River Systems

Chapter 15

Chapter 15 River Systems

Table of Contents

Movement of Water on Earth

water cycle the continuous movement of water between the atmosphere, the land, and the oceans

- More than two-thirds of Earth's surface is covered with water.
- In the atmosphere, water occurs as an invisible gas. This gas is called *water vapor*. Liquid water also exists in the atmosphere as small particles in clouds and fog.
- Earth's water is constantly changing from one form to another.

Movement of Water on Earth, *continued*

Evapotranspiration the total loss of water from an area, which equals the sum of the water lost by evaporation from the soil and other surfaces and the water lost by transpiration from organisms

- Each year, about 500,000 km^3 of water evaporates into the atmosphere. About 86% of this water evaporates from the ocean.
- Water vapor also enters the air by *transpiration*, the process by which plants and animals release water vapor into the atmosphere.

Movement of Water on Earth, *continued*

Condensation the change of state from a gas to a liquid

- When water vapor rises in the atmosphere, it expands and cools.
- As the vapor becomes cooler; some of it condenses, or changes into tiny liquid water droplets, and forms clouds.

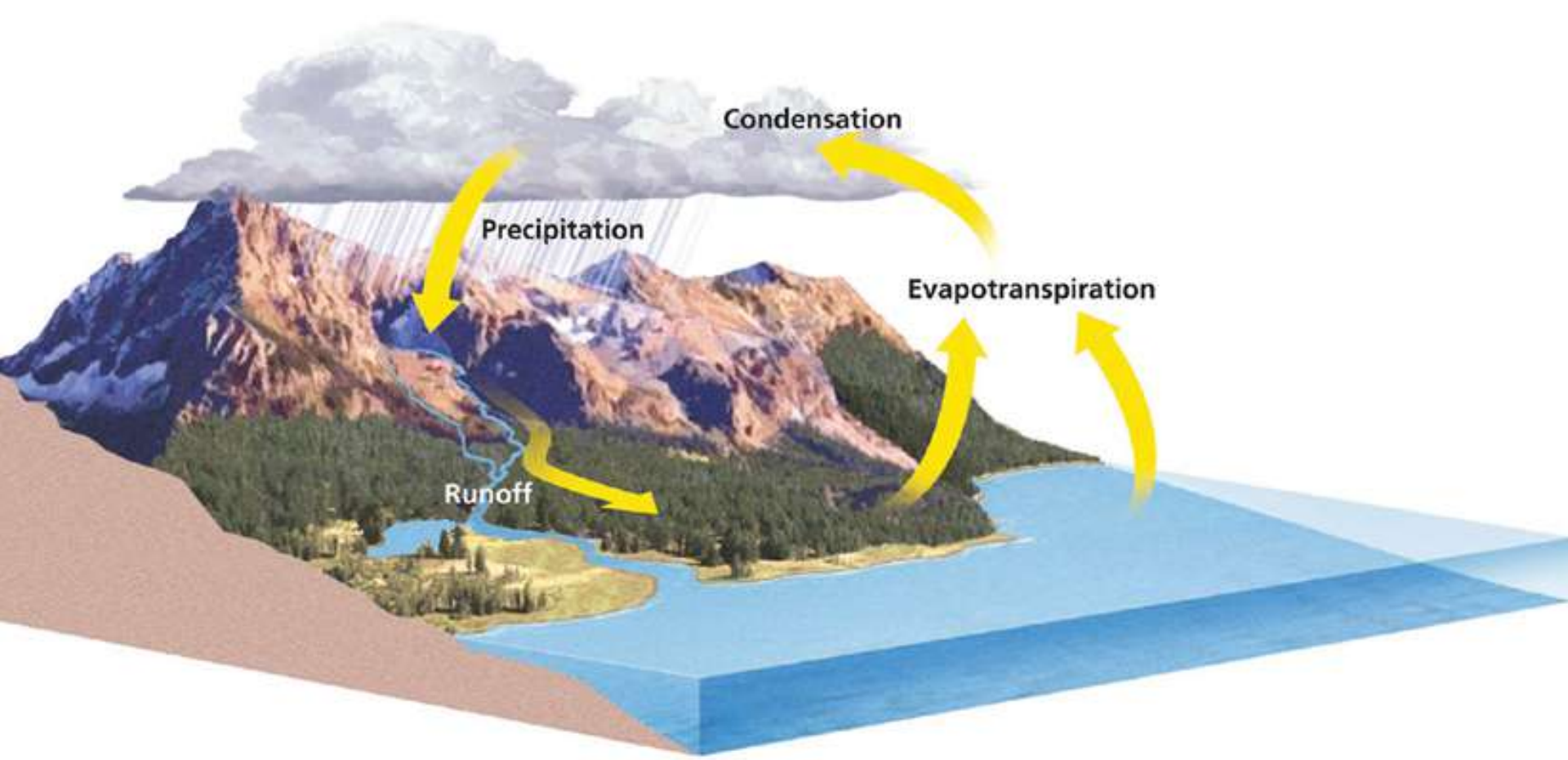
Movement of Water on Earth, *continued*

Precipitation any form of water that falls to Earth's surface from the clouds; includes rain, snow, sleet, and hail

- About 75% of all precipitation falls on Earth's oceans. The rest falls on land and becomes runoff or groundwater.
