Lab 9: Coasts – Natural and Man-made Hazards

Introduction

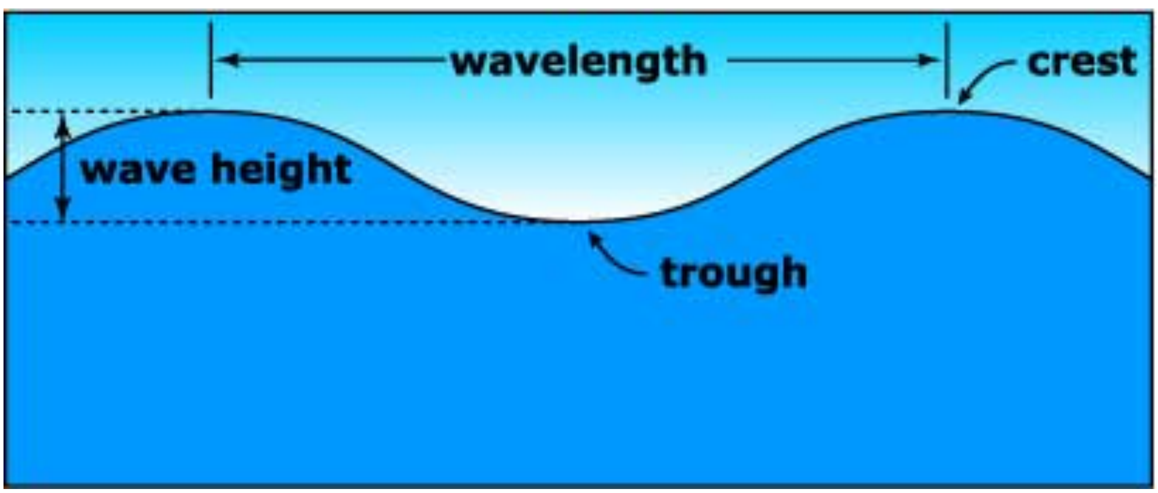
Nearly 80 % of the world's population lives within a 100 km of a coast. As sea levels rise, global warming produces larger storms and coastal population densities increase, the impact of coastal storms is increasing. Coastal storms produce significant property damage as well as large loss of human life. Recent disasters in the United States clearly demonstrates the increasing impact of coastal storms on a nation.

Wave Mechanics

A water wave is an oscillation of the water's free surface, i.e. the water-air interface, and represents energy in motion. It is the mechanical expression of moving energy. Waves are largest and most important as geologic agents on large lakes and the oceans. These are wind-produced waves that affect only the top part of the body of water.

Characteristics

Like other types of waves, water waves are described by the set of physical parameters. These are illustrated on the diagram below.



The key components of a wave are its:

- **crest**: the highest point on a wave
- **trough**: the lowest point on a wave
- **wave height (H)**: the vertical distance between crest and trough
- **wavelength (L)**: the horizontal distance between successive wave crests (or troughs)
- **wave period (T)**: the time interval between the arrival of successive wave crests at a fixed point
- **wave velocity (V)**: the velocity of individual wave crests

