

CHAPTER 1

ENVIRONMENT, ECOLOGY AND ECOSYSTEM

1.1 ENVIRONMENT

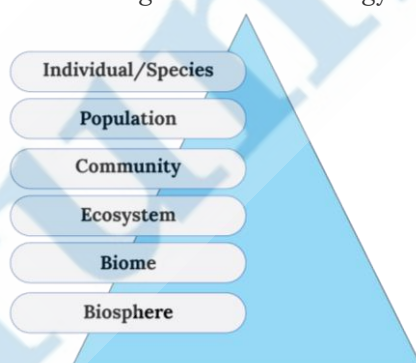
Environment means anything that surrounds us. It consists of both living (biotic) and non-living (abiotic) things. Interactions among the biotic and abiotic components shape the habitat and ecosystem of an organism.

The environment includes the physical (air, water), chemical (carbon cycle, nitrogen cycle) and biological (biomolecules, organisms) interactions that affect an organism.

Components of Environment	
Abiotic	Biotic
Water	Green plants
Soil	Non-green plants
Atmospheric gases	Man
Fire	Animals
Energy	Parasites
Temperature	Decomposers

1.2 ECOLOGY

Ecology is the study of relationships between living organisms, including humans and their physical environment. There are five main levels of organization of ecology.



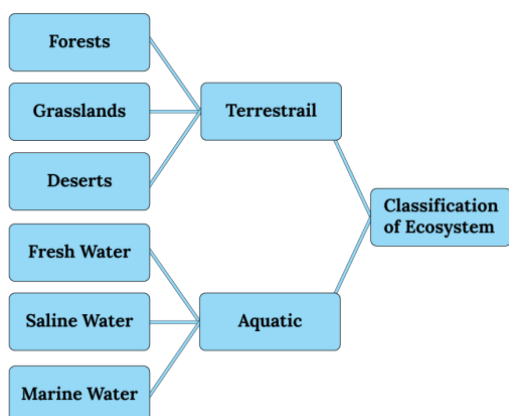
Ecological Organization

Population refers to a group of individuals usually of the same species, occupying a defined area during a specific time.

Community refers to all populations of different species that live in the same area and interact with one another. A community is composed of all of the biotic factors of a site. Communities in most instances are named after the dominant plant form and can be divided into two types:

- Major Community**- These are large-sized and relatively independent. They depend only on the sun's energy from outside. E.g., Tropical Evergreen Forests.
- Minor Community**- These are dependent on the neighboring communities. E.g., A mat of lichen on a cow dung pad.

Ecosystem is the structural and functional unit of a biosphere. It consists of a community of living organisms in conjunction with their environment's non-living components, both interacting and exchanging materials between them.



Some terms to remember:

1. **Autotrophs** -Primary producers like green plants, microscopic algae.
2. **Heterotrophs/Phagotrophs**- Consumers who are incapable of producing their own food, e.g., humans.
3. **Saprotrophs/Osmotrophs**- They are decomposers like bacteria, fungi, earthworms.

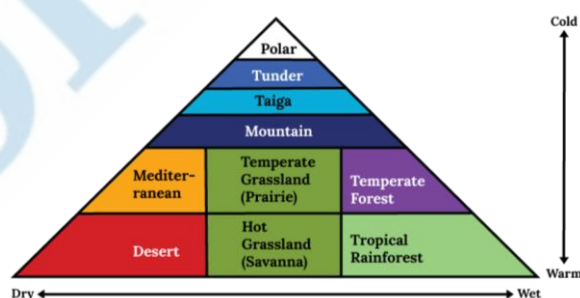
Ecotone is a zone of junction between two or more diverse ecosystems. E.g., the mangrove forests are an ecotone between marine and terrestrial ecosystems while grasslands represent an ecotone between forest and desert. Other ecotones are estuary and riverbank.

Important **characteristics of ecotone** are:

- a. It is a **zone of tension** with conditions intermediate to the ecosystems bordering it.
- b. It is **linear** as there is a progressive increase in species composition of incoming community and simultaneous decrease in species of outgoing adjoining community.
- c. There may be **organisms in an ecotone entirely different** from that of adjoining communities.
- d. Ecotones may have an **'edge effect'** wherein the number of species and population density of some species in this zone is much greater than either community.

Niche refers to the unique functional role or place of a species in an ecosystem. A niche is unique for a species and no two species in a habitat can have the same niche. Niche is important for the conservation of organisms. If we need to conserve a species in its native habitat, we need to know about the niche requirements of the species and ensure that all requirements of its niche are fulfilled.

Biome is the terrestrial part of the biosphere. They are characterized by climate, vegetation, animal life and general soil type.



Biome distribution based on Temperature and Precipitation:

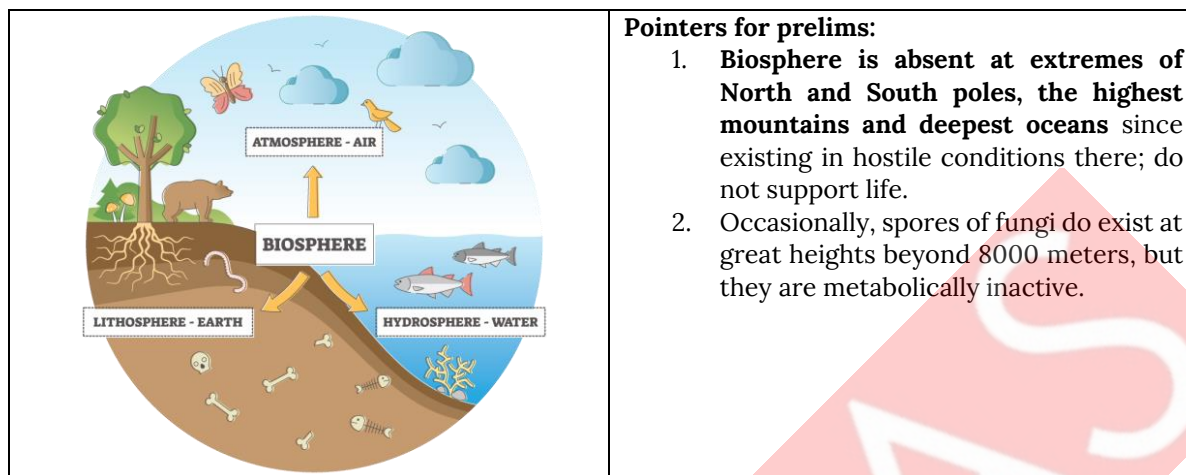
Sl. No	Biome	Distribution	Important characteristics
1	Tundra	Northern and Southernmost regions of the world adjoining the ice-bound poles.	<ul style="list-style-type: none"> • There are no trees due to permafrost. The lowest forms of vegetation like mosses, lichens are sparsely found on bare rocks. • Reptiles and amphibians are almost absent.

