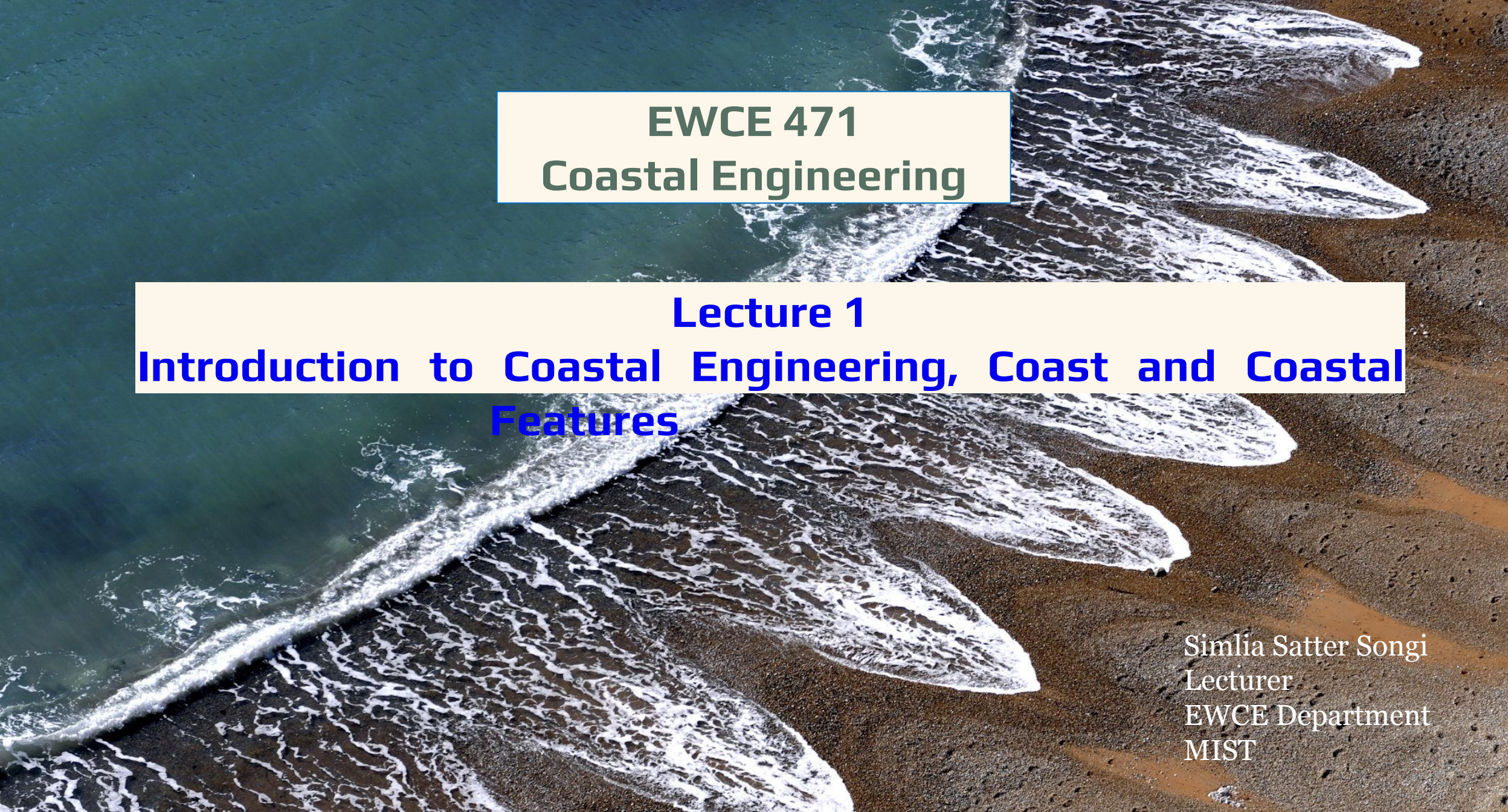


EWCE 471
Coastal Engineering

Lecture 1
Introduction to Coastal Engineering, Coast and Coastal Features

Simlia Satter Songi
Lecturer
EWCE Department
MIST

What is the Difference Between a Sea and an Ocean?

