HYDROSPHERE

Water on Earth

Of all Earth's resources, none is more fundamental to life than water. We can breathe it, drink it, bathe in it, travel on it or see beauty in its different forms. It is simultaneously a raw material, source of power, waste disposal agent, solvent, medium for heat transfer, or coolant as the needs of modern technology may require.

Water is the most universal and versatile of all resources. It is nature's greatest gift to mankind and its purity, adequacy and availability symbolises the lifestyles of modern human societies. The ocean and seas cover 70.8% of the surface of earth, which amounts to 361,254,000 km^2. (360 mn sq. km ; 36 USAs). Scientists believe that the amount of water on Earth does not change appreciatively over time. While the disbursement of this water changes from moment to moment.

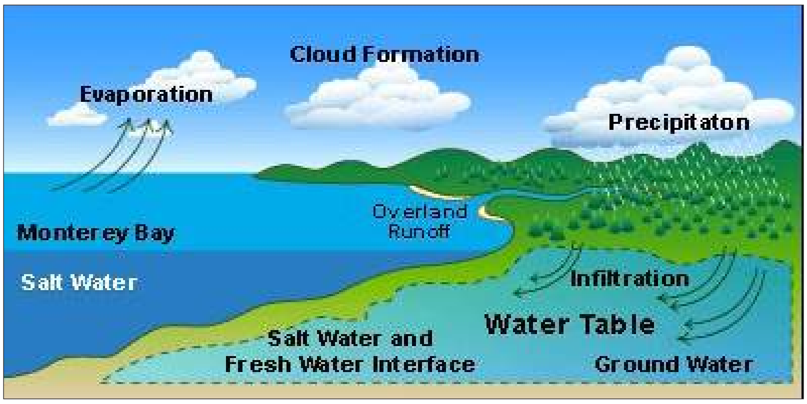
The properties of water in its three physical states make it by far the most useful of all compounds. Its high specific heat, ability to exist in all three states and capacity for storing or releasing latent heat with changes of state give it immense influence on atmospheric processes. The restless atmosphere is the most active agent involved in the constant redistribution of water on the earth's surface. While moving in its cycle, water also shapes the landforms through various processes.

Water plays a crucial role in sustaining life on Earth. Plants absorb nutrients from soil moisture and ground water. Excess water gets transpirated to the atmosphere in the form of water vapour, which escapes through the pores in the leaves. Animals also need water for their sustenance and growth. Water forms an important constituent of the body weight of animals. It plays a crucial role in the biological processes, as a reacting medium in bio-chemical processes such as photosynthesis and as a medium holding and transporting nutrients in solution and carrying away waste products of metabolism.

Thus, water circulates not only through hydrosphere, atmosphere and lithosphere, but also through the biosphere. Water is constantly in motion. The chief process responsible for moving water around the Earth is the hydrologic cycle. Some of the Earth's water supply is temporarily locked up within the many lifeforms found across the Earth's biosphere.

Hydrological Cycle

It is the complex cycle by which water moves from the ocean, to the atmosphere, to the land and back to oceans again, entailing residence of varying durations in life forms, fresh water bodies, ice accumulations or as ground water. The volume of water continually moving over the surface of the Earth is simply staggering. Calculations show that if the water evaporated from the oceans did not return by precipitation and surface run-off, the ocean basins would dry in 4000 years! The energy source that drives the system is heat from the sun.



Hydrological cycle is made possible by an intricate combination of processes like condensation, precipitation, runoff, evaporation, transpiration, infiltration, and ground water movements. Though the greater part of water that eventually falls as precipitation comes from oceans, some water takes a shortcut in the system and enters the atmosphere directly through evaporation and transpiration from soil and vegetation.

Oceans and Seas

The oceans comprise more than 70% of the earth's surface. They exert a great influence upon the global and regional climates in a variety of ways. They act as 'savings bank' for solar energy, storing the excess during summers and daytime and repaying back during nights and winters. They also help to modify the distribution of temperature along the coastal areas. Oceans are the primary source of moisture in the atmosphere and much of the rain over the continents. They help sustain the 'hydrological cycle'.

The sea, as a biological environment, is the easiest available and an inexhaustible source of food and other products of value to man. Of all the marine resources, fish is the most abundant and important, constituting about 90 per cent of all biotic resources extracted from the oceans.

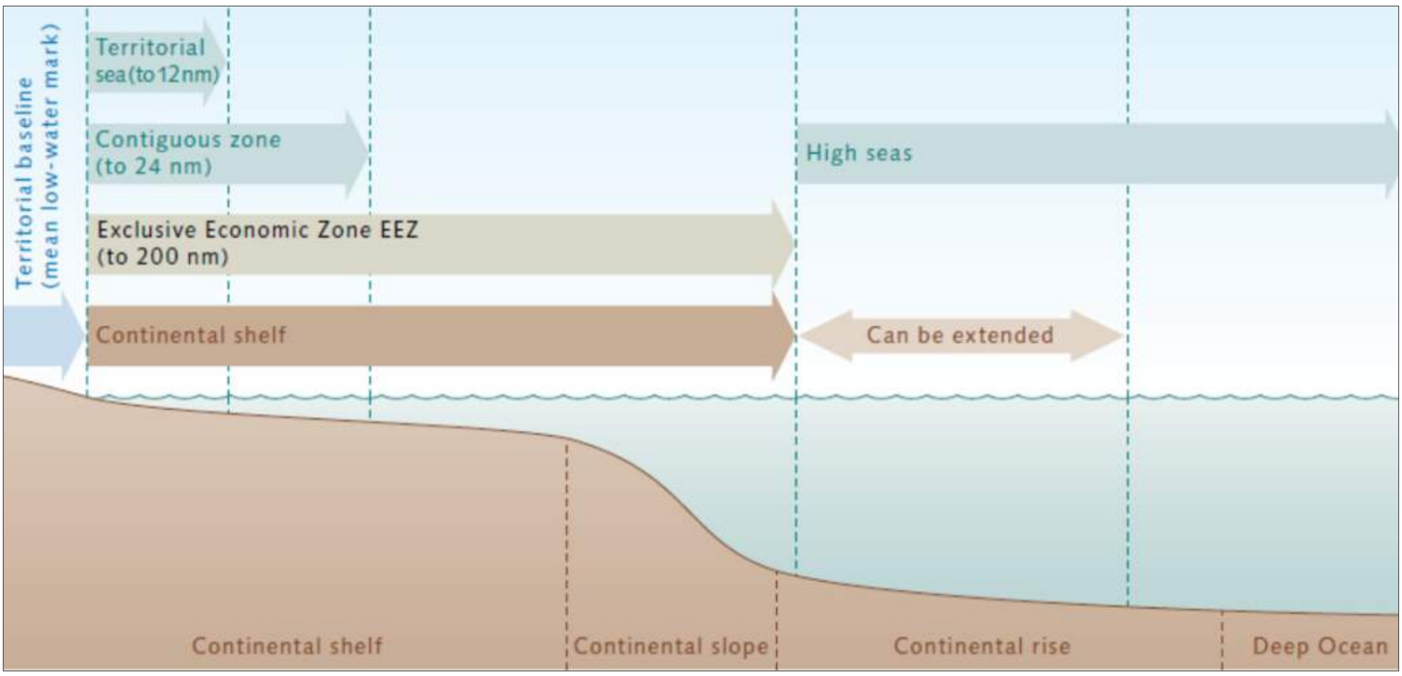
Oceans are the repository of a large number of useful metallic and non-metallic minerals such as petroleum, gas, common salt, manganese, gold, diamonds, tin and iron among others. Bromine and Sulphur, which are otherwise rare on land, can be abundantly sourced from oceans. Polymetallic nodules of copper, magnesium and cobalt are also found on the sea floor.

The energy resources of oceans come in various forms: the conventional forms like oil and natural gas and the non-conventional types. There are over 90 different possible ways to obtain energy from oceans, important among them being the energy derived from waves, wind and tides.

OCEAN ZONATION

Maritime Zones and Boundaries

- UNCLOS 1982 (entered into force 1994)
- **Two Maritime Zones:** National & International
- **National:** Coastal, Internal waters; Territorial waters; Contiguous Zone; Sovereign Rights (related to certain purpose); Archipelagic Zonation; Continental Shelf and EEZ
  - ✓ **Internal waters:** All waters landward of Territorial Baseline. (River mouths, harbours, bays etc.
  - ✓ **Archipelagic Waters:** Waters enclosed by Archipelagic Baseline.
- **International:** High Seas; Deep sea bed.



