Movements of ocean water: Waves, Tides and Ocean Currents

Our Geography notes continue. Having covered the most important concepts in land, we are now dealing with the water (hydrosphere). In the last article, we have seen the ocean bottom topography. In this comprehensive post, we will cover the movements of ocean water – waves, tides and ocean currents. We hope the notes will turn highly handy for quick learning and last-minute revision.

Movements of ocean water: The classification

You all know that the ocean water is never still. There are different types of movements of ocean water under the influence of different physical characteristics like temperature, salinity, density, etc. Movements of ocean water are also affected by external forces like the sun, moon and the winds.

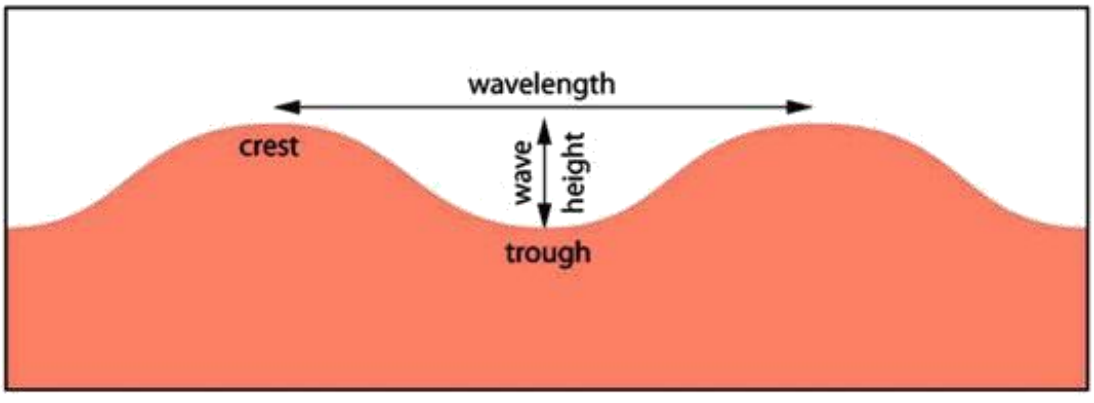
The major movements of the ocean waters can be classified into three. They are:

1. Waves
2. Tides
3. Ocean Currents

Waves and the ocean currents are horizontal movements of ocean waters while the tide is a kind of vertical movement of the ocean water.

