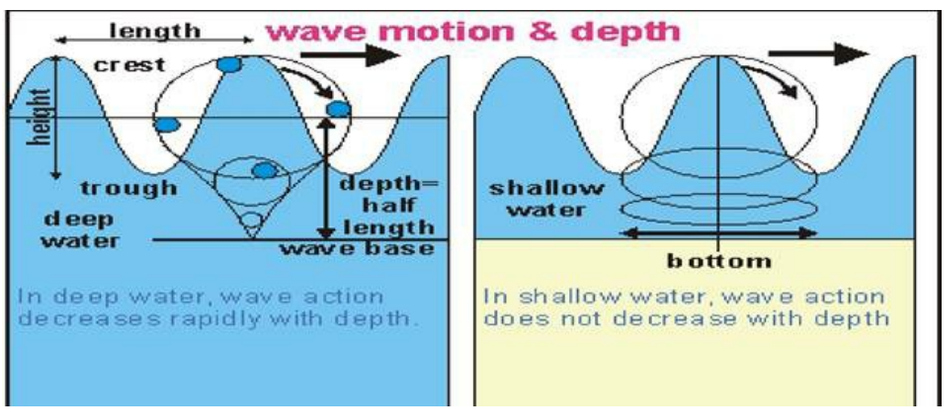
Fundamental of Physical Geography
Chapter-14 Movements of Ocean Water

This chapter deals with :

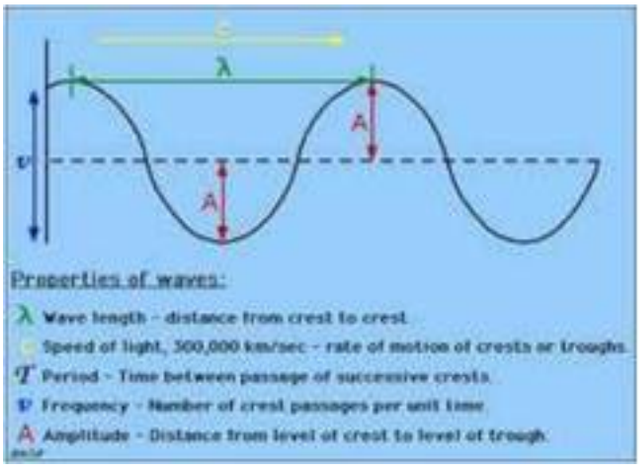
- Waves
- Effects of Ocean Currents
- Types of Tides Semidiurnal, Diurnal Tide, Mixed, Spring, Neap Tides
- Characteristics of Waves Tides Factors Influencing Waves and Tides
- Ocean Currents
- Types of Ocean Currents
- Major Ocean Currents
- Importance of Tides

The ocean water is dynamic. Its physical characteristics like temperature, salinity, density and the external forces like of the sun, moon and the winds influence the movement of ocean water.The horizontal and vertical motions are common in ocean water bodies.The horizontal motion refers to the ocean currents and waves.
The vertical motion refers to tides.Water moves ahead from one place to another through ocean currents while the water in the waves does not move, but the wave trains move ahead.The vertical motion refers to the rise and fall of water in the oceans and seas.Due to attraction of the sun and the moon, the ocean water is raised up and falls down twice a day. The upwelling of cold water from subsurface and the sinking of surface water are also forms of vertical motion of ocean water.

WAVES



Waves are actually the energy, not the water as such, which moves across the ocean surface. Wind causes waves to travel in the ocean and the energy is released on shorelines.



Characteristics of Waves :

- **Wave crest and trough:** The highest and lowest points of a wave are called the crest and trough respectively.
- **Wave frequency:** It is the number of waves passing a given point during a one second time interval.
- **Wave amplitude:** It is one-half of the wave height.
- **Wave period:** It is merely the time interval between two successive wave crests or troughs as they pass a fixed point.
- **Wave height:** It is the vertical distance from the bottom of a trough to the top of a crest of a wave.
- **Wavelength:** It is the horizontal distance between two successive crests.
- **Wave speed:** It is the rate at which the wave moves through the water, and is measured in knots.

TIDES :

- The periodical rise and fall of the sea level, once or twice a day.
- Movement of water caused by meteorological effects are called surges.
- Surges are not regular like tides.
- The ‘tide-generating’ force is the difference between these two forces; i.e. the gravitational attraction of the moon and the centrifugal force.
- On the surface of the earth, the horizontal tide generating forces are more important than the vertical forces in generating the tidal bulges.

- The tidal bulges on wide continental shelves, have greater height.
- When tidal bulges hit the mid- oceanic islands they become low.
- When the tide is channeled between islands or into bays and estuaries they are called tidal currents.

