that allow thunderstorms to persist for long periods of time.
- Explain the connection between topography and flash flooding.
- Realize the relationship between population growth and the likelihood of fatalities due to a flash flood.
- Read accounts of flash-flood disasters.
- Understand that wise land-use planning can reduce the danger from flash floods.

Think about It

Under certain conditions, thunderstorms can produce flash floods.

- What is the difference between a flood and a flash flood?
- How do flash floods impact communities?

What do you think? Record your ideas about these questions in your *EarthComm* notebook. Be prepared to discuss your responses with your small group and the class.



Investigate



Scale 1:100,000. One centimeter represents one kilometer on the ground. Contour interval is 10 m.

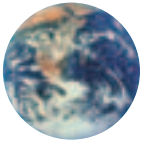
1. Look at the topographic map showing the course of the Sac River, which flows past the city of Comet, Missouri.
 - a) Place a clear plastic transparency sheet over the map or obtain a copy of the map. Make a dot anywhere on the map with a transparency marker. The dot represents a raindrop.
 - b) Draw a line from the dot that shows how the raindrop would flow downhill after reaching the ground. In other words, with your marker, take the raindrop to contour lines of successively lower elevation. Be sure to keep the line always perpendicular to the local contours, because water flows directly downhill. If the path leads to a gully or stream, follow the gully or stream downhill until it empties into a larger river. Would the raindrop end up in the Sac River?
 - c) Now look at the map again. Mark another dot on the map. This time try to pick a spot where you think the drop would flow into the Sac River. Draw a line from the spot showing the path the raindrop would take to the river. Again, make sure the path moves from higher to lower contour lines and is always perpendicular to contour lines.
 - d) Using a continuous dashed line, draw the boundaries of the entire area in which all raindrops will flow into the Sac River. When you've finished, check your work by marking several raindrop dots in different parts of the area and checking that they would really flow into the river.
2. Assume that intense rains caused the Sac River to rise above its normal level.
 - a) What if the Sac River rose 10 m above its normal level? Mark the area that would flood using a green transparency pen.
 - b) What if the river rose 20 m? Mark the area with a blue pen.
 - c) What if the river rose 30 m? Mark that area with a red pen.
 - d) Under what circumstances might a thunderstorm that doesn't actually pass over Comet cause flash flooding in downtown Comet?

3. Imagine that the entire area you enclosed with a dashed line is undeveloped land that is covered with deep soil and vegetation. Now imagine that the entire area is developed and covered with asphalt and cement.
 - a) Why would it make a difference whether the land was covered with vegetated soil or with pavement?
 - b) In each of the two cases, describe what would happen if several inches of rain fell in the area in a couple of hours. What effect would the storm have on the river in each case?
4. Use your map and transparency as a guide.
 - a) What damage would a flood cause if the Sac River rose 10 m? 20 m? 30 m?
5. Look at a topographic map of your community.
 - a) Determine and record the interval (in feet) between successive contour lines.
 - b) Locate the major rivers and streams that flow through your community. Pick one river or stream to study (if there are many choices, each group can pick a different one). Lay a transparency sheet on top of the map. Draw the drainage basin of your stream.
 - c) What areas of the drainage basin are particularly at risk for flooding?
 - d) How might flooding affect the public water supply, operations of the sewage treatment plant, automobile and public transportation, crops in the fields, homes, buildings, and industry?
 - e) Assume that an intense thunderstorm stalls over the drainage basin and produces persistent rains that cause the water level to rise some 10 ft. above its normal level. By tracing the appropriate contour line, outline the region of your community that would be flooded. Do the same for a 20-foot flood of water.
 - f) Would you describe your community as mostly urban or rural? How does this affect the potential for flash flooding in your community?
 - g) Describe the topographic features that make your community more or less vulnerable to flash flooding.
 - h) Find out if there are any flood-control structures (such as dams or levees) in your community.

Reflecting on the Activity and the Challenge

In this activity you learned how to interpret a topographic map to determine how a flash flood might affect a community. You also examined a topographic map of your area and

analyzed the flood dangers in your community. Your knowledge can be applied to help planners locate a safe place for a new concert arena.



Geo Words

flash flood: a sudden rise in the water level of a stream, a river, or a man-made drainage channel in response to extremely heavy rains.

drainage basin (also watershed): the land area from which rainfall collects to reach a given point along some particular river.