			<ul style="list-style-type: none"> • Most of the animals found have a long life. They are protected by thick cuticle and epidermal hair or fur.
2	Taiga	Northern Europe, Asia and North America.	<ul style="list-style-type: none"> • They are also known as boreal forests. Their productivity is lower than those of any other forest ecosystem. • Soils of boreal forests are characterized by thin podzols. Podzols have low pH (acidic) due to excessive leaching.
3	Temperate Deciduous Forest	Central and Southern Europe, Eastern North America, Western China, Japan, New Zealand etc.	<ul style="list-style-type: none"> • Soils of temperate forest are podzolic and fairly deep. • The flora includes oak, beech and maple.
4	Tropical Rainforest	They are found in the equatorial region.	<ul style="list-style-type: none"> • Multiple storey of broad-leaved, tall, closely set evergreen trees with crowns forming a continuous canopy are found. • The soil of rainforest is nutrient-poor as most of the nutrients are washed away by heavy rains. • Coexistence of a large number of species. • Presence of numerous epiphytes. • Flora includes mahogany, ebony etc.
5	Savannah	Tropical region: It is most extensive in Africa.	<ul style="list-style-type: none"> • Tall grass and short trees. • Trees are deciduous and have broad trunks for water storage. • Also known as 'Big Game Country' as thousands of animals are hunted for sports.
6	Steppe	Temperate conditions with low rainfall.	<ul style="list-style-type: none"> • They are practically treeless. • Grasses are short and nutritious.
7	Desert	Continental interiors with very low and sporadic rainfall.	<ul style="list-style-type: none"> • Vegetation is predominantly xerophytic or drought resistant. • Plants have long roots, few or no leaves, and the foliage is either waxy, leathery, hairy or needle-shaped to reduce the loss of water through transpiration. E.g., cacti.

Aquatic ecosystems are not called biomes; however, they are divided into distinct life zones. Based on the salinity, aquatic ecosystems are classified into the following types:

- Freshwater ecosystems** which have salt content less than 5 ppt. There are two types of freshwater ecosystems- Static or still water (Lentic) ecosystem like ponds, lakes, bogs, swamps and Running water (Lotic) ecosystem like springs, streams, rivers.
- Marine ecosystems** that have salt content of 35 ppt or more.
- Brackish water ecosystems** with salt content in between 5 to 35 ppt like mangroves, estuaries, salt marshes.

Biosphere is a part of the earth where life can exist. It comprises of the atmosphere (air), hydrosphere (water) and lithosphere (land).



Pointers for prelims:

1. **Biosphere is absent at extremes of North and South poles, the highest mountains and deepest oceans** since existing in hostile conditions there; do not support life.
2. Occasionally, spores of fungi do exist at great heights beyond 8000 meters, but they are metabolically inactive.

1.3 FUNCTIONS OF ECOSYSTEM

1.3.1 Ecological Succession

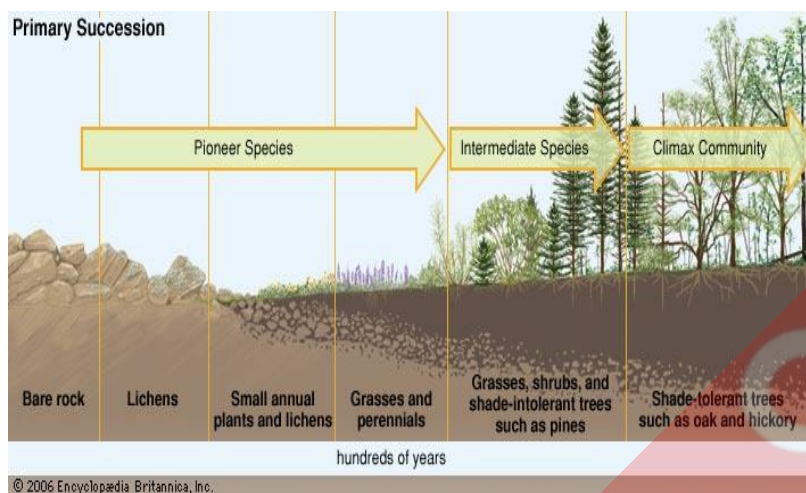
Ecological succession is the process of change in the species structure of an ecological community over time. The time scale can range from decades to even millions of years. Plants and animal species in an area are replaced or changed into another over a period of time. One community replaces another until a stable and mature climax community develops.

The stages leading to the climax community are called seres or successional stages. Succession is characterized by increased productivity, a gradual increase in food webs' complexity and increased diversity of organisms with increased niche development.

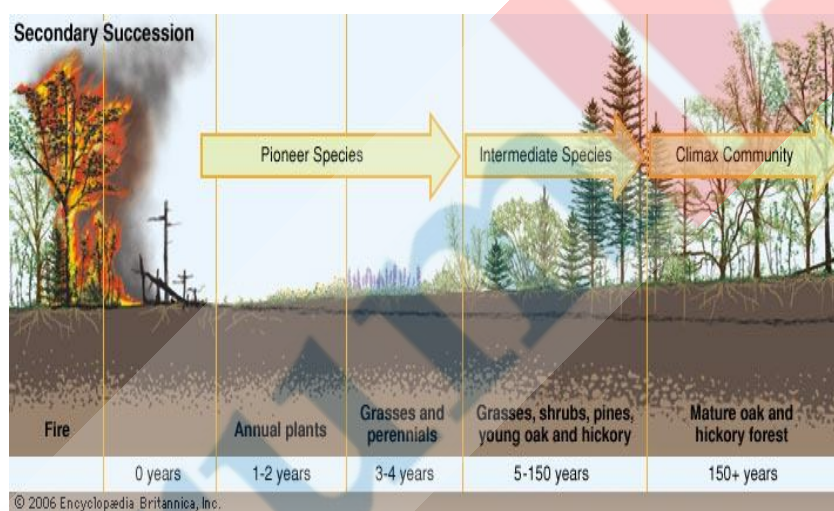
Succession occurs faster in regions existing in the middle of the large continent because seeds of plants belonging to the different seres would reach here much faster.

Stages in succession are:

- a. **Primary Succession:** It takes place over an area where no community has previously existed. Few hardy pioneer species like lichens, mosses and microbes first colonialize the new site. The pioneers, over a few generations, alter the habitat conditions by their growth and development. These new conditions may be conducive to establishing additional organisms that may subsequently arrive at the site.
- b. **Secondary Succession:** It is the sequential development of biotic communities following the complete or partial destruction of the existing community. A mature or intermediate community may be destroyed by natural events like floods or human interventions like deforestation.



This abandoned land is first invaded by hardy grasses species that can survive in bare, sunbaked soil. Tall grasses and herbaceous plants may soon join these grasses. Eventually, some trees come up in this area, seeds of which may be brought by wind or animals. And over the years, a forest community develops.



The **difference between primary and secondary succession** is that secondary succession is relatively faster than primary succession as it starts on a well-developed site already formed at the site. Also, secondary succession starts on a well-developed soil already formed at the site.

Types of succession are:

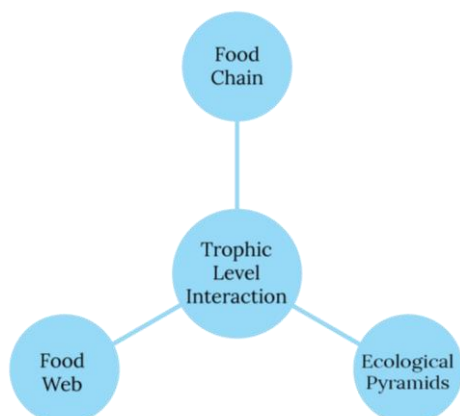
- Autogenic Succession:** When living inhabitants of the community itself bring about succession.
- Allogenic Succession:** When outside forces bring about succession.
- Autotrophic Succession:** Succession in which green plants are much more significant in quantity.
- Heterotrophic Succession:** Succession in which heterotrophs are more significant in quantity.

1.3.2 Energy Flow Through an Ecosystem



Energy flow is **unidirectional** and decreases from the first trophic level to upwards. This is due to loss in energy in the form of heat at each trophic level.

Trophic level interaction deals with how members of an ecosystem are connected based on nutritional needs.