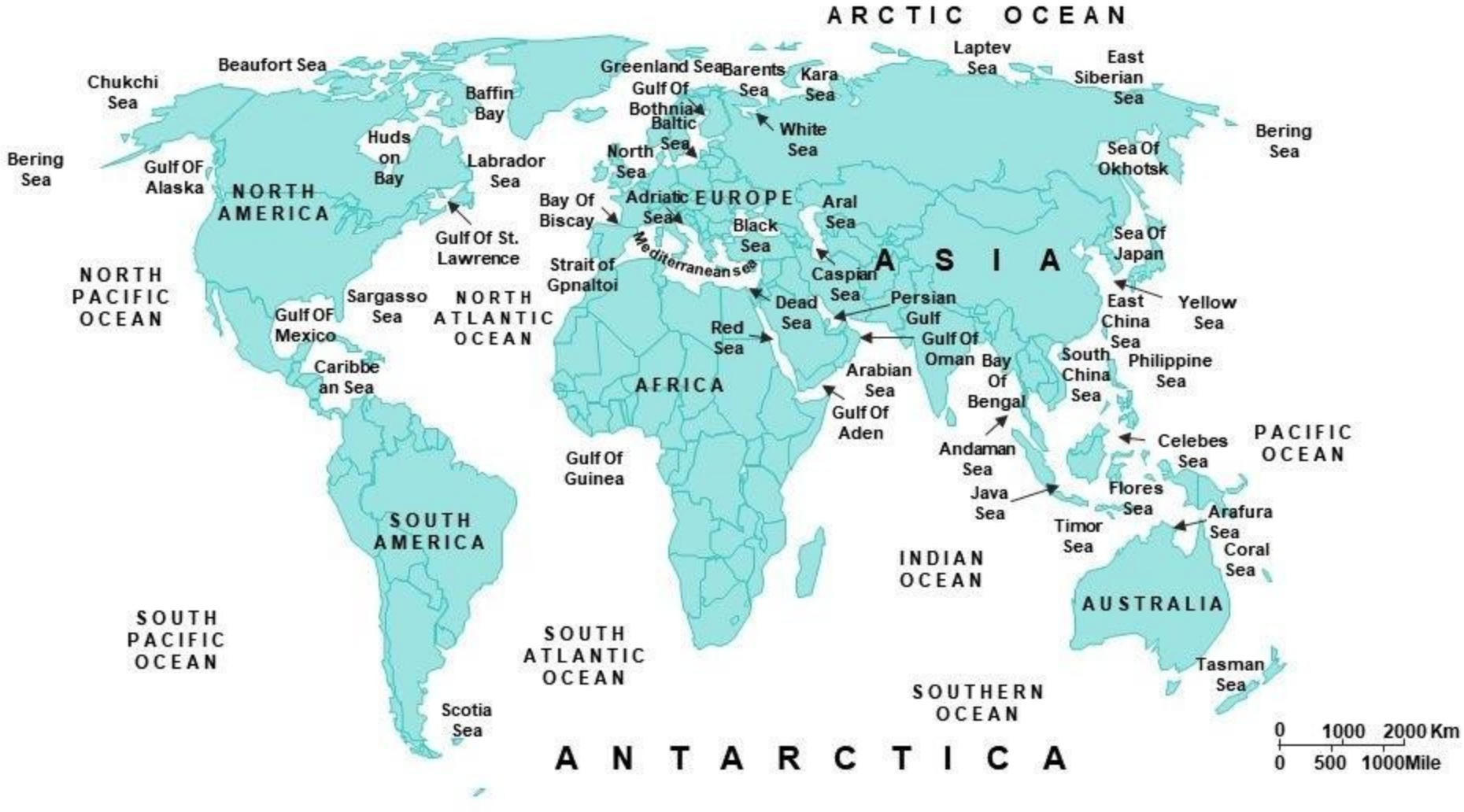


Ocean

- An ocean represents a far larger body of open water than a sea.
- Oceans are gigantic masses of water that covers around 70% of the earth. They are larger than the sea and deeper too.
- There are five oceans in the world, the Pacific ocean, Atlantic ocean, the Arctic ocean, the Indian ocean and the Antarctic ocean.

Sea

- A sea is a smaller part of an ocean and is typically partially contained by an area of land.
- Sea refers to a body of water which is smaller in size than the ocean.
- It is where the ocean meets the land and comprises of saline water.
- All of the seas are partially enclosedby land except for the Caspian Sea, which is enclosed by land on all sides.


ARCTIC OCEAN
Laptev Sea
East Siberian Sea
Beaufort Sea
Chukchi Sea
Greenland Sea
Barents Sea
Kara Sea
Baffin Bay
Gulf Of Bothnia
Baltic Sea
White Sea
Bering Sea
Huds on Bay
Labrador Sea
North Sea
Sea Of Okhotsk
Bering Sea
Gulf OF Alaska
NORTH AMERICA
Bay Of Biscay
Adriatic Sea
EUROPE
Aral Sea
Black Sea
Sea Of Japan
Gulf Of St. Lawrence
Mediterranean Sea
Strait of Gpnaltoi
Caspian Sea
A S I A
NORTH PACIFIC OCEAN
Sargasso Sea
NORTH ATLANTIC OCEAN
Dead Sea
Persian Gulf
East China Sea
Yellow Sea
Gulf OF Mexico
Red Sea
Gulf Of Oman
South China Sea
Philippine Sea
Caribbe an Sea
AFRICA
Arabian Sea
Bay Of Bengal
Gulf Of Aden
Gulf Of Guinea
Andaman Sea
Celebes Sea
PACIFIC OCEAN
Java Sea
Flores Sea
Arafura Sea
SOUTH AMERICA
Timor Sea
Coral Sea
INDIAN OCEAN
AUSTRALIA
SOUTH PACIFIC OCEAN
SOUTH ATLANTIC OCEAN
Tasman Sea
SOUTHERN OCEAN
Scotia Sea
A N T A R C T I C A
0 1000 2000 Km
0 500 1000Mile

Largest Oceans

1. Pacific Ocean: 60,060,700 square miles
2. Atlantic Ocean: 29,637,900 square miles
3. Indian Ocean: 26,469,900 square miles
4. Southern Ocean: 7,848,300 square miles
5. Arctic Ocean: 5,427,000 square miles

Largest Seas

1. Mediterranean Sea: 1,144,800 square miles
2. Caribbean Sea: 1,049,500 square miles
3. South China Sea: 895,400 square miles
4. Bering Sea: 884,900 square miles
5. Gulf of Mexico: 615,000 square miles
6. Okhotsk Sea: 613,800 square miles

Important Difference between Ocean and Sea

Basis of Comparison	Ocean	Sea
Meaning	Water bodies covering 2/3rd of the surface of the earth.	Bodies of saltwater that surrounds its landmasses.
Size	Large water bodies	Comparatively smaller in size
Water	Saltwater	Saline water
Depth	Very deep	Comparatively less deep
Land	Not enclosed by land	Partially enclosed by land

Important Difference between Ocean and Sea

Basis of Comparison	Ocean	Sea
Marine Life	Rare	Abundant
Uses	Industrial uses like mining for natural gas, oil, etc.	Commercial uses like fishing, recreational sport activities
Area	Covers a larger area	Covers smaller area in comparison
Example	Pacific Ocean, Atlantic Ocean, Indian Ocean, etc.	Mediterranean Sea, Caribbean Sea, South China Sea, etc.

Differences between Ocean and Sea

- **Size:** In terms of size, seas are generally smaller in area when compared to the oceans.

  As a general fact the smallest ocean, Arctic Ocean, has larger area than the largest sea i.e. Mediterranean Sea.

- **Depth:** We have some of the deepest trenches in the ocean beds with the challenger depth in the Mariana Trench of Pacific Ocean being deepest point on the Earth's geological crustal surface.

- While, seas generally are not so deeper when compared to the oceans.

  Fact: Carribean Sea is the deepest sea.

Differences between Ocean and Sea

- **Land proximity:** The seas generally touch the land surface on either of its shores where as oceans are not localized to any particular landmass. Eg - Arabian Sea is near the Arabian Peninsula and the South China Sea is in the Southern coast of China.
- While Oceans are not localized to any particular region or country.
-

Fact: Indian Ocean is the only ocean named after a country while Sargasso Sea is the only sea not surrounded by any landmass on all direction.

- **Marine Life:** The seas being shallower thrives marine lives of species that require more sunshine. While the oceans are deeper and thrive species that have their own luminous sources to guide in the dark and deep oceans floors.

Introduction to Coastal Engineering, Coast and Coastal Features

❑ Coastal engineering

Coastal engineering is the study of the processes ongoing at the shoreline and construction within the coastal zone.

The field involves aspects of near shore oceanography, marine geology, and civil engineering, often directed at combating erosion of coasts or providing navigational access.

❑ Coastal science

This field is a suite of interdisciplinary technologies applied to understanding processes, environments, and characteristics of the coastal zone

Coastal Zone

Coastal zone is the interface where the land meets the ocean encompassing shoreline environment as well as adjacent coastal waters.

Its components can include river deltas, coastal planes, wet lands, beaches, reefs, mangrove forest, lagoons and other coastal features.