Ocean Bottom Relief Features

Earth has had oceans for a very long time, dating back to the point where the surface had cooled enough to allow liquid water, only a few hundred million years after Earth's formation. At that time there were no continental rocks, so the water that was here was likely spread out over the surface in one giant (but relatively shallow) ocean. Presently the, ocean floor is covered with an average of nearly 4,000 m of water. However, the explorations reveal that Ocean basins are in many ways similar to the land surface. Just like on land, there are mountains, plains, plateaus and canyons. A section drawn across an ocean illustrates the typical submarine relief features:

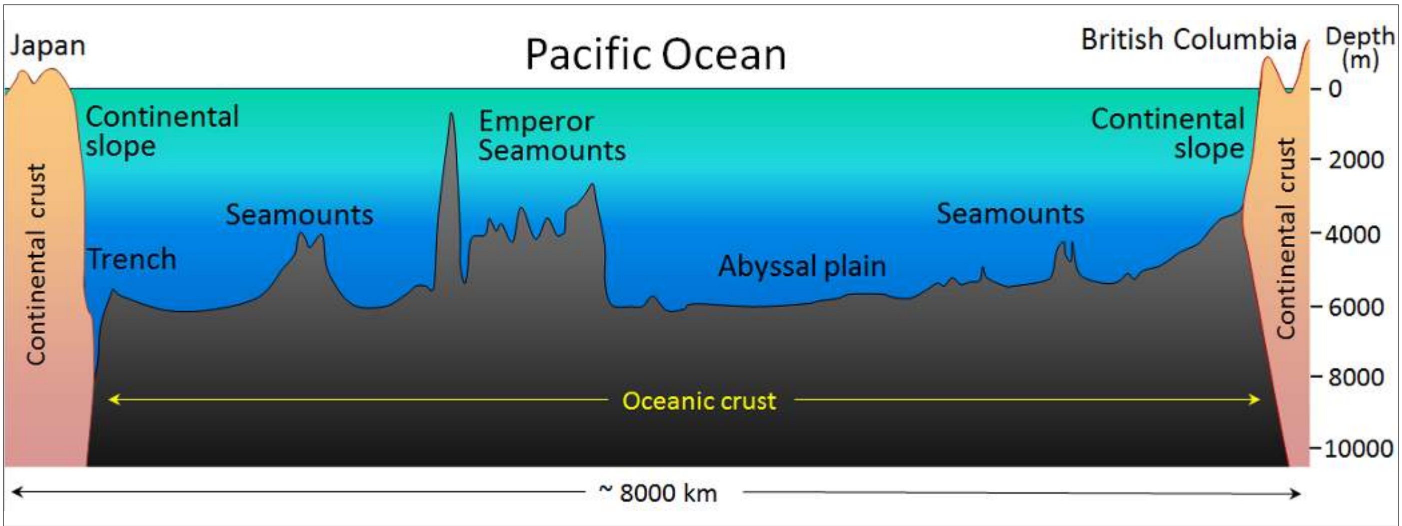
Continental Shelf is the seaward extension of the continent from the shoreline to the continental edge. Shallowness of the shelf enables sunlight to penetrate through the water, which encourages growth of minute plants and other microscopic organisms. They are thus, rich in plankton, on which millions of surface and bottom-feeding fishes thrive. Marine food comes almost entirely from them. The continental shelves are therefore the richest fishing grounds in the world, e.g. the Grand Banks off Newfoundland, the North Sea and the Sunda Shelf.

The shelves are also potential mining sites for minerals. A significant portion of the world production of petroleum and natural gas comes from them.

At the edge of the continental shelf, there is an abrupt change of gradient to about 1 in 20, forming the **Continental Slope**. This marks the seaward limit of the continental block.

Where the continental slope ends, the gently sloping continental rise begins which, with increasing depth, merges with **the Deep-Sea bottom floor**. This is the undulating plain lying beyond the continental rise, covering two-thirds of the ocean floor, the **Abyssal plain**. It has extensive **submarine plateaus, ridges, trenches, basins, and oceanic islands** that rise above sea level in the midst of oceans, e.g. the Azores and Ascension Island.

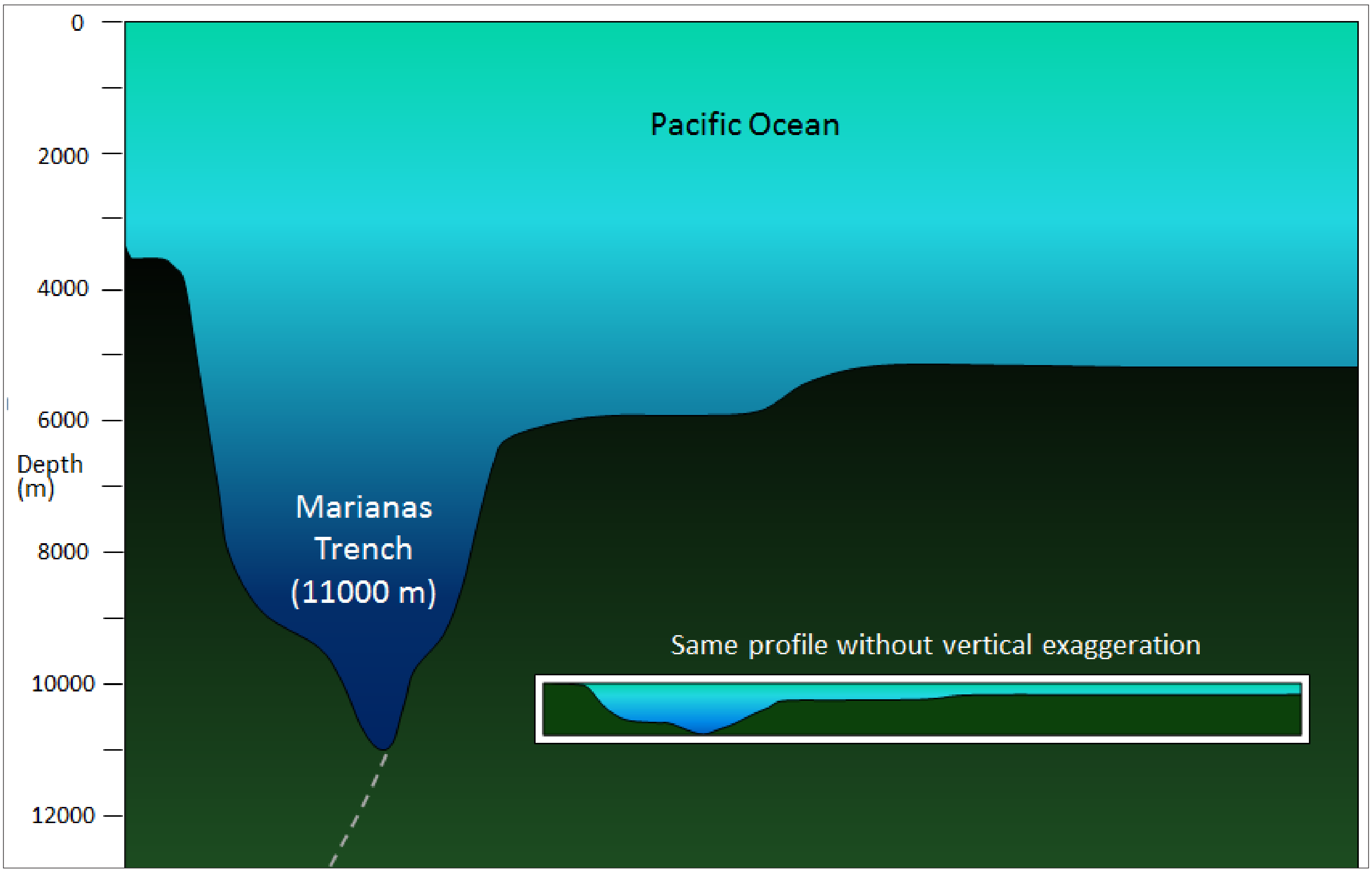
Ocean Deeps are the long, narrow trenches that plunge as great ocean deeps to a depth of more than 3,000 feet. The greatest known ocean deep is the Challenger Deep in Mariana Trench near Guam Island, which is more than 11,000 meter deep.



The generalized topography of the Pacific Ocean sea floor between Japan and British Columbia. The vertical exaggeration is approximately 200 times.