Tides of Bay of Fundy, Canada

The highest tides in the world occur in the Bay of Fundy in Nova Scotia, Canada. The tidal bulge is 15 - 16 m. Because there are two high tides and two low tides every day (roughly a 24 hour period); then a tide must come in within about a six hour period. As a rough estimate, the tide rises about 240 cm an hour (1,440 cm divided by 6 hours).

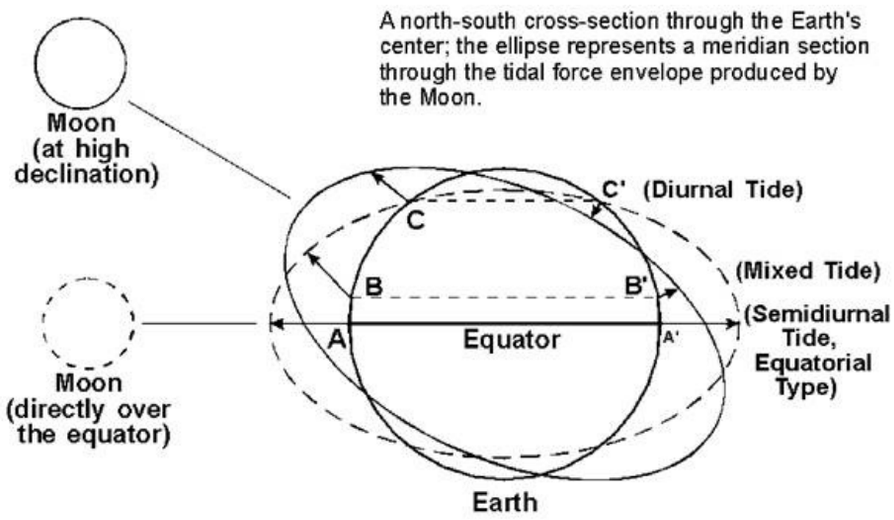
Types of Tides :

Tides vary in their direction and frequency, movement from place to place and also from time to time. Tides may be grouped into various types based on their frequency of occurrence in one day or 24 hours or based on their height.

Tides based on Frequency :

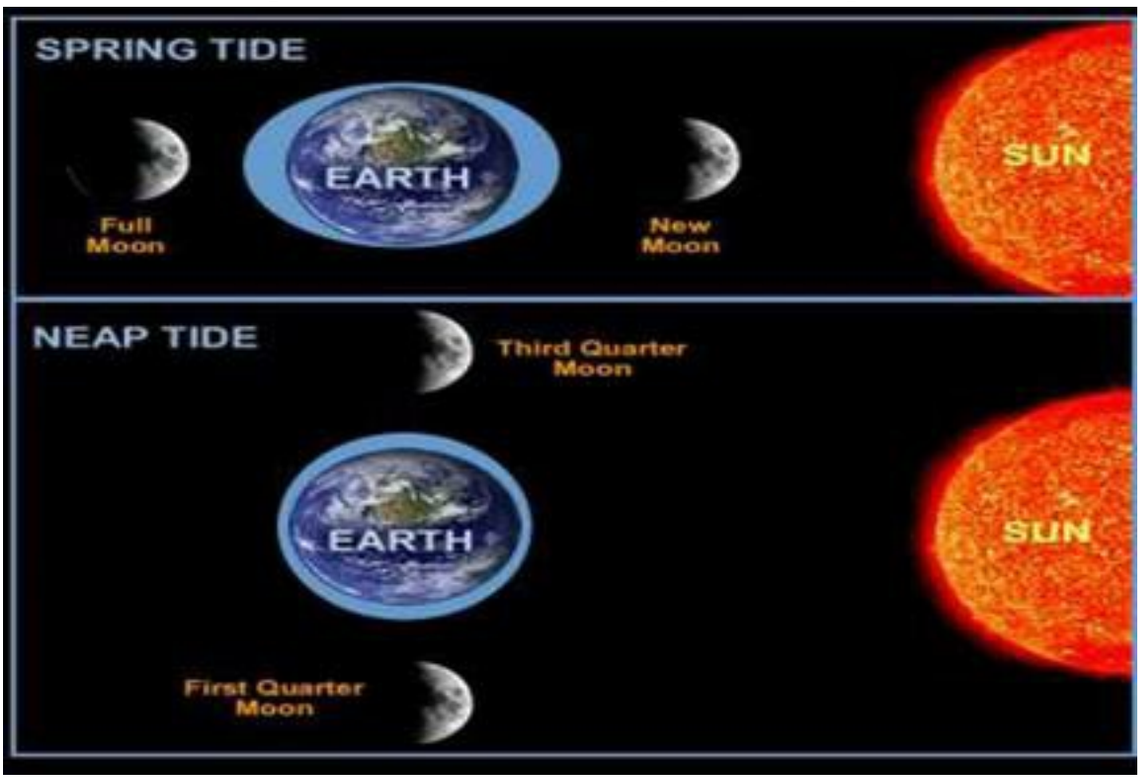
Semi-diurnal tide : The most common tidal pattern, featuring two high tides and two low tides each day. The successive high or low tides are approximately of the same height.