Figure 1 Rapidly rising waters during a flash flood submerged this car.



Digging Deeper

FLASH FLOODS

Thunderstorms can produce torrential rains. Usually the rain does not last very long and causes no serious problems. Sometimes heavy rains can last for hours. This can lead to flash flooding. A **flash flood** is a sudden rise in the water level of a stream, a river, or a man-made drainage channel in response to extremely heavy rains. Flash floods can also occur when a brief but heavy rain falls over the entire area of a very small watershed. In some places, water might overflow stream banks and collect in low-lying areas.

The life cycle of a thunderstorm cell is typically less than an hour. How could torrential thunderstorm rains last for many hours? Flooding usually results from more than one thunderstorm cell. Flooding thunderstorms are most likely in mountainous terrain where a persistent flow of humid air up a mountain slope can cause thunderstorm cells to develop and redevelop over and over. Outside of the mountains, another possible cause of flooding rains is a succession (or “train”) of slow-moving thunderstorm cells that mature over essentially the same geographical area. Thunderstorms move slowly when the steering winds in the middle and upper part of the troposphere are relatively weak.

The dotted line you drew on your map outlined the boundaries of the area where water from raindrops would drain downhill into the Sac River. A river plus all of its tributaries drain a fixed geographical area, and that area is the **drainage basin**, also called a **watershed**. Heavy rain falling on the upstream part of a drainage basin might cause flooding downstream in areas that received no rain. In other words, just because it is not raining where you are does not necessarily mean there is no flood danger.

Flash floods may be more likely in an urban area than in the surrounding countryside. The reason for this is that rain in the country can seep into the soil. In the city, rain cannot seep into asphalt or concrete parking lots, roads, and driveways. Frozen soil is also impervious to water. Instead, the water runs off these surfaces into nearby streams or other drainage ways. Storm sewers also channel water from roads into streams. Streams receiving so much water at one time can overflow their banks quickly. Also, storm sewers sometimes clog or cannot handle excessive volumes of water and back up into the streets.

The flash-flood hazard is particularly serious in mountainous terrain where river valleys are narrow and deep. Stream levels can rise very quickly because there are no broad areas next to the stream channel where the water can spread out. If the river valley also contains roads, campgrounds, or houses, a flood can be very destructive.

When a river overflows its banks in a non-mountainous area, excess water spreads over a broad flat area adjacent to the river known as a **floodplain**. Floodwaters are usually shallower than they are in mountain valleys where floodplains are very narrow or nonexistent. Also, in non-mountainous areas, roads and buildings usually are not located as close to the river as they might be in the mountains.

The Big Thompson Canyon Flood

On July 31, 1976, a flash flood in the Big Thompson Canyon in Colorado claimed 139 lives (many of them campers) and caused \$35.5 million in property damage. A combination of atmospheric conditions and topography contributed to the tragedy.

The Big Thompson Canyon is located in the Front Range of the Colorado Rockies about 80 km (50 mi.) northwest of Denver. During the late afternoon and evening of July 31, a persistent east-to-west flow of humid air up the mountain slopes triggered development of thunderstorm cells and heavy rainfall. Thunderstorm cells stayed in the same area because the steering winds in the upper atmosphere were weak. Runoff from the rainfall cascaded down the steep mountain slopes and into the river that winds along the narrow canyon floor. The river level rose abruptly and soon overflowed its banks as a flash flood.



Figure 2 In urban areas pavement prevents rain from filtering into the soil, making cities more susceptible to the dangers of flash floods.

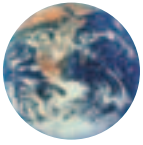
Geo Words

floodplain: any flat or nearly flat lowland that borders a river and which is covered by water when the river rises above flood stage.



Figure 3 Heavy rainfall and swiftly flowing waters filled the Big Thompson Canyon, causing extensive damage to homes and property.





The National Weather Service estimated that the upstream part of the drainage basin received 25 to 30 cm (10 to 12 in.) of rain, with perhaps 20 cm (8 in.) falling in only two hours! At one location along the river, the volume of flowing water was more than 200 times the river's normal discharge. A wall of water almost 6 m (20 ft.) high destroyed 418 houses and washed away 197 motor vehicles.

In the Big Thompson Canyon, the main road runs along the river. Many people tried desperately to escape the canyon in their cars; most of them were washed away and killed by floodwaters. These people could have survived if they had left their cars and climbed up the canyon slopes, out of reach of the water.