Particle Motion

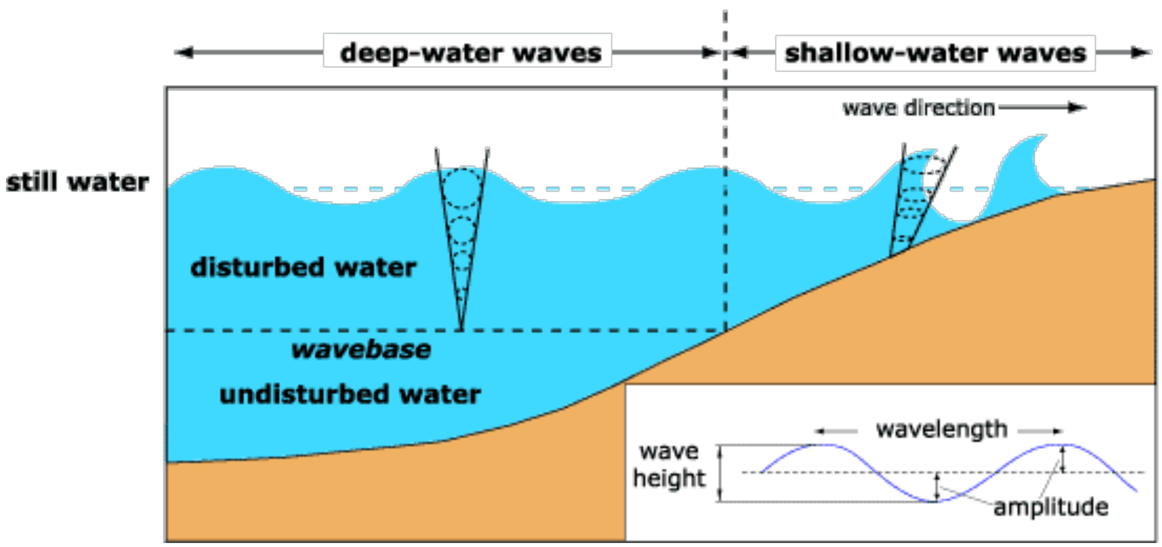
The energy of a wave is largely determined by its height. Just as with wind rippling grass, water particles do not travel with the wave. They remain essentially stationary while the energy of the wave moves through the water. This is an incredible efficient transfer of energy. Waves generated by storms can travel thousands of kilometers without losing much energy, i.e. height.

As a wave passes, water particles move in nearly circular orbits. At the surface, the diameter of the orbit equals the wave height. The orbits decrease with depth until eventually they diminish to zero. The depth where particle orbiting ends defines the **wavebase**. The depth of the wavebase is approximately one half the wavelength. Below the wavebase, the water is undisturbed by the passage of waves.

Wavebase

The relation between the wavebase and water depth defines two types of waves:

- **deep-water waves**: wavebase is less than the water depth, for these waves, the wave is not affected by the sea bottom, the waves advance with little loss of energy or change in physical characteristics
- **shallow-water waves**: the wavebase is greater than the water depth, these waves are affected by the sea bottom, the base of the wave is slowed causing the wave to steepen, as the water depth shallows, the wave height increases



Mechanics

The various parameters of a wave cannot vary independently of each other. Rather, there are fixed mathematical relations between the various components of a wave. These have been deduced and confirmed by observation of countless waves. These relations are relative simple equations. The velocity (V_w) of a deep-water wave equals the wavelength (L) divided by the wave period (T).

$$\text{velocity } (v_w) = \frac{\text{wavelength } (L)}{\text{period } (T)}$$

$$v_w = L/T$$

The depth to the wavebase (D_{wb}) equals half the wavelength (L).

$$\text{wavebase depth } (D_{wb}) = \frac{\text{wavelength } (L)}{2}$$

$$D_{wb} = L/2$$

Types Waves are produced as wind blows over a water surface. Originates from frictional drag of one fluid (air) moving over the surface of another (water). Characteristics of wave are determined by:

- wind speed
- duration of wind
- fetch (distance over which wind blows across a continuous water surface)

Variations of these three factors produce different wave types:
seas are short, choppy waves within and near storms. They produce a confused and chaotic sea surface without any discernable pattern.

Swells are a series of waves with similar size and characteristics. Generally they are produced by a storm hundreds or thousands of kilometers away. As the original waves from the storm leave the area of the storm and move outward, they change in shape to produce swells.

