

## CHAPTER 6

# STREAMS AND FLOODING

### Important Concepts

1. The *hydrosphere* includes all the water at and near the earth's surface. This water moves through the hydrologic cycle, whose main processes involve evaporation into and precipitation out of the atmosphere.
2. A *stream* is any body of flowing water confined within a channel. A stream's size is influenced by the area of its *drainage basin*, the climate, the amount of vegetation, and the underlying geology. The term *discharge* describes a stream's size and is defined as the volume of water flowing past a given point in a specified length of time.
3. A stream's *load* is the total quantity of material that the stream transports and consists of the bed load (material moved along the stream bed), the suspended load (fine material carried in suspension), and the dissolved load (dissolved material). The term *capacity* refers to the total load that a given stream can carry.
4. The steepness of a stream channel is called its *gradient*. Typically the gradient is steepest near a stream's source and tends to decrease downstream.
5. *Base level* is the lowest elevation to which a stream can erode downward. A sketch of a stream's elevation from source to mouth is called its longitudinal profile, which typically assumes a concave-upward shape.
6. Stream-transported sediments are usually well sorted by size or density and tend to become finer downstream through abrasion during transport.
7. The sinuous bends or curves in a stream channel are called *meanders*. The erosion along the outside curves of meanders, with accompanying deposition along inside curves, results in a slow downstream migration of the meanders. As the meanders enlarge and migrate, they eventually form a *floodplain* that borders the stream channel.
8. *Floods* occur when streams overflow their banks. The severity of a flood is influenced by the quantity of water involved and the rate at which it enters the stream. These factors are, in turn, influenced by climate, soil type, topography, and vegetation. Upstream floods are those that affect localized sections of a stream system; they are caused by intense rainstorms and events like dam failures. They are typically short-term events. Downstream floods are those that affect large areas of a stream system; they are typically caused by prolonged rain or extensive regional snowmelt. They typically last longer than upstream floods.
9. Stream *hydrographs* and *flood-frequency curves* are constructed to illustrate the behavior of a stream as a function of time and are useful in assessing regional flood hazards. Flood-frequency curves are useful in assessing the probability of flood occurrence in a given stream.
10. Human activities aggravate flood hazards. These include covering the land with impermeable materials, filling in floodplains, installing storm sewers, and removing surface vegetation.
11. Strategies for reducing flood hazards include restrictive zoning, the prohibition of construction in floodplain areas, channelization, and the construction of retention ponds, diversion channels, levees, and flood-control dams. Each of these measures has limitations.

## Key Terms

alluvial fan	hydrosphere
base level	infiltration
bed load	levees
capacity	load
channelization	longitudinal profile
crest	meanders
delta	oxbows
discharge	point bar
dissolved load	recurrence interval
downstream flood	retention pond
drainage basin	saltation
flood	stage
flood-frequency curve	stream
floodplain	suspended load
gradient	upstream flood
hydrograph	well sorted
hydrologic cycle	

## Multiple Choice

1. Most of the water of the hydrosphere
  - a. was outgassed from the earth's interior early in its history.
  - b. is brought up from the mantle by volcanic activity.
  - c. is being constantly created by chemical reactions occurring in the earth's crust.
  - d. is produced in the atmosphere.
2. The largest single reservoir in the hydrologic cycle is
  - a. ground water.
  - b. the atmosphere.
  - c. the oceans.
  - d. the polar ice caps.
3. All of the following processes add water to the atmosphere except
  - a. volcanic outgassing.
  - b. transpiration from plants.
  - c. evaporation.
  - d. infiltration.
4. The geographic region from which a stream draws water is called its
  - a. aquifer.
  - b. drainage basin.
  - c. recharge basin.
  - d. reservoir.

5. The size of a stream may be described by its
  - a. capacity.
  - b. discharge.
  - c. load.
  - d. channel cross section.
  
6. The process of sediment transport in which particles move in short hops or jumps is called
  - a. vaulting.
  - b. meandering.
  - c. saltation.
  - d. skipping.
  
