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Coastal Erosion and Flooding



GROUP PRESENTATION Topic 8. How nature and human kind alter the coasts



GROUP PRESENTATION Topic 9. Coastal Erosion and Flooding in Viet Nam \rightarrow Solutions

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Meteomarine for the coastal morphological processes

- Wind
- Waves
- Currents
- Variations in Water-Level
- Sea Level Rise and Subsidence

Coastal Settings

- Open coasts can be divided into two general categories based on the dominant processes acting on the coast over long periods of time (1000's of years or more)
- Erosional
 - Shorelines dominated by processes that form erosional features along the shore
 - Typically high-relief rocky coasts in tectonically active areas (e.g., the Pacific coast of North America) Typically high-relief rocky coasts
- Depositional
 - Shorelines dominated by processes that form deposits along the shore Include a wide spectrum of environments
 - Deltas, barrier islands, reef coasts, glaciated coasts, etc.
 - More typical of passive, or trailing-edge, continental margins (e.g., the Atlantic coast of North America)

Features of depositional coasts



Features of depositional shores



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Features of depositional coasts

Barrier islands along the South Carolina coast





21, 25-RPI

Barrier island, New Jersey



Figure 10-9c

Formation of barrier islands

- Sea level rose after the last Ice Age
- Caused barrier islands to roll toward shore like a tractor's tread



Features of erosional coasts



Features of erosional shores

- Headland
- Wave-cut cliff
- Sea cave
- Sea arch
- Sea stack
- Marine terrace



Sea stack and sea arch, Oregon





Features of erosional coasts



Beach compartments in southern California

- Beach compartments include:
 - Rivers
 - Beaches
 - Submarine canyons



Figure 10-12

Evidence of emerging and submerging shorelines

- Emergent features:
 - Marine terraces
 - Stranded beach deposits
- Submergent features:
 - Drowned beaches
 - Submerged dune topography
 - Drowned river valleys



Figure 10-13

Group discussion

Divide into 4 groups and find out the causes of coastal erosion

Causes of coastal erosion???

Group work

- Work individually in 5 minutes, point out several causes of coastal erosion
- Each group has 10 minutes to communicate and select the most dangerous causes.

Round-presentation

- Assign 1 speaker.
- Group's speaker has to visit each of your neighbor groups and present your findings in 3 minutes. Convince them that your solution is top choice. Take note.
- Other members: comment the visiting speaker. Take note.

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CAUSES OF COASTAL EROSION

Natural processes

Human activities

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A wave moving onto the shore

Wave movement Approaching shore – waves touch bottom Open ocean -Surf waves with constant (breakers form) (wavelength shortens) wavelength Depth is >1/2 wavelength Velocity decreases (wave height increases)



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Wave erosion

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



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Wave erosion



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20.6, 20.7-Tarbuck & Lutgens, 2005

Wave refraction

•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
 - Wave energy is spread out in bays and wave attack is weakened
 - Over time, wave erosion straightens an irregular shoreline

Wave refraction

- Wave energy focused on headland
- Wave energy dispersed over bay



9.19b-Thurman and Trujillo, 2004

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Wave refraction, Maili Point, Oahu



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Sediment movement on the shore

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- Movement parallel to the (\leftrightarrow) shoreline
 - Caused by wave refraction
 - Along most shorelines, waves strike the shore at an angle
 - Waves that reach the shoreline at an angle cause the sediment to move along a beach in a zigzag pattern called beach drift

Sediment movement on the shore

• Movement parallel to the (\leftrightarrow) shoreline

- 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

Movement of sand by longshore current



Sediment movement along a beach



11.19-Segar, 2007

Sediment movement on the shore

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- Movement perpendicular (‡) to the shoreline
 - Caused by breaking waves
 - Swash (†)
 - Backwash (\downarrow)



	Light wave activity	Heavy wave activity
Berm/longshore bars	Berm is built at the expense of the longshore bars	Longshore bars are built at the expense of the berm
Wave energy	Low wave energy (non-storm conditions)	High wave energy (storm conditions)
Time span	Long time span (weeks or months)	Short time span (hours or days)
Characteristics	Creates summertime beach: sandy, wide berm, steep beach face	Creates wintertime beach: steep beach face rocky, narrow berm, flattened beach face

TABLE 11-2 Characteristics of beaches affected by light and heavy wave activity.

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(a) Summertime beach (fair weather)

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(b) Wintertime beach (storm)

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11.2a-Thurman and Trujillo, 2004



Seasonal variation in beach profile



11.19-Segar, 2007

(c) Beach returns to summer profile when wave energy is decreased

Landforms and terminology in coastal regions



Figure 10-1

Movement of sand on the beach

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- Movement perpendicular (**‡**) to shoreline
 - Caused by breaking waves
 - Light wave activity moves sand up the beach face toward the berm
 - Heavy wave activity moves sand down the beach face to the longshore bars
 - Produces seasonal changes in the beach

Light versus heavy wave activity

	Light wave activity	Heavy wave activity
Berm/long- shore bar	Berm grows and longshore bars shrink	Longshore bars grow and berm shrinks
Wave energy	Low	High
Time span	Long	Short
Characteristics	Summertime beach: sandy, wide berm, steep beach face	Wintertime beach: rocky, thin berm, flattened beach face

