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ECOLOGY, ECOSYSTEM AND FUNCTIONS OF ECOSYSTEM

BASIC DEFINITIONS

- **Environment**: the sum total of all biotic (connected with living beings) and abiotic (connected with non-living) factors, substances and conditions that surround and potentially influence organisms without becoming their constituent part.
- **Ecology**: Subject which studies the interactions among organisms and between the organism and its physical (abiotic) environment. Term ecology coined combining two Greek words, oikos ('house' or 'dwelling place') and logos (study).

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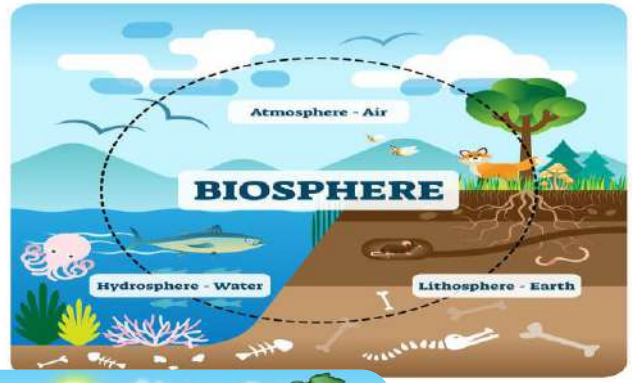
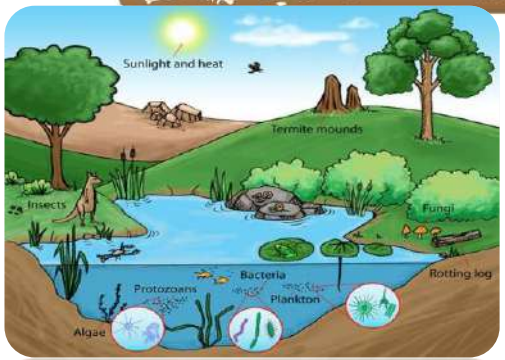
BASIC DEFINITIONS

- **Biosphere**: biological component (supporting life) of earth which includes the lithosphere, hydrosphere and atmosphere.
- **Ecosystem**: Structural and functional unit of biosphere consisting of community of living beings and the physical environment, both interacting and exchanging materials between them.





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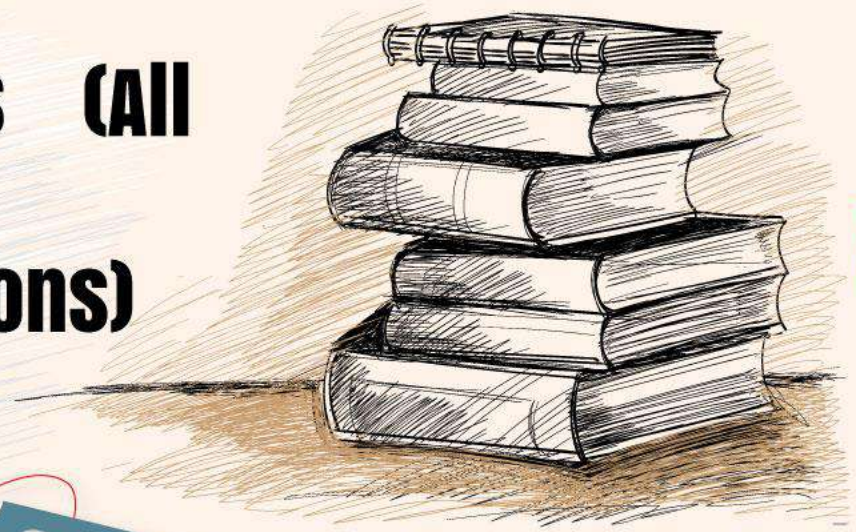

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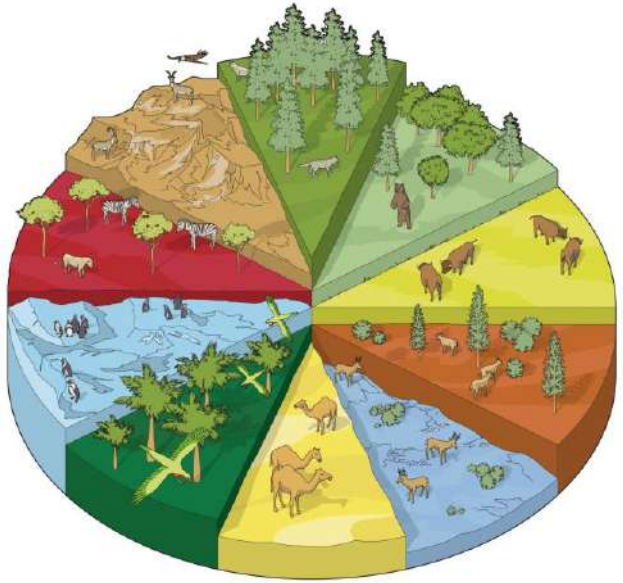
BASIC DEFINITIONS

- **Habitat**: The place where an organism lives or the place where one would go to find the particular organism is known as the habitat of that organism. The habitat of an organism actually represents a particular set of environmental conditions suitable for its successful growth. (All habitats are environments, but all environments are not habitats.)

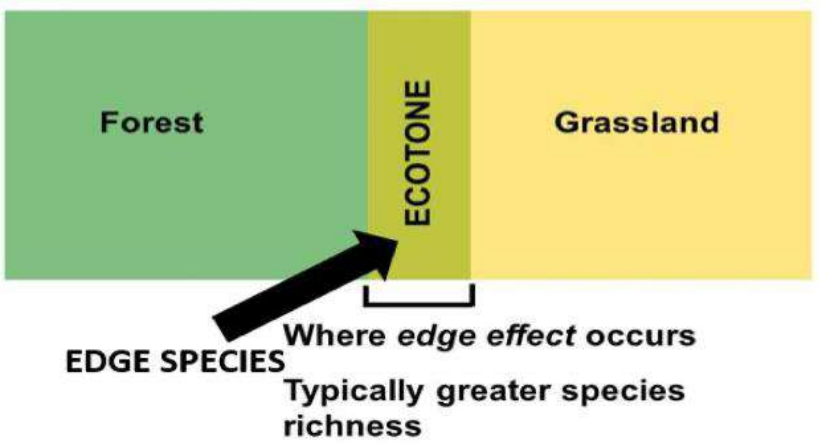


BASIC DEFINITIONS

- **Ecological Niche**: term niche was first time used by Grinnel (1917) to explain microhabitats. Ecological niche of an organism includes the physical space occupied by it, its functional role in the community i.e. trophic position, and its position in environment gradients of temperature, moisture, pH, soil etc and the conditions of existence. No two species have exact identical niche.

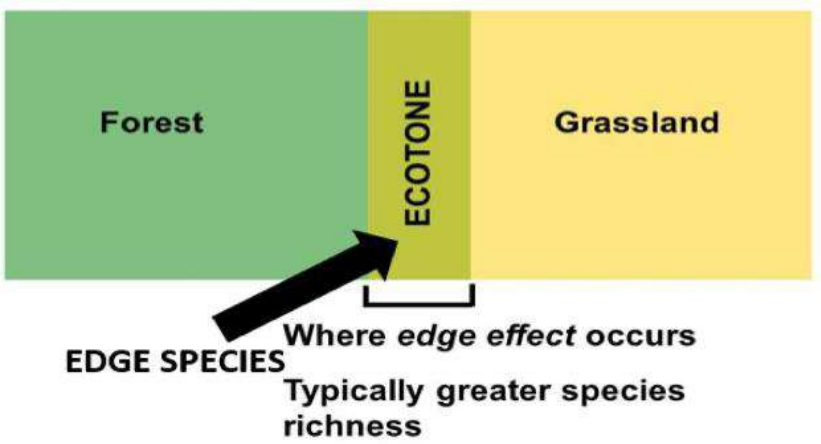
BASIC DEFINITIONS

- **Ecotone**: A transitional area of vegetation between two different plant communities, such as forest and grassland. It has some of the characteristics of each bordering biological community and often contains species that not found in the overlapping communities. E.g. Mangroves represent an ecosystem between marine and terrestrial ecosystems.



BASIC DEFINITIONS

- **Edge Effect**: ecological concept that describes how there is a greater diversity of life in the region where the edges of two adjacent ecosystems overlap, such as land/water, or forest/grassland. At the edge of two overlapping ecosystems, one can find species from both of these ecosystems, as well as unique species that aren't found in either ecosystem but are specially adapted to the conditions of the transition zone between the two edges.

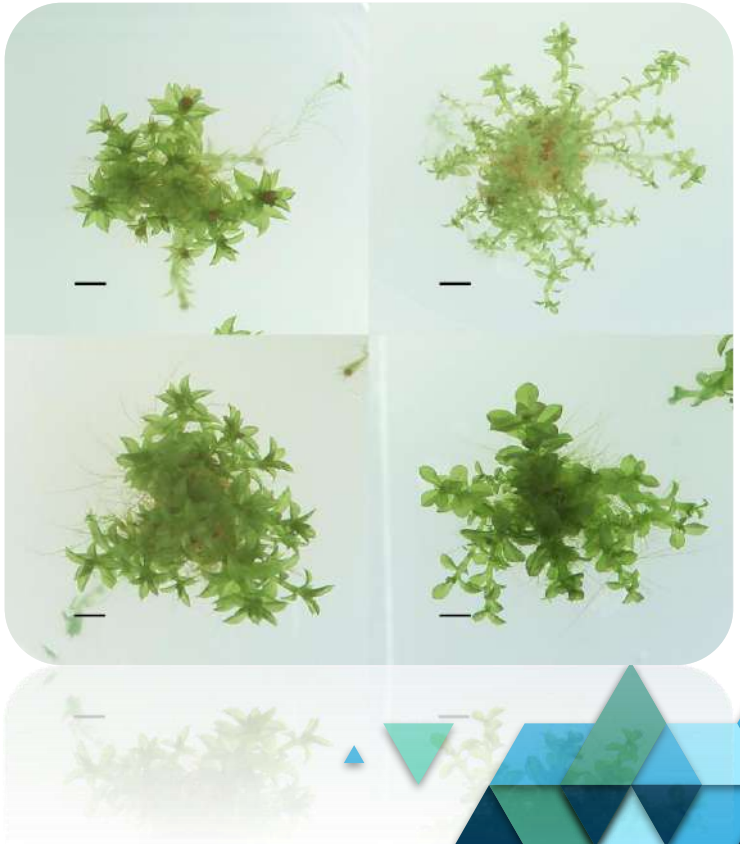


BASIC DEFINITIONS

- **Ecad**: An ecad of a plant species is a population of individuals which although belong to the same genetic stock, but differ markedly in vegetative characters such as size, shape, number of leaves etc. These variations are reversible as one type of ecad may change into another with the change in its habitat.

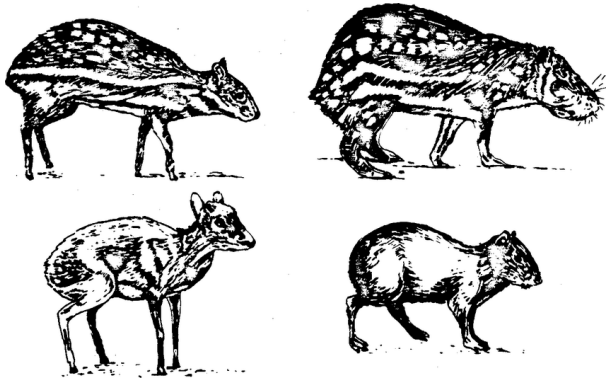
BASIC DEFINITIONS

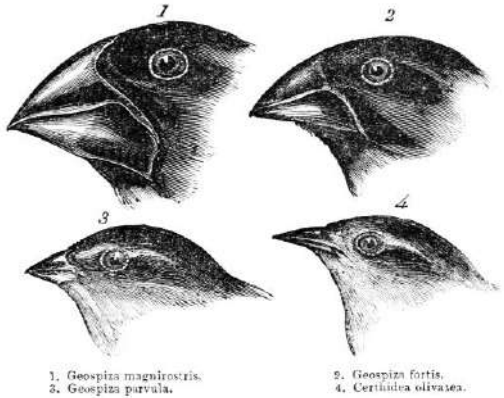
- **Ecotype**: A population of individuals of a species, which are genetically different. Since different ecotypes are interfertile, these are kept under the same taxonomic species. Their variations are permanent and irreversible as these are genetically fixed.
- **Deep ecology**: an environmental philosophy that promotes the inherent worth of all living beings regardless of their instrumental utility to human needs, and the restructuring of modern human societies in accordance with such ideas. Tree planting and man-made forests are examples of deep ecology.



BASIC DEFINITIONS

- **Ecological Equivalents**: Organisms that occupy the same or similar ecological niches in different geographical regions are known as ecological equivalents. E.g. Kangaroos of Australia are ecologically equivalent to the bison of North America.
- **Character displacement**: term used to describe an evolutionary change that occurs when two similar species inhabit the same environment. Under such conditions, natural selection favors a divergence in the characters (morphology, ecology, behaviour, or physiology) of the organisms.





BASIC DEFINITIONS

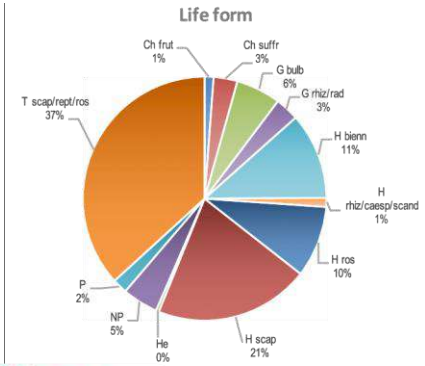
- **Population**: A group of individual organisms of the same species in a given area.
- **Species**: A uniform interbreeding population spread over time and space.
- **Community**: A group of populations of different species in a given area. It thus includes all the populations in that area (all plants, animals and microorganisms).

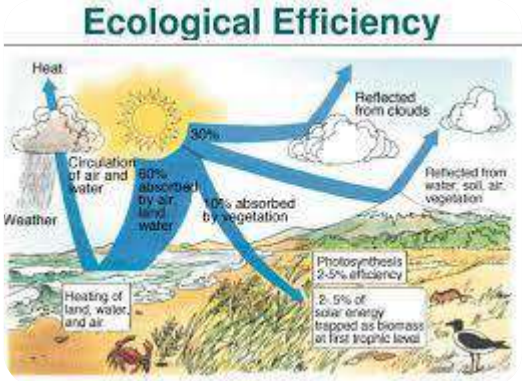
BASIC DEFINITIONS

- **Biome**: Complex of several communities (some in climax stage, and others in different stages of succession) in any area, represented by an assemblage of different kinds of plants, animals etc., sharing a common climate. Biomes are bigger units than communities, constitute the great regions of the world distinguished on an ecological bias, such as tundra biomes, forest biomes, grasslands and deserts etc.

BASIC DEFINITIONS

- **Biological Spectrum**: The relative numbers of plant species per biological type (as aerophytes, hygrophytes, phanerophytes, etc.) occurring in a particular ecosystem, each expressed as a percentage of the total.
- **Ecological Efficiency**: Ecological efficiency describes the efficiency with which energy is transferred from one trophic level to the next. The number of trophic levels in the grazing food chain is restricted as the transfer of energy follows 10 per cent law – only 10 per cent of the energy is transferred to each trophic level from the lower trophic level.





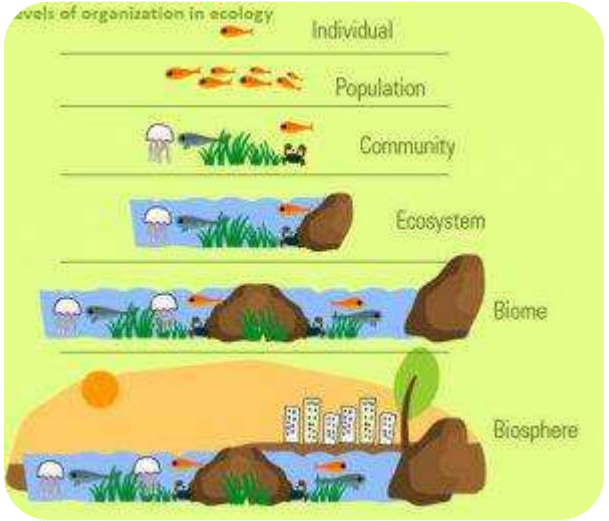
BASIC DEFINITIONS

- **Keystone Species:** A species that plays an essential role in the structure, functioning or productivity of a habitat or ecosystem. Disappearance of such species may lead to significant and disproportionate effect on ecosystem as compared to other species.
- **Indicator Species**: A species or group of species chosen as an indicator of, or proxy for, the state of an ecosystem or of a certain process within that ecosystem.

BASIC DEFINITIONS

Ecological Organization from smallest to Largest:

- Individual → Population → Species → Community → Ecosystem → Biosphere.

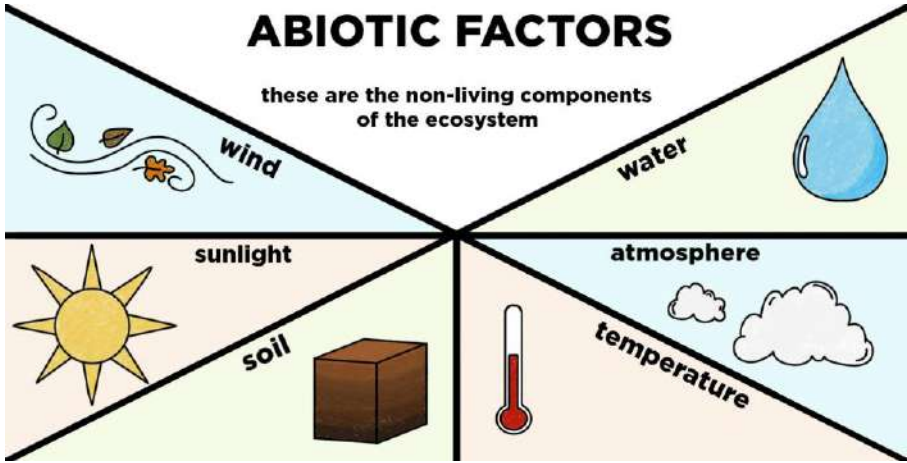


Difference between Flora and Vegetation

- **Flora**: It is the species content of the region irrespective of the numerical strength of each species.
- **Vegetation**: The collective and continuous growth of plants in space/region.

MAJOR ABIOTIC FACTORS

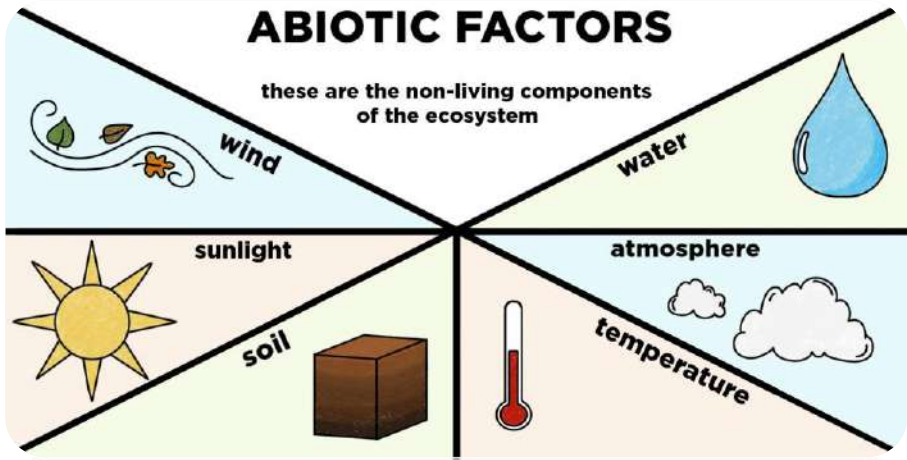
- An abiotic factor is a **non-living part of an ecosystem that shapes its environment**.
- In a terrestrial ecosystem - include temperature, light, and water.
- In a marine ecosystem - abiotic factors would include salinity and ocean currents.



MAJOR ABIOTIC FACTORS

Temperature

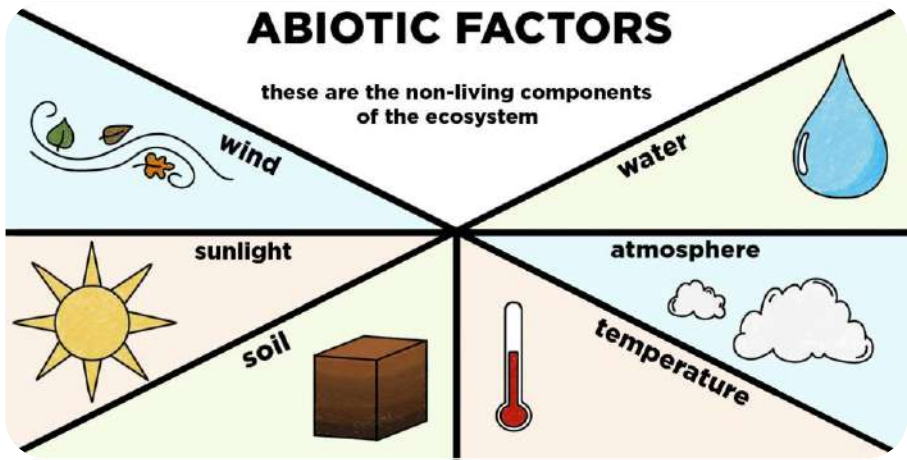
- Affects the kinetic of enzymes and through its basal metabolism, activity and other physiological functions of the organism.
- Level of thermal tolerance determines geographical distribution of an organism.
- **Eurythermal:** Organism that can tolerate wide range of temperature
- **Stenothermal:** Organism that are restricted to narrow range of temperature



MAJOR ABIOTIC FACTORS

Temperature

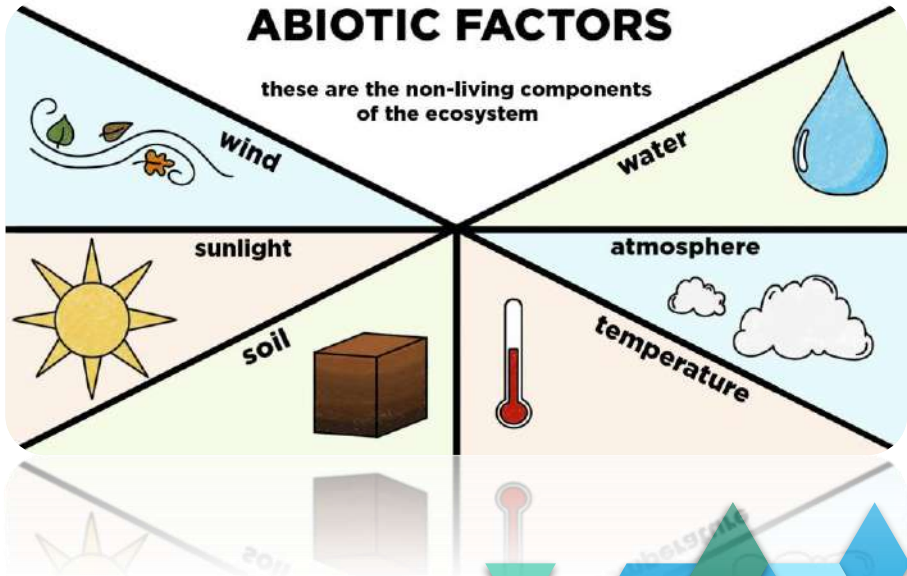
- High or low temperature causes inactivity and death of organisms. It is immediate in case of poikilothermic (ectodermal or cold blooded) animals and delayed in case of homeothermic (endothermal or warm blooded) animals.
- **Effect of temperature:** Growth, Metabolism, Reproduction, Sex ratio, Distribution, Colouration, Behaviour, Morphology.



MAJOR ABIOTIC FACTORS

Water

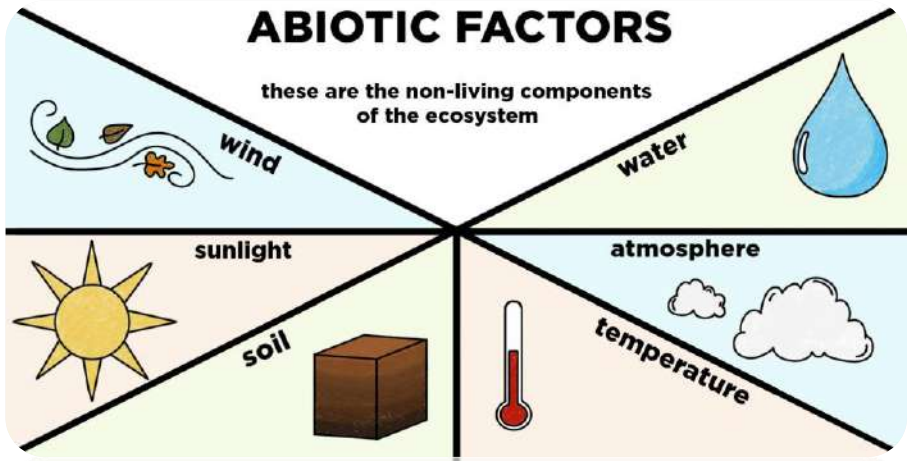
- **Hydrophytes**: Plants of aquatic habitats are called hydrophytes. They possess aerenchyma or air storing parenchyma to support themselves in water.
- **Mesophytes**: terrestrial plants which are neither adapted to particularly dry nor particularly wet environments.
- **Xerophytes**: Plants of dry areas are called xerophytes. They develop modifications to increase water absorption, reduce transpiration etc.



MAJOR ABIOTIC FACTORS

Water

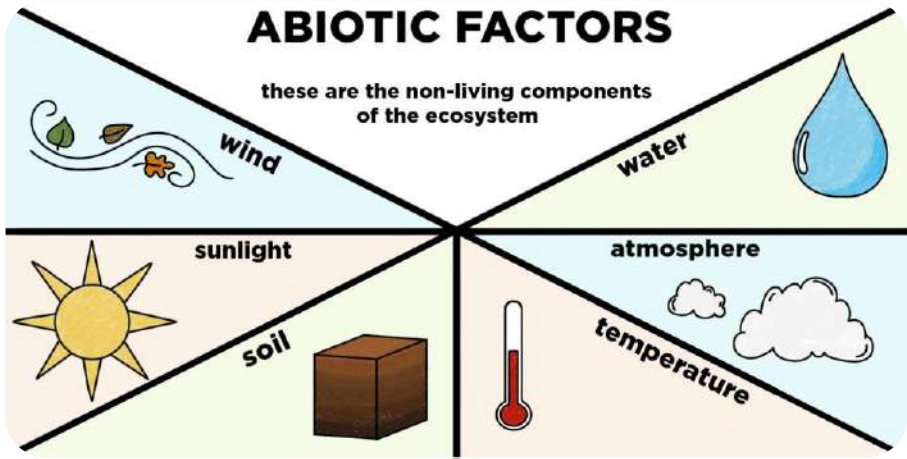
- **Halophytes**: salt tolerant plants that grow on soil or waters of high salinity such as mangroves swamps, marshes, sea shores and saline semi deserts.
- **Pneumatophores:** lateral roots that extend out of the surface of the water and facilitate the exchange of oxygen and carbon dioxide for the roots submerged in water. They are specialized aerial root structures present in plants where the oxygen required for normal respiration of roots is inadequate.



MAJOR ABIOTIC FACTORS

Water

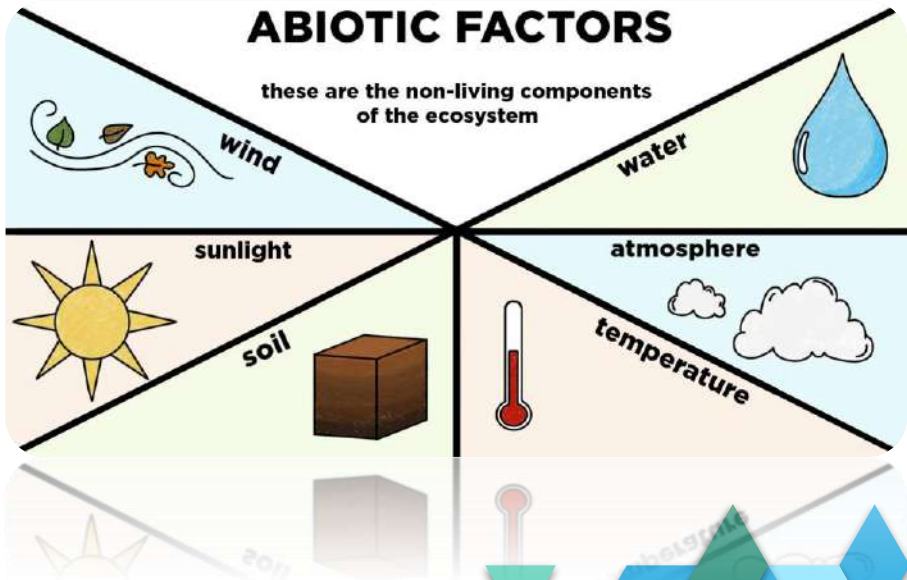
- **Euryhaline**: Organism that can tolerate wide range of salinities.
- **Stenohaline**: Organism that are restricted to narrow range of salinities.
- **Catadromous species**: Born in seawater, spends most of its life in freshwater and then returns to seawater to spawn.
- **Anadromous species**: Born in freshwater, spends most of its life in seawater and then returns to freshwater to spawn.
- **Note**: Certain animals of the dry areas do not drink water at all. E.g. Kangaroo Rat.



MAJOR ABIOTIC FACTORS

Light:

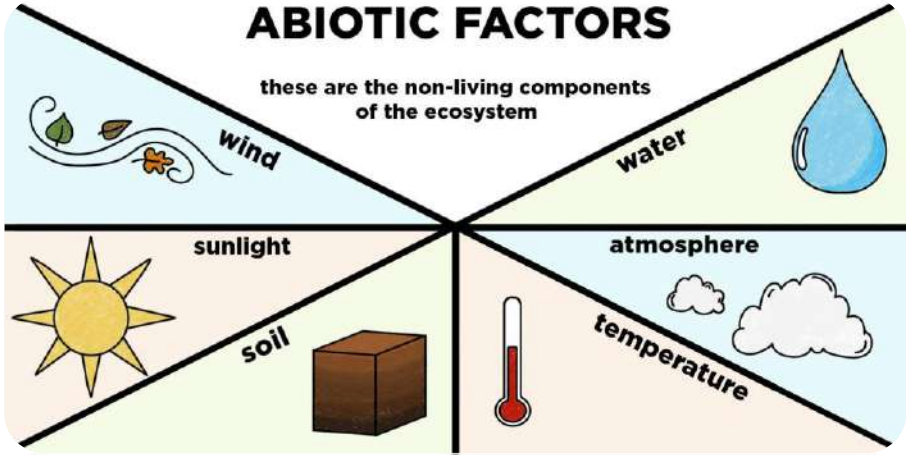
- **In relation to Plants**: Photosynthesis, Growth, Transpiration, Germination, Pigmentation, Movements, Photoperiodism.
  - **Photoblastic seeds**: Seeds sensitive to light for germination. It can be positively photoblastic or negatively photoblastic
  - **Photonasty**: Flowers of some plants open or close in response to light and darkness.
  - **Nyctinasty**: Folding of leaves in response to darkness.
  - **Photomorphogenesis**: Differentiation of various tissues and organs in response to light.



MAJOR ABIOTIC FACTORS

Light:

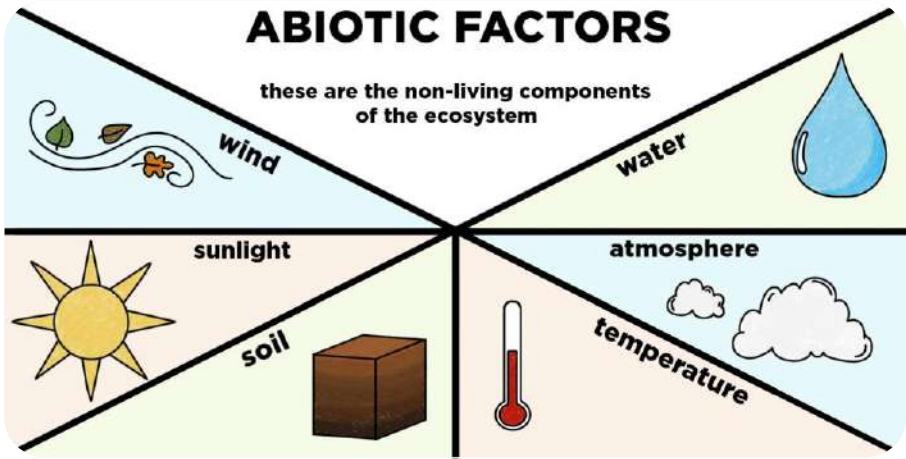
- **Heliophytes**: Plants which are adapted to live under plenty of sunlight are called heliophytes. e.g. banyan. Heliophytes form the roof of a forest.
- **Sciophytes**: Plants which are adapted to live under low light conditions are called sciophytes, e.g herbs. Sciophytes form the understory of a forest.



MAJOR ABIOTIC FACTORS

Light:

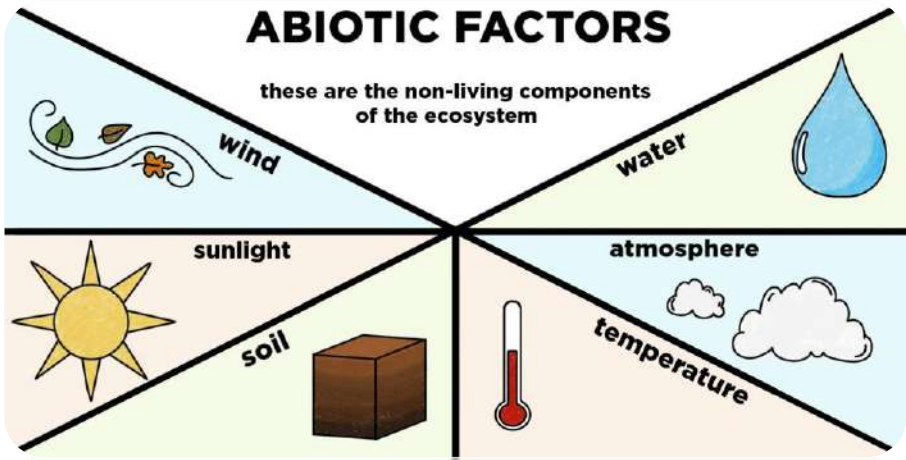
- **In relation to Animals:** Daily rhythm, Breeding, Pigmentation, Reproduction.
  - **Diurnal**: Active during daytime
  - **Nocturnal**: Active during night time
  - **Auroral**: Active at dawn or early morning
  - **Vesperal**: Active at the time of dusk or sunset.



MAJOR ABIOTIC FACTORS

Light:

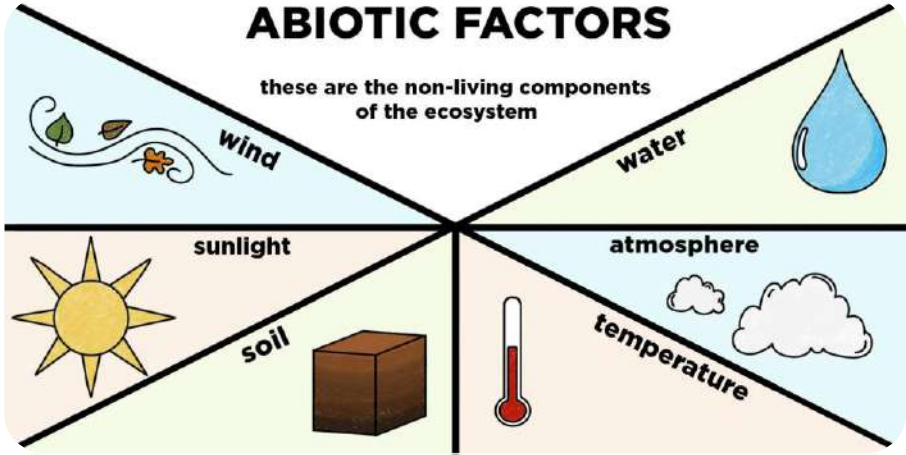
- **Light zones in Aquatic habitat:**
  - **Littoral zone**: It is the shallow coastal region where light is able to pass through shallow water and reach the bottom.
  - **Limnetic zone**: Open water zone where the water is very deep. Amount of light and oxygen decreases with depth.
  - **Profundal/Aphotic zone**: It is the zone of deep water below the photic zone and above the bottom to which light does not penetrate.
  - **Benthic zone**: It is the extreme bottom zone where light does not penetrate. Zone of extreme darkness.



MAJOR ABIOTIC FACTORS

Soil:

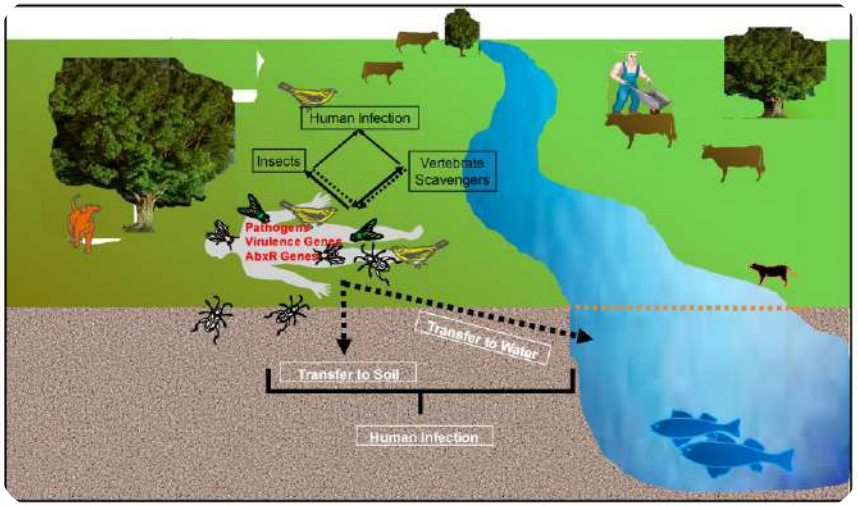
- The soil is one of the most important ecological factors called the **edaphic factor.** Soil is made up of different layers called **horizons.** The series of horizons form the **soil profile.**
- **Vegetation in any area are determined by:** Soil composition, Percolation and Grain size, Water holding capacity, pH, mineral composition, topography etc.



RESPONSE TO ABIOTIC FACTORS

Regulation

- **Homeostasis:** Animal organs and organ systems constantly adjust to internal and external changes in order to maintain this steady state.
- **Osmoregulation:** Osmoregulation is the process of maintaining salt and water balance (osmotic balance) across membranes within the body.
- **Thermoregulation:** It is the ability of an organism to keep its body temperature within certain boundaries, even when the surrounding temperature is very different.



RESPONSE TO ABIOTIC FACTORS

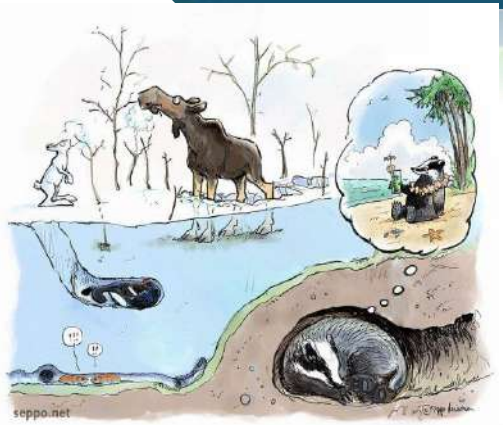
Migration

- **Drought evaders**: Adoption of either a short annual life cycle or undergo aestivation or other dormant state.
- **Winter migration**: Thousands of species of animals, birds, reptiles, and even insects participate in winter migration for the search for food or warmer temperatures.
- Animals that do not hibernate generally resort to migration. E.g. Keoladeo National Park (Bharatpur) Rajasthan, hosts thousands of migratory birds from Siberia during winter months

RESPONSE TO ABIOTIC FACTORS

Resistance

- **Dormancy:** Dormancy is a widely recognized behavioral and physiological state of both animals and plants generally involve inactivity and reduced metabolic rate.
- **Hibernation**: Way animals conserve energy to survive adverse weather conditions or lack of food. It involves physiological changes such as a drop-in body temperature and slowed metabolism. Hibernation is a type of dormancy, but not all dormant animals hibernate. That's because hibernation is a really specific kind of dormancy.



RESPONSE TO ABIOTIC FACTORS

Resistance

- **Diapause**: In animal dormancy, diapause is the delay in development in response to regularly and recurring periods of adverse environmental conditions.
- **Aestivation**: Animals aestivate to avoid desiccation, it is a lighter state of dormancy since they can reverse their physiological state rapidly and return to normal. The main concern of aestivating organisms is retaining water and conserving energy while stabilizing their body organs and cells.
- **Brumation:** It is a state of dormancy in a reptile that resembles hibernation. Reptiles undergo brumation during the late stages of autumn, and they can wake up only to drink water and then go back to sleep.

PRINCIPLES IN ECOLOGY

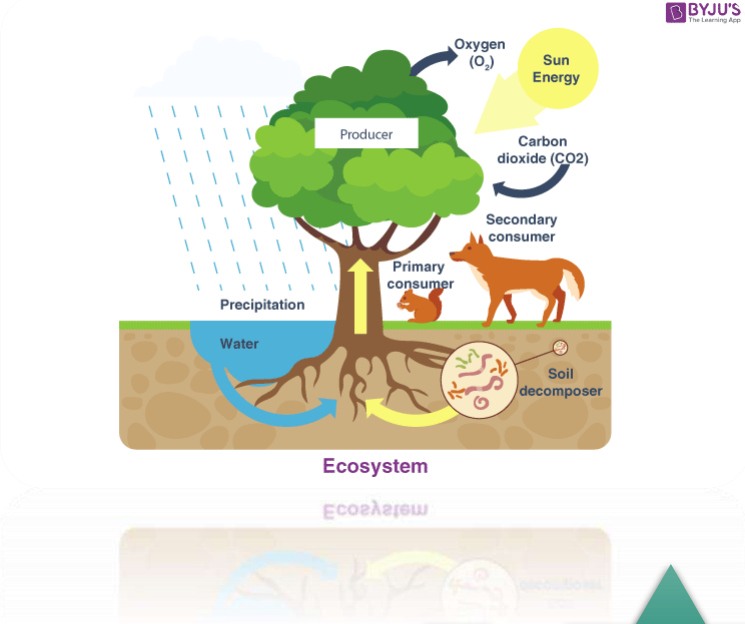
Evolution	• **Evolution is the change which gives rise to new species.** • **It happens in order to make the organism better suitable to the present environment.** • **A valid theory of evolution was propounded by Charles Darwin and Alfred Wallace in 1859.**
Adaptation	• An adaptation is the mode of life of an organism that enables it to survive in a particular environment. • Adaptations are inherited from one generation to another.
Variation	• Variations are induced by changes in genetic makeup due to addition or deletion of certain genes. • Mutations, change in climate, geographical barriers etc. induce variations over a period of time.

PRINCIPLES IN ECOLOGY

Speciation	• **Speciation is the process by which new species are formed, and evolution is the mechanism by which speciation is brought about.** • **Geographic isolation leads to speciation.** • **A species comprises of many populations. Often different populations of a species remain isolated due to some geographic barrier such as mountain, ocean, river, etc.**
Mutation	• Mutation (a change in genetic material that results from an error in replication of DNA) causes new genes to arise in a population. • Members of the same species show 'variation' and are not identical.
Natural Selection	• Natural Selection is the mechanism proposed by Darwin and Wallace. • Natural selection is the process by which species adapt to their environment.
Extinction	• Extinction is the termination of a kind of organism or of a group of kinds (taxon), usually a species. The moment of extinction is generally considered to be the death of the last individual of the species.

PRODUCTIVITY IN ECOSYSTEM

- The complexity and size of food web is generally **determined by the productivity of the ecosystem.**
- Productivity of an ecosystem **refers to the rate of production of biomass**, i.e., the amount of organic matter accumulated in any unit time.
- It is usually expressed in **units of mass per unit surface (or volume) per unit time**. The mass unit may relate to dry matter or to the mass of carbon generated.



PRODUCTIVITY IN ECOSYSTEM

Primary Productivity	• **It is defined as the rate of which radiant energy is stored by the producers, most of which are photosynthetic, and to a much lesser extent the chemosynthetic microorganisms.** • **Primary productivity is of two types: Gross Primary Productivity and Net Primary Productivity.**
Secondary Productivity	• It is the **rate of energy storage at consumer's levels-herbivores, carnivores and decomposers**. • Consumers tend to utilize already produced food materials in their respiration and also converts the food matter to different tissues by an overall process.

PRODUCTIVITY IN ECOSYSTEM

Net Productivity	• **It is the rate of storage of organic matter not used by the consumers.** • **It is equivalent to net primary production minus the consumption by consumers.** • **Thus, it can be also referred to as the rate of increase of biomass of the primary producers which has been left over by consumers.**
Point to Note:	• Terrestrial ecosystems have a higher productivity than aquatic ecosystems. • Tropical rainforests are the most productive terrestrial ecosystems. • Estuaries and coral reefs are most productive among aquatic ecosystems. Similarly, mangroves have high productivity like rainforests. • Open oceans and deserts have very low productivity. • Open ocean has low productivity but due to large size of open oceans, the total production is very high in open oceans.

ECOLOGICAL ADAPTATIONS

- Adaptation is any attribute of the organism (Morphological, Physiological, Behavioral) that enables organism to survive and reproduce in its habitat.

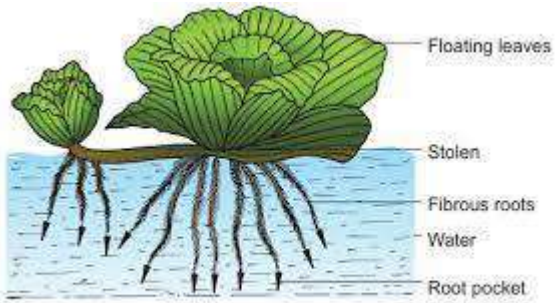


Figure 8a: Free floating hydrophyte – *Eichhornia*

ECOLOGICAL ADAPTATIONS

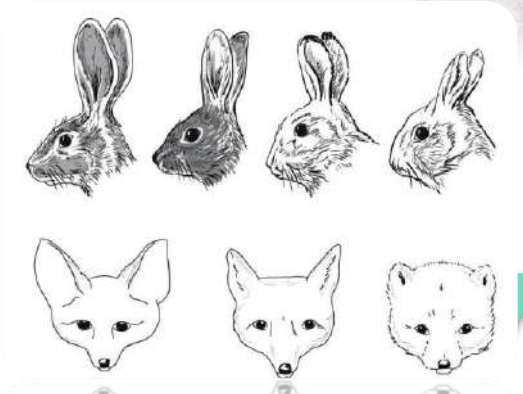
Morphological Adaptations:	• **Desert plants have thick cuticle on their leaf surface and stomata arranged in deep pits to minimize water loss through transpiration.** • **Mammals from colder climates have shorter ears and limbs to minimize heat loss. This is called Allen's Rule.**
Physiological Adaptations	• Mammals use evaporative cooling techniques to maintain a constant body temperature, while at the same time they use behavioral adaptations to reduce heat load and water loss. • E.g. altitude sickness: Our body compensate low Oxygen availability by increasing red blood cell production, decreasing the binding affinity of hemoglobin and by increasing breathing rate.

ECOLOGICAL ADAPTATIONS

Biochemical Adaptation:	• **Examples of biochemical responses to temperature in endotherms involve metabolic uncoupling mechanisms that decrease metabolic efficiency with the outcome of producing heat.** • **Ectothermic adaptations to temperature are best exemplified by the numerous mechanisms that allow for the tolerance or avoidance of ice crystal formation at temperatures below 0°C.**
Behavioural Adaptations	• E.g. Lizard they bask in the sun when body temperature drops, but moves to shade when ambient temperature starts increasing.

ECOLOGICAL ADAPTATIONS RULES

- **Gloger's rule:** states that within a species of endotherms, more heavily pigmented forms tend to be found in more humid environments, e.g. near the equator.
- **Allen's rule**: states that animals adapted to cold climates have shorter limbs and bodily appendages than animals adapted to warm climates. More specifically, it states that the body surface-area-to-volume ratio for homeothermic animals varies with the average temperature of the habitat to which they are adapted (i.e. the ratio is low in cold climates and high in hot climates).



ECOLOGICAL ADAPTATIONS RULES

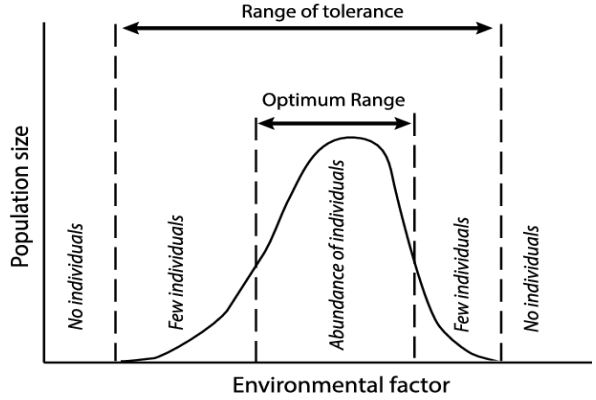
- **Bergmann's rule**: states that within a broadly distributed taxonomic clade, populations and species of larger size are found in colder environments, while populations and species of smaller size are found in warmer regions. Bergman's rule only describes the overall size of the animals, but does not include body parts like Allen's rule does.

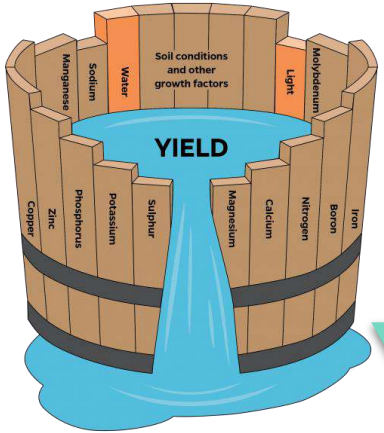
ECOLOGICAL ADAPTATIONS RULES

- **Rensch's rule**: a biological rule on allometrics, concerning the relationship between the extent of sexual size dimorphism and which sex is larger. Across species within a lineage, size dimorphism increases with increasing body size when the male is the larger sex, and decreases with increasing average body size when the female is the larger sex.
- **Hamilton's Rule**: It states that the more closely related two individuals are, the greater the potential genetic payoff. It supports the notion that natural selection favours genetic success, not reproductive success per se.

ECOLOGICAL ADAPTATIONS RULES

- **Shelford's law of tolerance:** stating that a certain organism's survival and existence depend upon the multifaceted set of conditions wherein each individual has definite minimum, maximum and optimum ecological factors to establish success
- **Liebig's Law of Minimum**: Yield is proportional to the amount of the most limiting nutrient, whichever nutrient it may be.





ECOLOGICAL ADAPTATIONS RULES

Detritivores vs Decomposers

- **Detritivores**: Individuals that feed on animal or plant detritus. They initiate the transformation of dead organic matter.
- **Decomposers**: Second stage of degradation of organic matter. Mineralization occurs by aerobic or anaerobic processes (fermentation) and organic molecules are broken into much smaller mineral molecules, the mineral salts.

INTERACTION AMONG BIOTIC FACTORS

Interaction type	Species 1	Species 2	Detailed effect(s)
Neutralism	0	0	• Neither population affects the other. • True neutralism is extremely unlikely.
Competition	-	-	• Direct inhibition of each species by the other. • Competition is the struggle between two organisms for the same resources within an environment.
Ammensalism	-	0	• Amensalism meaning, an ecological interaction between two species, but in this association among organisms of two different species, one is destroyed or inhibited, and other remains unaffected.

INTERACTION AMONG BIOTIC FACTORS

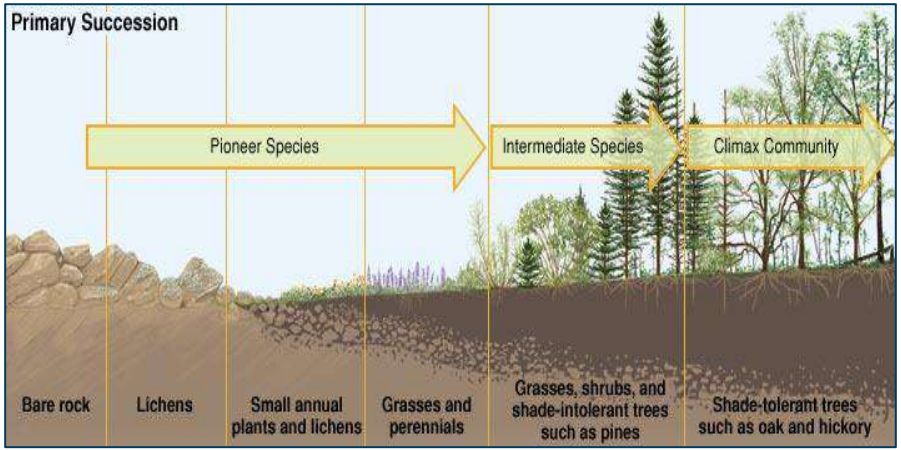
Interaction type	Species 1	Species 2	Detailed effect(s)
Parasitism	+	-	• Parasitism is a symbiotic relationship between species, where one organism, the parasite, lives on or inside another organism, the host, causing it some harm, and is adapted structurally to this way of life. • Many parasites have evolved to be host-specific (they can parasitize only a single species of host) in such a way that both host and the parasite tend to co-evolve.
Predation	+	-	• Predation is a biological interaction where one organism, the predator, kills and eats another organism, its prey. • Predators also help in maintaining species diversity in a community.

INTERACTION AMONG BIOTIC FACTORS

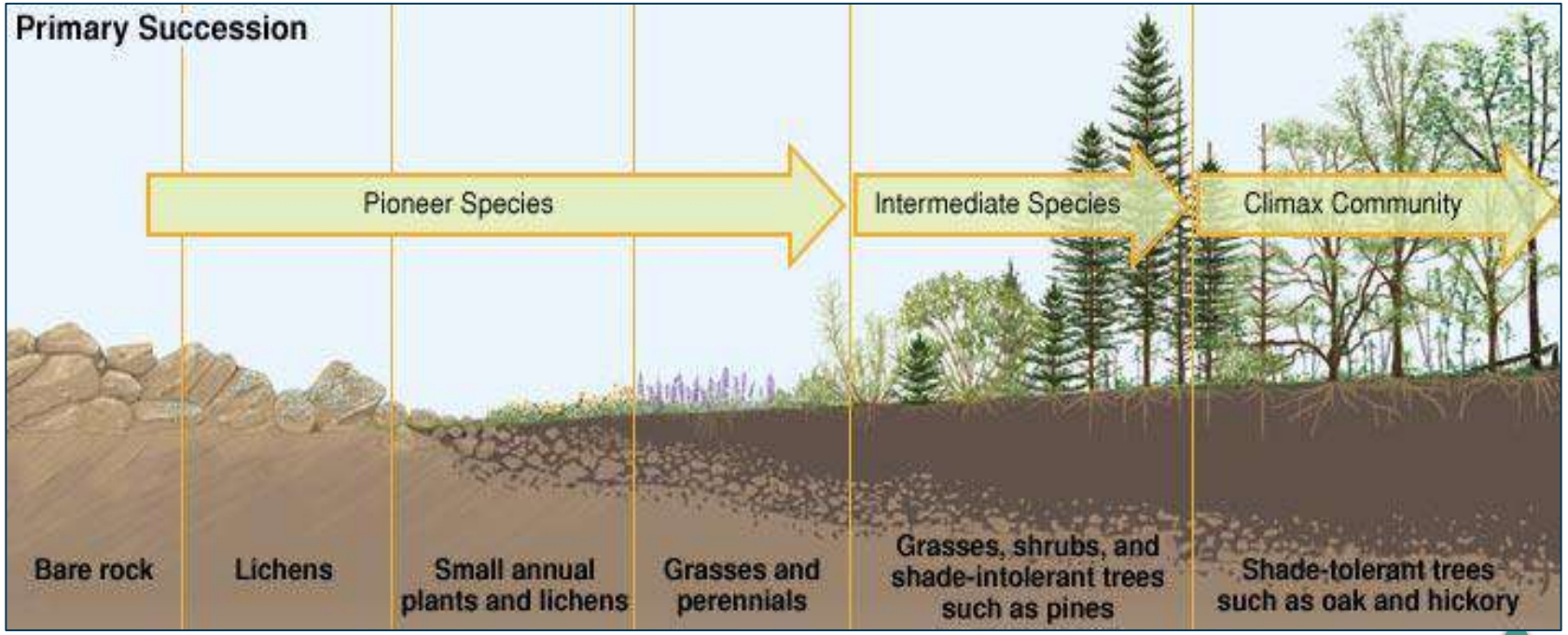
Interaction type	Species 1	Species 2	Detailed effect(s)
Commensalism	+	0	• Population 1, the commensal, benefits while the population 2. The host, is not affected • Commensalism is a long-term biological interaction in which members of one species gain benefits while those of the other species neither benefit nor are harmed.
Protocooperation	+	+	• Interaction favourable to both but not obligatory.
Mutualism	+	+	• Interaction favourable to both and obligatory.

ECOLOGICAL SUCCESSION

- Occurrence of relatively different sequences of communities over a period of time in the same area.
- **Trends of ecological succession:-**
  - An orderly continuous change in the kind of plants and animals.
  - Tends to increase in diversity of species.
  - An increase in organic matter and biomass supported by the available energy flow(reverse in heterotrophic succession)
  - Decrease in net community productivity or annual yield.

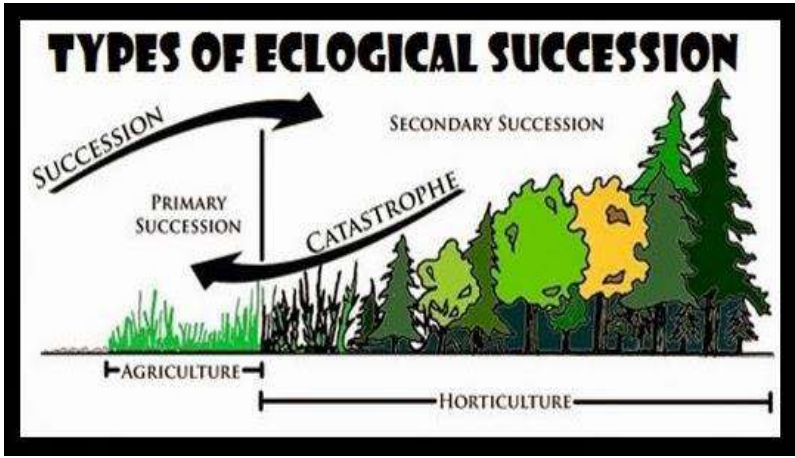


ECOLOGICAL SUCCESSION



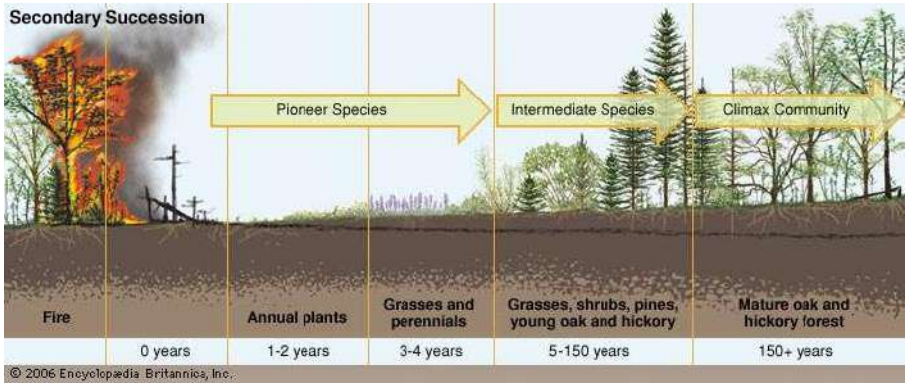
ECOLOGICAL SUCCESSION

- **Types of ecological succession:**
  - **Autotrophic succession**: Most of the organic matter is fixed by autotrophs and most living biomass is in plants.
  - **Heterotrophic (degradative) succession**: Succession on a degradable source; most living biomass is animal, fungal or microbial material.
  - **Primary succession**: Sequence of communities developing in a newly exposed habitat devoid of life (ex- succession on bare rock, newly deposited sand)



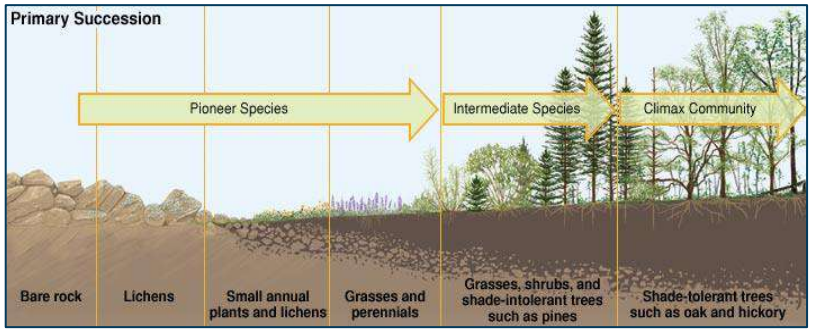
ECOLOGICAL SUCCESSION

- **Types of ecological succession:**
  - **Secondary succession**: Sequence of communities taking place on sites that have already supported life (ex- clear cut forests, burned areas).
  - **Autogenic succession**: Environment is modified by species of community itself such that conditions become favourable for that community and more favourable for upcoming communities.
  - **Allogenic succession**: Replacement of community is due to other external factors.