- Eventually, all of this water returns to the atmosphere by evapotranspiration, condenses, and falls back to Earth's surface to begin the cycle again.

Movement of Water on Earth, *continued*

The image below shows the water cycle.



Water Budget

- In Earth's water budget, precipitation is the income. Evapotranspiration and runoff are the expenses.
- The water budget of Earth as a whole is balanced because the amount of precipitation is equal to the amount of evapotranspiration and runoff.
- However, the water budget of a particular area, called the *local water budget*, is usually not balanced.

Water Budget, *continued*

Factors That Affect the Water Budget

- Factors that affect the local water budget include temperature, vegetation, wind, and the amount and duration of rainfall.
- The factors that affect the local water budget vary geographically.
- The local water budget also changes with the seasons in most areas of Earth.

Water Budget, *continued*

Water Use

- On average, each person in the United States uses about 95,000 L (20,890.5 gal) of water each year.
- As the population of the United States increases, so does the demand for water.
- About 90% of the water used by cities and industry is returned to rivers or to the oceans as wastewater.
- Some of this wastewater contains harmful materials, such as toxic chemicals and metals.

Water Budget, *continued*

Conservation of Water

- Scientists have identified two ways to ensure that enough fresh water is available today and in the future.
- One way is through conservation or the wise use of water resources.
- A second way to protect the water supply is to find alternative methods of obtaining fresh water.