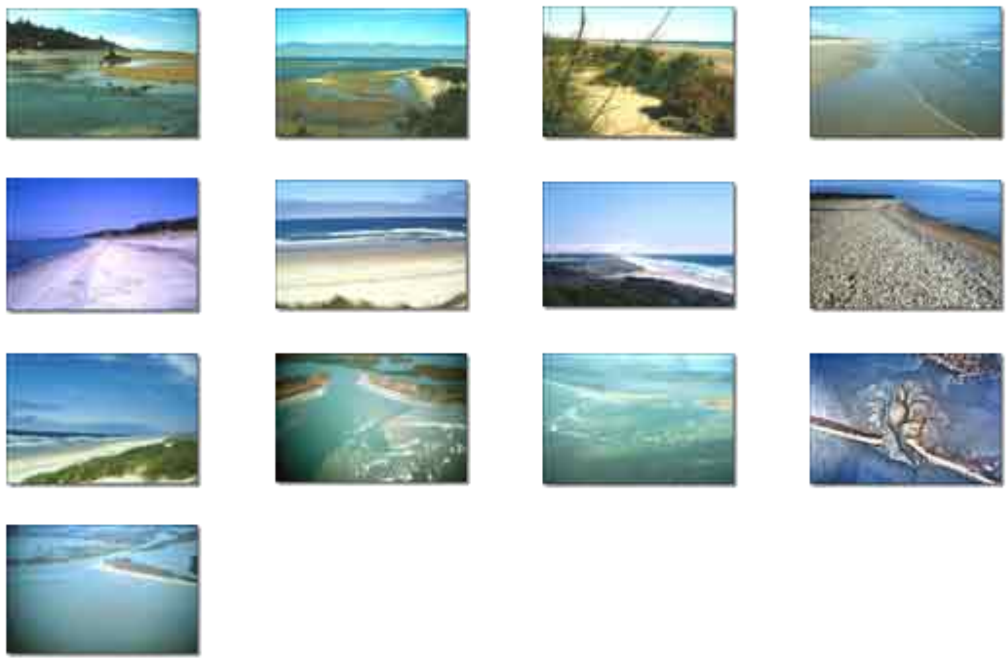
surf or **breakers**: These waves form when other waves shoal and break against the shore because of interaction with the ocean floor. They impart a great amount of energy from the ocean to the shoreline.

breakers

surf

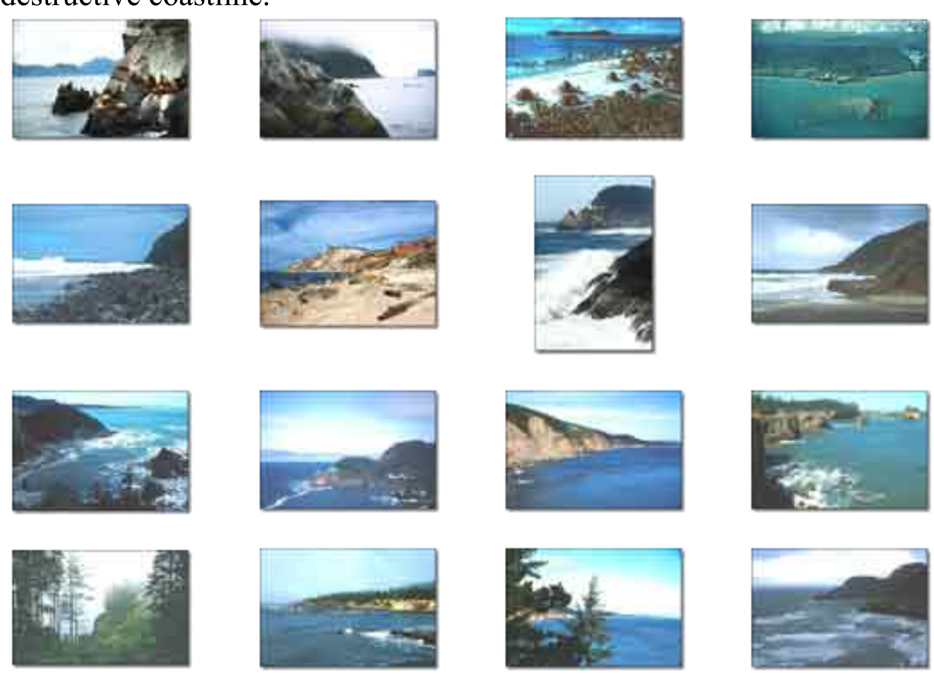
Constructive coasts

Constructive coasts are ones in which the dominate geologic processes are depositional in nature. The East Coast of the United States is a classic example of a constructive coast. This photo gallery illustrates some of the common characteristics of a constructive coastline.



Destructive coasts

Destructive coasts are ones in which the dominate geologic processes are erosional in nature. The West Coast of the United States is a classic example of a destructive coast. This photo gallery illustrates some of the common characteristics of a destructive coastline.



Reference:

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