ECOLOGICAL SUCCESSION

- **Mechanisms of ecological succession:**
  - The **gradual and fairly predictable change in the species composition of a given area** is called ecological succession.
  - **Pioneer community**: first plant to colonize an area is called the.
  - **Climax community**: final stage of succession. A climax community is the final stage of succession, remaining relatively unchanged until destroyed by an event such as fire or human interference. This is a community that is in near equilibrium with the environment.
  - **Sere**: The entire sequence of communities that successively change in a given area are called sere.

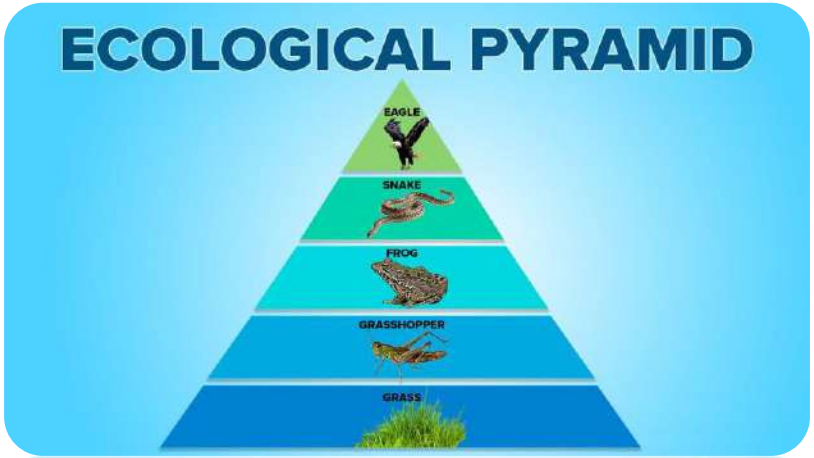


ECOLOGICAL SUCCESSION

Primary succession:	• **Primary succession takes place an over where no community has existed previously. E.g. rock outcrops, newly formed deltas and sand dunes, emerging volcano islands and lava flows, glacial moraines etc.** • **In primary succession on a terrestrial site, the new site is first colonized by a few hardy pioneer species that are often microbes, lichens and mosses.**
Secondary succession:	• Secondary succession begins in areas where natural biotic communities have been destroyed such as in abandoned farm lands, burned or cut forests, lands that have been flooded. • Since some soil or sediment is present, succession is faster than primary succession.

ECOLOGICAL PYRAMIDS

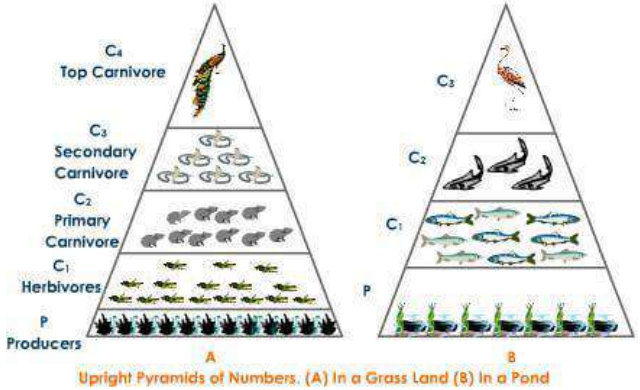
- The pyramidal **representation of trophic levels of different organisms based on their ecological position** (producer to final consumer) is called as an ecological pyramid.
- The pyramid consists of a number of **horizontal bars depicting specific trophic levels**. The length of each bar represents the total number of individuals or biomass or energy at each trophic level in an ecosystem.



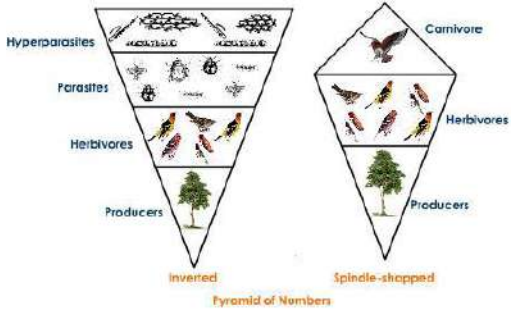
ECOLOGICAL PYRAMIDS

Pyramid of Numbers:

- Pyramid of numbers represents the total number of individuals of different species (population) at each trophic level.
- **Upright Pyramid of Numbers:** In this pyramid, the number of individuals decrease from lower level to higher trophic level. This type of pyramid can be seen in the grassland ecosystem and pond ecosystem.
- **Inverted Pyramid of Numbers:** In this pyramid, the number of individuals is increased from lower level to higher trophic level. E.g. Tree ecosystem.



Upright Pyramids of Numbers. (A) In a Grass Land (B) In a Pond

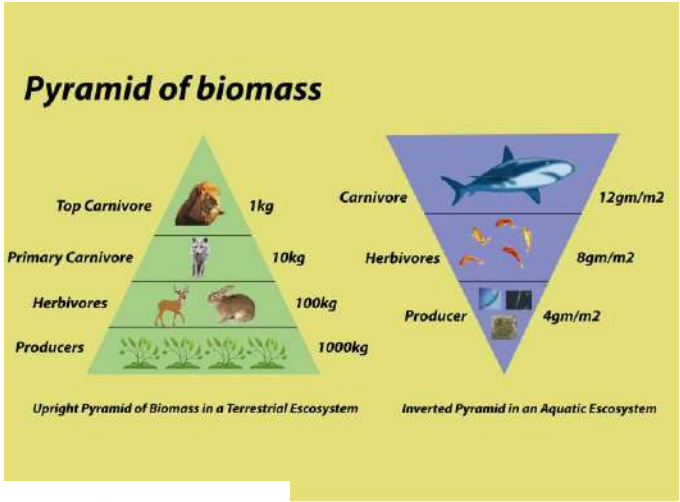


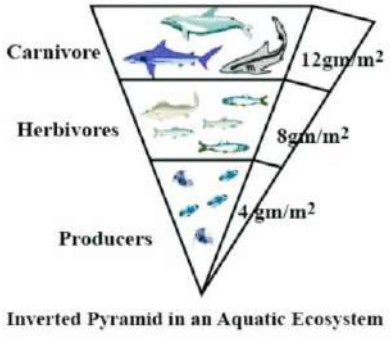
Pyramid of Numbers

ECOLOGICAL PYRAMIDS

Pyramid of Biomass:

- It arranges the biomass or weight of organisms in different trophic levels. Each trophic level has a certain mass of living material at a particular time called the standing crop.
- **Upright Pyramid of Biomass**: For most ecosystems on land, the pyramid of biomass has a large base of primary producers with a smaller trophic level perched on top.
- **Inverted Pyramid of Biomass**: In many aquatic ecosystems, the pyramid of biomass may assume an inverted form. (In contrast, a pyramid of numbers for the aquatic ecosystem is upright).

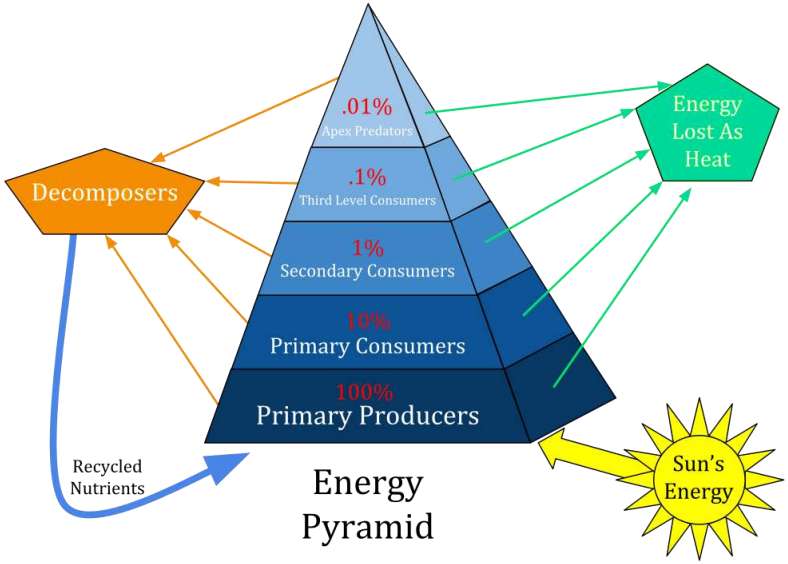




ECOLOGICAL PYRAMIDS

Pyramid of energy:

- An energy pyramid **represents the amount of energy at each trophic level**.
- It takes into account the loss of energy at each transfer to another trophic level. Hence the pyramid is **always upward**, with a **large energy base at the bottom**.
- As the usable energy decreases from sunlight to producer to herbivore to carnivore, the energy pyramid **also narrows down at the top.**
- The loss of energy in each transfer between trophic levels is determined by the **ecological efficiency.**



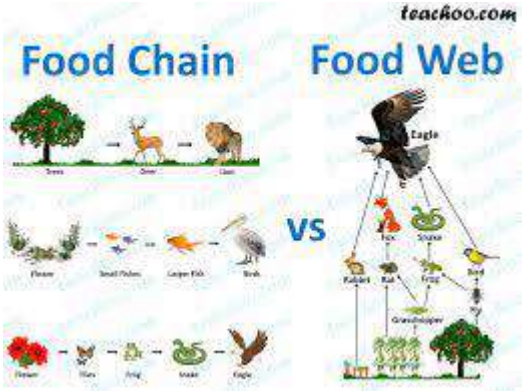
ECOLOGICAL PYRAMIDS

Points to Note:

- Energy cannot be created or destroyed, it is released as heat within each level. Approximately only 10% of energy is passed from one level to the next.
- **10% Energy Rule**: On average, only about 10 percent of energy stored as biomass in a trophic level is passed from one level to the next. This is known as “the 10 percent rule” and it limits the number of trophic levels an ecosystem can support.
- **Consumption Efficiency**: Measures the amount of energy transferred from one trophic level to the next.

FOOD CHAIN AND FOOD WEB

- **Food Chain**: Sequence of transfers of matter and energy in the form of food from organism to organism. Food chains intertwine locally into a food web because most organisms consume more than one type of animal or plant.
- **Food Web**: A network of interconnecting food chains in a natural community of different organisms. The food web begins with plants and ends with the top carnivore.

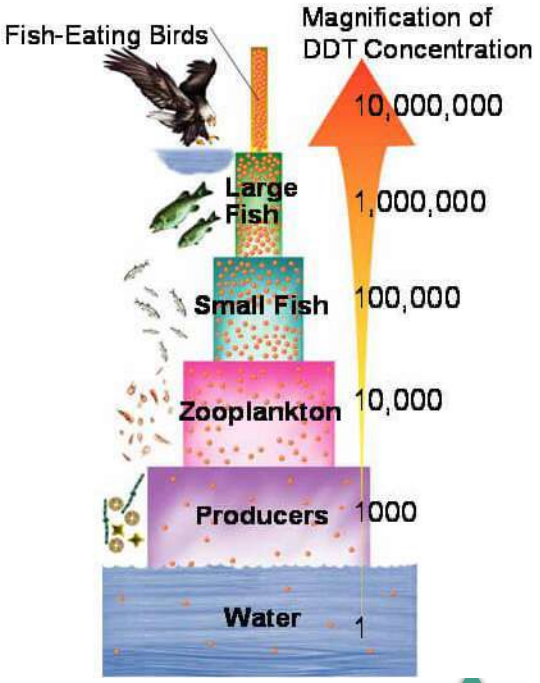


FOOD CHAIN AND FOOD WEB

Grazing Food Chain	Detritus Food Chain	Parasitic Food Chain
• **Directly dependent on an influx of solar radiation.** • **Food chain starts from the living green plants** • **Ex: Grass → Rabbit → Fox.**	• Depend chiefly on the influx of organic matter produced in another ecosystem. • Food chain goes from dead organic matter into microorganisms and then to organisms feeding on detritus. • Ex- Mangrove leaves falling in shallow estuary waters.	• A parasitic food chain starts with herbivores. • Food energy transfers from larger organisms to smaller organisms, without killing in case of a predator. • E.g. Tapeworms, fleas, and barnacles deriving energy from other living organisms.

POLLUTANTS AND TROPHIC LEVEL

- Non degradable pollutants move from different trophic level. Non-degradable (persistent) is which cannot be metabolized by living organisms. E.g. Chlorinated Hydrocarbons.



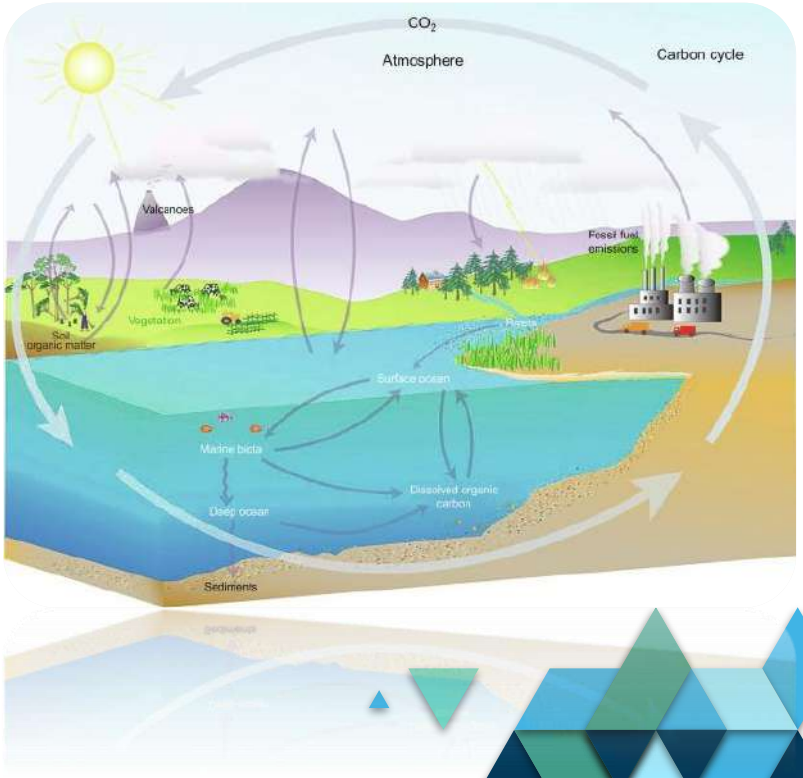
POLLUTANTS AND TROPHIC LEVEL

Bioaccumulation	• **It is the gradual accumulation of pollutants, chemicals (chronic poisoning) or other substances in an organism. Bioaccumulation occurs when the rate of loss of the substance from the body of the organism through catabolism (breakdown of complex molecules in living organisms), or excretion is lower than the rate of accumulation of the substance.**
Biomagnification	• Biomagnification refers to progressive bioaccumulation (increase in concentration) at each tropical level with the passage of time. In order for biomagnification to occur, the pollutant must have a long biological half-life (long-lived) & must not be soluble in water but must be soluble in fats. E.g. DDT.

BIOGEOCHEMICAL CYCLES

- More or less circular pathways through which the chemical elements, including all the essential elements of the protoplasm, circulate in the biosphere from environment to organisms and back to the environment. Generally there are two types biogeochemical cycles:

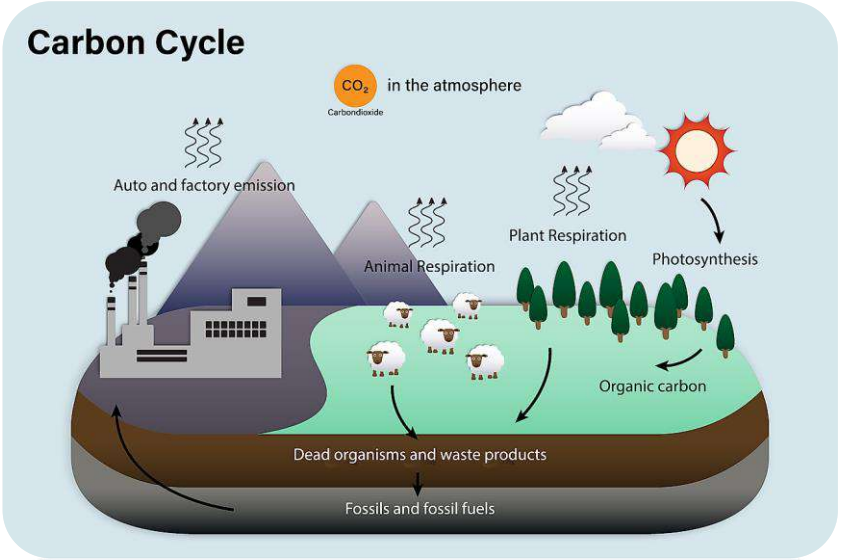
1. **Gaseous cycle** - Reservoir for gaseous type of nutrient cycle (e.g. water, nitrogen, carbon cycle) exists in the atmosphere.
2. **Sedimentary cycle** - For the sedimentary cycle (e.g. Sulphur and phosphorus cycle), the reservoir is located in Earth's crust.



BIOGEOCHEMICAL CYCLES

Carbon Cycle:

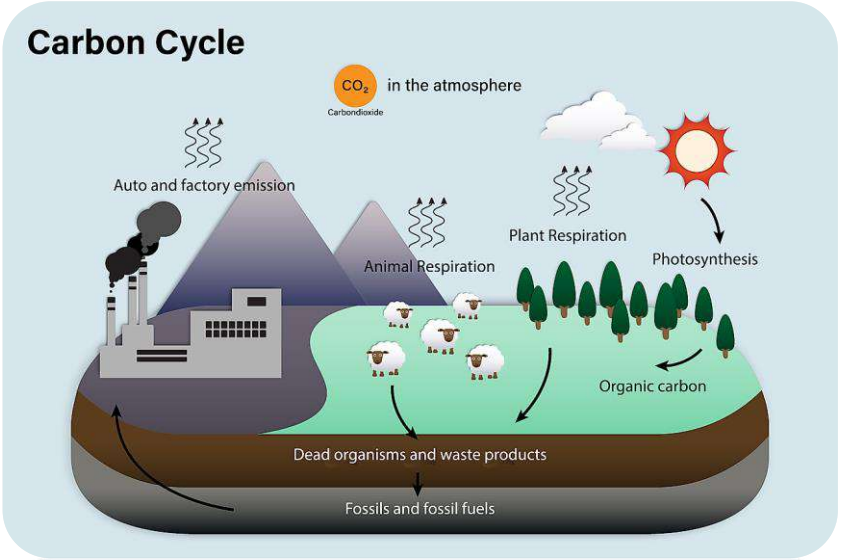
- **71 per cent carbon is found dissolved in oceans**. This oceanic reservoir regulates the amount of carbon dioxide in the atmosphere. Atmosphere only contains **about 1 per cent of total global carbon**.
- Carbon cycling **occurs through atmosphere, ocean and through living and dead organisms**.
- A considerable amount of carbon returns to the atmosphere as CO2 through **respiratory activities** of the producers and consumers.



BIOGEOCHEMICAL CYCLES

Carbon Cycle:

-
- **Decomposers also contribute substantially to CO2 pool** by their processing of waste materials and dead organic matter of land or oceans.
- **Human activities** have significantly influenced the carbon cycle. Rapid deforestation and massive burning of fossil fuel for energy and transport have significantly increased the rate of release of carbon dioxide into the atmosphere



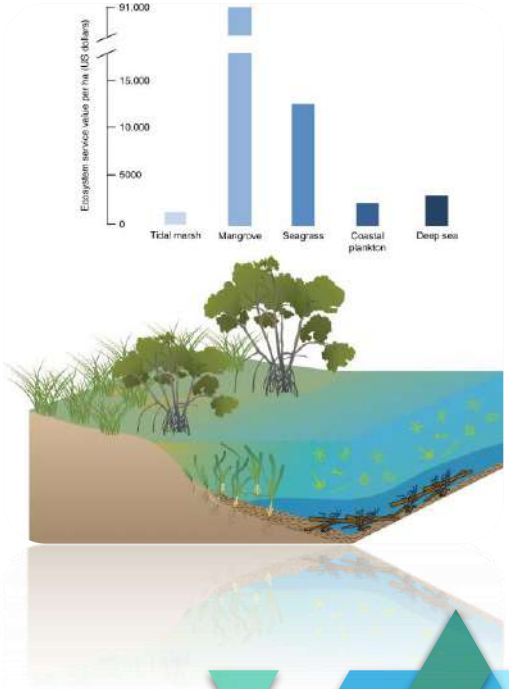
BIOGEOCHEMICAL CYCLES

Blue Carbon	Black Carbon
• **Carbon captured by the world's ocean and coastal ecosystems. Three types of coastal ecosystems — mangroves, seagrasses and tidal marshes — store half the "blue" carbon buried beneath the ocean floor.** • **These areas absorb and store carbon at a much faster rate than other areas, such as forests, and can continue to do so for millions of years.** • **The carbon found in coastal soil is often thousands of years old.**	• Black carbon, or soot, is part of fine particulate air pollution (PM2.5) and contributes to climate change. • Black carbon is formed by the incomplete combustion of fossil fuels, wood and other fuels. The complex mixture of particulate matter resulting from incomplete combustion is often referred to as soot. • Black carbon is a short-lived climate pollutant with a lifetime of only days to weeks after release in the atmosphere.

BIOGEOCHEMICAL CYCLES

Blue Carbon Initiative:

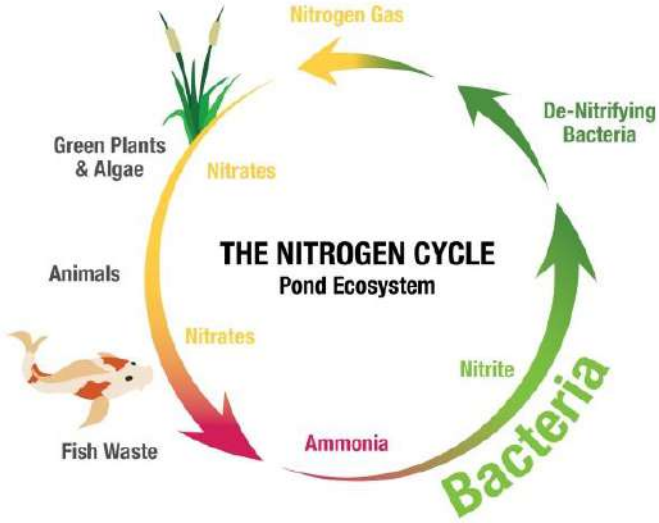
- Works **to protect and restore coastal ecosystems** for their role in reducing impacts of global climate change.
- **Focuses on the coastal ecosystems** - mangroves, tidal marshes and seagrasses, which are found on every continent except Antarctica.
- Conservation International (CI), IUCN, and the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific, and Cultural Organization (IOC-UNESCO) jointly launched it.



BIOGEOCHEMICAL CYCLES

Nitrogen Cycle:

- Nitrogen is a **constituent of amino acids, proteins, hormones, chlorophylls** and many of the vitamins
- Plants compete with microbes for the limited nitrogen that is available in the soil. Thus, **nitrogen is a limiting nutrient** for both natural and agricultural ecosystems.
- In nature, **lightning and ultraviolet radiation** provide enough energy to **convert nitrogen to nitrogen oxides** (NO, NO2, N2O).

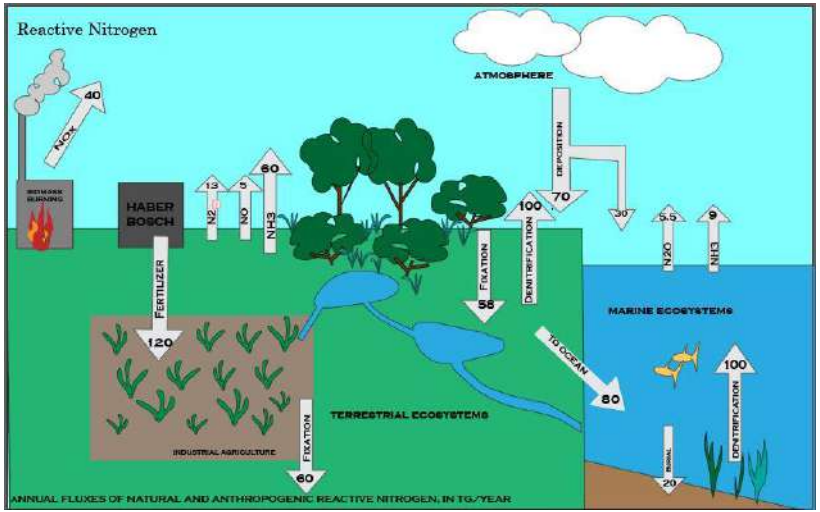


BIOGEOCHEMICAL CYCLES

Nitrogen Cycle:

- Industrial combustions, forest fires, automobile exhausts and power-generating stations are also sources of atmospheric nitrogen oxides.

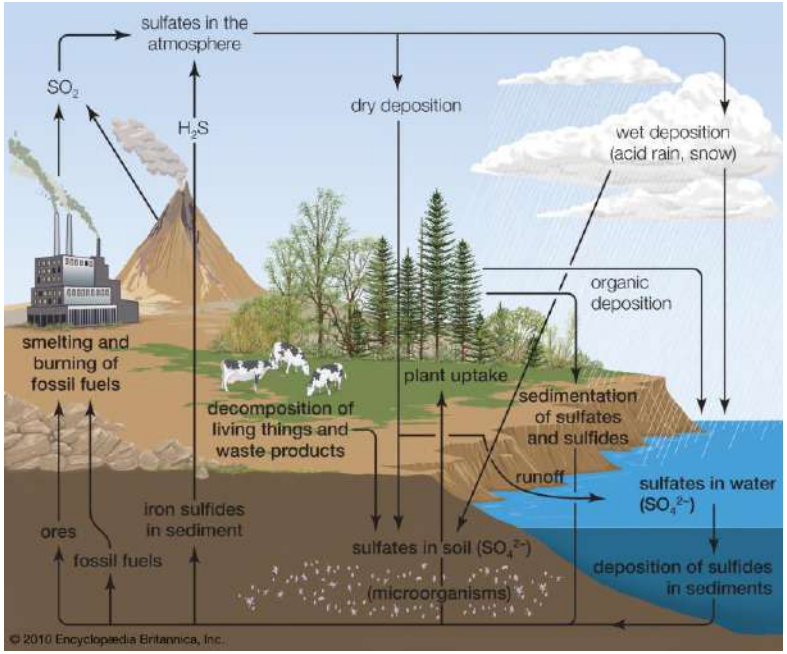
1. **Step 1**: N2 Fixing → Nitrogen → Ammonia or Ammonium Ions
2. **Step 2:** Nitrification → Ammonia or Ammonium Ions (bacteria: Nitrosomonas and/or Nitrococcus) → Nitrite (Nitrobacter)→ Nitrate
3. **Step 3:** Ammonification → Dead Matter + Animal Waste (Urea, Uric Acid) → Ammonia or Ammonium Ions
4. **Step 4**: Denitrification → Nitrate (bacteria: Pseudomonas and Thiobacillus) → Nitrogen



BIOGEOCHEMICAL CYCLES

Sulphur Cycle:

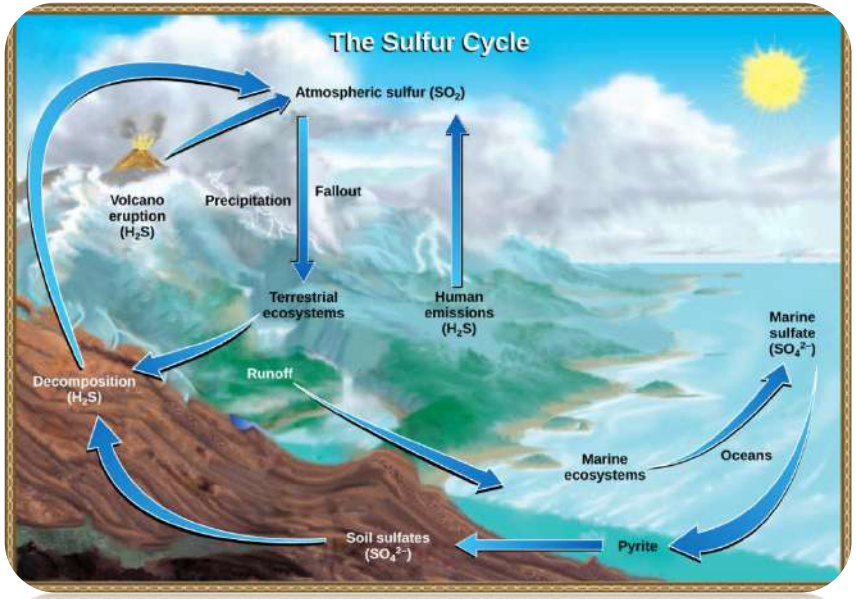
- In Sulphur cycle, there is a **circulation of sulphur in various forms through nature**. Sulphur **occurs in all living matter** as a component of certain amino acids.
- It is abundant in the soil in proteins and, through a series of microbial transformations, ends up as sulphates usable by plants.
- The **Sulphur reservoir is in the soil and sediments where it is locked in organic (coal, oil and peat) and inorganic deposits (pyrite rock and Sulphur rock)** in the form of sulphates, sulphides and organic Sulphur.



BIOGEOCHEMICAL CYCLES

Sulphur Cycle:

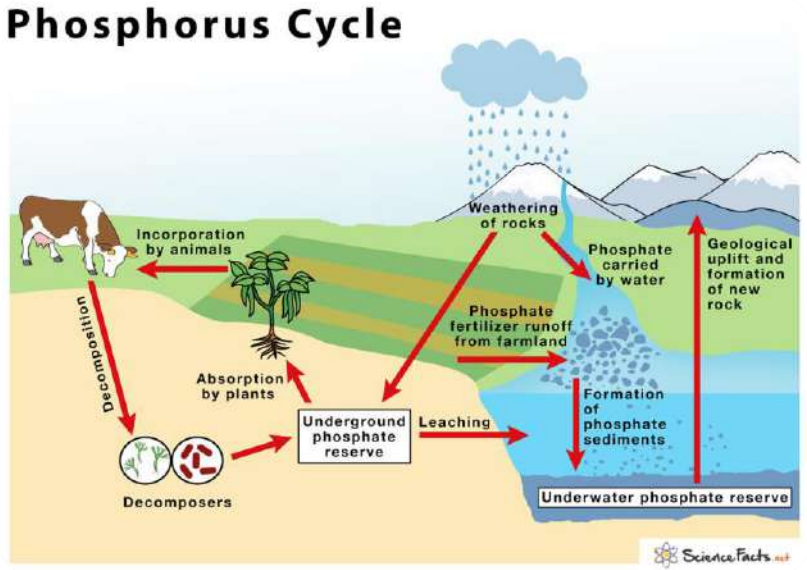
- It is **released by weathering of rocks, erosional runoff and decomposition of organic matter** and is carried to terrestrial and aquatic ecosystems in salt solution.
- **Sulphur cycle is mostly sedimentary** except two of its compounds, hydrogen sulphide (H2S) and Sulphur dioxide (SO2), which add a gaseous component.
- Sulphur enters the atmosphere from several sources like volcanic eruptions, combustion of fossil fuels (coal, diesel etc.), from the surface of the ocean and gases released by decomposition.



BIOGEOCHEMICAL CYCLES

Phosphorus Cycle:

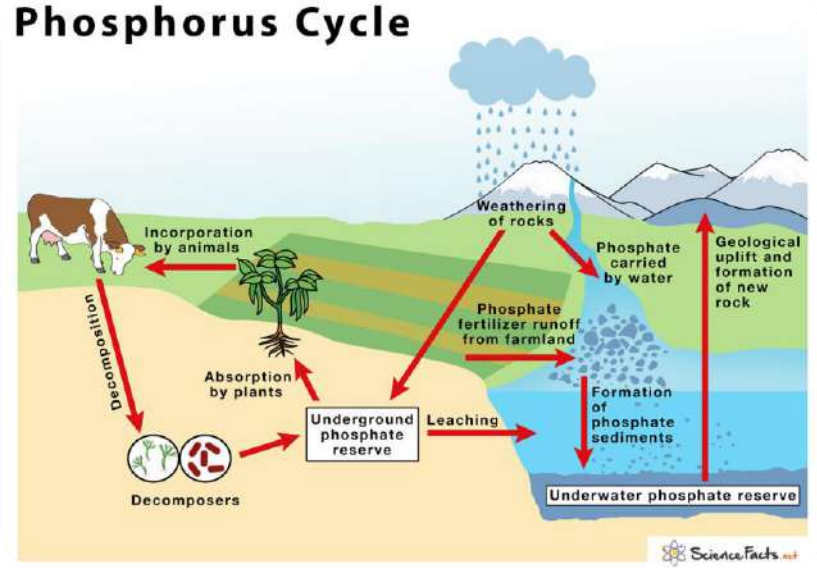
- Phosphorus is a **major constituent of biological membranes, nucleic acids and cellular energy transfer systems**.
- Many animals also **need large quantities of this element to make shells, bones and teeth**.
- The **natural reservoir of phosphorus is rock**, which contains phosphorus in the form of phosphates.
- When rocks are weathered, minute amounts of these phosphates dissolve in soil solution and are absorbed by the roots of the plants.

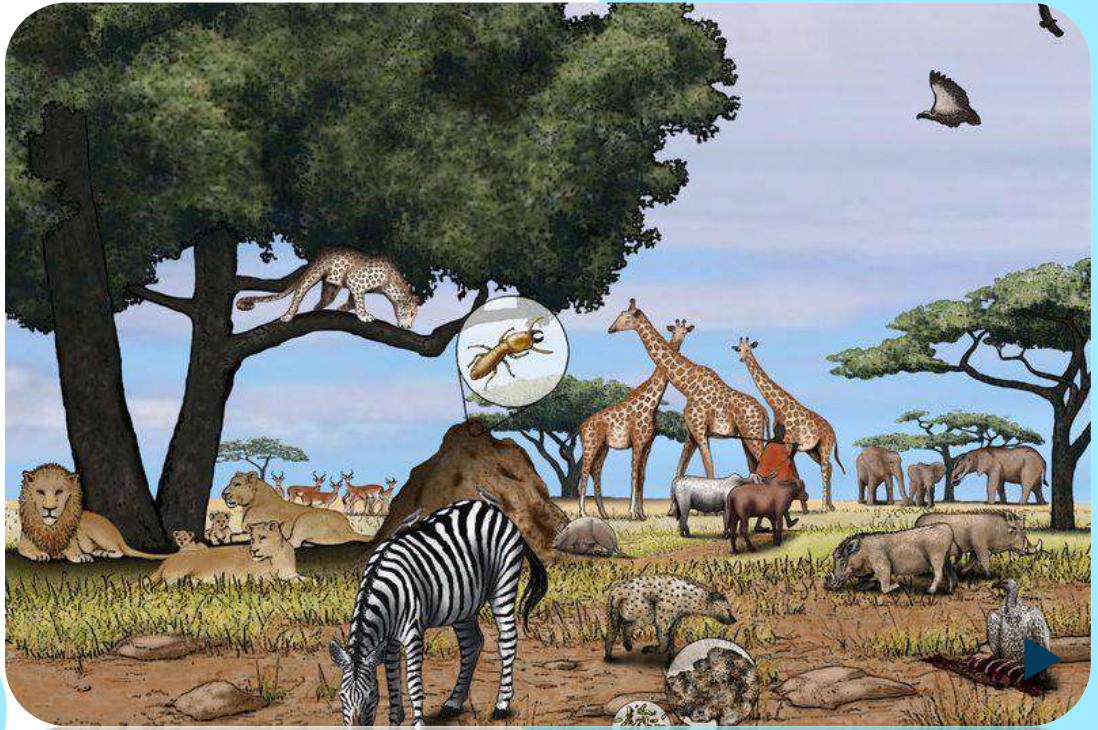


BIOGEOCHEMICAL CYCLES

Phosphorus Cycle:

- Herbivores and other animals obtain this element from plants. The waste products and the dead organisms are decomposed by phosphate-solubilizing bacteria releasing phosphorus.
- Unlike carbon cycle, there is no respiratory release of phosphorus into atmosphere.



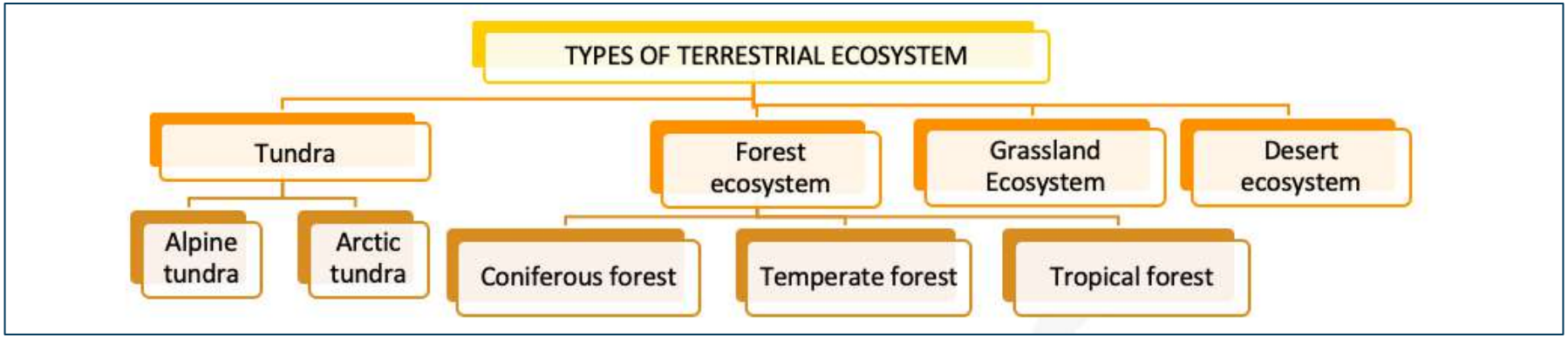


TERRESTRIAL ECOSYSTEM

Terrestrial Ecosystem

- A terrestrial ecosystem is a land-based community of organisms and the interactions of biotic and abiotic components in a given area. The terrestrial ecosystems can be found anywhere apart from heavily saturated places.
- **Type of TE found in a particular place is dependent on:** Topography (valleys, mountains, plains and plateaus), Altitudinal and latitudinal variations, Quality of soil, Amount of light, Amount of precipitation, Temperature range.

Terrestrial Ecosystem



TUNDRA

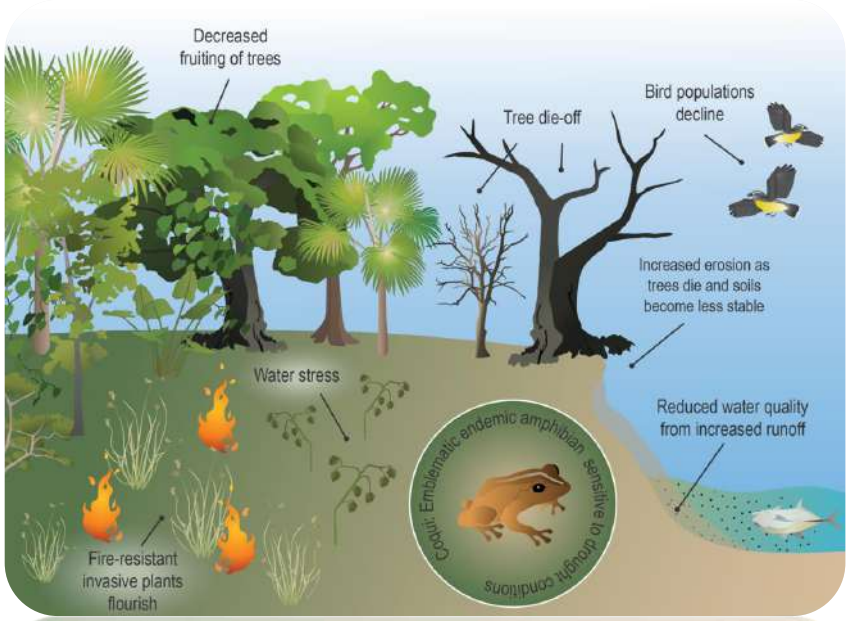
- Tundra means a “barren land”. Tundra ecosystems are treeless regions where environmental conditions are very severe.
- **Characteristics:**
  - **Harsh climatic conditions (cold and windy):** Winters are long and very severe; summers are cool and brief.
  - **Precipitation**: Scanty rainfall, precipitation is mainly in the form of snow.
  - **Soil**: Permafrost or soil that remains frozen all year round and is also scarce of nutrients.
  - Low biotic diversity
- **Types**: Arctic Tundra and Alpine Tundra

TUNDRA

Arctic Tundra	Alpine Tundra
• **Distribution: It extends as a continuous belt below polar ice cap and above tree line in the northern hemisphere.** • **On the south pole, tundra is very small since most of it is covered by ocean - limited to some parts of Antarctica and Falkland Islands.**	• **Distribution:** It is found at all latitude in a high-altitude area.
• **Examples: Alaska, Canada, Russia, Greenland, Iceland, and Scandinavia.**	• **Examples:** The Himalayas, the Alps, Tibetan Plateau, The Caucasus Mountains, the American Cordillera etc.
• **Flora: Mosses, lichens, sedges, cotton grass, sedges, dwarf heath, willows, birches**	• **Flora:** Mosses, sedges, liverworts, grassy vegetation.
• **Fauna: Arctic foxes, polar bears, caribou, musk-ox.**	• **Fauna:** Pikas, marmots, mountain goat, reindeer, musk ox, arctic hare, caribous, lemmings and squirrel.

FOREST ECOSYSTEM

- Forests represent the **largest and most ecologically complex systems**. They contain a wide assortment of trees, plants, mammals, reptiles, amphibians, invertebrates, insects and microorganisms which vary depending on the zone's climate. Forest ecosystems are of three types.



Coniferous Forest/ Taiga/Boreal Forest:

- It is sandwiched between the tundra to the north and the temperate forest to the south.
- **Distribution:**
  - It stretches in a great continuous belt across North America, Europe and Asia.
  - Absent in the southern hemisphere because of the narrowness of the southern continents in the high latitudes.
- **Abiotic components:**
  - **Well defined seasons:** prolonged bitterly cold winter; short cool summer. Presence of local winds like blizzards of Canada and buran of Eurasia.

Coniferous Forest/ Taiga/Boreal Forest:

- Precipitation: well distributed throughout the year.
- Soil type: Podzolized soil (acidic, excessively leached and mineral deficient)
- **Biotic components:**
- **Natural vegetation/Flora:** Consists mostly of conifers- evergreen; conical in shape; thick, leathery and needle-shaped leaves. E.g.: Pine, Fir, Spruce, Larch
- Fauna: Mink, Silver fox, Lynx, Wolf

Temperate Forest

- It is characterized by broad-leaved trees, which shed their leaves in autumn and grow new foliage in autumn.
- **It can be further divided into**: Temperate Deciduous (mainly in northern hemisphere), Temperate Evergreen (found in Mediterranean climatic region) and Temperate Rainforest (found in both the hemispheres, coastal region).
- **Distribution:**
  - Located in the mid-latitude areas, between polar regions (grade into boreal forest) and tropics (grade into Tropical rain forest).
  - Found in both northern and southern hemisphere.

Temperate Forest

- **Abiotic components:**
  - Presence of distinct seasons. Moist, warm summer and frosty or rainy winter
  - **Soil type:** Alfisol or brown forest soil
- **Biotic components:**
  - **Flora:** Broadleaf trees (oaks, maples, beeches), shrubs, perennial herbs, and mosses
  - **Fauna:** Squirrels, marsupials, brown bear, bats, rodents

Tropical Rain Forest

- It is characterized as most luxuriant forest with diverse array of communities and makes up one of the earth's largest biome.
- **Distribution**: Found in wet tropical uplands and lowlands around the Equator.
- **Abiotic components:**
  - High humidity and temperature (more or less uniform)
  - **Precipitation**: exceeds 200cm, evenly distributed throughout the year
  - **Soil type**: Red latosol (high rate of leaching makes it agriculturally useless, but can rejuvenate with nutrients when left undisturbed).

Tropical Rain Forest

- **Biotic Components:**
  - **Flora**: Diverse Angiosperms and relatively few Gymnosperms. Besides, liverworts, creepers, ferns, mosses, lichens and algae are also found. Presence of dense upper canopy and thick undergrowth.
  - **Fauna**: Monkeys, rhinos, large number of insects, birds.

Types of forests in India

Tropical Rain Forests

Tropical rain forests

Tropical rain forests incur heavy showers of 100-600cm a year, and hence the name, Rainforests. These forests experience an average temperature of about 26 degrees Celsius, with no pronounced cold or dry spells. Coffee, chocolate, banana tree, mango tree, papaya tree, avocados and sugarcane all originally came from tropical rainforests.

Temperate deciduous forests

Temperate Deciduous forests are those, which consist of predominantly broad-leafed trees. Species belonging to these forests drop leaves in autumn. The deciduous forests in tropical areas shed leaves when water becomes scarce. These areas receive an annual rainfall of 100 to 200cms in India. The deciduous forest can further be divided into Moist and Dry.

Temperate Deciduous

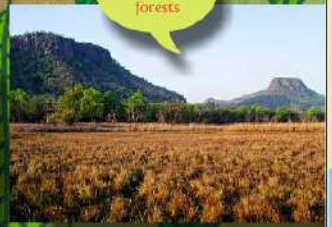
Moist Deciduous forests

The moist deciduous forests are scattered throughout India except in the western and the north-western regions. The trees have broad trunks, are tall and have branching trunks and roots to hold them firmly to the ground. These forests are dominated by Sal and Teak, along with Mango, Bamboo and Rosewood.

Dry Deciduous forests

Indian Dry Deciduous Forests are found throughout the northern part of the country except in the Northeast. It is also found in Madhya Pradesh, Gujarat, Andhra Pradesh, Karnataka and Tamil Nadu. The principal trees of these forests are Indian Teak Tree, Sal, Sandalwood, Mahua, Khair, Mango, Jackfruit, Wattle and Arjun, Semal, Myrobalan and Banyan

Dry Deciduous forests



Moist Deciduous forests

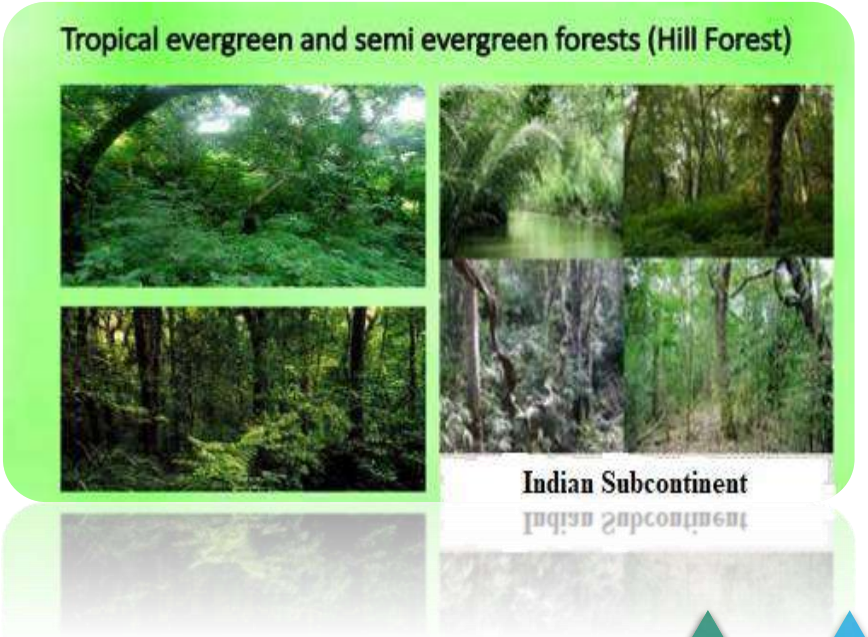
South Western Ghats Moist Deciduous Forest

NAME- Akshita Sharma
CLASS- 7-H

INDIAN FOREST TYPES

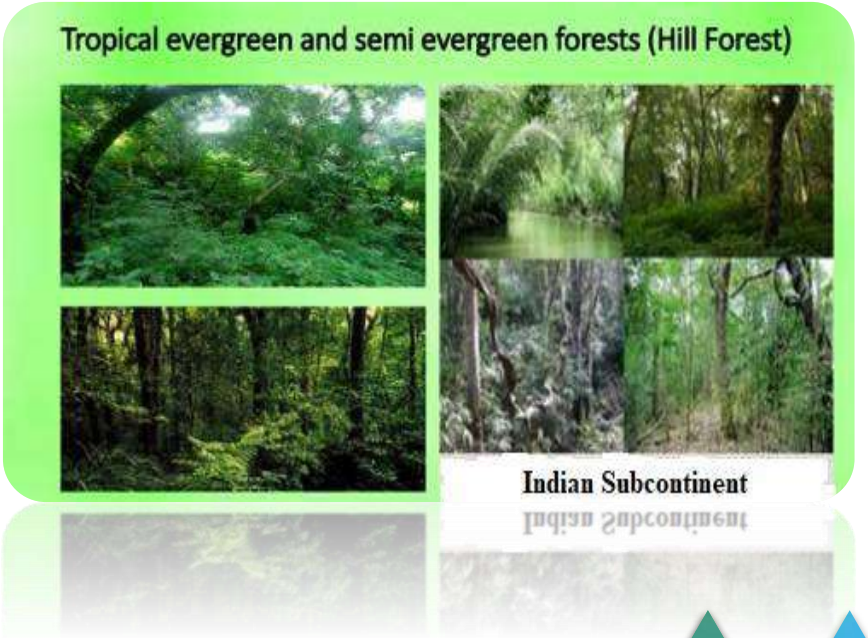
Tropical Evergreen and Semi Evergreen forests

- **Location:** Found in the western slope of the Western Ghats, hills of the northeastern region and the Andaman and Nicobar Islands in
- **Climatic condition:** Warm and humid conditions with an annual precipitation of over 200 cm and mean annual temperature above 22oC.
- **Characteristics:** Stratified with layers closer to the ground and are covered with shrubs and creepers, with short structured trees followed by a tall variety of trees. Trees reach great heights up to 60 m or above. There is no definite time for trees to shed their leaves, flowering and fruition and these forests appear green all the year round.



Tropical Evergreen and Semi Evergreen forests

- **Floral composition:** Rosewood, mahogany, aini, ebony, etc. The under growing climbers provide an evergreen character to these forests. Main species are white cedar, hollock and kail.
- **Faunal composition:** Elephants, monkey, lemur and deer, one-horned rhinoceros are found in jungles of Assam and West Bengal along with plenty of birds, bats, sloth, scorpions and snails etc.
- **The semi evergreen forests** are found in the less rainy parts of these regions. Such forests have a mixture of evergreen and moist deciduous trees.



Tropical Deciduous forests:

- Most widespread forests in India, also **called the monsoon forests.**
- **Climatic condition:** They spread over regions which receive rainfall between 70-200 cm. Based on the availability of water and rainfall, they are divided into: -

Tropical Deciduous forests:

Tropical Moist Deciduous Forests:

- **Location**: Northeastern states along the foothills of Himalayas, eastern slopes of the Western Ghats and Odisha.
- **Climatic condition**: Rainfall between 100-200 cm.
- **Floral Composition**: Teak, sal, shisham, hurra, mahua, amla, semul, kusum, and sandalwood etc
- **Faunal Composition**: Mammals include the predators Indian tiger, wolf, dhole, and sloth bear, and the herbivores gaur, chousingha, blackbuck, and chinkara.

Tropical Deciduous forests:

Dry deciduous forest:

- **Location**: Rainier areas of the Peninsula and the plains of Uttar Pradesh and Bihar. In the higher rainfall regions of the Peninsular plateau and the northern Indian plain
- **Climatic condition**: Rainfall ranges between 70 -100 cm.

Tropical Deciduous forests:

Dry deciduous forest:

- **Characteristics**: On the wetter margins, it has a transition to the moist deciduous, while on the drier margins to thorn forests. Forests have a parkland landscape with open stretches in which teak and other trees interspersed with patches of grass are common. As the dry season begins, the trees shed their leaves completely and the forest appears like a vast grassland with naked trees all around.
- **Floral composition**: Tendu, palas, amaltas, bel, khair, axlewood, etc.

Tropical Thorn forests

- **Location**: It includes semi-arid areas of south west Punjab, Haryana, Rajasthan, Gujarat, Madhya Pradesh and Uttar Pradesh.
- **Climatic condition**: Tropical thorn forests occur in the areas which receive rainfall less than 50 cm.
- **Characteristics**: Variety of grasses and shrub, plants remain leafless for most part of the year and give an expression of scrub vegetation.
- **Floral composition**: Babool, ber, and wild date palm, khair, neem, khejri, palas, etc.

Montane forests

- In mountainous areas, decrease in temperature with increasing altitude leads to a corresponding change in natural vegetation. Mountain forests can be classified into two types, the northern mountain forests and the southern mountain forests.
- **Location**: The southern mountain forests include the forests found in three distinct areas of Peninsular India viz; the Western Ghats, the Vindhyas and the Nilgiris and northern montane forests include mountain ranges in Kashmir, Uttarakhand, Himachal Pradesh, Sikkim and Darjeeling are covered by Himalayan temperate forests.

Montane forests

- **Climatic condition**: The mean annual rainfall here is 150 cm to 300 cm, the mean annual temperature is about 11°C to 14°C and the average relative humidity is over 80 per cent.
- **Characteristics**: Deciduous forests are found in the foothills of the Himalayas. It is succeeded by the wet temperate type of forests between an altitude of 1,000-2,000 m. The temperate forests are called **Sholas** in the Nilgiris, Anaimalai and Palani hills. Such forests are also found in the Satpura and the Maikal ranges.

Montane forests

- **Floral composition**: At higher altitudes, mosses and lichens form part of the tundra vegetation. Some of the other trees of this forest of economic significance include, Magnolia, Laurel, Cinchona and Wattle.
- **Faunal composition**: Hangul or Kashmir Stag, Shou or Sikkim Stag, Red Panda, Elephants, Sambhar, Swamp deer etc.

Littoral and Swamp forests

- Littoral forests are forests along the coast featuring salt-tolerant vegetation. They occur in patches and narrow strips along the mainland coast.
- **Location**: Along the coast and of the islands and to the deltas of the Ganga, the Mahanadi, the Godavari, the Krishna and the Cauvery
- **Characteristics**: Swamp forests are found on peat-poor soils that are permanently waterlogged. They may be created and maintained by land topography (basin swamps), hydrological barriers, and/or high-water tables. Aquatic habitats in swamp forests may be sporadic, seasonal, or permanent.

Littoral and Swamp forests

- **Floral Composition**: Consists mostly of whistling pines, mangrove dates, palms, etc. They have roots that consist of spongy tissue so that the plant can respire in the water.
- **Faunal Composition**: Salt water crocodiles, marine turtles, coconut crab, lizards, snakes (mainly reptiles and marine animals).

GRASSLAND ECOSYSTEM

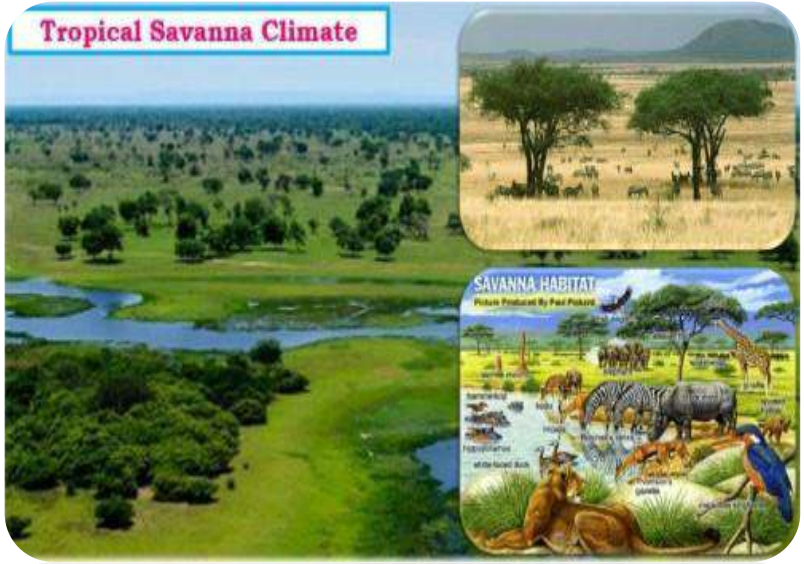
- Grassland ecosystem is an area where the **vegetation is dominated by continuous cover of grasses and herbaceous** (non-woody) plants. It accounts **between 20 and 40% of world's land area**.
- The grasslands are found where **rainfall is about 25-75 cm per year**, not enough to support a forest, but more than that of a true desert.

GRASSLAND ECOSYSTEM

- Typical grasslands are vegetation formations that are generally found in temperate climates. In India, they are found mainly in the high Himalayas. The rest of India's grasslands are mainly **composed of steppes and savannas.**
- **Steppes viz-a-viz savannas**: all the forage in the steppe is provided only during the brief wet season whereas in the savannas forage is largely from grasses that not only grow during the wet season but also from the smaller amount of regrowth in the dry season.

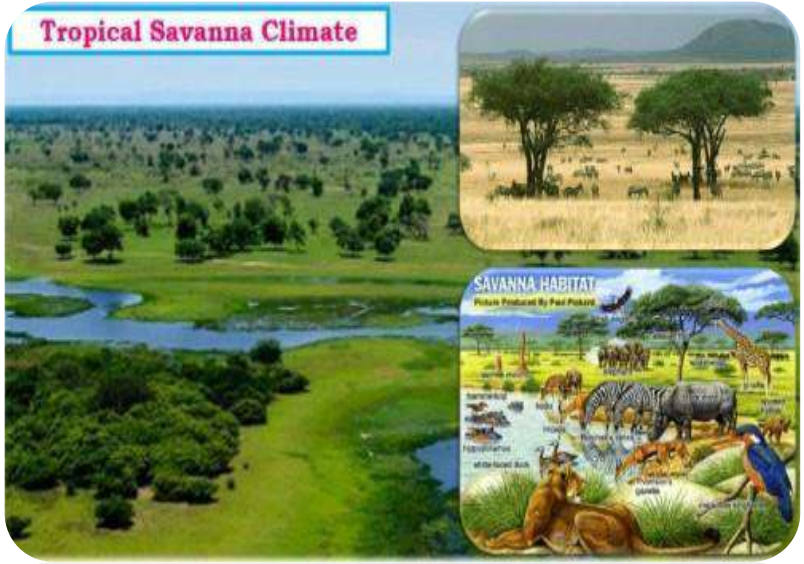
Savanna/ Tropical Grassland: "Big Game Country"

- Savanna **distinguished by their warmer drier climates and their seasonal droughts**. Savanna plant life is highly adapted to the hot and dry climate, with trunks that can store water for days or a special built in mechanism allowing the plant to lie dormant during periods of drought.
- **Distribution:**
  - Transitional between the equatorial forests and the trade wind hot deserts.
  - E.g.: Savanna of Africa, Campos of Brazilian highland, Llanos of Orinoco basin.



