CHAPTER

3

Hydrosphere

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It has been raining on Earth for thousands of years. Have you ever thought about why the water in the seas and oceans never dries up? Less than 1% of water that reaches the earth is useful to human beings. Can this water meet the necessities of all living beings? To know the answers to all these questions, let us read about the Hydrological cycle.

Hydrological Cycle

Water is a cyclical renewable resource. It can be used and reused. Water goes through a cycle from oceans to land and then from land to the oceans. The water cycle has been going on for billions of years and all the life on earth depends on it.

Hydrological cycle is the circulation of water in different forms i.e., liquid, solid and gaseous phases. It also refers to the continuous exchange of water between the oceans, atmosphere, land surface, sub surface and all the living organisms.

The hydrological cycle is sometimes expressed as

RF = RO + ET

Where RF (Rain Fall) includes all types of precipitation, RO is run off, ET is Evapo Transpiration.

There are six stages in the water cycle.

- Evaporation
- Transportation
- Condensation
- Precipitation
- Run off
- Groundwater

Evaporation: Water is transferred from the surface of Earth to the atmosphere through evaporation, the process by which water changes from liquid to gas. Sun's warmth heats up and evaporates the water from the earth's surface. Land, lakes, rivers and oceans send up a steady stream of water vapours through this process. Plants also lose water to the air through transpiration.

Transportation: The movement of water through the atmosphere specifically from over the ocean to over land, in the form of clouds is transportation. Clouds are propelled from one place to another by either upper air circulation, surface-based circulations like land and sea breezes or other mechanisms.

Condensation: The transported water vapour eventually condenses, forming tiny droplets and clouds.