SOURCE: Physical Geology by Steven Earle licensed under a Creative Commons Attribution 4.0 International License, https://opentextbc.ca/geology

The generalized topography of the Pacific Ocean floor in the area of the Marianas Trench, near Guam. The dashed grey line represents the subduction of the Pacific Plate (to the right) beneath the Philippine Plate



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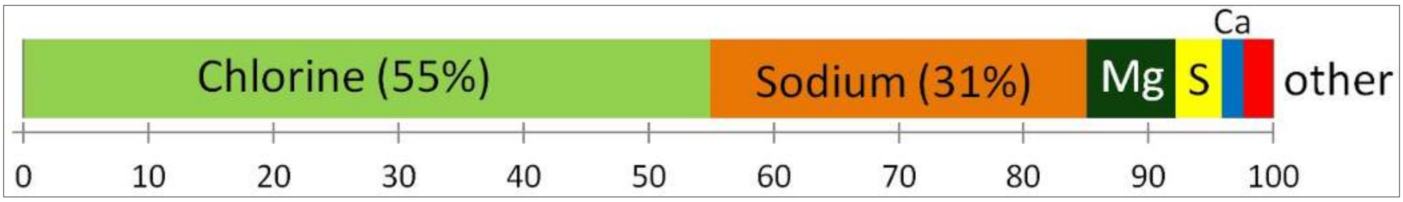
Ocean Salinity

The most characteristic feature of oceans and seas is their salinity. It is expressed as the number of grams of dissolved salts in 1000 grams of seawater. Salinity determines compressibility, thermal expansion, temperature, absorption of insolation, evaporation and humidity. The amount of salinity also determines the composition and movement of the sea water and the distribution of various marine lives.

Are oceans getting saltier?

About 99.7% of all dissolved materials are the major constituents of sea water, so variations in the concentration of other dissolved substances have very little effect on the overall salinity. These major constituents occur everywhere in the same relative proportions. This uniformity tells us that the oceans are very thoroughly mixed, just like the ingredients in a baking batter that has been stirred hundreds of times. Besides, the salts have always joined the oceans along with the water, so the oceans have always been about as salty as they are today.

The proportions (by weight) of the major dissolved elements in ocean water



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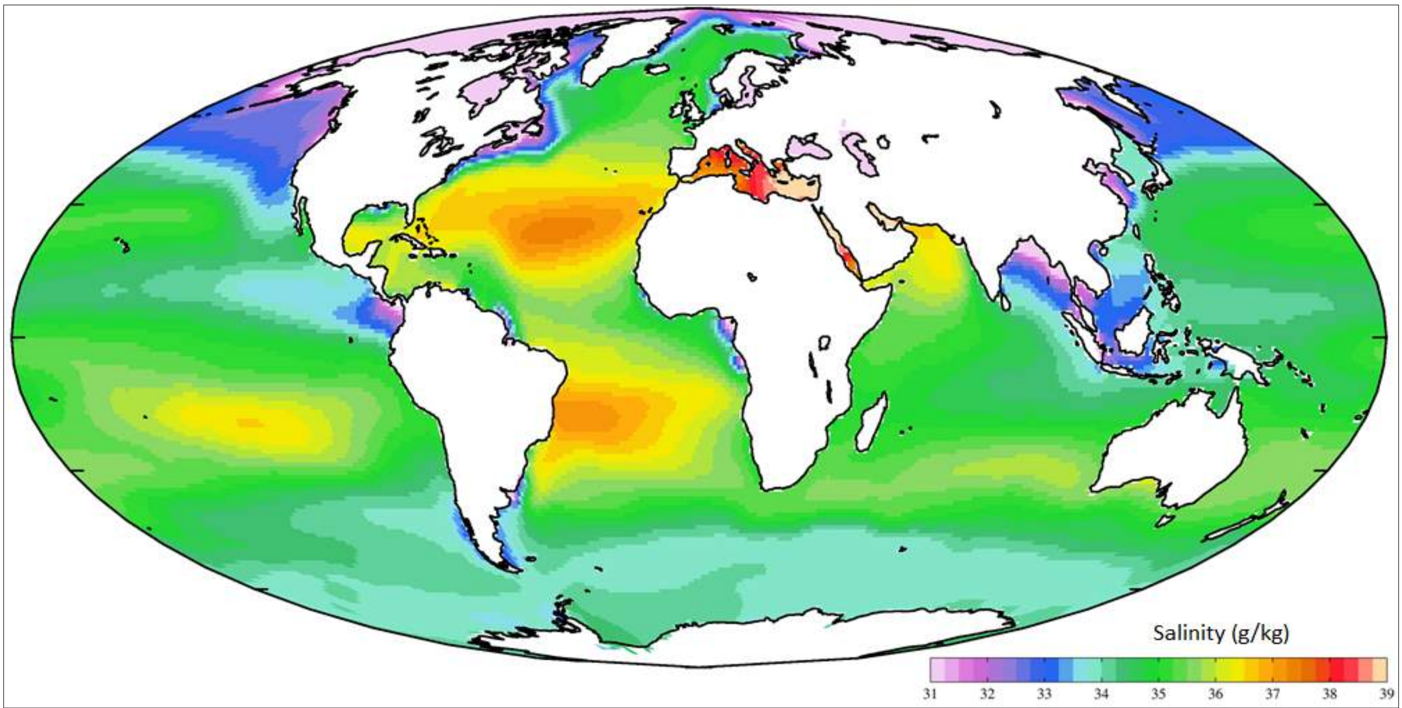
Of the total salt contents found in seawater, sodium chloride (NaCl) is the most abundant (78%).

The Composition of Sea Water	
Salt	**% age**
Sodium Chloride (NaCl)	78
Magnesium Chloride (MgCl2)	11
Magnesium Sulphate (MgSO4)	4.5
Calcium Sulphate (CaSO4)	3.5
Potassium Sulphate (KSO4)	2.5
Others	0.5

Spatial Salinity Variations:

The average salinity of the oceans is about 35 per thousand or $35^0/00$. Salinity varies both horizontally and vertically, and is maximum at the tropics and decreases towards the equator and the poles. Due to the free movement of ocean water, the proportions of different salts remain remarkably constant in all oceans and even to great depths.



SOURCE: The distribution of salinity in Earth's oceans and major seas [https://upload.wikimedia.org/wikipedia/commons/d/d5/WOA09_sea-surf_SAL_AYool.png]

- In the open ocean, salinities are elevated at lower latitudes because this is where most evaporation takes place. The highest salinities are in the subtropical parts of the Atlantic, especially north of the equator.
- Variations in sea-surface temperatures (SST) are related to redistribution of water by ocean currents, a good example of that is the plume of warm Gulf Stream water. The northern Atlantic is much more saline than the north Pacific because the Gulf Stream current brings a massive amount of salty water from the tropical Atlantic and the Caribbean to the region around Britain, Iceland, and Scandinavia. The salinity in the Norwegian Sea (between Norway and Iceland) is substantially higher than that in other polar areas.
- Ocean water is least salty (around 31 g/L) in the Arctic, and also in several places where large rivers flow in (e.g., the Ganges/Brahmaputra and Mekong Rivers in southeast Asia, and the Yellow and Yangtze Rivers in China). Ocean water is most salty (over 37 g/L) in some restricted seas in hot dry regions, such as the Mediterranean and Red Seas.

Ocean Water Temperature

- It is and important factor in controlling the movements of large masses of ocean water and their characteristics.
- The type and distribution of marine fauna and flora also depend largely on the temperature of the water.
- With respect to temperatue, there are three layer in the oceans from surface to the bottom in the tropics:
  - i. Epilimnion layer: It represents the top-layer of warm oceanic water and is 500m thick with temeprature ranging between 20^0 and 25^0C.
  - ii. Thermocline layer: It represents vertical zone of oceanic water below the first layer and is charactized by rapid rate of decrease of temperature with increasing depth.
  - iii. Hypolimnion layer: It is very cold and extends upto the deep ocean floor.
- The temperature decreases according to the increasing depth of the ocean.
- On an average, the temperature of surface water of the oceans is 26.7^0C and the temperature gradually decreases from equator towards the poles.
- The rate of decrease of temperature with increasing latitudes is generally 0.5^0F per latitude.
- The average temperatures become 22^0C at 20^0 latitude, 14^0C at 40^0 latitude, and)^{0}C near the poles.
- The oceans in the northern hemisphere record relatively higher average temperature than in the sourthern hemisphere.
- The average annual temperatures for the northern and southern hemisphers are 19.4^0C and 16.1^0C respectively.

Vertical Distribution of temperature

- The solar rays very effectively penetrate upto 20m depth and they seldom go beyond 200 m depth
  1. Photic (Euphotic) zone represents the upper surface upto depth of 200m and receive solar radition.
  2. Aphotic zone extends from 200m depth to the bottom and does not receive solar rays.
  3. The surface temperature of the seas decreases from equator towards the poles but the temperature at the ocean bottom is uniform from equator towards the pole.