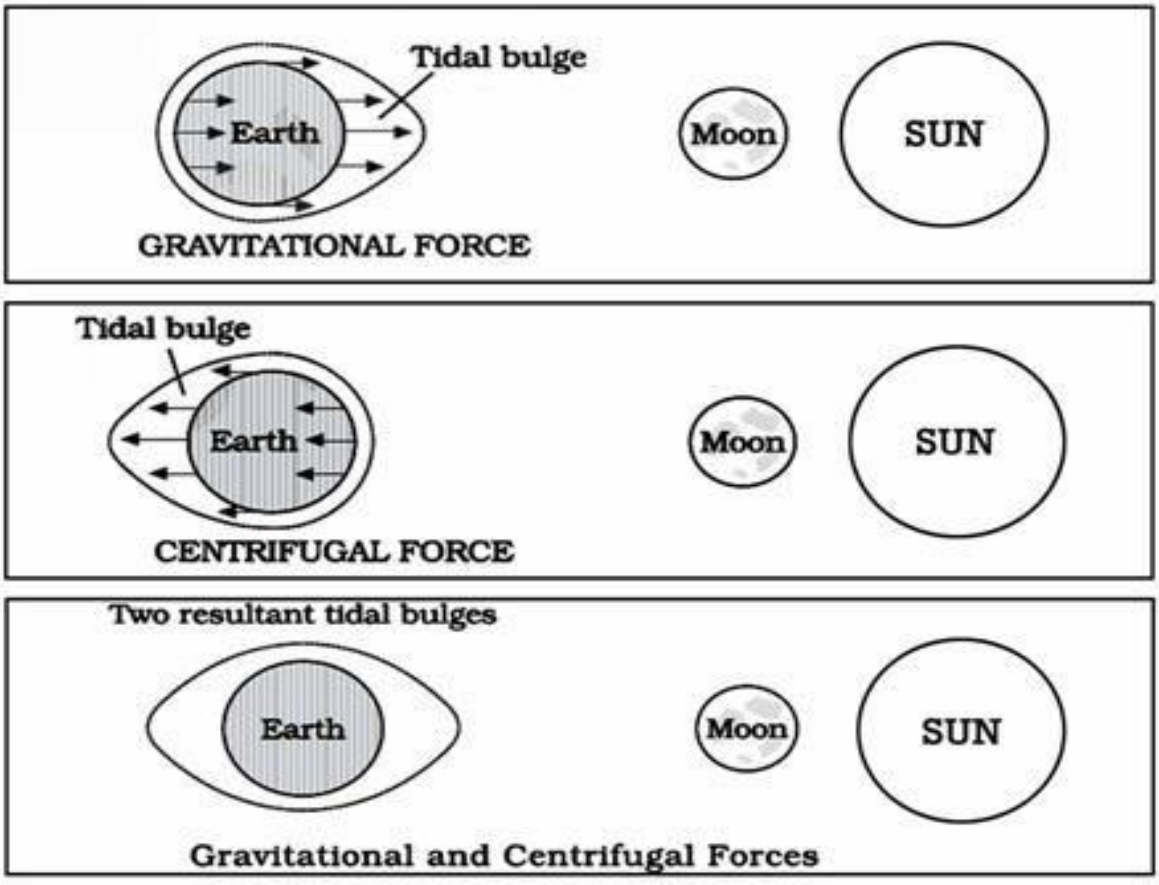
Waves

- Waves are nothing but the **oscillatory movements** that result in the rise and fall of water surface.
- Waves are a kind of horizontal movements of the ocean water.
- They are actually the energy, not the water as such, which moves across the ocean surface.
- This energy for the waves is provided by the **wind**.
- In a wave, the movement of each water particle is in a circular manner.
- A wave has two major parts: the raised part is called as the **crest** while the low-point is called as the **trough**.



Tides

- Tide are the **periodical rise and fall of the sea levels**, once or twice a day, caused by the combined effects of the gravitational forces exerted by the sun, the moon and the rotation of the earth.
- They are a vertical movement of waters and are different from movements of ocean water caused by meteorological effects like the winds and atmospheric pressure changes.
- Note: The water movements which are caused by the meteorological effects like the said above are called as **surges** and they are not regular like tides.
- The moon's gravitational pull to a great extent is the major cause of the occurrence of tides (the moon's gravitational attraction is more effective on the earth than that of the sun).
- Sun's gravitational pull and the centrifugal force due to the rotation of earth are
- the other forces which act along with the moon's gravitational pull.



- The **highest tides in the world occur in the Bay of Fundi** in Canada.
- When the tide is channeled between islands or into bays and estuaries, they are termed as **Tidal Currents.**

- The regular interval between two high or two low tides is 12 hours 25 minutes.

Flow Tide and Ebb Tide

- A **flow tide or a flood tide** is a **rising tide or incoming tide** which results in a high tide.
- It is thus the time period between a low tide and a high tide (i.e., the rising time).
- **Ebb Tide** is the **receding or outgoing tide**. It is the period between high tide and low tide during which water flows away from the shore.