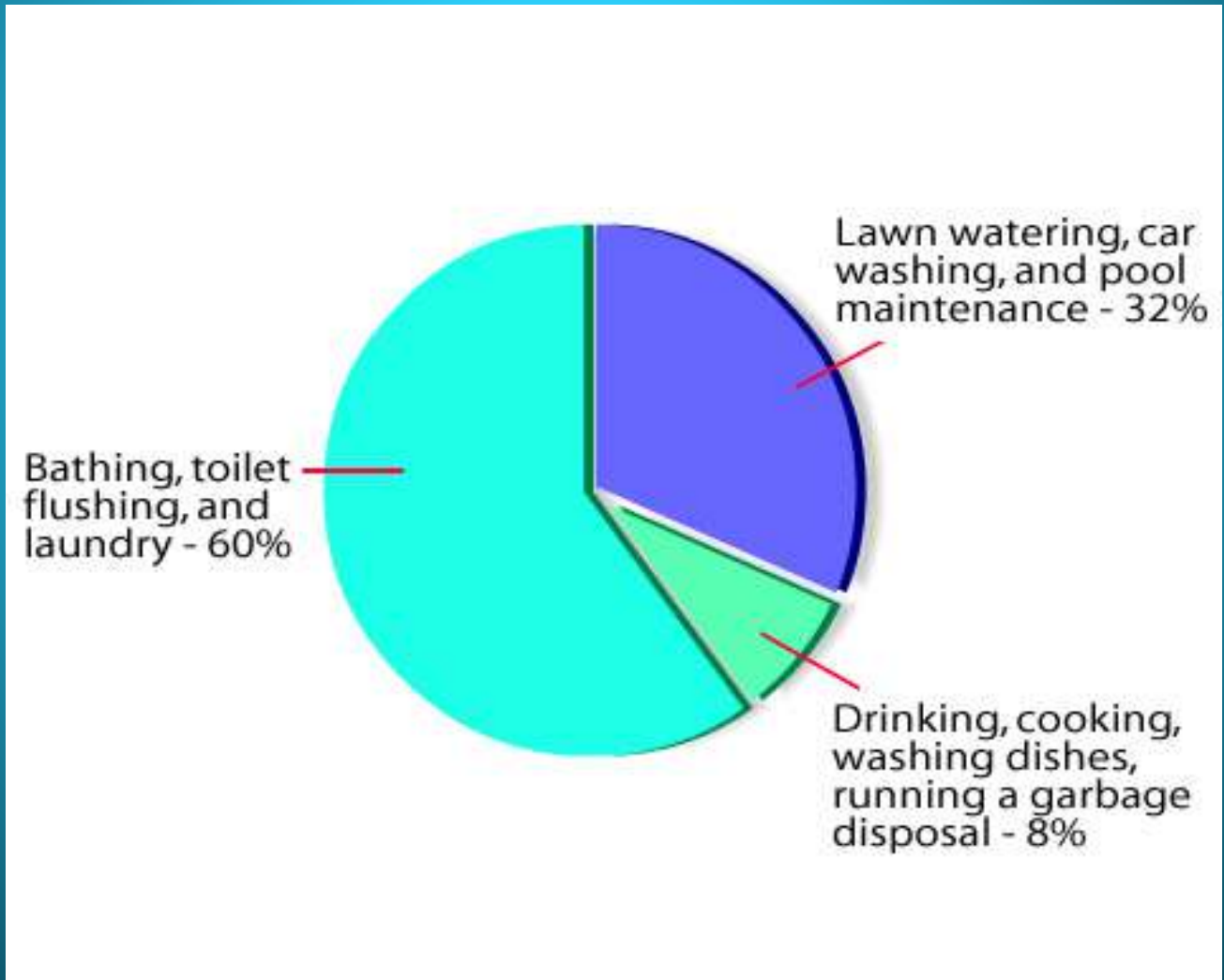
Water Budget, *continued*

Conservation of Water, continued

desalination a process of removing salt from ocean water

- Desalination is expensive and is impractical for supplying water to large populations.
- Currently, the best way of maintaining an adequate supply of fresh water is the wise use and conservation of the fresh water that is now available.

Water Use in Households



Parts of a River System

tributaries a stream that flows into a lake or into a larger stream

watershed the area of land that is drained by a river system

- A river system is made up of a main stream and tributaries.
- The ridges or elevated regions that separate watersheds are called *divides*.

Parts of a River System, *continued*

- The relatively narrow depression that a stream follows as it flows downhill is called its *channel*.
- The edges of a stream channel that are above water level are called the stream's *banks*.
- The part of the stream channel that is below the water level is called the stream's *bed*.
- A stream channel gradually becomes wider and deeper as it erodes its banks and bed.

Channel Erosion

- River systems change continuously because of erosion.
- In the process of *headward erosion*, channels lengthen and branch out at their upper ends, where run off enters the streams.
- In the process known as *stream piracy*, a stream from one watershed is "captured" by a stream from another watershed that has a higher rate of erosion.
- The captured stream then drains into the river system that has done the capturing.

Channel Erosion, *continued*

Stream Load the materials other than the water that are carried by a stream

- A stream transports soil, loose rock fragments, and dissolved mineral as it flows downhill.
- Stream load takes three forms: suspended load, bed load, and dissolved load.

Channel Erosion, *continued*

Stream Load, *continued*

- The *suspended load* consists of particles of fine sand and silt. The velocity, or rate of downstream travel, of the water keeps these particles suspended, so they do not sink to the stream bed.
- The *bed load* is made up of larger, coarser materials, such as coarse sand, gravel, and pebbles. This material moves by sliding and jumping along the bed.
- The *dissolved load* is mineral matter transported in liquid solution.