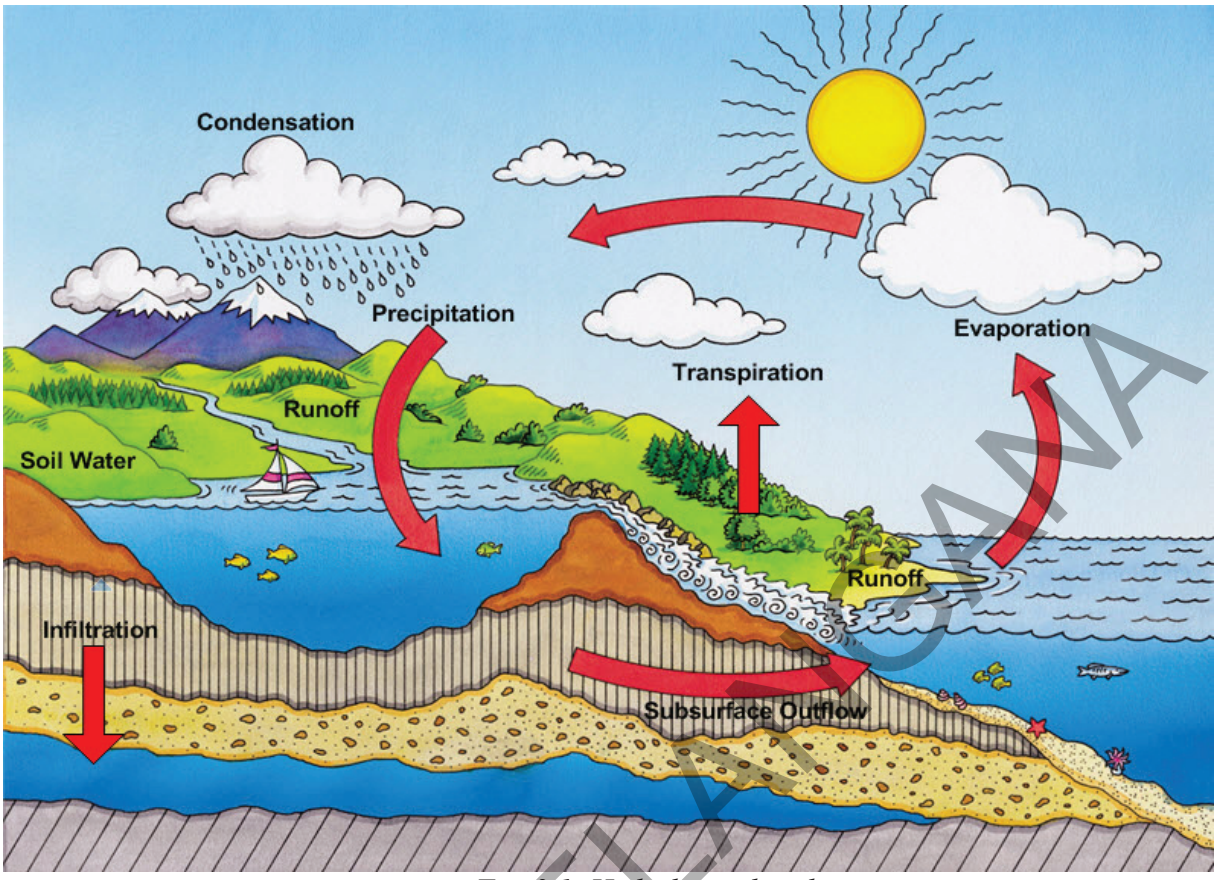

Fig. 3.1: Hydrological cycle

Precipitation: The primary mechanism for transporting water from the atmosphere to the surface of the earth is precipitation. When the clouds meet cool air over land, precipitation, in the form of rain, sleet or snow is triggered and water returns to the land (or sea).

Run off: Most of the water which returns to land flows down the hills as run off. Some of it penetrates into the land and charges the groundwater while the rest, as the rivers flow, returns to the oceans where it evaporates.

Groundwater: Under special circumstances, groundwater can even flow upward in artesian wells. The flow of groundwater is much slower than runoff.

The hydrological cycle is not a simple process of circulation of water between ocean, atmosphere and the land. There are a number of sub-cycles operating within it.

Reservoir	Percentage of the Total Water
Oceans	97.2169 %
Icecaps and glaciers	2.15 %
Groundwater	0.61 %
Inland seas	0.0089 %
Lakes	0.008 %
Soil moisture	0.005 %
Atmosphere	0.001 %
Rivers	0.0001 %
Biosphere	0.0001 %

Water Sources

97.2169% of water is saline ocean water and only 2.7831% is fresh water. The greatest portion of the fresh water (69.56%) is in the

form of ice and permanent snow cover in the Antarctica, the Arctic and in the mountain regions, 30.1% exists as fresh ground waters. Only 0.34% of the total amount of fresh water on the earth is concentrated in lakes, reservoirs and river system, where it is most easily accessible for our needs and absolutely vital for the water ecosystems.

Oceans

Continents and oceans are the first order relief features of the earth. The large water bodies are called oceans. The geographers have divided the oceanic part of the earth into five oceans namely: The Pacific Ocean, The Atlantic Ocean, The Indian Ocean, The Southern Ocean (Antarctic Ocean), and The Arctic Ocean.

The word 'sea' is often used interchangeably with 'ocean', but strictly speaking, a sea is a body of saline water, partly or fully enclosed by land.

The major oceanic divisions are defined in part by the continents, various archipelagoes and other criteria. See the table below for more information: Note that the table is in descending order in terms of size.

Rank	Ocean	Notes
1	The Pacific ocean	Separates Asia and Oceania (Australia, New Zealand, Papua New Guinea together) from the Americas.
2	The Atlantic ocean	Separates the America from Europe and Africa.
3	The Indian ocean	Washes upon Southern Asia and separates Africa and Australia.
4	The Antarctic ocean (Southern ocean)	Sometimes considered an extension of the Pacific, Atlantic and Indian oceans which encircles Antarctica
5	The Arctic ocean	Sometimes considered a sea of the Atlantic, which covers much of the Arctic and washes upon North America and Eurasia.

Do You Know?

Millions of years ago, oceans were combined together. The single super ocean was known as 'panthalsa'.

Formal oceanographic investigation began only with the British expedition of Challenger, the first successful world wide deep-sea expedition.

Relief of the Ocean

The ocean basins are in many ways similar to the land surface. There are submarine ridges, plateaus, canyons and terraces found within oceans. Ocean floor is divided into four parts.

1) Continental Shelf: The continental shelf, with a depth of up to 200 mts, occupies about 7.6% of the ocean area. It is the border zone between land and sea. The largest continental shelf is Siberian shelf in the Arctic Ocean, stretching to 1,500 kms in width.

Continental Shelf is important because:

- Fish wealth is more in this region.
- Crude oil, natural gas are found here.
- Building seaport is possible here.