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Types of Tides

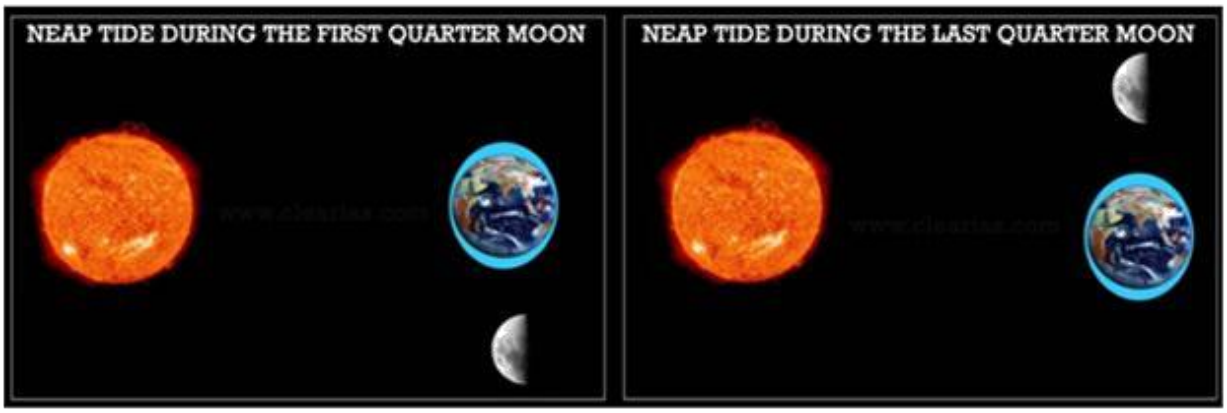
A. Tides based on the frequency

1. **Semi-diurnal Tide**: They are the most common tidal pattern, featuring two high tides and two low tides each day.
2. **Diurnal Tides**: Only one high tide and one low tide each day.
3. **Mixed Tide**: Tides having variations in heights are known as mixed tides. They generally occur along the west coast of North America.

B. Tides based on the sun, the moon, and the earth's positions

1. **Spring Tides**: When the sun, the moon, and the earth are in a straight line, the height of the tide will be higher than normal. These are called as a spring tides. They occur twice in a month-one on the full moon (Poornima) and the other on the new moon (Amavasya).

2. **Neap Tides**: Normally after seven days of a spring tide, the sun and the moon become at a right angle to each other with respect to the earth. Thus, the gravitational forces of the sun and the moon tend to counteract one another. The tides during this period will be lower than the normal which are called as the neap tides. They also occur twice in a month-during the first quarter moon and the last quarter moon.



Magnitude of Tides

Perigee: When the moon's orbit is closest to the earth, it is called as perigee. During this period, unusually high and low tide occur.

Apogee: When the moon's orbit is farthest from the earth, it is called as apogee. Tidal ranges will be much less than the average during this period.

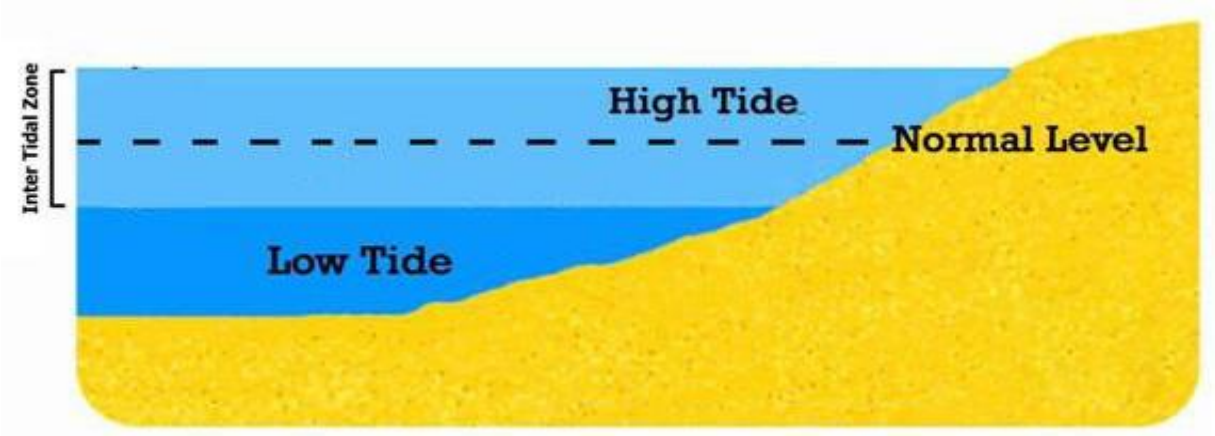
Perihelion: It is the position where the earth is closest to the sun (around January 3rd). Unusual high and low tides occur during this time.

Aphelion: It is the position where the earth is farthest from the sun (around July 4th). Tidal ranges are much less than the average during this period.

Tidal Bore

When the leading edge of the incoming tide forms a wave/ waves of water that travel up a river or a narrow bay against the direction of the river or bay's current, it is called as a tidal bore. The Indian rivers like the Ganges, Brahmaputra, Indus, etc exhibits tidal bores.

Inter-Tidal Zone



The intertidal zone, also known as the foreshore and seashore and sometimes referred to as the littoral zone, is the area that is above water at low tide and under water at high tide (i.e., the area between the tide-marks).