Channel Erosion, *continued*

Stream Discharge

discharge the volume of water that flows within a given time

- The faster a stream flows, the higher its discharge and the greater the load that the stream can carry.
- A stream's velocity also affects how the stream cuts down and widens its channel. Swift streams erode their channels more quickly than slow-moving streams do.

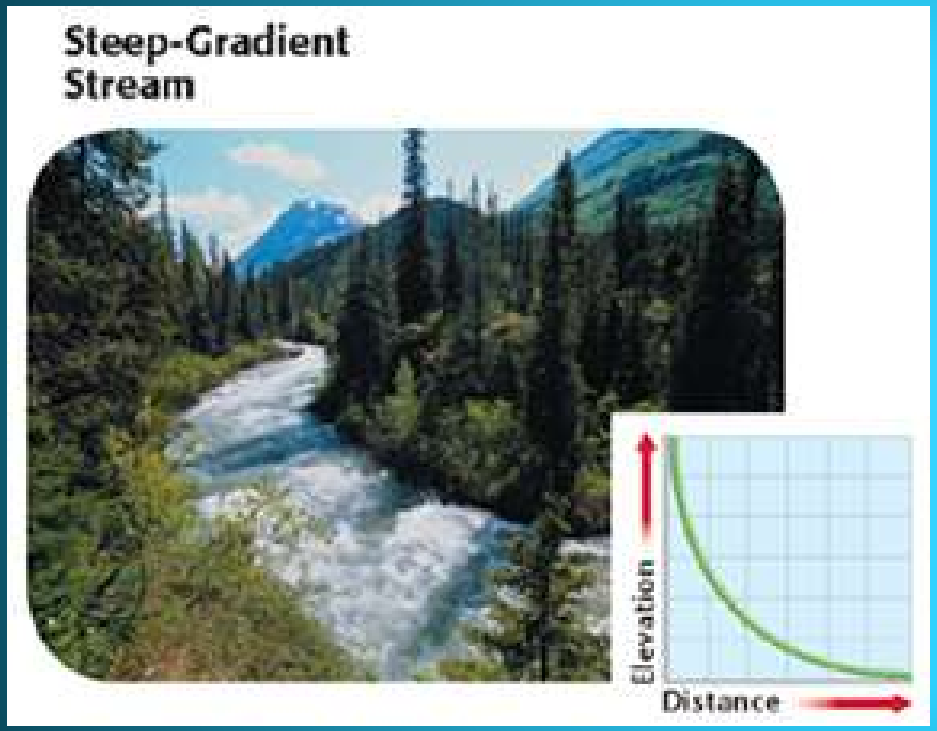
Channel Erosion, *continued*