The coastal zone is divided into four subzones. They are,

- Coast
- Shore
- Shore face
- Continental shelf

Coast

is the part near the water edge which never gets wet. It does not imply a simple line but is considered as a boundary in three dimensional space

Shore

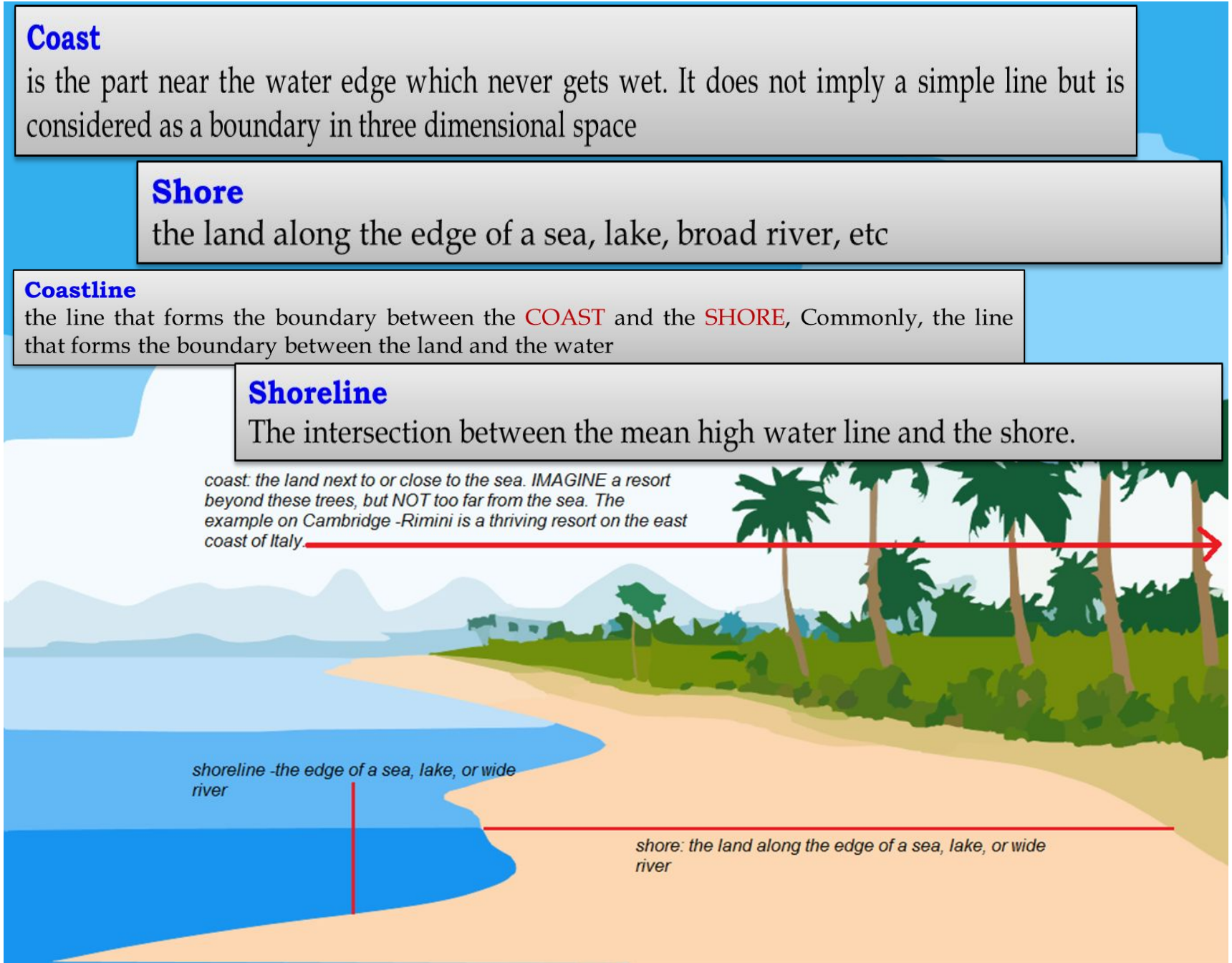
the land along the edge of a sea, lake, broad river, etc

Coastline

the line that forms the boundary between the COAST and the SHORE, Commonly, the line that forms the boundary between the land and the water

Shoreline

The intersection between the mean high water line and the shore.



- **Coast**

is the part near the water edge which never gets wet. It does not imply a simple line but is considered as a boundary in three dimensional space

- **Shore**

the land along the edge of a sea, lake, broad river, etc

- **Beach**

A **beach** is a landform alongside a body of water which consists of loose particles. The particles composing a beach are typically made from rock, such as sand, gravel, shingle, pebbles, or cobblestones

- **Coastline**

the line that forms the boundary between the COAST and the SHORE, Commonly, the line that forms the boundary between the land and the water

- **Shoreline**

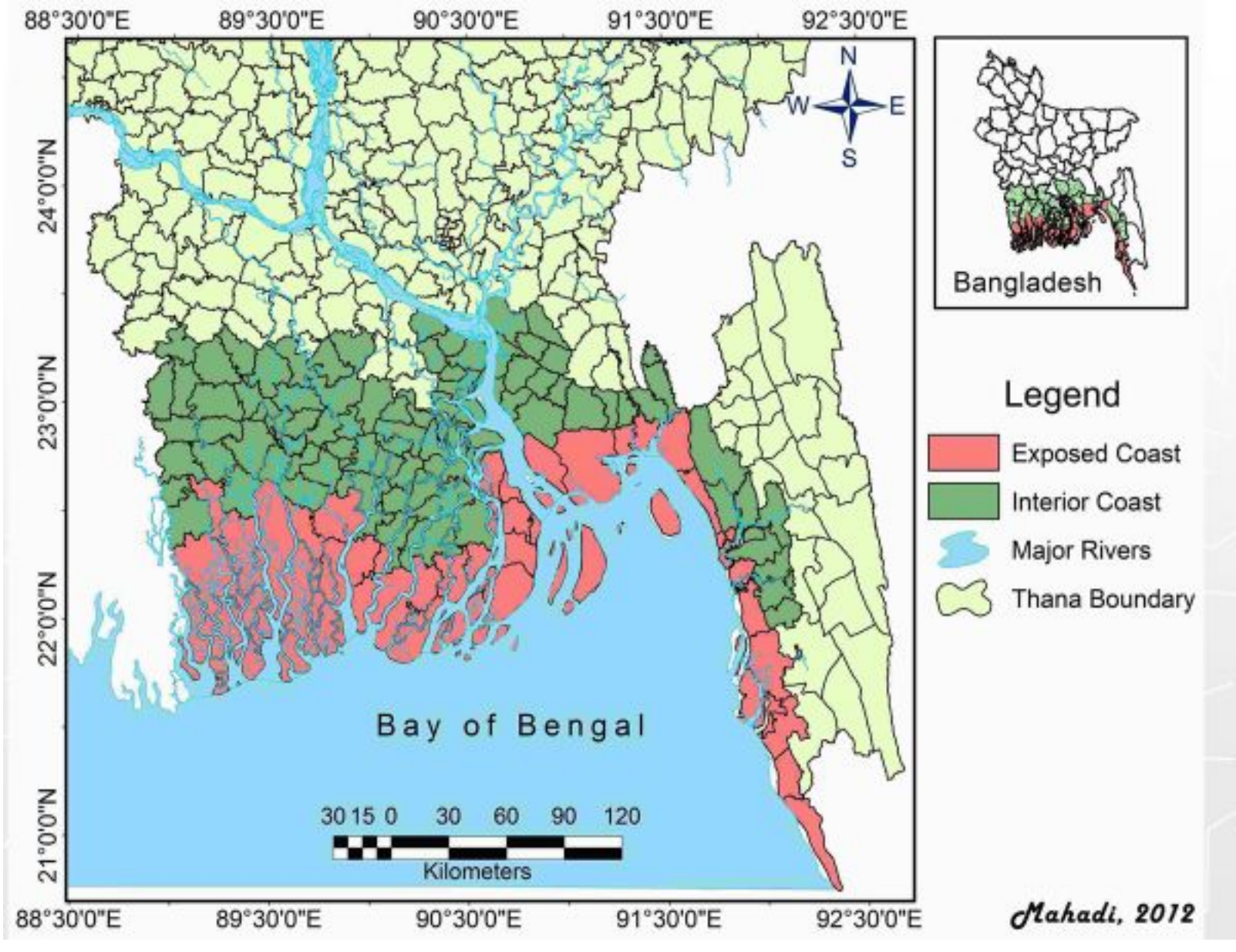
The intersection between the mean high water line and the shore. The shoreline is not easy to identify in the nature in contrast to the coastline, which is based on a clear morphological shift between the shore and the coast