Facts of Salinity and Temperature	
Average salinity of the sea water	35%o
Average Salinity of Atlantic Ocean	35.67%o
Maximum salinity occurs between	20^0N and 40^0N & 10^0S and 30^0S.
The highest salinity is found	The Lake Van (330%o)
Average Temperature of Pacific Ocean	19.10^0C
Average Temperature of Indian Ocean	17^0C
Average Temperature of Atlantic Ocean	16.91^0C
Average annual temperature of Oceans	17.2^0C
Average temperature of surface water	26.7^0C

Hyper-Saline Water Bodies

1. Lake Van (Salinity 350 ppt)
2. Dead Sea (Salinity 337 ppt)
3. Great Salt Lake, USA (in Utah is the largest salt lake in the Western Hemisphere.)
4. Garabogazköl Aylagy, Turkmenistan(also known as Kara-Bogaz-Gol or “black strait lake”.)
5. Lake Assal, Djibouti (“Lake Honey”,A crater lake.)

Oceanic Dynamism

Types of Flow in the ocean

- Many terms are used for describing the ocean circulation. Here are a few of the more commonly used terms for describing currents and waves.

1. **General Circulation** is the permanent, time-averaged circulation.
2. **Abyssal also called the Deep Circulation** is the circulation of mass, in the meridional plane, in the deep ocean, driven by mixing.
3. **Wind-Driven Circulation** is the circulation in the upper kilometer of the ocean forced by the wind. The circulation can be caused by local winds or by winds in other regions.
4. **Gyres** are wind-driven cyclonic or anticyclonic currents with dimensions nearly that of ocean basins.
5. **Boundary Currents** are currents flowing parallel to coasts. Two types of boundary currents are important:

- Western boundary currents on the western edge of the ocean tend to be fast, narrow jets such as the Gulf Stream and Kuroshio.
- Eastern boundary currents are weak, e.g. the California Current.

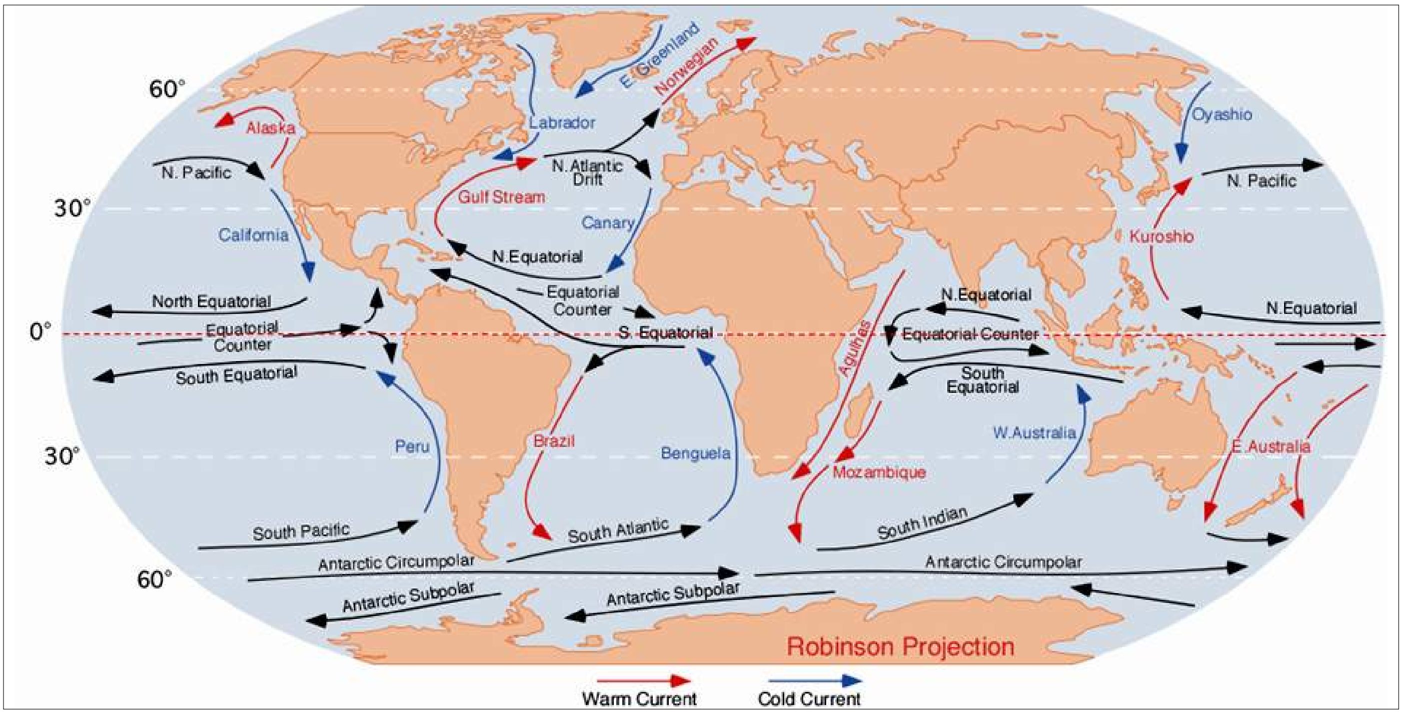
Ocean Currents

Like the global atmospheric circulation, world oceans too are a significant transporter of heat from equatorial to polar regions. Specifically, it is through the circulation of water masses in large-scale currents that the world ocean plays its vital role in constantly adjusting the earth's surface heat imbalance.

- These differences in surface water temperature produce a movement of water which is called an ocean current.
- Currents in the open ocean are created by wind moving across the water and by density differences related to temperature and salinity.
- **Ocean Currents** are swift moving, large masses of surface water that move in a fairly defined direction over great distances. They can broadly be divided into two classes– the warm currents and cold currents.
- Ocean currents which transfer heat are called warm ocean currents and they are surface currents. A flow of cold water in this circulation is called a cold ocean current. In general, warm ocean currents flow more quickly than cold ocean currents.
- The movement of these currents produces a worldwide water circulation that affects all the oceans. In the Northern Hemisphere, the currents move to their right and in the Southern they move to their left, due to the Coriolis force caused by the rotation of the earth results in ocean currents following curving paths . As a result, the northern hemisphere currents form circular patterns (**gyres**) that rotate clockwise, while the southern hemisphere gyres are counter-clockwise. (with the notable exception of the circulation in the northern Indian Ocean, where the currents change their direction in response to the reversal of the monsoon winds.)

In general, warm ocean currents bring warm water from equatorial regions to polar regions and cold ocean currents bring cold water from polar regions to equatorial regions.

Overview of the main open-ocean currents. Red arrows represent warm water moving toward colder regions. Blue arrows represent cold water moving toward warmer regions. Black arrows represent currents that don't involve significant temperature changes.

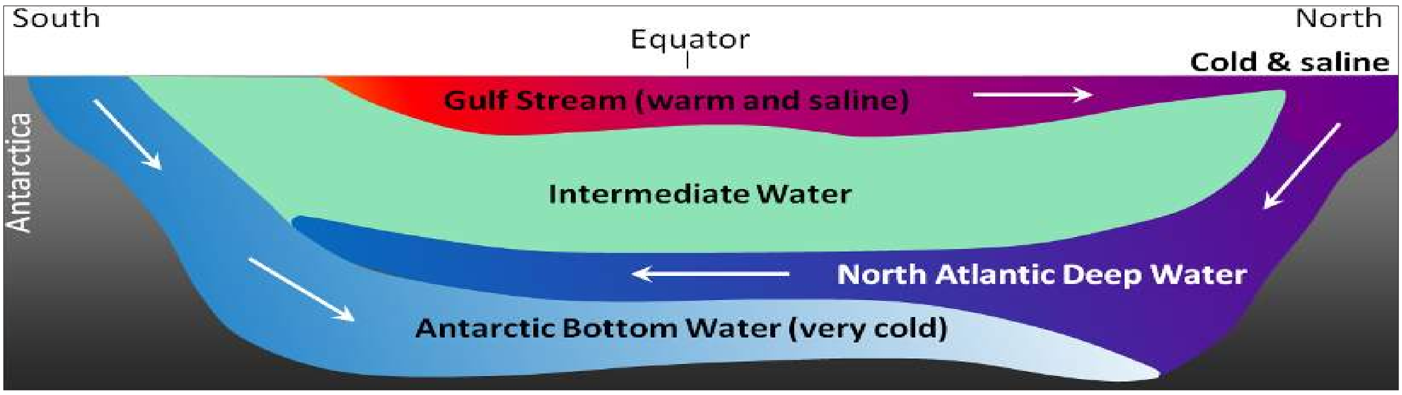


[Source From: https://upload.wikimedia.org/wikipedia/commons/9/9b/Corrientes-oceanicas.png]

- The trade winds blow so continuously and with such regular strength that they drag surface water from Africa and pile it up in the Caribbean and the Gulf of Mexico, causing the level of the water in the latter to rise. This pile up of warm water is one of the causes of the Gulf Stream.
- Similarly, the waters of the Gulf Stream are dragged along by the westerly winds towards the coasts of Britain and Europe.
- The main effect of prevailing winds on ocean current flow occurs in an east-west direction.
- The main effect of temperature differences occurs in north-south flows.

