

1  **Shorelines**

Earth 9th Edition – Chapter 20

2  **Shorelines: summary in haiku form**

Build house on cliff
for a view of the ocean -
be one with said view.

3  **Key Concepts**

- The shoreline and the “coastal zone.”
- Waves and their erosive activity.
- Sand movement on the beach.
- Erosional and depositional shoreline features.
- Stabilization of the shore.
- Coastal classification.
- Tides.

4  **The shoreline: A dynamic interface**

- The shoreline is a dynamic interface (common boundary) between air, land, and the ocean
- The shoreline is constantly being modified by waves
- Today the coastal zone is experiencing intense human activity

5 

6  **The coastal zone**

- Clarification of terms used to describe the land-sea boundary
 - ☒ Shoreline is the line that marks the contact between land and sea
 - ☒ The shore is the area that extends between the lowest tide level and the highest elevation on land that is affected by storms

7  **The coastal zone**

- Clarification of terms used to describe the land-sea boundary
 - ☒ The coast extends inland from the shore as far as ocean-related features are found
 - ☒ Coastline marks the coast’s seaward edge

8  **The coastal zone**

- Shore is divided into the
 - ☒ Foreshore – area exposed at low tide
 - ☒ Backshore – landward of the high-tide shoreline
 - ☒ The nearshore zone lies between the low tide shoreline and the point where waves break at low tide
 - ☒ Seaward of the nearshore is the offshore zone

9  **The coastal zone**

- Beach – an accumulation of sediment found along the landward margin of the ocean or a lake
 - ☒ The relatively flat platform composed of sand and marked by a change in slope at the seaward edge is a berm
 - ☒ Beach face is the wet sloping surface that extends from the berm to the shoreline

10  **Waves**

- Wind-generated waves provide most of the energy that shapes and modifies shorelines
- Characteristics of waves
 - ☒ Waves derive their energy and motion from the wind

11  **Waves**

- Characteristics of waves
 - ☒ Parts of a wave
 - Crest – top of the wave
 - Trough – low area between waves
 - ☒ Measurements of a wave

- ◆ Wave height – the distance between a trough and a crest
- ◆ Wavelength – the horizontal distance between crests

12 **Waves**

- Characteristics of waves
 - ☒ Measurements of a wave
 - ◆ Wave period – the time interval between the passage of two successive crests
 - ☒ Height, length, and period of a wave depend on
 - ◆ Wind speed
 - ◆ Length of time wind has blown
 - ◆ Fetch – the distance that the wind has traveled across open water

13 **Basic parts of a wave**

14

15 **Waves**

- Types of waves
 - ☒ Wave of oscillation
 - ◆ Wave energy moves forward, not the water itself
 - ◆ Occur in the open sea in deep water
 - ☒ Wave of translation
 - ◆ Begins to form in shallower water when the water-depth is about one-half the wavelength and the wave begins to “feel bottom”
 - ◆

16 **Waves**

- Types of waves
 - ☒ Wave of translation
 - ◆ As the speed and length of the wave diminish, the wave grows higher
 - ◆ The steep wave front collapses and the wave breaks along the shore
 - ◆ Turbulent water advances up the shore and forms surf

17 **A wave moving onto the shore**

18 **Wave erosion**

- Breaking waves exert a great force
- Wave erosion is caused by
 - ☒ Wave impact and pressure
 - ☒ Abrasion by rock fragments

19 **Sand movement on the beach**

- Movement perpendicular to the shoreline
 - ☒ Waves seldom approach the shore straight on, but rather at an angle
 - ☒ When waves reach shallow water with a smoothly sloping bottom they are bent and tend to become parallel to the shore

20 **Sand movement on the beach**

- Wave refraction
 - ☒ Bending of a wave
 - ☒ Causes waves to arrive nearly parallel to the shore
 - ☒ Consequences of wave refraction
 - ◆ Wave energy is concentrated against the sides and ends of headlands