Savanna/ Tropical Grassland: "Big Game Country”

- **Abiotic components:**
  - Characterized by: an alternate hot, rainy season and cool, dry season.
  - Local wind: Harmattan in Guinea coast
  - Soil type: Alfisols and Ultisols
- **Biotic components:**
  - Flora: tall, elephant grass and short trees that has long roots and water storing devices (e.g: baobabs and bottle trees).
  - Fauna: Grass-eating Herbivores and flesh-eating Carnivores.



Steppe/ Temperate Grassland: "Granaries of The World"

- **Distribution:** Found in the interiors of continents, away from maritime influence. E.g. Prairies of North America, Pampas of Argentina, Downs of Australia, Velds of Africa, Steppes of Eurasia, etc.
- **Abiotic components:**
  - **Characterized by:** Continental climate, not severe in the southern hemisphere.
  - **Local wind:** Chinook in Canada and America, Fohn in Switzerland.
  - **Soil type:** Chernozem soil
- **Biotic components:**
  - **Flora:** Short steppe type of grass, practically treeless (used for extensive wheat cultivation)
  - **Fauna:** Mainly domesticated animals- cattle, sheep, pigs are found.

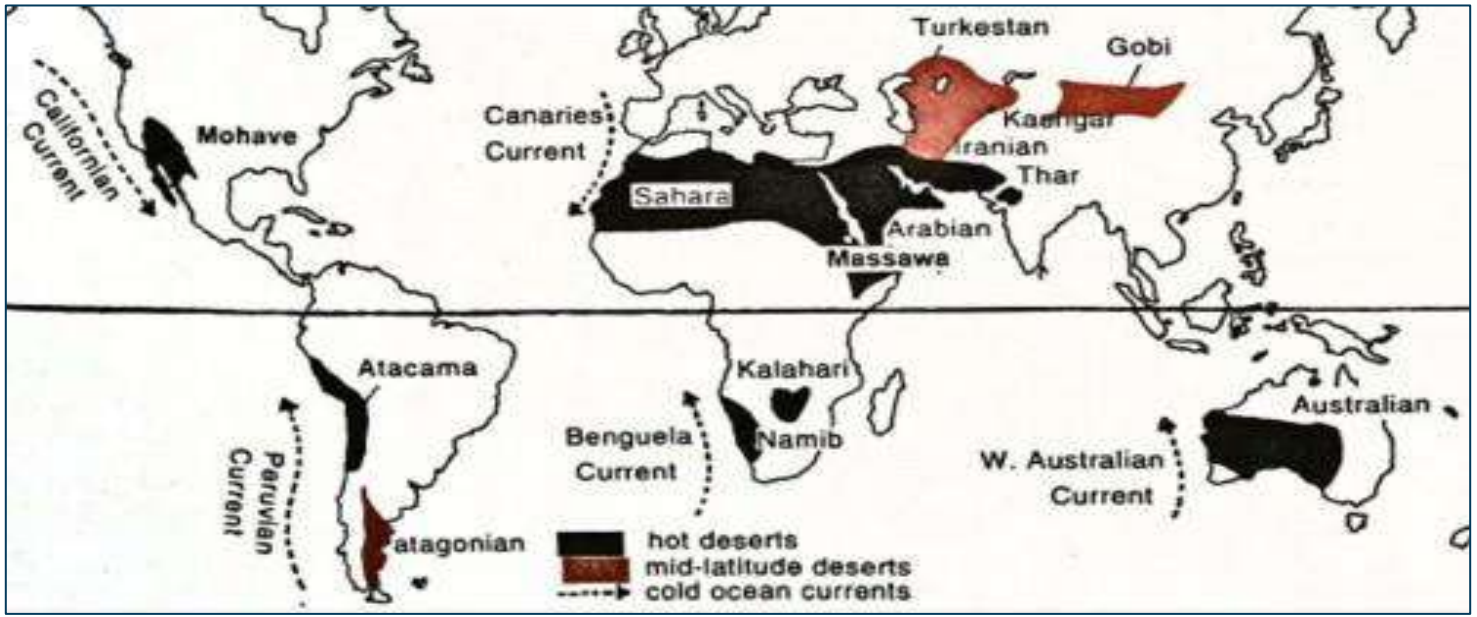
Points to note:

- **Role of fire**: Fire plays an important role in the management of grasslands. Under moist conditions fire favours grass over trees, whereas in dry conditions fire is often necessary to maintain grasslands against the invasion of desert shrubs. Burning increases the forage yields.
- **Impact of grazing**: Due to heavy grazing pressure, the quality of grasslands deteriorates rapidly, the mulch cover of the soil reduces, microclimate becomes drier and is readily invaded by xerophytic plants and borrowing animals.

DESERTS ECOSYSTEM

- Desert ecosystem is a region of **scanty rainfall supporting a community of distinctive plants and animals** specially adapted to the harsh environment. Deserts are formed in regions with **less than 25 cm of annual rainfall**. Deserts covers about one-fifth of our planet.

DESERTS ECOSYSTEM



Hot Desert

- The hot deserts of the world are caused by the presence of dry air and low precipitation from subtropical high-pressure cells.
- **Distribution:** Western coasts of continents between 15 and 30 N and S (lie in the region of Horse latitudes). E.g. Atacama (Chile), Western Sahara (Namibia), Arizona (USA).
- **Abiotic components:**
  - Extreme diurnal range of temperature. Less than 25cm of annual rainfall.
  - Soil type: saline, sandy soil with low water holding capacity.

Hot Desert

- **Biotic components:**
  - **Flora:** Xerophytic or drought resistant scrub, date palms, acacia etc.
  - **Fauna:** Diverse array of reptiles, marsupials, mammals (camels, hedgehog, hyenas).

Mid-Latitude/ Cold/Temperate Desert

- The cold desert biomes occur at higher altitudes where seasonal shifting of subtropical high pressure is of some influence less than six months of the year.
- Specifically, the interior locations are dry because of their distance from moisture sources (oceans) or their location in the rain-shadow areas on the leeward side of mountain ranges such as the Himalayas, Andes and Rockies.
- **Distribution**: Located interior of the continent, sheltered by the high mountains all around them. Examples are Gobi Desert of Mongolia, Ladakh in India, Patagonia etc.

Mid-Latitude/ Cold/Temperate Desert

- **Abiotic Components:** The annual range of temperature is much greater than that of the hot deserts. Continentality accounts for these extremes in temperature (Severe winter with cold wind).
- **Biotic components:**
  - **Flora**: Alpine Mesophytic, Grasses, bushes, shrubs and even trees like junipers, birch.
  - **Fauna**: Bactrian camel, Asiatic ibex, snow leopard, Tibetan wolf, Tibetan wild ass (kiang).

Adaptations of Desert Vegetation

- Extensive root system to tap underground water
- Thick cuticle or sunken stomata to reduce transpiration
- Leaves- Absent or reduced in size or modified into either thorn, leathery, hard and waxy leaves.
- Large fleshy (succulent) stems and leaves for water storage
- Plants lie dormant for years until rain falls

Adaptations of Desert Animals:

- Nocturnal in habit to avoid the sun's heat
- Store fat in their humps, thus they can live months without food
- Excrete concentrated urine to conserve water
- Camel "the ship of the desert" can travel several days without water (drink gallons of water at one go)
- Body temperature can change to avoid losing water through sweating.

DEFORESTATION

- It is an act of clearing or thinning forest to fulfill varied purpose of humankind. Following are the prominent causes of deforestation:
- **Shifting cultivation**: It is a practice of clearing a patch of land by burning and left abandoned to recover its fertility.
- **Infrastructure expansion**: It can be for construction of highways, industries, real estates, communication line, urban outgrowth.

DEFORESTATION

- **Forest fire**: It can be of natural cause (high atmospheric pressure and low humidity) or man-made cause (deliberate firing by local inhabitants, discarded cigarettes, electric spark and mining).
- **Logging**: It is a process of cutting and processing trees in order to meet the requirements of fuel, fiber, timber, pulp, latex and rubber etc.
- **Large-scale agriculture and overgrazing**: Burgeoning population demands for more food (crops and livestock) which in turn encroaches forest land.

DEFORESTATION

EFFECTS OF DEFORESTATION:

Aggravation of Global warming:	• **Through the released carbon dioxide.** • **Forest is a great carbon sink which sequesters as much as 45% of carbon stored on land.** • **Some 420 million hectares of world's forest have been lost since 1990 (The State of the World's Forests-FAO).**
Disturbance of hydrological cycle	• Causes immediate lowering of ground water level and reduction of precipitation (may lead to drought). • Rapid runoff (may lead to flood).
Loss of biodiversity	• Eighty percent of the world's land-based species live in forests. • Land degradation and soil erosion may lead to food insecurity. • Reduces the ability of forests to provide essential services.
Social issues	• Loss of livelihood of tribals and other forest dwellers • 1.6 billion population has been affected due to forest degradation and deforestation (IUCN).

DESERTIFICATION

- Desertification refers to the **persistent degradation of dryland ecosystems by climatic variations and human activities**.
- It occurs on **all continents (except Antarctica)** and affects the livelihoods of millions of people, including a large proportion of the poor in drylands.
- Climatic variations and Human activities can be regarded as the two main causes of desertification. Removal of the natural vegetation cover by taking too much fuel wood, agricultural activities in the vulnerable ecosystems of arid and semi-arid areas, which are thus strained beyond their capacity.

DESERTIFICATION

- **Desertification in India**: About 29.7 per cent of the country's land in that year became degraded, according to Desertification and Land Degradation Atlas of India that was published in June 2021 by the Space Applications Centre (SAC), Ahmedabad.
- Around 23.7% of the area undergoing desertification/ land degradation with respect to total geographic area of the country was contributed by Rajasthan, Maharashtra, Gujarat, Karnataka, Ladakh, Jharkhand, Odisha, Madhya Pradesh and Telangana.

DESERTIFICATION

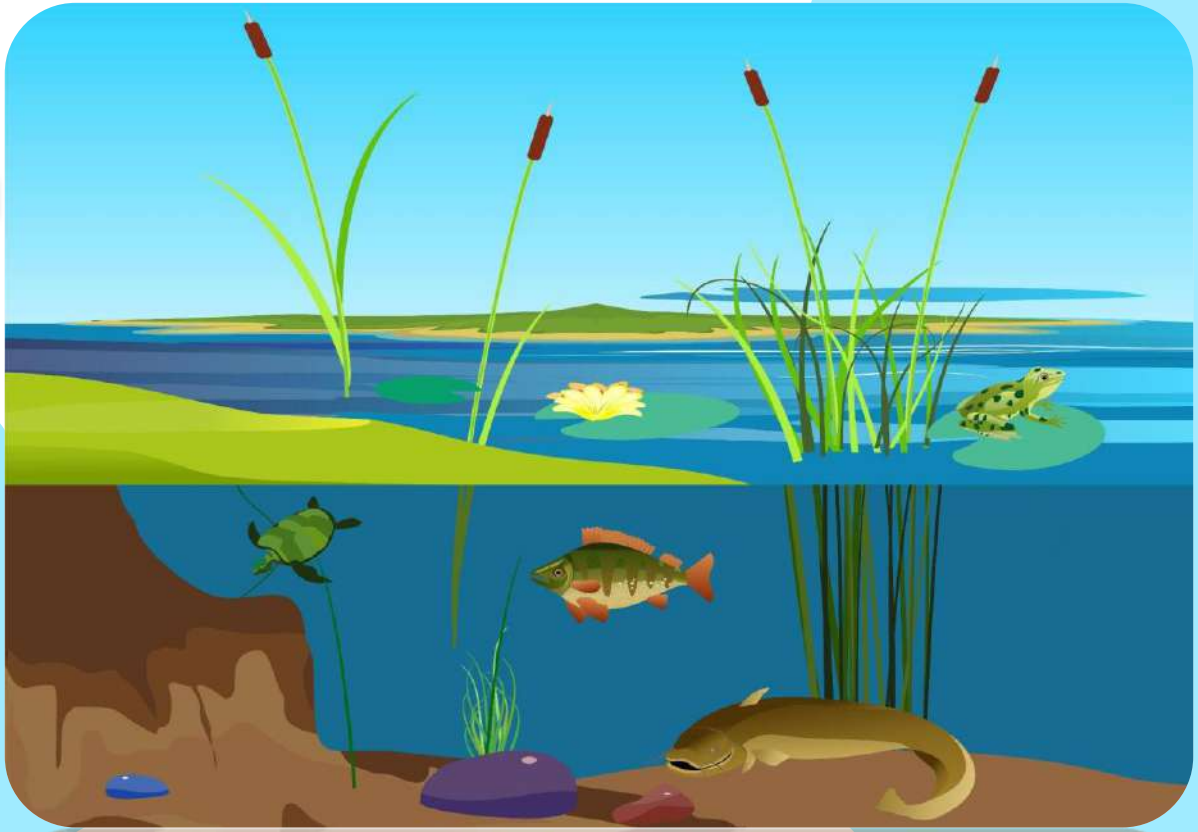
- **Mitigation measures:**
  - **India is a signatory to the UNCCD**. India is working hard to achieve its national commitment on Land Degradation Neutrality (LDN) (SDG 15.3) and aims to restore 26 million hectares of degraded land by 2030.
  - Delhi Declaration of 2019: signed by 14th CoP of the UNCCD, called for better access and stewardship over land, and emphasized gender-sensitive transformative projects.

DESERTIFICATION

- **Mitigation measures:**
- World Day to Combat Desertification and Drought was observed on June 17th. Theme: “Restoration. Land. Recovery. We build back better with healthy land”
- **ISRO (Indian Space Research Organization):** published Desertification and Land Degradation Atlas to provide information about the increasing Land Degradation and Desertification in recent years.

DESERTIFICATION

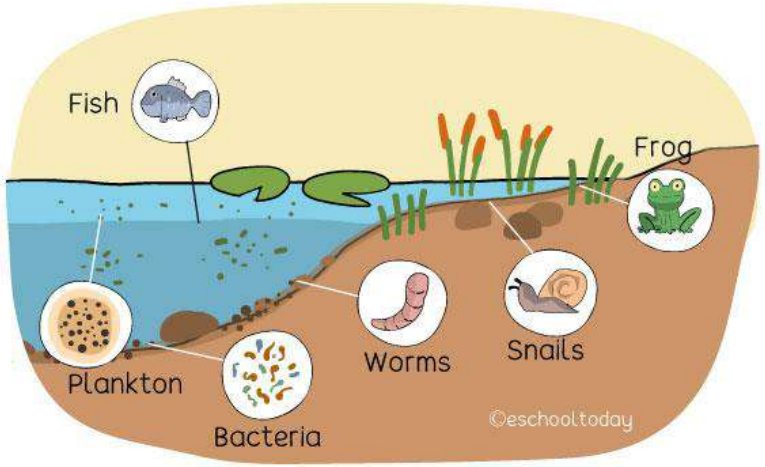
Land Degradation Neutrality (LDN)	• **LDN is a condition where further land degradation (loss of productivity caused by environmental or human factors) is prevented and already degraded land can be restored.** • **LDN has been defined by the Parties to the Convention as: A state whereby the amount and quality of land resources, necessary to support ecosystem functions and services and enhance food security, remains stable or increases within specified temporal and spatial scales and ecosystems.**
The Bonn Challenge	• The Bonn Challenge is a global goal to bring 150 million hectares of degraded and deforested landscapes into restoration by 2020 and 350 million hectares by 2030. • Launched by the Germany and IUCN in 2011, the Challenge surpassed the 150-million-hectare milestone for pledges in 2017.
Great Green Wall:	• Initiative by Global Environment Facility (GEF), where eleven countries in Sahel-Saharan Africa have focused efforts to fight against land degradation and revive native plant life to the landscape.



AQUATIC ECOSYSTEM

Aquatic Ecosystem

- Ecosystems consisting of water as the main habitat are known as aquatic ecosystems. Aquatic ecosystems are classified based on their salt content.



CLASSIFICATION OF AQUATIC ECOSYSTEMS BASED ON SALT CONTENT (PPT)

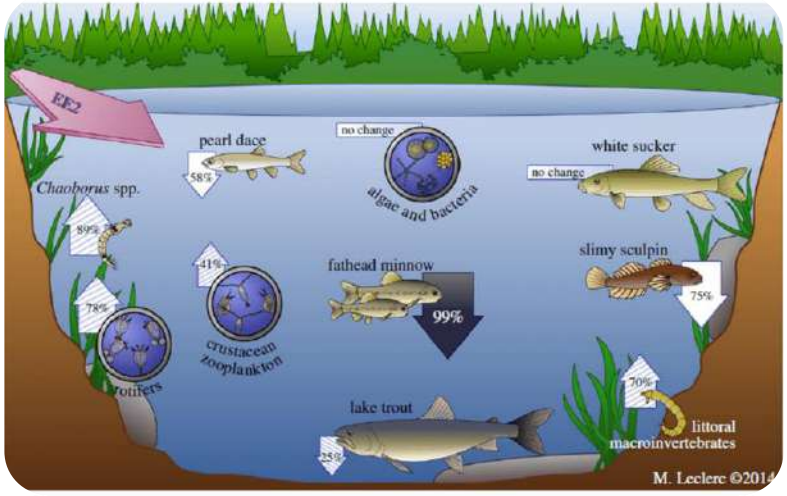
Freshwater Ecosystems	Marine Ecosystems	Brackish Water Ecosystems
Less than 5 ppt	35 ppt or above	5 to 35 ppt
E.g. Lakes, ponds, springs, rivers	E.g. Seas, oceans	E.g. Estuaries, mangroves

AQUATIC ORGANISMS

Neuston	Periphyton	Plankton	Nekton	Benthos
Unattached	Attached to stems	Locomotive power	Swimmers	Attached to bottom
Live at air-water interface	Live submerged in water	Live submerged in water	Live under water. Large & powerful	Live at bottom of water mass
E.g. Floating plants	E.g. Sessile algae	E.g. Algae, crustaceans	E.g. All sea animals	E.g. Sea stars, Sea urchins

AQUATIC ORGANISMS

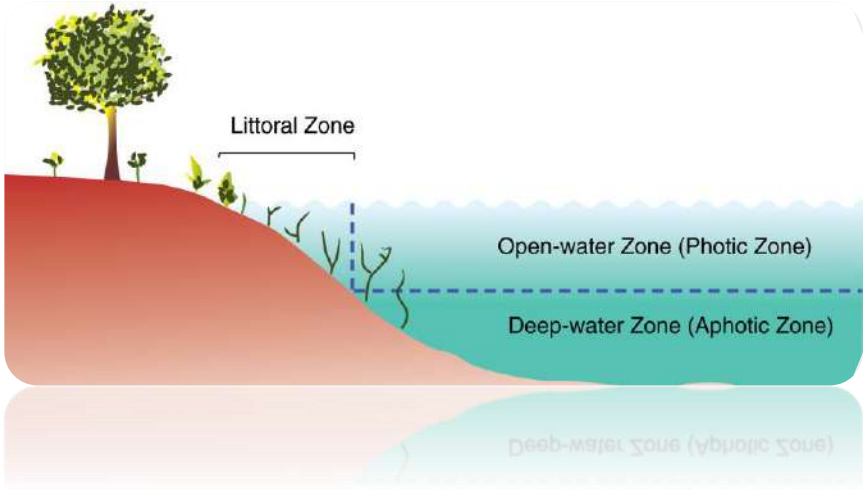
- **Phytoplankton**: also known as microalgae, are similar to terrestrial plants in that they contain chlorophyll and require sunlight in order to live and grow. Most phytoplankton are buoyant and float in the upper part of the ocean, where sunlight penetrates the water.
- **Zooplanktons**: Small floating or weakly swimming organisms that drift with water currents and, with phytoplankton, make up the planktonic food supply upon which almost all oceanic organisms are ultimately dependent. These are of various types:-
  - **Holoplankton**: Those which remain for their entire life cycle as planktons.
  - **Meroplankton**: Most of the benthos and much of the nekton in larval stages join the plankton assemblage for varying periods.



FACTOR INFLUENCING THE PRODUCTIVITY OF AQUATIC ECOSYSTEMS

Sunlight

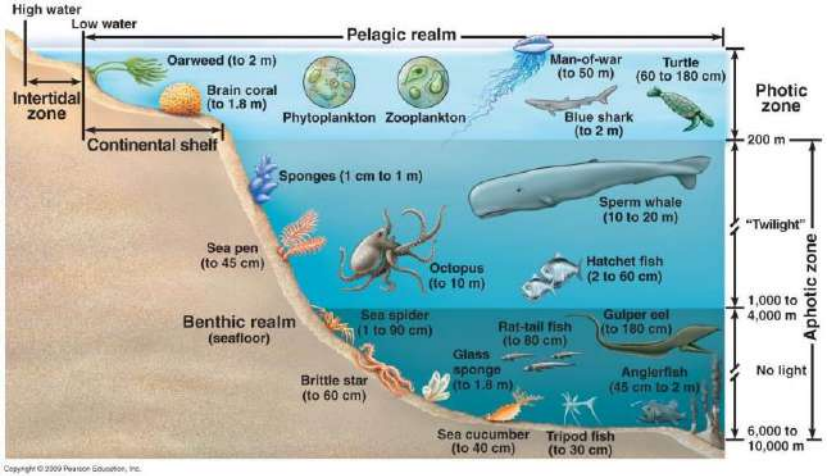
- To sustain photosynthetic ability sunlight penetration is of utmost importance. The depth to which sunlight penetrates determines the extent of vegetation and its distribution. Based on the vertical penetration of sunlight aquatic ecosystems are classified into two zones: -



FACTOR INFLUENCING THE PRODUCTIVITY OF AQUATIC ECOSYSTEMS

Sunlight

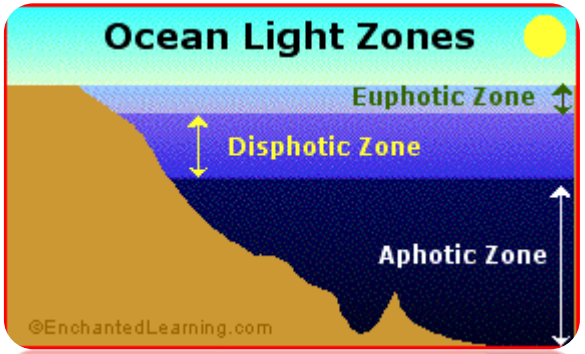
- **Photic zone:** It is the top layer, nearest to the surface of the ocean and is also called the sunlight layer. In this zone enough, light penetrates the water to allow photosynthesis. Ninety percent of marine life lives in the photic zone, which is approximately two hundred meters deep. This includes phytoplankton (plants), including dinoflagellates, diatoms, cyanobacteria, coccolithophorids, and cryptomonads.



FACTOR INFLUENCING THE PRODUCTIVITY OF AQUATIC ECOSYSTEMS

Sunlight

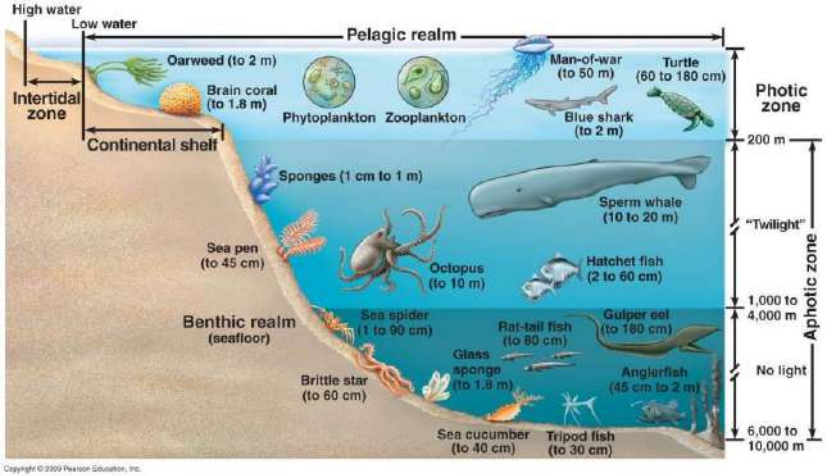
- **Aphotic zone:** The aphotic zone is the portion of the ocean that does not receive sunlight. Sunlight does not penetrate this zone. Absence of photosynthetic activity and hence no plant plants are found, only respiration activity takes place. Most food in this zone comes from dead organisms sinking to the bottom of the lake or ocean from overlying waters.



FACTOR INFLUENCING THE PRODUCTIVITY OF AQUATIC ECOSYSTEMS

Temperature and Oxygen concentration:

- Water temperature exerts a major influence on biological activity and growth, has an effect on water chemistry, can influence water quantity measurements, and governs the kinds of organisms that live in water bodies.
- Warm water holds less dissolved oxygen than cool water, and may not contain enough dissolved oxygen for the survival of different species of aquatic life. Some compounds are also more toxic to aquatic life at higher temperatures.



FACTOR INFLUENCING THE PRODUCTIVITY OF AQUATIC ECOSYSTEMS

Turbidity of the water:

- Turbidity affects the growth rate of algae (micro-aquatic plants) and other aquatic plants in streams and lakes because increased turbidity causes a decrease in the amount of light for photosynthesis.
- Turbidity can also increase water temperature because suspended particles absorb more heat.

FACTOR INFLUENCING THE PRODUCTIVITY OF AQUATIC ECOSYSTEMS

Transparency:

- Transparency affects the extent of light penetration.
- Suspended particulate matters such as clay, silt, phytoplankton, etc. make the water turbid.
- Consequently, it limits the extent of light penetration and the photosynthetic activity in a significant way.

FRESHWATER ECOSYSTEMS

- It emphasizes mainly the study of the relationship between organisms and the freshwater environment.
- **Limnology**: Study of all aspects(physical, chemical, geological and biological) of freshwater.
- Freshwater habitats occupy a relatively small portion of the earth's surface as compared to marine and terrestrial habitats.

FRESHWATER ECOSYSTEMS

- **Two types of freshwater ecosystems can be found:-**

1. **Standing water or Lentic** : Such as lakes, ponds, swamps, bog etc
2. **Running water or Lotic :** Such as river, stream, spring etc

- Temperature in freshwater ecosystems does not show much range of variations, which is due to several unique properties of water. Although temperature in such habitats shows less variations, it is a major limiting factor in distribution of organisms, as aquatic organisms generally have narrow tolerances i.e. stenothermal.

LAKE ECOSYSTEM

- Lake is body of water that lives in a hollow in the earth's surface and is entirely surrounded by land. Algae , bacteria, fungi, aquatic phanerogams, crustaceans, aquatic insects, molluscs and fish are common components of flora and fauna.

LAKE ECOSYSTEM

Lake born from geological or geomorphical process

Receive surface run-off water or ground discharge

Chemicals & minerals mix up

Lake begins to age

LAKE ECOSYSTEM

WINTERKILL PHENOMENA

- Snow cover of ice on water body can effectively cut off light, plunging the waters into darkness. Hence photosynthesis stops but respiration continues. Thus, in shallow lakes, the oxygen gets depleted. Fish die, but we won't know it until the ice melts and we find floating fish. This condition is known as winterkill.

LAKE ECOSYSTEM

Lakes classified on physiography aspects:	• **Natural Lakes** • **Artificial Lakes** • **Oxbow lake (Formed by river deposits)** • **Crater Lake (due to volcanic activity)**
Lakes classified on the basis of salt content:	• Freshwater • Brackish • Saline

LAKE ECOSYSTEM

Type of lake: Oligotrophic viz-a-viz Eutrophic Lakes

Parameter	Oligotrophic	Eutrophic
Aquatic plant production	Low	Eliminated due to Eutrophication
Aquatic animal production	Low	Eliminated due to Eutrophication
Aquatic plant nutrient flux	Low	High
Oxygen in the hypolimnion (bottom layer)	Present	Absent
Depth	Tend to be deeper	Tend to be shallower

LAKE ECOSYSTEM

Type of lake: Oligotrophic viz-a-viz Eutrophic Lakes

Parameter	Oligotrophic	Eutrophic
Water quality for domestic & industrial uses	Good	Poor
Total salts or conductance	Usually lower	Sometimes higher
Number of plant and animal species	Many	Many

"**Turn-over cycle of the lake**": extent to which the water is mixed and the number of times during the year.

LAKE ECOSYSTEM

Mechanisms For Cleaning Of Lakes:

- Deep water abstraction, Flushing, Algae skimming, Plants to suck nutrients, Harvest fish & macrophytes, Sludge removal, Filters for algae removal.

LAKE ECOSYSTEM

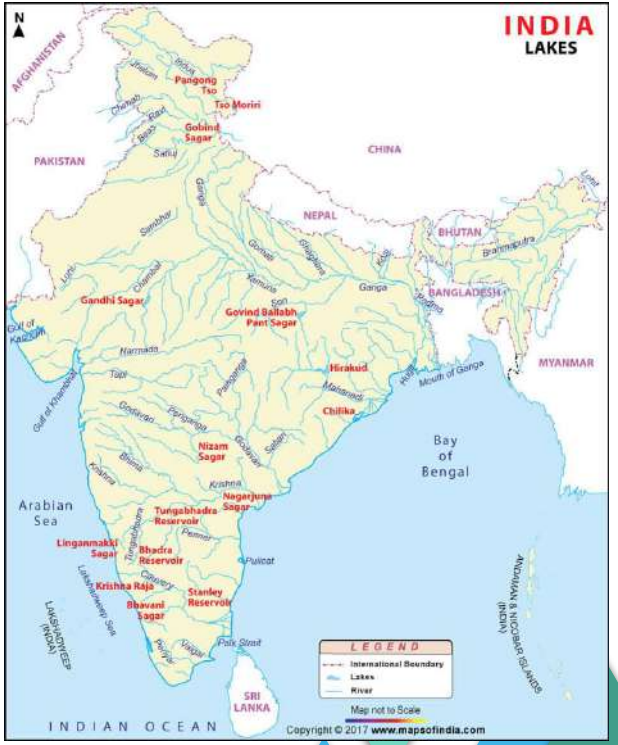
Lakes in India recently in news:

- **Chilika Lake in Odisha**: Asia's largest brackish water lake, was once part of the Bay of Bengal, a study by the marine archeology department of the National Institute of Oceanography (NIO), Goa, has found.
- **Ameenpur Lake:** First Biodiversity Heritage Site: Ameenpur Lake gets the status of the first Biodiversity Heritage Site in the country under the biodiversity act, 2002. It is an ancient man-made lake in a western part of Telangana.

LAKE ECOSYSTEM

Lakes in India recently in news:

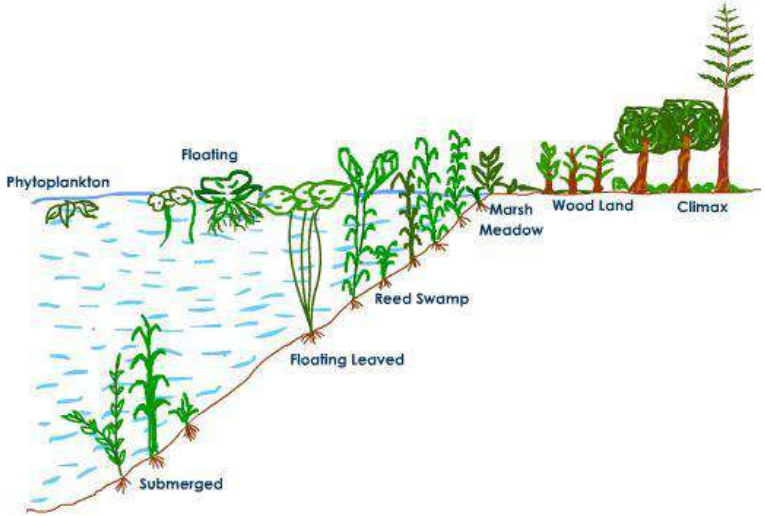
- **Largest freshwater lake in India**: Wular Lake, Jammu and Kashmir
- **Largest Saline water lake in India**: Chilka Lake, Orissa
- **Highest lake in India (Altitude)**: Cholamu lake, Sikkim
- **Longest Lake in India**: Vembanad lake, Kerala
- **Largest Artificial Lake in India**: Govind Vallabh Pant Sagar (Rihand Dam)
- **Dhebar Lake**: India's second-largest artificial lake, after Govind Ballabh Pant Sagar. It is located in the Udaipur District of Rajasthan.



LAKE ECOSYSTEM

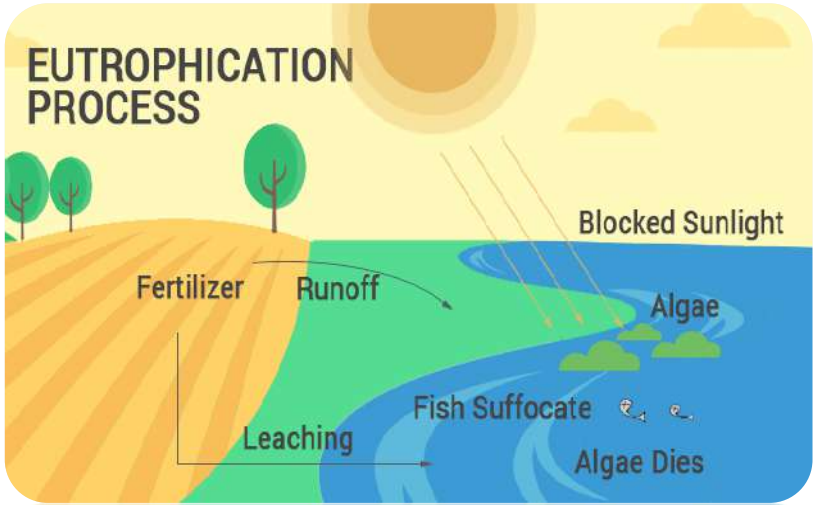
HYDROSERE

- It is a succession occurring in the aquatic environment. Hydrosere, originating in a pond, starts with the colonization of some phytoplanktons which form the pioneer plant community and finally terminates into a forest, which is a climax community together with their chief components of vegetation.



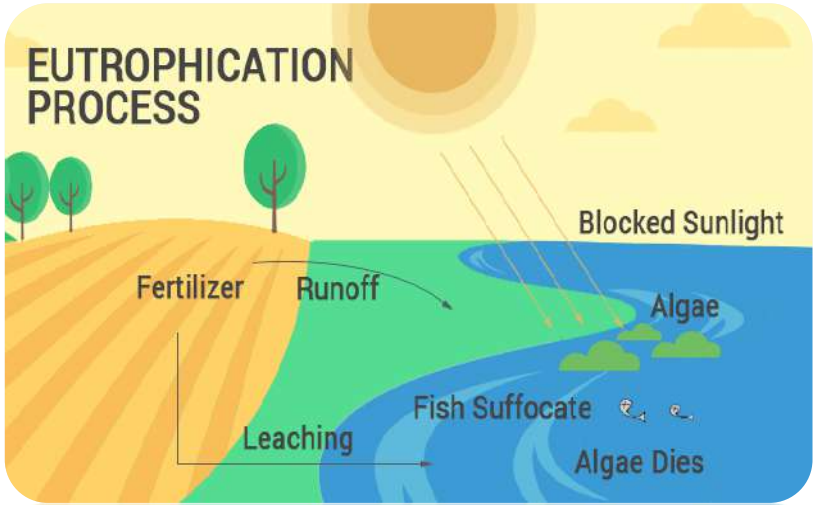
EUTROPHICATION

- **Eutrophication**: Due to addition of domestic waste (sewage), phosphates, nitrates etc, from wastes or their decomposition products in water bodies, they become rich in nutrients, especially phosphate and nitrate ions. With the passage of these nutrients through such organic wastes, the water bodies become highly productive or eutrophic.
- **Natural eutrophication**: The nutrient-enrichment of the lakes promotes the growth of algae, aquatic plants and various fauna.

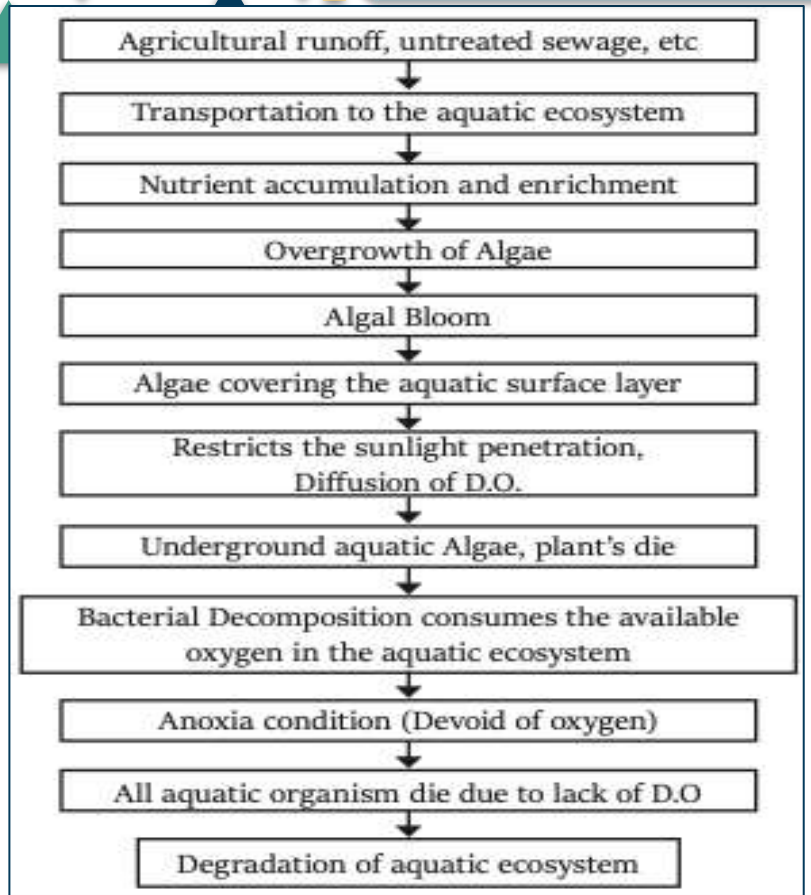


EUTROPHICATION

- **Cultural eutrophication:** Similar nutrient enrichment of lakes at an accelerated rate is caused by human activities (discharge of waste- waters or agricultural runoff) and the consequent ageing.
- **Effects:** Toxicity, new species invasion, decreased biodiversity, decrease in species richness and diversity, Toxic Aerosols in micro environment.
- **Policies & Mitigation For Curbing Eutrophication:** Restoration and preservation of ecosystems, Create buffer zones for sediments to collect, Nitrogen testing, Industrial waste treatment and efficiency, Reduce livestock densities, Reduce non-point pollution.



EUTROPHICATION



Point Source	Non-Point Source
• **Attributable to one influence** • **Travels directly from source to water** • **Easy to regulate**	• Multiple unknown sources • Difficult to regulate

EUTROPHICATION

Biological Oxygen Demand (BOD)	Chemical Oxygen Demand (COD)
• **It is the amount of water required for the biological oxidation by microbes in any unit volume of water.** • **BOD values generally approximate the amount of oxidizable organic matter, and is therefore used as a measure of degree of water pollution and waste level.** • **Thus, mostly BOD value is proportional to the amount of organic waste present in water.**	• It is an indicator of water or effluent quality which measures oxygen demand by chemical (as distinct from biological) means using potassium dichromate as the oxidizing agent. • Oxidation takes 2 hours and the method is thus much quicker than a 5- day BOD assessment. • The BOD:COD ratio is fairly constant for a given effluent.

ALGAL BLOOM

- Algal bloom is rapid increase or accumulation in the population of algae in freshwater or marine water systems.
- Four regions of India have been identified as bloom hotspots viz. a) North Eastern Arabian Sea b) coastal waters off Kerala c) Gulf of Mannar and d) coastal waters of Gopalpur.
- Blooms can be due to a number of reasons. Two common causes are nutrient enrichment and warm waters.

ALGAL BLOOM

- **Harmful algal blooms, or HABs**, occur when colonies of algae — simple plants that live in the sea and freshwater — grow out of control and produce toxic or harmful effects on people, fish, shellfish, marine mammals and birds. The human illnesses caused by HABs, though rare, can be debilitating or even fatal.

ALGAL BLOOM

- **Negative aspects of algal blooms:**
  - O2 level drops due to decomposition of dead algae and hence suffocates the living organisms around.
  - Potent neurotoxins that are produced can enter the food web thus reaching animals, fish and even humans.
  - Some toxins become airborne and people tend to breathe aerosolized HAB toxins near the beach.

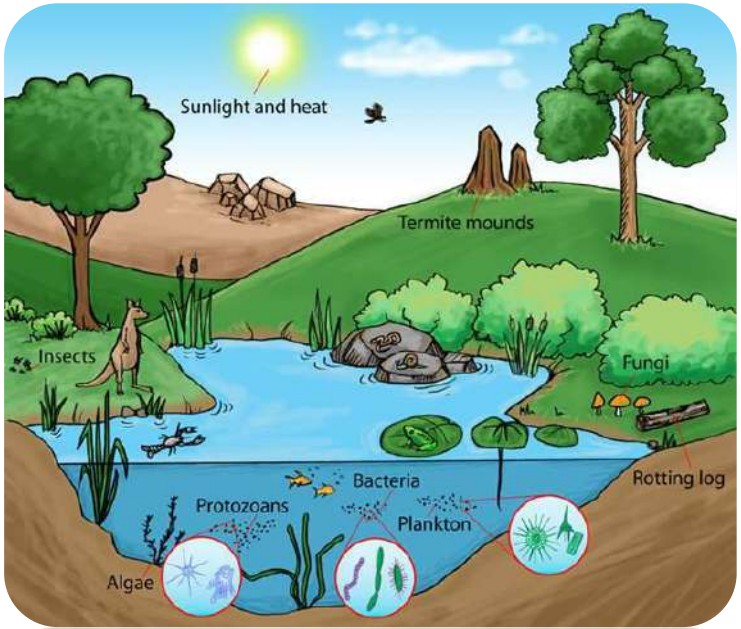
ALGAL BLOOM

Dead Zones

- Dead zones are areas of water bodies **where aquatic life cannot survive because of low oxygen levels**. Dead zones are generally **caused by significant nutrient pollution**, and are primarily a problem for bays, lakes and coastal waters since they receive excess nutrients from upstream sources.
- The majority of the world's dead zones are along the eastern coast of the US, and the coastlines of the Baltic States, Japan and the Korean Peninsula. Notable examples include the Gulf of Mexico and the Baltic Sea. The Gulf of Mexico has a seasonal hypoxic zone that forms every year in late summer.

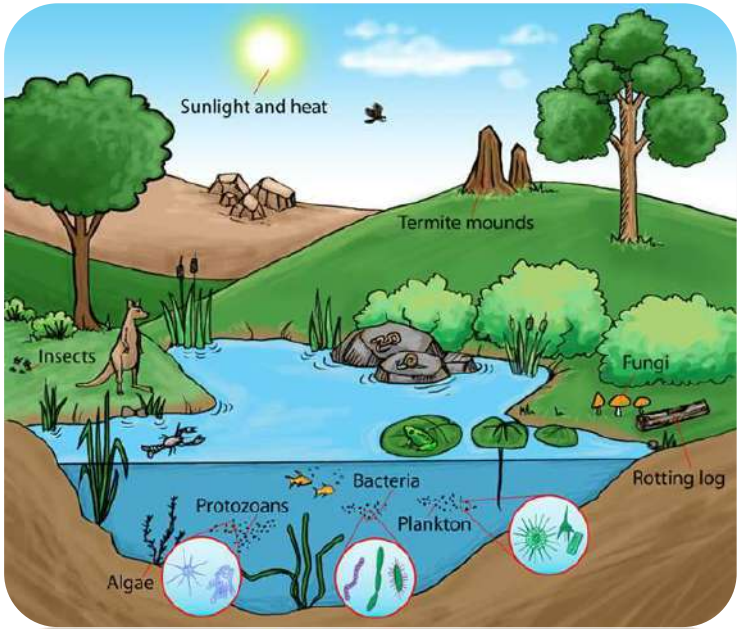
WETLAND ECOSYSTEM

- **Ramsar Convention defines wetland as** - “areas of marsh, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water, depth of which at low tides, does not exceed 6 meters.
- Wetlands are **areas intermediate in character between deepwater and terrestrial habitats**, also transitional in nature, and often located between them.



WETLAND ECOSYSTEM

- India became a party to the ‘Convention on Wetlands’, also known as the **Ramsar Convention** on 1st February 1982 and has since then designated about 47 wetlands covering an area of 10,90,230 hectares under the List of Wetlands of International Importance which includes 5 sites designated during 2020-2021.
- World Wetland Day - 2nd February
- Presently, **India stands first in South Asia and third in Asia** in terms of number of designated sites.



WETLAND ECOSYSTEM

Functions of wetlands	• **Habitat to various species, sediment filtration, water purification, pollution control, disaster management, nutrients recycling, ground water recharge, prevents erosion, species diversity, stabilize local climate, natural heritage.**
Reasons for depletion	• Land use changed for agriculture, sand removal from beds, overgrazing, deforestation, pollution, domestic waste, climate change, agricultural runoff, hazardous industrial waste, aqua culture.
Mitigation	• Eutrophication abatement, environmental awareness, afforestation, soil conservation, weed control, artificial regeneration, wildlife conservation, heritage management.

WETLAND ECOSYSTEM

Ramsar Criteria For Wetland Identification

- Sites containing rare or unique wetland types.
- Criteria based on species and ecological communities
- Specific criteria based on water birds: If it supports 20,000 or more & if it supports 1% individuals of a single species.
- Specific criteria based on fish.
- Ramsar Convention works with the collaboration of: International Union for Conservation of Nature **(IUCN),** Birdlife International, International Water Management Institute **(IWMI),** Wetlands International, Wildfowl & Wetlands Trust (**WWT**), WWF International.

WETLAND ECOSYSTEM

Ramsar Convention

- India signed in Ramsar, Iran, in 1971
- Sole treaty for particular ecosystem.
- **Includes:** lakes, rivers, estuaries, swamps, mangroves, coral reefs, oasis, peatlands, wetlands, deltas, tidal flats, fish ponds, rice paddies, reservoirs and salt pans.

WETLAND ECOSYSTEM

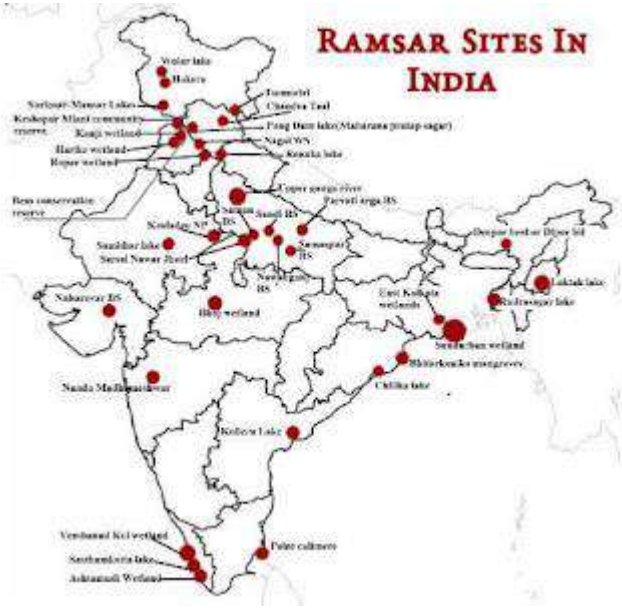
Lakes Vs Wetlands

Lakes	Wetlands
Acc. to NLCP - minimum depth 3 mts	Acc. To NLCP - minimum depth < 3 mts
Origin from multiple sources	Origin due to Geomorphic processes
Minor water level changes	Major water level changes
Small pelagial ratio	Large pelagial ratio
No waste treatment occurs	Waste treatment occurs
Low productivity	High productivity
Low biodiversity	High biodiversity
Oligo trophic status	Eutrophic status
Does not manage flood control	Very significant in managing floods
Thermal stratification	No Thermal stratification
Management objectives - Control of eutrophication and High-Water quality	Biodiversity conservation Specific Functions

WETLAND ECOSYSTEM

Important facts about Ramsar Sites in India:

- Sunderban is the largest while Renuka is the smallest Ramsar site in India.
- Chilika lake is the oldest Ramsar site in India. Irrawaddy dolphin (Endangered) is the flagship species of Chilika lake.
- National Waterway 3 passes through Ashtamudi Wetland.
- Beas Reserve hosts the only known population in India of the endangered Indus River dolphin (Endangered).
- Recently, the colour of Lonar lake water had turned pink due to a large presence of the salt-loving “haloarchaea” microbes.



WETLAND ECOSYSTEM

Important facts about Ramsar Sites in India:

- Wular lake is the largest freshwater lake in India.
- Loktak Lake is the largest freshwater lake in the north-eastern region of the country and Keibul Lamjao national park (only floating national park in the world) floats over it.
- Nalsarovar Bird Sanctuary hosts a significant population of Indian Wild Ass (Near Threatened)
- The Sambhar Salt Lake is India's largest inland saltwater lake.
- Vembenad Kol Wetland is the second-largest Ramsar Site in India after Sundarbans.

WETLAND ECOSYSTEM

- A **register of wetland sites on the List of Wetlands of International Importance** where changes in ecological character have occurred, are occurring, or are likely to occur as a result of technological developments, pollution or other human interference.

Montreux Record:

- It is maintained as part of the Ramsar List.
- **Montreux Record Sites in India:**
  - **Chilika Lake, Orissa:** Placed in 1993 due to choking at mouth. Removed in 2002. Won Ramsar Wetland Conservation Award for 2002.
  - **Loktak Lake, Manipur:** Places in 1993 due to deforestation in area & pollution.
  - **Keoladeo National Park**, Rajasthan: Placed in 1990 due to water shortage and Unbalanced grazing around.

Montreal Protocol

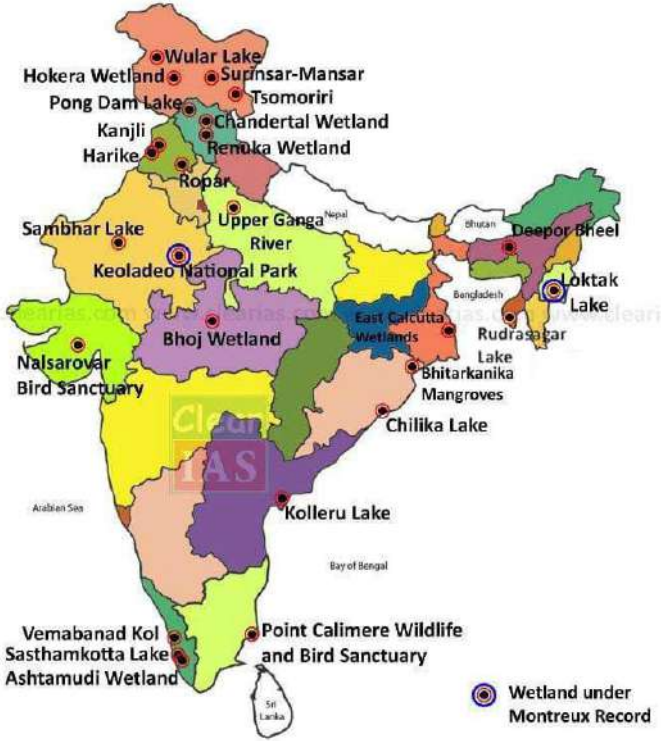
- An **international treaty designed to protect the ozone** layer by phasing out the production of numerous substances that are responsible for ozone depletion.
- It was agreed on 16 September 1987, and entered into force on 1 January 1989.

WETLAND ECOSYSTEM

Recent Ramsar Sites in India:

- **Haiderpur Wetland in Uttar Pradesh** has been added as the **47th Ramsar Site in December 2021**. It is a human-made wetland formed in 1984 and is located within the boundaries of Hastinapur Wildlife Sanctuary.
- **Four new sites have been added to the list of Ramsar Sites in India in August 2021. These are:**

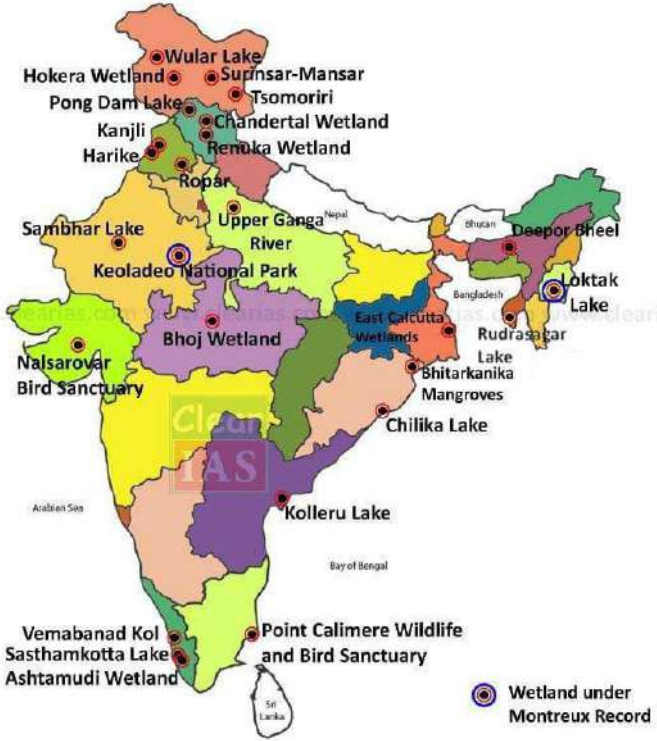
1. Sultanpur National Park – Gurugram, Haryana
2. Bhindawas Wildlife Sanctuary – Jhajjar, Haryana
3. Thol Lake Wildlife Sanctuary – Near Ahmedabad, Gujarat
4. Wadhvana Wetland – Vadodara, Gujarat



WETLAND ECOSYSTEM

- **In 2020, the following sites were added to the Ramsar Sites of India List:**

1. The Tso Kar Wetland Complex was added to the list of Ramsar sites in India. This includes the high-altitude wetland complex of two connected lakes, Startsapuk Tso and Tso Kar, in Ladakh.
2. Maharashtra: Lonar Lake
3. Agra (Uttar Pradesh): Sur Sarovar also called, Keetham Lake
4. Uttarakhand: Asan Barrage
5. Bihar: Kanwar Lake or Kabal Taal
6. Kolkata: Sunderban Reserve Forest (Sundarban Wetlands)



WETLAND ECOSYSTEM

Cities4Forests global campaign: It works closely with cities around the world to connect with forests, emphasizes the importance of wetlands and their multiple benefits to help combat climate change and protect biodiversity in cities

WETLAND ECOSYSTEM

Wetlands (Conservation and Management) Rules, 2017:

- **Nodal authority:** Wetlands Authority within a state is the nodal authority for all wetland-specific authorities in a state/UT for the enforcement of the rules.
- **Prohibited activities:**
  - Setting up any industry and expansion of existing industries.
  - Dumping solid waste or discharge of untreated wastes and effluents from industries and any human settlements.
  - Encroachment or conversion for non-wetlands uses.

WETLAND ECOSYSTEM

Wetlands (Conservation and Management) Rules, 2017:

- **Integrated Management Plan**: The guidelines recommend that the state/UT administration prepare a plan for the management of each notified wetland by the respective governments.
- **Penalties**: Undertaking any prohibited or regulated activities beyond the thresholds (defined by the state/UT administration) in the wetlands or its zone of influence, will be deemed violations under the Wetlands Rules. Violation of the Rules will attract penalties as per the Environment (Protection) Act, 1986.

MARINE (OCEAN) ECOSYSTEM

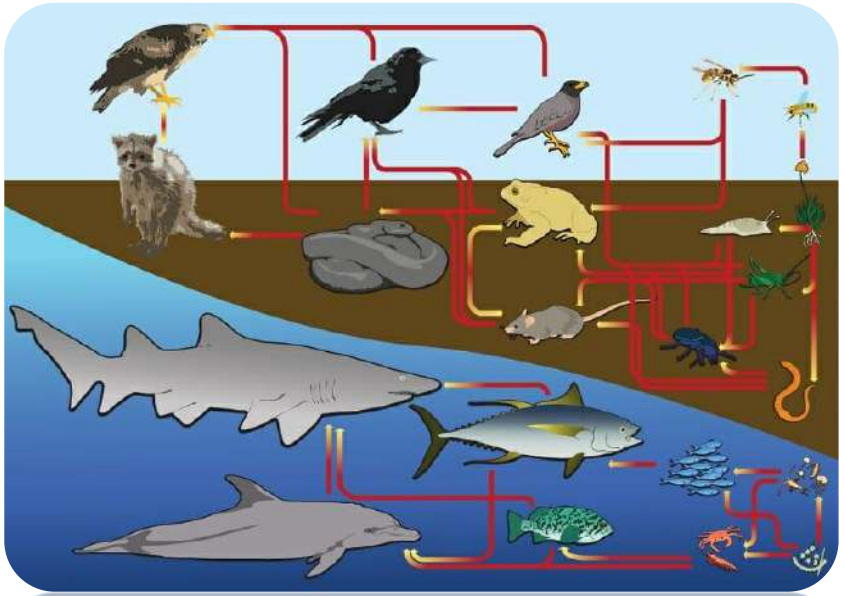
- Marine environments as compared with fresh water, **appear to be more stable in their chemical composition** due to being saline and moreover other such physio-chemical aspects such as dissolved oxygen content, light and temperature are also different. The biotic components of an ocean ecosystem are of the following orders:

MARINE (OCEAN) ECOSYSTEM

- **Producers:**
  - Autotrophs responsible for trapping radiant energy of the sun with the help of their pigments.
  - They show distinct zonation at different depths of water in the sea.
  - Examples are mainly phytoplankton and macroscopic sea weeds such as brown and red algae.

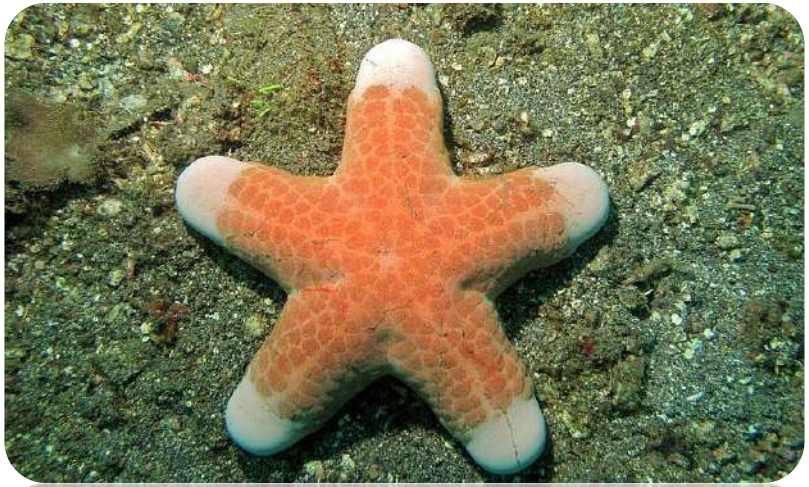
MARINE (OCEAN) ECOSYSTEM

- **Consumers:**
  - All heterotrophic macroconsumers being dependent for their nutrition on the producers.
  - **Primary consumers**: Herbivores that feed directly on producers and are chiefly crustaceans, molluscs, fish etc.
  - **Secondary consumers**: These are carnivorous fishes feeding on herbivores.
  - **Tertiary consumers**: Carnivorous fishes that feed on other carnivores or secondary consumers.