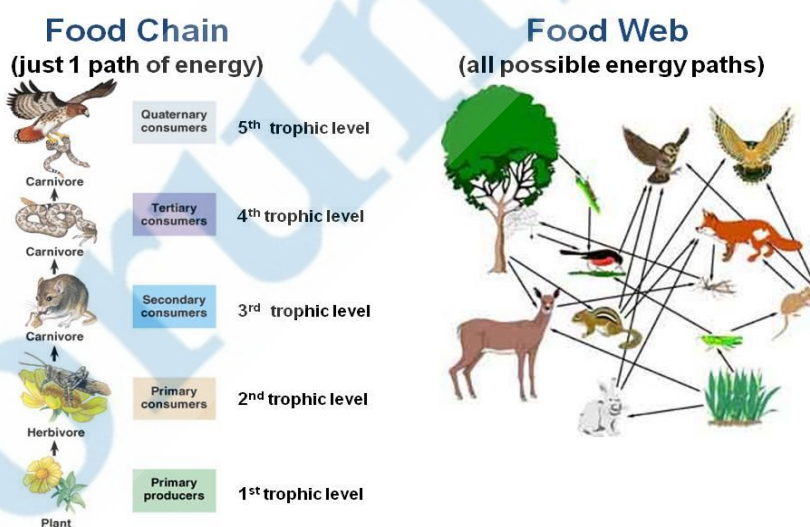


Basic Concepts:

1. **Food Chain:** A sequence of organisms that feed on one another form a food chain. It can be a grazing food chain (beginning from green plants at the base) or a detritus food chain (beginning from dead organic matter). Food chains are not found within the population of a species (for e.g., a lion won't eat a lion).
2. **Food Web:** Multiple interlinked food chains make a food web. A food web denotes the numbers of each organism which are eaten by others.

A **food web consists of many food chains**. A food chain only follows just one path as animals find food. E.g., a hawk eats a snake, which has eaten a frog, which has eaten a grasshopper, which in turn has eaten grass.

However, a **food web consists of many food chains**. A food web shows many different paths through which plants and animals are connected. For e.g., a hawk might also eat a mouse, a squirrel or some other animal. The snake may eat a beetle or a caterpillar. And the process continues for all the other animals in the food chain.



The arrow points to the eater and shows the transfer of energy.

Picture Credits: www.cadavies.com/food-chains-and-food-webs.html

Food Chain v/s Food Web

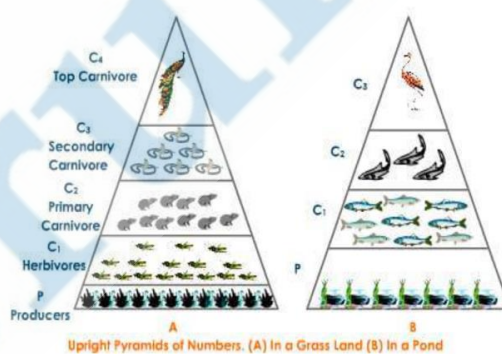
Terrestrial Food Chain: Grass→Grasshopper→Mouse→Snake→Hawk.

Aquatic Food Chain: Phytoplankton (diatoms, cyanobacteria) →Crustaceans→Herrings.

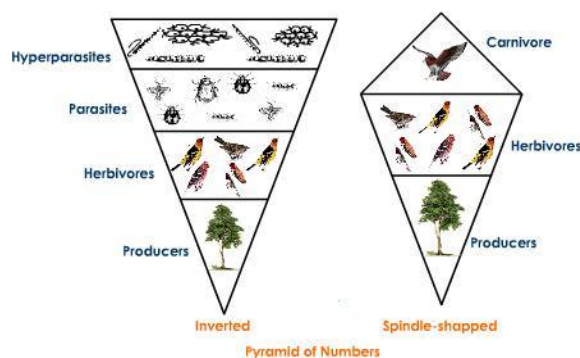
Biotic Interactions				
Sl. No	Type	Species 1	Species 2	Example
1	Mutualism	+	+	<ul style="list-style-type: none"> Sea Anemone gets attached to the cell of hermit crab Coral reefs Pollination
2	Commensalism	+	0	<ul style="list-style-type: none"> Suckerfish attaches to shark Cow dung and dung beetles. Trees and epiphytic plants
3	Amensalism	-	0	<ul style="list-style-type: none"> A large tree shades a small plant
4	Competition	-	-	<ul style="list-style-type: none"> Two species compete for the same food
5	Predation	+	-	<ul style="list-style-type: none"> Predators like lion, tiger
6	Parasitism	+	-	<ul style="list-style-type: none"> Parasites getting nourishment from the host
'+' means benefitted '-' means harmed '0' means neither benefitted nor harmed				

Ecological Pyramids: They are pyramidal representation of trophic levels of different organisms based on their ecological position (producer to final consumer). They are classified into three categories:

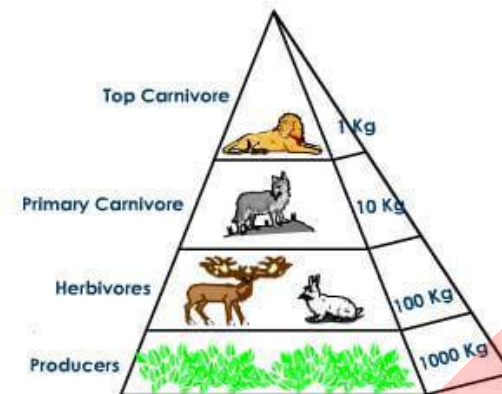
1. **Pyramid of numbers:** This shows the total number of individual organisms at each level in an ecosystem's food chain.
 - a. **Pyramid of numbers-upright:** In this pyramid, the number of individuals decreases as one moves from lower to higher trophic level. Grassland and pond ecosystem shows this type of pyramid.



- b. **Pyramid of numbers-inverted:** In this, the number of individuals is increased from lower to higher trophic level. E.g., tree ecosystem.

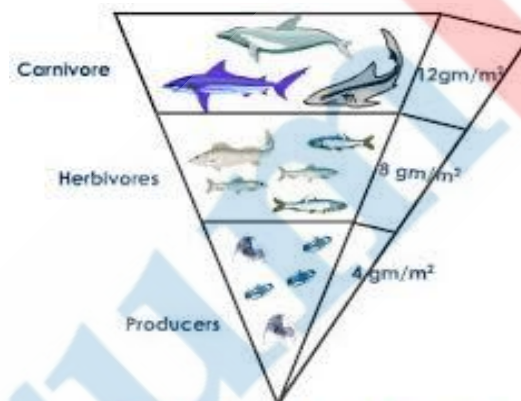


2. **Pyramid of biomass:** It is determined by collecting all organisms at each trophic level and measuring their dry weight.
- a. **Pyramid of biomass-upright:** For the majority of ecosystems on land, the pyramid of biomass shows a large base of primary producers and a smaller trophic level perched on top.