21 **Properties of Waves**

22 **Wave Motion/Refraction**

23 **Refraction of waves**

24

25

26

27

28 **Sand movement on the beach**

- Wave refraction
 - ☒ Consequences of wave refraction
 - Wave energy is spread out in bays and wave attack is weakened
 - Over time, wave erosion straightens an irregular shoreline
 - ☒ Moving sand along the beach
 - Waves that reach the shoreline at an angle cause the sediment to move along a beach in a zigzag pattern called beach drift

29 **Sand movement on the beach**

- Wave refraction
 - ☒ Moving sand along the beach
 - Oblique waves also produce longshore currents
 - Currents in the surf zone
 - Flow parallel to the coast
 - Easily moves fine suspended sand and rolls larger sand and gravel along the bottom

30 **Movement of sand by longshore current**

31 **Shoreline features**

- Features vary depending on several factors including
 - ☒ The rocks along the shore
 - ☒ Currents
 - ☒ Wave intensity
 - ☒ Whether the coast is stable, sinking, or rising

32 **Shoreline features**

- Features caused by wave erosion
 - ☒ Wave-cut cliffs
 - ☒ Wave-cut platform
 - ☒ Features associated with headlands
 - Sea arch
 - Sea stack

33

34 **A cliff undercut by wave erosion**

35 **Shoreline features**

- Features related to beach drift and longshore currents
 - ☒ Spits
 - Elongated ridges of sand extending from the land into the mouth of an adjacent bay
 - Often the end of a spit hooks landward in response to wave-generated currents

36

37

38

39

40

41

42 ***A spit on the Olympic Peninsula***

43 ***Beach Drift and Longshore Currents***

44 **Shoreline features**

- Features related to beach drift and longshore currents
 - ☒ Baymouth bar – a sand bar that completely crosses a bay
 - ☒ Tombolo – a ridge of sand that connects an island to the mainland or another island

45 **Depositional features of coastal Massachusetts**

46 ***San Elijo Lagoon – a baymouth bar***

47 ***Point Sur, California – a tombolo***

48 **Shoreline features**

- Barrier islands
 - ☒ Mainly along the Atlantic and Gulf coasts
 - ☒ Low ridges of sand that parallel the coast 3 to 30 kilometers offshore
 - ☒ Probably form in several ways
- If the shoreline remains stable, the result of shoreline erosion and deposition is to eventually produce a straighter coast

49 

50 

51  **Barrier islands along the Texas coast**

52  ***Port Isabel, Texas***

edge of Laguna Madre

53  **Stabilizing the shore**

- Shoreline erosion is influenced by several local factors including
 - ☒ Proximity to sediment-laden rivers
 - ☒ Degree of tectonic activity
 - ☒ Topography and composition of the land
 - ☒ Prevailing wind and weather patterns
 - ☒ Configuration of the coastline and nearshore areas

54  **Stabilizing the shore**

- Three basic responses to erosion problems
 - ☒ Building structures
 - ◆ Jetties
 - Usually built in pairs to develop and maintain harbors
 - Extend into the ocean at the entrances to rivers and harbors

55  **Jetties are built to prevent deposition**

56 

57 

58 

59 

60  ***Mission Bay jetties***

61  **Stabilizing the shore**

- Three basic responses to erosion problems
 - ☒ Building structures
 - ◆ Groins
 - Built to maintain or widen beaches
 - Constructed at a right angle to the beach to trap sand

62  **Stabilizing the shore**

- Three basic responses to erosion problems
 - ☒ Building structures
 - ◆ Breakwater
 - Barrier built offshore and parallel to the coast
 - Protects boats from the force of large breaking waves

63  **Stabilizing the shore**

- Three basic responses to erosion problems
 - ☒ Building structures
 - ◆ Seawall
 - Barrier parallel to shore and close to the beach to protect property
 - Stops waves from reaching the beach areas behind the wall
 - ◆ Often the building of structures is not an effective means of protection