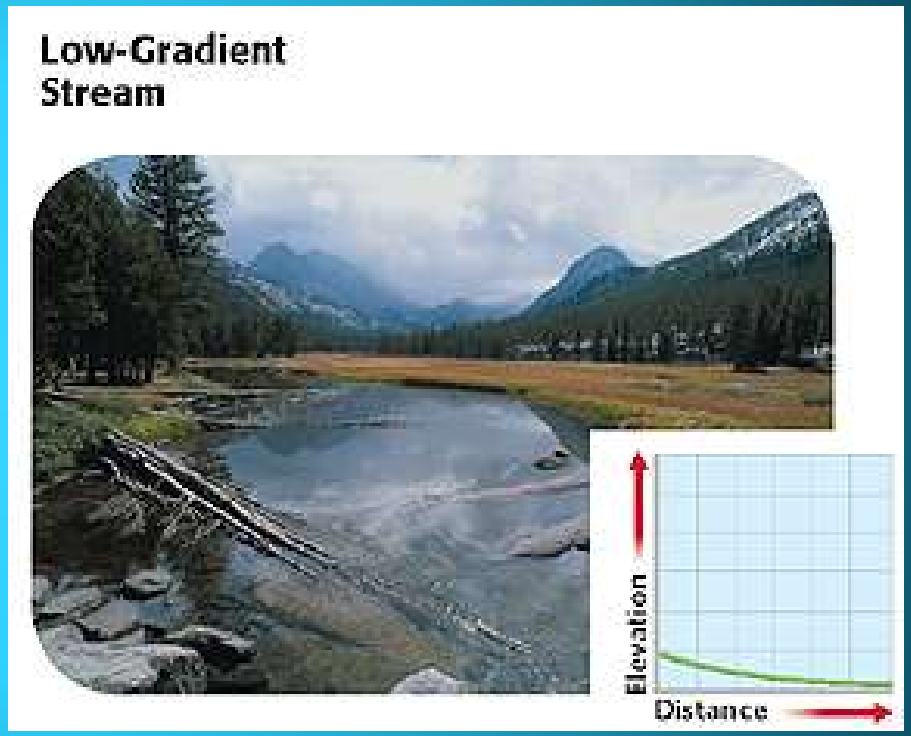
Stream Gradient

gradient the change in elevation over a given distance

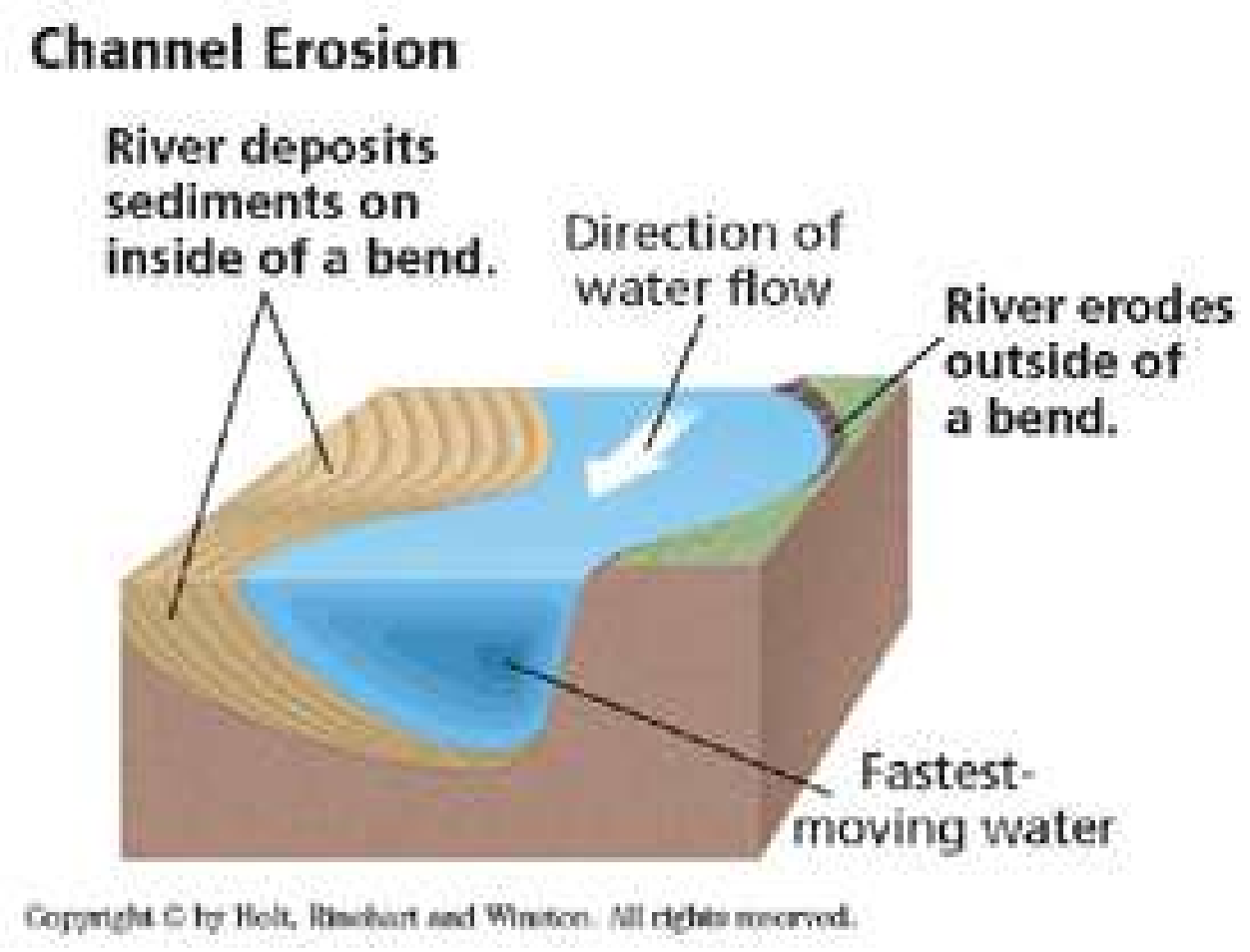
- Near the *headwaters*, or the beginning of a stream, the gradient generally is steep. This area of the stream has a high velocity, which causes rapid channel erosion.
- As the stream nears its *mouth*, where the stream enters a larger body of water, its gradient often becomes flatter.