- **Coastal Area**

The land and sea areas bordering the shoreline

- **Coastal Hinterland**

The land that extends landward of the coast and which is not influenced by coastal processes

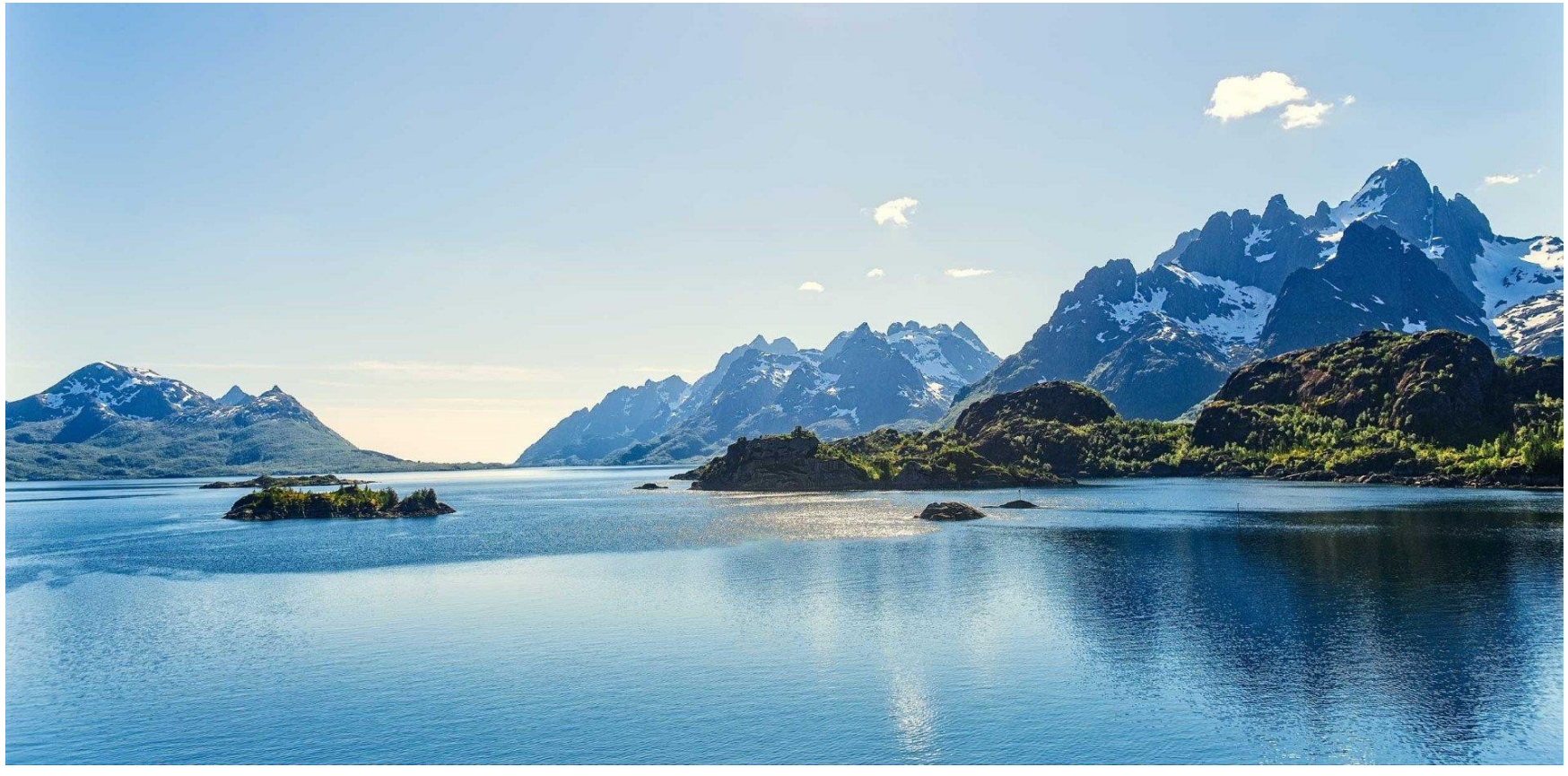

88°30'0"E
89°30'0"E
90°30'0"E
91°30'0"E
92°30'0"E
24°0'0"N
23°0'0"N
22°0'0"N
21°0'0"N
N
W
E
S
Bangladesh
Legend
Exposed Coast
Interior Coast
Major Rivers
Thana Boundary
Bay of Bengal
30 15 0 30 60 90 120
Kilometers
Mahadi, 2012

Longest Coastlines of the World

1. Canada 202,080 km



2. Norway 83,281km



3. Indonesia 54, 720 km



4. Greenland 44,087 km



5. Russia 37,653 km



Length of the Coastline of Bangladesh 580 km



Course Content

Section A (Lec Rafid)	Section B (Lec Simlia)
✔ Coast and coastal features	✔ Tides and currents;
✔ waves and its characteristics	✔ tidal flow measurement;
✔ forces of waves and tides in the design of coastal and harbour structures	✔ coastal zone processes;
✔ coastal water level fluctuation - storm surge, tsunami and basin oscillation	✔ deltas and its characteristics;
✔ estuary and estuary control	✔ docks and harbours;
	✔ design of shore protection works

Course Outcome

- **CO1** : to understand the basic nomenclature of coast and coastal zones, beach profiles, humans and the coastal zones, factors influencing coastal morphology and processes
- **CO2** : to understand the tides and coastal processes: characteristics of tides, theory behind tidal analysis and prediction, tidal flow measurement
- **CO3** : to understand the coastal water level fluctuations: tides, storm surge, wind setup, basin oscillations, mechanics of wave motion: linear wave theory, wave kinematics, wind wave generation, wave refraction, diffraction and reflection
- **CO4 :** to apply the principles coastal processes, sediment transport, deltas and delta management plan, estuary and estuary control
- **CO5** : to apply fundamental concepts in designing shore protection works and planning dock and harbour