Diurnal tide : There is only one high tide and one low tide during each day. The successive high and low tides are approximately of the same height.



Mixed tide: Tides having variations in height are known as mixed tides. These tides generally occur along the west coast of North America and on many islands of the Pacific Ocean.Tides based on the Sun, Moon and the Earth Positions The height of rising water (high tide) varies appreciably depending upon the position of sun and moon with respect to the earth. Spring tides and neap tides come under this category.

Spring tides**:** The position of both the sun and the moon in relation to the earth has direct bearing on tide height. When the sun, the moon and the earth are in a straight line, the height of the tide will be higher. These are called spring tides and they occur twice a month, one on full moon period and another during new moon period.



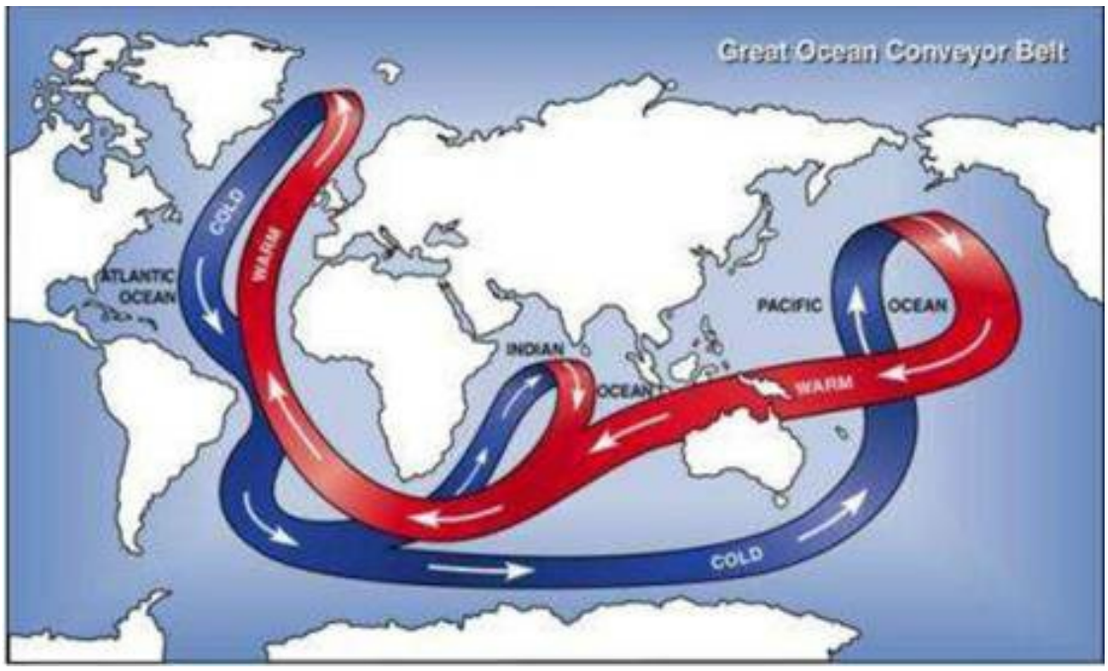
Neap tides: Normally, there is a seven day interval between the spring tides and neap tides.

At this time the sun and moon are at right angles to each other and the forces of the sun and moon tend to counteract one another. The Moon's attraction, though more than twice as strong as the sun's, is diminished by the counteracting force of the sun's gravitational pull. Once in a month, when the moon's orbit is closest to the earth (perigee), unusually high and low tides occur. During this time the tidal range is greater than normal. Two weeks later, when the moon is farthest from earth (apogee), the moon's gravitational force is limited and the tidal ranges are less than their average heights.

Importance of Tides :

- This helps the navigators and fishermen plan their activities.
- Tidal flows are of great importance in navigation.
- Tidal heights are very important, especially harbors near rivers and within estuaries having shallow 'bars' at the entrance, which prevent ships and boats from entering into the harbour.
- Tides are also helpful in desilting the sediments and in removing polluted water from river estuaries.
- Tides are used to generate electrical power (in Canada, France, Russia, and China). A 3 MW tidal power project at Durgaduani in Sunderbans of West Bengal is under way.