Channel Erosion, *continued*





Channel Erosion, *continued*



Evolution of River Channels

Meandering Channels

meander one of the bends, twists, or curves in a low-gradient stream or river

- When a river rounds a bend, the velocity of the water on the outside of the curve increase. However, on the inside of the curve, the velocity of the water decreases.
- This decrease in velocity leads to the formation of a *bar* of deposited sediment, such as sand or gravel.

Evolution of River Channels, *continued*

Meandering Channels, *continued*

- As this process continues, the curve enlarges while further sediment deposition takes place on the opposite bank, where the water is moving more slowly.
- Meanders can become so curved that they almost form a loop, separated by only a narrow neck of land.
- When the river cuts across this neck, the meander can become isolated from the river, and an *oxbow lake* forms.

Evolution of River Channels, *continued*

Braided Streams

braided stream a stream or river that is composed of multiple channels that divide and rejoin around sediment bars

- Braided streams are a direct result of large sediment load, particularly when a high percentage of the load is composed of coarse sand and gravel.
- Although braided streams look very different from meandering streams, they can cause just as much erosion.

Deltas and Alluvial Fans

delta a fan-shaped mass of rock material deposited at the mouth of a stream; for example, deltas form where streams flow into the ocean at the edge of a continent

- A stream may deposit sediment on land or in water.
- The exact shape and size of a delta are determined by waves, tides, offshore depths, and the sediment load of the stream.

Deltas and Alluvial Fans, *continued*

alluvial fan a fan-shaped mass of rock material deposited by a stream when the slope of the land decreases sharply; for example, alluvial fans form when streams flow from mountains to flat land

- When a stream descends a steep slope and reaches a flat plain, the speed of the stream suddenly decreases. As a result, the stream deposits some of its load on the level plain at the base of the slope.
- Alluvial fans differ from deltas in that alluvial fans form on land instead of being deposited in water.

Floodplains

floodplain an area along a river that forms from sediments deposited when the river overflows its banks

- The volume of water in nearly all streams varies depending on the amount of rainfall and snowmelt in the watershed.

Floodplains, *continued*

Natural Levees

- When a stream overflows its banks and spreads out over the floodplain, the stream loses velocity and deposits its coarser sediment load along the banks of the channel.

- The accumulation of these deposits along the banks eventually produces raised banks, called *natural levees*.

Floodplains, *continued*

Finer Flood Sediments

- Finer sediments are carried farther out into the floodplains by the flood waters and are deposited there.
- A series of floods produces a thick layer of fine sediments, which becomes a source of rich floodplain soils.

Human Impacts on Flooding

- Human activity can contribute to the size and number of floods in many areas.
- Vegetation, such as trees and grass, protects the ground surface from erosion by taking in much of the water that would otherwise run off.
- Logging and the clearing of land for agriculture or housing development can increase the volume and speed of runoff, which leads to more frequent flooding.

Flood Control

- Indirect methods of flood control include forest and soil conservation measures that prevent excess runoff during periods of heavy rainfall.
- More-direct methods include the building of artificial structures that redirect the flow of water.
- The most common method of direct flood control is the building of *dams*. Another direct method of flood control is the building of *artificial levees*.

The Life Cycle of Lakes

- Most lakes are relatively short lived in geologic terms.
- Many lakes eventually disappear because too much of their water drains away or evaporates.
- Lake basins may also disappear if they fill with sediments. Streams that feed a lake deposit sediments in the lake. The lake basin may eventually become dry land.