Deep Sea Currents:

Surface currents, discussed above, only involve the upper few hundred metres of the oceans. But there is much more going on underneath. **The Gulf Stream**, for example, which is warm and saline, flows past Britain and Iceland into the Norwegian Sea (where it becomes the Norwegian Current). As it cools down, it becomes denser, and because of its high salinity, which also contributes to its density, it starts to sink beneath the surrounding water (As shown in the adjacent figure) . At this point, it is known as **North Atlantic Deep Water (NADW),** and it flows to significant depth in the Atlantic as it heads back south. Meanwhile, at the southern extreme of the Atlantic, very cold water adjacent to Antarctica also sinks to the bottom to become **Antarctic Bottom Water** (AABW) which flows to the north, underneath the NADW.



A depiction of the vertical movement of water along a north-south cross-section through the Atlantic basin.

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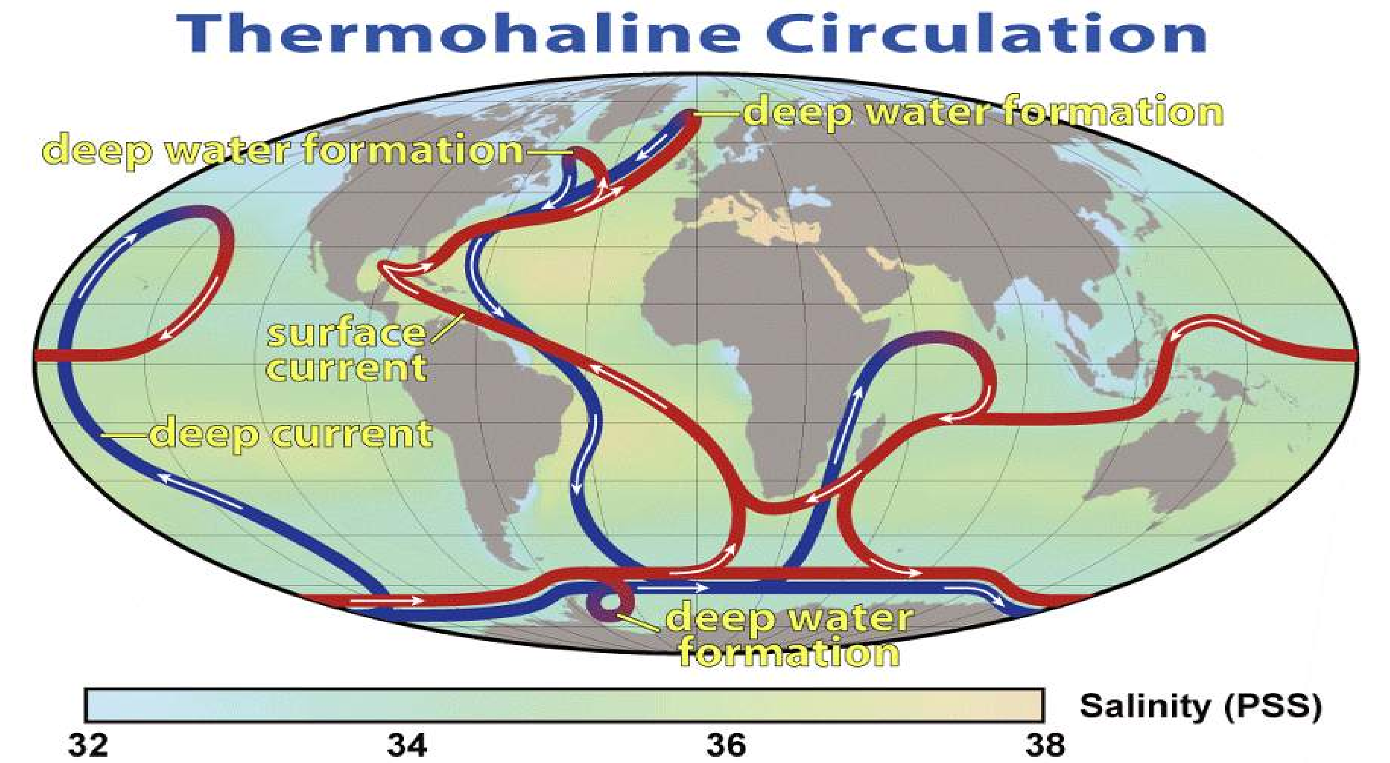
The descent of the dense NADW is just one part of a global system of seawater circulation, both at surface and at depth, as illustrated in Thermo-Haline Circulation (THC) figure. The water that sinks in the areas of deep water formation in the Norwegian Sea and adjacent to Antarctica moves very slowly at depth. It eventually resurfaces in the Indian Ocean between Africa and India, and in the Pacific Ocean, north of the equator.



The thermohaline circulation system, also known as the Global Ocean Conveyor [from NASA at: https://en.wikipedia.org/wiki/Thermohaline_circulation#/media/File:Thermohaline_Circulation_2.png]

The Thermohaline Circulation is critically important to the transfer of heat on Earth. It brings warm water from the tropics to the poles, and cold water from the poles to the tropics, thus keeping polar regions from getting too cold and tropical regions from getting too hot. A reduction in the rate of thermohaline circulation would lead to colder conditions and enhanced formation of sea ice at the poles. This would start a positive feedback process that could result in significant global cooling.

Effect Of Currents On Coastal Areas

- Cold water upwelling and desert formation is an effect of prevailing winds on ocean water flow along some leeward coasts, i.e. coasts where the winds are offshore. This can be seen along the west coast of Africa. As the winds blow water away from the coast, sub-surface cold water wells up offshore which forms the cold currents known as the Canaries and Benguela currents. The Sahara desert and Namib deserts formed in the vicinity are a result of the desiccating effect of these cold currents._
- Ocean currents influence the climate of bordering coastal regions. They affect temperature, humidity and precipitation.
- Cold currents bring planktons from the cold polar and sub-polar zones and thus increase the food supply for fish. As a result, fish thrive in large numbers in these areas.

OCEAN WAVES

Waves

Oceanic Waves

- **Waves** are the oscillatory movements in water mainly produced by winds, manifested by an alternate rise and fall of the sea surface.
- Waves are the forward movement of the ocean's water due to the oscillation of water particles by the frictional drag of WIND over the water's surface.
- The waves are an important agent of erosion in the coastal regions where they sculpt and carve out various landforms like caves, bays and gulfs, capes and cliffs.

Size of a Wave

- Waves have crests (the peak of the wave) and troughs (the lowest point on the wave). The wavelength, or horizontal size of the wave, is determined by the horizontal distance between two crests or two troughs.
- Waves travel in groups called **wave trains.**

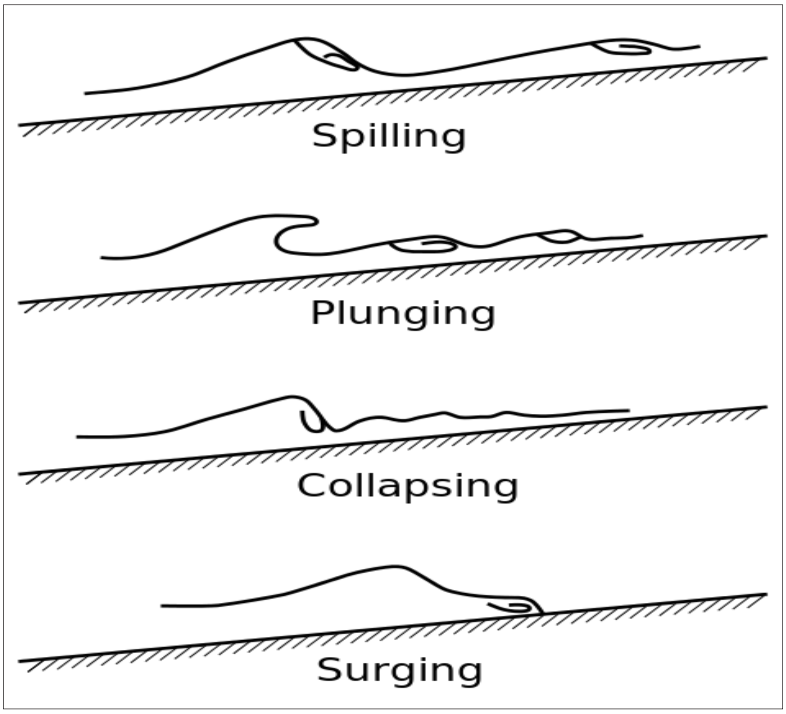
Different Kinds of Waves

Besides wind-produced waves, other types of waves include catastrophic waves (sudden, violent and temporary), storm waves and **seiches (stationary waves).**