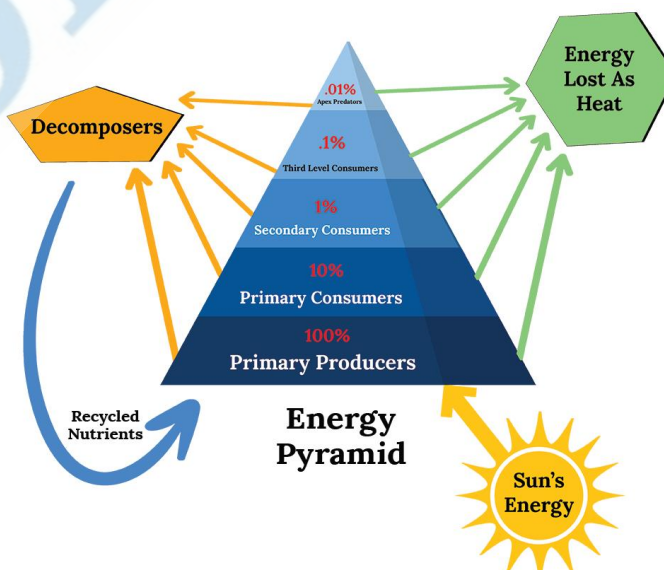
Upright Pyramid of biomass in a Terrestrial Ecosystem

- b. **Pyramid of biomass-inverted:** In contrast, in many aquatic ecosystems, the pyramid of biomass may assume an inverted form. This is because producers are tiny phytoplankton.



Inverted Pyramid in an Aquatic Ecosystem

3. **Pyramid of Energy:** An energy pyramid is a model that shows the flow of energy from one trophic level to the next along a food chain. It is always upright with a large energy base at the bottom.



Issues with Ecological Pyramid:

1. Saprophytes are not given a place in ecological pyramids.
2. It does not consider the same species belonging to two or more trophic levels.
3. It does not accommodate a food web.

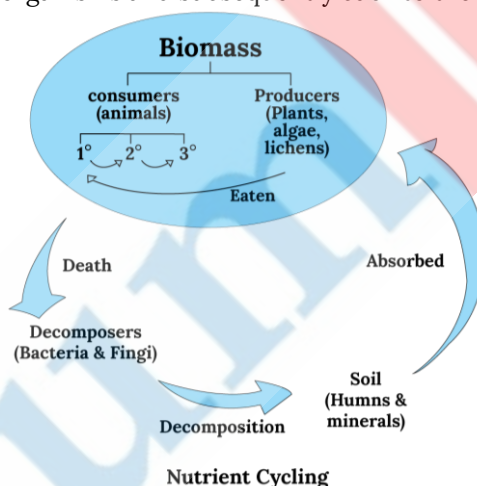
Basic Concepts:

1. **Bioaccumulation:** It refers to how pollutants enter a food chain. Bioaccumulation occurs when an organism absorbs a toxic substance at a rate greater than that at which the substance is eliminated.
2. **Biomagnification:** It refers to the pollutant's tendency to concentrate as they move from one trophic level to the next. For biomagnification to occur, pollutants must be long-lived, mobile, soluble in fats, biologically active. For e.g., the concentration of DDT moves up the food chain, from one trophic level to another.

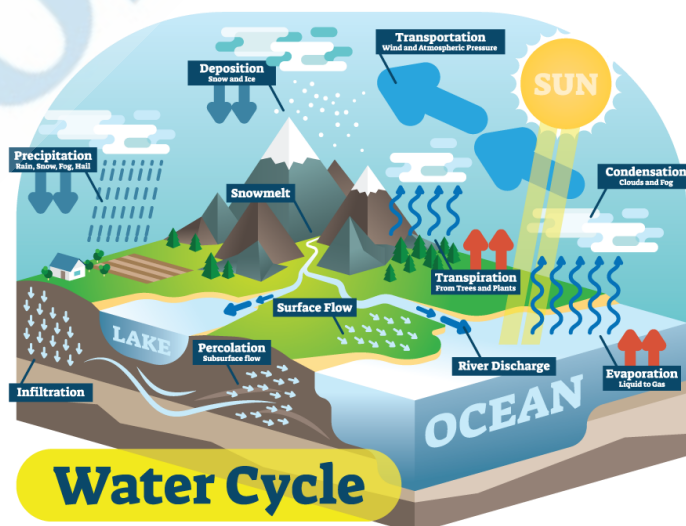
1.3.3 Bio-geo-chemical cycle

Bio-geo-chemical cycle is a pathway by which a chemical substance moves through the biotic and abiotic compartments of the earth. They are of the following types:

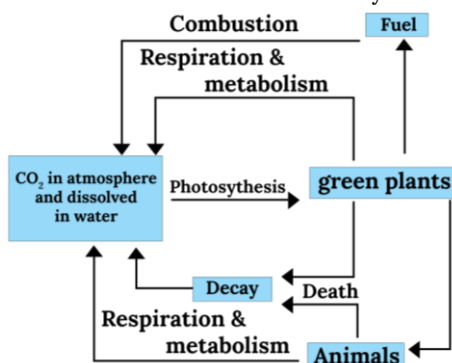
1. **Nutrient Cycling:** It is a concept that describes how nutrients move from the physical environment to the living organisms and subsequently back to the physical environment.



2. **Gaseous Cycles:** Some of the most important gaseous cycles are water, carbon and nitrogen.
 - a. **Water Cycle:** It involves a continuous circulation of water in the Earth-atmosphere system, which is driven by solar energy.



- b. **Carbon Cycle:** It involves a continuous exchange of carbon between the atmosphere and organisms. It is usually a short-term cycle. Respiration, decay and volcanic actions are some factors that add CO_2 to the Carbon Cycle.

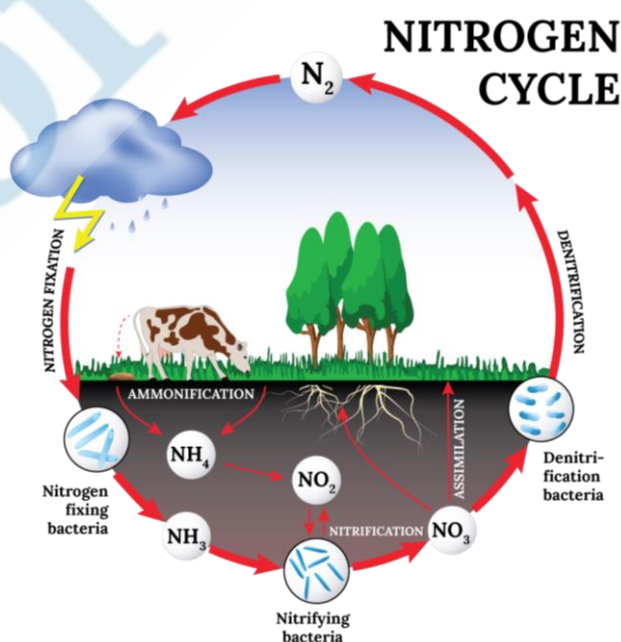


Carbon Cycle

- c. **Nitrogen Cycle:** Nitrogen is converted into many chemical forms as it circulates from the atmosphere to the soil to organism and back into the atmosphere.
- i. **Nitrogen fixation:** They are accomplished in three different ways: by microorganisms like bacteria and blue-green algae, by man using industrial process like fertilizer factories and to a limited extent by atmospheric phenomenon like thunder and lightning.