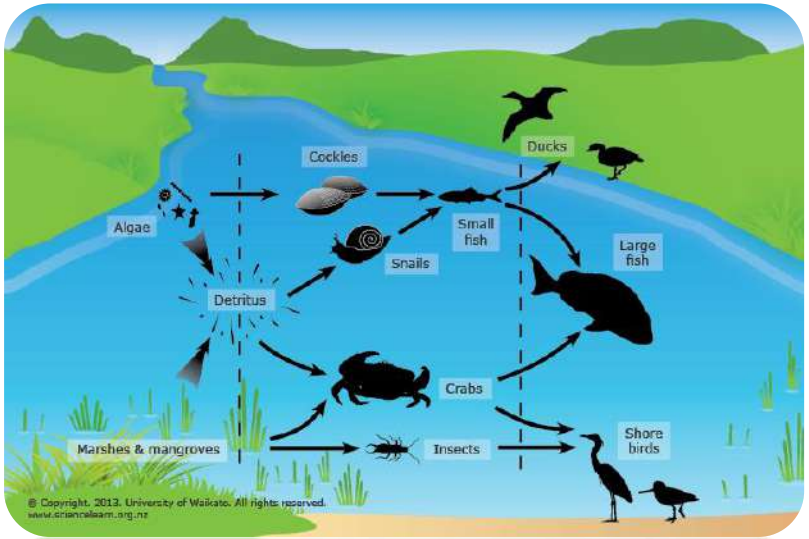
MARINE (OCEAN) ECOSYSTEM

- **Decomposers:**
  - The microbes active in the decay of dead organic matter of producers and macroconsumers are chiefly bacteria and some fungi.



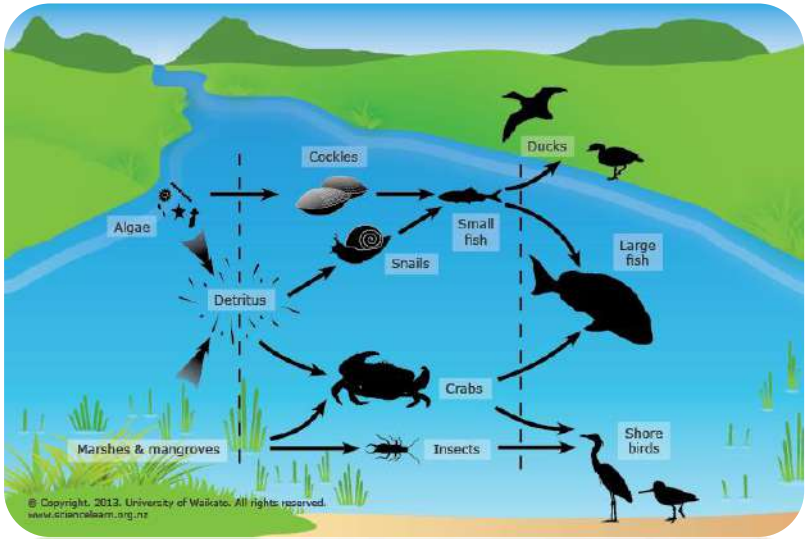
ESTUARINE ECOSYSTEM

- **Areas where river meets the sea (exhibiting gradient in salinity),** resulting in mixture of fresh river water with salty ocean water, subject to tidal variations.
- **Examples of estuaries**: river mouths, coastal bays, tidal marshes and water bodies behind barrier beaches. Thus estuaries are also considered as ecotones between the freshwater and marine habitats.
- **Four major types of estuaries classified by their geology**: drowned river valley, bar-built, tectonic, and fjords.



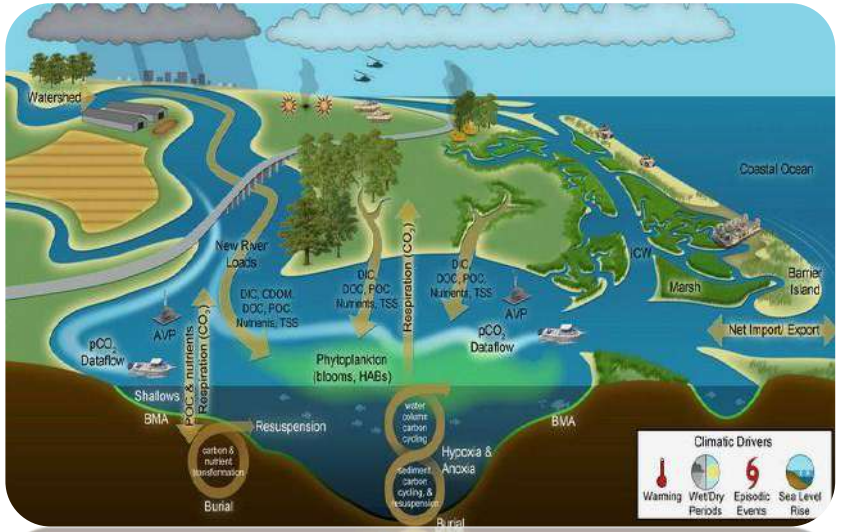
ESTUARINE ECOSYSTEM

- **Conditions required for Estuary Formation**: (1) rising sea level; (2) movement of sand and sandbars; (3) glacial processes; and (4) tectonic processes.
- **Characteristics:** Filter for river water, Traps mud & sands, Semi-enclosed coastal body, Connection with open sea, Salinity range - 0 to 35 ppt, Heavily populated, Little wave action.



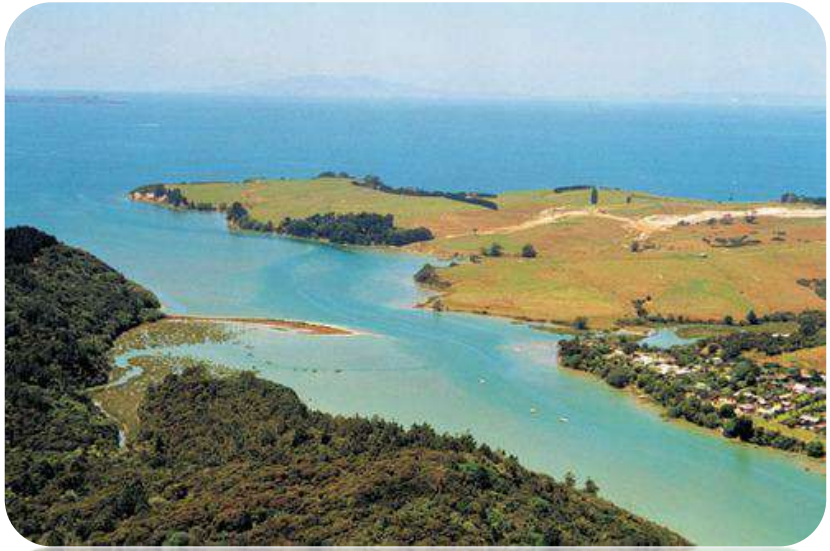
ESTUARINE ECOSYSTEM

- **Benefits of Estuarine ecosystems**: Commercial fishing, Ports and harbours, Travel and tourism, Economic and social benefits, Water purification, Breeding hotspot, Recreational and community benefits, Erosion protection, Stores and recycles nutrients.
- **Biologically most productive region**- receives a high amount of nutrients from fresh and marine water.



ESTUARINE ECOSYSTEM

- **India's major estuaries occur on the east coast** (for example Hooghly estuary). In contrast, **the estuaries on the west coast are smaller**. Two typical examples of estuaries on the west coast are the Mandovi and Zuari estuaries.
- **Estuaries In India:** India has 14 major, 44 medium and 162 minor rivers. Major estuaries occur in the Bay of Bengal region. West- flowing rivers are generally fast-moving ones giving rise to formation of estuaries.



ESTUARINE ECOSYSTEM

- **Lagoons Viz-a-Viz estuaries**: In estuaries, the water flows fast and strong, while in lagoons the water is more shallow and flows sluggishly. Estuaries are usually deeper than lagoons.
- Communities of estuaries are a **mixture of endemic species and those which come from the sea**. An estuary consists of several basic subsystems linked together by the ebb and flow of water that is driven by the hydrological cycle and the tidal cycle.
- **Issues relating to Indian Estuarine Ecosystems:** Modification of catchment areas, Pollution, Recreation & unsustainable tourism, Increased dredging and shipping, unstainable Land-use pattern, Fishing & aquaculture, Climate change.

MANGROVE ECOSYSTEM

- Mangroves are **tropical trees or shrubs that grow in swampy areas and have tangled roots located above ground, or a tidal swamp** with a number of these types of trees and shrubs.
- **High adaptation to salinity** (Halophytic adaptability) and water logging.
- Most of them produce **special type of branched,** negatively geotropic roots that comes out of the mud surface to encourage the entry of oxygen gas- such roots are called **pneumatophores**.

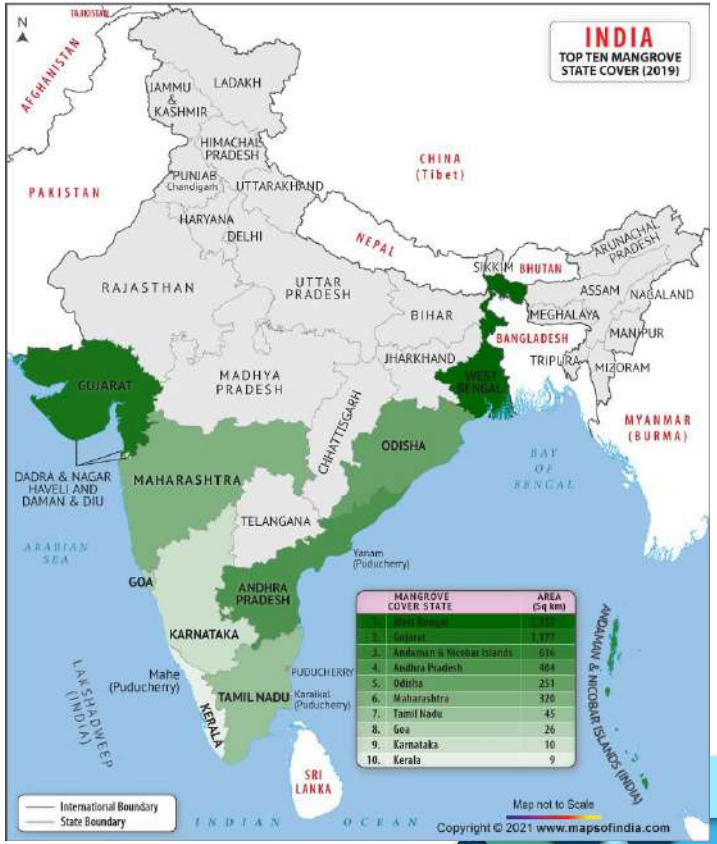
MANGROVE ECOSYSTEM

- Some of the mangrove species show the phenomenon of **vivipary** i.e., germination of seeds before they are shed from the parent plant.
- Adventitious roots, also called **stilt roots.**
- **Examples**: Rhizophora, Sonneratia, Avicennia, Heritiera (Its common names include sunder, sundri, jekanazo and pinlekanazo), etc.
- **Benefits of Mangroves**: Reduce inundation, moderate monsoonal tidal floods, Prevent coastal soil erosion, enhance nutrient recycling, Source of firewood, medicinal plants, edible plants to locals.

MANGROVE ECOSYSTEM

Mangrove in India

- **India houses the largest mangroves of the world -** Sunderbans. It is home to the Royal Bengal Tiger and crocodiles.
- Odisha's Bhitarkanika mangroves are the 2nd largest in the Indian subcontinent.
- **Godavari-Krishna deltaic regions of Andhra Pradesh**: Set in the eastern coast of India, the Godavari-Krishna mangroves lie in the deltas of the Godavari and Krishna rivers and extend from Odisha to Tamil Nadu. The forest is under protection for Calimere Wildlife and Pulicat Lake.
- In **Gujarat** they are found in the Gulf of Kachchh and Kori creek.
- **Andaman & Nicobar Islands** possess diverse undisturbed mangrove flora - Andaman's Baratang Island.



MANGROVE ECOSYSTEM

Advantages of Mangrove Ecosystem

- They perform important ecological functions like nutrient cycling, hydrological regime, coastal protection, fish-fauna production, etc
- Mangroves act as shock absorbers. They reduce high tides and waves and help prevent soil erosion and protect shorelines from storm, hurricane winds, waves, and floods
- Prevent erosion by stabilizing sediments with tangled root systems
- Provide nursery habitat for many commercial fish and provide livelihood opportunities to coastal communities.

MANGROVE ECOSYSTEM

Mangrove Cover as per the recent State of Forest Report, India

- Mangrove cover in the country has **increased by 54 sq. km (1.10%)** as compared to the previous assessment.
- Current assessment shows that mangrove cover in the country is 4,975 sq. km, which is **0.15% of the country's total geographical area.**
- **West Bengal has 42.45% of India's mangrove cover**, followed by Gujarat 23.66% and A&N Islands 12.39%.
- **Gujarat shows a maximum increase** of 37 sq. km in mangrove cover.
- South 24 Parganas district of West Bengal alone accounts for 41.85% mangrove cover of the country

MANGROVE ECOSYSTEM

Mangroves for the Future (MFF)

- MFF is a unique partner-led initiative to promote investment in coastal ecosystem conservation for sustainable development.
- Co-chaired by IUCN and UNDP, MFF provides a platform for collaboration among the many different agencies, sectors and countries which are addressing challenges to coastal ecosystem and livelihood issues.
- The goal is to promote an integrated ocean-wide approach to coastal management and to building the resilience of ecosystem-dependent coastal communities.
- Mangroves are the flagship of the initiative, but MFF is inclusive of all types of coastal ecosystem, such as coral reefs, estuaries, lagoons, sandy beaches, seagrass and wetlands.

CORAL REEFS

- Corals are living animals, which lives in a Symbiotic relationship with ‘zooxanthellae’. Both have a mutual type of relation.
- There are 2 types of corals: Hard and soft - only hard corals build reefs.
- Majority coral reefs are **found in tropical and sub-tropical water,** however there are exceptions of deep-water corals in colder regions.

CORAL REEFS

Zooxanthellae	• **Assist coral in nutrient production through photosynthetic activities.** • **Provide fixed carbon compounds, enhance calcification, mediate elemental nutrient flux.**
Coloration	• Tissues of corals are clear white. • Corals receive coloration from zooxanthellae living within tissues.
Coral Polyp	• Protects zooxanthellae and supplies carbon-dioxide for photosynthesis.

CORAL REEFS

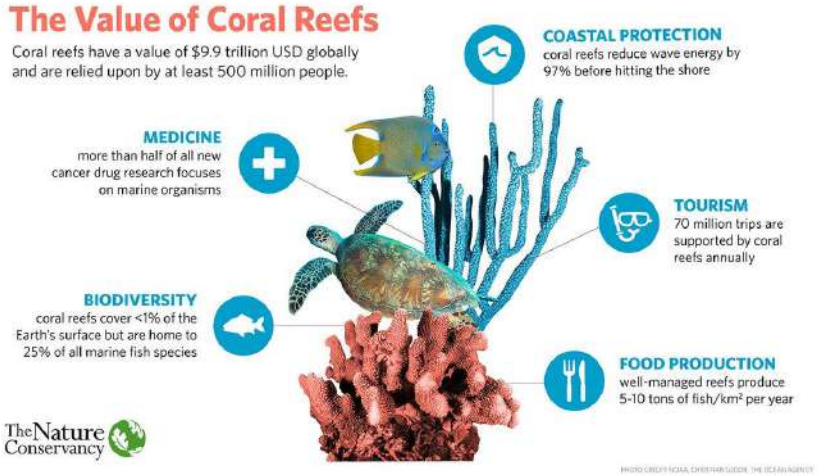
Location And Classification:

Fringe Reefs	Patch Reefs	Barrier Reefs	Atoll
• Most common, contiguous with shore	• Isolated and discontinuous lying shoreward of offshore reef	• Linear offshore structures. Run parallel to coastline. • Water body between reef & shore is called 'lagoon'	• Circular or semi - circular reefs, arise from subsiding sea floor platform
• Seen in Andamans	• Seen in Palk Bay, Gulf of Mannar & Kachchh	• Seen in Nicobar and Lakshadweep	• Seen in Nicobar and Lakshadweep

CORAL REEFS

Advantages Of Coral Reefs:

- Natural protective barriers against storms and soil erosion, Food, Tourism, Capture nutrients and plankton from water, Largest biogenic calcium carbonate producer, Home to variety of animals and plants, Sources of new medicines being developed to treat cancer, arthritis, human bacterial infections, Alzheimer's disease, heart disease, viruses, and other diseases. More than 1 billion people depend on food from coral reefs.



CORAL REEFS

Coral Bleaching:

- Without algae, coral loses its major source of food, turns white or pale and is more susceptible to diseases and eventually starves to death.
- Bleaching of corals occur when densities of zooxanthellae decline and/or concentration of photosynthetic pigments within zooxanthellae fall.
- **Global Warming Induced Threats To Corals:** Unsustainable fishing, Water Pollution, Marine Debris, Habitat Destruction.

Ongoing bleaching events worldwide:

- Over 4000 miles of coral reefs in Fiji.
- Third mass bleaching of Great barrier reef.
- Port Douglas (severe)

CORAL REEFS

Ecological Causes of Coral Bleaching:

- **Temperature**: Anomalously low and high temperatures induce bleaching.
- **Solar Irradiance**: Bleaching during summers occurs on exposed and shallow-living corals.
- **Subaerial Exposure**: Sudden exposure to air during sea level drop/tectonic movements affect corals.
- **Sedimentation**: Few instances of bleaching linked to sediments.

CORAL REEFS

Ecological Causes of Coral Bleaching:

- **Fresh Water Dilution**: Though rare, rapid dilution from storm surges and runoffs cause bleaching.
- **Inorganic Nutrients**: Increase in ambient elemental nutrient content indirectly causes bleaching.
- **Xenobiotics**: Exposure to chemicals like Cu, herbicides and oil leads to zooxanthellae loss.
- **Epizootics**: It is a type of pathogen induced bleaching.

NATIONAL PLAN FOR CONSERVATION OF AQUATIC ECOSYSTEMS (NPCA)

- NPCA is a single conservation programme for **both wetlands and lakes**.
- Centrally sponsored scheme, currently being implemented by the MoEFCC.
- Formulated in 2015 by merging of the National Lake Conservation Plan and the National Wetlands Conservation Programme.
- NPCA seeks to promote better synergy and avoid overlap of administrative functions.


Biodiversity

Biodiversity

- **United Nations Earth Summit (1992)**: Biodiversity is defined as 'the variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems'.
- **More than 70 per cent of all the species recorded are animals**, while plants (including algae, fungi, bryophytes, gymnosperms and angiosperms) comprise no more than 22 per cent of the total.

Biodiversity

- Among animals, **insects are the most species-rich taxonomic group**, making up **more than 70 per cent** of the total.
- **India**: accounts for **nearly 7% of recorded species**.
- **Largest biodiversity**: found in Amazon rain forest on earth.
- **Endemism:** state of a species being native to a single defined geographic location, such as an island, state, nation, country or other defined zone.

Biodiversity

PATTERNS OF BIODIVERSITY

- **Latitudinal gradients**: Diversity of plants and animal is not uniform throughout the world.
- Species diversity decreases as we move away from the equator towards the pole.
- Tropic harbour more species than temperature or polar areas

Biodiversity

WHY TROPIC ACCOUNT GREATER BIOLOGICAL DIVERSITY?

- **Speciation**: It is function of time, unlike temperate regions subjected to frequent glaciations in the past, tropical latitudes have remained relatively undisturbed for millions of years.
- Tropical environments, unlike temperate ones, are **less seasonal, relatively more constant and predictable**. Such **constant environments promote niche specialization** and lead to a greater species diversity.
- **More solar energy available in the tropics**, which contributes to higher productivity; this in turn might contribute indirectly to greater diversity.

LEVELS OF BIODIVERSITY

- **Genetic Diversity:** It is concerned with the variation in genes within a particular species. Genetic diversity allows species to adapt to changing environments. This diversity aims to ensure that some species survive drastic changes and thus carry on desirable genes. Genetic diversity gives us beautiful butterflies, roses, parakeets or coral in a myriad hues, shapes and sizes.

LEVELS OF BIODIVERSITY

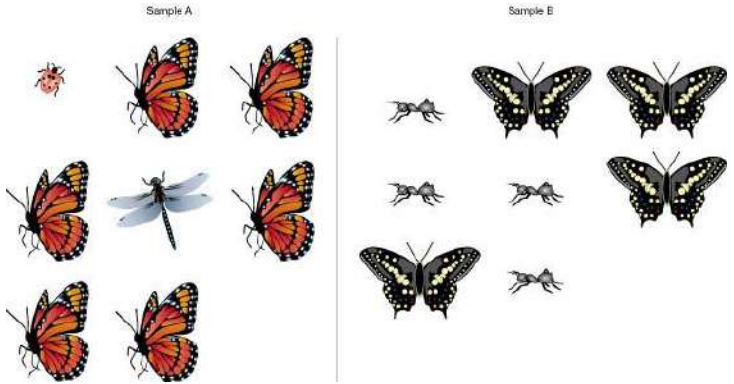
- **Species diversity**: It refers to the variety of living organisms on earth. Species differ from one another, markedly in their genetic makeup, do not inter-breed in nature. Closely-related species however have in common much of their hereditary characteristics. It is the ratio of one species population over total number of organisms across all species in the given biome. ‘Zero’ would be infinite diversity, and ‘one’ represents only one species present.

LEVELS OF BIODIVERSITY

- **Ecosystem/ Community diversity**: refers to the different types of habitats. A habitat is the cumulative factor of the climate, vegetation and geography of a region. There are several kinds of habitats around the world. Corals, grasslands, wetland, desert, mangrove and tropical rain forests are examples of ecosystems.
- **Pattern diversity**: Diversity resulting from the differences due to zonation, periodicity, stratification, food webs, patchiness and habitat condition. It is environmentally induced diversity.

MEASUREMENT OF BIODIVERSITY

- Biodiversity is measured by two major components: (1) Species richness, (2) Species evenness.



MEASUREMENT OF BIODIVERSITY

<table>
<tr><td rowspan="4">Species Richness</td><td colspan="2">Species richness is the number of different species represented in an ecological community, landscape or region. Species richness is simply a count of species, and it does not take into account the abundances of the species or their relative abundance distributions.
It is measurement of the relative frequency of each species.</td></tr>
<tr><td>a) Alpha diversity</td><td>Diversity within a particular area or ecosystem, and is usually expressed by the number of species (i.e., species richness) in that ecosystem.</td></tr>
<tr><td>b) Beta diversity</td><td>It is a comparison of diversity between ecosystems, usually measured as the change in amount of species between the ecosystems.</td></tr>
<tr><td>b) Gamma diversity</td><td>It is a measure of the overall diversity for the different ecosystems within a region.</td></tr>
</table>

MEASUREMENT OF BIODIVERSITY

Species Evenness	• **Species evenness refers to how close in numbers each species in an environment is. Mathematically it is defined as a diversity index, a measure of biodiversity which quantifies how equal the community is numerically. So, if there are 40 foxes and 1000 dogs, the community is not very even.** • **It is a number of species found in said environment.**

- **Note**: Species diversity of an environment is essentially a combined measurement of richness and evenness. Sometimes, it is called the **"Shannon Diversity Index".**

MEASUREMENT OF BIODIVERSITY

ECOSYSTEM SERVICES

- Protection of water resources, Soils formation and protection, Nutrient storage and recycling, Pollution breakdown and absorption, Contribution to climate stability, Maintenance of ecosystems, Recovery from unpredictable events.

MEASUREMENT OF BIODIVERSITY

CAUSES FOR BIODIVERSITY LOSS

- **Natural Causes**: floods, earthquakes, landslides, rivalry among species, lack of pollination and diseases.
- **Man-Made causes:** Habitat destruction, Uncontrolled commercial exploitation, Hunting & poaching, Conversion of rich bio-diversity site for human settlement and industrial development, Extension of agriculture, Pollution, Filling up of wetlands, Destruction of coastal areas.

TERMINOLOGIES RELATED TO SPECIES

Term	Meaning	Examples
Flagship Species	• A species selected to act as an ambassador, icon or symbol for a defined habitat, issue, campaign or environmental cause. • Flagship species may or may not be keystone species and may or may not be good indicators of biological process.	• Indian tiger, the giant panda, the Golden lion, the African elephant, Asian elephant, etc.
Keystone Species	• Species whose addition to or subtraction from an ecosystem leads to major changes in abundance or occurrence of at least one other species. • Plays role in structure, functioning or productivity of a habitat or ecosystem.	• All top predators like Lion, Tiger, Crocodile, Elephant.

TERMINOLOGIES RELATED TO SPECIES

Priority Species	• **A "priority species" is reflective of a key threat across that eco-region - such that conservation of the species will contribute significantly to a broader threat mitigation outcome.** • **It is often crucial to the economic and/or spiritual well-being of peoples within that ecoregion.**	
Indicator Species	• Species or group of species chosen as an indicator of, or proxy for, the state of an ecosystem or of a certain process within that ecosystem.	• Crayfish as indicators of freshwater quality; • Corals as indicators of marine processes such as siltation, seawater rise and sea temp. fluctuation; • Lichens are indicators of air quality (sensitive to sulfur dioxide); • Amphibians (e.g. Frog) indicates global warming and air pollution.

TERMINOLOGIES RELATED TO SPECIES

Foundation Species	• **Dominant primary producer in an ecosystem both in terms of abundance and influence.**	• **Corals**
Charismatic Species	• Large animal species with widespread popular appeal that environmental activists use to achieve conservation goals well beyond those species.	• Barasingha (Bhoorsingh from kanha national park), Giant panda, The Bengal tiger, Blue whale.

TERMINOLOGIES RELATED TO SPECIES

Umbrella Species	• **It acts as an umbrella. Conservation of umbrella species would extend protection to other species as well.**	• **Conservation of Tiger, efforts have been made to save the populations of wild Tigers in order to save other species that are present in the same ecosystems such as Leopards, Monkey, Hares, Boars, etc.**
Invasive/Alien Species	• Species that occur outside their natural range and threaten native plants and animals or other aspects of biodiversity by altering and utilizing the components of the ecosystem in which they are introduced.	• Goat weed, Alternanthera paronychioides, Prickly poppy, Palmyra, Toddy palm, Calotropis/ Madar, Swallow wort, Water Hyacinth.


Biodiversity

IMPORTANT TERMS RELATED TO ECOSYSTEM

Biopiracy:	• Practice in which indigenous knowledge of nature, originating with indigenous peoples, is used by others for profit, without authorization or compensation to the indigenous people themselves.
Bioprospecting:	• Systematic and organized search for useful products derived from bioresources including plants, microorganisms, animals, etc., that can be developed further for commercialization and overall benefits of the society.

IMPORTANT TERMS RELATED TO ECOSYSTEM

Biomining:	• Process of using microorganisms (microbes) to extract metals of economic interest from rock ores or mine waste. Biomining techniques may also be used to clean up sites that have been polluted with metals
Bioassay:	• A test in which organisms are used to detect the presence or the effects of any other physical factor, chemical factor or any other type of ecological disturbance. It is very common in pollution studies; the aim is to detect lethal concentration or effective concentration causing mortality or other effects.

BIODIVERSITY CONSERVATION

Botanical Garden	• **Botanical garden refers to the scientifically planned collection of living trees, shrubs, herbs, climbers and other plants from various parts of the world**
Zoological Park	• Zoo is an establishment, whether stationary or mobile, where captive animals are kept for exhibition to the public and includes a circus and rescue centers but does not include an establishment of a licensed dealer in captive animals - CZA

BIODIVERSITY CONSERVATION

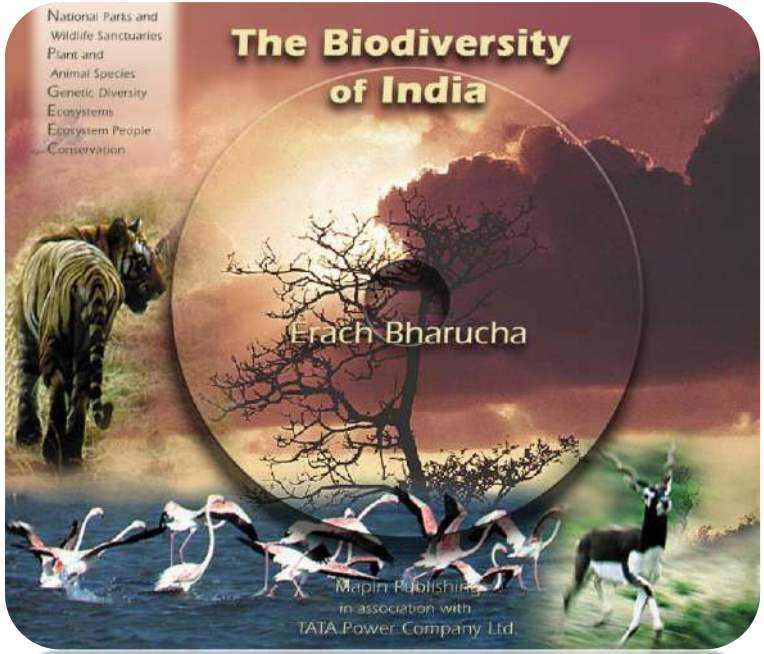
Ex-situ conservation	• **Conserving biodiversity outside the areas where they naturally occur is known as ex- situ conservation.** • **Here, animals are reared or plants are cultivated like zoological parks or botanical gardens. Reintroduction of an animal or plant into the habitat from where it has become extinct is another form of ex situ conservation.** • **Gangetic gharial has been reintroduced in the rivers of Uttar Pradesh, Madhya Pradesh and Rajasthan where it had become extinct.** • **Seed banks, botanical, horticultural and recreational gardens are important centers for ex-situ conservation.**
In-situ conservation:	• Conserving the animals and plants in their natural habitats is known as in-situ conservation. The established natural habitats are: National park, Sanctuaries, Biosphere reserves and Reserved forests, Protected forests.

BIODIVERSITY CONSERVATION

Die-back: Phenomena in which **progressive dying** of plant happens, usually backwards from the tip of any portion of plant. This is one of the **adaptive mechanisms** to avoid adverse conditions.

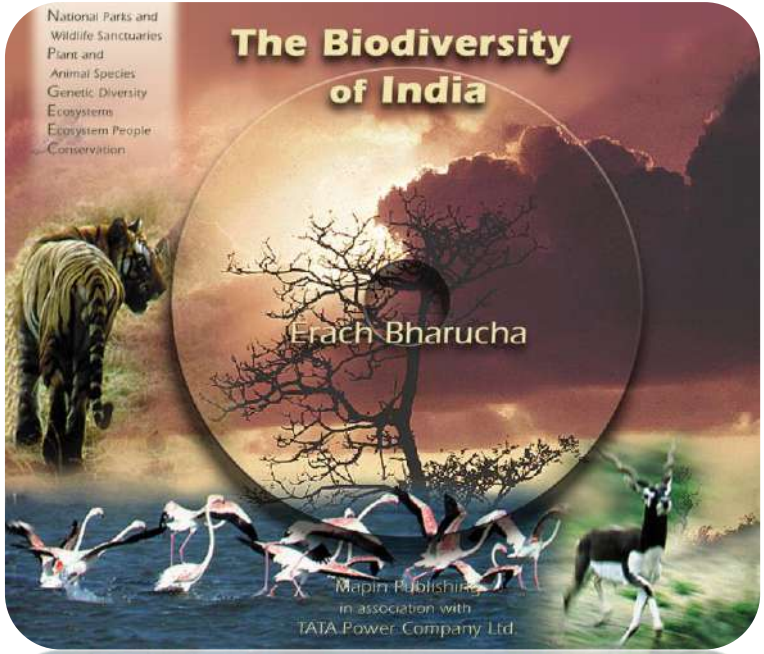
BIODIVERSITY IN INDIA

- India, a mega diverse country with **only 2.4% of the world's land area, accounts for 7-8% of all recorded species**, including **over 45,000 species of plants and 91,000 species of animals.** The most biodiversity rich regions are the Western Ghats (4 % area) and North East (5.2% area).
- The country's diverse physical features and climatic conditions have resulted in a variety of ecosystems such as forests, wetlands, grasslands, desert, coastal and marine ecosystems.



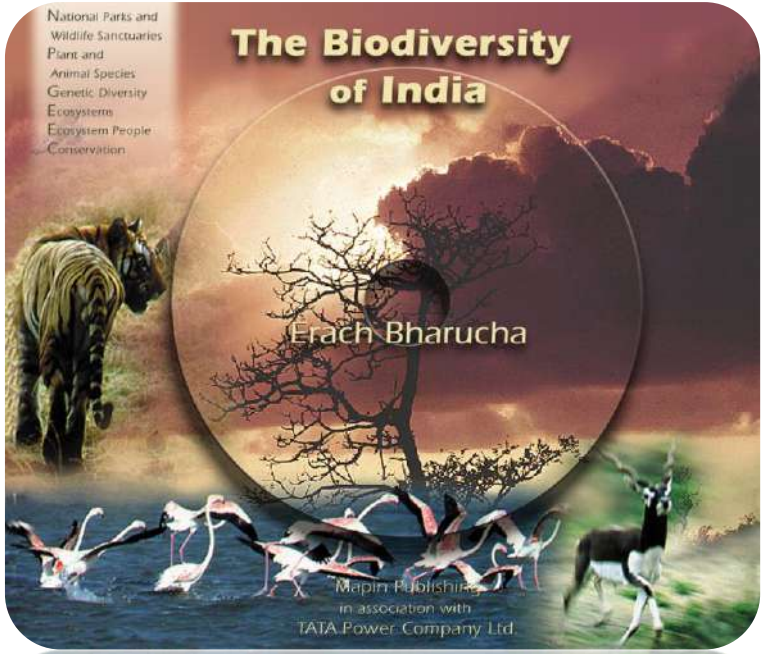
BIODIVERSITY IN INDIA

- **Four of 34 globally identified biodiversity hotspots**: The Himalayas, the Western Ghats, the North-East, and the Nicobar Islands, can be found in India.
- In terms of species richness, India ranks seventh in mammals, ninth in birds and fifth in reptiles.
- **World Conservation Monitoring Centre (WCMC) of the United Nations Environment Program (UNEP)** has identified a total of 17 megadiverse countries: **India**, Australia, D R of Congo, Madagascar, Philippines, Brazil, Ecuador, Malaysia, Peru, China, USA, Papua New, South Africa, Colombia, Indonesia, Guinea, Venezuela.



BIODIVERSITY IN INDIA

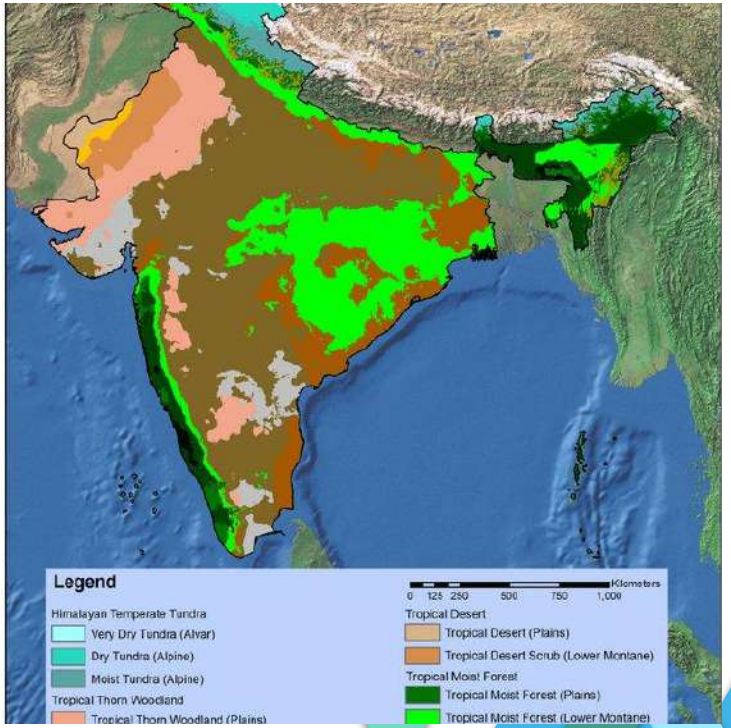
The national gene bank at National Bureau Of Plant Genetic Resources (NBPGR), Delhi is primarily responsible for conservation of unique accessions on long-term basis, as base collections for posterity, predominantly in the form of seeds.



BIODIVERSITY IN INDIA

Biomes of India:

- The term biome means the main groups of plants and animals living in areas of certain climate patterns. It includes the way in which animals, vegetation and soil interact together. The plants and animals living in the area are adapted to that environment.
- **The five biomes of India are**: 1) Tropical Humid Forests 2) Tropical Dry or Deciduous Forests (including Monsoon Forests) 3) Warm deserts and semi-deserts 4) Coniferous forests and 5) Alpine meadows.

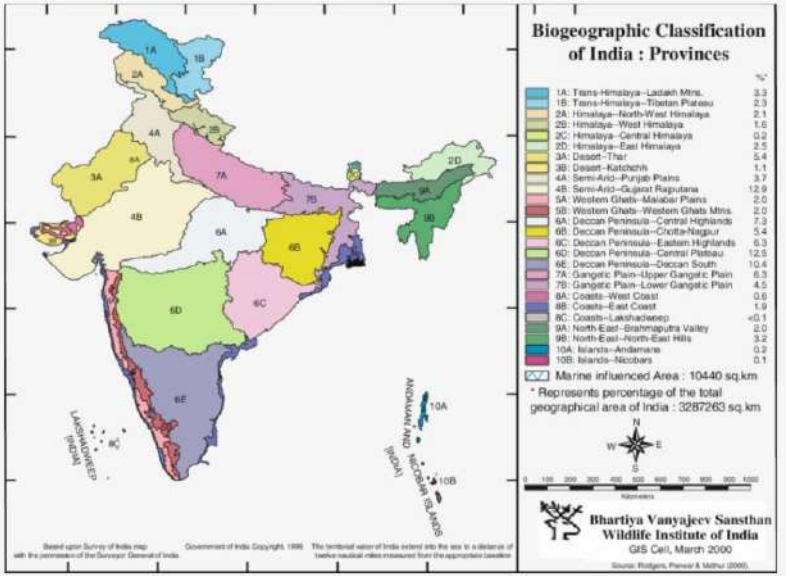


BIODIVERSITY IN INDIA

10 Biogeographic Zones and 25 Biogeographic Provinces in India:

- **Biogeography**: "one of the aspects of geography which deals with the correlation among the animals, plants and their geography".

1. **Phyto-geography (plant geography):** deals with origin, distribution and environmental interrelationships of plants.
2. **Zoogeography**: deals with the migration and distribution of animals.



BIODIVERSITY IN INDIA

Trans Himalayan zone	• **An extension of the Tibetan plateau, harboring high-altitude cold desert in Ladakh (J&K) and Lahaul Spiti (H.P) comprising 5.7 % of the country's landmass.** • **This region consists of Karakoram, Ladakh, Zaskar and Kailash mountain ranges (5.6%).**	• **Himalaya - Ladakh Mountains** • **Himalaya - Tibetan Plateau** • **Trans - Himalaya - Sikkim**
Himalayan zone	• This region extends from east to west upto 2400 kms from Kashmir to Arunachal Pradesh. • The entire mountain chain running from north-western to northeastern India, comprising a diverse range of biotic provinces and biomes, 7.2 % of the country's landmass.	• Himalaya - North West Himalaya • Himalaya - West Himalaya • Himalaya - Central Himalaya • Himalaya - East Himalaya

BIODIVERSITY IN INDIA

Desert zone	• **This region lies mostly in the Rajasthan state of India and extended into some parts of Haryana, Punjab and Gujarat.** • **The desert region extends from the Aravalli hills in the north-east to the Rann of Kutch along the coast and the alluvial plains of the Indus River in the West and North-West (6.6%).**	• **Desert – Thar** • **Desert – Kacchh**
Semi-Arid zone	• A transition zone between the desert and the dense forest of Western Ghats. The Indian semi-arid region mainly lies in the states of Gujarat, Punjab, Haryana and western parts of Rajasthan. • The zone between the desert and the Deccan plateau, including the Aravalli hill range. • 15.6 % of the country's landmass.	• Semi - Arid - Punjab Plains • Semi - Arid - Gujarat Rajputana

BIODIVERSITY IN INDIA

Western Ghats	• **The hill ranges and plains running along the western coastline, south of the Tapti river, covering an extremely diverse range of biotic provinces and biomes.** • **5.8% of the country's landmass.**	• **Western Ghats - Malabar Plains** • **Western Ghats - Western Ghats Mountains**
Deccan plateau	• The largest of the zones, covering much of the southern and southcentral plateau with a predominantly deciduous vegetation. 4.3 % of the country's landmass.	• Deccan Peninsular - Central Highlands • Deccan Peninsular - Chotta Nagpur • Deccan Peninsular - Eastern Highlands • Deccan Peninsular - Central Plateau • Deccan Peninsular - Deccan South

BIODIVERSITY IN INDIA

Gangetic plain zone	• **Defined by the Ganges river system, these plains are relatively homogenous.** • **11% of the country's landmass.** • **The great plains of India stretching from Delhi to Kolkata covering the states of Uttar Pradesh, Bihar and West Bengal.**	• **Gangetic Plain - Upper Gangetic Plains** • **Gangetic Plain - Lower Gangetic Plains**
North East zone	• The plains and non-Himalayan hill ranges of northeastern India, with a wide variation of vegetation. 5.2% of the country's landmass. • Region represents the transition zone between Indian, Indo-Malayan and Indo-Chinese biogeographical regions as well as being a meeting point of the Himalayan Mountains and Peninsular India.	• North - East - Brahmaputra Valley • North - East – North East Hills

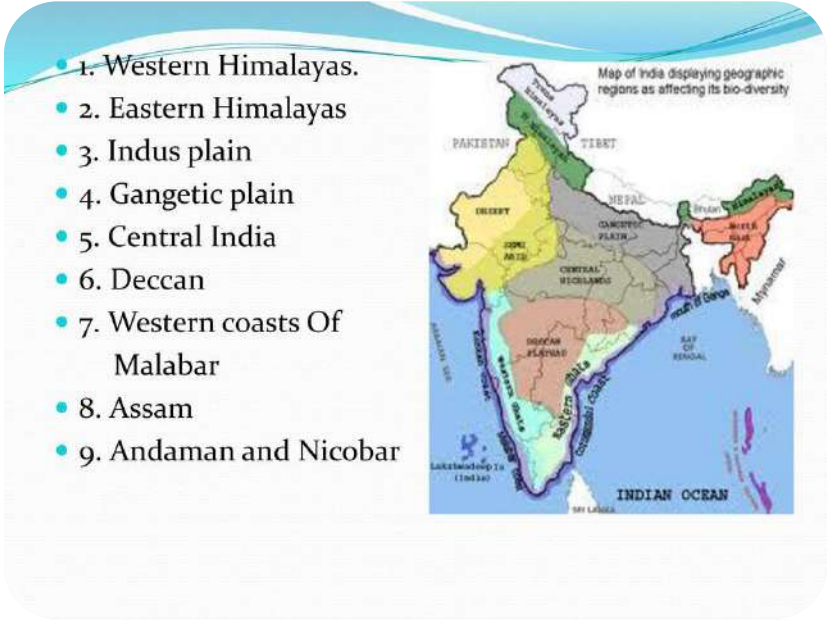
BIODIVERSITY IN INDIA

Islands	• **The Andaman and Nicobar Islands in the Bay of Bengal, with a highly diverse set of biomes.** • **0.03% of the country's landmass.**	• **Islands – Andamans** • **Islands – Nicobars**
Coasts	• A large coastline distributed both to the west and east, with distinct differences between the two; Lakshadweep islands are included in this with the percent area being negligible.	• Coasts - West Coast • Coasts - East Coast • Coasts – Lakshadweep

BIODIVERSITY IN INDIA

Floristic (Botanical) Regions of India

- For the study of flora, India has been divided into the following nine floristic regions: I. Western Himalayas. II. Eastern Himalayas. III. West Indian Desert. IV. Gangetic Plains V. Assam VI. Central India. VII. Malabar. VIII. The Deccan. IX. Andamans.



FLORAL DIVERSITY OF INDIA

Algae	**The green non-differentiated plants (non-differentiated into organs like root, stem and leaf) possessing chlorophyll**
Fungi	Non-green non-differentiated plants characterized by total absence of chlorophyll are called Fungi.
Bacteria	Non-chlorophyllous micro-organisms which lead saprophytic or parasitic existence. Many of them are pathogenic; Saprophytic bacteria are rather beneficial.
Lichens	A lichen is a peculiar combination of an alga and a fungus– the two live deriving mutual benefit.

FLORAL DIVERSITY OF INDIA

Bryophytes	**The plant body is differentiated into a small stem and simple leaves, but true roots are absent.**
Pteridophytes	The pteridophytes have well-differentiated plant bodies, consisting of roots, stems and leaves. Moreover, they possess vascular bundles.
Gymnosperms	Gymnosperms (Gymnos → naked; Sperma → seed) are the naked-seeded plants.
Angiosperms	Angiosperms (Angeion → a case) are the closed-seeded plants.
Insectivorous Plants	Plants are specialized in trapping insects. This is an adaptability mechanism of plant in nutrient poor soil.

FLORAL DIVERSITY OF INDIA

Floral Endemism - Order

1) Peninsular India including western and Eastern Ghats (about 2,600 species)
2) Eastern Himalaya and north-eastern region (about 2,500 species)
3) North-western Himalaya (about 800 species)
4) Andaman & Nicobar Islands (about 250 species).

PLANT DIVERSITY OF INDIA

Insectivorous Plants

- These plants are specialised in trapping insects.
- Insectivorous plants can broadly be divided into active and passive types based on their method of trapping their prey - active ones can close their leaf traps the moment insects land on them and passive plants have a 'pitfall' mechanism, having some kind of jar or pitcher-like structure into which the insect slips and falls, to eventually be digested.
- **Insectivorous plants of India**: Drosera or Sundew, Aldrovanda, Nepenthes, Utricularia or Bladderworts, Pinguicula or Butterwort

PLANT DIVERSITY OF INDIA

Invasive Alien Species

- Aliens are species that occur outside their natural range. Alien species that threaten native plants and animals or other aspects of biodiversity are called alien invasive species.
- **Effects**: Loss of Biodiversity, Decline of Native Species (Endemics), Habitat Loss, introduced pathogens reduce crop and stock yields, Degradation of marine and freshwater ecosystems.
- **Invasive Alien Flora of India**: Needle Bush, Black Wattle, Goat weed, Prickly Poppy, Palmyra, Toddy Palm, Water Hyacinth, Balsam, Parthenium/Congress grass, Prosopis juliflora, Lantana camara, Sleeping Grass.

PLANT DIVERSITY OF INDIA

Medicinal Plants

- Beddomes Cycad, Pooshkarmoola, Blue vanda, Ladies Slipper Orchid, Red vanda, Sarpagandha, Indian Podophyllum, Tree Ferns, Cycads, Elephant's foot.

- **Animal Discoveries 2019:** Annual publication released by Zoological Survey of India (ZSI).
- **Plant Discoveries 2019:** Annual Publication released by Botanical Survey of India (BSI).

WILDLIFE DIVERSITY OF INDIA

Himalayan foothills:

- **Flora:** Natural monsoon evergreen and semi-evergreen forests; Species like Sal, giant bamboos, silk cotton trees; tall grassy meadow with savannahs in terai are dominant.
- **Fauna:** Elephant, sambar, swamp deer, cheetal, hog deer, barking deer, wild boar tiger, panther, hyena, black bear, sloth bear, Great Indian one-horned rhinoceros, wild buffalo, Gangetic gharial, golden langur.

WILDLIFE DIVERSITY OF INDIA

Western Himalayas (High altitude region)

- **Flora:** Natural monsoon evergreen and semi-evergreen forests; rhododendrons; dwarf hill bamboo and birch forests mixed with alpine pastures.
- **Fauna:** Tibetan wild ass (kiang), wild goats (thar, ibex) and blue sheep; antelopes (Chiru and Tibetan gazelle), deers (hangul of Kashmir stag and shou or Sikkim stag, musk deer); golden eagle, snow cocks, snow partridges; snow leopard, black and brown bears; birds like Griffon vultures.

WILDLIFE DIVERSITY OF INDIA

Eastern Himalayas

- **Flora**: The Eastern Himalayas can be divided into the following climatic regions: arctic, sub-arctic, temperate, subtropical, and warm tropical. The forest region is very humid. Sal forests and evergreen trees are found extensively all along the foothills of the Eastern Himalayas. Subtropical forests cover the hills up to an elevation of about 2000 m. Oaks, magnolias, laurels and birches covered with moss and ferns; coniferous forests of pine, fir, yew and junipers with an undergrowth of scrubby rhododendrons and dwarf bamboos; lichens, mosses, orchids, and other epiphytes dominant.
- **Fauna**: Red panda, hog badgers, forest badgers, crestless porcupines, Great one-horned rhinoceros Asian elephant ,Takin ,Wild water buffalo, Swamp Deer, Tiger Snow leopard, Clouded leopard.

WILDLIFE DIVERSITY OF INDIA

Peninsula India

- **Flora**: Sal in north and east extensions (higher rainfall) and teak in southern plateau are dominant trees. Western Ghats have evergreen vegetation (flora and fauna similar to evergreen rainforests of north-eastern of India. In dry areas of Rajasthan and Aravalli hills, trees are scattered, and thorny scrub species predominate.
- **Fauna**: Elephant, wild boar, deers (cheetal or axis deer), hog deer swamp deer or barasinga, sambar, muntjac or barking deer, antelopes (four-horned antelope, Nilgiri, blackbuck, chinkara gazelle), wild dog or dhole, tiger, leopard, cheetah, lion, wild pig, monkey, striped hyena, jackal, gaur.

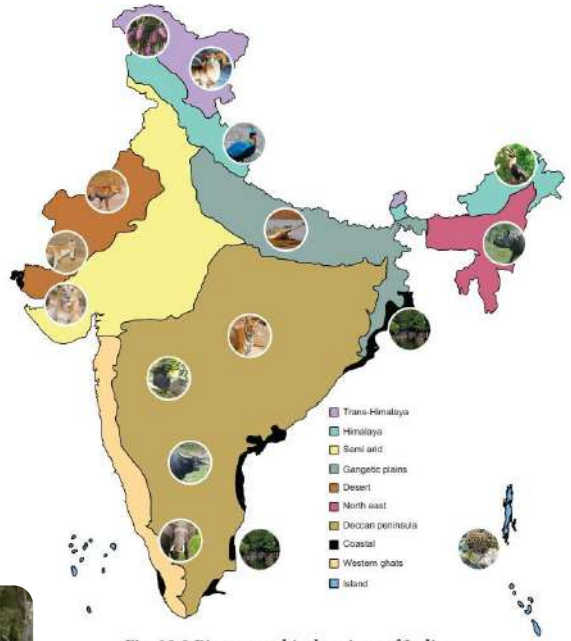
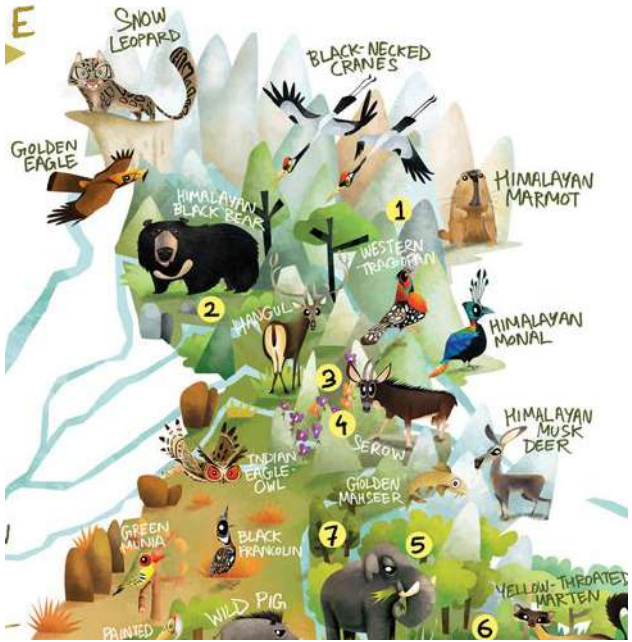


Fig. 12.3 Biogeographical regions of India

WILDLIFE DIVERSITY OF INDIA

Indian desert

- **Flora**: Thorny trees with reduced leaves like babool, ber, khejri tree; cactus, other succulents are the main plants.
- **Fauna**: Its diverse fauna includes the great Indian bustard, blackbuck, chinkara, fox, Bengal fox, wolf, caracal, rodents, Asiatic wild ass, desert cat, red fox; reptiles (snakes, lizards and tortoise) well represented. Desert lizards include geckos.



WILDLIFE DIVERSITY OF INDIA

Tropical rain forest region

- Distributed in areas of Western Ghats and northeast India.
- **Flora**: Extensive grasslands interspersed with densely forested gorges of evergreen vegetation known as shoals occur in the Nilgiris (an offshoot of Western Ghats). The rain forests of the Western Ghats have dense and lofty trees with much species diversity. Mosses, ferns, epiphytes, orchids, lianas and vines, herbs, shrubs make diverse habitat. Ebony Indian rosewood, Malabar Kino, teak and Indian laurel trees predominate in these forests.

WILDLIFE DIVERSITY OF INDIA

Tropical rain forest region

- **Fauna:** Wild elephants, gaur and other larger animals. The most prominent are hoolock gibbon (only ape found in India), golden langur, capped langur or leaf monkey, Assam macaque and the pig-tailed macaque, lion-tailed macaque, Nilgiri langur, slender loris, bats, giant squirrel, civets, flying squirrels, Nilgiri mongoose, spiny mouse.

WILDLIFE DIVERSITY OF INDIA

Mangrove swamps of Sundarbans

- **Flora**: Various species of mangroves –
- **Fauna**: In the higher regions of mangroves, there are spotted deer, pigs, monitor lizard, monkey, Royal Bengal Tiger.

IMPORTANT ANIMALS IN INDIA

Pygmy Hog

- World's smallest wild pig, with adults weighing only 8 kgs. This species constructs a nest throughout the year.
- It is one of the most useful indicators of the management status of grassland habitats. The grasslands where the pygmy hog resides are crucial for the survival of other endangered species such as Indian Rhinoceros, Swamp Deer, Wild Buffalo, Hispid Hare, Bengal Florican and Swamp Francolin.

IMPORTANT ANIMALS IN INDIA

Pygmy Hog

- **Habitat:** Relatively undisturbed, tall 'terai' grasslands.
- **Distribution:** Formerly, the species was more widely distributed along the southern Himalayan foothills but now is restricted to only a single remnant population in Manas Wildlife Sanctuary and its buffer reserves.
- In 1996, a captive-breeding programme of the species was initiated in Assam, and some hogs were reintroduced in Sonai Rupai area in 2009.

IMPORTANT ANIMALS IN INDIA

Malabar Civet

- It is considered to be one of the world's rarest mammals.
- It is endemic to India and was first reported from Travancore, Kerala.
- It is nocturnal in nature and found exclusively in the Western Ghats.
- **Habitat**: Wooded plains and hill slopes of evergreen rainforests, Western Ghats.

IMPORTANT ANIMALS IN INDIA

Sumatran Rhinoceros

- It is the smallest and most endangered of the five Rhinoceros species.
- It is now thought to be regionally extinct in India, though it once occurred in the foothills of the Himalayas and north-east India.
- The Javan Rhinoceros (Rhinoceros sondaicus) is also believed to be extinct in India and only a small number survive in Java and Vietnam.

IMPORTANT ANIMALS IN INDIA

Kashmir stag/ hangul

- Its subspecies of Red Deer which is native to India.
- **Habitat / distribution:** in dense riverine forests, high valleys, and mountains of the Kashmir valley and northern Chamba in Himachal Pradesh.
- State animal of J&k.
- **Threat:** habitat destruction, over-grazing by domestic livestock, and poaching.

IMPORTANT ANIMALS IN INDIA

Dugong

- Coastal Island water belt East Africa & Vanuate belt latitude 27° N - South of Equator (India - Andaman & Nicobar, Laccadives)
- Dugong also called as **sea cow.**
- **Habitat:** Coastal water, wide shallow mangrove & sizeable sea grass bed.
- Occurs in near shore waters of Gulf of Mannar, Gulf of Kachchh and Andaman and Nicobar Islands.

IMPORTANT ANIMALS IN INDIA

Freshwater/ river dolphin

- **Habitat/ distribution**: India, Bangladesh, Nepal and Pakistan which is split into two subspecies, the Ganges river dolphin and Indus river dolphin.

IMPORTANT ANIMALS IN INDIA

Ganges river dolphin

- Indus-Ganges-Brahmaputra, Megna, Karnaphuli-Sangu river system of south.
- **Habitat/distribution:** Ganges and Brahmaputra Rivers and their tributaries in Bangladesh, India and Nepal.
- Ganges river dolphin has been recognized by the govt. of India as its **National Aquatic Animal**.

IMPORTANT ANIMALS IN INDIA

Indus river dolphin

- **Habitat / distribution**: Indus River in Pakistan and its Beas and Sutlej tributaries.

IMPORTANT ANIMALS IN INDIA

Bengal Florican

- A rare bustard species that is very well known for its mating dance. Among the tall grasslands, secretive males advertise their territories by springing from the ground and flitting to and from in the air.
- **Habitat**: Grasslands occasionally interspersed with scrublands.
- **Distribution**: Native to only 3 countries in the world - Cambodia, India and Nepal. In India, it occurs in 3 states, namely Uttar Pradesh, Assam and Arunachal Pradesh

IMPORTANT ANIMALS IN INDIA

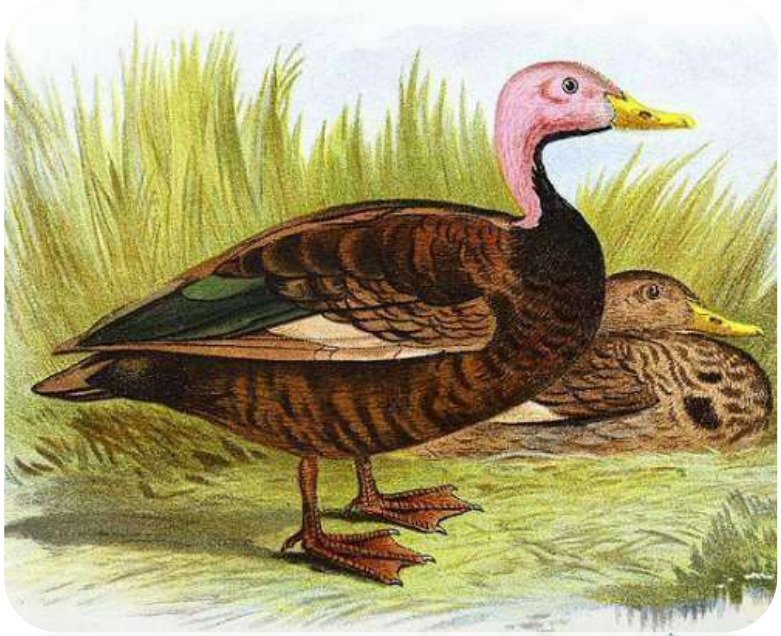
White-bellied Heron

- Extremely rare bird found in five or six sites in Assam and Arunachal Pradesh, one or two sites in Bhutan, and a few in Myanmar.
- **Habitat**: Rivers with sand or gravel bars or inland lakes.
- **Distribution**: Bhutan and north-east India to the hills of Bangladesh and north Myanmar

IMPORTANT ANIMALS IN INDIA

Pink- headed Duck

- It has not been conclusively recorded in India since 1949. Males have a deep pink head and neck from which the bird derives its name.
- **Habitat:** Overgrown still-water pools, marshes and swamps in lowland forests and tall grasslands.
- **Distribution:** Recorded in India, Bangladesh and Myanmar. Maximum records are from north-east India.



IMPORTANT ANIMALS IN INDIA

Siberian Crane

- It is a large, strikingly majestic migratory bird that breeds and winters in wetlands. They are known to winter at Keoladeo National Park, Rajasthan. However, the last documented sighting of the bird was in 2002.
- **Habitat**: Wetland areas.
- **Located distribution**: Keoladeo National Park in Rajasthan.

IMPORTANT ANIMALS IN INDIA

Chinese Pangolin

- **Distribution:** Occur in Himalayan foot hills in Eastern Nepal, Bhutan, Northern India, North East Bangladesh (India - Sikkim).
- **Habitat:** Primary & Secondary tropical forest, lime stone forest, bamboo forest, grassland & agricultural field. It is nocturnal animal.