64  **Stabilizing the shore**

- Three basic responses to erosion problems
 - ☒ Beach nourishment

- ◆ The addition of large quantities of sand to the beach system
 - ◆ Only an economically viable long-range solution in a few areas
 - ☒ Abandonment and relocation of buildings away from the beach
- 65  **Stabilizing the shore**
- Contrasting the Atlantic and Pacific Coasts
 - ◆ Shoreline erosion problems are different along the opposite coasts
 - ◆ Atlantic and Gulf coasts
 - Broad, gently sloping coastal plains
 - Tectonically quiet regions
- 66  **Stabilizing the shore**
- Contrasting the Atlantic and Pacific Coasts
 - ◆ Atlantic and Gulf coasts
 - Development occurs mainly on the barrier islands (also called barrier beaches or coastal barriers)
 - Barrier islands face the open ocean
 - They receive the full force of storms
- 67  **Stabilizing the shore**
- Contrasting the Atlantic and Pacific Coasts
 - ☒ Pacific Coast
 - ◆ Relatively narrow beaches backed by steep cliffs and mountain ranges
 - ◆ A major problem is a significant narrowing of many beaches
 - ◆ Shoreline erosion varies considerably from one year to the next largely because of the sporadic occurrence of storms
- 68  **Coastal classification**
- Emergent coasts
 - ☒ Develop because of uplift of an area or a drop in sea level
 - ☒ Features of an emergent coast
 - ◆ Wave-cut cliffs
 - ◆ Wave-cut platforms
- 69  **Coastal classification**
- Submergent coast
 - ☒ Caused by subsidence of land adjacent to the sea or a rise in sea level
 - ☒ Features of a submergent coast
 - ◆ Highly irregular shoreline
 - ◆ Estuaries – drowned river mouths
- 70  ***Chesapeake Bay is an example of a submergent coastline***
- 71  **Tides**
- Daily changes in the elevation of the ocean surface
 - Causes of tides
 - ☒ Tidal bulges are caused by the gravitational forces of the Moon, and to a lesser extent the Sun
- 72  **Tides are caused by the gravity of the Moon and Sun acting on the ocean**
- 73  **Tides**
- Monthly tidal cycle
 - ☒ Spring tides
 - ◆ Occur during new and full moons
 - ◆ Gravitational forces of the Moon and Sun are added together
 - ◆ Especially high and low tides
 - ◆ Large daily tidal range
- 74  ***Spring Tide***
- 75  **Tides**

- Monthly tidal cycle
 - ☒ Neap tides
 - Occur during the first and third quarters of the moon
 - Gravitational forces of the Moon and Sun are offset
 - Daily tidal range is least

76 **Neap Tide**

77 **Monthly Tidal Cycle**

78 **Tides**

- Other factors that influence tides
 - ☒ Shape of the coastline
 - ☒ Configuration of the ocean basin
- Tidal patterns
 - ☒ Diurnal tidal pattern = a single high tide and a single low tide each tidal day
 - ☒ Semidiurnal tidal pattern = 2 high tides and 2 low tides each tidal day

79

80

81

82 **Tides**

- Tidal patterns
 - ☒ Mixed tidal pattern = large inequality in high water heights, low water heights or both
- Tidal currents
 - ☒ Horizontal flow of water accompanying the rise and fall of the tide

83 **Tides**

- Tidal currents
 - ☒ Types of tidal currents
 - Flood current – advances into the coastal zone as the tide rises
 - Ebb current – seaward-moving water as the tide falls
 - ☒ Areas affected by the tidal currents are called tidal flats
 - ☒ Occasionally form tidal deltas

84 **Tidal delta and tidal flats**

85 **Tides**

- Tides and Earth's rotation
 - ☒ Tidal friction against the ocean floor acts as a weak brake that is steadily slowing Earth's rotation
 - The day is increasing by 0.002 seconds per century
 - This small effect becomes very large over millions of years
 - ☒ Length of each day must have been shorter in the geologic past

86 **End of Chapter 20**