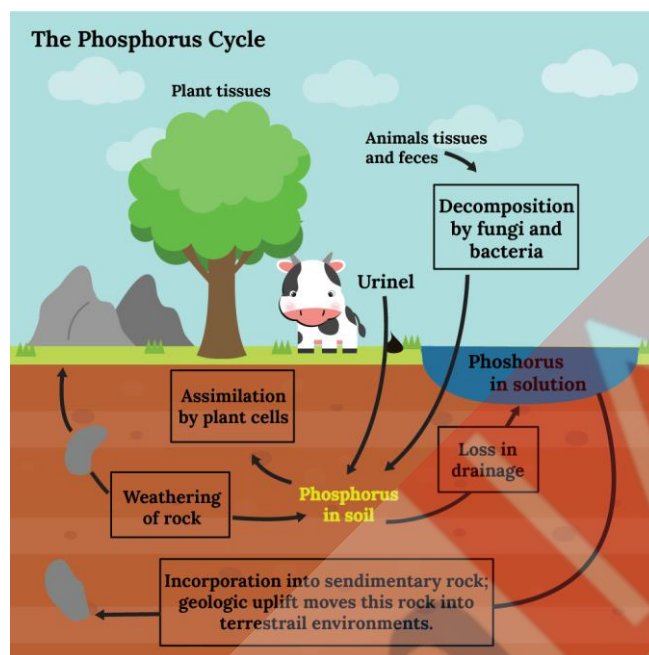
Certain microorganisms are capable of fixing atmospheric nitrogen into ammonium ions. These are free living nitrifying bacteria (e.g., aerobic azotobacter and anaerobic clostridium) and symbiotic nitrifying bacteria living in association with leguminous plants and symbiotic bacteria living in non-leguminous root nodule plants (e.g., rhizobium) as well as blue green algae (e.g., anabaena, spirulina)

- ii. **Nitrification:** Ammonium ions are oxidized to nitrites or nitrates by two specialized bacteria; Nitrosomonas bacteria to promote ammonia transformation into nitrite, which is then further transformed into nitrate by the bacteria Nitrobacter.
- iii. **Denitrification:** Special denitrifying bacteria pseudomonas convert nitrites/nitrates to elemental nitrogen.



3. **Sedimentary Cycles:** Phosphorus and sulphur circulate by means of sedimentary cycle.

- a. **Phosphorus Cycle:** The main storage for phosphorus is in the earth's crust. It occurs in large amounts as a mineral in phosphate rocks and enters the cycle from erosion, weathering and mining activities.

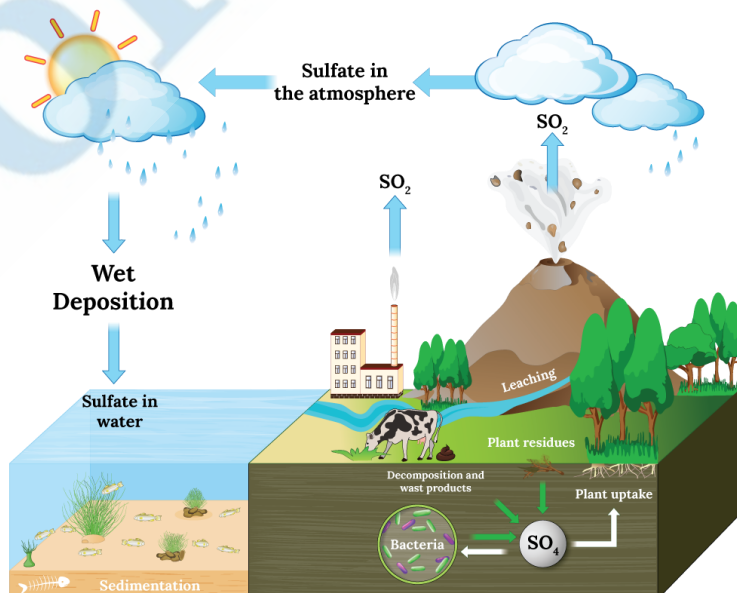


- b. **Sulphur Cycle:** Sulphur is locked in organic (coal, oil and peat) and inorganic deposits (pyrite rocks and Sulphur rocks).

It is released by weathering activities. It also enters the atmosphere from sources like volcanic eruptions, fossil fuel combustion, ocean surface and decomposition.

While the Sulphur cycle is mostly sedimentary, hydrogen sulphide and Sulphur dioxide add a gaseous component to it. This hydrogen sulphide also gets oxidized into Sulphur dioxide which dissolves in rainwater and falls as acid rain.

Sulfur Cycle



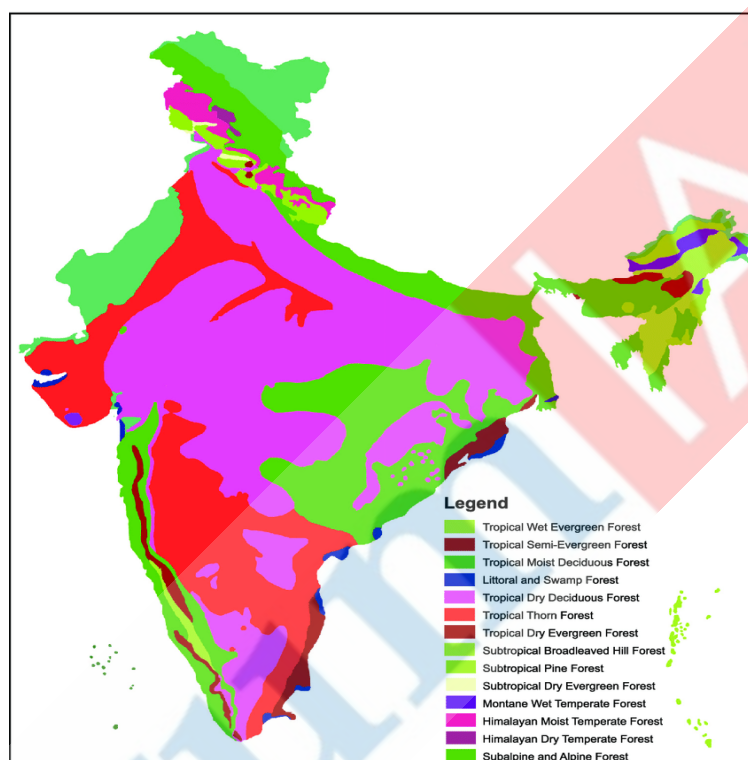
1.4 TERRESTRIAL AND AQUATIC ECOSYSTEMS

1.4.1 Terrestrial Ecosystem

Terrestrial ecosystems, namely tundra forest, boreal forest, temperate deciduous forest, tropical rain forest, savannah, steppe and desert have been discussed earlier in this booklet.

Important terrestrial ecosystems required from prelims point of view will be discussed in this chapter.

1. Indian Forest Types (based on Champion and Seth classification of forest)



Picture Credits: Wildlife Institute of India

- Grassland Ecosystem:** These are found in regions where rainfall is about 25-75 cm per year. Rainfall is not enough to support a forest, but more than a true desert. Steppe formations are found in western Rajasthan while dry savannah grasslands are found in the central and eastern parts of Rajasthan. Fire is a natural part of the grassland ecosystem which helps control trees, woody shrubs and invasive species and maintain its health and vigor.

Heavy grazing in grasslands leads to a reduction of the mulch cover of the soil. Microclimate becomes dry and is readily invaded by xerophytes. Due to the absence of humus cover, the mineral soil surface is heavily trampled. It reduces the infiltration of water into the soil and accelerates run-off, resulting in soil erosion.

Banni Grassland of Gujarat is the largest natural grassland in the Indian subcontinent. Maldhari tribes dominate this area. A huge freshwater lake, Chhari-Dhand is a prominent feature of the Banni grassland.

- Desert Ecosystem:** Animals are physiologically and behaviorally adapted to desert conditions: they are fast runners, nocturnal in habit, have long legs to keep the body away from the hot ground and conserve water by excreting concentrated urine.

Thar desert is an example of Indian desert. It is home to the **Great Indian Bustard, Flamingoes and Asiatic Wild Ass**. Asiatic Wild Ass, also known as **ghudkhar** in local Gujrati language, is a sub-species of the onager native of South Asia. The animal has no predators in that area, but its existence is threatened due to the destruction of habitats. It is currently listed as Near Threatened by IUCN.