IMPORTANT ANIMALS IN INDIA

Indian Gazelle (Chinkara)

- **Distribution:** Western & Central India through Pakistan, South-West Afghan. (Thar desert remains strong hold)
- **Habitat:** Inhabits arid area, Sand deserts, Flat plains & hills, dry scrub & light forest.

IMPORTANT ANIMALS IN INDIA

Clouded Leopard

- **Distribution:** Himalayan foot hill in Nepal through mainland South East Asia - China
- **Habitat**: Arboreal, forest habitat (Primary every green tropical rainforest, also in dry deciduous forest Himalaya - 2500 m.

IMPORTANT ANIMALS IN INDIA

India Gaur	• **Distribution: Gaur historically occured throughout main land south. South east asia, Srilanka.** • **Habitat: From sea level upto least 2800m. (hill & low-lying area.) undisturbed forest tact, hilly terrain, availability of water, availability of coarse grasses.**
Golden Langur	• Distribution: Bhutan and North- east India (Assam). Forest beltwest Assam between manas river in east, sankosh - Brahmaputra • Habitat: Moist evergreen, diptero carp, riverine & moist deciduous forest
Himalyan Ibex	• Distribution: Central & Northeast Afghanistan, China, North (India) - Hima of Jammu and Kashmir & Himachal Pradesh Hindu Kush range (Karakoram, Trans-Himalayan) • Habitat: Mountain, open alpine meadow & crags (not in forest zone)

IMPORTANT ANIMALS IN INDIA

Hoolock Gibbon	• **Western: Northeast India, Bangladesh (A.P., Assam, Manipur, Meghalaya, Tripura, Mizoram, Nagaland) Upto South of Brahamaputra & East of Dibang.** • **Habitat: Forest dweller, locale, inhabit tropical evergreen (Tree to tree more)**
	• Eastern: Southern China & Chindwin river Myanmar. Boundary between (2) Hoolock gibbon uncertain in chindwin head water. • Habitat: Hill forest, Mountainous, piro dominated forest. • Not found in India except Eastern A.P.
Leopard	• Distribution: Southwest Asia, Himalayan foothills, India, China, Jawa, Srilanka “Leopards occur widely in forest of India - sub continent. • Habitat: Rainforest to desert. India - all forest type-tropical rainforest to temp deciduous and alpine coniferous.

IMPORTANT ANIMALS IN INDIA

Red Panda	• **Distribution: Nepal, India, Bhutan, Myanmar, Southern China. (Meghalayan Plateau - North east India).** • **Habitat: Temparate Forest having bamboo and thickest under stories.**
Lion tailed Macaque	• Distribution: Endemic to Western Ghats hills range in South Western India (Karnataka, Kerala, Tamil Nadu). • Habitat: Upper canopy of primary tropical evergreen rainforest - Monsoon forest in hilly country.
Nilgiri Tahr	• Distribution: 5% of West Ghats in South India (Kerala & Tamil Nadu) • Habitat: High elevation, grass covered hills, open terrain • Nilgiri Tahr is the state animal of Tamil Nadu.

IMPORTANT ANIMALS IN INDIA

Himalayan Musk Deer	• **Distribution: Himalayan of Bhutan, North India (Sikkim), Nepal & China** • **Habitat: Alpine environment, barren plateaus at high altitude meadows, fell fields, shurblands forest.**
Greater one horn Rhino	• Distribution: Northern part - India along Indus, Ganga, Brahmaputra basin includes Nepal, Bhutan, Bangladesh, Pakistan. • Habitat: Riverine grassland - Terai. Alluvial grass land - swamps & forest
Swamp Deer	• Distribution: Northern & Central India, Southwestern Nepal (Assam - Sundarbans (Indo - Gangetic) • Habitat: Open Sal, with grass understorey and grassland forms, true swamp deer, Mangroves of Sundarbans.

IMPORTANT ANIMALS IN INDIA

Tibetan Gazelle	• **Distribution: Tibet Plateau, India (Ladakh, Sikkim).** • **Habitat: High altitude plains, hills also grasses in wetland margin.**
Tiger	• Distribution: Southwest Asia, Central Asia, (Java & Bali) - disappeared. • Asian Countries – Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Laos, Malaysia, Myanmar, Nepal, Russia, Thailand & Vietnam • Habitat: Forest of tropical Asia
Snow leopard	• Distribution: High mountain of C.A, Pamir, Karakorum, Hindu Kush and Himalayan Range. India – J and K, Himachal Pradesh, Sikkim, Uttarakhand. • Habitat: Alphine & Sub alphine ecological zone favouring steep terrain.

IMPORTANT ANIMALS IN INDIA

Gharial	• **Distribution: India - Chambal River, Girwa river, Son River.** • **Habitat: Terrestrial, Fresh Water**
Olive Ridly	• Distribution: Throughout tropical water (Except Mexico). • Habitat: Multiple habitat, Migration less compared to other - usually carred by major currents
Nilgai	• Distribution: Widely distributed in India. lowland of Nepal & border areas of Pakistan extinct in Bangladesh • Habitat: Arid areas, scrub, dry deciduous, agricultural areas. Avoids Dense Forest, deserts.

IMPORTANT ANIMALS IN INDIA

Bird's Migration

- Migration refers to the regular, recurrent and cyclical seasonal movement of birds from one place to other.
- The distance of migration ranged from short distance to thousands of kilometres. But at the end of period, birds will eventually return to the original place.
- **Reasons for migration**: To avoid extreme climatic condition, To manage food shortage, To manage shortage of water, To have a better breeding conditions, Less competition for safe nesting places.

Winter birds	Summer birds
Siberian Cranes, Greater Flamingo, Common Teal, Yellow Wagtail, White Wagtail, Northern Shoveler, Rosy Pelican, Wood Sandpiper, Spotted Sandpiper, Eurasian Pigeon, Black Tailed Godwit, Spotted Redshank Starling Bluethroat, Long Billed Pipit.	Asian Koel, Black Crowned Night Heron, Eurasian Golden Oriole, Comb Duck, Blue Cheeked Bee Eater, Blue-Tailed Bee-Eater, Cuckoos.

SCHEDULES OF WILDLIFE PROTECTION ACT 1972

- Wildlife Protection Act (WPA), 1972 **consists of 6 schedule lists**, which give varying degrees of protection.
- Poaching, smuggling and illegal trade of animals listed Schedule 1 to schedule 4 are prohibited

SCHEDULES OF WILDLIFE PROTECTION ACT 1972

Schedule 1 and part II of Schedule 2	• **Provisions:** Animals listed in schedule 1 and part II of schedule 2 have absolute protection - offences under these are pre- scribed the highest penalties. • **Examples of animals listed in schedule 1:** Lion Tailed Macaque, Rhinoceros, Great Indian Bustard, Narcondam Hornbill, Nicobar Megapode, Black Buck, etc. • **Examples of animals listed in schedule 2:** Rhesus Macaque, Dhole, Bengal Porcupine, King Cobra, Flying Squirrel, Himalayan Brown Bear, etc.
Schedule 3 and schedule 4	• Animals listed in schedule 3 and schedule 4 are also protected, but the penalties are lower compared to schedule 1 and part 2 of schedule 2. • **Examples of animals listed in schedule 3:** Hyaena, Hogdeer, Nilgai, Goral, Sponges, Barking Deer, etc. • **Examples of animals listed in schedule 4:** Mangooses, Vultures, etc.

SCHEDULES OF WILDLIFE PROTECTION ACT 1972

Schedule 5	• **Animals listed in schedule 5 are called "vermin" which can be hunted.** • **Mice, Rat, Common Crow and Flying Fox (Fruit Eating Bats) are the list of animals (only 4) in schedule 5 (i.e. vermin).**
Schedule 6	• Cultivation, Collection, extraction, trade, etc. of Plants and its derivatives listed in schedule 6 are prohibited. • Red Vanda, Blue Vanda, Kuth, Pitcher Plant, Beddomes Cycad and Ladies Slipper Orchid are the list of plants listed in schedule 6.

IUCN CLASSIFICATION OF CONSERVATION PRIORITY

- Red Data Book was **first issued in 1966 by the IUCN's Special Survival Commission** as a guide for formulation, preservation and management of species listed.
- **Pink pages:** Include the critically endangered species. As the status of the species changes, new pages are sent to the subscribers.
- **Green pages**: used for those species that were formerly endangered, but have now recovered to a point where they are no longer threatened.

IUCN CLASSIFICATION OF CONSERVATION PRIORITY

Extinct (EX)	• **A taxon is Extinct when there is no reasonable doubt that the last individual has died.**
Extinct in the Wild (EW)	• A taxon is Extinct in the Wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range.
Critically Endangered (CR)	• A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria for Critically Endangered: ○ Reduction in population (> 90% over the last 10 years), ○ Population size (number less than 50 mature individuals), ○ Quantitative analysis showing the probability of extinction in wild in at least 50% in their 10 years) ○ Considered to be facing an extremely high risk of extinction in the wild.

IUCN CLASSIFICATION OF CONSERVATION PRIORITY

Endangered (EN)	• **A taxon is Endangered when the best available evidence indicates that it meets any of the criteria for Endangered:** ○ **Reduction in population size (70%overthelast10years),** ○ **Population size estimated to number fewer than 250 mature individuals,** ○ **Quantitative analysis showing the probability of extinction in wild in at least 20% within 20 years** ○ **Considered to be facing a very high risk of extinction in the wild.**
Vulnerable (VU)	• A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria for Vulnerable: ○ Reduction in population (> 50% over the last 10 years) ○ Population size estimated to number fewer than 10,000 mature individuals, ○ Probability of extinction in wild is at least 10% within 100 years, and ○ Considered to be facing a high risk of extinction in the wild.

IUCN CLASSIFICATION OF CONSERVATION PRIORITY

Near Threatened (NT)	• **A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.**
Least Concern (LC)	• A taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. • Widespread and abundant taxa are included in this category.
Data Deficient (DD)	• A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. • A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. • Data Deficient is therefore not a category of threat.
Not Evaluated (NE)	• A taxon is Not Evaluated when it is has not yet been evaluated against the criteria.

ENVIRONMENTAL DEGRADATION AND POLLUTION

ENVIRONMENTAL DEGRADATION AND POLLUTION

- **Environmental Degradation:** making the environment unfit or less suitable for the survival of different life forms thereby causing immense ecological damage.
- **Pollution:** deterioration of the environment due to the addition of harmful materials (pollutants) to it.
- **Causes of pollution:** Uncontrolled human population, Rapid industrialization, Urbanization, Exploitation of nature, Forest fires, Radioactivity, Volcanic eruptions, Strong winds etc.,
- **Types of Pollution**: Air Pollution, Water Pollution, Radioactive pollution, Soil & Plastic pollution, etc.

CLASSIFICATION OF POLLUTION

On the basis of the form in which they persist	• **Primary pollutants: Persist in the form in which they are added to the environment e.g. DDT, plastic.** • **Secondary Pollutants: Formed by interaction among the primary pollutants e.g. peroxyacetyl nitrate (PAN)- interaction of nitrogen oxides and hydrocarbons.**
On the basis of existence in nature	• **Quantitative Pollutants**: Occur in nature and become pollutant when concentration reaches beyond a threshold level. E.g. carbon dioxide, nitrogen oxide. • **Qualitative Pollutants**: These are man-made and do not occur in nature. E.g. fungicides, herbicides, DDT etc.
On the Basis of Disposal	• **Biodegradable Pollutants**: Waste products or the pollutants which are decomposed/degraded by natural processes microbial action. E.g. sewage. • **Non Bio-degradable Pollutants**: The pollutants which don't decompose naturally or decompose slowly e.g. DDT, Aluminum cans.
On the basis of origin	• **Natural:** These pollutants are released during volcanic eruptions, forest fires, grass fires, etc. • **Anthropogenic:** CO_2 emission from the burning of fossil fuels.

AIR POLLUTION

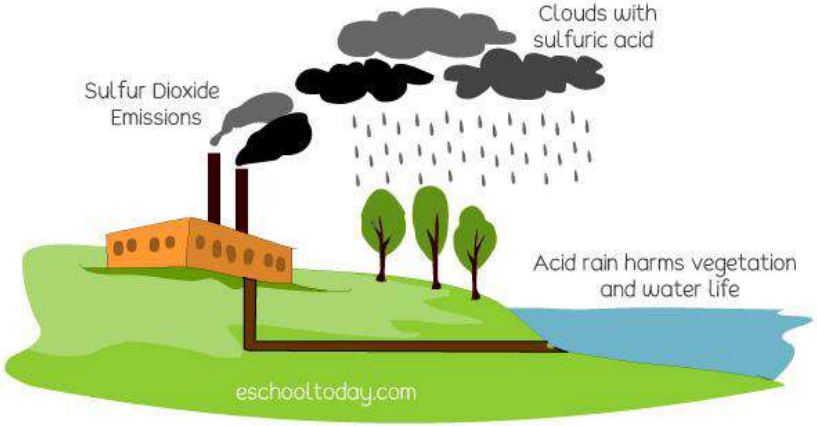
- Air pollution is the **degradation of air quality due** to the contamination of pollutants.
- It was the **4th leading risk factor** for early death worldwide in 2019 **(State of Global Air Report** 2020).
- Industries (51%), Vehicles (27%), and Crop burning (17%) are the largest contributor to Air pollution.

AIR POLLUTION

- **Types of air pollutants:**
  - **Primary pollutants:** Enter the atmosphere directly from their source. E.g. – Co2
  - **Secondary pollutants**: Forms from a chemical reaction of primary pollutants. Ex: Ozone (O3), Acid rain.
  - **Indoor air pollution (IAP):** The poor air quality within and around buildings is called IAP. It is caused by burning solid fuel such as firewood, dung for cooking.
  - **Outdoor (ambient) air pollution**: originates from natural and anthropogenic sources. EX - bushfires, volcanoes, Automobile emission, etc.

AIR POLLUTION

- **Effects on Vegetation:** Retard photosynthesis, Sulphur dioxide causes chlorosis, plasmolysis, membrane damage and metabolic inhibition. Hydrocarbons such as ethylene cause premature leaf fall, fruit drop, shedding of floral buds, curling of petals and discoloration of sepals. Ozone damage chlorenchyma and thus destructs the foliage in large number of plants.



MAJOR AIR POLLUTANTS AND THEIR SOURCES

Gas	Properties	Sources	Impact
Carbon Monoxide (CO)	Colourless, odourless, tasteless and highly toxic gas, slightly less dense than air. Short-lived (stay only a few months) in the atmosphere.	**Anthropogenic:** Incomplete combustion of fuels such as propane, natural gas, gasoline, oil, coal, or wood. **Natural:** volcanic eruptions, forest fires, tropospheric photo-chemical reactions etc. Also, from the combustion of natural and synthetic products such as cigarettes.	**Environmental:** • It is a weak greenhouse gas • Helps formation of ground-level ozone and can elevate concentrations of methane (a strong greenhouse gas) **Health:** • More easily combine with haemoglobin than oxygen, hence, lowers the amount of oxygen that enters our blood. • It can slow our reflexes and make us confused and sleepy.

MAJOR AIR POLLUTANTS AND THEIR SOURCES

Gas	Properties	Sources	Impact
Carbon Dioxide (CO2)	Colourless, odourless greenhouse gas, heavier than air.	**Natural:** volcanoes, hot springs and geysers. **Anthropogenic:** burning of coal, oil, and natural gases. As it is soluble in water, it occurs naturally in groundwater, rivers and lakes, in ice caps and glaciers and also in seawater.	**Environmental:** It is a quantitative pollutant and Principle Greenhouse gas. Since the industrial revolution it has led to global warming. **Health:** CO2 is an asphyxiant gas. Concentrations of CO2 may cause suffocation, dizziness, headache, and unconsciousness, etc.

MAJOR AIR POLLUTANTS AND THEIR SOURCES

Gas	Properties	Sources	Impact
Chloro-Fluoro Carbons (CFC)	Organic chemicals and contain carbon, (sometimes hydrogen,) chlorine, and fluorine.	Released mainly from air-conditioning systems and refrigeration.	**Environmental:** It rise to the stratosphere, come in contact with few other gases, which lead to depletion of the ozone layer that protects the earth from the harmful ultraviolet rays of the sun. **Montreal Protocol:** an international treaty to protect the ozone layer by phasing out the production of numerous substances including CFCs which are responsible for ozone depletion.

MAJOR AIR POLLUTANTS AND THEIR SOURCES

Gas	Properties	Sources	Impact
Ozone (O3)	It is a gas that occurs **both in the Earth's upper atmosphere and at ground level.** Ozone can be '**good' or 'bad'** for our health and the environment, depending on its location in the atmosphere.	**Major source at ground level**: Vehicles and industries. Carbon monoxide, Nitrogen dioxide play a major role in converting O2 to O3.	**Environmental:** Occurs naturally in the upper layers of the atmosphere, shields earth atmosphere from harmful UV rays of the sun. At the ground level, it is a pollutant with highly toxic effects. **Health:** Makes our eyes itch, burn, and water, also lowers our resistance to cold and pneumonia.

MAJOR AIR POLLUTANTS AND THEIR SOURCES

Gas	Properties	Sources	Impact
Nitrogen Oxide (NOx)	Generic term for the various nitrogen oxides produced during combustion.	**Natural:** Lightening Agricultural fertilisation and the use of nitrogen-fixing plants contribute to atmospheric NOx. **Anthropogenic:**Produce from burning fuels including petrol, diesel, and coal.	**Environmental:** NOx gases react to form smog and acid rain. Photochemical Smog produce by the reaction of NOx and volatile organic compounds (VOCs) in the presence of sunlight. **Health:** Irritation and inflammation of lungs, breathlessness, causes bronchitis and asthma.

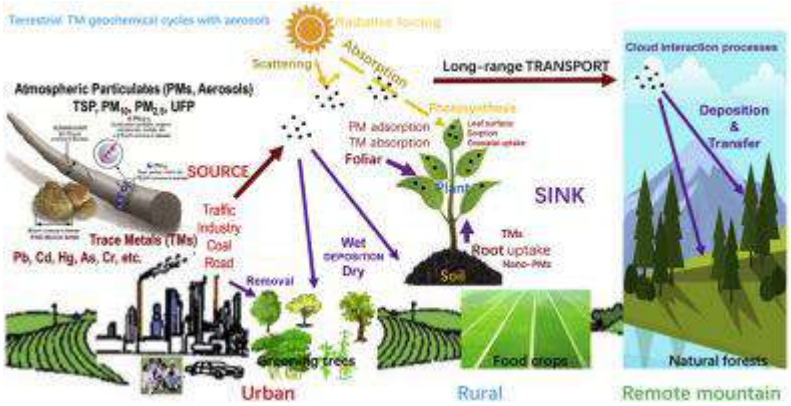
MAJOR AIR POLLUTANTS AND THEIR SOURCES

Gas	Properties	Sources	Impact
Sulphur Dioxide (SO2)	It is a toxic gas with a pungent, irritating smell.	**Natural:** volcanic activity **Anthropogenic:** Produced from burning coal, mainly in thermal power plants. Industrial processes like production of paper and smelting of metals, produce sulphur dioxide.	**Environmental:** Major contributor to smog and acid rain. **Health**: increased respiratory symptoms and premature death.
Volatile Organic Compounds (VOCs)	Large group of carbon-based chemicals that easily evaporate at room temperature	Main indoor sources: perfumes, hair sprays, furniture polish, glues, air fresheners, repellents, wood preservatives, and other products.	**Health:** Irritation of the eye, nose and throat, headaches, nausea and loss of coordination.

PARTICULATE POLLUTANTS

Particulate Matter (PM)

- PM is a mixture of solid particles & liquid droplets found in the air.
- **Sources:** Vehicles, power plants, construction activities, oil refinery, railway yard, industries, etc.
- **PM10:** are inhalable particles sized 10 micrometres or less in diameter.
- **PM2.5:** fine inhalable particles, sized 2.5 micrometres or less in diameter. These are more harmful to health as they move freely with air current & block the tiny pores in our lungs.



PARTICULATE POLLUTANTS

Fly Ash

- Fly ash is ejected mostly by thermal power plants as by-products of coal burning operations.
- Pollutes air and water and may cause heavy metal pollution in water bodies
- It affects crops and vegetation as a result of its direct deposition on leaf surfaces

PARTICULATE POLLUTANTS

Lead

- It presents in petrol, diesel, lead batteries, paints, hair dye products, etc.
- Tetraethyl lead (TEL) is used as an anti-knock agent in petrol for a smooth and easy running of vehicles.
- The lead particles coming out from the exhaust pipes of vehicles is mixed with air.
- Lead mixed with water and food can create cumulative poisoning
- Can cause nervous system damage and digestive problems, cancer, etc. It has long term effects on children as it lowers intelligence.

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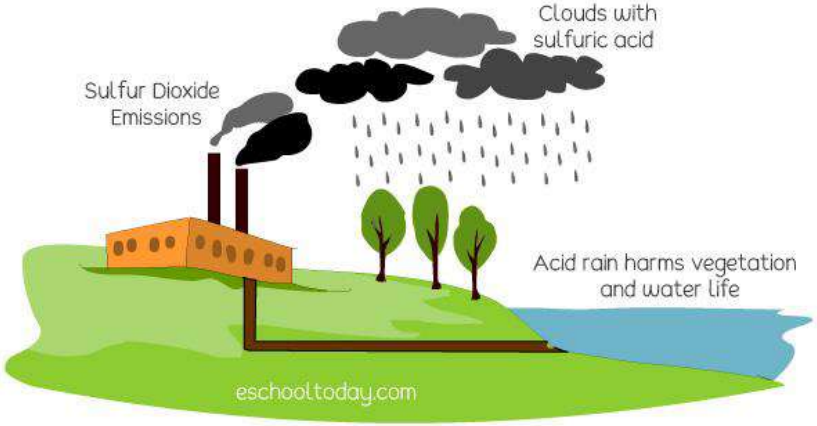
- Industries (51%), Vehicles (27%), and Crop burning (17%) are the largest contributor to Air pollution.

AIR POLLUTION

- **Types of air pollutants:**
  - **Primary pollutants:** Enter the atmosphere directly from their source. E.g. – Co2
  - **Secondary pollutants**: Forms from a chemical reaction of primary pollutants. Ex: Ozone (O3), Acid rain.
  - **Indoor air pollution (IAP):** The poor air quality within and around buildings is called IAP. It is caused by burning solid fuel such as firewood, dung for cooking.
  - **Outdoor (ambient) air pollution**: originates from natural and anthropogenic sources. EX - bushfires, volcanoes, Automobile emission, etc.

AIR POLLUTION

- **Effects on Vegetation:** Retard photosynthesis, Sulphur dioxide causes chlorosis, plasmolysis, membrane damage and metabolic inhibition. Hydrocarbons such as ethylene cause premature leaf fall, fruit drop, shedding of floral buds, curling of petals and discoloration of sepals. Ozone damage chlorenchyma and thus destructs the foliage in large number of plants.



MAJOR AIR POLLUTANTS AND THEIR SOURCES

Gas	Properties	Sources	Impact
Carbon Monoxide (CO)	Colourless, odourless, tasteless and highly toxic gas, slightly less dense than air. Short-lived (stay only a few months) in the atmosphere.	**Anthropogenic:** Incomplete combustion of fuels such as propane, natural gas, gasoline, oil, coal, or wood. **Natural:** volcanic eruptions, forest fires, tropospheric photo-chemical reactions etc. Also, from the combustion of natural and synthetic products such as cigarettes.	**Environmental:** • It is a weak greenhouse gas • Helps formation of ground-level ozone and can elevate concentrations of methane (a strong greenhouse gas) **Health:** • More easily combine with haemoglobin than oxygen, hence, lowers the amount of oxygen that enters our blood. • It can slow our reflexes and make us confused and sleepy.

MAJOR AIR POLLUTANTS AND THEIR SOURCES

Gas	Properties	Sources	Impact
Carbon Dioxide (CO2)	Colourless, odourless greenhouse gas, heavier than air.	**Natural:** volcanoes, hot springs and geysers. **Anthropogenic:** burning of coal, oil, and natural gases. As it is soluble in water, it occurs naturally in groundwater, rivers and lakes, in ice caps and glaciers and also in seawater.	**Environmental:** It is a quantitative pollutant and Principle Greenhouse gas. Since the industrial revolution it has led to global warming. **Health:** CO2 is an asphyxiant gas. Concentrations of CO2 may cause suffocation, dizziness, headache, and unconsciousness, etc.

MAJOR AIR POLLUTANTS AND THEIR SOURCES

Gas	Properties	Sources	Impact
Chloro-Fluoro Carbons (CFC)	Organic chemicals and contain carbon, (sometimes hydrogen,) chlorine, and fluorine.	Released mainly from air-conditioning systems and refrigeration.	**Environmental:** It rise to the stratosphere, come in contact with few other gases, which lead to depletion of the ozone layer that protects the earth from the harmful ultraviolet rays of the sun. **Montreal Protocol:** an international treaty to protect the ozone layer by phasing out the production of numerous substances including CFCs which are responsible for ozone depletion.

MAJOR AIR POLLUTANTS AND THEIR SOURCES

Gas	Properties	Sources	Impact
Ozone (O3)	It is a gas that occurs **both in the Earth's upper atmosphere and at ground level.** Ozone can be '**good' or 'bad'** for our health and the environment, depending on its location in the atmosphere.	**Major source at ground level**: Vehicles and industries. Carbon monoxide, Nitrogen dioxide play a major role in converting O2 to O3.	**Environmental:** Occurs naturally in the upper layers of the atmosphere, shields earth atmosphere from harmful UV rays of the sun. At the ground level, it is a pollutant with highly toxic effects. **Health:** Makes our eyes itch, burn, and water, also lowers our resistance to cold and pneumonia.

MAJOR AIR POLLUTANTS AND THEIR SOURCES

Gas	Properties	Sources	Impact
Nitrogen Oxide (NOx)	Generic term for the various nitrogen oxides produced during combustion.	**Natural:** Lightening Agricultural fertilisation and the use of nitrogen-fixing plants contribute to atmospheric NOx. **Anthropogenic:**Produce from burning fuels including petrol, diesel, and coal.	**Environmental:** NOx gases react to form smog and acid rain. Photochemical Smog produce by the reaction of NOx and volatile organic compounds (VOCs) in the presence of sunlight. **Health:** Irritation and inflammation of lungs, breathlessness, causes bronchitis and asthma.

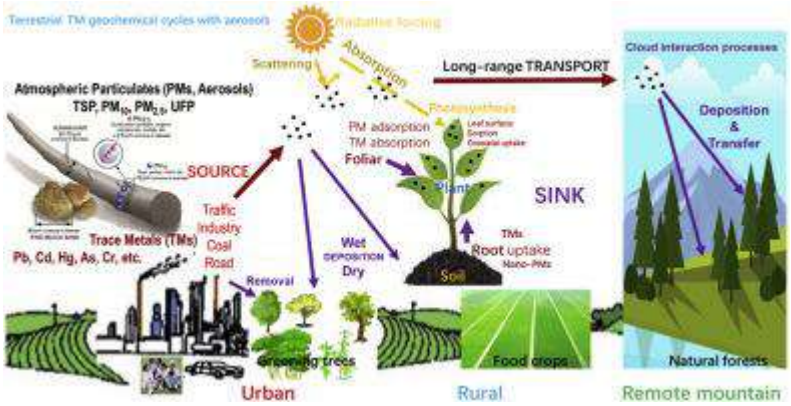
MAJOR AIR POLLUTANTS AND THEIR SOURCES

Gas	Properties	Sources	Impact
Sulphur Dioxide (SO2)	It is a toxic gas with a pungent, irritating smell.	**Natural:** volcanic activity **Anthropogenic:** Produced from burning coal, mainly in thermal power plants. Industrial processes like production of paper and smelting of metals, produce sulphur dioxide.	**Environmental:** Major contributor to smog and acid rain. **Health**: increased respiratory symptoms and premature death.
Volatile Organic Compounds (VOCs)	Large group of carbon-based chemicals that easily evaporate at room temperature	Main indoor sources: perfumes, hair sprays, furniture polish, glues, air fresheners, repellents, wood preservatives, and other products.	**Health:** Irritation of the eye, nose and throat, headaches, nausea and loss of coordination.

PARTICULATE POLLUTANTS

Particulate Matter (PM)

- PM is a mixture of solid particles & liquid droplets found in the air.
- **Sources:** Vehicles, power plants, construction activities, oil refinery, railway yard, industries, etc.
- **PM10:** are inhalable particles sized 10 micrometres or less in diameter.
- **PM2.5:** fine inhalable particles, sized 2.5 micrometres or less in diameter. These are more harmful to health as they move freely with air current & block the tiny pores in our lungs.



PARTICULATE POLLUTANTS

Fly Ash

- Fly ash is ejected mostly by thermal power plants as by-products of coal burning operations.
- Pollutes air and water and may cause heavy metal pollution in water bodies
- It affects crops and vegetation as a result of its direct deposition on leaf surfaces

PARTICULATE POLLUTANTS

Lead

- It presents in petrol, diesel, lead batteries, paints, hair dye products, etc.
- Tetraethyl lead (TEL) is used as an anti-knock agent in petrol for a smooth and easy running of vehicles.
- The lead particles coming out from the exhaust pipes of vehicles is mixed with air.
- Lead mixed with water and food can create cumulative poisoning
- Can cause nervous system damage and digestive problems, cancer, etc. It has long term effects on children as it lowers intelligence.

PARTICULATE POLLUTANTS

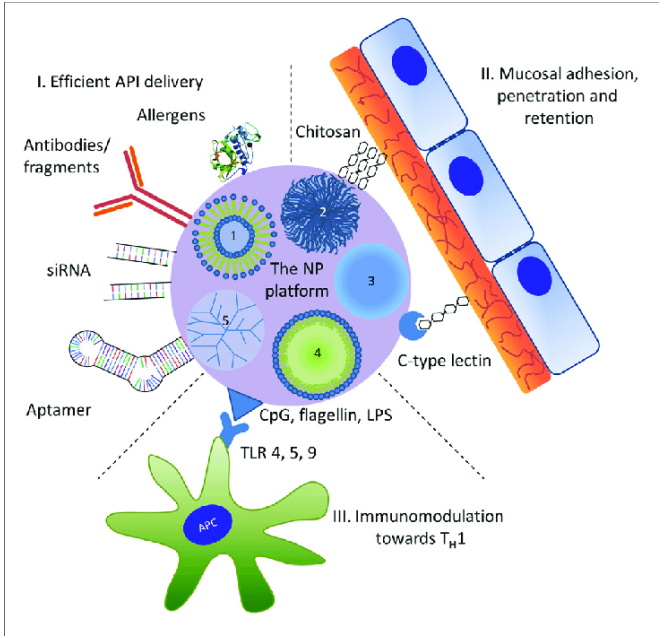
Metallic Oxides

- Oxides of iron, aluminium, manganese, magnesium, zinc and other metals have an adverse effect due to deposition of dust on plants during mining operations and metallurgical processes
- Create physiological, biochemical and developmental disorders in plants and also contribute towards reproductive failure in plants.

PARTICULATE POLLUTANTS

Nanoparticles (NPs)

- Nanoparticles are particles with dimensions comparable to 1/109 of a metre.
- **Natural NPs:** sourced from forest fires, volcanic eruptions, weathering, dust storms etc.
- **Anthropogenic NPs:** unknowingly or purposely released in the environment during various industrial and mechanical processes.
- Quite heterogeneous in size and can be transported over thousands of kilometres and remain suspended in the air for several days.
- It influences dust cloud formation, environmental hydroxyl radical concentration, ozone depletion, or stratospheric temperature change.



PARTICULATE POLLUTANTS

Soot and Dust

- Minute particles of impure carbon particles resulting from incomplete combustion of hydrocarbons.
- Can directly enter the blood streams of living organisms
- These aerosols lead to formation of Asian brown clouds over east and south Asia
- Asian brown clouds carry large amounts of soot and black carbon (NPs) and deposit them on the Himalayan glaciers.

FOG, SMOG, SULFUROUS SMOG, AEROSOLS AND PHOTOCHEMICAL SMOG

Fog

- Fog is a cloud of smoke particles, water droplets, or mixtures of these components suspended in the air.
- Fog usually appears over a region of high pressure where humidity is greater than 75%.
- It reduces visibility & causes accidents.

FOG, SMOG, SULFUROUS SMOG, AEROSOLS AND PHOTOCHEMICAL SMOG

Smog

- Smoke + Fog = Smog (a type of intense air pollution).
- Smog is a harmful mixture of fog, dust & air pollutants such as nitrogen oxides, VOCs, etc.
- **Impacts**: cause itchy, burning eyes, damage lung tissues, cardiac and respiratory disorders, it can kill plants etc.
- **Types**: Sulphurous smog & Photochemical smog

FOG, SMOG, SULFUROUS SMOG, AEROSOLS AND PHOTOCHEMICAL SMOG

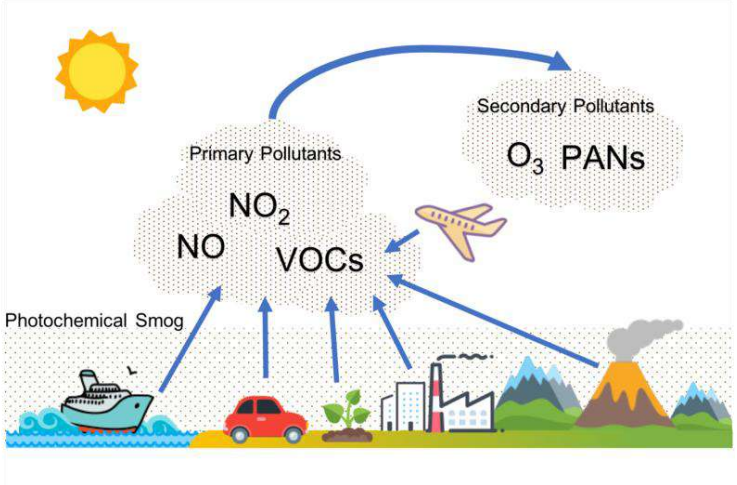
Sulfurous Smog (London Smog)

- This occurs in a cool humid climate.
- It is a mixture of Smoke, Fog & Sulphur Dioxide.
- Chemically, it is a reducing mixture and so it is also called reducing smog.
- It is also called **winter smog or classic smog**.

FOG, SMOG, SULFUROUS SMOG, AEROSOLS AND PHOTOCHEMICAL SMOG

Photochemical Smog

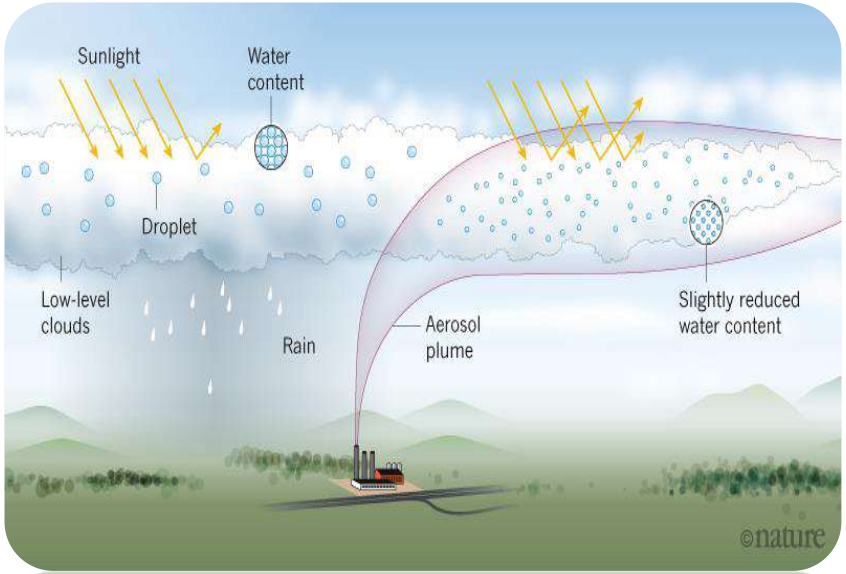
- Produced when **sunlight reacts with Nitrogen Oxides & volatile organic compounds** in the atmosphere which results in the formation of **Bad ozone.**
- It is visible as a brown haze. Contains more oxidizing agents.
- Often referred to **as "summer smog" or "Los Angeles smog,"** it occurs most prominently in urban areas.



FOG, SMOG, SULFUROUS SMOG, AEROSOLS AND PHOTOCHEMICAL SMOG

Aerosols

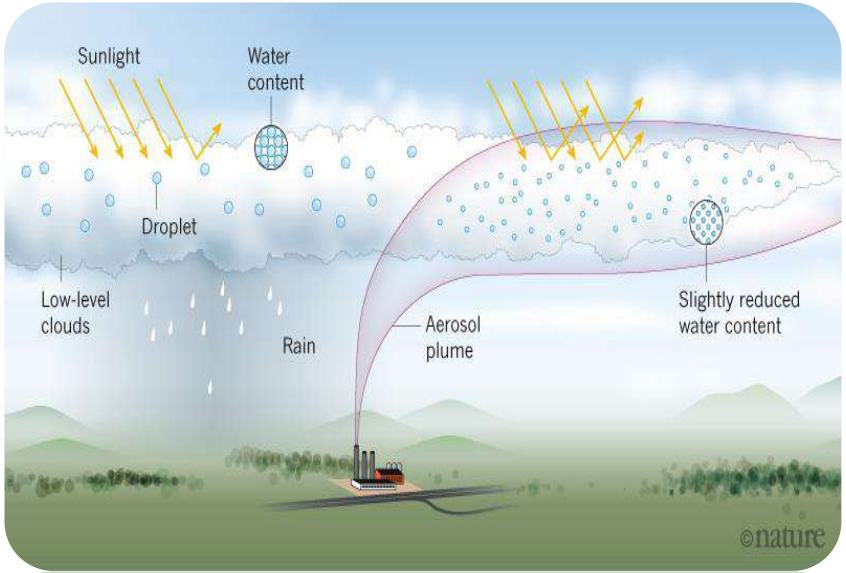
- Aerosols have an outsized effect on the planet's climate. Some of them, like black and brown carbon, warm the Earth's atmosphere, while others, like sulfate droplets, cool it.
- **Atmospheric aerosols affect climate in two important ways:**
  - They cause scattering and absorbing the solar and infrared radiation
  - They change the microphysical and chemical properties of clouds and possibly their lifetime and extent



FOG, SMOG, SULFUROUS SMOG, AEROSOLS AND PHOTOCHEMICAL SMOG

Aerosols

- Aerosols can be transported thousands of kilometers from the sources of origin by winds and upper level circulation in the atmosphere.
- Human activity has increased the amount of aerosols in the atmosphere in several ways like, burning of fossil fuels, using of ammonia as fertilizers, industrial processes too releases a wide variety of aerosols, etc.
- The amount of very fine material generally referred to as **"PM2.5"** particulate matter less than 2.5 microns across has increased by 60 percent since before the Industrial Revolution.



FOG, SMOG, SULFUROUS SMOG, AEROSOLS AND PHOTOCHEMICAL SMOG

Black Carbon:

- It is a component of fine particulate matter formed through the incomplete combustion of fossil fuels, biofuel, and biomass.
- It is a short-lived pollutant with a lifetime of only days to weeks.
- It is one of the main types of particles in soot.
- This could lead to higher absorption of the sun's heat (reduced albedo) and potentially contributing to the increased melting of glaciers.

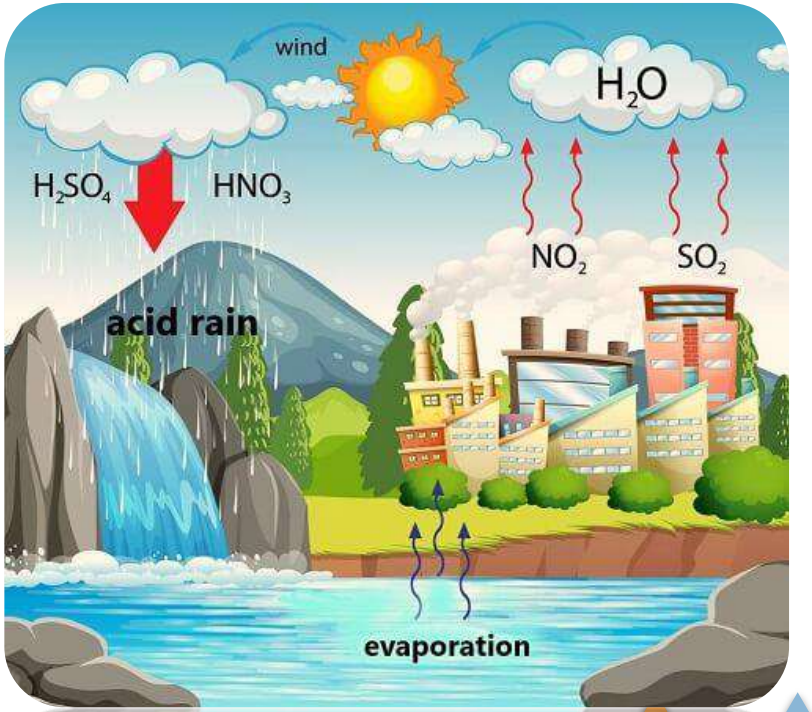
FOG, SMOG, SULFUROUS SMOG, AEROSOLS AND PHOTOCHEMICAL SMOG

Brown Carbon:

- Brown carbon is a ubiquitous and unidentified component of organic aerosol. Biomass burning (possibly domestic wood burning) is shown to be a major source of brown carbon.
- Brown carbon is generally referred for greenhouse gases and black carbon for particles resulting from impure combustion, such as soot and dust.

ACID RAIN

- Normal rain has a **pH of about 5.6** when pH falls below this; it is called **Acid rain (pH 4.2 to 4.4).**
- Acid rain results when Sulphur Dioxide (SO_2) & Nitrogen Oxides (NO_X) react with water, oxygen & other chemicals to form Sulfuric & Nitric acids.
- **Acid Rain (HNO_3 + H_2SO_4)** = NOx + SO_2 + Moisture + other chemicals.
- **Effects**: Harms microorganisms in the soil, inhibit the activity of nitrogen fixation bacteria, soil acidification, ocean acidification, affects the growth of plants, effects on food chain, kill aquatic animals, corrosion of metals & weathering of stone buildings & statues.



FLY ASH

- Fly ash is a fine powder that is **a by-product of burning pulverized coal** in electric power generating plants.
- Indian coal is of low grade with more ash content (30-45 %) compared to imported coal.
- **Main Composition Of Fly Ash**: Silicon dioxide (SiO2), Aluminium oxide (Al2O3) & Calcium oxide (CaO).
- **Minor Constituents**: Arsenic, Beryllium, Boron, Cadmium, Chromium, Hexavalent Chromium, Cobalt, Lead, Manganese, Mercury, Molybdenum, Selenium, Strontium, Thallium, Vanadium, & Un-burnt Carbon.

FLY ASH

- **Negative Effects Of Fly Ash**: It contains acidic, toxic & radioactive matter, Carcinogenic & damages nervous system, causing cognitive defects, developmental delays, and other respiratory diseases.
- **Utilization of Fly Ash:**
  - As a replacement for some of the Portland cement contents.
  - GoI has made it mandatory for use of fly ash bricks in construction activities happening 300 kms around thermal power plants.

FLY ASH

- As soil conditioner for acidic soils. Also, it improves the porosity & water holding capacity of the soil.
- Maharashtra is the first state in India to adopt the Fly Ash Utilization Policy.
- The Govt has launched the ‘ASHTRACK’ mobile app for fly ash utilization.

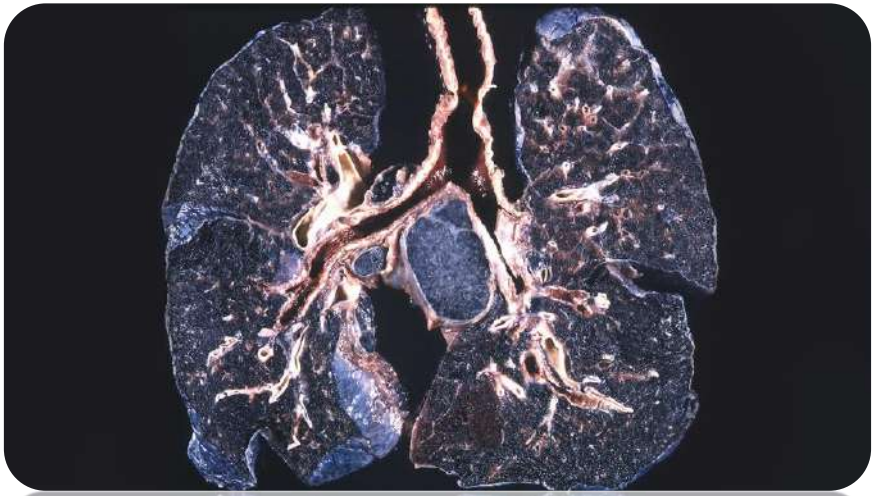
OTHER IMPORTANT POLLUTANTS

Benzene	• **Natural constituent of crude oil and is one of the elementary petrochemicals** • **Benzene has a high-octane number (A measure of the performance of Petrol. The higher is the octane number of fuels, the more compression it can withstand before exploding)** • **Health effects: Increases the risk of cancer and other illnesses. Also it is notorious cause of bone marrow failure.**
Ethylene	• Widely used in the chemical industry • Much of this goes toward polyethylene, a widely used plastic containing polymer chains of ethylene units. • Important natural plant hormone, used in agriculture to force the ripening of fruits. • **Health effects:** headache, drowsiness, dizziness and unconsciousness. Ethylene oxide (not ethylene)is a carcinogen (cancer-causing agent).
Asbestos	• A set of six naturally occurring silicate fibrous minerals: chrysotile, crocidolite, amosite, anthophyllite, tremolite, and actinolite. • Health effects: prolonged inhalation can cause lung cancer, mesothelioma, and asbestosis (a type of pneumoconiosis).
Radon	• Emitted naturally by the soil • Due to modern houses having poor ventilation, it is confined inside the house and causes lung cancers.

OCCUPATIONAL HEALTH HAZARDS

Black lung disease

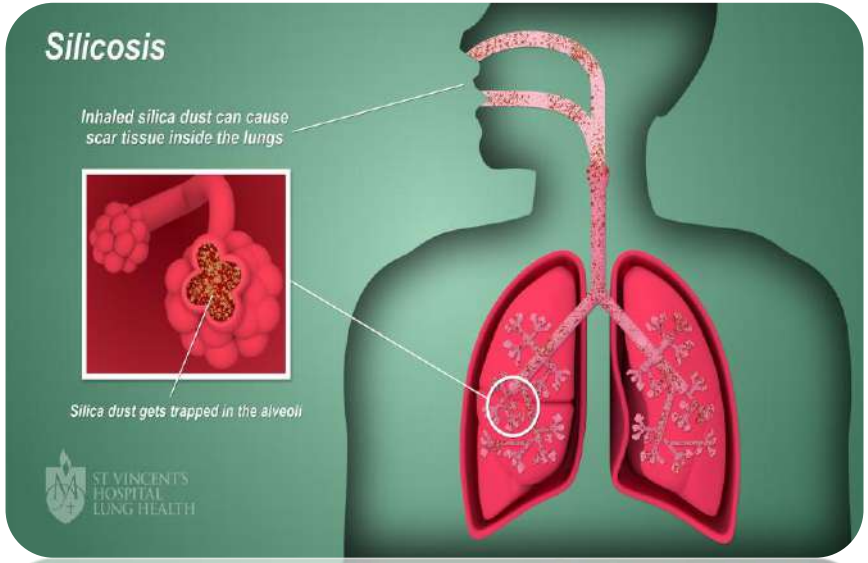
- It is the common name for **pneumoconiosis (CWP) or Anthracosis,** a lung disease of older workers in the coal industry, caused by inhalation over many years, of small amounts of coal dust.
- In coal mining areas coal dust is the main air pollutant. The particles of fine coal dust accumulate in the lungs.
- The deposits of coal dust make miners lungs look black instead of a healthy pink and hence the name black lung disease.



OCCUPATIONAL HEALTH HAZARDS

Silicosis

- It is a **progressive lung disease caused by inhalation of silica** over a long period of time.
- Silicosis is characterized by shortness of breath, cough, fever and bluish skin.
- Silicosis is an incurable condition with its potential to cause permanent physical disability.
- Silicosis occurs most commonly in people working in the quarrying, manufacturing, and building construction industries.
- In 2019 **Saharia tribe** miners in Madhya Pradesh have appealed to the government to treat them for silicosis rather than Tuberculosis.



OCCUPATIONAL HEALTH HAZARDS

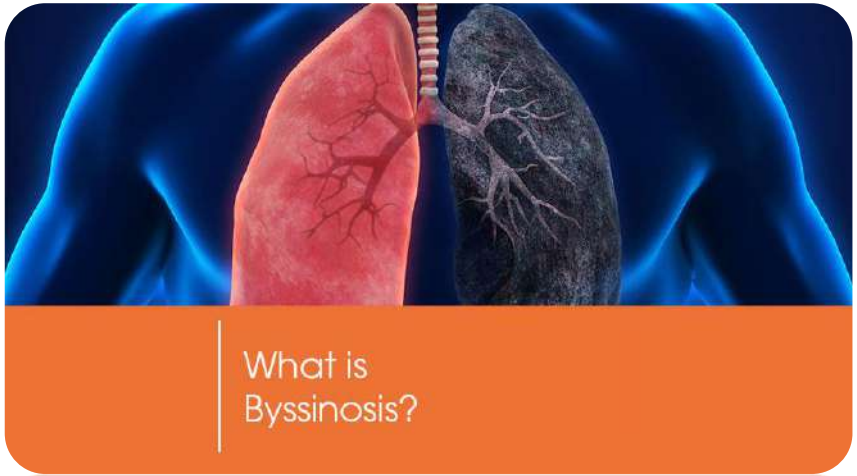
Pneumoconiosis

- It is the general term for a class of **interstitial lung diseases** (the tissue and space around the alveoli) where inhalation of dust has caused interstitial fibrosis.
- It is **occupational health disease** and mostly affects workers who work and inhale toxic dust in the mining and construction sectors, esp. in mica and textile industry.

OCCUPATIONAL HEALTH HAZARDS

Byssinosis

- It is an occupational lung disease caused by exposure to cotton dust in inadequately ventilated working environments.
- Commonly occurs in workers who are employed in yarn and fabric manufacture industries



OCCUPATIONAL HEALTH HAZARDS

Asbestosis

- It is a **chronic, inflammatory lung disease caused due to prolonged exposure** to asbestos.
- Commonly occurs in **workers associated with asbestos industry.**
- Asbestos also causes malignant diseases such as lung cancer, pleural mesothelioma and peritoneal mesothelioma.
- Recently, there have been allegations against Johnson & Johnson that its Baby Powder (talcum powder) contains asbestos which can cause Mesothelioma, a type of rare cancer.

AIR POLLUTION IN INDIA

- **As per WHO:** India's air pollution, ranked among the worst in the world is adversely impacting the lifespan of its citizens, reducing most Indian lives by over three years.
- Of the world's top 20 polluted cities, 13 are in India. Air pollution slashes life expectancy by 3.2 years for the 660 million Indians who live in cities.
- **Sources of pollutants:** ranging from agriculture waste burning, power utilities, industry, dust, transport and waste which account for nearly 95% of the sources of air pollution.

GOVERNMENT INITIATIVES TO COUNTER AIR POLLUTION

The Air (Prevention & Control of Pollution) Act 1981

- It was enacted to prevent, control& abate air pollution.
- Under this Act, all industries operating within designated air pollution control areas must obtain a permit from the State Boards.
- The states are required to prescribe emission standards for industry & automobiles.
- It expanded the authority of the CPCB to include Air Pollution under it.
- The 1987 amendment introduced a citizen's suit provision into the Air Act & extended the Act to include Noise pollution.

GOVERNMENT INITIATIVES TO COUNTER AIR POLLUTION

Bharat Stage Norms

- These are emission standards to reduce vehicular pollution.
- Norms **set by CPCB** (Central Pollution Control Board) under the MoEF&CC.
- India **introduced emission norms in 1991 & BS-1 in 2000 based on European standards**.
- India **skipped BS-V** & moved to BS-VI norms directly in 2020.
- BS-VI fuel is estimated to bring **around 80% reductions in Sulphur content.**
- BS-VI will cut down the harmful NOx (Nitrogen Oxides) from diesel cars by nearly 70% and 25% in the petrol cars.
- BS-VI will bring down the cancer-causing PM in diesel cars by a phenomenal 80%.

GOVERNMENT INITIATIVES TO COUNTER AIR POLLUTION

National Air Quality Index (NAQI)

- CPCB **launched AQI in 2014 under the Swachh Bharat Abhiyan** to disseminate information on air quality in an easily understandable form for the general public.
- It transforms complex air quality data of 8 pollutants into a single number, nomenclature, color.
- AQI has **six categories** of air quality.
- **Eight pollutants**: Particulate Matter (PM10), Particulate Matter (PM2.5), Nitrogen Dioxide (NO2), Sulphur Dioxide (SO2), Carbon Monoxide (CO), Ozone (O3), Ammonia (NH3), and Lead (Pb).

GOVERNMENT INITIATIVES TO COUNTER AIR POLLUTION

Air Quality Early Warning System (AQEWS)

- An initiative of the **Ministry of Earth Sciences and Environment (MoES).**
- **Objective**: To predict extreme air pollution events over the Delhi region & give alerts to take necessary steps as per the **Graded Response Action Plan (GRAP).**
- It uses data of stubble burning incidents from the past 15 years to predict and help authorities to act in advance.
- It is developed by the **Indian Institute of Tropical Meteorology (IITM), Pune.**

GOVERNMENT INITIATIVES TO COUNTER AIR POLLUTION

System of Air Quality and Weather Forecasting And Research (SAFAR)

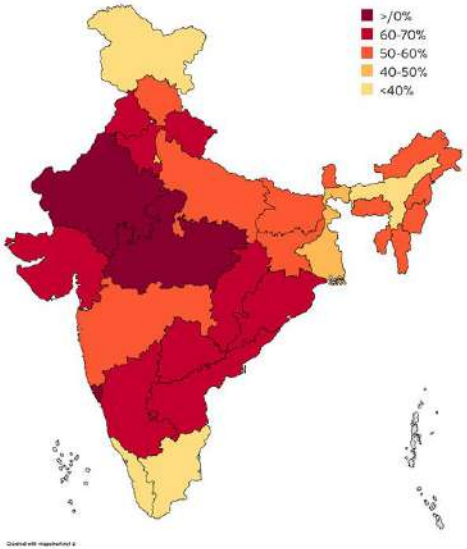
- It was **indigenously developed by Indian Institute of Tropical Meteorology, Pune**.
- It is **run by India Meteorological Department (IMD).**
- **Objective**: to provide Real-time air quality index on 24×7 basis with colour coding along with 72-hour advance weather forecast.
- Another goal is to issue health advisory to prepare citizens well in advance.

SAFAR

GOVERNMENT INITIATIVES TO COUNTER AIR POLLUTION

National Ambient Air Quality Standards (NAAQS)

- Notified **by CPCB** (under powers given to it by Air Act, 1981) **in 2009.**
- **It covers 12 pollutants**: Sulphur Dioxide, Nitrogen Dioxide, PM10, PM2.5, Ozone, Lead, Carbon Monoxide, Ammonia, Benzene, Benzo Pyrene, Arsenic, Nickel.



GOVERNMENT INITIATIVES TO COUNTER AIR POLLUTION

Graded Response Action Plan (GRAP)

- It is a set of stratified actions to enforce in the NCR if the pollution level reaches a certain specified limit.
- It was **formulated by Environment Pollution (Prevention & Control) Authority (EPCA)** on the advice of the Supreme Court in 2016.
- **Objective**: To specify actions required to control air pollution, when the air quality moves from 'Poor' to 'Very Poor' on AQI.
- GRAP works **only as an emergency measure, not throughout the year.**
- These measures were **earlier implemented in Delhi only.** However recently GRAP has been **extended to the NCR towns also.**

GOVERNMENT INITIATIVES TO COUNTER AIR POLLUTION

Continuous Ambient Air Quality Monitoring System (CAAQMS)

- It will monitor air pollution of the city on a real-time basis and its readings will be considered a benchmark of quality
- It includes measuring pollutants like SO2, NO, NO2, NH3, CO, O3, VOC, and particulate matters (PM 10 and PM 2.5).
- It will also display relative humidity, ambient temperature, solar radiation, wind speed and direction, barometric pressure and rain gauge.
- The data so collected can be remotely monitored on the internet and can also be published in various desired formats for public awareness.

GOVERNMENT INITIATIVES TO COUNTER AIR POLLUTION

CENTRAL POLLUTION CONTROL BOARD (CPCB) OF INDIA

- The CPCB is a **statutory organization** established **under** the **Water** (Prevention and Control of Pollution) **Act, 1974**.
- It is also **entrusted with the powers & functions under** the **Air** (prevention and control of pollution) **Act,** 1981.
- It works under the Ministry of Environment, Forest & Climate Change **(MoEF&CC)**.
- **Important functions**:
  - To prevent, control & abate water & air pollution in the country
  - To provide technical services to the MoEF&CC under the provisions of the Environment (Protection) Act, 1986
  - Collect, compile & publish technical and statistical data relating to water and air pollution.

LOW-EMISSION (GREEN) CRACKERS

- These are produced using less harmful raw materials & have additives which reduce emissions by suppressing dust.
- Developed by **CSIR-NEERI**
- Names of these crackers are: "Safe Water Releaser (SWAS)", "Safe Minimal Aluminium (SAFAL)" & "SAFE THERMITE CRACKER (STAR)".
- Firecrackers are regulated by **PESO**.
- PESO (Petroleum & Explosives Safety Organisation) is an office under the Department for Promotion of Industry & Internal Trade, Ministry of Commerce and Industries.

ENVIRONMENT POLLUTION CONTROL AUTHORITY (EPCA)

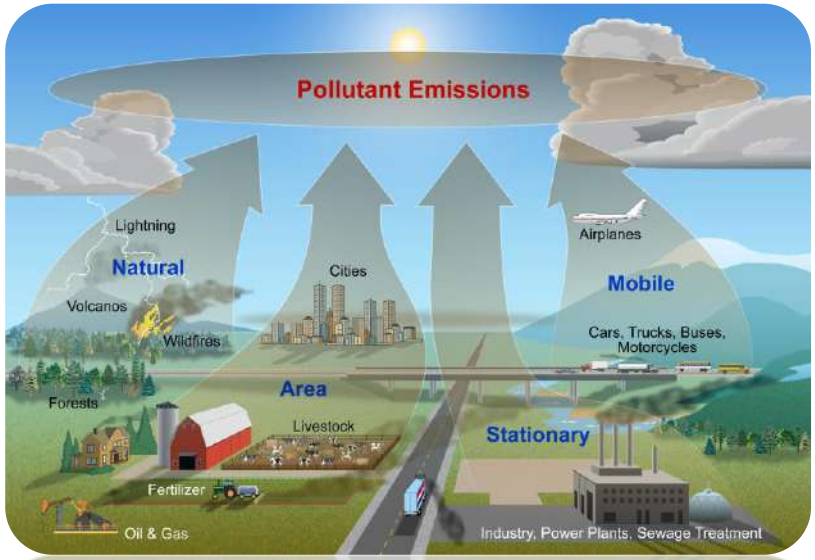
- EPCA is **Supreme Court mandated statutory body**, Notified by MoEF&CC in 1998 **under Environment Protection Act, 1986.**
- **Objective**: to protect and improve the environmental quality & pollution control in the NCR-National Capital Region (Delhi).
- **Enforces Graded Response Action Plan (GRAP)** in NCR as per the pollution levels.
- EPCA has the power to take action suo-moto.