7. The lowest elevation to which a stream can erode its channel is called its
  - a. terminal gradient.
  - b. mouth.
  - c. bed elevation.
  - d. base level.
  
8. In temperate climates, as stream gradient decreases from source to mouth,
  - a. sediment particle sizes increase.
  - b. total capacity decreases.
  - c. total velocity decreases.
  - d. total discharge increases.
  
9. In the development of stream meanders, channel erosion is greatest
  - a. on the inside of curves.
  - b. at the outside of curves on the upstream side.
  - c. at the outside of curves on the downstream side.
  - d. along the stream segments between meanders.
  
10. Meander cutoffs are called
  - a. oxbows.
  - b. levees.
  - c. floodplains.
  - d. retention ponds.
  
11. Compared to upstream floods, downstream floods
  - a. are typically of brief duration.
  - b. are often the result of prolonged heavy rains over broad areas.
  - c. affect only small, localized areas.
  - d. are caused by sudden, locally intense rainstorms.
  
12. On a hydrograph, an upstream flood appears as a
  - a. gently upward sloping line.
  - b. shallow dip.
  - c. low, broad peak.
  - d. high, sharp peak.

13. A flood-frequency curve for a certain stream indicates a recurrence interval of 12.5 years for a discharge of 400 cubic feet/second. The probability of occurrence for a flood of this size for this stream would be
- 0.25%.
  - 8%.
  - 12.5%.
  - 32%.
14. Most human activities tend to
- decrease the recurrence intervals of high-discharge events.
  - increase the recurrence intervals of high-discharge events.
  - not alter the recurrence intervals of high-discharge events.
  - eliminate high-discharge events.
15. A disadvantage of both channelization and levees as methods for reducing flood hazards is
- the potential of trapping water outside the stream channel.
  - the increased risk of downstream flooding.
  - the restriction of navigation.
  - the prevention of surface runoff from reaching the stream.
16. Which of the following is not a problem associated with flood control dams?
- displacement of people living in the area that will become inundated
  - silting of the reservoir
  - generation of hydroelectricity
  - impact on aquatic life

### Fill In the Blanks

- \_\_\_\_\_ is the most important agent sculpting the earth's surface.
- The \_\_\_\_\_ includes all the water at and near the earth's surface.
- The \_\_\_\_\_ includes all the processes by which water in the hydrosphere circulates.
- A \_\_\_\_\_ is any body of flowing water confined within a channel.
- Stream \_\_\_\_\_ is the amount of water flowing past a given point in a specified length of time.
- A hundred-year flood is a flood with \_\_\_\_\_ of one hundred years.
- Stream \_\_\_\_\_ is a measure of the total load of material a stream can carry.
- A \_\_\_\_\_ is a fan-shaped deposit of sediment formed at a stream's mouth.
- An \_\_\_\_\_ is a fan-shaped deposit of sediment formed where a stream flows from a mountain into a dry plain or desert, or flows into a more slowly flowing, larger stream.
- A \_\_\_\_\_ is the area surrounding a stream channel into which the stream spills over during floods.
- The \_\_\_\_\_ of a stream is the elevation of the stream's water surface at any point along the stream's course.

12. A \_\_\_\_\_ is constructed by plotting stream stage or discharge as a function of time.
13. A \_\_\_\_\_ is constructed by plotting stream stage or discharge as a function of recurrence interval or annual probability of occurrence.
14. \_\_\_\_\_ are raised banks along a stream channel that help to contain high discharge to prevent flooding.
15. The \_\_\_\_\_ River is the highest-discharge stream in the United States.

### **True or False**

Indicate whether the following statements are true or false. If false, correct the statement to make it true.