Cold Desert of India is found in Leh, Ladakh and Kargil of Kashmir and Spiti valley of Himachal Pradesh and some parts of Uttarakhand and Sikkim. The soil of this region is sandy to sandy loam, while the pH type is neutral to slightly alkaline. Tibetan Wild Ass (**Kiang**) and **Snow Leopard** are important fauna found here.

Pointers for prelims:

1. **Forest-plus 2.0**, a 5-year program focusing on improving the status of forests in three terrains in Bihar, Kerala and Telangana, has been launched by **USAID and MoEF&CC**.
2. Kerala has adopted **Miyawaki style afforestation** technique used to create urban forests. The Miyawaki method, also called the Potted Seedling Method, is an afforestation technique that uses native species to create dense, multilayered forests.
3. **New York Declaration on Forests (NYDF)** is a voluntary and non-binding international declaration to take action to halt global deforestation.
4. **Bonn Challenge** was launched in 2011 by the government of Germany and IUCN. It envisages a global goal to bring 150 million hectares of degraded land and deforested landscapes into restoration by 2020 and 350 million hectares by 2030.
5. **Red Sanders** is an endemic tree of South India. It is found in Tropical Dry Deciduous Forest of Palakonda and Seshachalam hill ranges of Andhra Pradesh and is also found in Tamil Nadu and Karnataka. IUCN has classified it under endangered category.
6. **Shola forests** are stunted tropical montane forests found in Nilgiris, Annamalai and Palani hills.
7. **Nilambur teak**, grown in Kerala's Nilambur region, is the first forest produce to get GI tag in India. It exhibits high resistance to fungal decay and has antioxidant properties.
8. **Kelp forests** are large brown algae seaweeds. They grow in "underwater forests" in shallow oceans and nutrient-rich waters. Generally speaking, kelps live farther from the tropics than coral reefs. However, a few species have been known to occur exclusively in tropical deep waters.
 - a. They are considered as keystone species.
 - b. They help reduce coastal erosion and acts as a breakwater during large storms.
 - c. They are an important source of potash and iodine. Many kelps produce algin, a complex carbohydrate useful in industries such as tire manufacturing, ice-cream industry.

Indian State of Forest Report, 2019 (ISFR)

ISFR report is a biennial publication of **Forest Survey of India (FSI)**.

1. **Forest Cover**
 - a. Forest Cover (Area wise): M.P.>Arunachal Pradesh>Chhattisgarh>Odisha
 - b. Forest Cover (Percent wise): Mizoram>Arunachal Pradesh>Meghalaya
2. The total **forest and tree cover** of the country is 24.56% of the country's geographical area, which is an increase of 0.65% over the previous assessment.
 - a. The total forest cover of the country is 21.67% and the total tree cover is 2.89%.
 - b. The percentage of Very Dense Forests has increased over the assessment of 2017.
 - c. The top five states and UT to have shown an increase in forest cover include Karnataka>Andhra Pradesh>Kerala>J&K>Himachal Pradesh
3. There has been a **decline in the forest cover in the North Eastern Region** to the extent of 0.45%. **Except for Assam and Tripura**, all the states in the region have shown a decrease in forest cover.
4. There has been a decrease of 741 sq km of forest cover within the Recorded Forest Area/Green Wash (RFA/GW) in the tribal districts.

5. Increase in the tree cover
 - a. **Maharashtra** has the highest increase in tree cover.
6. **Mangrove cover** in the country has increased by 54 sq km as compared to the previous assessment.
7. **Total Carbon Stock** of the country has increased by 42.6% compared to the last assessment.
8. **Gujarat** has the highest number of wetlands within the Recorded Forest Area (RFA).
9. The analysis revealed that 21.40% of the country's forest cover is extremely fire prone.
10. **Special Features in ISFR 2019**
 - a. Includes the "extent of trees outside forest (TOF)"
 - b. Assesses "plant biodiversity in forests"
 - c. Provides for "refined forest type map of India"
 - d. Maps "fire prone forest areas"
 - e. Includes "wetlands in forest areas"
 - f. Provides information on "forest cover on slopes"
 - g. Lists "major invasive species"
 - h. Lists "important NTFP species"

The **State of World's Forests (SOFO) 2020 report** is published by Food and Agricultural Organization (FAO) and United Nations Environment Program (UNEP). The report assesses the progress to date in meeting global targets and goals related to forest biodiversity and examines the effectiveness of policies, actions and approaches, in terms of both conservation and sustainable development outcomes.

The report focusses on combining conservation and sustainable use of forest biodiversity to create balanced solutions for both people and the planet.

Due to increasing population, pressure on forest resources have increased. This has led to **higher frequency of forest fires**. In general, forest fires play an important role in forest ecosystem. It helps recycle nutrients, remove invasive species and maintain habitat for some wildlife. In a way, forest fire helps in better regeneration of tree species.

However, as the cycle of fire has spun out of balance, forest fires have become a global concern. Forest fires have drastic impacts like:

1. It releases billions of tonnes of CO₂ into the atmosphere, thus aggravating global warming.
2. Habitats of several animals are destroyed.
3. Exposure to smoke from forest fires has led to various health issues in humans.
4. Forest fires also have a major impact on the micro-climate, thus affecting local weather and precipitation patterns.

Some of the **reasons for forest fires** include:

1. Natural causes include thunderstorms, volcanic eruptions.
2. Dry deciduous forest in India faces 5 to 6 months of dry period and are vulnerable to fires.
3. Man-made causes include slash and burn cultivation practiced in North-East India. Also, many a times, people visiting forests would leave behind inflammable materials like burning bidis, thus causing fire.

Australian Bushfire was the most devastating bushfire faced by Australia in at least 20 years. Although bushfires are common in Australia, the spread and intensity of 2020 bushfire was never seen before. Some of the reasons for the 2020 bushfire in Australia includes:

1. Prolonged drought in the region.

2. Rare stratospheric warming over Antarctica which contributed to the unusual heat and dryness in Australia.
3. Presence of positive Indian Ocean Dipole (IOD) which are often associated with more severe fire season in South-east Australia.
4. Climate change has also increased the intensity and frequency of forest fires.

Deemed Forest: There are areas that are like forests but are neither recorded nor notified. Supreme Court has ordered that states classify them as deemed forests. Deemed forests are already a legal category of forests in some states.

Forest Advisory Committee (FAC) is a statutory body under the Forest Conservation Act 1980, which considers questions on diversion of forest land for non-forest purposes such as mining, townships and advises the government on the issue of granting forest clearances.

1.4.2 Aquatic Ecosystem

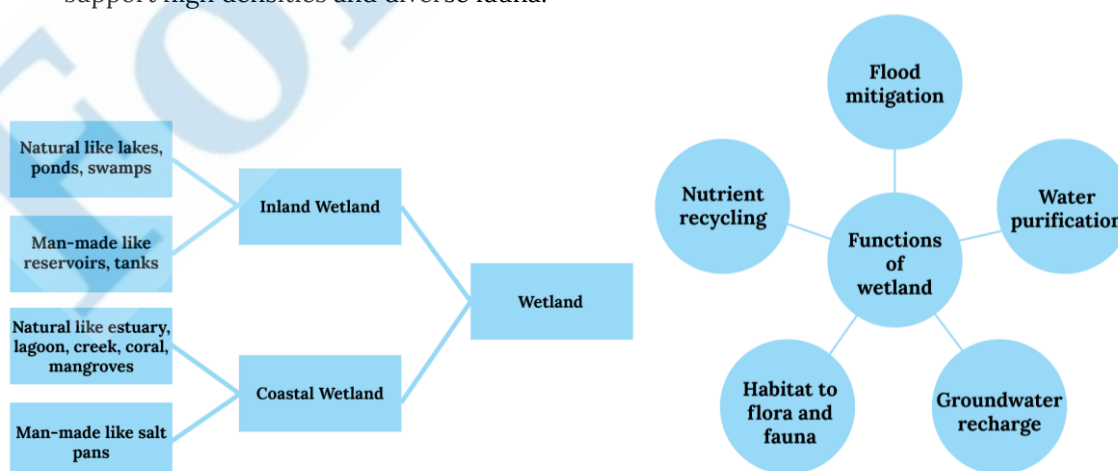
Ecosystems consisting of water as the main habitat are known as aquatic ecosystems.