Fort Collins Flood

Some 21 years later, on July 28, 1997, Colorado residents were reminded of the Big Thompson Canyon tragedy when a thunderstorm system poured record rainfall on Fort Collins, Colorado. Between 5:30 and 11:00 p.m. up to 25 cm (10 in.) of rain fell on the southwest side of Fort Collins. A flash flood claimed the lives of five people along the swollen Spring Creek, just downstream from the heaviest rainfall. Floodwaters also damaged buildings, including many on the Colorado State University campus. Floodplain management, particularly along Spring Creek, likely prevented a greater loss of life and residential property damage. Management strategies enacted long before the flood included relocating buildings away from the river and constructing holding ponds near the riverbanks that could capture excess water if the river overflowed its banks.



Figure 4 Recovery efforts immediately following the Fort Collins flood.

Fort Collins is located just east of the Rocky Mountain Front Range. The atmospheric conditions that led to the Fort Collins flood were similar to those responsible for the Big Thompson Canyon flood. Unusually humid air was flowing westward over eastern Colorado toward the mountains and winds in the middle to upper troposphere were weak. Persistent upslope winds combined with weak steering winds set the stage for slow-moving thunderstorm cells that developed and redeveloped over the Front Range.

Safety Tips for Floods

Flash floods can strike any time and any place with little or no warning. In mountainous or flat terrain, distant rain may be channeled into gullies and ravines, turning a quiet streamside campsite or wash into a rampaging torrent in minutes. City streets can become rivers in seconds. Observe these flash-flood safety rules. They could save your life.

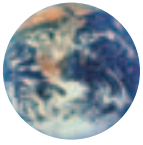
- Keep alert for signs of heavy rain (thunder and lightning), both where you are and upstream. Watch for rising water levels.
- Know where high ground is and get there quickly if you see or hear rapidly rising water.
- Don't pitch your tent in a dry streambed.
- Be especially cautious at night; the danger is harder to recognize then.
- Do not attempt to cross flowing water that may be more than knee deep. If you have doubts, do not cross.
- Do not try to drive through flooded areas.
- If your vehicle stalls, abandon it and seek higher ground immediately.
- During threatening weather, listen to commercial radio or TV, or NOAA Weather Radio for weather watch and warning bulletins.

Check Your Understanding

1. What is a flash flood?
2. Why is it dangerous to camp in a mountain valley?
3. Why are urban areas particularly vulnerable to flash flooding?
4. Why is it dangerous to drive a motor vehicle through flooded streets?
5. List five safety tips for floods that would be applicable in your community.

Understanding and Applying What You Have Learned

1. What might cause hours of thunderstorm rains along a mountain slope?
2. What might cause a prolonged period of heavy thunderstorm rains over relatively flat terrain?
3. How does knowing the drainage basin of a river help you assess the flash-flood potential of the area?
4. How is weather radar useful in determining the potential for flash flooding from thunderstorms?



Preparing for the Chapter Challenge

Use your interpretation of local topography to write a report about the potential for flash flooding in your community. You will use this report in your **Chapter Challenge**. Some of the questions below might help you prepare a report to ensure the safety of concert-goers at the proposed arena:

- Which parts of the community are particularly at risk for flooding?
- How often does this hazard affect your community?
- What weather conditions might indicate that a flash flood is possible?

- How can community members stay informed?
- What can the community as a whole do to prepare for flash floods and lessen their negative impact?
- What should citizens do if the National Weather Service issues a flash-flood watch or warning for the community?
- What can individuals do to protect themselves during a flash flood?

Inquiring Further

1. Flash flooding in your community

Do some research on a flash flood that affected your community or another community in your state. Find out how weather, topography, and other factors contributed to the flood. Use the *EarthComm* web site to help you with your research.

- a) Was the community prepared for the flood? Why or why not?
- b) How did weather contribute to flooding?
- c) How much higher than usual was the stream?
- d) During the flood, was the stream water a different color than usual?

- e) Describe any evidence of flooding after the floodwaters returned to their banks.
- f) Was there any injuries, loss of life, or major property damage?

2. City planning and severe weather

Conduct research in your community about the way that the city has been designed to handle the runoff from rain or snowmelt.

3. Investigate current flash-flood events

Visit the *EarthComm* web site to learn more about current flash-flood warnings in the United States.