Also read: Ocean Floor: Everything you need to know

Effects of tides

- Tides act as a link between the port and the open sea. Some of the major ports of the world, such as London port on the river Thames and Kolkata port on river Hugli are located on the rivers away from the sea coast.
- The tidal current clear away the river sediments and slows down the growth of delta.
- It increases the depth of water which helps ships to move safely to the ports.
- It also acts as a source for producing electricity.

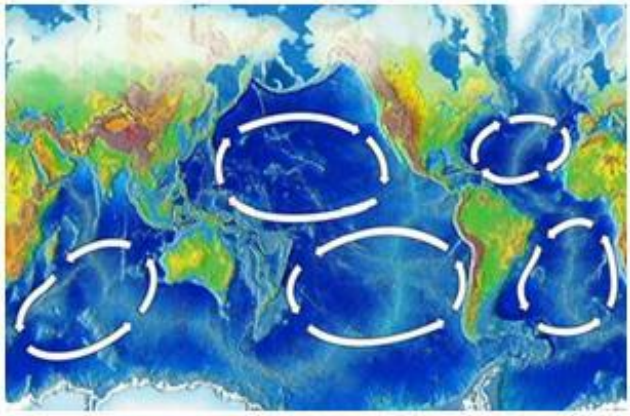
Ocean Currents

- The ocean currents are the horizontal flow of a mass of water in a fairly defined direction over great distances.
- They are just like a river flowing in an ocean.
- Ocean currents can be formed by the winds, density differences in ocean waters due to differences in temperature and salinity, gravity and events such as earthquakes.
- The direction of movement of an ocean current is mainly influenced by the rotation of the earth (**due to Coriolis force, most ocean currents in northern hemisphere move in clockwise manner and ocean currents in southern hemisphere move in an anti-clockwise manner**).

Gyre, Drift, and Stream

- Any large system of rotating ocean current, particularly those involved with large wind movements is called as a **Gyre**. They are caused by the Coriolis force.

- When the ocean water moves forward under the influence of prevailing wind, it is called as **Drift** (The term 'drift' is also used to refer the speed of an ocean current which is measured in knots). E.g. North Atlantic Drift.
- When a large mass of the ocean water moves in a definite path just like a large river on the continent, it is called as a **Stream**. They will have greater speed than drifts. E.g. Gulf Stream.



Types of Ocean Currents

1. Warm Ocean Currents:

- Those currents which flow from equatorial regions towards poles which have a higher surface temperature and are called warm current. They bring warm waters to the cold
- regions.
- They are usually observed on the east coast of the continents in the lower and middle latitudes of both hemispheres.
- In the northern hemisphere, they are also found on the west coast of the continents in the higher latitudes (E.g. Alaska and Norwegian Currents).

2. Cold Ocean Currents:

- Those currents which flow from polar regions towards equator have a lower surface temperature and are called cold currents.
- They bring cold waters into warm areas.
- These currents are usually found on the west coast of the continents in low and middle latitudes of both hemispheres.
- In the northern hemisphere, they are also found on the east coast in the higher latitudes (E.g. Labrador, East Greenland and Oyashio currents).

The ocean currents can be also classified as:

1. **Surface Currents**: They constitute about 10% of all the waters in an ocean. These waters are occupied at the upper 400m of an ocean or the **Ekman Layer**. It is the layer of the ocean water which moves due to the stress of blowing the wind and this motion is thus called as **Ekman Transport**.
2. **Deep Water Currents**: They constitute about 90% of the ocean water. They move around the ocean basin due to variations in the density and gravity.

