

## CHAPTER 7

# COASTAL ZONES AND PROCESSES

### Important Concepts

1. Gently sloping, broad beaches are typically associated with *passive continental margins*, such as the eastern margin of North America.
2. Causes of long-term sea-level change include the melting of polar ice and the expansion in volume of warmed ocean water as a result of global warming, tectonic processes, changes related to glaciation, and the extraction of underground fluids such as groundwater and petroleum.
3. *Submergent coasts* can be recognized by the presence of drowned valleys, *emergent coasts* by the presence of wave-cut platforms.
4. *Waves* and *currents* are the principal natural agents of shoreline modification caused by erosion and sediment deposition.
5. *Wave refraction*, the deflection of waves around irregularities in the coastline, results in the rapid erosion and rounding out of angular coastline features.
6. A subtle but continuous process of coastal erosion is caused by *longshore currents* (the lateral movement of water along the shoreline) that transport sediment particles in the same general direction as the motion of the longshore current (*littoral drift*).
7. Coastal erosion is aggravated by a long-term, sustained sea-level rise, probably due to the melting of polar ice, and by short-term disturbances such as storm events and tsunamis.
8. Human-made structures constructed to protect and stabilize shorelines include *seawalls*, *riprap*, *groins*, *jetties*, and *breakwaters*. Such structures, although effective for short-term protection of specific segments of a beach, often result in increased erosion along unprotected sections of the beach.
9. Expensive *beach nourishment* projects to restore some beaches that experience rapid erosion and widespread development have not been particularly effective.
10. Barrier islands and estuaries are fragile coastal environments that are especially vulnerable to natural forces and/or human activities.
11. Buildings on beachfront properties should be located at least five meters above normal high tide and behind many high dunes.

## Key Terms

active margin  
barrier island  
beach  
beach nourishment  
breakwater  
current  
drowned valley  
emergent coastline  
estuary  
groin  
littoral drift

longshore current  
milling  
passive margin  
seawall  
submerged coastline  
surge  
tide  
wave  
wave base  
wave-cut platform  
wave refraction

## Multiple Choice

1. Census data for the United States taken since 1940 show that the density of population in coastal counties is
  - a. about the same as that in interior counties.
  - b. slightly higher than that in interior counties.
  - c. much higher than that in interior counties.
  - d. lower than that in interior counties.
2. The water molecules in a wave move
  - a. in the same direction as the wave.
  - b. opposite to the direction of the wave.
  - c. perpendicular to the direction of the wave and parallel to the shore.
  - d. in circular orbits beneath the water surface.
3. The fjords of Scandinavian countries represent
  - a. wave-cut platforms.
  - b. ancient berms.
  - c. sea cliffs.
  - d. drowned valleys.
4. Construction of a breakwater can cause shoreline erosion
  - a. down-current of the breakwater.
  - b. up-current of the breakwater.
  - c. on the seaward side of the breakwater.
  - d. directly along the shore behind the breakwater.
5. The construction of the Galveston seawall has resulted in
  - a. a reduced number of hurricanes in the Galveston area.
  - b. the creation of longshore currents along the Galveston section of the Gulf Coast.
  - c. loss of sandy beach in front of the seawall.
  - d. decreased erosion along the seawall.

6. Coral reef communities off Waikiki Beach, Hawaii and off Miami Beach, Florida have been killed because of
  - a. interference with sediment-laden waters due to the construction of breakwaters and marinas.
  - b. the lowering of sea level due to tectonic processes.
  - c. increased turbidity induced by beach-replenishment efforts.
  - d. the loss of protective offshore barrier islands.
  
7. All of the following structures are used to stabilize shorelines except
  - a. seawalls.
  - b. jetties.
  - c. wave-cut platforms.
  - d. breakwaters.
  
8. The Zuider Zee in the Netherlands is an example of a
  - a. drowned valley.
  - b. partially filled estuary.
  - c. steep-walled fjord.
  - d. barrier island.
  
9. A probable cause of coastal erosion in the United States is
  - a. the melting of polar ice.
  - b. an increase in the number of hurricanes striking the United States coastline.
  - c. the tectonic subsidence of much of the United States.
  - d. the loss of barrier islands.
  
10. Unusually high tides associated with storms and strong onshore winds are called
  - a. tsunamis.
  - b. neap tides.
  - c. flood tides.
  - d. storm surges.
  
11. The best solution to the problems caused by the development of coastal areas is to
  - a. construct breakwaters, groins, and other structures to stabilize eroding shorelines.
  - b. maintain beaches by replenishing the sand.
  - c. move buildings and highways farther inland as beaches erode.
  - d. restrict the development of coastal areas.
  
12. In 1987, Hurricane Emily had maximum wind speed of 127 miles per hour. At the height of her fury, Hurricane Emily was a category \_\_\_\_\_ storm on the Saffir-Simpson Hurricane Scale.
  - a. 2
  - b. 3
  - c. 4
  - d. 5
  
13. In the United States, the risk of tsunamis is greatest for those states bordering the
  - a. Great Lakes.
  - b. Gulf of Mexico.
  - c. Atlantic Ocean.
  - d. Pacific Ocean.

14. Water levels in the Great Lakes
  - a. have steadily increased since 1987.
  - b. have declined rapidly for the past twenty years.
  - c. fluctuate for a variety of reasons.
  - d. have remained basically unchanged since the end of the Ice Age.
  
15. Most of the environmental problems associated with some estuaries have been caused by
  - a. the daily cycles of rise and fall of the water level in the estuary due to tides.
  - b. changes in the water chemistry due to pollution.
  - c. a lack of adequate rain or snow in the surrounding region.
  - d. excessive recreational fishing.
  