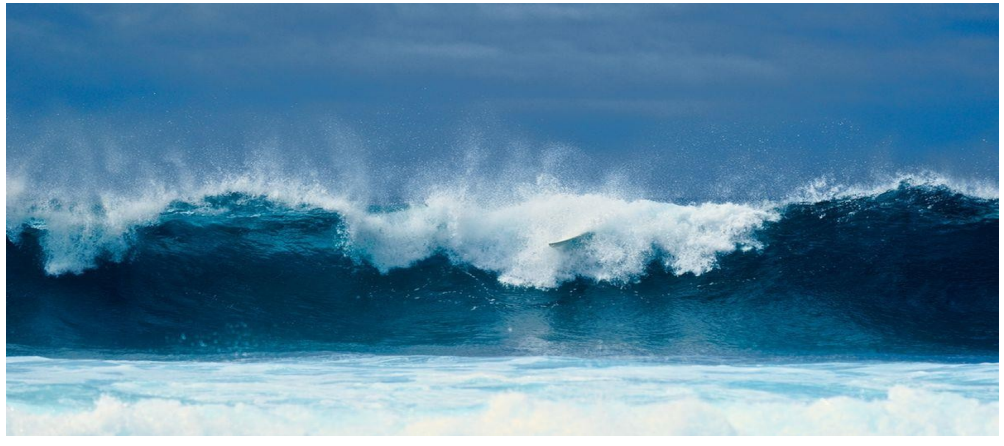
Reference Books

- Coastal Engineering Manual by Us Army Corps of Engineers (USACE)
- Dock and Harbour Engineering (Second Edition) by Oza and Oza
- Coastal Engineering-2 by R Silverster
- Shore Protection Manual, U.S. Army Coastal Engineering Research Center
- Estuary and Coastline Hydrodynamics, A.T. Ippen (ed.) : McGraw-Hill Book Co., Inc., 1966.

Coastal Engineering Vocabulary

Waves

- A deformation of the water's surface
- When the wind blows over water it exerts a drag on water surface and water by virtue of its fluidity gets disturbed giving rise to waves.
- Such waves are referred as wind waves or storm waves.
- Waves are usually defined by their height, length and period.

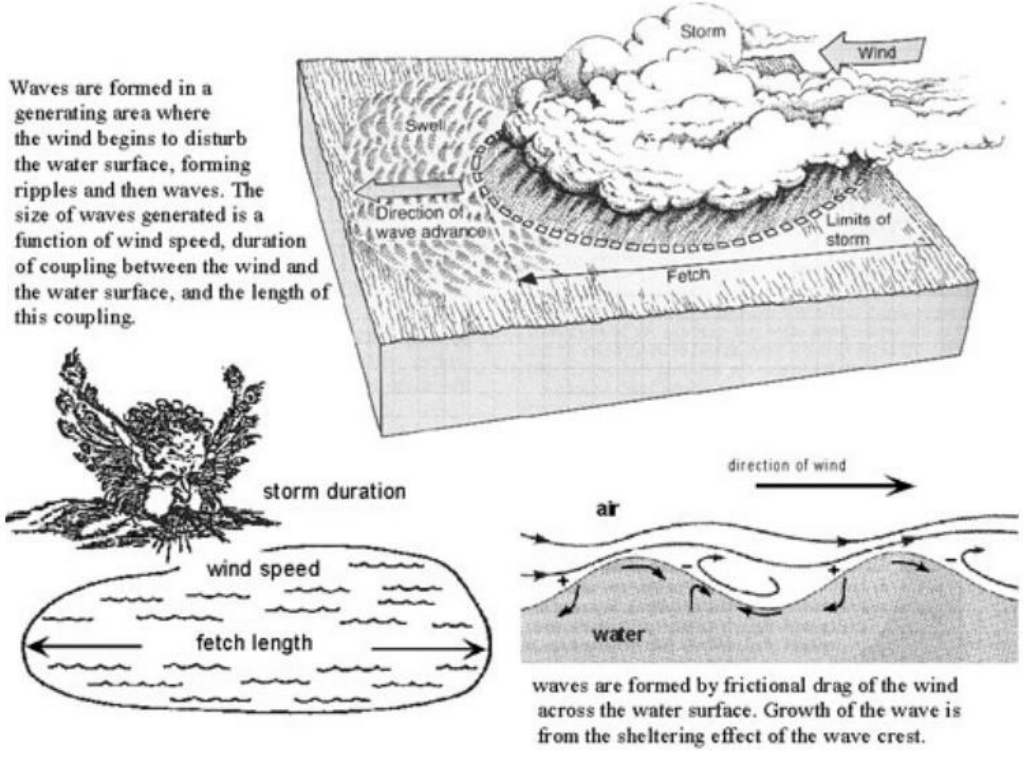


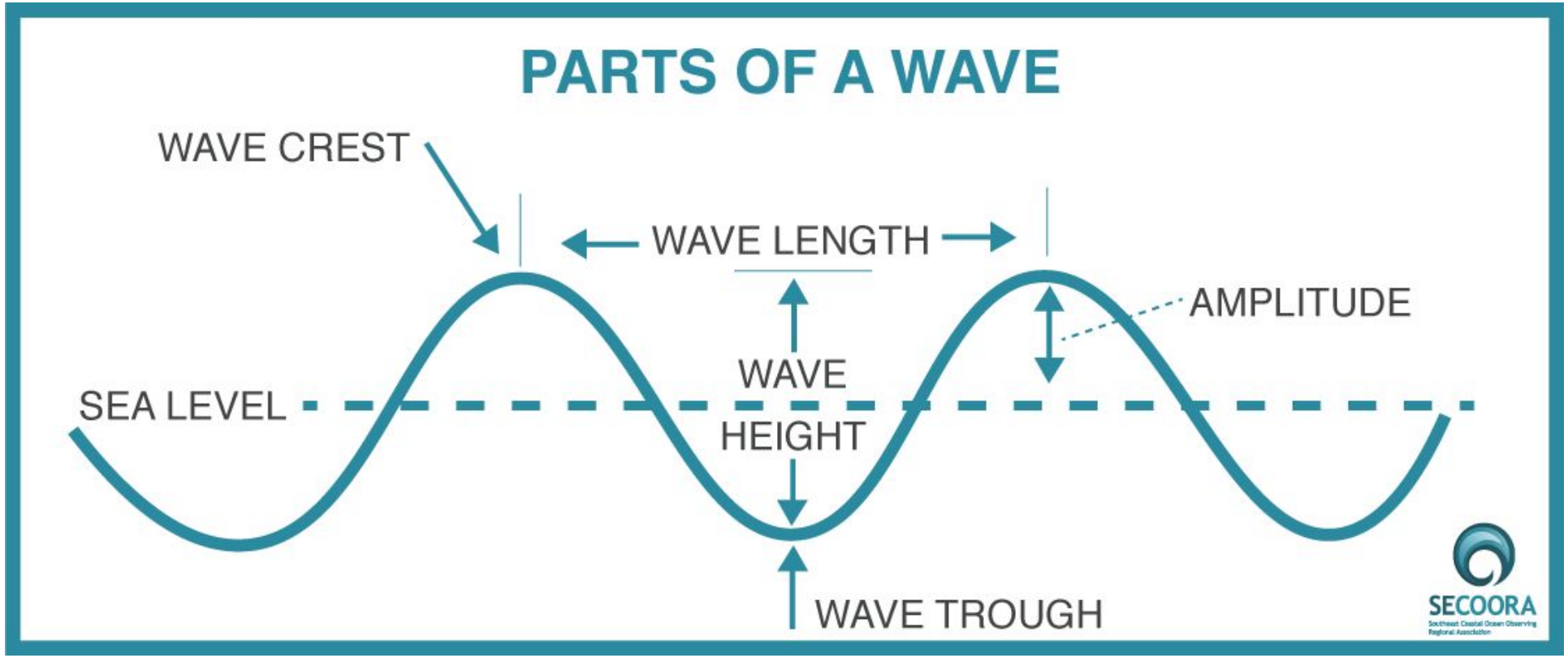
Wav

Duration - length of time the wind blows.