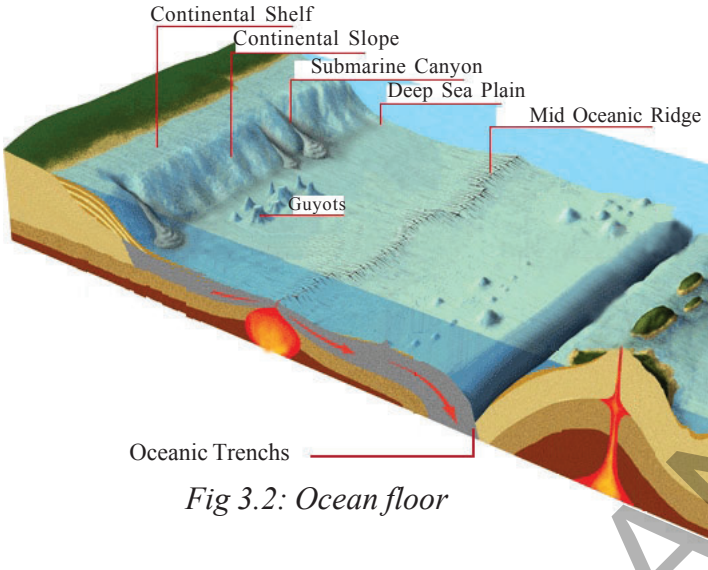

Fig 3.2: Ocean floor

2) Continental Slope: The Continental slope is spread from 200 mts to 3,000 mts depth, with a complex relief. It comprises of 15% of the ocean area. The continental slope boundary indicates the continents. Submarine canyons have also been observed in this region. These are formed by the process of erosion of glaciers and rivers.

3) Deep Sea plain (or) Abyssal Plain: Deep sea plains are gently sloping areas of the ocean basins. These are the flattest and smoothest regions of the world. The depths vary between 3000-6000 mts. It covers about 76.2% of the ocean basin.

4) Oceanic deeps (or) Trenches: These are large narrow trenches that plunge as great ocean deeps to a depth of 6,000 mts. Contrary to our expectations, most of the deepest trenches are not located in the midst of oceans. They are found more close to the continents. That is why they are very significant in the study of plate movements. As many as 57 deeps have been explored so far.

Do You Know?

Isobaths – A line joining points on the sea bed at an equal vertical distance beneath the surface. Sometimes referred to as depth contours.

Do you know major ocean trenches?

Sl. No	Name of the trench	Ocean	Depth (mts)
1	Challenger (or) Mariana	The Pacific Ocean	11,022
2	Puertorico (or) Naves	The Atlantic Ocean	10,475
3	Java	The Indian Ocean	7,450

Salinity of the Ocean

Have you ever eaten food without salt? Was it tasty? Did early human beings use salt in their food? Where is salt available other than the oceans? Is salt used just for taste or for any other reasons? Is water salty in your village tank? If not, why is ocean water salty? Did you know that using salt as a medium of protest, Mahatma Gandhi had led the civil disobedience movement (or) Dandi march which was one of the biggest freedom movements in the world?

Have you ever wondered why the oceans are filled with salt water instead of fresh water? Where did the salt come from and is it the same salt you find on your dining room table? Most of the salt in the oceans come from land. Over millions of years, rain, rivers and streams have washed over rocks containing the compound Sodium Chloride (NaCl), and carried it into the sea. You may know Sodium Chloride by its common name table salt. Some of the salt in the oceans comes from under sea volcanoes and hydro thermal vents. When water evaporates from the surface of the ocean, the salt is left behind. Over millions of years, the oceans have developed a noticeably salty water.

Fig. 3.3: Water Salinity

Salinity is the term used to define the total content of dissolved salts in sea water. It is calculated as the amount of salt (in grams) dissolved in 1,000 gms of sea water. It is usually expressed as parts per thousand (‰) or PPT. Generally speaking, the average salinity of the oceans is 35‰ or about 35 parts of salt in 1,000 parts of water. All sea water contains large amounts of dissolved mineral matter, of which Sodium Chloride or common salt alone constitutes 77.8‰.

Do You Know?

River water contains 2‰ of sodium chloride.

Factors affecting salinity on the surface layers of the Ocean:

1. Evaporation and precipitation.
2. In coastal regions, by the fresh water flow from rivers and in Polar regions, by the process of freezing and thawing of ice.
3. Winds by transferring water to other areas.
4. The ocean currents.