16. Barrier islands are particularly vulnerable to the fury of storm events because
  - a. nature knows that the people living in these islands are rich and so can absorb the damage.
  - b. most barrier islands have a low relief to the sea level.
  - c. we do not have enough money to build protective structures.
  - d. tides tend to be higher around barrier islands.

### Fill In the Blanks

1. A continental margin can be described as a \_\_\_\_\_ margin if it is far removed from an active plate boundary.
2. A \_\_\_\_\_ is a gently sloping shoreline area washed over by waves and covered by sediment.
3. The depth at which water motion within a wave is negligible is the \_\_\_\_\_.
4. \_\_\_\_\_, or abrasion, is the erosion caused by the grinding action of sand-laden waves on a coast.
5. \_\_\_\_\_ are steplike terraces cut into bedrock along a coast by wave action as a consequence of rising land or falling water level.
6. A \_\_\_\_\_ is a coastline stream valley that is partially flooded by the sea as a consequence of rising sea level or coastline subsidence.
7. A \_\_\_\_\_ refers to the net movement of water parallel to a coastline.
8. \_\_\_\_\_ refers to the movement of sand along the length of a beach in the same general direction as the longshore current.
9. \_\_\_\_\_ is the deflection of waves as they approach the shore.
10. \_\_\_\_\_ are long, narrow islands paralleling a coastline.
11. An \_\_\_\_\_ is a body of water along a coastline that contains a mix of fresh and salt water.
12. A storm \_\_\_\_\_ is a local increase in the water level of an ocean or large lake that occurs in response to low air pressure associated with a major storm, such as a hurricane.

## True or False

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

- \_\_\_\_\_ 1. Waves and currents are the principal forces behind natural shoreline modification.
- \_\_\_\_\_ 2. Wave-cut platforms are more pronounced along coastlines composed of soft, unconsolidated material than along coastlines composed of resistant bedrock.
- \_\_\_\_\_ 3. Chesapeake Bay is an example of a drowned valley.
- \_\_\_\_\_ 4. The construction of groins results in the loss of beach up-current of the groins and in the buildup of beach below.
- \_\_\_\_\_ 5. The damming of a large river whose mouth is near a beach can result in erosion of the beach.
- \_\_\_\_\_ 6. Replenishment of sand along eroded beaches (beach nourishment) is the most cost-effective method of beach restoration.
- \_\_\_\_\_ 7. Barrier islands tend to retreat seaward with time.
- \_\_\_\_\_ 8. Water circulation is very limited in estuaries, making them vulnerable to pollution.
- \_\_\_\_\_ 9. The rate of shoreline erosion in the future may be higher due to global warming enhanced by the greenhouse effect.
- \_\_\_\_\_ 10. A 1971 study showed that the erosion of the Great Lakes shoreline had been significantly reduced after the installation of shoreline protection structures.

## Review Questions

1. Discuss the processes by which erosion and deposition occur along the shorelines.
2. What is wave refraction and how does it affect a shoreline?
3. What is the difference between submergent and emergent coasts? How can you determine if a particular coast is emergent or submergent?
4. What are barrier islands and why do they constitute a particularly unstable environment for development? Give an example.

5. What are the measures commonly adopted for protecting selected segments of coastlines from erosion? Discuss the long-term success of these measures.
6. Sketch a shoreline with an impermeable groin for the protection of a beach resort. Explain where sand erosion and deposition will occur subsequently and how this will reshape the shoreline.
7. What is an estuary? Why do estuaries constitute such a distinctive and relatively fragile environment?

## **Surfing the Net**

“Coasts in Crisis,” an excellent review with a lot of pictures (U.S. Geological Survey):

<http://pubs.usgs.gov/circular/c1075/>

Coastal ocean modeling movies in FLC format with emphasis on the Massachusetts Bay and Boston harbor (USGS Woods Hole Field Center):

<http://crusty.er.usgs.gov>

World’s largest archive of weather data (National Climatic Data Center):

<http://www.ncdc.noaa.gov/>

A large number of links to coastal sites and coastal process (National Marine and Coastal Survey):

<http://marine.usgs.gov>

Information about estuaries in the U.S. (U.S. Environmental Protection Agency):

<http://www.epa.gov/owow/estuaries/>

Excellent data on hurricanes and major storms (NOAA):

<http://www.aoml.noaa.gov/hrd/tcfaq/>

## CHAPTER 7 ANSWER KEY

### Multiple Choice

- |                    |      |                   |       |
|--------------------|------|-------------------|-------|
| 1. c (figure 7.1)  | 5. c | 9. a              | 13. d |
| 2. d               | 6. c | 10. d             | 14. c |
| 3. d               | 7. c | 11. d             | 15. b |
| 4. a (figure 7.11) | 8. b | 12. b (table 7.1) | 16. b |

### Fill In the Blanks

- |                       |                      |
|-----------------------|----------------------|
| 1. passive            | 7. longshore current |
| 2. beach              | 8. Littoral drift    |
| 3. wave base          | 9. Wave refraction   |
| 4. Milling            | 10. Barrier islands  |
| 5. Wave-cut platforms | 11. estuary          |
| 6. drowned valley     | 12. surge            |

### True or False

1. True
2. False. Wave-cut platforms are more pronounced along rocky coasts.
3. True
4. False. When groins are constructed, sediment is added to the beach up-current of the groins and lost below.
5. True
6. False. The costs of replenishing sand to restore a beach and to continually maintain it can be millions of dollars.
7. False. Barrier islands tend to retreat landward with time.
8. True
9. True
10. False. The 1971 study showed that more than one-third of the Great Lakes coastline was eroding significantly, despite the presence of shoreline protection structures.