- **Wind generated Waves.**
- **Tidal Waves :** The rise and fall of water due to tides also causes some horizontal movement of water, especially on coastlines with indentations and irregular shapes. **Tidal Waves** refer represent this horizontal component of Tides.
- In addition, undersea earthquakes or other sharp motions in the seafloor can sometimes generate enormous waves, called **Tsunami** that can devastate entire coastlines.
- Finally, regular patterns of smooth, rounded waves in the open ocean are called **Swells.**

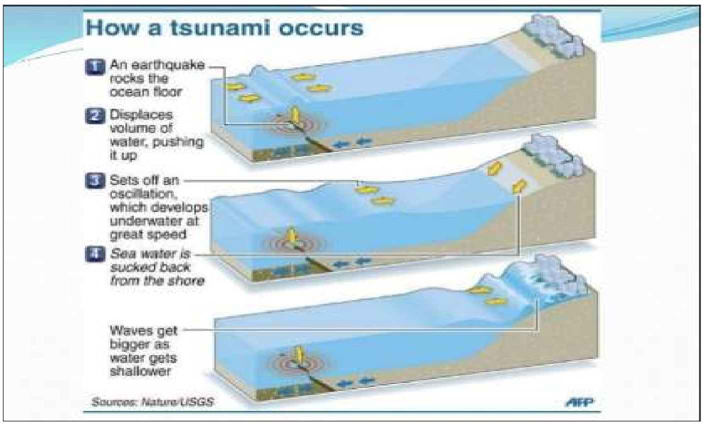
Why Waves Break?

Waves break when they become too high to be adequately supported. As a series of waves approaches shore, the lead waves are in the shallowest water and moving slowest. The rear waves gain on them, and so the distance between waves decreases. The water and energy of each wave become concentrated in a narrower zone, and so the wave grows taller. The water's orbital velocity increases, but the wave speed decreases. Eventually, the orbital speed is larger than the wave speed. The crest gets out ahead of the wave and the wave breaks. As a general rule, waves break when they reach a water depth, measured to the still water level that is about 1.3 times the wave height.



Source Redrawn after: U.S. Department of Transportation–Federal Highway Agency (FHWA) by: S.L. Douglas and J. Krolak, FHWA

Non Wind Generated Waves



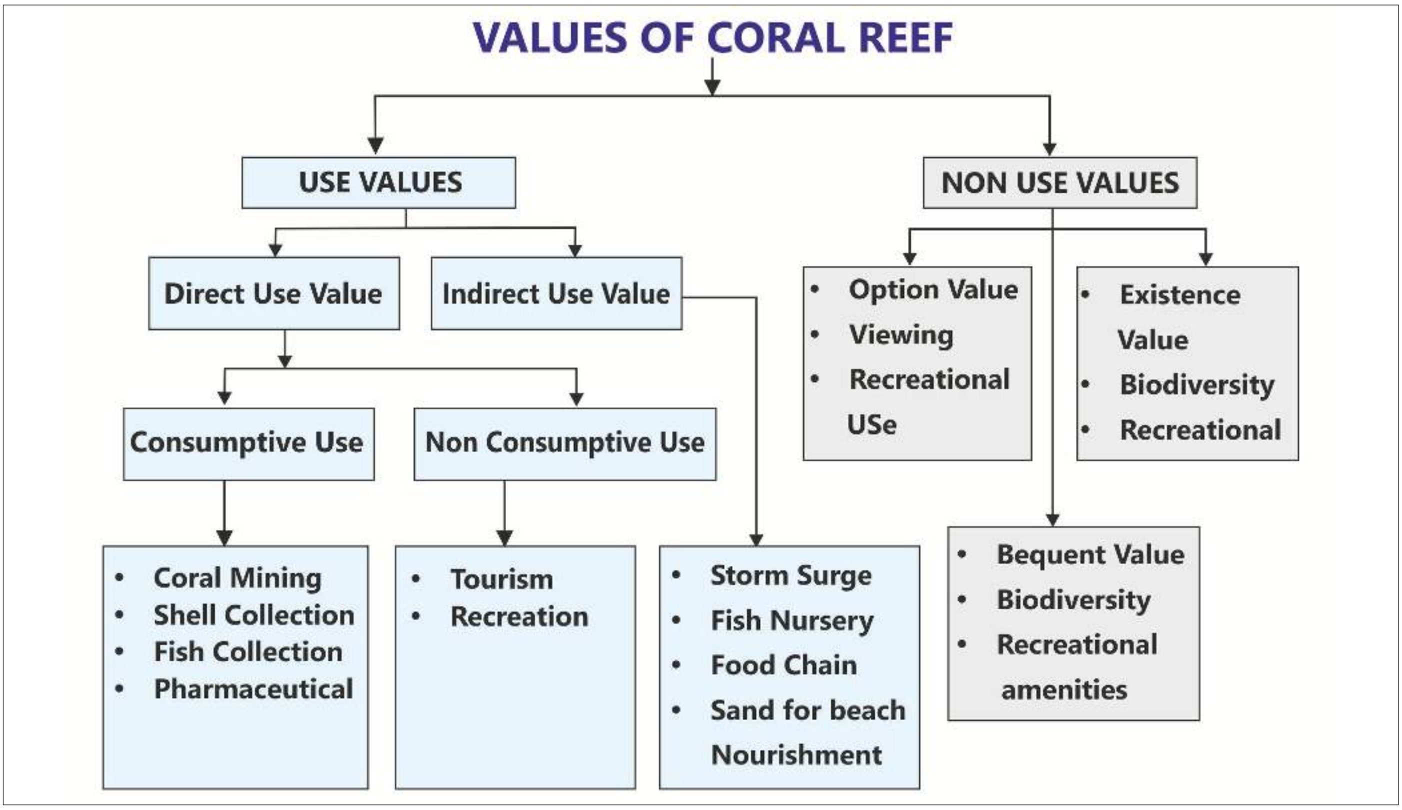
- Movements of the solid Earth may also create waves. This movement may include events such as slippage of the seafloor along an earthquake fault, underwater volcanic explosions, or underwater landslides. Waves generated in this manner are called tsunamis or seismic sea waves. They can be quite dangerous.

Tides

- The seawater rises regularly twice a day at constant intervals. This periodic phenomenon of alternate rise and fall in the sea levels is known as **TIDE**, and is produced due to gravitational interaction of Earth, moon and sun. Moon exerts the strongest influence on tides because of its closeness to Earth.
- On the full moon and the new moon, tides are the highest **(Spring Tides)** while on the 1st and 3rd quarters, tides are lower than the usual **(Neap Tides).**
- Spring tide: Very high tide is caused as the Sun, the moon and the earth are almost in the same line.
- The position of the Sun, the earth, the moon in straight line is called syzygy.
- The situation of solar eclipse when the Sun and the moon are in one side of the earth is called Conjuction.
- Neap tides: Sun and the moon work in opposite direction and hence low tide is caused.
- Friendly side of the tides
- Tides generally help in making some of the rivers navigable for ocean-going vessels.
- London and Calcutta have become important ports owing to the tidal nature of the mouths of Thames and Hooghly, respectively.
- Tides also clear away the sediments brought by rivers and thus retard the formation of deltas and help in cleaning the coastal regions.
- The tidal force may also be used as a source for generating electricity as is being done already in La Rance, France (a pioneer in this field), Japan and now in India (in the Gulfs of Cambay and Kutch).