1. **Aquatic organisms** are classified based on their zone of occurrence and their ability to cross these zones.
 - a. **Neuston:** They live at the air-water interface. E.g., beetles, back-swimmers
 - b. **Periphytons:** These organisms remain attached to the stems and leaves of rooted plants.
 - c. **Plankton:** This group includes microscopic plants like algae and animals like crustaceans and protozoans (zooplankton). Their locomotory powers are primarily controlled by ocean currents.
 - d. **Nekton:** This group contains animals that are swimmers.
 - e. **Benthos:** These organisms are found at the bottom of the water mass.

Factors like sunlight and oxygen are the most important limiting factors of the aquatic ecosystem. Other factors include dissolved oxygen, transparency and temperature.

2. **Wetland Ecosystem:** Wetlands are areas of marsh or peatland with water that is static or flowing, fresh, brackish or saline, including areas of marine water, the depth of which at low tide does not exceed 6 m. Wetlands are ecotones between terrestrial and aquatic ecosystems.

Wetlands occupy 18.4% of the country's area, of which 70% is under paddy cultivation. They are usually rich in nutrients and have an abundant growth of aquatic macrophytes. Wetlands support high densities and diverse fauna.



3. **Lake Ecology:** A body of standing water, generally large enough in area and depth, irrespective of its hydrology, ecology and other characteristics, is generally known as lake. Ageing of lake

occurs as it accumulates mineral and organic matter and gradually gets filled up. Lakes are less productive than the estuary ecosystem but are more than oceans.

The term “**Oligotrophic**” is used to describe lakes with low primary productivity due to nutrient deficiency.

Eutrophication is the process by which a body of water becomes overly enriched with minerals and nutrients from activities like agricultural run-off, disposal of industrial wastes and sewage discharge. This in turn induces excessive growth of algae.

Dead Zones or hypoxia, which refers to reduced levels of oxygen in the water, results from eutrophication. When excessive algae due to eutrophication die, they are decomposed. The bacterial decomposition of their biomass consumes the oxygen in water, thereby creating a state of hypoxia.

Eutrophication thus leads to decreased biodiversity, new species invasion, toxicity and migration of species. Gradually, the water body is reduced into a marsh.

Oligotrophic v/s Eutrophic		
Parameters	Oligotrophic lake	Eutrophic lake
Aquatic plant and animal production	Low	Eliminated due to eutrophication
Nutrient influx	Low	High
Depth	Deeper	Shallow
Water quality	Good	Poor
Oxygen in the bottom layer	Present	Absent

Lake v/s Wetland		
Characteristic	Lake	Wetland
Origins	Tectonic forces	Mostly fluvial
Thermal Stratification	Yes	No
Vertical mixing	Thermally regulated	Wind regulated
Dominant producer	Phytoplanktons	Macrophytes
Food Chain	Grazing pathway	Detritus pathway
Littoral: Pelagial ratio	Small	Large
Productivity	Low	High

Majuli Island is the largest inhabited river island in the world and India’s first island district. It is surrounded by the Brahmaputra river, KherkatiaSuti, LuitSuti and Subansiri Rivers.

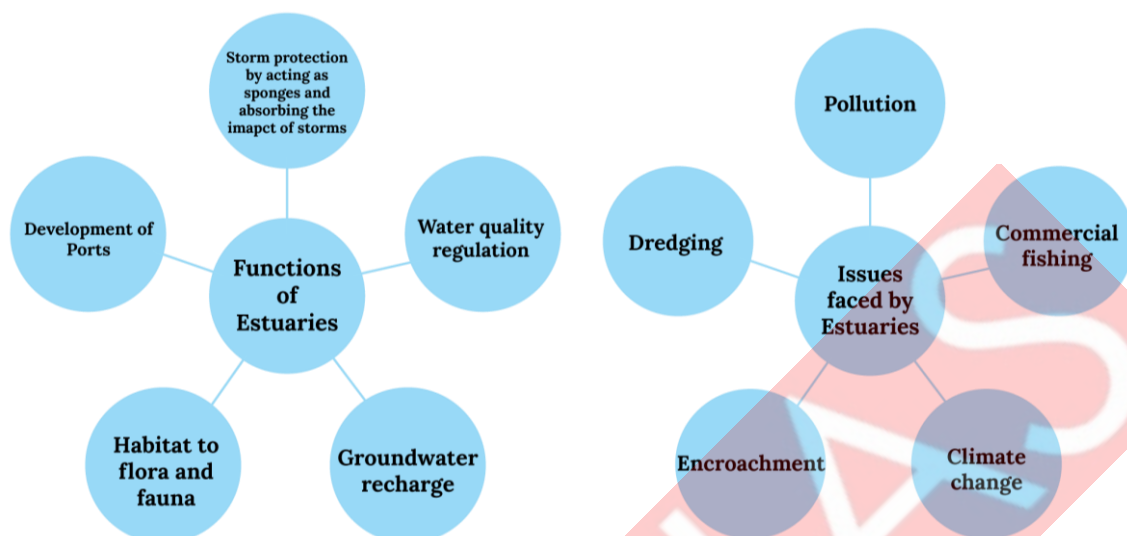
Ameenpur Lake is the first waterbody in the country to be declared a Biodiversity Heritage Site. Under the Biological Diversity Act 2002, State Government in consultation with local bodies notifies Biodiversity Heritage Sites.

Floating Treatment Wetland (FTW) was set up on **Neknampur Lake** in Hyderabad. It helps purify the lake by breaking down and consuming the organic matter in water with the help of microorganisms growing in the plant root system of FTW through microbial decomposition.

Red Tide refers to Harmful Algal Blooms (HAB), which are large concentrations of aquatic microorganisms such as protozoa and unicellular algae. Nutrient enrichment, warm waters, surface run-off and upwelling in seas are common causes for such blooms.

Marine upwelling is an oceanographic phenomenon that involves wind-driven motion of nutrient-rich water from deep water towards the ocean surface, thus replacing the nutrient-depleted surface water.

4. **Estuarine ecosystem:** An estuary is a place where a river or stream opens into the sea. They are the most productive water bodies in the world.



5. **Mangroves:** Evergreen forests that grow in sheltered low-lying coasts, estuaries, mudflats, tidal creek backwaters, marshes and lagoons of the tropical and subtropical regions. They are salt-tolerant or halophytes and are adapted to harsh ecological conditions. E.g., *Sonneratia* and *Avicennia*.

Some **characteristics of mangroves** are:

- Require high solar radiation.
- Produces pneumatophores (blind roots/aerial roots) to overcome respiration problems in anaerobic soil conditions or adventitious roots (roots emerging from main trunk of the tree).
- Exhibit viviparity mode of reproduction (seeds germinate in the tree itself before falling to the ground).
- Some secrete excess salts through their leaves.