Wind speed - How fast the wind is blowing.

Fetch - The horizontal distance (in direction of the wind) over which a wind blows.




PARTS OF A WAVE
WAVE CREST
WAVE LENGTH
AMPLITUDE
WAVE
HEIGHT
SEA LEVEL
WAVE TROUGH
SECOORA
Southeast Coastal Ocean Observing
Regional Association

Waves

Crest

- The highest point on a wave.

Trough

- The lowest point on a wave.

Wavelength

- horizontal distance, either between the crests or troughs of two consecutive waves.

Wave height

- vertical distance between a wave's crest and the next trough.

Wave period

- The time it takes for two consecutive crests or troughs to pass a stationary point.

Refraction

Wave reflection occurs when waves “bounce back” from an obstacle they encounter. Reflected waves can cause interference with oncoming waves, creating standing waves.

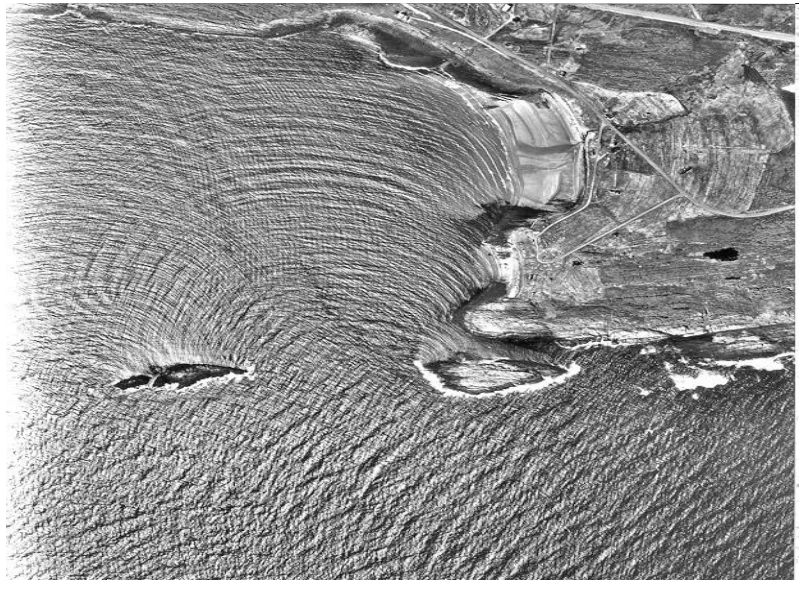


Example of water wave refraction at Allenhurst, Lock Arbour, Asbury Park, 1987.

Diffraction

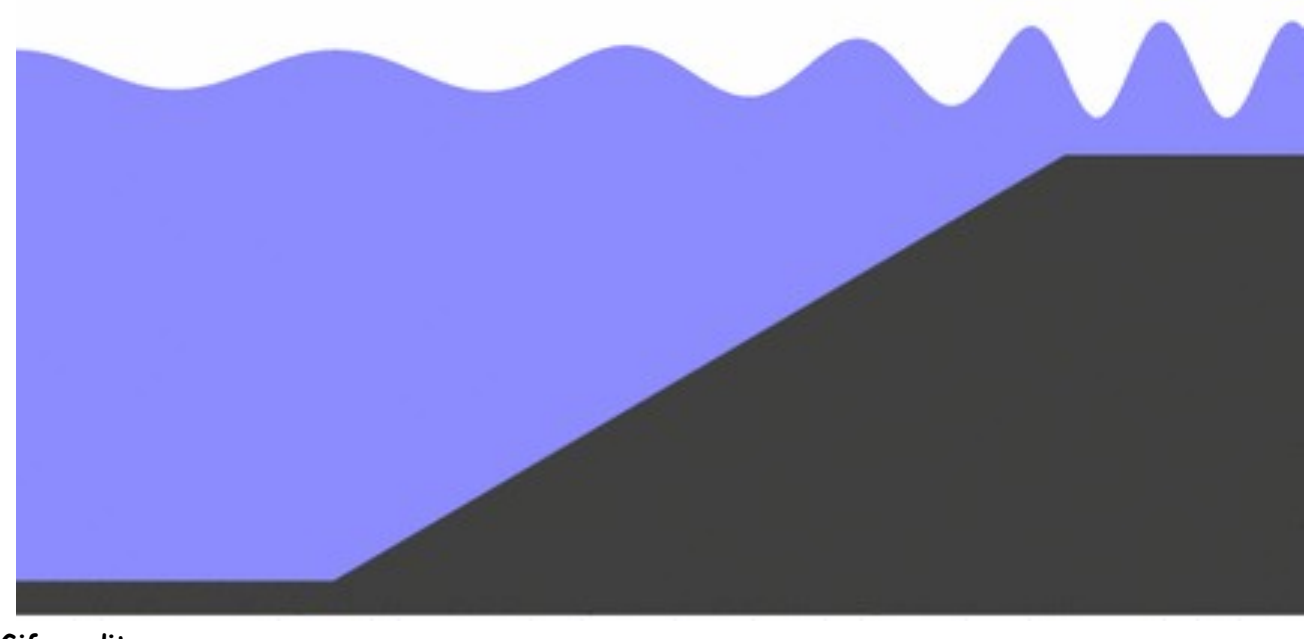
Diffraction can be seen when there are sheltering structures such as breakwaters.

Diffraction is the process by which the waves propagate into the lee zone behind the structures by energy transmittance laterally along the wave crests.



Shoaling

As the wave moves from deep water towards the coast its height generally increases and its length reduces. This phenomenon is known as shoaling.



Gif credit:
http://upload.wikimedia.org/wikipedia/commons/2/2d/Propagation_du_tsunami_en_profondeur_variable.gif.

Types of Currents

A body of water or air moving in a definite direction, especially through a surrounding body of water or air in which there is less movement is called current.

Surface Current:

- These are currents that occur near the ocean's surface. They involve large masses of water moving horizontally.
- At the surface, currents are mainly driven by four factors—wind, the Sun's radiation, gravity, and Earth's rotation. All of these factors are interconnected. The Sun's radiation creates prevailing wind patterns, which push ocean water to bunch in hills and valleys. Gravity pulls the water away from hills and toward valleys and Earth's rotation steers the moving water.