AIR POLLUTION IN DELHI

- Air quality in Delhi is the worst of any major city in the world - WHO

Causes of air pollution:

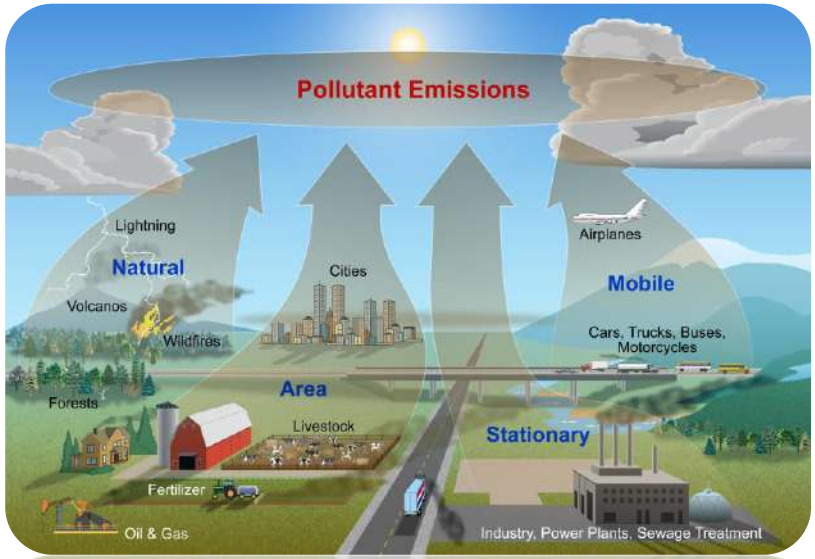
- It is a yearly problem and seasonal.
- **Geography:** change in wind direction during winter (northwesterly), dip in wind speed, & dust storms (from the Gulf) make the landlocked Delhi region more prone to pollution.
- Vehicular Pollution& firecrackers
- Emissions from nearby industries & thermal power plants.
- Stubble burning in surrounding states.



AIR POLLUTION IN DELHI

Measures taken to tackle:

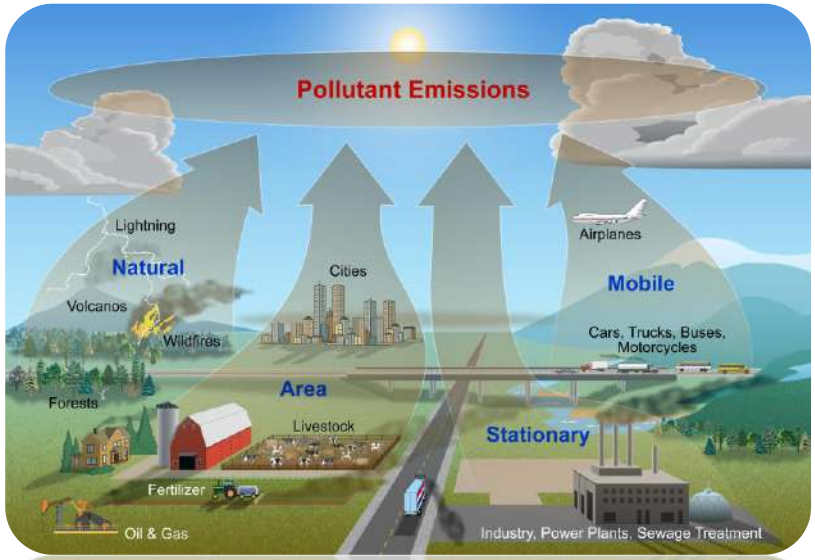
- Introduction of BS-VI vehicles, push for electric vehicles (EVs), Odd-Even scheme to reduce vehicular pollution.
- Delhi is the 1st city in India running with BS-VI fuels & scheduled to use Hydrogen-CNG
- Implementation of the GRAP
- Subsidy to farmers for buying **Turbo Happy Seeder** to reduce stubble burning. **Happy Seeder** is a tractor-mounted machine that cuts & lifts rice straw, sows wheat into the bare soil, and deposits the straw over the sown area as mulch.



AIR POLLUTION IN DELHI

Measures taken to tackle:

- **Torrefaction**: thermal process to convert biomass into a coal-like material, which has better fuel **characteristics** than the original biomass. Torrefied biomass is more brittle, making grinding easier & less energy-intensive.
- Development of the National AQI for public information.
- The initiative of '**The Great Green Wall of Aravalli'** green ecological corridor along with Aravalli range from Gujarat to Delhi.



HYDROGEN- COMPRESSED NATURAL GAS (HCNG)

- HCNG is a hydrogen-enriched Compressed Natural Gas (CNG).

Benefits:	• **Cleaner, safer & more economical than CNG.** • **It reduces the engine's unburned hydrocarbon emissions and speeds up the process of combustion.** • **Ensures 70% more Carbon Monoxide reductions compared to CNG.**
Concerns :	• It requires new infrastructure to prepare HCNG • Determining the most optimized H2/ NG (Natural Gas) ratio • Costlier than CNG

THE GREAT GREEN WALL OF ARAVALLI

- It will be a 1,400km long & 5km wide **green belt from Gujarat to the Delhi-Haryana border**.
- The **'Green wall'** idea mooted in the COP14 of **UNCCD**, India in 2019.
- It intends **to restrict** land degradation & the eastward march of the **Thar Desert**.
- Also, it will **act as a barrier for dust** coming from the deserts in western India and Pakistan.

NATIONAL CLEAR AIR PROGRAMME (NCAP)

- It was launched **by the MoEF&CC in 2019**
- It is the **first-ever effort** by India **to frame a national framework** for air quality management with a **time-bound reduction** target.
- **Objective**: to reduce particulate matter (PM) pollution by 20-30% in at least 102 **non-attainment cities** by2024 with 2017 as the base year.
- **Non-attainment cities**: These are those that have fallen short of the NAAQS for over five years.

NITROGEN POLLUTION

- Nitrogen **becomes a pollutant when it escapes into the environment & reacts with other organic compounds.**
- **Sources:** Agriculture, fossil fuel burning sewage etc.,
- **Impacts:** global warming, acid rain and eutrophication etc.,
- **UNEP's Colombo Declaration**: Aims to halve Nitrogen waste by 2030
- **International Nitrogen Initiative:** Joint initiative of UNEP & Global Environmental Facility

NOTABLE DISASTERS

Chemical Disasters	• **Bhopal gas tragedy, 1984** • **Caused by Methyl Iso Cyanide (MIC) gas leak from the Union Carbide Factory, Bhopal.** • **MIC is used in the manufacture of polyurethane foam, pesticides, & plastics.**
	• Visakhapatnam Gas leak, 2020 • Caused by Styrene gas leak at the LG Polymers chemical plant, Vizag. • Styrene (C6H5CH=CH2) is a flammable liquid (can evaporates easily) used in the manufacturing of polystyrene plastics, fiberglass, rubber, & latex. • Exposure to Styrene can cause Irritation to the eyes, skin, nose & damages Central nervous system and kidney.
Nuclear Disasters	• The Chernobyl disaster, 1986, Ukraine (the then USSR). • Fukushima Daiichi nuclear disaster in Japan, 2011.

NOTABLE DISASTERS

India's UNFCCC commitments (Intended Nationally Determined Contributions)

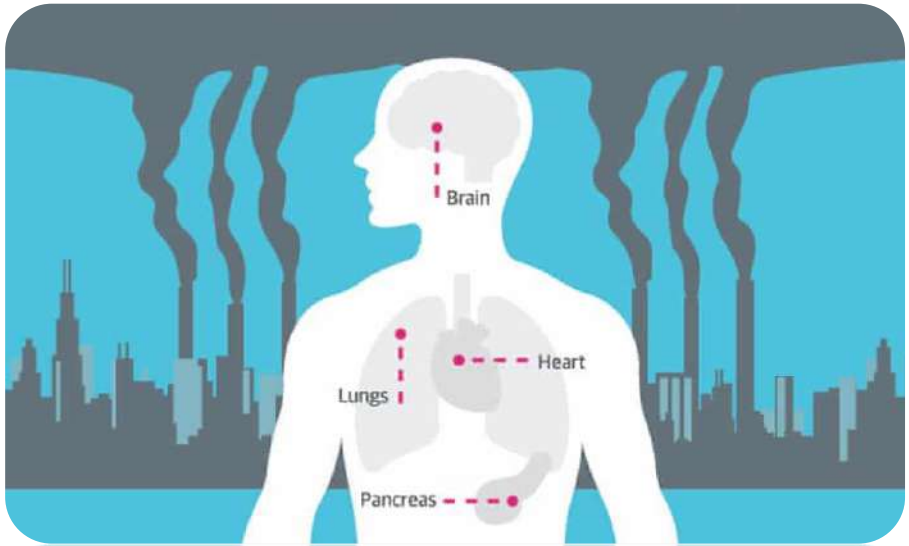
- Improve the emissions intensity of its GDP by 33 to 35 per cent by 2030 below 2005 levels.
- Increase the share of non-fossil fuels based electricity to 40 per cent by 2030.
- Enhance forest cover which will absorb 2.5 to 3 billion tonnes of carbon dioxide by 2030.

OZONE POLLUTION

- Ozone can be good or bad, depending on where it is found. It is a secondary pollutant.
- Stratospheric ozone is good ozone that protects the earth from UV radiation.
- Ground-level ozone, which is bad ozone, is a colourless & highly irritating gas that forms just above the earth's surface (lower troposphere).

OZONE POLLUTION

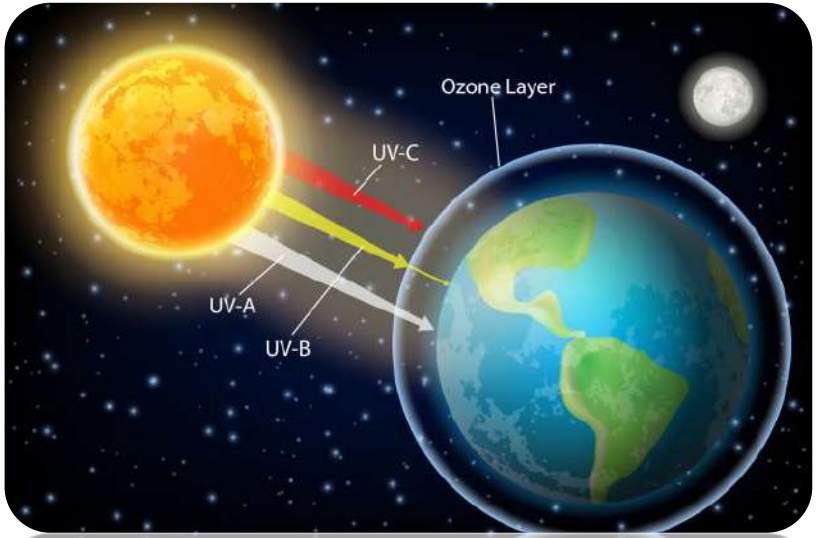
- **Harmful effects:**
  - Health problems including chest pain, coughing, throat irritation, reduced lung function, can worsen bronchitis, emphysema, & asthma
  - It inhibits photosynthesis thus, slows down plant growth & reduces CO2 absorbing ability.
  - Decreased photosynthesis increases CO2 concentration in the atmosphere.



OZONE POLLUTION

Ozone Depletion:

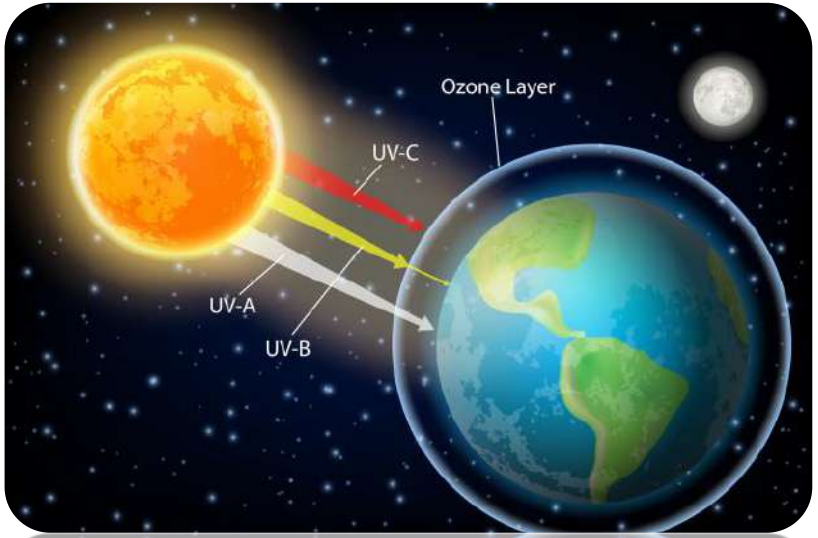
- The gradual decline in the concentration of ozone in the stratosphere, especially over the polar areas, is known as ozone depletion or ozone hole.
- **Depletion of ozone is due to increase in halocarbons:** chloro-carbons, bromo-carbons etc.
- Ozone depleting substances are dissociated under sunlight to form free radicals like chlorine atoms that destroy the ozone molecule.



OZONE POLLUTION

Ozone Depletion:

- **Ozone depleting substances**: halocarbon refrigerants, solvents, propellants, and foam-blowing agents (Chlorofluorocarbons (CFC), Hydrochlorofluorocarbons (HCFC), Hydrobromofluorocarbons (HBFC), Halons (used in fire extinguishers), Methyl Bromide, Carbon Tetrachloride, Methyl Chloroform etc.



INTERNATIONAL EFFORTS TO MITIGATE OZONE DEPLETION

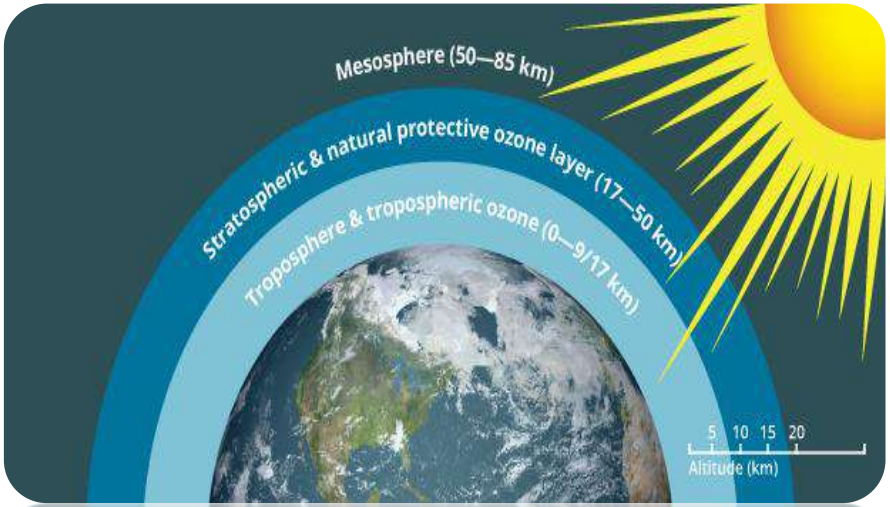
Vienna Convention for The Protection of The Ozone Layer

- Vienna Convention for the Protection of the Ozone Layer (Vienna Convention) was **agreed in 1985.**
- It **established global monitoring and reporting on ozone depletion.**
- It does **not include legally binding reduction goals** for the use of CFCs, the main chemical agents causing ozone depletion.
- It also created a framework for the development of protocols for taking more binding action.
- These are **laid out in the accompanying Montreal Protocol legally binding.**

INTERNATIONAL EFFORTS TO MITIGATE OZONE DEPLETION

Montreal Protocol

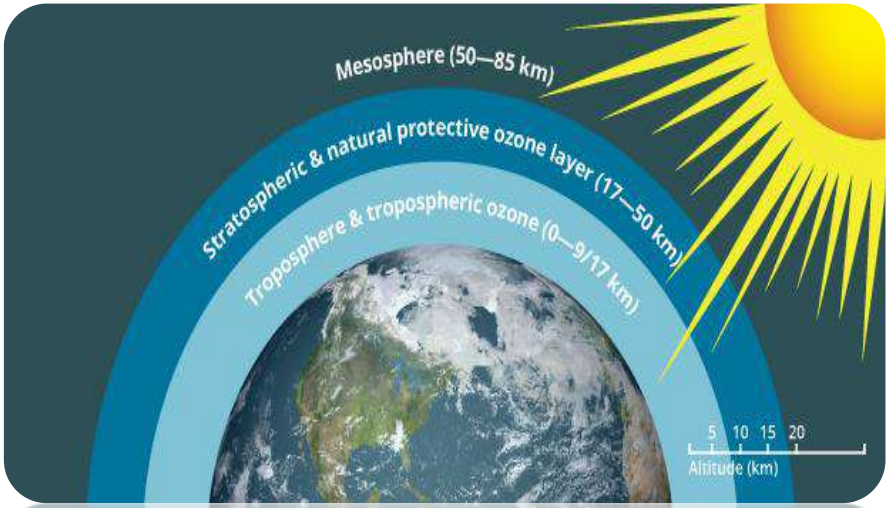
- Montreal Protocol **under the Vienna Convention (the protocol)** was agreed in 1987.
- It facilitates global cooperation in reversing the rapid decline in atmospheric concentrations of ozone.
- Under the protocol **countries agreed to phase out the production and consumption of certain chemicals that deplete ozone.**



INTERNATIONAL EFFORTS TO MITIGATE OZONE DEPLETION

Montreal Protocol

- Phase out of these substances is required by **specific deadlines.**
- Vienna Convention and its Montreal Protocol are the **first and only global environmental treaties to achieve universal ratification, with 197 parties.**
- As a result of the international agreement, the **ozone hole in Antarctica is slowly recovering.**
- Climate projections indicate that the ozone layer will return to 1980 levels between 2050 and 2070.



INTERNATIONAL EFFORTS TO MITIGATE OZONE DEPLETION

Kigali Amendment to Montreal Protocol 2016

- In the 28th meeting of the Parties (2016) to the Montreal Protocol, negotiators from 197 nations have **signed an agreement to amend the Montreal Protocol in Kigali.**
- The parties are expected **to reduce the manufacture and use of Hydrofluorocarbons (HFCs) by roughly 80-85% from their respective baselines, till 2045.**

INTERNATIONAL EFFORTS TO MITIGATE OZONE DEPLETION

Kigali Amendment to Montreal Protocol 2016

- This phase down is **expected to arrest the global average temperature rise up to 0.5 °C by 2100.**
- It is a **legally binding agreement** between the signatory parties with non-compliance measures.
- It came into effect **from 1st January 2019.**

INTERNATIONAL EFFORTS TO MITIGATE OZONE DEPLETION

Gothenburg Protocol, 1999

- Aims **to Abate Acidification, Eutrophication & Ground-level Ozone.**
- Also **known as the Multi-effect protocol**, was adopted by the countries of UNECE (United Nations Economic Commission for Europe).
- The protocol sets national emission ceilings for 2010 up to 2020 for four pollutants: Sulphur dioxide, Nitrogen Oxides (NOx), volatile organic compounds (VOCs) & Ammonia (NH3).
- Protocol also is a **part of the convention on long Range Transboundary Air Pollution**.

INTERNATIONAL EFFORTS TO MITIGATE OZONE DEPLETION

Ozone Depleting Substances (Regulation and Control) Rules:

- The ODS (Regulation and Control) Rules, 2000 **under the Environment (Protection) Act**, in July 2000.
- These Rules **set the deadlines for phasing out of various ODSs, besides regulating production, trade import and export** of ODSs and the product containing ODS.
- Ozone Depleting Substances (Regulation and Control) Rule, 2000 was **amended in 2001, 2003, 2004, 2005 and 2019** to facilitate implementation of ODS phase-out at enterprises in various sectors.

INTERNATIONAL EFFORTS TO MITIGATE OZONE DEPLETION

Ozone Depleting Substances (Regulation and Control) Rules:

- These Rules **prohibit the use of CFCs in manufacturing various products beyond 1st January 2003,** except in metered dose inhaler and for other medical purposes.
- Further, the **use of methyl bromide has been allowed upto 1st January 2015**. Since HCFCs are used as interim substitutes to replace CFC, these are **allowed upto 1st January 2040.**
- MoEFCC issued a **notification to prohibit the issuance of import license for HCFC-141b from January 1, 2020,** under ODS (Regulation and Control) Amendment Rules, 2019 issued under the Environment (Protection) Act, 1986

INTERNATIONAL EFFORTS TO MITIGATE OZONE DEPLETION

Ozone Depletion Is Strongest Over The Poles And In The Winters

- During winters, polar vortices are strengthened, especially in southern hemisphere. This leads to formation of polar stratospheric clouds which contain water, nitric acid, sulfuric acid etc. Such clouds accelerates the process of ozone depletion.

WATER POLLUTION

- Water pollution is the **contamination of water bodies,** usually as a result of human activities.
- Types of sources:
  - **Point pollution sources**, where the source is a well-defined location.
  - **Non-point pollution sources,** which are spread over larger areas.
- **Causes**: Agricultural sources, Sewage water, Industrial effluents, Thermal Pollution, Oil-spills, ships & other economic activities.
- **Effects**: Decline on Dissolved oxygen, Increase in BOD, Death of Aquatic species, Eutrophication etc.

DO VS BOD VS COD

Dissolved Oxygen (DO)	Biological Oxygen Demand (BOD)	Chemical Oxygen Demand (COD)
• The amount of oxygen that is present in water. • Oxygen is poorly soluble in water. Its solubility is related to Pressure & Temperature. • The higher the temperature, the lower is the DO levels in the water. • During summer due to increased biological oxidation, the DO level reduces.	• The amount of oxygen required by microorganisms for the aerobic decomposition of organic matter in the water body. • It is a measure of the amount of oxygen required to remove waste organic matter from water. • It is used as an indicator of the degree of pollution. • The greater BOD indicates the lower amount of DO available in the water.	• Measures the amount of oxygen in ppm required to oxidize organic and oxidizable inorganic compounds in the water sample. • Breakdown of organic matter is done by chemical reagents. • CoD is a slightly better mode used to measure pollution load in the water than BoD.

MAJOR INDUSTRIES/SECTORS AND WATER POLLUTANTS

Industry	Water Pollutants
Mining	• Chlorides, various metals, ferrous sulphate, sulphuric acid, hydrogen sulphide, ferric hydroxide, surface wash offs, suspended solids, chlorides and heavy metals
Iron and Steel	• Suspended solids, iron cyanide, thiocyanate, sulphides, oxides of copper, chromium, cadmium, and mercury
Pharma	• Organic solvent, intermediate products, drugs and antibiotics
Paper and Pulp	• Sulphides, bleaching liquors, organic acids.
Chemical Industries	• Various acids and alkalies, chlorides, sulphates, nitrates of metals, phosphorus, fluorine, silica and suspended particles, aromatic compounds solvents

MAJOR INDUSTRIES/SECTORS AND WATER POLLUTANTS

Industry	Water Pollutants
Agricultural Runoff	• It contains dissolved salts such as nitrates, phosphates, ammonia and other nutrients from fertilisers and chemical toxins (such as pesticides, insecticides like DDT, Endosulfan etc.) which ultimately flow into the surface water bodies and also leach into the groundwater.
Thermal Pollution	• Nuclear and thermal power plants, chemical and other industries use a lot of water for cooling purposes, and the used hot water is discharged into rivers, streams or oceans, which may increase the temperature of the water and leads to decrease of dissolved oxygen in the water. • Aquatic organisms are more sensitive to temperature changes, thus a sudden rise in temperature is very harmful to marine flora and fauna.
Groundwater Pollution:	• In India at many places, the ground water is threatened with contamination due to seepage from industrial and municipal wastes and effluents, sewage channels and agricultural runoff.

MARINE POLLUTION

- Oceans are the ultimate sink of all natural and manmade pollutants from dumping of sewerage and garbage to navigational discharge of oil, grease, detergents, oil spills, etc.
- Oil being lighter than water covers the water surface as a thin film cutting off oxygen to floating plants and other producers.
- Plastics and microplastics are a major pollutant in the marine waters as they are not decomposed naturally. Microplastics can enter the marine food chain and cause bioaccumulation and biomagnification.

MARINE POLLUTION

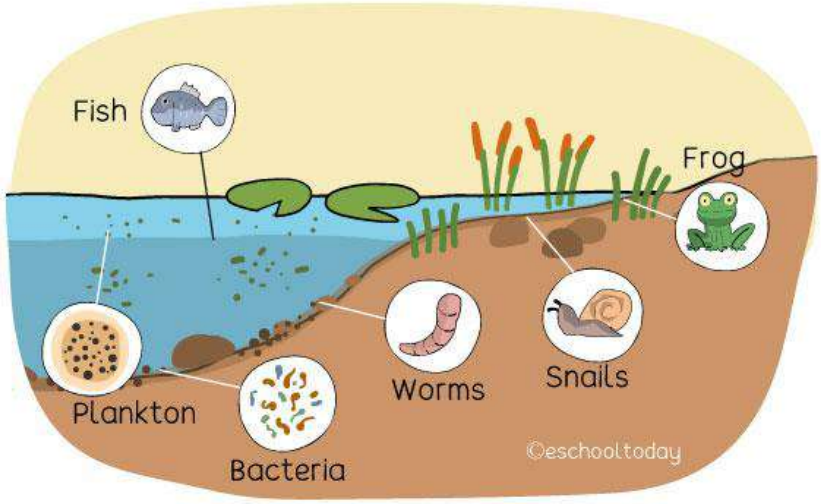
International Conventions To Mitigate Marine Pollution:

- Convention on Dumping Wastes at Sea or London Convention.
- 1996 Protocol to the Convention on the Prevention of Marine Pollution and 2006 amendments to the protocol.
- United Nations Convention on Law of the Sea.

EFFECTS OF WATER POLLUTION

On aquatic ecosystem

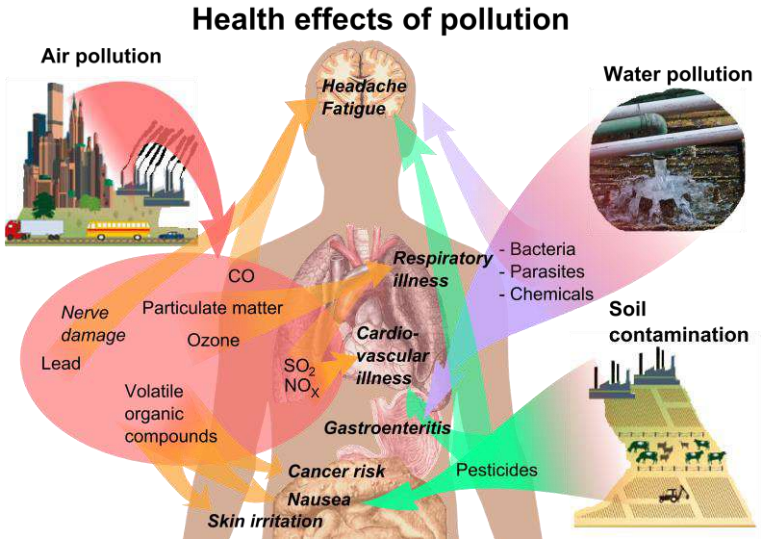
- Polluted water reduces Dissolved Oxygen (DO) content, thus eliminates sensitive organisms like plankton, molluscs and fish etc.
- Biocides, polychlorinated biphenyls (PCBs) and heavy metals directly eliminate sensitive aquatic organisms.
- Hot waters discharged from industries, when added to water bodies, lowers its Dissolved Oxygen (DO)



EFFECTS OF WATER POLLUTION

On human health

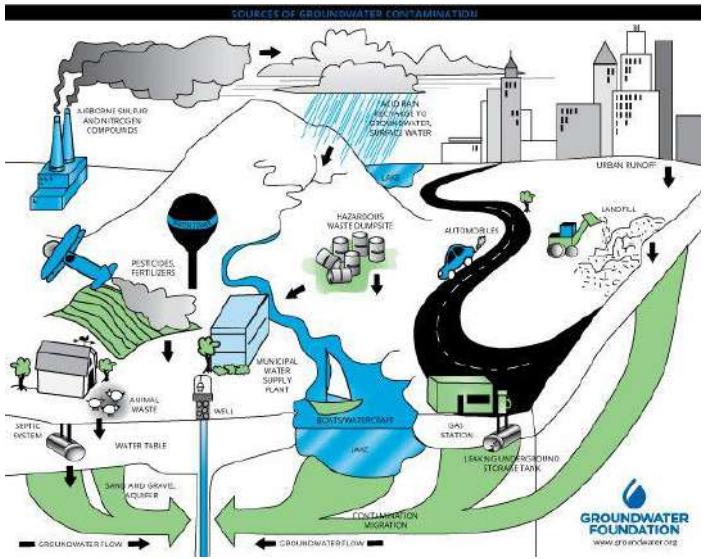
- Polluted water usually **contains pathogens** like virus, bacteria, parasitic protozoa and worms, a source of water borne diseases like jaundice, cholera, typhoid, amoebiasis etc.
- **Mercury compounds** in waste water are converted to toxic methyl mercury, causes numbness of limbs, lips and tongue, deafness, blurring of vision and mental derangement.
- Water contaminated with cadmium can **cause itai itai disease also called ouch-ouch disease.**
- **Compounds of lead cause**: anaemia, headache, loss of muscle power and bluish line around the gum.



EFFECTS OF WATER POLLUTION

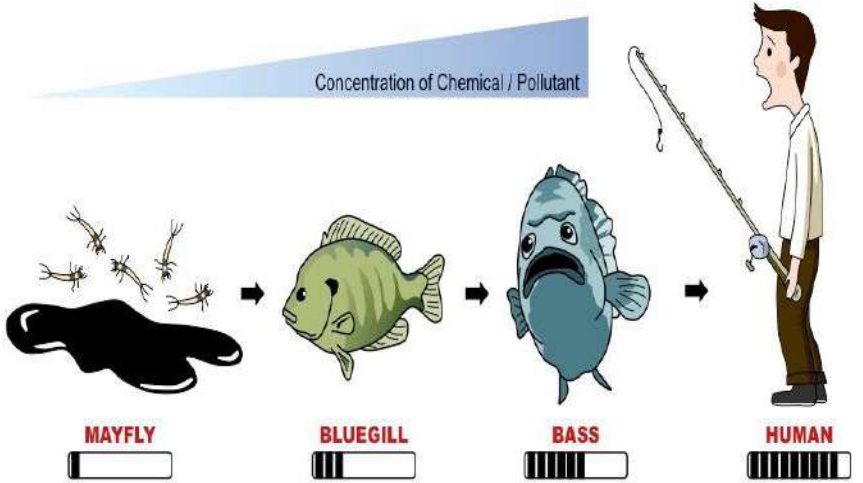
Hazards of ground water pollution

- Presence of **excess nitrate in drinking water** is dangerous for human health and may be fatal for infants **(blue baby syndrome)**.
- **Excess fluoride in drinking water causes**: neuro-muscular disorders, gastro-intestinal problems, teeth deformity, hardening of bones and stiff and painful joints
- **Over exploitation of ground water** may lead to leaching of arsenic from soil and rock sources and contaminate ground water. Chronic exposure to arsenic causes **black foot disease**



BIO-MAGNIFICATION

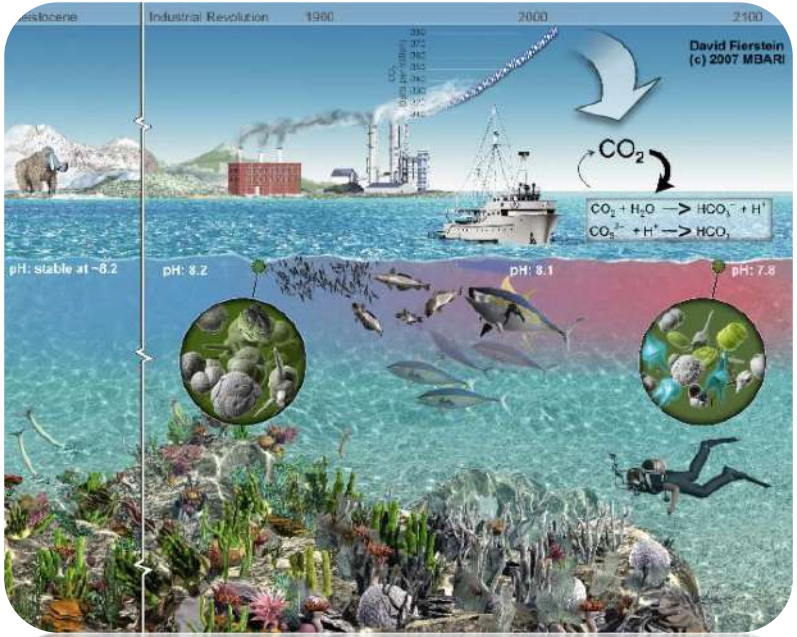
- It is the process where toxic substances move up the food chain and become more concentrated at each level. E.g. DDT
- It adversely affects human and marine life. It can also destroy Coral Reefs. It can disrupt the food chain.



Tubifex worms or sludge worm: These pose a significant risk for trophic transfer & Bio-magnification of micro-plastics up the aquatic food chain. They can survive in heavily polluted areas where almost no other species can endure. It is an indicator species for polluted water.

OCEAN ACIDIFICATION

- Ocean acidification is the **reduction in the pH** of seawater due to excessive absorption of CO_2 by the oceans.
- **Effects**: Loss of Coral reefs, marine biodiversity, disruption in food chain etc.



DISEASES ASSOCIATED WITH WATER POLLUTION

Disease	Potential sources / cause& their effects
Minamata	Neurological disease caused by severe mercury poisoning.
Blue Baby Syndrome	It is a bluish discoloration of infants' skin because of poorly oxygenated blood due to Nitrate contamination in water.
Itai-Itai	Cadmium pollution causing lung and liver cancer.
Skeletal Fluorosis	Fluoride contamination causing teeth deformity, hardening of bones and joint pains.
Trachoma	An infectious eye disease caused by unclean water.

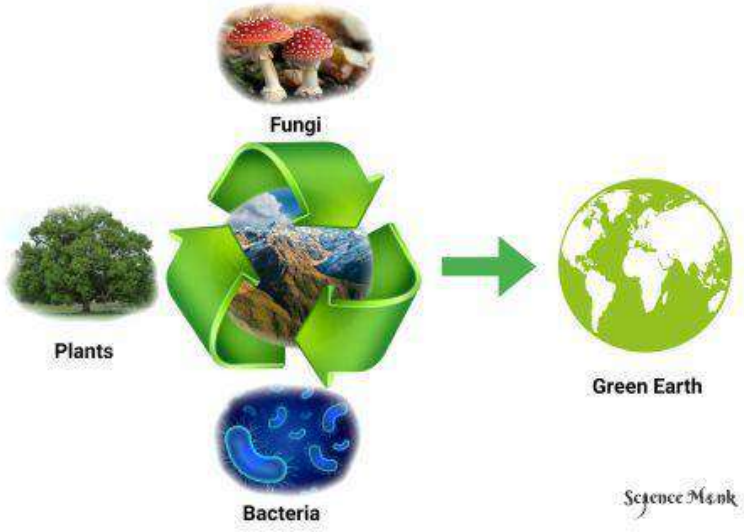
MITIGATING WATER POLLUTIONS

Restricting Pollutant Inflow into Water Bodies	• **Minimising the toxins and pollutants in the effluents going into water bodies through sewage treatment plants and effluent treatment in industries.** • **This approach is suitable for point sources of pollution.**
Reducing Pollution Levels in Water Bodies	• Can be done through processes like bioremediation, phytoremediation etc. • This approach is most suitable for reducing pollution from diffused sources of water pollution.

MITIGATING WATER POLLUTIONS

Bioremediation

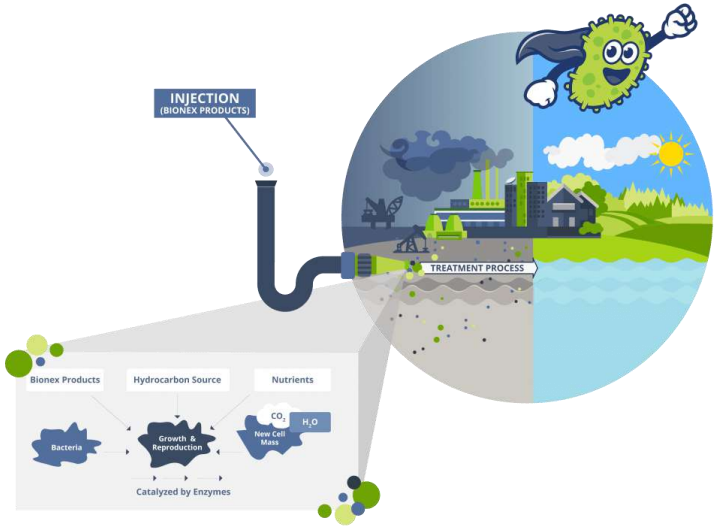
- It is the use of microorganisms (bacteria and fungi) to degrade the environmental contaminants into less toxic forms.
- Microorganisms can be specifically designed for bioremediation using genetic engineering techniques.



MITIGATING WATER POLLUTIONS

Bioremediation

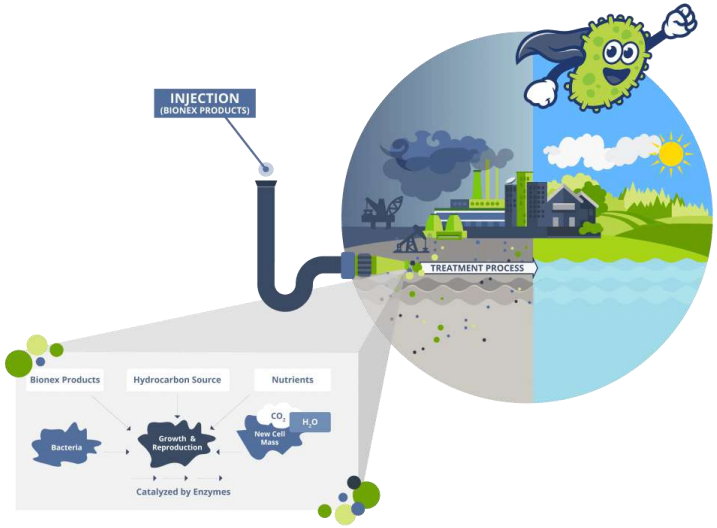
- **In-situ bioremediation techniques:**
  - **Bioventing**: supply of air and nutrients through wells to contaminated soil to stimulate the growth of indigenous bacteria.
  - **Biosparging**: Injection of air under pressure below the water table to increase groundwater oxygen concentrations and enhance the rate of biological degradation of contaminants by naturally occurring bacteria.
  - **Bioaugmentation**: Microorganisms are imported to a contaminated site to enhance the degradation process.



MITIGATING WATER POLLUTIONS

Bioremediation

- **Ex situ bioremediation techniques:**
  - **Land-farming**: turning contaminated soil for aeration & sifting to remove contaminants, or deliberately depleting soil of nitrogen to remove nitrogen-based organisms.
  - **Bioreactor**: the use of specially designed containers to hold the waste while bioremediation occurs
  - **Windrows**: rely on the periodic turning of piled polluted soil to enhance bioremediation by increasing degradation activities of indigenous and/or transient hydrocarbon clastic bacteria present in polluted soil.



MITIGATING WATER POLLUTIONS

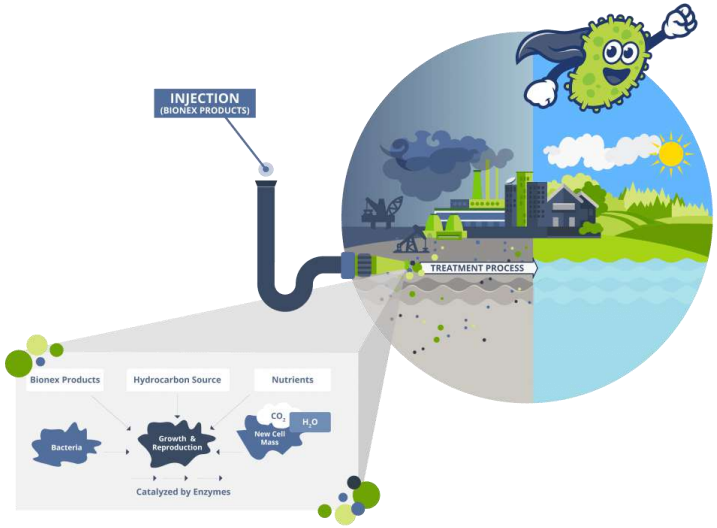
Bioremediation

- **Biolpiling**: It is a hybrid of composting & land farming.
  - **Advantages**: Useful for destruction of a wide variety of contaminants; Can be carried out on-site, without disturbing normal activities; Less expensive & effective treatment.
  - **Disadvantages**: Limited to only biodegradable compounds; Biological processes are often highly specific; Takes a longer time & consumes more area as well as water.

MITIGATING WATER POLLUTIONS

Bioremediation

- **Note:** Using bioremediation techniques, TERI has developed a mixture of bacteria called ‘Oilzapper and Oilivorous-S’ which degrades the pollutants of oil contaminated sites, leaving behind no harmful residues.



MITIGATING WATER POLLUTIONS

Coagulation or Flocculation	• **A coagulant like Aluminium Sulphate (alum), Ferric Sulphate etc. are added to the polluted water, this causes the tiny particles of dirt in the water to stick together or coagulate.** • **These coagulations can then be easily removed.**
Phytoremediation	• Phytoremediation is the use of plants to remove contaminants from soil and water. • Natural phytoremediation is carried out by mangroves, estuarine vegetation and other wetland vegetation
Disinfection	• Water can be disinfected to kill any pathogen and parasites in it. • Common disinfectants that are used include chorine and ozone gases.
Ph Correction	• Lime is added to the filtered water to adjust the pH and stabilise the naturally soft water in order to minimise corrosion in the distribution system and within customers' plumbing.
Other Measures	• Treatment of sewage water and the industrial effluents, Sustainable Agriculture, Conservation of wetlands, etc.

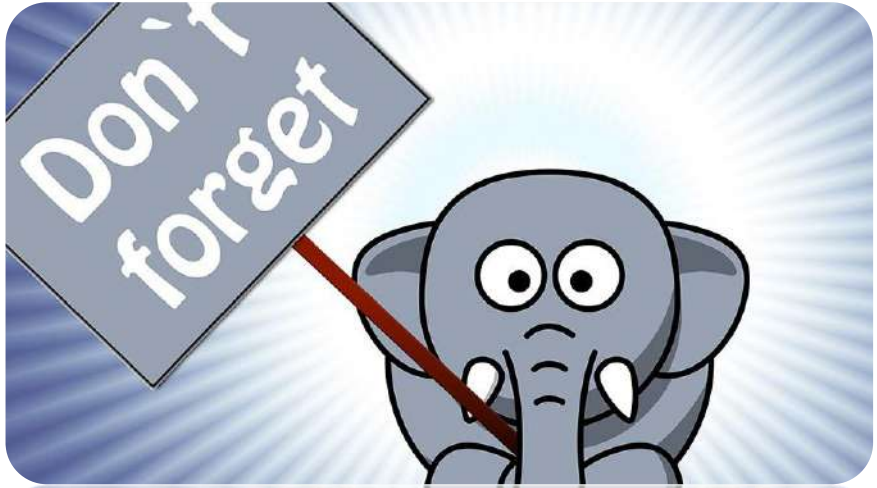
GOVERNMENT MEASURES TO MITIGATE WATER POLLUTION

- **Water (Prevention and Control of Pollution) Act, 1974:** The Act was made to provide for the prevention and control of water pollution, and for the maintaining or restoring of wholesomeness of water in the country.
- **Ganga Action Plan:** An ambitious plan launched in 1985 to save the river Ganga.
- **Central Pollution Control Board (CPCB):** an apex body in the field of water quality management, has developed a concept of "designated best use". The water body is designated as A, B, C, D, E on the basis of – pH, dissolved oxygen, BOD, total coliform, free ammonia, electrical conductivity etc.

GOVERNMENT MEASURES TO MITIGATE WATER POLLUTION

Things To Remember:

- Water hyacinth can purify water by taking some toxic materials and a number of heavy metals from water.
- Oil spills in water can be cleaned with the help of bregoli — a by-product of paper industry resembling sawdust, oil zapper, microorganisms.
- Eucalyptus: It can absorb all surplus wastewater rapidly and release pure water vapour into the atmosphere



SOIL POLLUTION

- Soil pollution is the deterioration in quality & fertility of soil due to the presence of toxic pollutants.

Causes: Natural + Anthropogenic	Effects
• **Poor Agricultural & Livestock practices.** • **Improver solid waste management** • **Unsafe storage of hazardous chemicals & nuclear waste** • **Urban and transport infrastructure** • **Natural calamities**	• Naturally contributes to air pollution • may alter plant metabolism & reduce crop yields • Bio-magnification • leads to soil erosion & eutrophication • Reduced nitrogen fixation & loss of soil nutrients • Carcinogenic

MAJOR SOURCES OF SOIL POLLUTION

Industrial Sources	• **Includes fly ash, metallic residues, mercury, lead, copper, zinc, cadmium, cyanides, chromates, acids, alkalies, organic substances, nuclear wastes.** • **Also, a large number of industrial chemicals, dyes, acids, etc. find their way into the soil.**
Agricultural Sources	• Chlorohydrocarbons (CHCs) like DDT, endosulfan, heptachlor accumulate in soil and cause biomagnification. • Excessive use of chemical fertilisers reduces the population of soil-borne organisms and the productivity of the soil and increases salt content of the soil.
Plastics	• Accumulate in soil and prevents germination of seeds. They stay in the soil for centuries without decomposing (nonbiodegradable). • Burning of plastic release harmful gases and toxic solid residue left after burning remains in the soil. The harmful gases enter soils through chemical cycles.
Other Sources	• Air and Water pollutants ultimately become part of the soil, and the soil also receives some toxic chemicals during weathering of certain rocks. • Radioactive elements from mining and nuclear power plants, find their way into the water and then into the soil.

SOIL CONTAMINANTS AND THEIR EFFECTS ON HEALTH & ENVIRONMENT

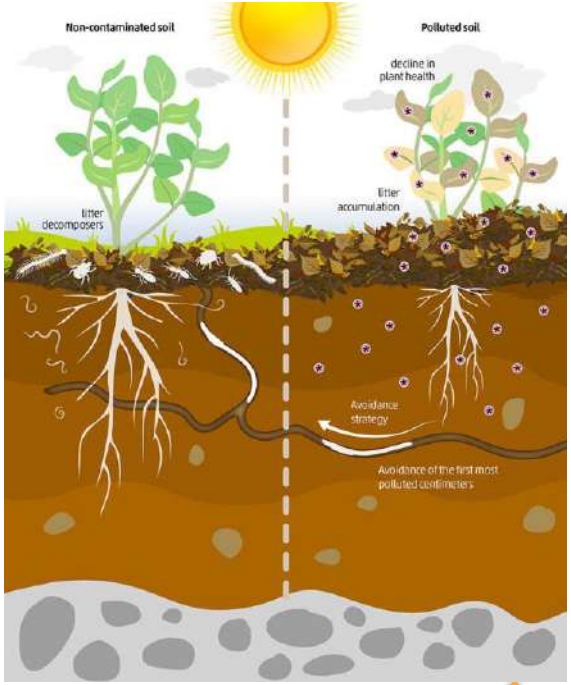
Substance	Potential Sources & Their Effects
Lead (Pb)	• Lead paint, mining, foundry activities, vehicle exhaust, construction-activities, agriculture activities, and batteries etc., • May leads to Learning difficulties, abdominal cramps & vomiting, Fatigue, Neurological problems, Headache, Growth reduction etc.
Mercury (Hg)	• From mining, incineration of coal, alkali and metal processing, medical waste, volcanoes & geologic deposits. • A tingling sensation in one's limbs, Speech impairment, Loss of balance & coordination, Tremors, Depression, mood changes, Severe neurological damage, Itching, burning, pain, Damage to brain, kidneys, and lungs, Pink disease (acrodynia) – a skin discoloration, High BP & Hyper-salivation

SOIL CONTAMINANTS AND THEIR EFFECTS ON HEALTH & ENVIRONMENT

Substance	Potential Sources & Their Effects
Arsenic (As)	• From mining, coal-fired power plants, lumber facilities, electronics industry, foundry activities, agriculture, natural accumulation. • Leads to Neurotoxicity, abdominal pain, muscle cramps, blood in urine, pregnancy complications, infant mortality, cognitive problems in infants, bladder or lung cancer
Herbicides /Insecticide	• From agricultural activities, gardening etc. • Birth defects, Endocrine disruption, Reproductive problems, Leukemia and other cancers.
Nickel	• Mining; foundry activities; construction activities • Lung cancer, Neurological problems, Childhood developmental issues, Kidney and liver failure, Cardiovascular disease.

SOIL CONTAMINANTS AND THEIR EFFECTS ON HEALTH & ENVIRONMENT

- **Effects Of Soil Pollution:** Reduced soil fertility, Reduced nitrogen fixation, Increased erosion, Runoff due to deforestation cause loss of soil and nutrients, Deposition of silt in tanks and reservoirs due to soil erosion.



NOISE POLLUTION

It is an **unwanted** or **excessive sound** that **can have adverse effects** on human health, wildlife, and the environment

Effects of Noise Pollution	• **Affects both the health & behaviour, of people and wildlife.** • **Cardiovascular disorders, hypertension, high-stress levels, tinnitus, hearing loss, sleep disturbance** • **Cognitive Issues & Behavioral Change**
Control measures	• Control at receiver's end, Suppression of Noise at Source, Acoustic Zoning, Sound Insulation at Construction Stages, Planting trees, Strict legislative measures.

RADIOACTIVE POLLUTION

- **Radioactive pollution** is the result of the release of radioactive substances into the environment.
- **Radioactive substances** are those which can emit high energy particles like **alpha, beta & gamma rays**.
- These substances are **highly unstable** & are continuously emitting these particles **to gain some stability**.
- It is **not a constant or regular phenomenon** & hence the **duration and frequency** of pollution **vary** with time & conditions.

RADIOACTIVE POLLUTION

Types of Radiation	Effect on the body.
Alpha particles	Generally, they cannot penetrate the skin. But if their sources is inside the body, they can cause damage to bones or lungs.
Beta particles	Can penetrate the skin but cannot damage the tissues. They can damage the skin and eyes(cataract).
Gamma particles	Can easily penetrate the body and pass through it. They cause damage to the cell structure.
X- rays	Can travel very far and pass through the body tissues except bones. They can cause damage to the cells.

RADIOACTIVE POLLUTION

Two very serious problems:

1. Accidental leakage – Three Mile Island, Chernobyl and Fukushima incidents
2. Safe disposal of radioactive wastes

Causes / Sources of Radioactive Pollution	• **Uranium mining & processing (thorium (monazite is the ore of thorium)** • **Radiation therapy (X-Rays, Chemotherapy, etc.)** • **Nuclear power reactors, & use of radionuclides in industries** • **Nuclear tests carried out by the defence personnel, wars (strontium-90, caesium-137, iodine-131, etc.)** • **Disposal of nuclear waste.** • **Natural sources like; radiation from space & earth crust (radium-224, uranium-238, thorium-232, potassium-40, carbon-14)**
Effects	• Genetic Mutations • Causes cancer, leukemia, anaemia, hemorrhage, premature aging etc., • Soil infertility • Radioactive material can enter the food chain, remains in the environment for hundreds of years causing somatic damage ie damage to organs of the body.

LIGHT POLLUTION

- Light pollution is excessive, misdirected, or obtrusive artificial (usually outdoor) light.
- **Consequences**: it washes out starlight in the night sky, interferes with astronomical research, disrupts ecosystems, has adverse health effects and wastes energy.

ONLYIAS
Nothing Else

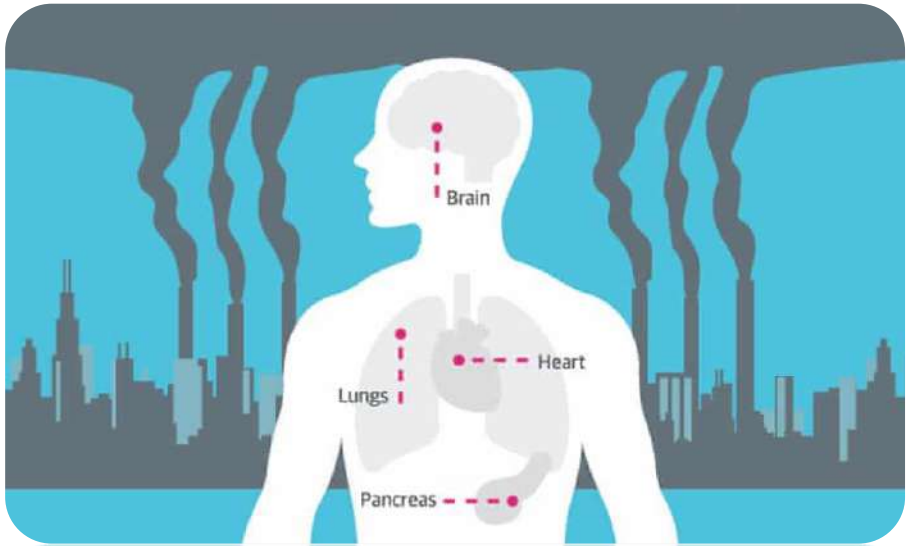
ENVIRONMENTAL DEGRADATION AND POLLUTION

OZONE POLLUTION

- Ozone can be good or bad, depending on where it is found. It is a secondary pollutant.
- Stratospheric ozone is good ozone that protects the earth from UV radiation.
- Ground-level ozone, which is bad ozone, is a colourless & highly irritating gas that forms just above the earth's surface (lower troposphere).

OZONE POLLUTION

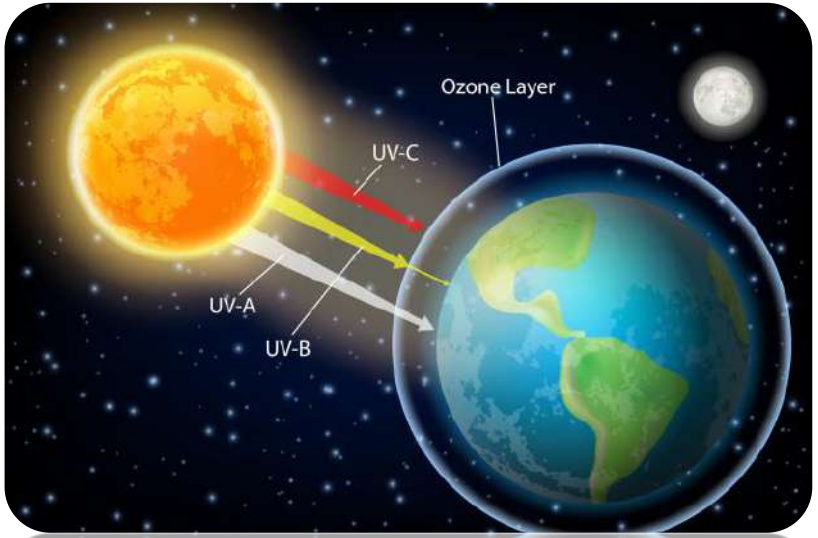
- **Harmful effects:**
  - Health problems including chest pain, coughing, throat irritation, reduced lung function, can worsen bronchitis, emphysema, & asthma
  - It inhibits photosynthesis thus, slows down plant growth & reduces CO2 absorbing ability.
  - Decreased photosynthesis increases CO2 concentration in the atmosphere.



OZONE POLLUTION

Ozone Depletion:

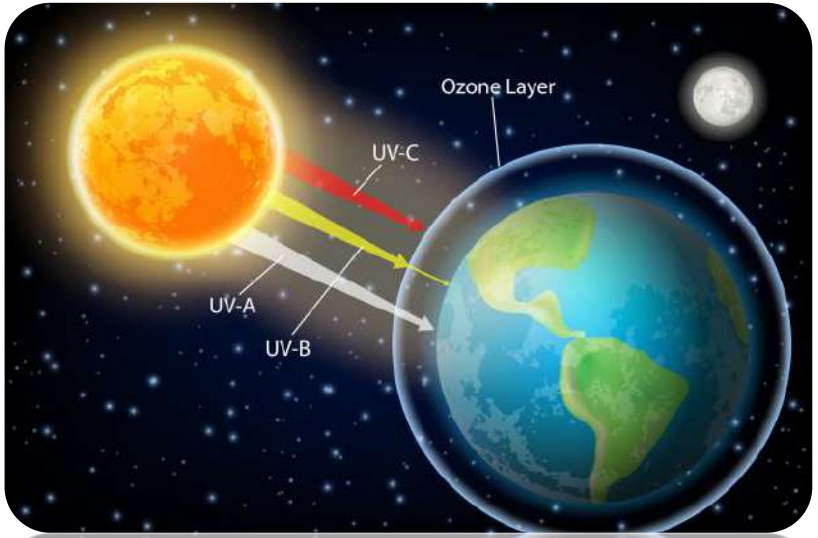
- The gradual decline in the concentration of ozone in the stratosphere, especially over the polar areas, is known as ozone depletion or ozone hole.
- **Depletion of ozone is due to increase in halocarbons:** chloro-carbons, bromo-carbons etc.
- Ozone depleting substances are dissociated under sunlight to form free radicals like chlorine atoms that destroy the ozone molecule.



OZONE POLLUTION

Ozone Depletion:

- **Ozone depleting substances**: halocarbon refrigerants, solvents, propellants, and foam-blowing agents (Chlorofluorocarbons (CFC), Hydrochlorofluorocarbons (HCFC), Hydrobromofluorocarbons (HBFC), Halons (used in fire extinguishers), Methyl Bromide, Carbon Tetrachloride, Methyl Chloroform etc.



INTERNATIONAL EFFORTS TO MITIGATE OZONE DEPLETION

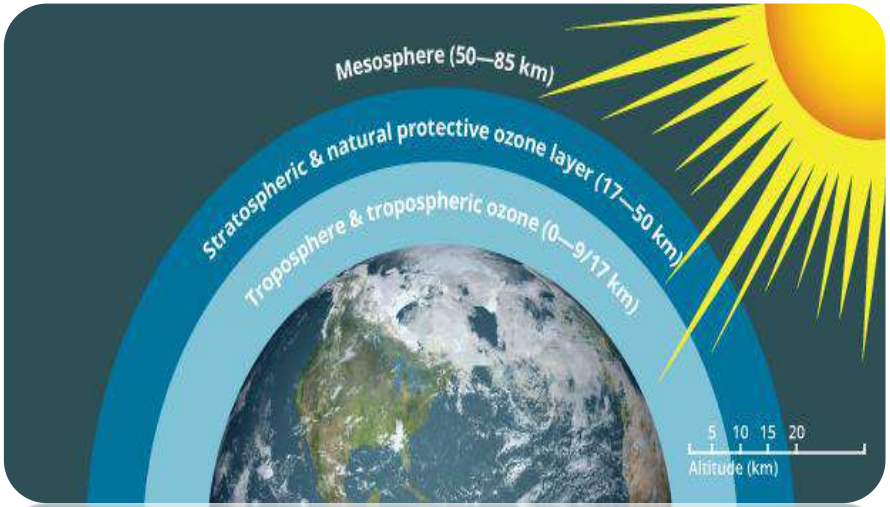
Vienna Convention for The Protection of The Ozone Layer

- Vienna Convention for the Protection of the Ozone Layer (Vienna Convention) was **agreed in 1985.**
- It **established global monitoring and reporting on ozone depletion.**
- It does **not include legally binding reduction goals** for the use of CFCs, the main chemical agents causing ozone depletion.
- It also created a framework for the development of protocols for taking more binding action.
- These are **laid out in the accompanying Montreal Protocol legally binding.**

INTERNATIONAL EFFORTS TO MITIGATE OZONE DEPLETION

Montreal Protocol

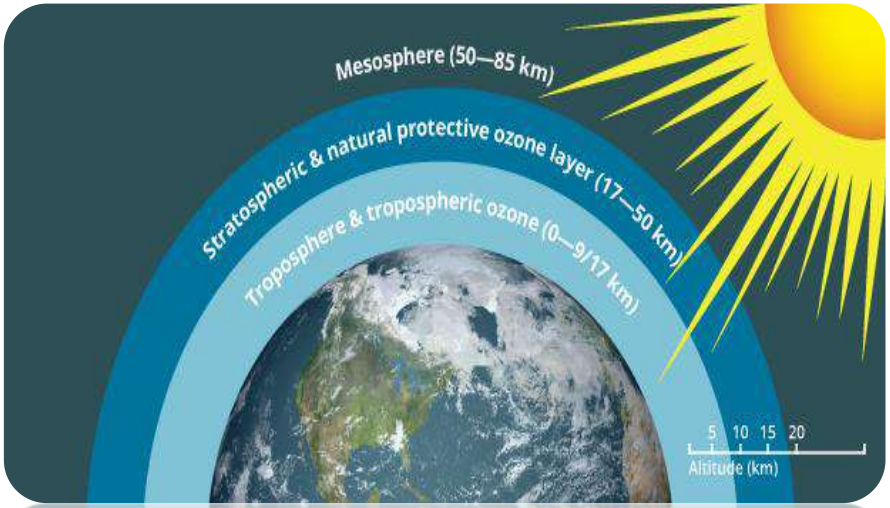
- Montreal Protocol **under the Vienna Convention (the protocol)** was agreed in 1987.
- It facilitates global cooperation in reversing the rapid decline in atmospheric concentrations of ozone.
- Under the protocol **countries agreed to phase out the production and consumption of certain chemicals that deplete ozone.**



INTERNATIONAL EFFORTS TO MITIGATE OZONE DEPLETION

Montreal Protocol

- Phase out of these substances is required by **specific deadlines.**
- Vienna Convention and its Montreal Protocol are the **first and only global environmental treaties to achieve universal ratification, with 197 parties.**
- As a result of the international agreement, the **ozone hole in Antarctica is slowly recovering.**
- Climate projections indicate that the ozone layer will return to 1980 levels between 2050 and 2070.