Summertime and wintertime beach conditions





Summertime beach (fair weather)

Summertime beach





Wintertime beach (storm)

Wintertime beach

Figure 10-2

Movement of sand on the beach



- Movement parallel (\leftrightarrow) to shoreline
 - Caused by wave refraction (bending)
 - Each wave transports sand either upcoast or downcoast
 - Huge volumes of sand are moved within the surf zone
 - The beach resembles a "river of sand"

Longshore current and longshore drift

- Longshore current = zigzag movement of water in the surf zone
- Longshore drift = movement of sediment caused by longshore current



Figure 10-3b

Changes in sea level

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- Sea level has changed throughout time
- Tectonic and isostatic movements are localized and change the level of the land
- Eustatic changes cause sea level to rise or fall worldwide and are produced by:
 - Changes in seawater volume
 - Changes in ocean basin capacity

Sea level has risen since the last Ice Age

- Sea level was 120 meters (400 feet) lower during the last lce Age
- About 18,000 years ago, sea level began to rise as the glacial ice melted



Figure 10-14

Relative sea level rise at New York City

- Sea level has risen 40 centimeters (16 inches) since 1850
- Global warming is predicted to increase the rate of sea level rise



Figure 10-15

U.S. coastal erosion and deposition



Figure 10-16

Natural processes

- Differences in the wave conditions at certain coastal sections, a curved coastline or special bathymetric conditions \rightarrow increasing transport rates
- The loss of sand inland due to breaching and over-wash of a barrier island and wind transport
- Storm surge conditions with large waves → offshore loss of sediments due to non-equilibrium in the profile during the storm surge
- At coastlines with a very oblique wave approach → spit formations occur naturally parallel to the coast
- The loss of material from an area exposed on one or two sides typically happens at the tip of deltas, which do not receive sufficient material from the river → natural shifting of the river alignment (also due to human activities)
- Sea level rise



- Most of the causes affecting coastal communities are due to human intervention in the transport processes along the coastlines and/or reductions in the supply of sand to the shorelines:
 - Measures aimed at coastal protection, erosion protection and port engineering
 - Removal of coastal vegetation
 - Reduction of the sediment supply from the estuaries due to river engineering activities
 - Dredging and dumping of sediment

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- Coastal Structures Interfering Actively with the Littoral Transport (the most common cause of coastal erosion)
- Passive Coastal Protection Structures
- Erosion of Crescent-Shaped Bays
- River Regulation Works and Sand Mining in Rivers
- Wake from Fast Ferries
- Sand and Coral Mining, and Maintenance Dredging

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- Coastal Structures Interfering Actively with the Littoral Transport (the most common cause of coastal erosion)
 - A series of effects:
 - Trapping of sand on the upstream side of the structure takes sand out of the sediment budget → shore erosion along adjacent shorelines. Mostly, of course, on the lee side, but large structures may also cause (initial) erosion on the upstream side.
 - Loss of sand to deep water
 - Trapping of sand in entrance channels and outer harbours.

• Name the types of structure which may cause coastal erosion?

- The structures, which may cause coastal erosion:
 - Groins and similar structures perpendicular to the shore
 - Ports
 - Inlet jetties at tidal inlets and river mouths
 - Detached breakwaters



GROUP PRESENTATION

Topic 5. Definition, classification, allowed and prohibited activities in MPA. Analysis a case study about MPA of any country.

Group discussion

Divide into 3 groups and find out the Causes and solutions for coastal flooding

Causes and solutions for coastal flooding???

Group work

- Work individually in 5 minutes, point out several causes and solutions for coastal flooding
- Each group has 10 minutes to communicate and select the most effective solution.

Round-presentation

- Assign 1 speaker.
- Group's speaker has to present your findings in 3 minutes. Convince the class that your solution is top choice. Take note.
- Other members: comment the speaker. Take note.

CAUSES OF FLOODING

- Flooding is an even more severe phenomenon along low-lying coasts than coastal erosion. It appears very quickly and often covers huge areas. Coastal flooding causes extensive damage and very often loss of life.
- Flooding in estuaries and delta areas caused by river floods is also very important, but not covered in these guidelines
- Flooding only occurs in areas where the coast and the coastal hinterland are low relative to extreme water levels.

CAUSES OF FLOODING

- Extreme water levels:
 - Recurring events: normally occur as the result of the combined effect of tide, seasonal variations and meteorologically generated storm surge (e.g. by typhoons) together with the action of waves
 - Long-term trends: Sea level rise and subsidence may give an increased risk of flooding combined with recurring events ← normally not cause flooding by themselves, but they will increase the flood level

- Regulation or reclamation work in a tidal inlet or an estuary \rightarrow change the tidal regime and thus the flood levels in the estuary.
- The construction of dykes decreases the storage capacity in certain areas \rightarrow increased flood levels along the estuary
- Extensive cutting of mangrove areas \rightarrow change the flood conditions in the hinterland
- Long-term trends in sea level rise and subsidence → increase the risk of flooding in areas prone to naturally recurring flood events
- The extraction of groundwater, oil or gas... → Subsidence due to human interference in coastal areas

THANK YOU!