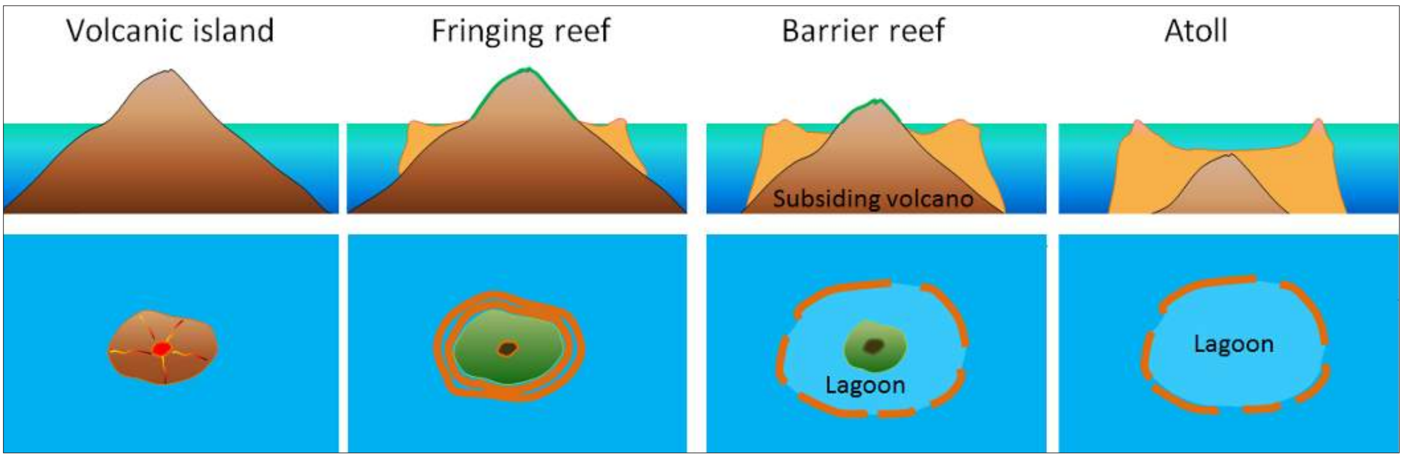
Coral Reef

- Coral reefs are structures produced by living organisms, found in shallow, tropical marine waters with little or no nutrients in the water.
- In most reefs, the predominant organisms are stony corals, colonial cnidarians that secrete an exoskeleton of calcium carbonate (limestone).
- The accumulation of skeletal material, broken and piled up by wave action and bioeroders, produces a massive calcareous formation that supports the living corals and a great variety of other animal and plant life.



Coral reefs can take a variety of forms, the principal ones are as follows:

- **Fringing reef:** reef that is directly attached to a shore or borders it with an intervening shallow channel or lagoon.
- **Barrier reef:** reef separated from a mainland or island shore by a deep lagoon.
- **Atoll reef:** a more or less circular or continuous barrier reef extending all the way around a lagoon without a central island.
- **Apron reef:** short reef resembling a fringing reef, but more sloped; extending out and downward from a point or peninsular shore.
- **Ribbon reef:** long, narrow, somewhat winding reef, usually associated with an atoll lagoon.
- **Table reef:** isolated reef, approaching an atoll type, but without a lagoon.
- **Bank Reef:** Bank reefs are larger than patch reefs and are linear or semi-circular in outline.



The formation of a fringing reef, a barrier reef, and an atoll around a subsiding tropical volcanic island.

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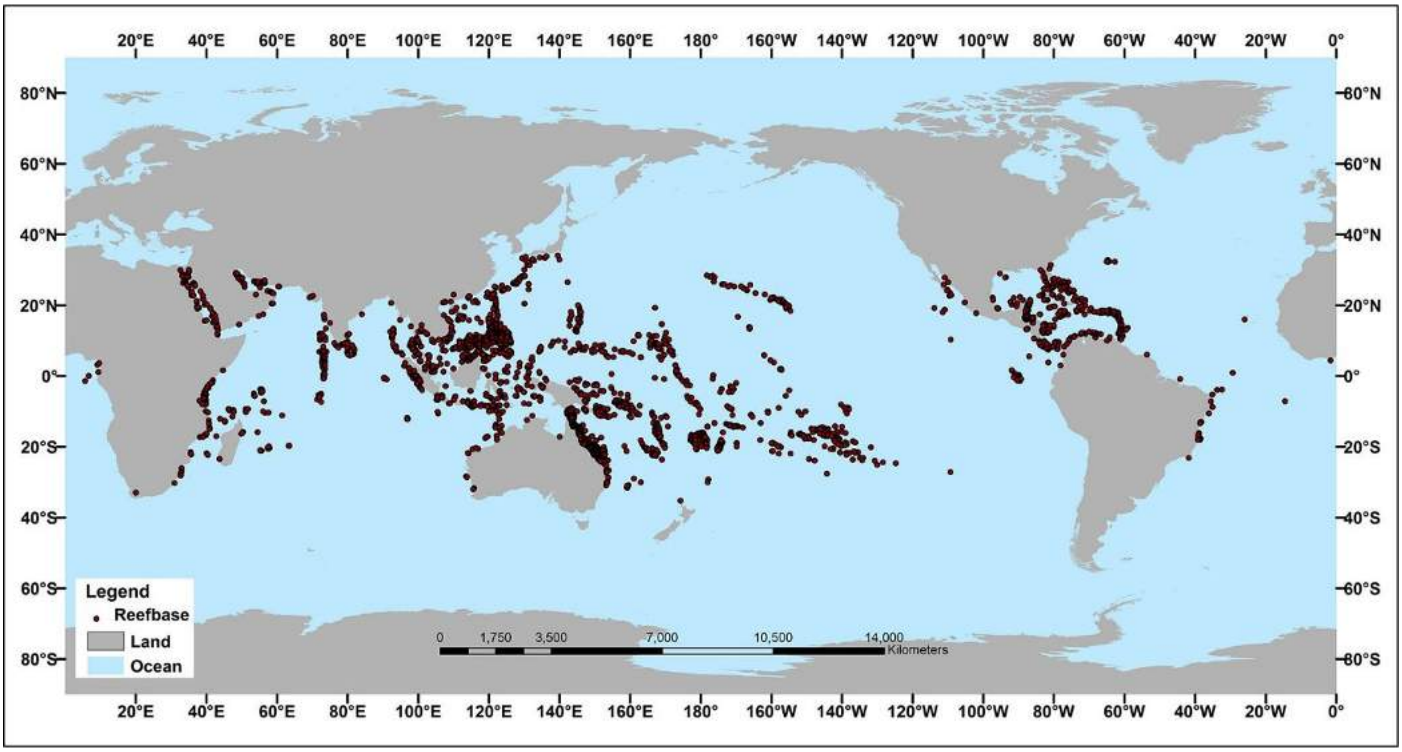
Condition for the development of coral polyps:

- Coral requires high mean annual temperature ranging between (20°C-21°C) for their survival.
- Coral do not live in deeper water i.e. not more than 60-77m below sea level.
- There should be clean sediment free water and fresh water is also injurious for the growth of corals.
- The salinity ranging between 27%o and 30%o is most ideal for the growth and development of coral polyps.
- There should be extensive submarine platform for the formation of colonies by coral polyps.



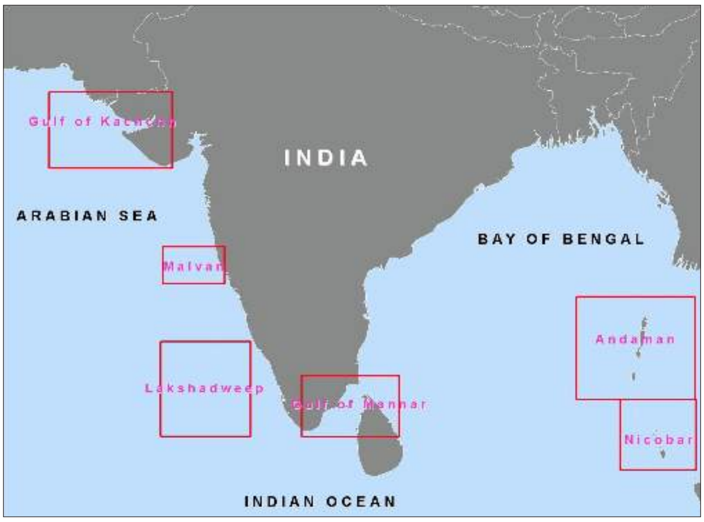
World-wide distribution of reefs

- Coral reefs are usually limited to warm tropical and subtopical Ocean and sea waters in shallow regions, with the Indo-Pacific region (including the Red Sea, Indian Ocean, Southeast Asia and the Pacific) accounting for 91.9% of the total.
- Southeast Asia accounts for 32.3% of that figure, while the Pacific including Australia accounts for 40.8%.
- Atlantic and Caribbean coral reefs only account for 7.6% of the world's total.
- Coral reefs are either restricted or absent from along the west coast of the Americas, as well as the west coast of Africa.
- This is primarily due to upwelling and strong cold coastal currents that reduce water temperatures in these areas.
- Corals are also restricted from off the coastline of South Asia from Pakistan to Bangladesh.
- They are also restricted along the coast around north-eastern South America and Bangladesh due to the release of vast quantities of freshwater from the Amazon and Ganges rivers respectively.