OCEAN CURRENTS



Ocean currents are like river flow in oceans. They represent a regular volume of water in a definite path and direction.

Ocean currents are influenced by two types of forces namely:

i. primary forces that initiate the movement of water;
ii. secondary forces that influence the currents to flow.

The primary forces that influence the currents are:

1. **Heating by solar energy :** Heating by solar energy causes the water to expand. That is why, near the equator the ocean water is about 8 cm higher in level than in the middle latitudes.
2. **Wind :** This causes a very slight gradient and water tends to flow down the slope.Wind blowing on the surface of the ocean pushes the water to move. Friction between the wind and the water surface affects the movement of the water body in its course.
3. **Gravity :** Gravity tends to pull the water down the pile and create gradient variation.
4. **Coriolis force :** The Coriolis force intervenes and causes the water to move to the right in the northern hemisphere and to the left in the southern hemisphere. These large accumulations of water and the flow around them are called Gyres. These produce large circular currents in all the ocean basins.

Characteristics of Ocean Currents :

1. Currents are referred to by their “drift”.
2. The currents are strongest near the surface and may attain speeds over five knots.
3. We refer to the speed of a current as its “drift.”
4. A current is usually strongest at the surface and decreases in strength (speed) with depth.
5. Drift is measured in terms of knots.
6. Differences in water density affect vertical mobility of ocean currents.
7. The strength of a current refers to the speed of the current. A fast current is considered strong.
8. Denser water tends to sink, while relatively lighter water tends to rise.
9. Most currents have speeds less than or equal to 5 knots.
10. At depths, currents are generally slow with speeds less than 0.5 knots.
11. Water with high salinity is denser than water with low salinity and in the same way cold water is denser than warm water.
12. Cold-water ocean currents occur when the cold water at the poles sinks and slowly moves

towards the equator.
Warm-water currents travel out from the equator along the surface, flowing towards the poles to replace the sinking cold water.

Types of Ocean Currents

The ocean currents may be classified based on their depth as surface currents and deep water currents:

i. surface currents constitute about 10 per cent of all the water in the ocean, these waters are the upper 400 m of the ocean;
ii. deep water currents make up the other 90 per cent of the ocean water. These waters move around the ocean basins due to variations in the density and gravity. Deep waters sink into the deep ocean basins at high latitudes, where the temperatures are cold enough to cause the density to increase.

Ocean currents can also be classified based on temperature:
as cold currents and warm currents:

i. cold currents bring cold water into warm water areas.
These currents are usually found on the west coast of the continents in the low and middle latitudes (true in both hemispheres) and on the east coast in the higher latitudes in the Northern Hemisphere;
ii. warm currents bring warm water into cold water areas and are usually observed on the east coast of continents in the low and middle latitudes (true in both hemispheres). In the northern hemisphere they are found on the west coasts of continents in high latitudes.

Major Ocean Currents Figure 14.31.

1. Major ocean currents are greatly influenced by the stresses exerted by the prevailing winds and coriolis force.
2. The oceanic circulation pattern roughly corresponds to the earth's atmospheric circulation pattern.
3. The air circulation over the oceans in the middle latitudes is mainly anticyclonic (more pronounced in the southern hemisphere than in the northern hemisphere).
4. In regions of pronounced monsoonal flow, the monsoon winds influence the current movements.
5. Due to the coriolis force, the warm currents from low latitudes tend to move to the right in the northern hemisphere and to their left in the southern hemisphere.
6. The oceanic circulation transports heat from one latitude belt to another in a manner similar to the heat transported by the general circulation of the atmosphere.
7. The cold waters of the Arctic and Antarctic circles move towards warmer water in tropical and equatorial regions, while the warm waters of the lower latitudes move pole wards.

Effects of Ocean Currents : Ocean currents have a number of direct and indirect influences on human activities.

1. West coasts of the continents in tropical and subtropical latitudes (except close to the equator) are bordered by cool waters.
2. The best fishing grounds of the world exist mainly in these mixing zones.
3. There is fog, but generally the areas are arid.
4. The mixing of warm and cold currents help to replenish the oxygen and favor the growth of planktons, the primary food for fish population.
5. They are characterized by cool summers and relatively mild winters with a narrow annual range of temperatures.
6. West coasts of the continents in the middle and higher latitudes are bordered by warm waters which cause a distinct marine climate.
7. Warm currents flow parallel to the east coasts of the continents in tropical and subtropical latitudes. This results in warm and rainy climates.
8. These areas lie in the western margins of the subtropical anti-cyclones.
9. Their average temperatures are relatively low with a narrow diurnal and annual ranges.