INTERNATIONAL EFFORTS TO MITIGATE OZONE DEPLETION

Kigali Amendment to Montreal Protocol 2016

- In the 28th meeting of the Parties (2016) to the Montreal Protocol, negotiators from 197 nations have **signed an agreement to amend the Montreal Protocol in Kigali.**
- The parties are expected **to reduce the manufacture and use of Hydrofluorocarbons (HFCs) by roughly 80-85% from their respective baselines, till 2045.**

INTERNATIONAL EFFORTS TO MITIGATE OZONE DEPLETION

Kigali Amendment to Montreal Protocol 2016

- This phase down is **expected to arrest the global average temperature rise up to 0.5 °C by 2100.**
- It is a **legally binding agreement** between the signatory parties with non-compliance measures.
- It came into effect **from 1st January 2019.**

INTERNATIONAL EFFORTS TO MITIGATE OZONE DEPLETION

Gothenburg Protocol, 1999

- Aims **to Abate Acidification, Eutrophication & Ground-level Ozone.**
- Also **known as the Multi-effect protocol**, was adopted by the countries of UNECE (United Nations Economic Commission for Europe).
- The protocol sets national emission ceilings for 2010 up to 2020 for four pollutants: Sulphur dioxide, Nitrogen Oxides (NOx), volatile organic compounds (VOCs) & Ammonia (NH3).
- Protocol also is a **part of the convention on long Range Transboundary Air Pollution**.

INTERNATIONAL EFFORTS TO MITIGATE OZONE DEPLETION

Ozone Depleting Substances (Regulation and Control) Rules:

- The ODS (Regulation and Control) Rules, 2000 **under the Environment (Protection) Act**, in July 2000.
- These Rules **set the deadlines for phasing out of various ODSs, besides regulating production, trade import and export** of ODSs and the product containing ODS.
- Ozone Depleting Substances (Regulation and Control) Rule, 2000 was **amended in 2001, 2003, 2004, 2005 and 2019** to facilitate implementation of ODS phase-out at enterprises in various sectors.

INTERNATIONAL EFFORTS TO MITIGATE OZONE DEPLETION

Ozone Depleting Substances (Regulation and Control) Rules:

- These Rules **prohibit the use of CFCs in manufacturing various products beyond 1st January 2003,** except in metered dose inhaler and for other medical purposes.
- Further, the **use of methyl bromide has been allowed upto 1st January 2015**. Since HCFCs are used as interim substitutes to replace CFC, these are **allowed upto 1st January 2040.**
- MoEFCC issued a **notification to prohibit the issuance of import license for HCFC-141b from January 1, 2020,** under ODS (Regulation and Control) Amendment Rules, 2019 issued under the Environment (Protection) Act, 1986

INTERNATIONAL EFFORTS TO MITIGATE OZONE DEPLETION

Ozone Depletion Is Strongest Over The Poles And In The Winters

- During winters, polar vortices are strengthened, especially in southern hemisphere. This leads to formation of polar stratospheric clouds which contain water, nitric acid, sulfuric acid etc. Such clouds accelerates the process of ozone depletion.

SOLID WASTE MANAGEMENT

- Solid waste consists of Municipal Solid Waste (MSW), e-waste & Biomedical wastes.
- Solid Waste Management involves a collective activity involving segregation, collection, transportation, re-processing, recycling & disposal of various types of wastes.

SOLID WASTE MANAGEMENT

Waste Minimization Circles

- WMC helps Small and Medium Industrial Clusters in waste minimisation in their industrial plants.
- **Assisted by:** World Bank with the Ministry of Environment and Forests acting as the nodal ministry.
- **Implementation:** with the assistance of the National Productivity Council (NPC), New Delhi.
- **Aims:** to realise the objectives of the Policy Statement for Abatement of Pollution (1992), which states that the government should educate citizens about environmental risks, the economic and health dangers of resource degradation and the real economic cost of natural resources.

METHODS OF DISPOSAL OF SOLID WASTE

Open dumps	• **It refer to uncovered areas that are used to dump solid waste of all kinds. It is a breeding ground for flies, rats and other insects that spread diseases**
Landfills	• Pits that are dug on the ground and are generally located in urban areas. The garbage is dumped and the pit is covered with soil everyday thus preventing the breeding of rats and flies
Sanitary Landfills	• More hygienic and built in a methodological manner to solve the problem of leaching. These are lined with materials that are impermeable soil.
Incineration plants	• Process of burning waste in a large furnace. In these plants, the recyclable material is segregated and the rest of the material is burnt and ash is produced.

METHODS OF DISPOSAL OF SOLID WASTE

Pyrolysis	• **Process of combustion of material in absence of oxygen. It is an alternative to incineration. The gas and liquid thus obtained can be used as fuels.**
Composting	• Biological process in which microorganisms mainly fungi and bacteria decompose degradable organic waste into humus like substances in the presence of oxygen.
Vermiculture	• Earthworms are added to the compost. These worms break the waste and the added excreta of the worms makes the compost very rich in nutrients

E-WASTE

- E-waste is any electrical or electronic equipment that's been discarded.
- **India's first e-waste clinic** - at **Bhopal**.

E-WASTE

E-waste sources	Constituents	Health effects
PCBs, glass panels, and Computer monitors	Lead	Damage nervous systems, & kidney, Impair child's brain development
Resistors & Semiconductors	Cadmium	Accumulates in kidney & liver, Causes neural damage
Relays and switches, & PCBs	Mercury	Damages brain, Respiratory & skin disorders
Galvanized steel plates & decorator or hardener	Chromium	Causes Bronchitis

E-WASTE

E-waste sources	Constituents	Health effects
Cabling, Computer& housing	Plastics &PVC	Burning produces Dioxin that causes reproductive & developmental problems
Electronic equipment & circuit boards	Brominated flame-retardants	Disrupt endocrine systems
Front panels of CRTs	Barium, Phosphorus & Heavy metals	Muscle weakness & damages heart, liver
Copper wires, PCB tracks.	Copper	Stomach cramps, nausea, liver damage
Nickel Cadmium batteries	Nickel	Skin Allergy, asthma
Lithium-ion battery	Lithium	Li can pass into breast milk& may harm a nursing baby may cause lung edema
Motherboards	Beryllium	Carcinogenic Beryllium

E-WASTE

E-WASTE (MANAGEMENT) RULES, 2016

- Notified by the **Ministry of Environment, Forest & Climate Change.**
- The new e-waste rules **included CFL & other Mercury-containing lamps**, as well as other such equipment.
- For the first time, **rules brought the producers under Extended Producer Responsibility (EPR),** along with targets.
- Producers can have a **separate Producer Responsibility Organisation (PRO)** & ensure the collection & disposal of E-waste in an environmentally sound manner.

E-WASTE

E-WASTE (MANAGEMENT) RULES, 2016

- **Deposit Refund Scheme** has been introduced, wherein the producer charges an additional amount as a deposit at the time of sale and returns it to the consumer along with interest when equipment is returned.
- The **role of State Governments has been also introduced** to ensure the safety, health & skill development of the workers involved in dismantling & recycling operations.

E-WASTE

E-WASTE (MANAGEMENT) RULES, 2016

- **Bulk consumers have to file annual returns** it prescribes a waste collection target of 30% waste generated for the first 2 years and progressively going up to 70% in the 7th year from rule notified.
- Provision of **penalty for violation of rules.**
- **Urban Local Bodies has been assigned the duty to collect & channelize the orphan products** to authorized dismantlers or recyclers.

INTERNATIONAL CONVENTIONS TO REGULATE WASTE DISPOSAL

Stockholm Convention on Persistent Organic Pollutants

- International environmental treaty which aims to eliminate or restrict the production and use of persistent organic pollutants (POPs).
- POPs: chemical substances that persist in the environment, bioaccumulate through the food web, and pose a risk of causing adverse effects to human health and the environment

INTERNATIONAL CONVENTIONS TO REGULATE WASTE DISPOSAL

Basel Convention

- **Basel Convention on control of transboundary movements of hazardous wastes and their disposal** is an international treaty that was designed to reduce the movements of hazardous waste between nations.
- Objective: to prevent the transfer of hazardous waste from developed to less developed countries (LDCs).
- **Note**: Does not address the movement of radioactive waste.

INTERNATIONAL CONVENTIONS TO REGULATE WASTE DISPOSAL

Rotterdam Convention

- Rotterdam Convention **on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade.**
- It is a **multilateral treaty** to promote shared responsibilities in relation to the importation of hazardous chemicals.
- Promotes an open exchange of information and calls on exporters of hazardous chemicals to use proper labelling, safe handling, and inform purchasers of any known restrictions or bans.
- Signatory nations can decide whether to allow or ban the importation of chemicals listed in the treaty.

PLASTICS POLLUTION

- It is the harmful accumulation of synthetic plastic products in the environment.
- India aims to **eliminate single-use plastic by 2022.**
- UNEP's 2018-World Environment Day's theme: 'Beat Plastic Pollution'.
- **Causes/ Sources of Plastic Pollution**: Households, Industrial use, Bio-medical wastes, Agriculture, Fishing and marine economic activities.

PLASTICS POLLUTION

Effects Of Plastic Waste:

- The land gets littered by plastic bag garbage and becomes ugly and unhygienic.
- Upset food chain
- Conventional plastics have been associated with reproductive problems in both humans and wildlife.
- **Dioxin** (highly carcinogenic and toxic) by-product of the manufacturing process is one of the chemicals believed to be passed on through breast milk to the nursing infant.
- Burning of plastics, especially PVC releases dioxin and also furan into the atmosphere.

PLASTICS POLLUTION

Dioxins: Environmental pollutants, belong to the so-called “dirty dozen” – a group of dangerous chemicals known as persistent organic pollutants (POPs).

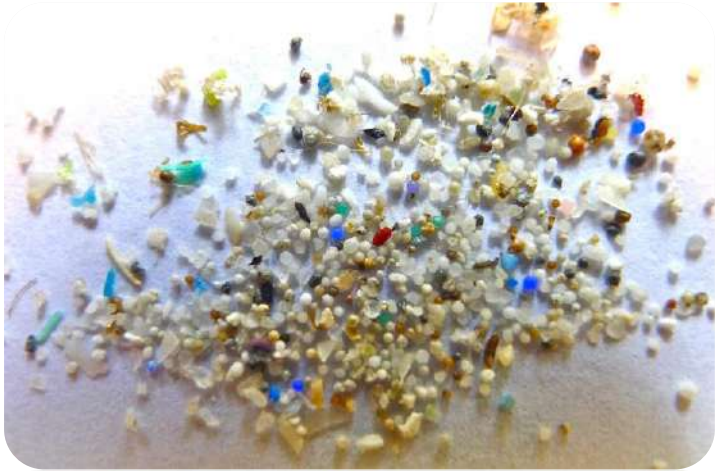
Plastic Waste In Road Construction

- Polyblend is a fine powder of recycled and modified plastic waste.
- This mixture is mixed with the bitumen that is used to lay roads.
- Blends of Polyblend and bitumen, when used to lay roads, enhanced the bitumen’s water repellent properties, and helped to increase road life by a factor of three.

PLASTICS POLLUTION

Micro-Plastics

- Microplastics are any type of plastic fragment that is less than 5 mm in length. Ex: Microbeads, microfibers.
- They enter natural ecosystems from a variety of sources, including cosmetics, clothing, & industrial processes.
- Concerns: toxins, can block the gastrointestinal tracts of organisms.



PLASTICS POLLUTION

THE GLOBAL TOURISM PLASTICS INITIATIVE

- The **Initiative is led by UNEP & the World Tourism Organization**, in collaboration with the Ellen MacArthur Foundation.
- Aims to **address the root causes of plastic pollution.**
- Developed within the **framework of the 'One Planet Sustainable Tourism Programme'.**
- It enables businesses, governments, & other tourism stakeholders to make a set of concrete & actionable commitments by 2025.

ENVIRONMENTAL LAWS AND POLICIES

CONSITUTIONAL PROVISIONS

Fundamental Rights	• **Article 21: No person shall be deprived of his life or personal liberty except according to procedures established by law.** • **Maneka Gandhi vs. Union of India: Supreme Court interpreted the right to life and personal liberty to include the right to a clean environment.**
Fundamental Duties	• **Article 51A(g):** It shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wild life and have compassion for living creatures
DPSP (Liberal-Intellectual)	• **Article 48A:** The State shall endeavour to protect and improve the environment and to safeguard the forests and wildlife of the country.

WATER (PREVENTION AND CONTROL OF POLLUTION) ACT OF 1974

- **Objective:** to provide prevention and control of water pollution and maintaining or restoring of wholesomeness and purity of water (in the streams or wells or on land).
- The Act **vests regulatory authority in State Pollution Control Boards (SPCB).**
- **State Pollution Control Boards**: control sewage and industrial effluent discharges by approving, rejecting, or impose conditions while granting consent to discharge.

WATER (PREVENTION AND CONTROL OF POLLUTION) ACT OF 1974

- **Central Pollution Control Board (CPCB):** performs the same functions for Union Territories and formulates policies and coordinates activities of different State Boards.
- The Act grants power to SPCB and CPCB to **test equipment and to take the sample for analysis**
- **Amendment act 1988**: empowered SPCB and CPCB to close a defaulting industrial plant.

WATER (PREVENTION AND CONTROL OF POLLUTION) CESS ACT OF 1977

- **Water Cess:** a tax levied under the Water (Prevention and Control of Pollution) Cess Act, 1977 on water consumed by persons operating and carrying on certain types of industrial activities.
- **Local govt. authority:** entrusted with the duty of supplying the water is also liable to pay the cess.
- Creates economic incentives for pollution control and requires local authorities and certain designated industries to pay a **cess (tax) for water effluent discharge**.

WATER (PREVENTION AND CONTROL OF POLLUTION) CESS ACT OF 1977

- The Central Government, after deducting the expenses of collection, pays the central and state boards such sums, as it seems necessary.
- To encourage capital investment in pollution control, the **Act gives a polluter a 70% rebate of the applicable cess upon installing effluent treatment equipment.**

AIR (PREVENTION AND CONTROL OF POLLUTION) ACT OF 1981

- To implement the decisions taken at the **United Nations Conference on the Human Environment held at Stockholm** in June 1972, Parliament enacted the nation-wide Air Act.
- **Objective:** to improve the quality of air and to prevent, control, and abate air pollution in the country.
- The Air Act's framework is **similar to that of the Water Act of 1974**.
- Expanded the authority of the central and state boards established under the Water Act, **to include air pollution control**.

AIR (PREVENTION AND CONTROL OF POLLUTION) ACT OF 1981

- States not having water pollution boards were required to set up air pollution boards.
- All industries operating within designated air pollution control areas **must obtain "consent" (permit) from the State Boards.**
- The states are required to **prescribe emission standards for industry and automobiles** after consulting the central board and noting its ambient air quality standards.
- Grants power to SPCB and to **test equipment and to take the sample for analysis** from any chimney, fly ash or dust or any other.

AIR (PREVENTION AND CONTROL OF POLLUTION) ACT OF 1981

- **Amendment act 1988:**
  - Empowered SPCB and CPCB to close a defaulting industrial plant.
  - Introduced a citizen's suit provision into the Air Act and extended the Act to **include noise pollution**.

WILDLIFE PROTECTION ACT 1972

- **Objective**: To protect wild animals, birds, plants & matter connected with them.
- **Appointment of:**
  - Wildlife Advisory Board, Wildlife Warden.
  - Central Zoo Authority and National Board for Wildlife.
  - Establishment of National Parks, Wildlife Sanctuaries, Conservation reserve, Community reserves & Tiger reserves.
- License for Trade & commerce in some wildlife species & Ban trade or commerce in scheduled animals.
- In-situ & ex-situ conservation of wildlife. Regulations for hunting wild animals & birds.

WILDLIFE PROTECTION ACT 1972

- **There are 6 Schedules which gives varying degree of protection:**
  - **Schedule I & II:** provides absolute protection with highest penalties for violation.
  - **Schedule III & IV:** species are also protected, but the penalties are lower.
  - **Schedule V:** includes "vermin" animals, which can be hunted.
  - **Schedule VI:** includes endemic plants that are prohibited from cultivation & planting.
- **WPA (Amendment) 2006**: Created the National Tiger Conservation Authority & Wildlife Crime Control Bureau (WCCB).

FOREST (CONSERVATION) ACT, 1980

- **Objective**: To protect the forest and control its deterioration.
- Mandatory Central Government's prior approval for diversion of forest land for non-forestry purposes.
- Checks deforestation & encourage afforestation.

NATIONAL FOREST POLICY, 1988

- **Objective:** To-ensure environmental stability & ecological balance.
- Conservation of existing Natural Heritage.
- Checking Soil Erosion & Denudation in catchment areas.
- Checking extension of dunes in desert areas of Rajasthan & along coastal tracts.
- Substantially increasing Forest or Tree Cover through Afforestation & Social Forestry.

NATIONAL FOREST POLICY, 1988

- Increasing the productivity of Forests to meet National Needs.
- Encourage efficient utilization of Forest Produce & Optimum Use of Wood (Timber).
- Generation of Work Opportunities, the involvement of Women.
- Forest policy 1952 recommends 33% forest cover (60% in mountainous region & 25% in plain area) of the total area.

ENVIRONMENT (PROTECTION) ACT, 1986

- **Objective**: To protect, improve environment & reduce pollution.
- Enacted **aftermath of Bhopal Gas Tragedy (1984).**
- Authorizes the central government to control & reduce pollution from all sources.
- Provides procedures for setting standards of emission or discharge of environmental pollutants.

INDIAN FOREST ACT, 1927

- **Objective:** To protect & conserve forests.
- It categorized forest into Reserve forest, Protected forest & Village forest.
- Act defines forest offence, Specifies the acts prohibited inside a Reserved Forest, and penalties for the violation.

NEW DRAFT NATIONAL FOREST POLICY, 2018

- **Objective**: to bring a minimum of one-third of India's total geographical area under forest cover through scientific interventions and enforcing strict rules to protect the dense cover.
- **Focus**: on the international challenge of climate change.
- **Concepts**: The draft has introduced some new concepts such as:
  - Economic valuation of ecosystem services;
  - Forest certification;
  - **NFEMIS**: National Forest Ecosystem Management Information System

NEW DRAFT NATIONAL FOREST POLICY, 2018

- **Approach**: The 1988 forest policy had a local community- and ecology-centric approach.
- **Tribal to Timber**: The importance offered to the rights of local, forest-dependent communities are being diluted.
- **Production forestry**: The 1988 policy had sections called ‘Rights and Concessions’ and ‘Tribal People and Forests’.
- **Industry**: The draft stresses the need to stimulate growth in the forest based industry sector.

NEW DRAFT NATIONAL FOREST POLICY, 2018

- **Livelihood**: The current draft mentions about the livelihoods of local communities -
  - as passive recipients of benefits accruing from wildlife tourism
  - as labour for forest-based industries
  - in relation to Non-Timber Forest Produce (NTFP)
- **PPP:** The draft proposes a public-private partnership model for afforestation and reforestation activities.
- **Protection measures:** The policy proposes to restrict schemes and projects which interfere with forests that cover steep slopes.

NEW DRAFT NATIONAL FOREST POLICY, 2018

- **Mechanism:** Suggests setting up of two national-level bodies for better management of the country's forests.
- **Community participation:** Efforts to ensure synergy between gram sabha & JFMC (Joint Forest Management Committee) will be taken up.
- **Financing:** The compensatory afforestation fund which is being transferred to the states will provide for management of forests.

NEW DRAFT NATIONAL FOREST POLICY, 2018

- **Forest fire:** The draft policy includes measures to safeguard ecosystems from forest fires, which include:
  - Mapping the vulnerable areas
  - Developing and strengthening early warning systems
  - Remote sensing technology to control fire
  - Improved community participation
- **Climate change:** Forests are natural carbon sinks, assisting in climate change mitigation.
- **Human-wildlife conflict:** Quick response, dedicated teams of well-equipped and trained personnel would be developed.

THE SCHEDULED TRIBES AND OTHER TRADITIONAL FOREST DWELLERS (RECOGNITION OF FOREST RIGHTS) ACT, 2006

- **Objective**: To **restore** the deprived forest rights of the **Scheduled Tribes** & other traditional **forest dwellers** across India.
- Grants **legal recognition to the rights** of traditional forest-dwelling communities.
- **National Parks,** Sanctuaries, Reserve Forest & Protected Forests are included for the recognition of Rights.
- Act defines **'Critical wildlife habitats'** as areas of national parks & wildlife sanctuaries that are kept aloof for wildlife conservation.

THE SCHEDULED TRIBES AND OTHER TRADITIONAL FOREST DWELLERS (RECOGNITION OF FOREST RIGHTS) ACT, 2006

- **Rights recognized:**
  - **Title Rights**: To legally hold forest lands (up to 4 acres). Applies for land that is being cultivated by the concerned family, no new lands are granted.
  - **Use Rights**: Forest produce including non-timber forest produce of plants by the community.
  - **Community forest resource rights**: To protect, regenerate, conserve or manage forest resources for sustainable use, providing for community governance of forests.

THE SCHEDULED TRIBES AND OTHER TRADITIONAL FOREST DWELLERS (RECOGNITION OF FOREST RIGHTS) ACT, 2006

- **Eligibility criteria:**
  - **Must be a Scheduled Tribe** in the area where the right is claimed.
  - **Primarily resided in forest or forests land** for three generations (25X3 = 75 years) **before 13-12-2005**; and
  - Depend on the forest or forest land for livelihood needs.

THE SCHEDULED TRIBES AND OTHER TRADITIONAL FOREST DWELLERS (RECOGNITION OF FOREST RIGHTS) ACT, 2006

- **Process of recognition of rights:**
  - **Gram Sabha**: Pass a resolution recommending whose rights to which resources should be recognized.
  - **Screening committees**: Resolution is screened & approved at the level of the sub-division (or taluka) and the district level.
- **Note:** The screening committees consist of **three government officials** (Forest, Revenue & Tribal Welfare departments) and **three elected members** of the local body at that level. These committees also hear appeals.

BIOLOGICAL DIVERSITY ACT 2002

- **Objective**: To conserve, promote sustainable use of biological diversity & ensure fair & equitable sharing of its benefits.
- The Act was enacted to **meet the obligations under the Convention on Biological Diversity (CBD).**
- Prohibits the transfer of Indian genetic material outside the country, without specific approval.
- **Prior permission is mandatory to claim IPR** over Biodiversity & its derivatives.
- Regulation of the use of **GM organisms**.
- **Establishes:** National, State, & Local Biodiversity Funds.
- Set up **Biodiversity Management Committees** at the local village level, **State Biodiversity Boards** at the state level, & **National Biodiversity Authority** at the national level.

NATIONAL GREEN TRIBUNAL (NGT) ACT, 2010

- **Objective**: For effective & expeditious disposal (within 6 months of appeal) of the environmental cases and to help reduce the burden of litigation in the higher courts.
- Establishes NGT & it has **jurisdiction over all civil cases** involving substantial questions relating to the environment.
- **Provides for Enforcement** of legal environmental rights, **relief & compensation** for damages caused.
- Tribunal is guided by **principles of natural justice & its order** is **executable** as a **decree of a civil court**.

NATIONAL GREEN TRIBUNAL (NGT) ACT, 2010

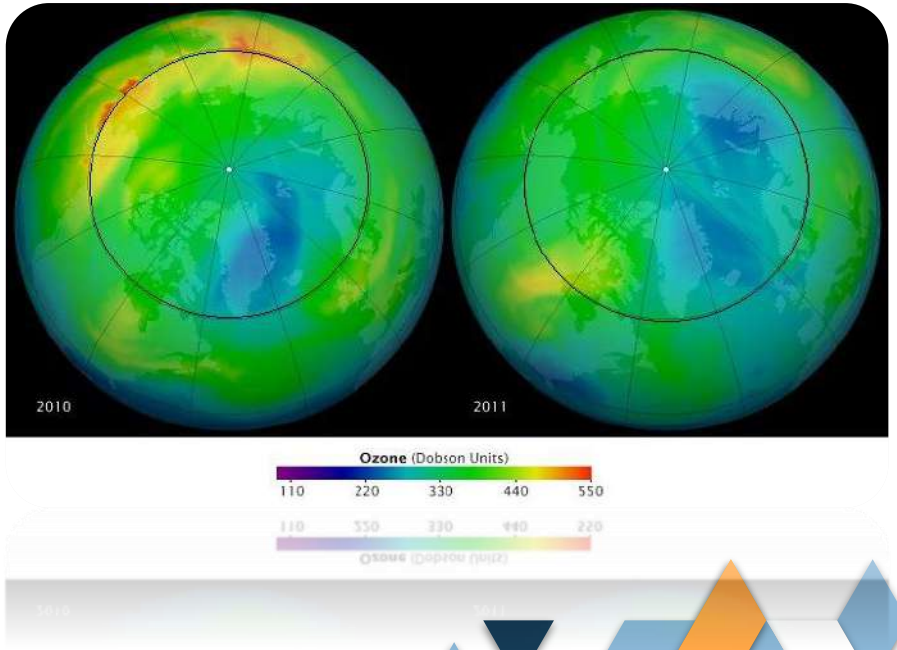
- NGT **orders** are **binding but can be challenged in the SC within 90 days.**
- NGT **Principal Bench at New Delhi & 4 regional benches** in Pune, Bhopal, Chennai & Kolkata. There is also a mechanism for circuit benches.
- The **chairperson** of the **NGT** is a **retired judge** of the **Supreme Court**.
- Each bench of the NGT comprises at **least one judicial member and one expert member**.

NATIONAL GREEN TRIBUNAL (NGT) ACT, 2010

- **NGT deals with:** Water act, 1974; Water cess act, 1977; Forest (Conservation) Act, 1980; Air Act, 1981; EPA, 1986; Public Liability Insurance Act, 1991; Biological Diversity Act, 2002.
- **It does not deal with:** Wildlife (Protection) Act (1972); Indian Forest Act (1927); Forest Rights Act (2006).
- **Note**: NGT Act, draws inspiration from India's constitutional provision of **Art. 48A (DPSP).**

THE OZONE DEPLETING SUBSTANCES (ODS) RULES, 2000

- **Objective:** To regulate production, consumption & phasing out the ODSs following the Montreal Protocol.
- **Rules notified under EPA, 1986:**
  - Prohibit the use of CFCs except for medical purposes.
  - Since HCFCs are used as interim substitutes to replace CFCs, these are allowed up to 1st January 2040.
  - Mandatory registration of ODS producers, sellers, importers, and stockiest.
- **ODS-Amendment Rules, 2019:**
  - India achieved the **complete phase-out of HCFC** (Hydrochlorofluorocarbon)-**141b**.
  - The issuance of an **import license for HCFC-141b is prohibited** under this amendment.



ENVIRONMENTAL LAWS AND POLICIES

THE PROTECTION OF PLANT VARIETY AND FARMERS RIGHT ACT, 2001

- **Objective**: To protect plant varieties, the rights of farmers and plant breeders and to encourage the development of new varieties of plants; Recognizes rights of Farmers, Breeders & researchers.

THE PROTECTION OF PLANT VARIETY AND FARMERS RIGHT ACT, 2001

- **Farmers Rights:**
  - **Recognition and rewards** for the conservation of Plant Genetic Resources.
  - A farmer who has developed a new variety is entitled to **registration and protection**.
  - **Compensation** to the farmers for non-performance of variety.
  - Farmers are not liable to pay any fee in any proceeding before the Authority/Registrar/Tribunal/High Court under the Act.

THE PROTECTION OF PLANT VARIETY AND FARMERS RIGHT ACT, 2001

- **Breeders' Rights:** Breeders will have exclusive rights to produce, sell, market, distribute, import, or export the protected variety.
- **Researchers' Rights:**
  - Researcher **can use any of the registered variety** under the Act for conducting experiments or research.
  - **Investment in R&D** for the development of new plant varieties.
  - Facilitate the **growth of the seed industry**, ensure the availability of high-quality seeds & planting material.

COMPENSATORY AFFORESTATION FUND ACT (CAMPA ACT), 2016

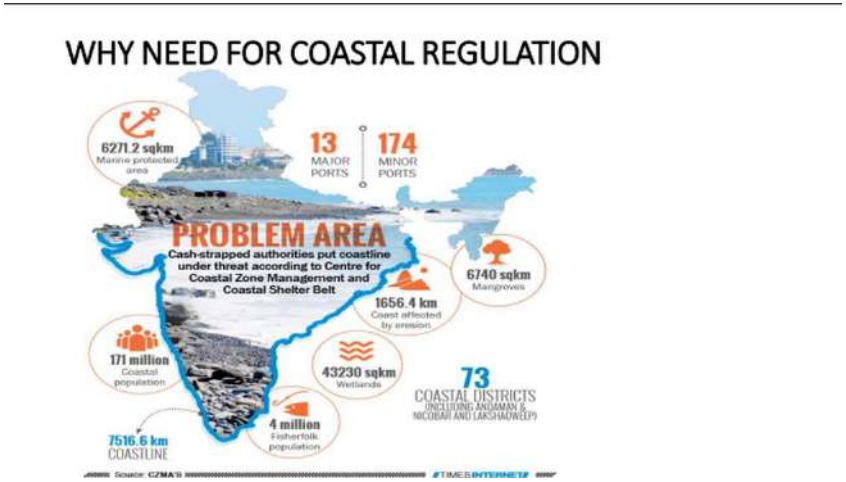
- **Objective**: To provide an appropriate institutional mechanism to utilize afforestation funds.
- **Set up** Compensatory Afforestation Fund Management & Planning Authority **(CAMPA)** at central & state level.
- **Establishes a National Compensatory Afforestation Fund under** the Public Account of India, & a State Compensatory Afforestation Fund **under** the Public Account of each state.

COMPENSATORY AFFORESTATION FUND ACT (CAMPA ACT), 2016

- **National Fund** receives **10% & State Fund gets 90% of funds** collected.
- **Funds are utilized for:** afforestation, regeneration of forest ecosystem, wildlife protection & infrastructure development.
- Forest Conservation Act of 1980 provides that non-forest land, equal to the size of the forest being **"diverted"**, is afforested or money deposited for the same.

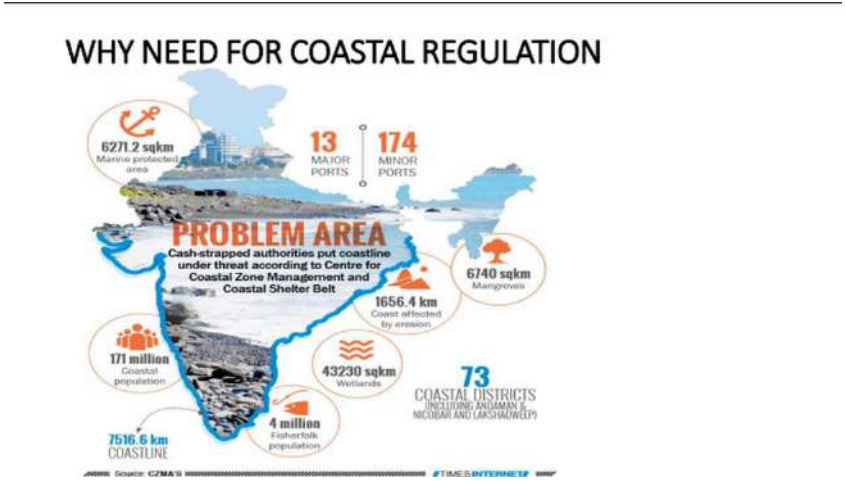
COASTAL REGULATION ZONE (CRZ) RULES, 2019

- **Objective**: To promote sustainable development and conserve coastal environments.
- It governs human and industrial activity close to the coastline.
- The Rules, mandated under **Environment Protection Act, 1986,** were first framed in 1991.
- **Shailesh Nayak Committee** was set up on CRZ.



COASTAL REGULATION ZONE (CRZ) RULES, 2019

- **For CRZ-III (Rural) areas, two separate categories:**
  - **CRZ-III(A):** with a population density of more than 2161, the **No Development Zone (NDZ) is reduced to 50 meters** from 200 meters from High Tide Line (HTL).
  - **CRZ-III(B):** with less than 2161 the **NDZ is 200 meters from High Tide Line (HTL).**
- A NDZ of 20 meters specified for all Islands.
- **Temporary tourism facilities are permitted** in Beaches in the NDZ of the CRZ-III areas.
- **Involvement of coastal communities** for management of Critically Vulnerable Coastal Areas (CVCA) identified under the EPA, 1986.
- The treatment facilities are permitted in CRZ-I B area to address pollution.



ISLAND PROTECTION ZONE (IPZ) 2019 FOR ANDAMAN AND NICOBAR

- **It allows:**
  - **Eco-tourism projects** 20 metres from the high tide line (HTL) in smaller islands like Baratang, Havelock and Car Nicobar, and at 50 metres in larger ones.
  - **Eco-tourism activities** like mangrove walks, tree huts, and nature trails in island coastal regulation zone IA (classified as the most eco-sensitive region of the islands which includes turtle nesting grounds, marshes, coral reefs, etc).

ISLAND PROTECTION ZONE (IPZ) 2019 FOR ANDAMAN AND NICOBAR

- **It allows:**
  - **Construction of roads**, on stilts by reclaiming land in exceptional cases for defence installations, public utilities, or strategic purposes in eco-sensitive zones. In case of mangroves, a minimum three times the mangrove area destroyed during the construction process shall be taken up for compensatory plantation of mangroves elsewhere.
  - **Many new activities** in the inter-tidal zone between the low tide line and HTL.

WETLAND CONSERVATION AND MANAGEMENT RULES 2017

- Wetlands are defined as an area of marsh, fen, peatland or water.
- It could be natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt.
- **The rules apply to:**
  - Wetlands categorised as “wetlands of international importance” under the Ramsar Convention.
  - Wetlands as notified by the central and state governments and UT administration.

WETLAND CONSERVATION AND MANAGEMENT RULES 2017

- **Management:** The new Rules farm out wetland management to states and union territories.
- **CWRA:** The new riles have done away with the earlier Central Wetlands Regulatory Authority (CWRA) entirely.
- **Restrictions:** As per the new rules, encroachments on wetlands have been banned.

SOLID WASTE MANAGEMENT RULES, 2016

- **It replace the Municipal Solid Wastes (Management and Handling) Rules, 2000**, are now applicable beyond municipal areas and have included urban agglomerations, census towns, notified industrial townships etc.
- **Focus on segregation of waste at source**, responsibility on the manufacturer to dispose of sanitary and packaging wastes, user fees for collection, disposal and processing from the bulk generator.

SOLID WASTE MANAGEMENT RULES, 2016

- It has also been advised that the bio-degradable waste should be processed, treated and disposed of through composting or bio-methanation within the premises as far as possible and the residual waste shall be given to the waste collectors or agency as directed by the local authority.
- The **rules promote the use of compost**, conversion of waste into energy, revision of parameters for landfills location and capacity.

SOLID WASTE MANAGEMENT RULES, 2016

- **The government has also constituted a Central Monitoring Committee** under the chairmanship of Secretary, MoEF&CC to monitor the overall implementation of the rules.
- **The Rules for the Safe Treatment of Legacy Waste** prescribe bio-remediation and bio-mining in all open dumpsites and existing operational dumpsites in India.

BIO-MEDICAL WASTE RULES, 2016

- **Objective**: To manage bio-medical waste (2016 rules are an improvement to BMW-1998 rules).
- The **ambit of the rules has been expanded** to include vaccination camps, blood donation camps, surgical camps, or any other healthcare activity.
- The **use of chlorinated plastic bags, gloves & blood bags** to be phased out within two years.
- **Pre-treatment** of the laboratory waste, microbiological waste, blood samples & blood bags through disinfection on-site in the manner prescribed by the WHO or by the NACO.

BIO-MEDICAL WASTE RULES, 2016

- Regular training & immunization for all health care workers.
- A **Bar-Code System for bags or containers** containing bio-medical waste for disposal.
- **Categorization**: 4 categories of waste instead of the earlier 10 to improve the segregation of waste at source.
- **State Govt has to provide the land** for common bio-medical waste treatment and disposal facilities.
- **These rules shall not apply to:** Radioactive wastes, Wastes covered under the MSW Rules (2000), E-waste, Hazardous microorganisms.

E-WASTE MANAGEMENT RULES 2016 (AMENDMENT TO 2011 RULES)

- Notified **under EPA, 1986**
- **Included**: CFL & other Mercury containing lamps as e-waste.
- Brought the producers under **Extended Producer Responsibility (EPR),** along with targets.
- **State Governments** have **to ensure safety, health** & **skill development** of the workers involved in dismantling & recycling operations.
- **Penalty** for violation of rules.
- **Urban Local Bodies:** the right to charge user fees and levy spot fines for littering and non-segregation.

E-WASTE (MANAGEMENT) AMENDMENT RULES, 2018

- **Objective:** To channelize the E-waste generated in the country towards authorized dismantlers & recyclers to formalize the e-waste recycling sector.
- E-waste collection targets under EPR have been revised - 10% (for 2017-18) of the quantity of waste generated with a 10% increase every year until 2023. (Target set at 70% after 2023 onwards).
- Separate E-waste collection targets for new producers.
- **PROs** (Producer Responsibility Organizations) must register with **CPCB** to undertake activities prescribed.

HAZARDOUS AND OTHER WASTES (MANAGEMENT AND TRANS-BOUNDARY MOVEMENT) AMENDMENT RULES, 2019

- **Objective:** To strengthen the implementation of environmentally sound management of hazardous waste.
- **Prohibition** on the import of solid plastic waste even in SEZ & EOU (Export Oriented Units). Silk waste exports are exempted.
- Electrical & electronic assemblies and components manufactured in & exported from India if found defective can be imported back into the country, within a year of export, without obtaining permission.

HAZARDOUS AND OTHER WASTES (MANAGEMENT AND TRANS-BOUNDARY MOVEMENT) AMENDMENT RULES, 2019

- **Industries that do not require consent under Water Act 1974 & Air Act 1981, are exempted** under the 'Hazardous & Other Wastes Rules, 2016', provided that wastes generated by such industries are handed over to the authorized actual users, waste collectors, or disposal facilities.

PLASTIC WASTE MANAGEMENT AMENDMENT RULES, 2021

- The manufacture, import, stocking, distribution, sale and use of the identified **single-use plastic will be prohibited with effect from the 1st July, 2022**.
- The ban will **not apply to commodities made of compostable plastic.**
- For banning other plastic commodities in the future, other than those that have been listed in this notification, the **government has given industry ten years** from the date of notification for compliance.

PLASTIC WASTE MANAGEMENT AMENDMENT RULES, 2021

- The permitted thickness of the plastic bags, **currently 50 microns, will be increased to 75 microns** from 30th September, 2021, and **to 120 microns from the 31st December, 2022**.
- **Central Pollution Control Board, along with state pollution bodies, will monitor** the ban, identify violations, and impose penalties already prescribed under the Environmental Protection Act, 1986.

PLASTIC WASTE MANAGEMENT AMENDMENT RULES, 2021

- The plastic packaging waste, which is not covered under the phase out of identified single use plastic items, shall be collected and managed in an environmentally sustainable way through the **Extended Producer Responsibility (EPR)** of the Producer, importer and Brand owner (PIBO), as per Plastic Waste Management Rules, 2016.

ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

Meaning

- It is a process of **evaluating the likely environmental impacts of a proposed project or development,** taking into account inter-related socio-economic, cultural and human-health impacts, both beneficial and adverse.
- **As per UNEP:** EIA as a tool used to identify the environmental, social and economic impacts of a project prior to decision-making.

ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

Aim

- To predict environmental impacts at an early stage in project planning and design, find ways and means to reduce adverse impacts, shape projects to suit the local environment and present the predictions and options to decision-makers.

ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

EIA in INDIA

- **Need first arose in 1976-77** when the Planning Commission asked the Department of Science and Technology to examine the river-valley projects from an environmental angle.
- The **first EIA notification was promulgated in 1994 by the then Ministry of Environment and Forests** (now MoEF&CC).
- **EIA in India is statutorily backed by the Environment Protection Act, 1986** which contains various provisions on EIA methodology and process.

ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

2006 Amendment to the EIA Notification

- **Decentralisation of Project Clearances**: It classified the developmental projects in two categories:
- **Category A (national level appraisal):** projects are appraised by Impact Assessment Agency (IAA) and the Expert Appraisal Committee (EAC)
- **Category B (state level appraisal):** State Level Environment Impact Assessment Authority (SEIAA) and State Level Expert Appraisal Committee (SEAC) provide clearance to the Category B projects.

ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

2006 Amendment to the EIA Notification

- **Introduction of Different Stages**: The Amendment introduced four stages into EIA Cycle; Screening, Scoping, Public hearing and Appraisal.
- **Category A projects require mandatory environmental clearance** and thus they do not have to undergo the screening process.
- Category B projects undergo a screening process and are further classified into B1 (Mandatorily requiring EIA) and B2 (Not requiring EIA).

ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

2006 Amendment to the EIA Notification

- **Projects with Mandatory Clearance**: Projects such as mining, thermal power plants, river valley, infrastructure (road, highway, ports, harbours and airports) and industries including very small electroplating or foundry units are mandated to get environment clearance.

DRAFT EIA NOTIFICATION 2020

- **Reduced Time for Public Hearings:** One of the major steps of the EIA Mechanism is the public participation. The 2020 draft proposes to reduce the notice period for public hearings from 30 days to 20 days.
- **Exemption of Projects:** Furthermore, by classifying a number of projects into A, B1 and B2, a host of projects are exempted from public scrutiny.

DRAFT EIA NOTIFICATION 2020

- **Post-clearance compliance:** It implies that once a project gets approved by the concerned authority, the proponent projects are required to adhere to certain rules laid down in the EIA report in order to ensure that no further environmental damages take place.
- **Annual Submission of Reports:** The new draft EIA, proposes the submission of compliance reports annually whereas as per the 2006 notification, the compliance report was to be submitted every six months

DRAFT EIA NOTIFICATION 2020

- **No Public Reporting for Non-Compliance:** The EIA Notification 2020 excludes reporting of violations and non-compliance by the public. Instead, the government will take cognisance of reports only from the violator-promoter, government authority, Appraisal Committee or Regulatory Authority.

DRAFT EIA NOTIFICATION 2020

- **Post-facto Clearance:** Another major proposal in the draft 2020 is granting ‘post-facto clearance’ where a project that has been operating without environmental clearance, can be regularised or allowed to apply for clearance.
- **Penalty for Firms:** Firms found violating the terms of their establishment, if they have to get the clearance, however, will have to pay a penalty.

CENTRAL POLLUTION CONTROL BOARD (CPCB)

- The CPCB is a **statutory organization** established **under** the **Water** (Prevention and Control of Pollution) **Act, 1974**.
- It is also **entrusted with the powers & functions under** the **Air** (prevention and control of pollution) **Act,** 1981.
- It works under the Ministry of Environment, Forest & Climate Change **(MoEF&CC)**.
- **Important functions**:
  - To prevent, control & abate water & air pollution in the country
  - To provide technical services to the MoEF&CC under the provisions of the Environment (Protection) Act, 1986
  - Collect, compile & publish technical and statistical data relating to water and air pollution.

CENTRAL WATER COMMISSION

- It is an **apex technical organization of India in the field of Water Resources**. Functions as an attached office of **Ministry of Jal Shakti**
- It is charged with the general responsibilities of initiating and coordinating schemes of control, utilization and conservation of water resources throughout the country.
- **Purpose of the schemes**: Flood Control, Irrigation, Navigation, Drinking Water Supply and Water Power Development.
- Also undertakes the investigations, construction and execution of any such schemes as required.

CENTRAL WATER COMMISSION

- **The work of the Commission is divided among 3 wings namely :**
  - River Management Wing (RM),
  - Designs and Research Wing (D&R) and
  - Water Planning and Projects Wing (WP&P).
- CWC provides a classification of the tolerance limits for inland surface waters for the various classes of water use:
  - **Class A:** Drinking water source without conventional treatment but after disinfection

CENTRAL WATER COMMISSION

- **The work of the Commission is divided among 3 wings namely :**
  - **Class B:** Outdoor bathing
  - **Class C:** Drinking water source with conventional treatment followed by disinfection.
  - **Class D:** Fish culture and wildlife propagation
  - **Class E:** Irrigation, industrial cooling or controlled waste disposal.

ANIMAL WELFARE BOARD OF INDIA (AWBI)

- Established in 1962 under the Section 4 of the **Prevention of Cruelty to Animals Acts 1960.**
- **HQ**: Ballabhgarh in Haryana (earlier based at Chennai).
- **Key person:** Smt. Rukmini Devi Arundale (also the 1st Chairperson of AWBI).
- AWBI is a **statutory advisory body** under the Ministry of Fisheries, Animal Husbandry and Dairying.
- **Member and Tenure:** 28 Members; The term of office of Members is for a period of 3 years.

ANIMAL WELFARE BOARD OF INDIA (AWBI)

- **Functions:**
  - Board is highly concerned about “abuse of animals in research” and “cruelty involved when animals were used in entertainment”.
  - It **advices governments** on the matters related to Animal welfare.
  - Board **oversees Animal Welfare Organizations (AWOs)** by granting recognition to them if they meet its guidelines.
  - The Board **provides financial assistance** to recognized Animal Welfare Organizations (AWOs)
  - The Board **suggests changes to laws and rules** about animal welfare issues.
  - The Board **issues publications to raise awareness** of various animal welfare issues.

CENTRAL ZOO AUTHORITY (CZA)

- **Established** in 1992 with HQ in New Delhi.
- CZA is a **statuary body** under 1991 Amendment to **Wildlife (Protection) Act 1972**
- **Ministry:** MoEF&CC
- **Members: Chairman**(Minister of Environment), 10 members and a member Secretary.
- **Objectives**: To oversee the functioning and development of zoos in the country.
- **Powers**: Recognition of zoos; Permission for acquisition of wild / captive animals; Cognizance of offences; Grant of licences, certificate of ownership, recognition; etc.

CENTRAL ZOO AUTHORITY (CZA)

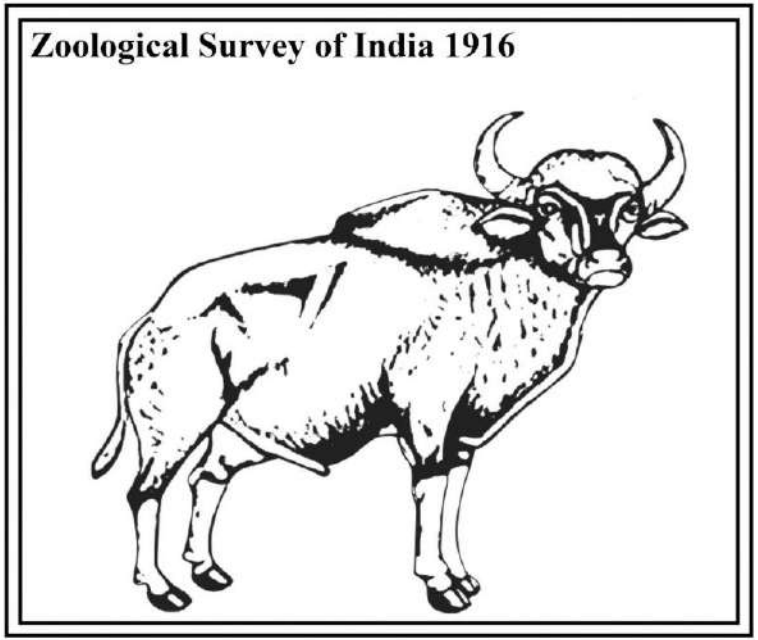
- **Functions:**
  - Specify the **minimum standards for housing, upkeep and veterinary care** of animals kept in a zoo
  - **Recognize and derecognize** zoos
  - **Identify endangered species of wild animals** for purposes of captive breeding
  - Co-ordinate the **acquisition, exchange and loaning of animals** for breeding purposes

CENTRAL ZOO AUTHORITY (CZA)

- **Functions**:
  - Ensure **maintenance of stud-books of endangered species** of wild animals bred in captivity
  - **Co-ordinate research in captive breeding** and educational programs for the purposes of zoos
  - Perform such other functions as may be necessary to carry out the purposes of this Act with regard to zoos

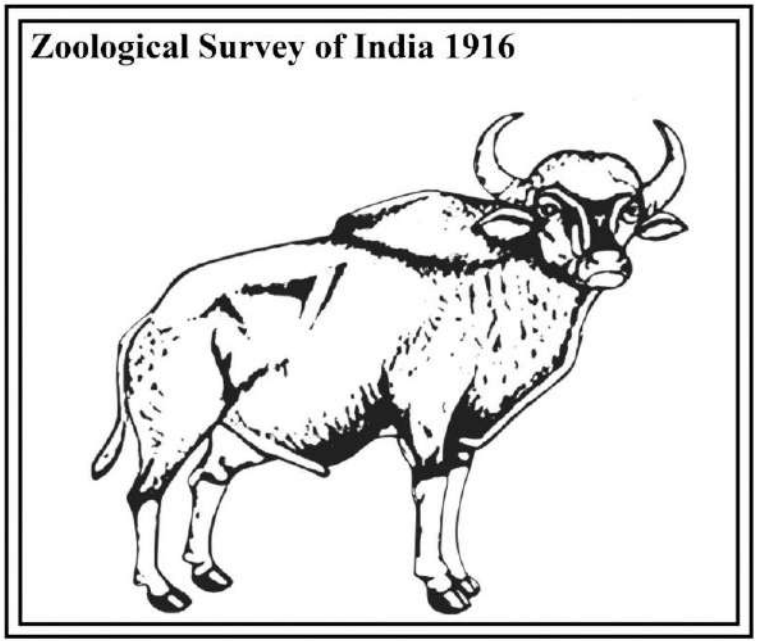
ZOOLOGICAL SURVEY OF INDIA (ZSI)

- Established in **1916**
- **Historical background**: Goes back to Asiatic Society of Bengal founded by Sir William Jones in 1784.
- **Headquarter**: Kolkata
- **Regional stations**: 16 regional stations located in different geographic locations of the country.
- **Ministry**: a subordinate organization of the Ministry of Environment and Forests and Climate Change (MoEF&CC)



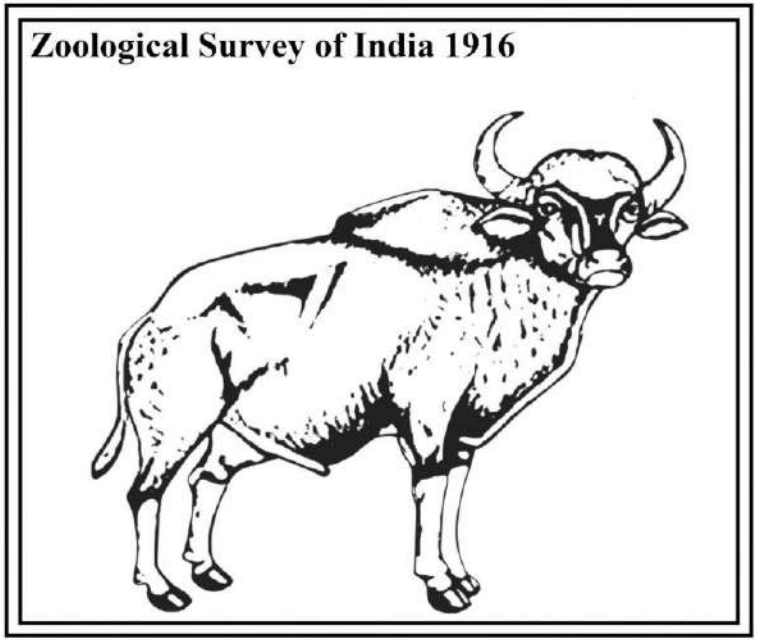
ZOOLOGICAL SURVEY OF INDIA (ZSI)

- **Objective**: to promote faunistic survey and exploration of the resources leading to the advancement of knowledge on the exceptionally rich faunal diversity of the country.
- **Functions**:
  - Training, Capacity Building and Human Resource Development of the people involved.
  - It works for the development of **Environmental Information System (ENVIS)** and **Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)** Centers.



ZOOLOGICAL SURVEY OF INDIA (ZSI)

- **Publications:**
  - Red Data Book on Indian Animals
  - Fauna of India, Fauna of States and Fauna of Conservation Areas



FOREST SURVEY OF INDIA (FSI)

- Established in **1981**
- **Headquarter**: Dehradun in Uttarakhand
- **Ministry**: Ministry of Environment and Forests and Climate Change (MoEF&CC)
- **Historical Background**: started as 'Pre-Investment Survey of Forest Resources (PISFR)' in 1965 before re-organized as FSI in 1981.
- **Objective**:
  - To **prepare State of Forest Report biennially**, providing assessment of latest forest cover

FOREST SURVEY OF INDIA (FSI)

- To conduct **inventory in forest and non-forest areas and develop database** on forest tree resources.
- To prepare **thematic maps on 1:50,000 scale**, using aerial photographs.
- To **function as a nodal agency for collection, compilation, storage and dissemination of spatial database** on forest resources.
- To **support State/UT Forest Departments (SFD)** in forest resources survey, mapping and inventory.

- **Forest Survey Report**: Released by FSI since 1987, biennially (once in two years).

FOREST SURVEY OF INDIA (FSI)

India State of Forest Report-2021	
In News	• Recently, the MoEFCC released the India State of Forest Report-2021.
About	• It is an **assessment of India's forest and tree cover, published every two years** by the Forest Survey of India. • The **first survey was published in 1987**, and ISFR 2021 is the 17th. • India is one of the few countries in the world that brings out such a survey every two years, and this is widely considered comprehensive and robust.
Used in	• Planning and formulation of policies in forest management as well as forestry and agroforestry sectors.
Categories	• Very dense forests (canopy density over 70%) • Moderately dense forests (40-70%) • Open forests (10-40%). • Note: Scrubs (canopy density less than 10%) are also surveyed but not categorized as forests.

ENVIRONMENTAL ORGANISATIONS AND INSTITUTIONS IN INDIA

FOREST SURVEY OF INDIA (FSI)

Findings

- **Increase of 2,261 sq km in the total forest and tree cover** of the country in last two years.
- **Area-wise Madhya Pradesh has the largest forest** cover in the country.
- **Percentage-wise Mizoram (84.53%)** has the largest forest cover in the country
- States in North East India have the highest percentage of forest cover.
- Maximum increase in forest cover witnessed in **Andhra Pradesh (647 sq km)** followed by Telangana (632 sq km) and Odisha (537 sq km).

FOREST SURVEY OF INDIA (FSI)

Findings

- **17 states/UT's have above 33 percent** of the geographical area under forest cover.
- Total carbon stock in country's forest is estimated to be 7,204 million tonnes, an increase of 79.4 million
- Total mangrove cover in the country is 4,992 sq km, an **increase of 17 sq Km observed**

FOREST SURVEY OF INDIA (FSI)

Forests in India's mountainous states

- Increase in forest loss in India's mountainous states along its Himalayan frontier, which are already in the throes of climate change
- J & K has lost very dense forests but gained open forests. The increase in open forests is led by commercial plantations.
- The report has attributed the loss of forest cover in the Himalayas and North East to an increase in developmental activities as well as agriculture.

FOREST SURVEY OF INDIA (FSI)

Forest cover at Lion Conservation Area (LCA) at Gir in Gujarat

- The LCA has seen a **decrease** of 33.43 sq km in its forest cover during the last decade
- It attributed the decrease to 'habitat improvement measures' taken in the last decade.
- This includes the removal of Prosopis juliflora, an invasive species from grassland areas and canopy manipulation for creating openings in the Very Dense Forest and Moderately Dense Forest areas.
- **Wetlands**: Gir National Park and Wildlife Sanctuary have 31 wetlands

BOTANICAL SURVEY OF INDIA (BSI)

- **Established**: in 1890 (under the direction of **Sir George King**)
- **Headquarter**: Kolkata
- **Ministry:** Ministry of Environment and Forests and Climate Change **(MoEF&CC)**
- BSI is the **apex taxonomic research organization** of the country.
- **Mandate**: Biosystematics research, floristic studies, documentation of flora, digitization of herbarium specimens, & advisory services etc.,
- BSI publishes: **'Red Data Book of Indian Plants'**.

भारतीय वनस्पति सर्वेक्षण

BOTANICAL SURVEY OF INDIA

BOTANICAL SURVEY OF INDIA (BSI)

- **Functions:**
  - Exploration, inventorying and documentation of Phyto-diversity in general and protected areas, hotspots and fragile ecosystems in particular.
  - Publication of National, State and District Floras.
  - Identification of threatened and red list species and species rich areas needing conservation.
  - Ex-situ conservation of critically threatened species in botanical gardens.
  - Develop National database of Indian plants.

भारतीय वनस्पति सर्वेक्षण

BOTANICAL SURVEY OF INDIA

NATIONAL BIODIVERSITY AUTHORITY (NBA)

- Established in **2003**
- **Headquarter**: Chennai
- **Ministry**: Ministry of Environment and Forests and Climate Change (MoEF&CC)
- NBA is a **statutory body under Biological Diversity Act, 2002**.
- The act was **enacted to give effect-to the Convention on Biological Diversity (CBD)** (India signed it in 1992)
- **Structure**: The Authority, Secretariat, SBBs, BMCs and Expert Committees
- **Mandate**: to perform regulatory & advisory functions for the GoI on issues of conservation, sustainable use of biological resources.

NATIONAL BIODIVERSITY AUTHORITY (NBA)

- NBA supports **creation of State Biodiversity Boards (SBBs).**
- **Biodiversity Heritage Sites**: Notified by State Governments in consultation with local bodies.

NATIONAL BIODIVERSITY AUTHORITY (NBA)

- **Main functions:**
  - Advise the Central and State Government on matters relating to the conservation of biodiversity
  - Perform such other functions as may be necessary to carry out the provisions of this Act.
  - National Biodiversity Authority may, on behalf of the Central Government, take any measures necessary to oppose the grant of Intellectual Property Rights in any country outside India on transfer of biological resource or knowledge from India.

WILDLIFE CRIME CONTROL BUREAU (WCCB)

- Established in **2006**
- **Headquarter**: New Delhi
- **Ministry**: Ministry of Environment and Forests and Climate Change (MoEF&CC)
- It is a **statutory body** constituted under the **Wildlife (Protection) Act 1972 (WPA 2006, Amendment).**
- **Five regional offices**: Delhi, Kolkata, Mumbai, Chennai & Jabalpur.
- **Objective**: to combat organized wildlife crime
- Additional Director General (Wild Life) is the ex-officio director of the WCCB.