Famous coral reefs and reef areas of the world include:

- The Great Barrier Reef: largest coral reef system in the world, located in Queensland, Australia;
- The Belize Barrier Reef: second largest in the world, located in Belize, Central America; and
- The Red Sea Coral Reef: located off the coast of Egypt and Saudi Arabia.
- Pulley Ridge: deepest photosynthetic coral reef, located in Florida, USA.
- Numerous reefs are found scattered over the Maldives.

Coral Bleaching



- Coral bleaching refers to the loss of colour of corals, due to stress-induced expulsion of symbiotic unicellular algae.
- Coral reef bleaching, the whitening of diverse invertebrate taxa, results from the loss of symbiotic zooxantheallae and/or a reduction in photosynthetic pigment concentrations in zooxanthellae residing within scleractinian corals.

Coral bleaching is a vivid sign of corals responding to stress which can be induced by any of the following:

1. increased or reduced water temperatures (often attributed to global warming)
2. increased solar irradiance (photosynthetically active radiation and ultraviolet band light)
3. changes in water chemistry (in particular ocean acidification)
4. increased sedimentation (can be contributed to silt runoff)
5. pathogen infections
6. changes in salinity

Initiatives To Protect Coral Reefs

International Level

- **UN Sustainable Development Goals –** Goal #14 (Life below water)
- **Global Coral Reef Partnership -** Initiated by UNEP and Regional Seas Conventions and Action Plans to support countries deliver internationally agreed coral reef commitments through ecosystem-based management of coral reefs.
- **International Coral Reef Initiative (ICRI) -** a partnership of Nations and organizations which strives to preserve coral reefs and related ecosystems.
- **Global Coral Reef Monitoring Network -** works through a global network to strengthen the provision of best available scientific information on and communication of the status and trends of coral reef ecosystems, for their conservation and management.
- **Global Coral Reef Alliance -** a coalition of volunteer scientists, divers, environmentalists and other individuals and organizations, committed to coral reef preservation.

National Level

Legislative

- Coral reef is included in Schedule I of the Wild Life Protection Act, 1972 which affords it the highest degree of protection.
- Protected Areas, viz. National Parks, Sanctuaries and Marine Biosphere Reserve have been created all over the country under the provisions of the Wild Life (Protection) Act, 1972 to conserve marine life including coral reef.

Regulatory:

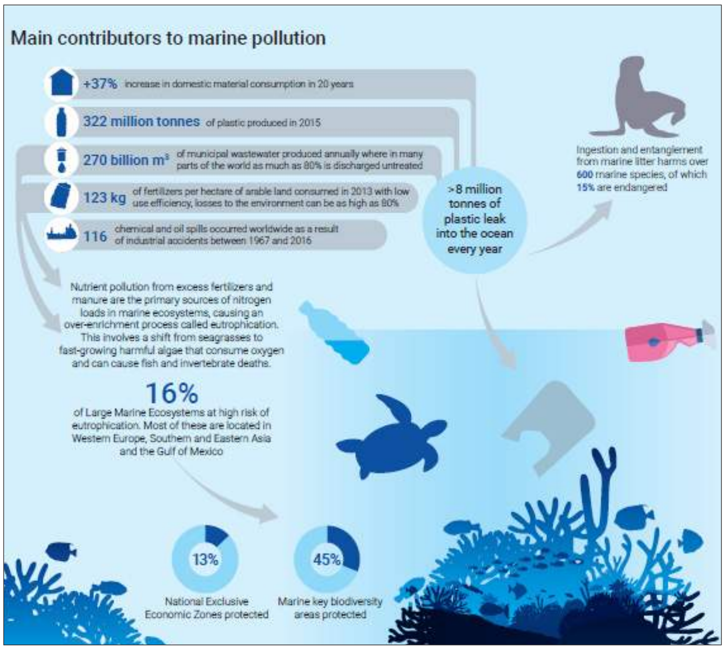
- The Coastal Regulation Zone (CRZ) Notification (2019) and the Island Protection Zone (IPZ) Notification (2019) regulates the development activities along the Sea coast and tidal influenced water bodies. To enforce them, the Ministry of Environment and Forests has constituted the National and State/UT level Coastal Zone Management Authorities.
- Zoological Survey of India has been undertaking studies on the serious threat to coral colonies in India. The mangroves and coral reefs areas are categorized as ecological sensitive areas (CRZ-I) where no new constructions are permitted with a few exceptions

Research:

Zoological Survey of India has been undertaking studies on the serious threat to coral colonies in India.

Marine Pollution

- Human beings and anthropogenic activities have left an indelible impact on Hydrosphere.
- The diverse human impact includes such multifactorial phenomena as
  i. changes in temperature regime and radioactive background,
  ii. discharges of toxic effluents and inflow of nutrients,
  iii. irretrievable water consumption and damage of water organisms during seismic surveys,
  iv. landing of commercial species and their cultivation,
  v. destruction of the shoreline and



- Marine pollution refers to that harmful effect caused by the entry into the ocean of pollutants, chemicals or particles. Marine pollution is the result of deliberate or accidental discharge of untreated wastewater, dumping of solid wastes and other polluted runoff from a variety of land-based activities directly into our rivers and coastal waters. Healthy oceans are productive oceans, and resilient marine and coastal ecosystems are essential to achieve sustainable development.

Sources: CRED/EM-DAT (2013), FAO (2011), FAO (2013), PlasticsEurope (2016), UNEP (2017), UNEP/RSP (2017), UNEP-WCMC (2017)"

Marine Debris

- **Marine debris**, also known as **marine litter**, is human-created waste that has deliberately or accidentally become afloat in a lake, sea, ocean or waterway. Oceanic debris tends to accumulate at the centre of gyres and on coastlines, frequently washing aground where it is known as **beach litter**.
- Some forms of marine debris, such as harmless driftwood, occur naturally, and human activities have been adding similar material into the oceans for thousands of years. Only recently, however, with the advent of plastic, has human influence become an issue as many types of plastics do not biodegrade.
- Ocean dumping, accidental container spillages, and wind-blown landfill waste are all contributing to this growing problem.

Oil Spill

- An **oil spill** is the release of a liquid petroleum hydrocarbon into the environment due to human activity, and is a form of pollution. The term often refers to marine oil spills, where oil is released into the ocean or coastal waters.
- The oil may be a variety of materials, including crude oil, refined petroleum products (such as gasoline or diesel fuel) or by-products, ships' bunkers, oily refuse or oil mixed in waste. Spills take months or even years to clean up.
- Oil is also released into the environment from natural geologic seeps on the sea floor. Most human-made oil pollution comes from land-based activity, but public attention and regulation has tended to focus most sharply on sea-going oil tankers.

Environmental effects

i. The oil penetrates and opens up the structure of the plumage of birds, reducing its insulating ability, and so making the birds more vulnerable to temperature fluctuations and much less buoyant in the water.

ii. It also impairs birds' flight abilities, making it difficult or impossible to forage and escape from predators.

iii. As they attempt to preen, birds typically ingest oil that coats their feathers, causing kidney damage, altered liver function, and digestive tract irritation. This and the limited foraging ability quickly causes dehydration and metabolic imbalances. Most birds affected by an oil spill die unless there is human intervention.

iv. Marine mammals exposed to oil spills are affected in similar ways as seabirds. Oil coats the fur of sea otters and seals, reducing its insulation abilities and leading to body temperature fluctuations and hypothermia. Ingestion of the oil causes dehydration and impaired digestion.

Methods for Cleaning up Include:

- Bioremediation: use of microorganisms or biological agents to break down or remove oil
- Controlled burning can effectively reduce the amount of oil in water, if done properly. But it can only be done in low wind, and can cause air pollution.
- Dispersants act as detergents, clustering around oil globules and allowing them to be carried away in the water. This improves the surface aesthetically, and mobilises the oil. Smaller oil droplets, scattered by currents, may cause less harm and may degrade more easily. But the dispersed oil droplets infiltrate into deeper water and can lethally contaminate coral. Recent research indicates that some dispersants are toxic to corals.
- Watch and wait: In some cases, Natural attenuation of oil may be most appropriate, due to the invasive nature of facilitated methods of remediation, particularly in ecologically sensitive areas.
- Dredging: for oils dispersed with detergents and other oils denser than water.
- Skimming: Requires calm waters
- Solidifying

SOURCE : UNEP Science Division (Marine Pollution. Brief 001/2017)