Shoreline Current:

- Local currents that run along the shore are caused by winds and shifting sands

Longshore Current:

- type of shoreline current that carries large amounts of materials from one place to another.

Rip Current:

- Shoreline current that flows away from the beach.

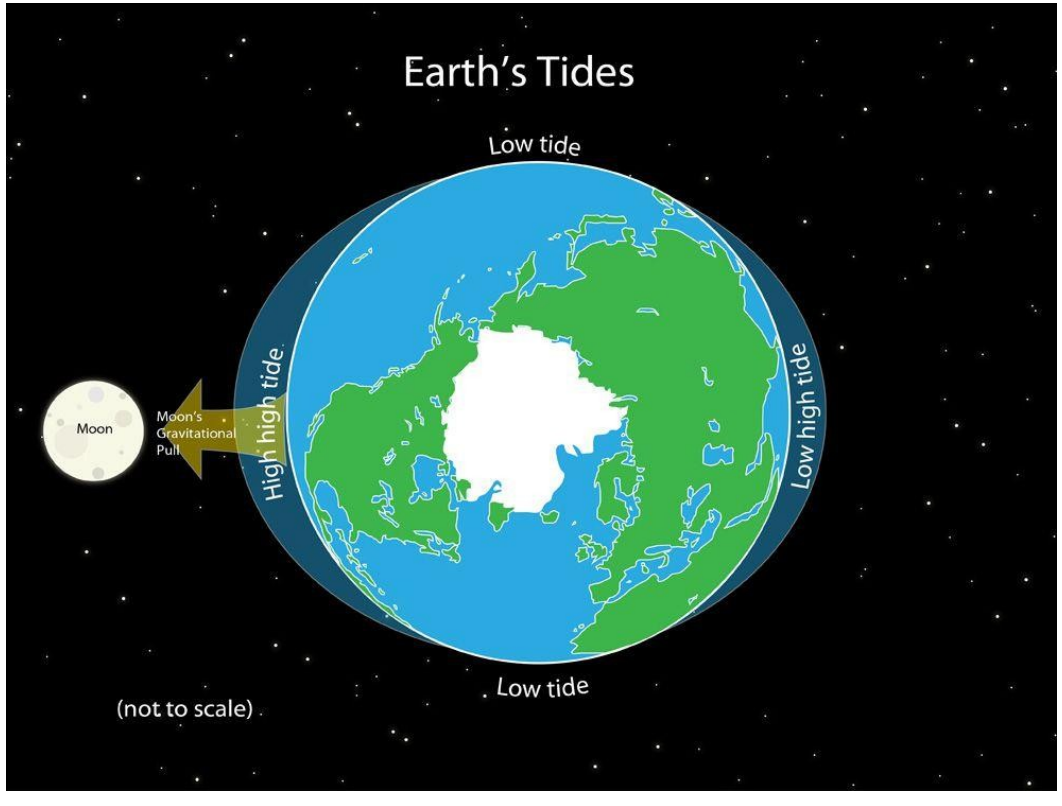
Deep Ocean Current:

- caused by differences in water temperature Cold water is heavier than warm water so it sinks.

Tid

Two bulges of water - one on the side of the earth facing the moon (and sun) and one on the opposite side.

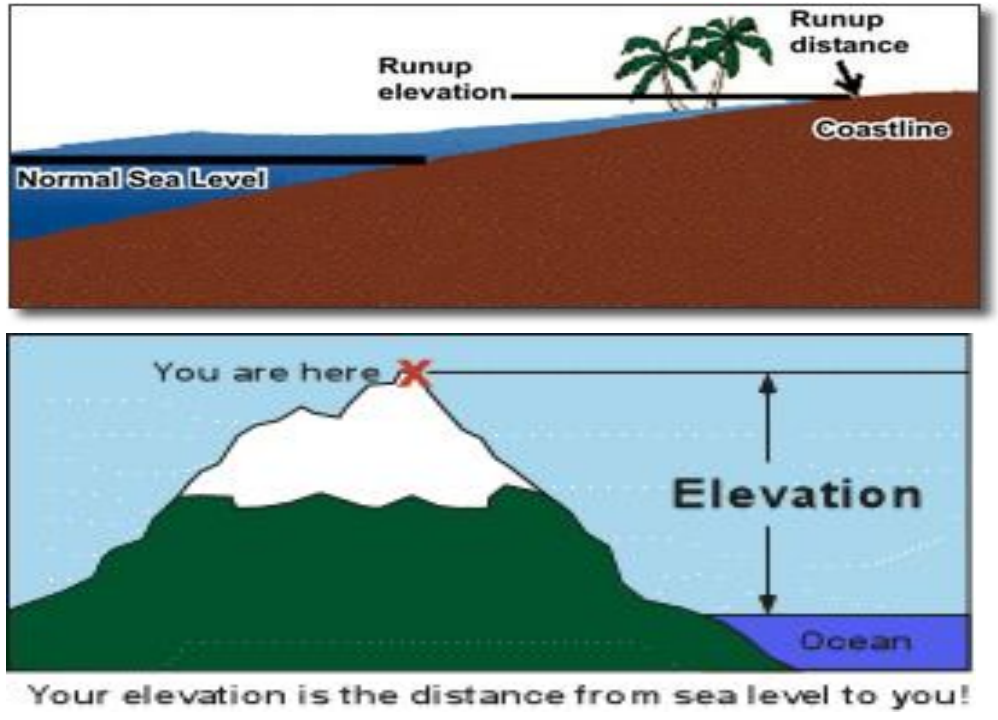
The bulges are stationary (relative to the Moon or sun), but the rotation of the earth about its polar axis causes the bulges to move relative to the earth.



Sea Level: the level of the sea's surface

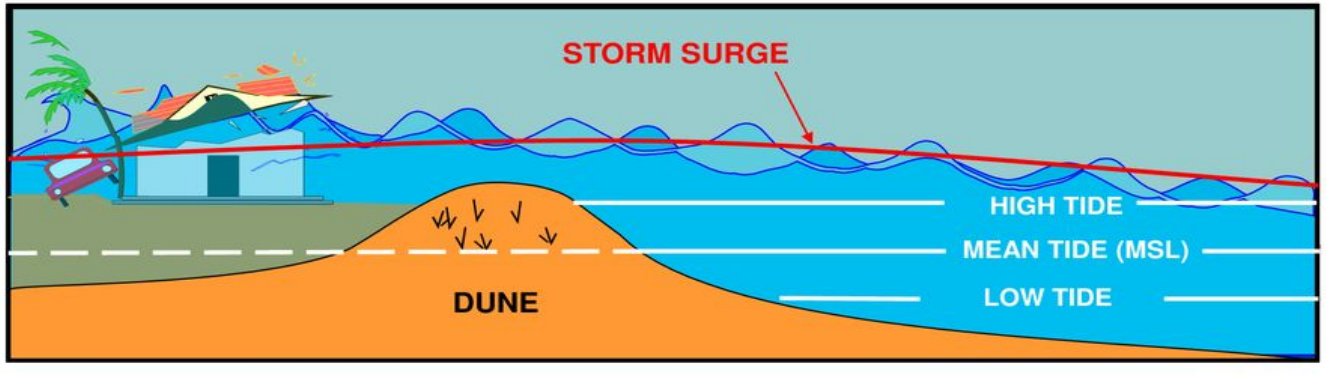
Mean sea level (MSL)

is an average level of the surface of one or more of Earth's oceans from which heights such as elevations may be measured. MSL is a type of vertical datum.