Role of mangroves:

- Preventing coastal soil erosion.
- Acting as "**Bio-Shields**" by protecting coastal lands from tsunamis and floods as they do not get uprooted during tsunami due to extensive roots.
- Nutrient recycling.
- Provides habitat to flora and fauna.
- Supplies woods, fire and medicinal plants.
- Provides employment to locals.



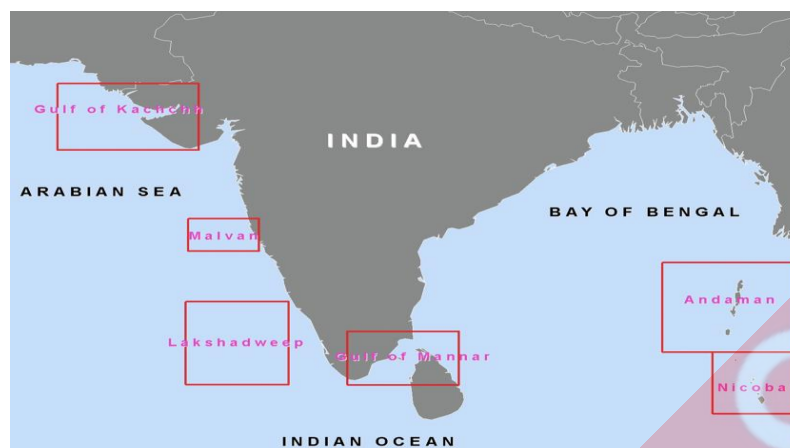
Pointers for prelims:

1. **Sundarbans** is a UNESCO World Heritage Site. It is dominated by 'Sundri trees' and is the largest single block of halophytic mangrove forest in the world.
 - a. It is the only mangrove reserve in the world inhabited by tigers.
 2. **Mangrove for the Future (MFF)** is a regional initiative coordinated by UNDP and IUCN. It aims at promoting coastal ecosystem conservation in six tsunami hit countries including India.
6. **Coral Reefs:** Corals are marine invertebrates. They typically live in compact colonies of many identical individual polyps. Corals are in a symbiotic relationship with 'zooxanthellae' microscopic algae which live on coral. Zooxanthellae assists the coral in nutrient production while the coral polyp in return provides zooxanthellae with a protected environment to live within. A coral reef is made of a thin layer of Calcium Carbonate.

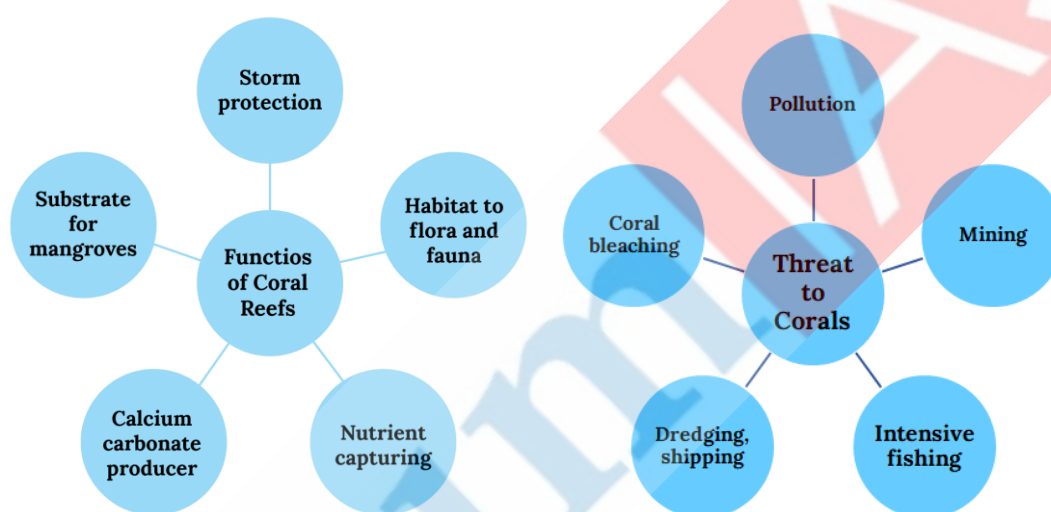
Corals are of two types- hard corals and soft corals. Only hard corals build reefs. Most of the world's corals are found in tropical shallow waters less than 50 meters deep. Scientists estimate that more than 25,000 described species from thirty-two of the world's thirty-three animal phyla live in reef habitats—four times the number of animal phyla found in tropical rain forests. Australia accounts for around 17% and Indonesia around 16% of the world's corals.

They are highly productive and are also referred to as the '**Tropical Rainforests of the Oceans**'. They are classified into fringing reefs, patch reefs, barrier reefs and atolls.

Coral reefs have been included in Schedule I of the Wildlife Protection Act, 1972, thus offering it maximum protection. Also, they have been classified as CRZ-I A under the Coastal Regulation Zone (CRZ) notification, 2011.



Coral Reef distribution in India



Coral Bleaching occurs when coral polyps expel algae that lives inside their tissues. In such cases, corals lose their vibrant colours and turn white. Several reasons for coral bleaching are:

- a. Warm water temperature.
- b. Solar irradiance.
- c. Subaerial exposure.
- d. Sedimentation.
- e. Freshwater dilution.
- f. Epizootics (Pathogen).

Angria Bank is a shallow submerged atoll located 100 miles off the coast of Ratnagiri and Sindhudurg district of Maharashtra. Coral reefs have been found in this area and the peculiarity of coral reefs present here is that it is in the middle of the ocean, unlike other corals which are either coastal or island corals.

Angria Bank has the potential to become **India's Great Barrier Reef**.

Pointers for prelims:

1. Coral species in news:

- a. **Fire Coral** is critically endangered as per IUCN.
- b. **Orange Cup-Coral** is an Invasive Alien Species (IAS) as per Zoological Survey of India (ZSI).

2. The **International Conference on Status and Protection of Coral Reefs (STAPCOR)**-2018 took place at Bangaram Coral island of Lakshadweep. Theme of the conference was "Reef for Life".
 - a. STAPCOR takes place in every 10 years since its foundation in 1998.
3. Tamil Nadu deployed **artificial reefs** in Vaan island in the Munnar region.
4. ZSI with the help from Gujarat's forest department, attempted for the first time a process to restore coral reefs using **bio-rock or mineral accretion technology**. Bio-rock technology is a method that applies safe, low voltage electric currents through seawater, causing dissolved minerals to crystallize on structures, growing into white limestone (CaCO_3) similar to that which naturally makes up coral reefs and tropical white sand beaches.
5. World's **largest artificial coral reef** is installed in Maldives.
6. **Coral Bleaching Alert System (CBAS)** has been developed by Indian National Centre for Ocean Information Services (INCOIS).
7. **Coral Reef Recovery Project** is a joint venture between Wildlife trust of India and the Gujarat forest department.
8. **Reef-Watch India** is an NGO that has taken up two projects- Re(e)Build and Re(e)Grow.
9. **Palau** is the first country to ban 'Reef toxic' sun cream. Sun cream includes common ingredients like oxybenzone that disrupts coral reproduction, causes coral bleaching and damages coral DNA.
10. **International Coral Reef Initiative (ICRI)** is an informal partnership between nations and organizations that strives to preserve coral reefs and related ecosystems worldwide. The initiative was founded in 1994.
 - a. India is a member but not a founding member.
 - b. Decisions are not binding.
 - c. It is not a United Nations body.