- \_\_\_\_\_ 1. Floods are probably the most widely experienced geologic hazards.
- \_\_\_\_\_ 2. The main processes of the hydrologic cycle involve surface runoff and infiltration.
- \_\_\_\_\_ 3. A stream's gradient is usually steeper near its source and tends to decrease downstream.
- \_\_\_\_\_ 4. At any given point, stream-deposited sediments tend to be well mixed in terms of size or weight.
- \_\_\_\_\_ 5. Oxbow lakes are characteristic of relatively young stream channels.
- \_\_\_\_\_ 6. The major factors that determine whether a flood will occur are the amount of water involved and the rate at which it enters the stream system.
- \_\_\_\_\_ 7. Once an area experiences a one-hundred-year flood, it will not experience a flood of similar size for at least another one hundred years.
- \_\_\_\_\_ 8. Buildings in a floodplain can increase flood heights by occupying volume that water formerly could fill.
- \_\_\_\_\_ 9. Farming can contribute to flooding by removing the natural vegetation and leaving the soil exposed, which increases surface runoff.
- \_\_\_\_\_ 10. Construction of a flood-control dam results in a new base level downstream from the dam.

## Review Questions

1. What is a flood? What are the factors that increase the chances of flood?
2. Discuss the various measures that can be taken to minimize the hazards related to floods.
3. A common measure for controlling floods is the construction of flood-control dams. What are the problems associated with such dams?
4. What is the usefulness of a flood-frequency curve? What are the limitations?
5. The Mississippi flood of 1993 is often described as a one-hundred-year flood. Assuming that the statement is correct, what is the recurrence interval of such a flood? What is the probability of such a flood occurring in a given year?

## Surfing the Net

Advice on appropriate actions before, during, and after a flood; mitigation of floods (FEMA):

<<http://www.fema.gov/library/flood.htm>>

Real-time and historical streamflow data (U.S. Geological Survey):

<<http://water.usgs.gov/public/realtime.html>>

Flood archive and images (Dartmouth Flood Observatory):

<<http://www.dartmouth.edu/artsci/geog/floods/index.html>>

Streamflow data (current) in the U.S. and southern Canada (The National Water Conditions):

<<http://water.usgs.gov/nwc>>

Excellent database for the Mississippi River flooding in 1993 (U.S. Army Corps):

<<http://www.wes.army.mil/EL/flood/fl93home.html>>

Satellite images of pre-flooding and post-flooding scenarios for a section of the Mississippi River (U.S. Geological Survey):

<<http://edcwww2.cr.usgs.gov/moberly.html>>

The 2000 report of the World Commission on Dams and Development:

<<http://www.dams.org>>

General information about floods, flood insurance, flood mitigation (Federal Emergency Management Agency, FEMA):

<<http://www.fema.gov/library/floodf.htm>>

## CHAPTER 6 ANSWER KEY

### Multiple Choice

- |                   |                   |       |       |
|-------------------|-------------------|-------|-------|
| 1. a              | 5. b              | 9. c  | 13. b |
| 2. c              | 6. c              | 10. a | 14. a |
| 3. d (figure 6.1) | 7. d              | 11. b | 15. b |
| 4. b              | 8. d (figure 6.5) | 12. d | 16. c |

### Fill In the Blanks

- |                        |                           |
|------------------------|---------------------------|
| 1. Water               | 9. alluvial fan           |
| 2. hydrosphere         | 10. floodplain            |
| 3. hydrologic cycle    | 11. stage                 |
| 4. stream              | 12. hydrograph            |
| 5. discharge           | 13. flood-frequency curve |
| 6. recurrence interval | 14. Levees                |
| 7. capacity            | 15. Mississippi           |
| 8. delta               |                           |

### True or False

1. True
2. False. The main processes of the hydrologic cycle involve evaporation into and precipitation out of the atmosphere.
3. True
4. False. At any given point, stream-deposited sediments tend to be well sorted in terms of size or weight.
5. False. Oxbow lakes are characteristic of mature streams with well-developed floodplains.
6. True
7. False. The probabilities assigned to floods are statistical; the occurrence of a one-hundred-year flood does not affect the occurrence of the next one-hundred-year flood. There is no guarantee that another one-hundred-year flood could not occur during the same year, or during any of the following years.
8. True
9. True
10. False. Construction of a flood-control dam results in a new base level immediately behind the dam and a change in the stream profile downstream from the dam (figure 6.26).