Do You Know?

Highest Salinity in Water bodies	Lowest Salinity in Water bodies
1) Don Juan Pond – Antarctica – 440‰	1) Baltic Sea – 10‰
2) Lake Retba – Senegal – 400‰	2) Hudson Bay – 3-15‰
3) Lake Vanda – Antarctica – 350‰	(Source : worldatlas.com)

Isohaline: A line joining the points in the ocean having the same degree of salinity.

- Give reasons for the low salinity of Baltic sea.

Ocean Temperature

When compared to land, the temperature in the oceans does not show much variation. But these little variations show great impact. For example, the activeness of South West monsoon in India is affected by 'El Nino' and 'La Nina'. These are the effects caused by the changes in temperature in the Pacific Ocean. The ocean temperature is influenced by latitudes, winds, ocean currents, unequal distribution of land and change of seasons.

Normally, the temperature in the oceans varies from – 2^0C to 29^0C.

Do You Know?

The highest temperature is recorded in Inland Seas. The temperature is the highest in Red Sea i.e. 38^0C.

Vertical Distribution of Temperature: As one goes deep inside the oceans, the temperature decreases. The fall in temperature is very steep for the first kilometre. After that, there is a steady decline upto a depth of 5 kilometres. Below that, the temperature is steady at about 2^0C.

Ocean Currents

The ocean current is the general movement of a mass of water in a fairly defined direction over a great distance. The ocean currents are sometimes called ocean rivers. Ocean currents may be classified, based on temperature, as cold currents and warm currents.

Generally, warm currents flow towards the poles, cold currents flow towards the Equator. Ocean currents are classified as stream and drift, based on their speed.

The ocean water current which flows speedily is called a stream and that which flows slowly is called a drift.Ocean currents are caused by the following factors.

1. Centrifugal Force: The Centrifugal force at the equator is greater than that at the poles because the great circles at the time of revolution coincide with the equator. The variation of these forces makes the equatorial water to move towards the poles.

2. Effect of Winds: The stresses due to wind and the wind movement modifies the direction of the currents. Due to the frictional gliding of winds, water is dragged along the wind direction. Thus, a wind at the speed of 50 miles per hour will produce a current whose velocity would be 0.75 miles per hour.

3. Precipitation: The equatorial areas receive the greatest rainfall. Hence, the sea level is higher. As a result, water moves north and south from the equator.

4. Solar Energy: Heating by solar energy causes the water to expand. That is why, the ocean water is about 8 cm higher in level near the equator than in the middle latitudes. This causes a very slight gradient and water tends to flow down the slope.

Salinity, density differences, melting of ice also affect the ocean currents.

Ocean as a Resource

Most life on earth is under the water. Human beings still have not finished identifying all the different forms of life in the oceans. Human beings have depended on oceans for their food and livelihood from the ancient times. Oceans provided abundant food resources like fish and salt. We also use the sand, gravel etc. for our industries or housing. Humans extract minerals like chlorine, fluorine, iodine from it. Ocean waves are used for generating power. Ocean floor is mined for oils. Oceans also provide us with gems and pearls. For centuries, we have created our civilisations on its shores and traded across with each other travelling on them.

Fig. 3.4: Petroleum drilling at Bombay High

Yet today, oceans have also fallen victim to our exploitation. Many large fish like whales have been disappearing. Oceans have also become dumping ground for plastic and other forms of toxic waste.

Do You Know?

Access of Pure Water	
69.56%	Ice and snow
30.10%	Underground water
0.34%	Rivers, lakes and reserviors
100.0%	**Total**

Keywords

1. Stream
2. Drift
3. Ocean currents
4. Transpiration

Improve your learning

1. Find the odd one out and give an explanation for your choice.

(i) a) evaporation b) condensation
c) salination d) precipitation

(ii) a) tectonics b) centrifugal force
c) solar energy d) precipitation

2. Correct the false statements.
   a) Ocean trenches can be located near the continents
   b) Relief features of the oceans are like plains
   c) Most salt in the seas is washed into it from land over centuries
   d) Temperature of ocean water remains the same across the globe
3. Do you think that the description of blue planet is accurate? Describe any one way in which your activity impacts its oceans.
4. Why are there differences in the salinity of oceans?
5. How is human life dependent upon oceans?
6. Observe the map 1 on page 35 and write down the names of a few warm and cold currents.
7. Read the para 'Ocean as a Resource' on page 33 and comment on it.