Sea level Fluctuation: Storm Surge

A storm surge is a change in sea level from the usual predicted tidal water levels driven by weather systems. It can reach heights of 8m.



Sea level
Fl
Su

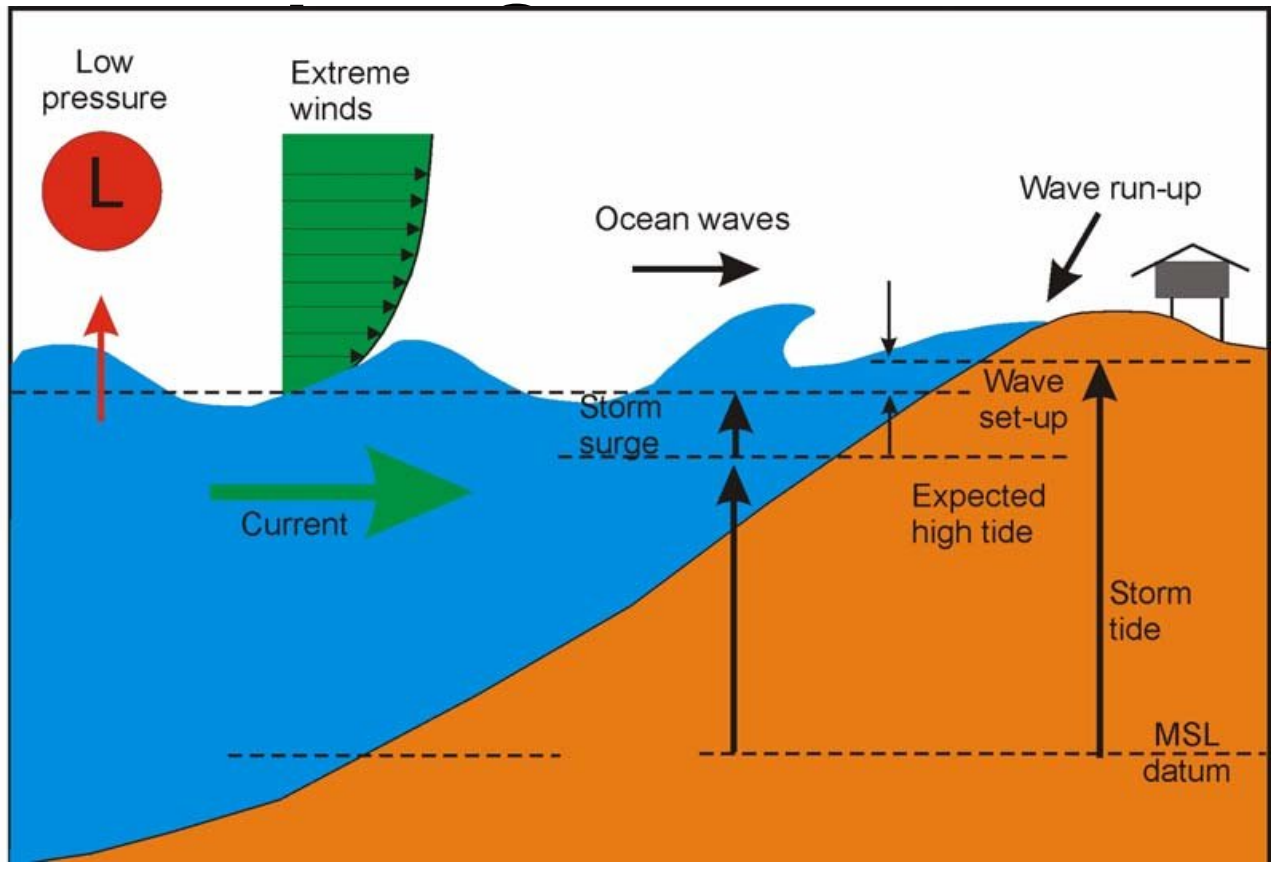
Components:

Pressure surge

Wind surge

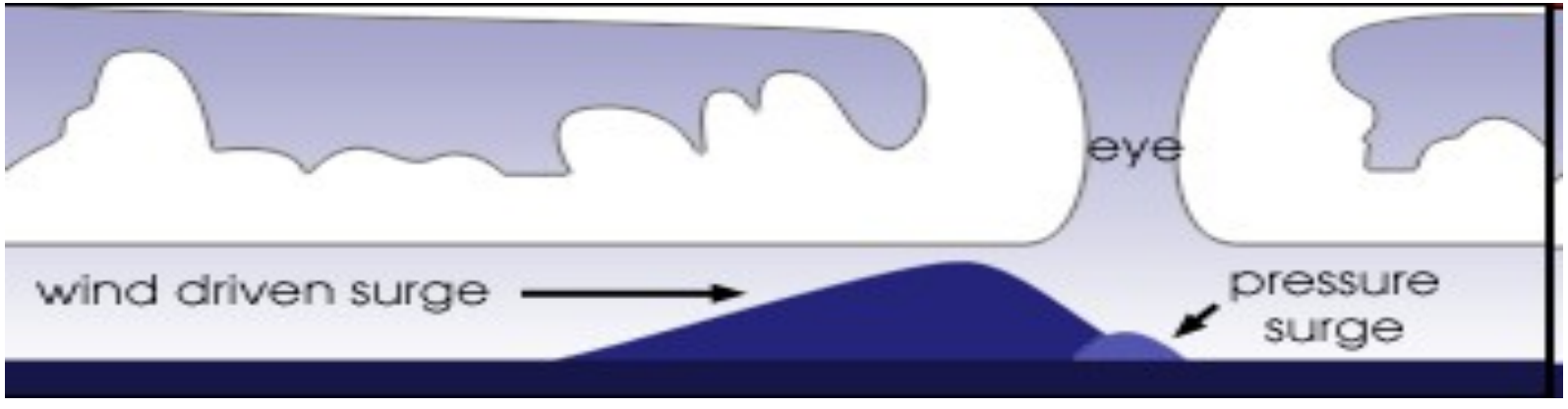
Wave setup

Wave run-up



Pressure Surge

- It is a pressure wave caused due to a sudden change in flow velocity.
- The light blue bulge represents to water surface increase due to the reduced pressure in the eye of the storm.



Wind Driven Surge

Surface stress (due to the wind) is balanced by a water surface slope.

Wind surge becomes more pronounced in shallow water.

ANALOGY - if several people sit around the edge of a waterbed, the center of the bed rises!

Wave Run-up

Wave runup is the maximum vertical extent of wave uprush on a beach or structure above the still water level (SWL).



Wave Setup

Wave setup is the elevation of the mean water level at the shoreline due to wave breaking in the surf zone.

Thank You