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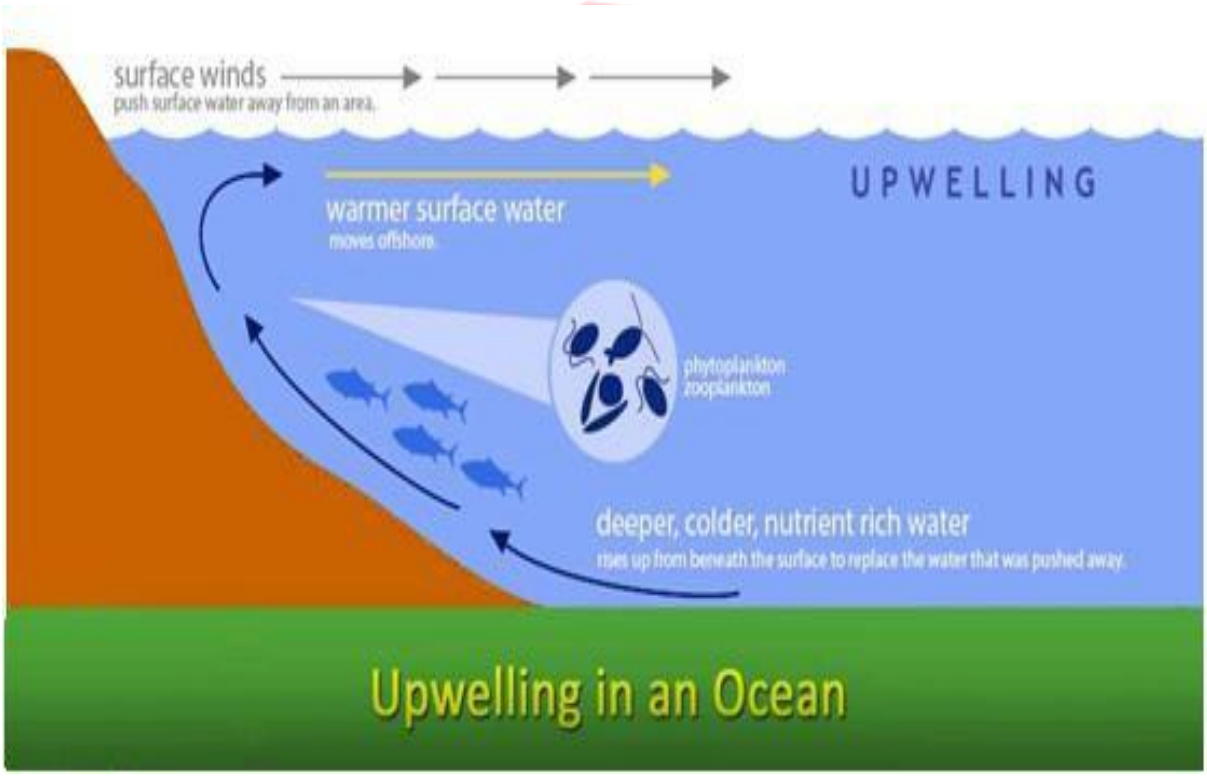
Factors influencing the origin and nature of ocean currents

1. **Difference in density**

- As we all know, the density of sea water varies from place to place according to its temperature and proportion of salinity.
- The **density increases with an increase in salinity** and decreases with a decrease in salinity.
- But when **the temperature increases, density decreases** and when the temperature decreases density increases.
- This increase and decrease in density due to the differences in temperature and salinity causes the water to move from one place to another.
- Such a movements of water due to the differences in density as a function of water temperature and salinity is called as the **Thermohaline Circulation**.
- In polar regions, due to a lower temperature, the waters will be of high density. This causes the waters to sink to the bottom and then to move towards the less dense middle and lower latitudes (or towards the equatorial regions).
- They rise (upwelling) at the warm region and push the already existing less dense, warm water towards the poles.



- While considering the equatorial region, the high temperature in those regions causes the water to expand. Thus, the waters in these regions will be at a higher level than that of the middle and upper latitudes. This also creates a gradient and results in the movement of waters from equatorial region to middle and upper latitudes.

2. **The earth's rotation**

- Earth's rotation causes Coriolis force which deflects the air to its right in the northern hemisphere and to its left in the southern hemisphere-Ferrel's Law.
- Similarly, oceans water also affected by the Coriolis force and follows the Ferrel's Law.
- Hence, ocean currents in the northern hemisphere move in a clockwise (towards right) direction and ocean currents in southern hemisphere moves in an anti-clockwise (towards left) direction (In the Indian Ocean due to the impact of the Asian monsoon, the currents in the northern hemisphere do not follow this pattern of movements all time).

3. **The winds**

- The winds like trade winds and westerlies drive the ocean water in a steady flow in front of them.
- When the direction of the winds changes, the direction of the current also gets changed.