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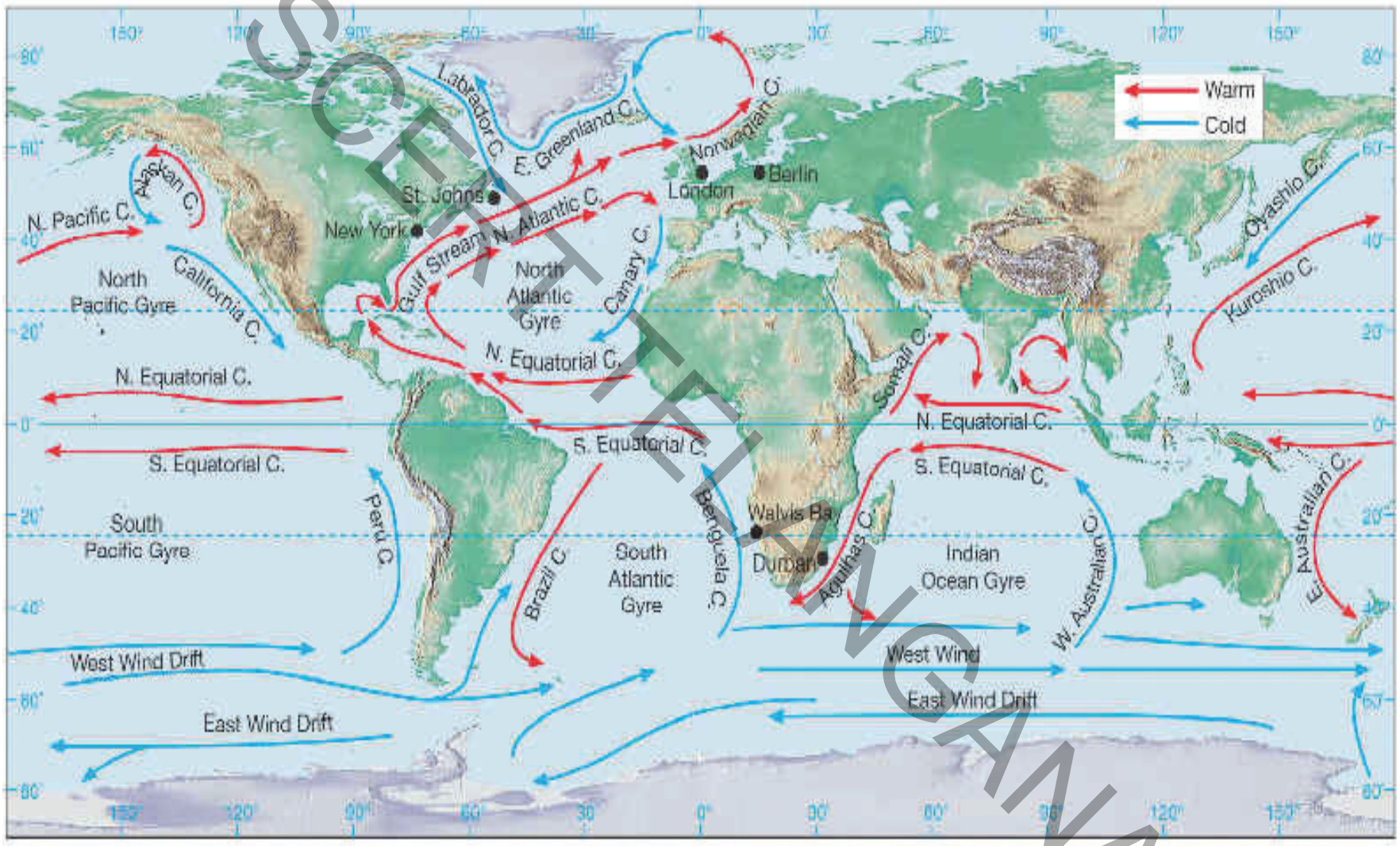
Project

Prepare a list of currents which are found in the Pacific, Atlantic and Indian oceans. Identify the cold and warm currents in different oceans. Fill in the table.

The Pacific Ocean		The Atlantic Ocean		The Indian Ocean	
Warm currents	Cold currents	Warm currents	Cold currents	Warm currents	Cold currents



Map 1: Ocean currents