WILDLIFE CRIME CONTROL BUREAU (WCCB)

- **WCCB is the nodal point for SAWEN** (South Asia Wildlife Enforcement Network) in India.
- **WCCB has conducted**: Operation Save Kurma, Thunder Bird, Wild-Net, Lesknow, Birbil, Clean Art etc.
- UNEP has awarded WCCB with **'Asia Environment Enforcement Awards'** in 2018.

WILDLIFE CRIME CONTROL BUREAU (WCCB)

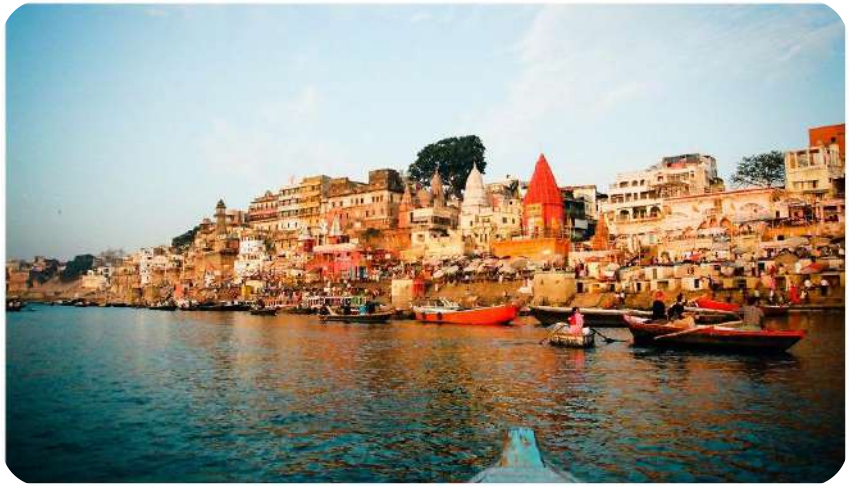
- **Functions:**
  - **Collect intelligence** related to organized wildlife crime activities.
  - Establish a **centralized wildlife crime data bank**.
  - **Coordinates with foreign authorities** and international organization
  - Build capacity of the wildlife crime enforcement agencies for scientific and professional investigation
  - Assist State Governments to ensure success in prosecutions related to wildlife crimes.

WILDLIFE CRIME CONTROL BUREAU (WCCB)

- **Functions:**
  - **Advise the Govt** on issues relating to wildlife crimes having national and international ramifications.
  - It also **assists & advises** the **Customs authorities** in inspection of the consignments of **flora & fauna** as per the provisions of WPA, CITES & EXIM Policy.

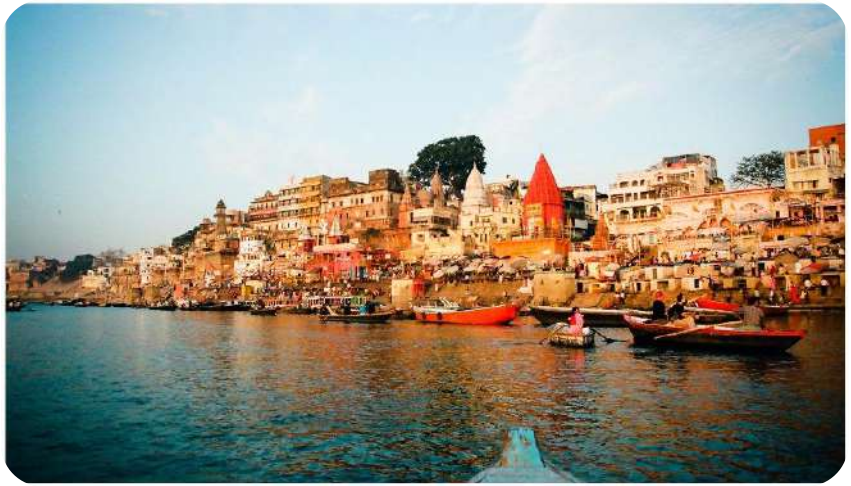
NATIONAL GANGA RIVER BASIN AUTHORITY

- Established in **2009**
- **Headquarter**: New Delhi
- **Ministry**: Ministry of Jal Shakti
- **Mandate**: Abatement of pollution & conservation of the river Ganga.
- The NGRBA is **chaired by the Prime Minister**
- **Members include**: Union Ministers concerned, the Chief Ministers of the States through which Ganga flows.



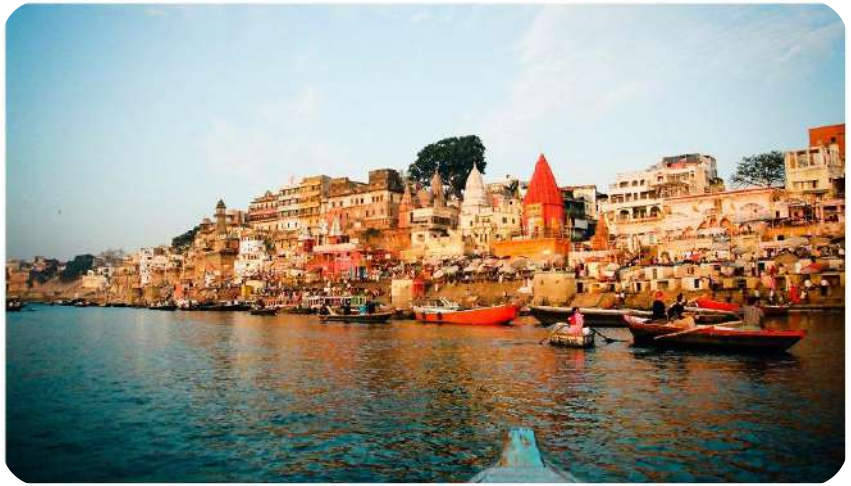
NATIONAL GANGA RIVER BASIN AUTHORITY

- **Powers:**
  - The Authority has both regulatory and developmental functions.
  - The Authority will take measures for effective abatement of pollution and conservation of the river Ganga in keeping with sustainable development needs.
- **Functions:**
  - Development of river basin management plan
  - Regulation of activities
  - Maintenance of minimum ecological flows in the river Ganga



NATIONAL GANGA RIVER BASIN AUTHORITY

- **Functions:**
  - Collection, analysis and dissemination of information
  - Promotion of water conservation practices including recycling and reuse, rain water harvesting, and decentralised sewage treatment systems
  - Issuance of directions under Environment (Protection) Act 1986 for the purpose of exercising and performing all or any of the above functions and to take such other measures as the Authority deems necessary or expedient for achievement of its objectives.



NATIONAL BOARD FOR WILDLIFE (NBWL)

- Established in **2003**
- **Headquarter**: New Delhi
- **Ministry**: Ministry of Environment and Forests and Climate Change (MoEF&CC)
- **Replaced**: 'Indian Board for Wildlife', which was formed in 1952 as an advisory board.
- NBWL is a **statutory body constituted under the WPA, 1972**.
- **NBWL Composition**: Chairperson (the Prime Minister); Vice-Chair (Minister of Environment); 45 other members including 19 ex-officio members, 3 MPs (2 from LS & 1 from RS), 5 NGOs.

NATIONAL BOARD FOR WILDLIFE (NBWL)

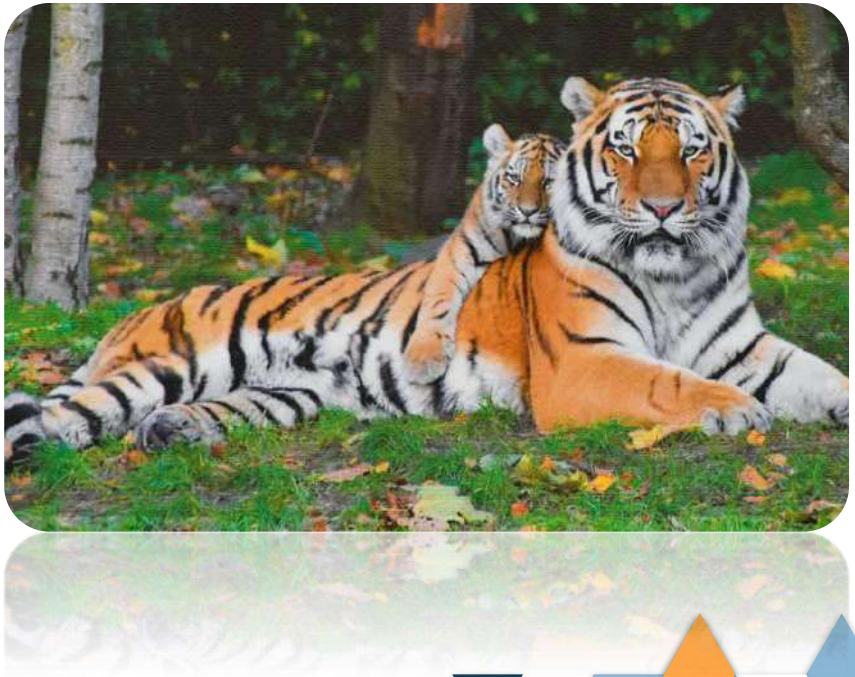
- **Objective**: To promote the conservation and development of wildlife and forests.
- **Power**: to review all wildlife-related matters and approve projects in and around national parks and sanctuaries.
- **No alternation of boundaries** in National Parks and Wildlife Sanctuaries can be done without approval of the NBWL.

NATIONAL TIGER CONSERVATION AUTHORITY (NTCA)

- **Wild Life (Protection) Amendment Act, 2006 provides for creating:**
  - National Tiger Conservation Authority and
  - Tiger and Other Endangered Species Crime Control Bureau (Wildlife Crime Control Bureau).
- **Headquarter**: New Delhi
- **Ministry**: Ministry of Environment and Forests and Climate Change (MoEF&CC)

NATIONAL TIGER CONSERVATION AUTHORITY (NTCA)

- Established in **2006, as a statutory body** under the WPA, 1972 (Amendment Act, 2006).
- **Chairperson**: Minister of Environment.
- It provides **statutory authority** to Project Tiger.
- Addresses the livelihood interests of local people in areas surrounding Tiger Reserves.
- **State level Steering Committees** will be set up in the Tiger States under the Chairmanship of respective Chief Minister.



BOMBAY NATURAL HISTORY SOCIETY

- **Founded in 1883,** is one of the **largest NGO in India** engaged in conservation and biodiversity research.
- BNHS is the partner of **BirdLife International in India**
- **Logo:** The BNHS logo is the great hornbill.
- It supports many research efforts through **grants** and **publishes the Journal** of the BNHS.
- Department of Science and Technology has designated it as a 'Scientific and Industrial Research Organisation'.

BOMBAY NATURAL HISTORY SOCIETY

- It organizes and conducts nature trails and camps for the general public.
- Many prominent naturalists, including the ornithologists Salim Ali and S. Dillon Ripley, have been associated with it
- **Internet of Birds:** IT consultancy firm Accenture and the BNHS have developed Internet of Birds platform that identifies bird species found in India using Artificial Intelligence technology, including machine learning and computer vision, from digital photos that are uploaded by the public.

ENVIRONMENTAL CONVENTIONS

MAJOR INTERNATIONAL ENVIRONMENTAL CONVENTIONS

Nature Conservation

- United Nations Conference On Environment And Development (UNCED)
- Convention on Biological Diversity (CBD)
- Ramsar Convention on Wetlands
- Convention on International Trade in Endangered Species of Fauna and Flora (CITES)
- The Wildlife Trade Monitoring Network (TRAFFIC)

MAJOR INTERNATIONAL ENVIRONMENTAL CONVENTIONS

Nature Conservation

- Convention on the Conservation of Migratory Species (CMS)
- Coalition Against Wildlife Trafficking (CAWT)
- International Tropical Timber Organization (ITTC)
- United Nations Forum on Forests (UNFF)
- International Union for Conservation of Nature and Natural Resources (IUCN)
- Global Tiger Forum (GTF)

MAJOR INTERNATIONAL ENVIRONMENTAL CONVENTIONS

Hazardous Material	• **Stockholm Convention** • **Basel Convention** • **Rotterdam Convention**
Land	• United Nations Convention to Combat Desertification (UNCCD)
Marine Environment	• International Whaling Commission (IWC)
Atmosphere	• Vienna convention and Montreal Protocol • United Nations Framework Convention on Climate Change (UNFCCC) • Kyoto Protocol

UNITED NATIONS CONFERENCE ON THE HUMAN ENVIRONMENT (1972)

- United Nations Conference on the Human Environment (known as the **Stockholm Conference)** was an international conference convened under **United Nations** auspices held in Stockholm, Sweden (1972).
- It was the **UN's first major conference on international environmental issues,** and marked a turning point in the development of international environmental politics.
- First conference was held in Stockholm, Sweden, in 1972.

UNITED NATIONS CONFERENCE ON THE HUMAN ENVIRONMENT (1972)

Stockholm Declaration	• **It set out the principles for various international environmental issues, & the relationship between the environment and development.** • **It is also known as 'The Declaration on the Human Environment'.**
Stockholm+50	• It is a high-level meeting that the Govt. of Sweden plans to hold in conjunction with the 50th anniversary of the first UN conference on the human environment – the 1972 Stockholm Conference. • **Aim:** to contribute to concrete action and leveraging sustainable consumption and production patterns and nature-based solutions in order to achieve climate-neutral, resilient, circular and inclusive economies.

UNITED NATIONS CONFERENCE ON THE HUMAN ENVIRONMENT (1972)

Brundtland Commission

- Formerly known as the **World Commission on Environment & Development (WCED)**
- **Mission**: to unite countries to pursue sustainable development together.
- The Commission was **officially dissolved in December 1987 after releasing "Our Common Future"**, also known as the **Brundtland Report**, in October 1987.
- The document popularized (and defined) the term **"Sustainable Development"**.

UNITED NATIONS CONFERENCE ON ENVIRONMENT AND DEVELOPMENT (UNCED), 1992

- Also **known as the Rio Summit, Rio Conference, Earth Summit** held in Rio de Janeiro in June 1992.
- Earth Summit was held as a platform for Member States to collaborate in conservation efforts.
- **Systematic scrutiny of production of toxic components:** lead in gasoline, or poisonous waste including radioactive chemicals.
- **Alternative sources of energy:** to replace the use of fossil fuels which are linked to global climate change
- **New reliance on public transportation systems:** to reduce vehicle emissions, congestion in cities and the health problems caused by polluted air and smog.

UNITED NATIONS CONFERENCE ON ENVIRONMENT AND DEVELOPMENT (UNCED), 1992

Outcomes of Earth Summit 1992

Non legally binding documents	Legally binding agreemnets
1) Rio declaration on environment and development	1) (United nations framework convention on climate change) UNFCCC
2) Agenda 21	2) (Convention on biological diversity) CBD
3) Forest principles	3) (United nations conventions to combat desertification) UNCCD

UNITED NATIONS CONFERENCE ON ENVIRONMENT AND DEVELOPMENT (UNCED), 1992

- Three Rio Conventions—on Biodiversity, Climate Change and Desertification—derive directly from the 1992 Earth Summit:
  - United Nations Framework Convention on Climate Change (UNFCCC)
  - UN Convention on Biological Diversity (UNCBD)
  - UN Convention to Combat Desertification (UNCCD)
- **Major Outcomes:**

1. Rio Declaration on Environment and Development
2. Agenda 21
3. Forest Principles

UNITED NATIONS CONFERENCE ON ENVIRONMENT AND DEVELOPMENT (UNCED), 1992

Rio Declaration on Environment and Development

- The Rio Declaration consisted of 27 principles intended to guide countries in future sustainable development. It was signed by over 175 countries.

UNITED NATIONS CONFERENCE ON ENVIRONMENT AND DEVELOPMENT (UNCED), 1992

Agenda 21

- It is a **non-binding action plan** sourced from Rio Earth Summit, 1992.
- The number **"21" refers to an agenda for the 21st century.**
- **Objective:** to achieve Global sustainable development.
- Since 2015, Sustainable Development Goals are included in the Agenda 2030.

UNITED NATIONS CONFERENCE ON ENVIRONMENT AND DEVELOPMENT (UNCED), 1992

Agenda 21

Local Agenda 21	• **The implementation of Agenda 21 was intended to involve action at international, national, regional and local levels, often known as 'Local Agenda 21' or 'LA21'.**
Agenda 21 for culture	• Advocates establishing the groundwork of an undertaking by cities and local governments for cultural development.
RIO+5 (1997)	• UN General Assembly held a special session to appraise the status of Agenda 21 (Rio +5) • Assembly recognized progress as 'uneven' and identified key trends: increasing globalization, widening inequalities in income and a continued deterioration of the global environment.

UNITED NATIONS CONFERENCE ON ENVIRONMENT AND DEVELOPMENT (UNCED), 1992

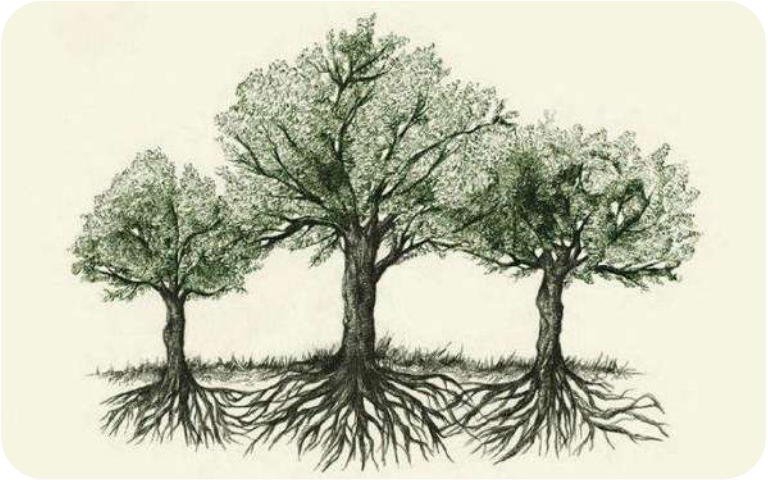
Agenda 21

RIO+10 (2002)	• **The Johannesburg Summit:** ○ The Johannesburg Plan of implementation, agreed to at the World Summit on Sustainable Development (Earth Summit 2002). ○ UN commitment: to "full implementation" of Agenda 21, alongside achievement of the MDGs and other international agreements.
RIO+20 (2012)	• The attending members reaffirmed their commitment to Agenda 21 in their outcome document called "The Future We Want". 180 nation leaders participated. • **Two main themes:** 1. How to build a green economy to achieve sustainable development and lift people out of poverty; and 2. How to improve international coordination for sustainable development.

UNITED NATIONS CONFERENCE ON ENVIRONMENT AND DEVELOPMENT (UNCED), 1992

Forest Principles

- Also known as Rio Forest Principles, 1992.
- It is a **Non-legally binding document** on Conservation and Sustainable Development of all Types of Forest.



GLOBAL ENVIRONMENT FACILITY (GEF)

- GEF was established on the eve of the **1992 Rio Earth Summit** to help tackle environmental issues.
- Located in **Washington D.C.,** United States + Parties: 184.
- The GEF is **jointly managed by UNDP, World Bank, & UNEP.**
- **As an independent financial organization, GEF provides grants for projects related to**: Biodiversity, Climate change, International waters, Land degradation, Ozone layer, Persistent Organic Pollutants (POPs), Mercury, Sustainable Forest management, Food security, Sustainable cities.

GLOBAL ENVIRONMENT FACILITY (GEF)

- **Note**: Although **GEF not linked formally to the Montreal Protocol** on Substances that Deplete the Ozone Layer, it supports implementation of the Protocol in countries with economies in transition.
- **GEF also serves as financial mechanism for six conventions:** Stockholm, UN-FCC, UN-CBD, UN-CCD, Montreal Protocol, Minamata Convention.

GLOBAL ENVIRONMENT FACILITY (GEF)

GEF's SMALL GRANTS PROGRAMME (SGP):

- It was launched in 1992 with 33 participating countries.
- It provides financial & technical support to communities and Civil Society Organizations (CSOs)
- SGP is specifically designed to mobilize community-led bottom-up approach for Sustainable Development.
- **It is currently implemented by** UNDP **on behalf of GEF.**

UNITED NATIONS ENVIRONMENT PROGRAMME (UNEP) OR UN ENVIRONMENT

- It is an **agency of the United Nation**, established on 5th June **1972**.
- Coordinates the UN's environmental activities and **leading global environmental authority**.
- **Headquarters:** Nairobi, Kenya.
- **UNEP's governing body**: called the United Nations Environment Assembly.
- **Functions:** It sets the global environmental agenda, promotes the sustainable development within the United Nations system, and serves as an authoritative advocate for global environment protection.

UNITED NATIONS ENVIRONMENT PROGRAMME (UNEP) OR UN ENVIRONMENT

- UNEP has been established by the **United Nations General Assembly (UNGA) in pursuance of the Stockholm Conference (1972).**
- **Major Campaigns:** Beat Pollution, UN75, World Environment Day, Wild for Life.
- **Major Programmes of the UNEP:** Earth Hour, Clean up the World, Billion Tree Campaign, Seal the Deal, Pain for the Planet, TUNZA.
- **Major Reports:** Emission Gap Report, Adaptation Gap Report, Global Environment Outlook, Frontiers, Invest into Healthy Planet.

UNITED NATIONS ENVIRONMENT PROGRAMME (UNEP) OR UN ENVIRONMENT

- World Meteorological Organization and UN Environment established the **Intergovernmental Panel on Climate Change (IPCC) in 1988.**
- **It is also one of several Implementing Agencies** for the Global Environment Facility (GEF) and the Multilateral Fund for the Implementation of the Montreal Protocol.
- **Registered several successes:** Montreal Protocol (1987) and the Minamata Convention (2012).

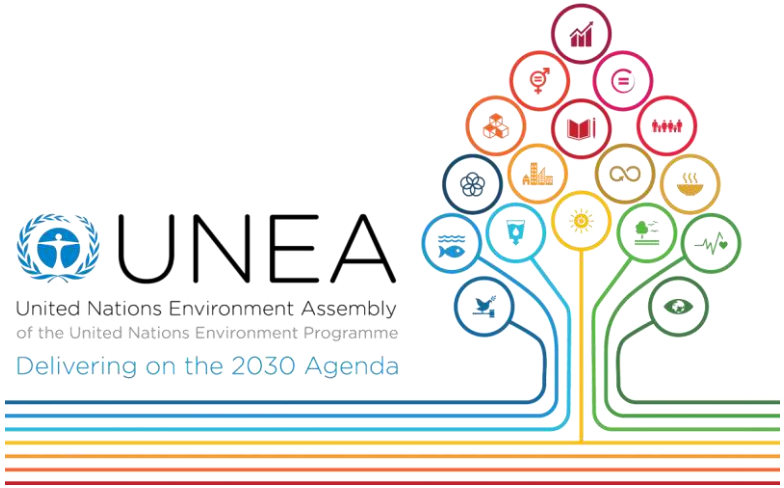
UNITED NATIONS ENVIRONMENT PROGRAMME (UNEP) OR UN ENVIRONMENT

- In 2019, **India joined the Climate & Clean Air Coalition (CCAC),** whose Secretariat is hosted by the UNEP.
- The **UNEP awarded PM Narendra Modi with the 'Champions of the Earth' award** along with French President Emmanuel Macron in the category 'policy leadership'.

UNITED NATIONS ENVIRONMENT PROGRAMME (UNEP) OR UN ENVIRONMENT

United Nations Environment Assembly

- It is the governing body of the UN Environment Programme.
- It is the world's highest-level decision-making body on the environment.
- It meets biennially to set priorities for global environmental policies and develop international environmental law.
- It was created in June 2012, during the United Nations Conference on Sustainable Development, also referred to as RIO+20.
- Currently, it has 193 member states (all UN member countries).



INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC)

- It is the international body for **assessing the science** **related to climate change**.
- It was **set up in 1988 by the World Meteorological Organization (WMO) and United Nations Environment Programme (UNEP)** to provide policymakers with regular assessments of the scientific basis of climate change, its impacts and future risks, and options for adaptation and mitigation.
- **The 2007 Nobel Peace Prize** was shared, in two equal parts, between the IPCC and an American Environmentalist.

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC)

- **Aims of the IPCC:** To assess scientific information relevant to: Human-induced climate change; Impacts of human-induced climate change; Options for adaptation and mitigation.
- IPCC assessments **provide a scientific basis for governments at all levels to develop climate related policies,** and they underlie negotiations at the UN Climate Conference – UNFCCC.

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC)

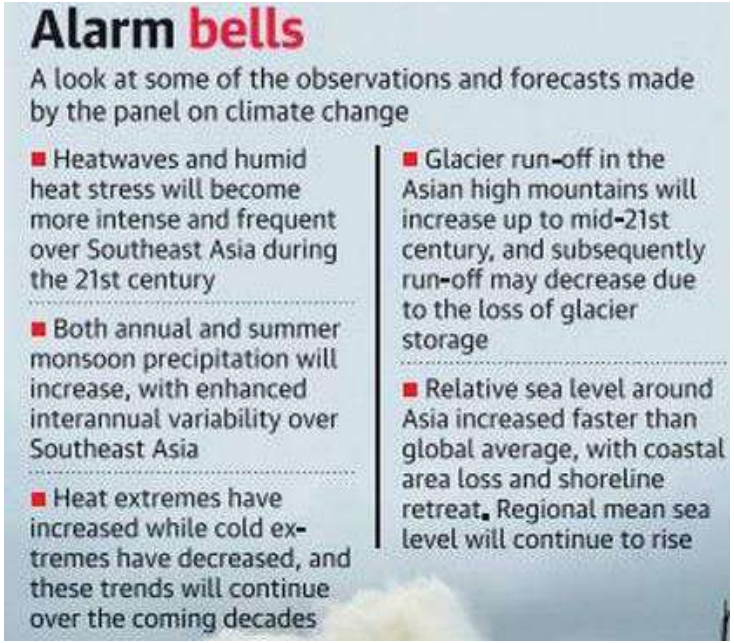
IPCC Assessment Reports (ARs):

- Every few years (about 7 years), the IPCC produces assessment reports that are the **most comprehensive scientific evaluations of the state of earth's climate.**
- Assessment Reports - by three working groups of scientists:
  - Working Group-I - Deals with the scientific basis for climate change.
  - Working Group-II - Looks at the likely impacts, vulnerabilities and adaptation issues.
  - Working Group-III - Deals with actions that can be taken to combat climate change.

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC)

SIXTH ASSESSMENT REPORT (AR6):

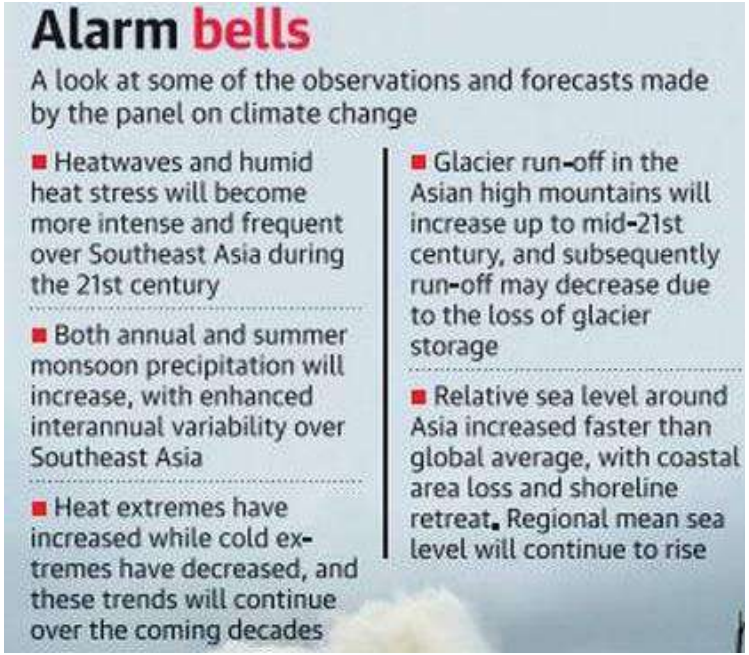
- **Theme**: "Climate Change 2021: The Physical Science".
- It is the **sixth in a series of reports** intended to assess scientific, technical, and socio-economic information concerning climate change.
- It is **prepared by the scientists of Working Group-I.** The **two remaining parts would be released in 2022.**
- It sets the stage for the **Conference of Parties (CoP)** 26 conference in **Glasgow, Scotland (2021).**



INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC)

SIXTH ASSESSMENT REPORT (AR6):

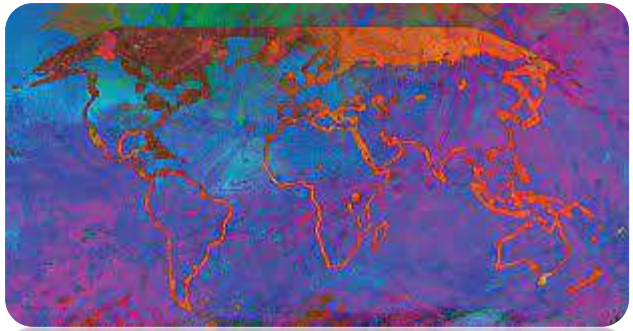
- It noted that **global net-zero by 2050 was the minimum required to keep the temperature rise to 1.5 degree Celsius.**
- The report evaluates the physical science of climate change **looking at the past, present, and future climate**.
- It reveals how human-caused emissions are altering our planet and what that means for our collective future.



INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC)

SIXTH ASSESSMENT REPORT (AR6):

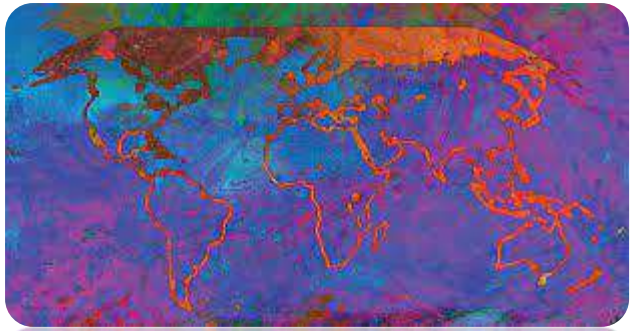
- Weather and climate events – such as extreme heat, heavy rainfall, fire conditions, and droughts – are becoming more severe and frequent because of climate change.
- The report finds **we are already edging closer to a 1.5 degrees Celsius warmer world**, and every day emissions rise the prospects for averting the worst impacts of climate change become dimmer.
- **Carbon dioxide has been and will continue to be the dominant cause of global warming** under all greenhouse gas emissions scenarios.



INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC)

SIXTH ASSESSMENT REPORT (AR6):

- Also, **IPCC report vindicates India's position** that historical cumulative emissions are the source of the climate crisis that the World faces today.
- **Major Concerns:**
  - Arctic Sea ice is at its lowest level in more than 150 years;
  - Sea levels are rising faster than at any time in at least the last 3,000 years;
  - Glaciers are declining at a rate unprecedented in at least 2,000 years.



UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (UNFCCC)

- UNFCCC is the **primary multilateral treaty** governing actions to combat climate change through adaptation and mitigation efforts directed at control of emission of GHGs that cause global warming.
- **Negotiated & signed at the UN (CED)** - Conference on Environment & Development (Earth Summit), held in Rio de Janeiro, June 1992.
- **Headquartered:** Bonn
- **Came into force:** on 21 March 1994

United Nations Framework Convention on Climate Change

UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (UNFCCC)

- **Objective**: To stabilize Greenhouse Gas (GHG) concentrations in the atmosphere at a level that would stop dangerous anthropogenic interference with the climate system.
- It has been ratified by **197 countries** and is called to have a **near-universal membership**. The countries that have ratified the convention are called the **UNFCCC conference of parties (COP).**
- **India ratified** the UNFCCC in 1993.

UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (UNFCCC)

- **Nodal agency** for the UNFCCC in India is the Ministry of Environment, Forests and Climate Change (MoEFCC).
- Originally it **sets no binding limits on GHG emissions** for individual countries & contained no enforcement provisions.
- **Kyoto Protocol (1997)** was negotiated under this framework.
- **COP is the supreme governing body** of the UNFCCC.
- **Climate-Tech Centre Network:** is the operational arm of UNFCCC. It promotes transfer of tech for low Carbon & Carbon resilient development.

UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (UNFCCC)

- The latest, **COP26, was held in Glasgow, Scotland in 2021.**
- It is called the Rio Convention along with its sister conventions:
  - UN Convention on Biological Diversity and
  - UN Convention to Combat Desertification.

KYOTO PROTOCOL

- Kyoto Protocol was an **international treaty which extended the 1992 UNFCCC** that commits state parties to reduce greenhouse gas emissions.
- **Adopted in Kyoto**, Japan in **1997 at CoP3** of UNFCCC; Came into force by Feb-2005.
- **Parties:** 192 (Andorra, Canada, South Sudan, & United States are not members).
- **India ratified** the protocol in **2002**.

KYOTO PROTOCOL

- Protocol aimed to cut emissions of GHGs across the developed world by about 5% by 2012 compared with 1990 levels, in the 1st commitment period, 2008 to 2012.
- The Kyoto Protocol applies to the 6 GHG listed in Annex A: Carbon dioxide (CO_2), Methane (CH_4), Nitrous oxide (N_2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulfur Hexafluoride (SF_6).
- It is based on the **'Principle of Common But Differentiated Responsibilities'.**

KYOTO PROTOCOL

Common But Differentiated Responsibilities (CBDR)

- CBDR was **formalized in UNFCCC of Earth Summit in Rio de Janeiro, 1992**.
- The CBDR principle is **mentioned in UNFCCC**.
- It was the **first international legal instrument to address climate change** and the most comprehensive international attempt to address negative impacts to global environment.

KYOTO PROTOCOL

Common But Differentiated Responsibilities (CBDR)

- CBDR principle **acknowledges all states have shared obligation to address environmental destruction but denies equal responsibility of all states** with regard to environmental protection.
- CBDR is based on co-relationship between industrialization and climate change.
- The more industrialized a country is, more likely that it has contributed to climate change.

KYOTO PROTOCOL

- **Classification of Parties:**

Annex-I countries	• **List of industrialized countries and economies in transition** • **Compulsory binding targets to reduce GHG emissions**
Annex II	• A sub-group of Annex 1. • These countries are required to give financial assistance & technology to Non-annex countries.
Non-Annex	• Developing countries like India, Brazil, China. • No binding targets to reduce GHG emissions
LDCs	• Least-developed countries • No binding targets

KYOTO PROTOCOL

Under Kyoto Protocol, there are two commitment periods:

- 2008 – 2012
- 2013 – 2020 (Doha Amendment to the protocol, 2012)

- The second commitment period is a **failure**, due to non-acceptance of required (144) number of parties.
- **Note**: Kyoto Protocol is the only global treaty with binding limits on GHG emissions.
- Apart from national measures, the agreement has three mechanisms that are means to achieve the Kyoto targets:

1. International Emissions Trading
2. Clean Development Mechanism
3. Joint Implementation

KYOTO PROTOCOL

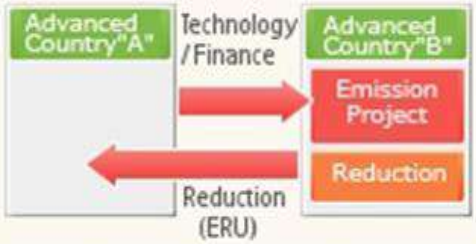
Under Kyoto Protocol, there are two commitment periods:

- **India is a non-Annex I country. India** is exempt from the treaty's framework. The Indian government ratified the treaty in August 2002. Since the per capita emission rates are much smaller for developing countries compared to the developed countries, India takes the stand that the major responsibility of reducing emissions lies with the latter.

KYOTO PROTOCOL

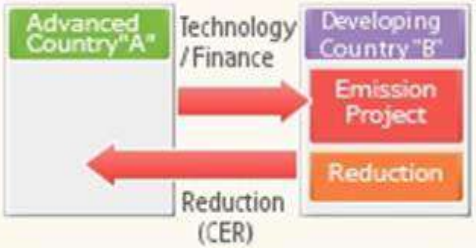
1. Joint Impementation (JI)

Joint Implementation(JI)
Implement emission reduction project between Advanced country"A" and Advanced country "B" and utilize the ERU(Emission Reduction Units) to achieve target for each country



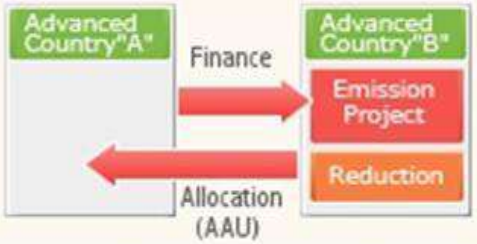
2.Clean Development Mechanism (CDM)

Clean Development Mechanism(CDM)
Implement emission reduction project between Advanced country "A" and Developing country "B" and utilize the CER(Certified Emission Reduction) for Advanced country



3. Emission Trading

Emission Trading
System to sell and buy AAU(Assigned Amount Unit) among Advanced countries to achive reduction target



IMPORTANT UNFCCC COPS POST-KYOTO PROTOCOL

COP	Description
Bali Summit COP13	• Introduction of **Nationally Appropriate Mitigation Actions (NAMA),** to engage developing countries in voluntary mitigation effort.
Copenhagen Summit COP15	• This was the **first Climate Agreement which endorsed the 2ºC warming limit as the benchmark** for global progress on climate change. • Copenhagen Accord (2009) **abandoned the spirit of the Rio principles** & wanted voluntary GHG reduction targets. • However, developing countries revolted & **Paris Agreement was born out of Copenhagen and adopted in 2015.**
Cancun Summit COP16	• Cancun Agreement – all parties to the convention have agreed to report their voluntary mitigation goals for implementation. • **Outcome of COP16:** Technology Mechanism, Green Climate Fund, Adaptation Fund.

IMPORTANT UNFCCC COPS POST-KYOTO PROTOCOL

COP	Description
Durban Summit COP17	• Second phase of Kyoto Protocol secured • Launching the **Green Climate Fund (GCF)** • Adaptation and Transparency mechanism • Review of Adaptation Fund
Doha Summit COP18	• Amendment to the Kyoto Protocol to start second commitment period (2013-2020)
Warsaw Summit COP19	• Two important things emerged: 1. **INDC:** Intended Nationally determined Contribution 2. **REDD+:** Reduction in Emission from Deforestation and Forest Degradation

ONLYIAS
Nothing Else

ENVIRONMENTAL CONVENTIONS

IMPORTANT UNFCCC COPS POST-KYOTO PROTOCOL

Paris Summit COP21

- **Legally binding** International Treaty on Climate Change.
- It was **adopted by 196 Parties at COP 21 in Paris, on 12 December 2015** & entered into force on 4 November **2016.**
- **Goal**: to limit global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels.
- It **requires all parties to put forward their Nationally Determined Contributions (NDCs)** which is **voluntary in nature.**

IMPORTANT UNFCCC COPS POST-KYOTO PROTOCOL

Paris Summit COP21

- The agreement talks about 20/20/20 targets:
  - CO2 emissions reductions by 20%
  - To increase the Renewable energy market share by 20%
  - To increase energy efficiency by 20%
- **USA announced to withdraw** from the deal in 2017.
- **Review mechanism** – A review every 5 years – first world review will be **done by 2023.**

IMPORTANT UNFCCC COPS POST-KYOTO PROTOCOL

Marrakech Summit COP22

- Discussed on how to tackle Global Stock take.
- Parties conducted the first review of the Warsaw International Mechanism for Loss and Damage
- **Contentious issues:**
  - "Orphan" issues on establishing common timeframe for NDCs
  - Whether the Adaptation Fund would continue or not.

IMPORTANT UNFCCC COPS POST-KYOTO PROTOCOL

Bonn Summit COP23

Talanoa dialogue
to encourage the international community to take more action to close the global climate mitigation gap

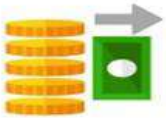
Gender action plan
to make women part of all climate change projects and decisions internationally and nationally

Clean Energy Transitions programme
to support clean energy transitions around the world

Global average temperature
to keep the global average temperature rise below 2 Celsius

Launch of Fiji clearing house for risk transfer
A new online platform to help vulnerable countries find affordable insurance and solutions to avoid climate risk

By 2020



Long-term finance
to deliver $100 Billion per year for supporting developing countries to take climate action

Ocean pathway partnership
to strengthen action and funding that link climate change action with healthy oceans

InsuResilience - the climate risk insurance initiative
$125 million insurance coverage from the government of Germany to protect 400 million poor and vulnerable people from extreme weather events

By 2030

New Small Island Developing State (SIDS) health initiative
to triple the levels of international financial support on climate and health for people living in SIDS

IMPORTANT UNFCCC COPS POST-KYOTO PROTOCOL

Katowice Summit COP24

- UNFCCC's COP-24, **held in Katowice, Poland.**
- **Outcome**: "Katowice Rulebook" to implement Paris Agreement.
- Parties' commitment to NDCs was revised and enhanced.
- Guidelines for the **"global stocktake"** pledge-and-review cycle.
- Developed countries commitment of $100 billion annually from 2020 to fund climate action in developing countries

COP24·KATOWICE 2018
UNITED NATIONS CLIMATE CHANGE CONFERENCE

United Nations Framework Convention on Climate Change

IMPORTANT UNFCCC COPS POST-KYOTO PROTOCOL

Katowice Summit COP24

- **Katowice Rulebook includes:**
  - The steps that each member nation is required to take to fight global climate change
  - It operationalizes the provisions of the Paris Agreement.
  - Extends support to developing nations to implement their NDCs.
  - The Global Stock Take (GST) to assess the effectiveness of climate action in 2023.
  - To assess progress on the development and transfer of technology

IMPORTANT UNFCCC COPS POST-KYOTO PROTOCOL

Katowice Summit COP24

- **Katowice Rulebook includes:**
- **Significance**: ensure that each 'tonne of GHG emissions' is accounted.
- **Issues**: Failure to agree common rules on carbon markets and emissions trading.
- **Non-agreement** on general commitment to limit global warming to below 1.5°C above pre-industrial levels.

COP24·KATOWICE 2018
UNITED NATIONS CLIMATE CHANGE CONFERENCE

United Nations Framework Convention on Climate Change

IMPORTANT UNFCCC COPS POST-KYOTO PROTOCOL

COP25 Madrid

- It was **originally planned in Brazil but, took place under the Presidency of Chile** & held with logistical support from the Spain.
- Adopted the **"Chile Madrid Time for Action"** document.
- **"Santiago Network" was established**, as part of the Warsaw International Mechanism (WIM) [on loss & damage], to catalyze the technical assistance needed for most vulnerable countries.

COP25
CHILE
MADRID 2019

IMPORTANT UNFCCC COPS POST-KYOTO PROTOCOL

COP25 Madrid

- However, **no clear timeline** was set for nations to enhance their NDCs in 2020.
- Discussion and talks on various issues remain unresolved and have been pushed to COP26 (to be held in November 2021 at Glasgow).
- Discussions were held on the following:
  - UNEP Annual Report on Emission Gap
  - Global Carbon Project Report
  - IPCC special report on Lands, Oceans and the Cryosphere

COP25
CHILE
MADRID 2019

IMPORTANT UNFCCC COPS POST-KYOTO PROTOCOL

COP25 Madrid

- Reiteration of Paris Rachet Mechanism
- Corporate Climate Movement
- 39 countries committed to include oceans in their NDCs

- **Santiago Call for Action on Forests:**
- Chile as the President of COP 25 of UNFCCC initiated the Santiago Call for Action on forests.
- It states that forests & trees combined with improved land management could provide up to 30% of GHG mitigation needed by 2030 to limit the global average temperature rise below 20C.

IMPORTANT UNFCCC COPS POST-KYOTO PROTOCOL

COP26 GLASSGOW

- **Four goals:**

1. **Secure global net-zero by mid-century** and keep 1.5 degrees within reach.
2. **Adapt:** to protect communities and natural habitats.
3. **Mobilise finance**: To deliver on our first two goals, developed countries must make good on their promise to mobilise at least $100bn in climate finance per year by 2020.
4. '**Finalise the Paris Rulebook**': Leaders will work together to frame a list of detailed rules that will help fulfil the Paris Agreement.

IMPORTANT UNFCCC COPS POST-KYOTO PROTOCOL

COP26 GLASSGOW

- **Glasgow Leaders' Declaration on Forests and Land Use:**
  - **Conservation**: Conserve forests and other terrestrial ecosystems and accelerate their restoration.
  - **Sustainable Development**: Facilitate trade and development policies, internationally and domestically, that promote sustainable development, and sustainable commodity production and consumption.

IMPORTANT UNFCCC COPS POST-KYOTO PROTOCOL

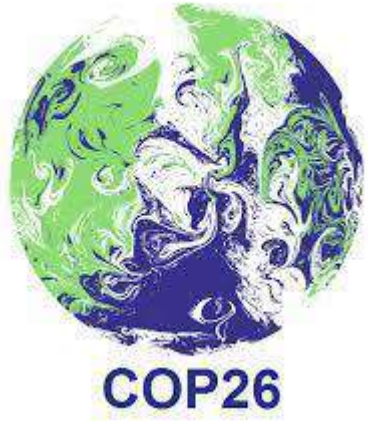
COP26 GLASSGOW

- **Building Resilience:** Reduce vulnerability, build resilience and enhance rural livelihoods, including through empowering local communities.
- **Recognising Indigenous Rights**: The development of profitable, sustainable agriculture, and recognition of the multiple values of forests, while recognising the rights of Indigenous.
- **Financial Commitments:** Reaffirm international financial commitments and significantly increase finance and investment from a wide variety of public and private sources.

IMPORTANT UNFCCC COPS POST-KYOTO PROTOCOL

COP26 GLASSGOW

- **India's Stand on the Declaration:**
  - India, Argentina, Mexico, Saudi Arabia and South Africa are the only G20 countries that did not sign the declaration.
  - The declaration interlinks trade to climate change and forest issues.
  - Trade falls under the World Trade Organization and should not be brought under climate change declarations.
  - India and others had asked the word "trade" to be removed, but the demand was not accepted. Therefore, they didn't sign the declaration.



IMPORTANT UNFCCC COPS POST-KYOTO PROTOCOL

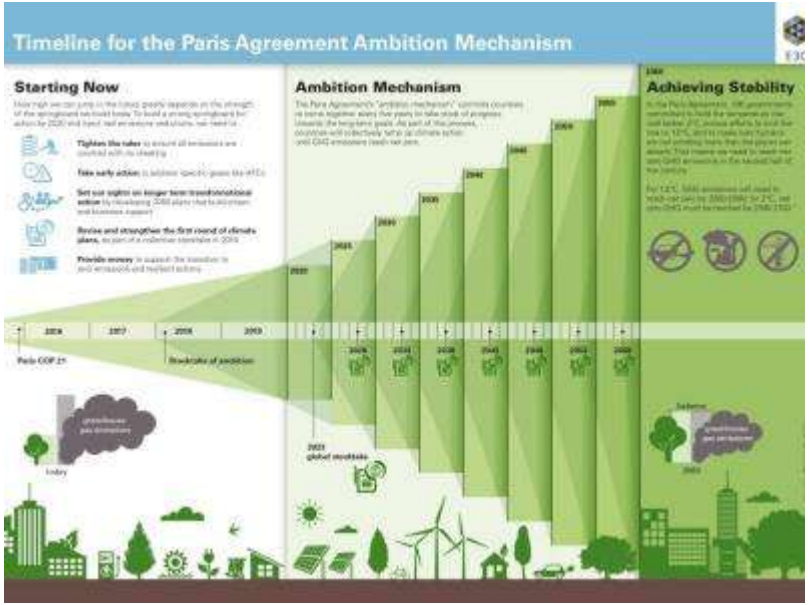
COP27 (Sharm El-Sheikh, Egypt)

- COP 27 was originally **expected to take place from 8-20 November 2021**.
- Due to the COVID-19 pandemic, COP 26 was rescheduled from November 2020 to November 2021.
- As a result, COP 27 will take place from 7-18 November 2022.

IMPORTANT UNFCCC COPS POST-KYOTO PROTOCOL

Paris Ratchet Mechanism:

- Also known as the **Paris Ambition Mechanism** that ensures that member nations reflect and progress their NDCs by raising ambitions to fight climate change over time.



IMPORTANT UNFCCC COPS POST-KYOTO PROTOCOL

Carbon Markets under the Paris Agreement:

- **Market Mechanism 1:** It sets up a Carbon Market which allows countries to sell any extra emission reductions [called as Internationally Transferred Mitigation Outcomes (ITMO)] which they have achieved compared to their Nationally Determined Contributions (NDCs) target.
  - This is a voluntary direct bilateral cooperation between countries aiming to promote sustainable development.

IMPORTANT UNFCCC COPS POST-KYOTO PROTOCOL

Carbon Markets under the Paris Agreement:

- **Market Mechanism 2:** The second mechanism will create a new international carbon market for the trading of emissions reduction created anywhere in the world by the public or the private sector.
  - This new market is referred to as the "Sustainable Development Mechanism (SDM)" which seeks to replace the "Clean Development Mechanism (CDM)" of Kyoto Protocol.
  - The delivery of "Overall Mitigation in Global Emissions (OMGE)" is a key requirement of SDM.

IMPORTANT UNFCCC COPS POST-KYOTO PROTOCOL

REDD	REDD+
UN REDD is a flagship partnership of UN between FAO, UNEP and UNDP.	REDD+ is a political framework under UNFCCC.
To protect, manage and save their forest resources, delivering Paris Agreement and SDGs.	Goes beyond deforestation and forest degradation. Includes Conservation, sustainable management of forests and enhancements of carbon stocks.
It assists the countries to develop the capacities needed to develop commitments to meet UNFCCC-REDD+ commitments	It supports countries that reduce emissions and undertake sustainable management of forests by giving funds and resources as incentives.

CONVENTION ON INTERNATIONAL TRADE IN ENDANGERED SPECIES OF WILD FAUNA AND FLORA (CITES)

- Also known as the **Washington Convention** – Located in Geneva
- **Objective**: to ensure that international trade in specimens of wild animals & plants does not threaten their survival.
- Drafted in 1963, at IUCN members meet.
- Came into force by July 1975, currently has 183 Parties.
- **1976**: India joined the CITES.
- CITES, **legally binding** but does not take the place of national laws.
- Amendments to the Convention must be supported by a two-thirds majority who are "present and voting".

CONVENTION ON BIOLOGICAL DIVERSITY (CBD)

- Legally binding treaty to conserve biodiversity has been in force since 1993.
- **Objectives:**
  - The conservation of biological diversity.
  - The sustainable use of the components of biological diversity.
  - The fair and equitable sharing of the benefits arising out of the utilization of genetic resources.
- **Ratification**: Nearly all countries have ratified it (notably, the US has signed but not ratified).
- **CBD Secretariat**: Montreal, Canada

CONVENTION ON BIOLOGICAL DIVERSITY (CBD)

- **Conference of Parties (COP):** The Parties (Countries) under Convention of Biodiversity (CBD), meet at regular intervals.
- UNCBD called as Rio Convention along with its sister conventions:
  - United Nations Framework Convention on Climate Change (UNFCCC)
  - UN Convention to Combat Desertification (UNCCD)

Convention on Biological Diversity

CONVENTION ON BIOLOGICAL DIVERSITY (CBD)

- **India and CBD:**
  - India has ratified the CBD.
  - India also enacted the Biological Diversity Act in 2002 and notified the Rules in 2004 to give effect to the provisions of the CBD.
  - India has got presidency of CBD for two years. (2012-14) previously it was with Japan.

CONVENTION ON BIOLOGICAL DIVERSITY (CBD)

Cartagena Protocol	• **The Protocol seeks to protect biological diversity from the potential risks posed by living modified organisms resulting from modern biotechnology – protocol on Biosafety.**
Nagoya Protocol	• On **Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising** from their Utilization (ABS) • It not only applies to genetic resources that are covered by the CBD, and to the benefits arising from their utilization but also covers traditional knowledge associated with genetic resources that are covered by the CBD and the benefits arising from its utilization.

CONVENTION ON BIOLOGICAL DIVERSITY (CBD)

Aichi Targets

- Adopted by the Convention on Biological Diversity (CBD) at its **Nagoya conference**.
- It is a **short term plan provides a set of 20 ambitious yet achievable targets**, collectively known as the Aichi Targets.
- **They can be divided into:**

1. **Strategic Goal A:** Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society.

CONVENTION ON BIOLOGICAL DIVERSITY (CBD)

2. **Strategic Goal B:** Reduce the direct pressures on biodiversity and promote sustainable use.
3. **Strategic Goal C:** To improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity.
4. **Strategic Goal D:** Enhance the benefits to all from biodiversity and ecosystem services.
5. **Strategic Goal E:** Enhance implementation through participatory planning, knowledge management and capacity building.

CONVENTION ON BIOLOGICAL DIVERSITY (CBD)

COP11 (Hyderabad)

- Total **170 countries** participated in the conference.
- The **last decade (2011-2020)** had been declared as the **United Nations Decade on Biodiversity and United Nations Decade for Deserts and the Fight against Desertification.**
- **COP11-HYDCBD** is the first conference during above special 'decades'.
- Hyderabad also hosted the 6th meeting of parties to Cartagena Protocol on Biosafety (under CBD). This is known as **COP-MOP-6.**

CONVENTION ON BIOLOGICAL DIVERSITY (CBD)

The Economics of Ecosystems and Biodiversity (TEEB)

- It is an international initiative to draw attention to the global economic benefits of biodiversity.
- In 2007, **environment ministers from G8+5 countries** meeting in Germany proposed TEEB to initiate the process of:
  - Analysing the global economic benefit of biological diversity,
  - The costs of the loss of biodiversity
  - The failure to take protective measures versus the costs of effective conservation.

CONVENTION ON BIOLOGICAL DIVERSITY (CBD)

The Economics of Ecosystems and Biodiversity (TEEB)

- In response to TEED, a global study was initiated in 2017 and was **led by Pavan Sukhdev.**
- Pavan Sukhdev is an Indian environmental economist whose field of studies include green economy and international finance.

INTERNATIONAL CONVENTIONS TO REGULATE WASTE DISPOSAL

Stockholm Convention

- International environmental treaty which aims to eliminate or restrict the production and use of **Persistent Organic Pollutants (POPs).**
- **POPs:** chemical substances that persist in the environment, bioaccumulate through the food web, and pose a risk of causing adverse effects to human health and the environment.

INTERNATIONAL CONVENTIONS TO REGULATE WASTE DISPOSAL

Basel Convention

- Basel Convention **on control of transboundary movements of hazardous wastes and their disposal** is an international treaty that was designed to reduce the movements of hazardous waste between nations.
- **Objective**: to prevent the transfer of hazardous waste from developed to less developed countries (LDCs).
- **Note**: Does not address the movement of radioactive waste

INTERNATIONAL CONVENTIONS TO REGULATE WASTE DISPOSAL

Rotterdam Convention

- Rotterdam Convention on the **Prior Informed Consent (PIC) Procedure** for Certain Hazardous Chemicals and Pesticides in International Trade.
- It is a multilateral treaty to promote shared responsibilities in relation to the importation of hazardous chemicals.
- Creates **legally binding obligations** for the implementation of the PIC procedure.
- **Promotes an open exchange of information** and calls on exporters of hazardous chemicals to use proper labelling, safe handling, and inform purchasers of any known restrictions or bans.
- **Signatory nations can decide whether to allow or ban the importation** of chemicals listed in the treaty.

RAMSAR CONVENTION ON WETLANDS

- It is an international treaty **for "the conservation and sustainable use of wetlands".**
- It is also known as the **Convention on Wetlands.** It is named **after the city of Ramsar in Iran.**
- The Convention was signed on **2nd of February 1971** (2nd Feb celebrated each year as World Wetlands Day).
- **Parties**: 171.
- It is the **only international treaty** that addresses a specific ecosystem (wetland.)
- Ramsar Convention is **not a regulatory regime**.

RAMSAR CONVENTION ON WETLANDS

- The convention works on three pillars that define the purpose of the Ramsar Convention:

1. **Wise Use**: maintenance of ecological character within the context of sustainable development.
2. **List of Wetlands of International Importance**: Designate suitable wetlands under the Ramsar List to effectively manage.
3. **International Cooperation**: To bring cooperation internationally over the transboundary wetlands, shared wetland systems and shared species.

RAMSAR CONVENTION ON WETLANDS

- **Examples of Wetlands**: Marine and coastal areas; Estuaries; Lakes and rivers; Marshes and peatlands; Groundwater and human-made wetlands such as rice paddies, shrimp ponds, and reservoirs.
- **Ramsar Convention has six international organization partners**: Birdlife International, IUCN, Wetlands International, WWF, International Water Management Institute, Wildfowl and Wetlands Trust.
- The convention comes with a **six-year strategic plan**. The **latest one is the 4th Ramsar Convention Strategic Plan 2016-2024 which was approved at COP12** of the convention.

RAMSAR CONVENTION ON WETLANDS

India regulated the following wetlands:	• Wetlands designated under the Ramsar List. • Those wetlands are notified under central, state, and UT rules.
India does not regulate the following wetlands under Wetlands Rules:	• River channels • Paddy fields • Human-made water bodies specifically constructed for drinking water purposes; aquaculture purposes; salt production purposes; recreation purposes; and for irrigation purposes • Wetlands falling within areas covered under the Indian Forest Act, 1927; Forest (Conservation) Act, 1980; and State Forest Acts. • Wetlands falling within areas covered under the Wildlife (Protection) Act, 1972. • Wetlands falling within areas covered under the Coastal Regulation Zone Notification, 2011.

RAMSAR CONVENTION ON WETLANDS

Ramsar Site

- At the time of joining the Convention, **each Contracting Party undertakes to designate at least one wetland site for inclusion in the List of Wetlands** of International Importance.
- The inclusion of a "Ramsar Site" in the List embodies the government's commitment to take the steps necessary to ensure that its ecological character is maintained.
- There are over 2400+ Ramsar Sites on the territories of 171 Ramsar Contracting Parties across the world.
- The countries with the most Sites are the **United Kingdom with 175** and Mexico with 142.
- **Bolivia has the largest area** under Ramsar protection.

RAMSAR CONVENTION ON WETLANDS

Montreux Record

- Montreux Record is a **register of wetland sites** on the List of Wetlands of International Importance **where changes in ecological character have occurred, are occurring, or are likely to occur** as a result of technological developments, pollution or other human interference.
- It is **maintained as part of the Ramsar List.**

RAMSAR CONVENTION ON WETLANDS

Recent Development w.r.t. India

- Two new Ramsar sites (Wetlands of International Importance) were announced by Minister for MoEF&CC, on World Wetlands Day 2 Feb, 2022.

1. Khijadia Wildlife Sanctuary in Gujarat and
2. Bakhira Wildlife Sanctuary in Uttar Pradesh.

- Thus, increasing the total number of Ramsar sites to **49.**
- **2nd February 2021 marked the 50th anniversary** of the Ramsar Convention.
- India on this occasion **established the Centre for Wetland Conservation & Management** which is the **first in the country**. It is set up under the MoEF&CC, at the National Centre for Sustainable Coastal Management (NCSCM) in **Chennai**.

UNITED NATIONS CONVENTION TO COMBAT DESERTIFICATION (UNCCD)

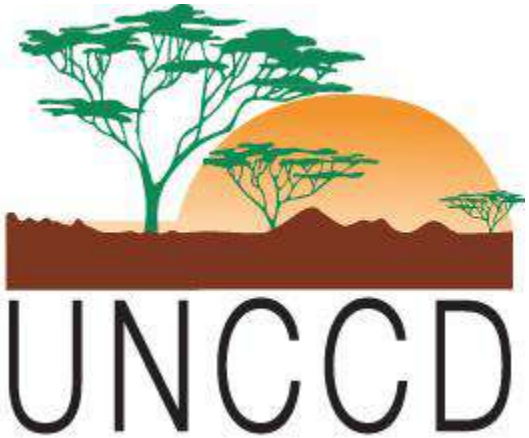
- Established in **1994.**
- It is the **sole legally binding international agreement** linking environment and development to sustainable land management.
- **Aim**: Its 197 Parties aim, through partnerships, to implement the Convention and achieve the Sustainable Development Goals. The end goal is to protect land from over-use and drought, so it can continue to provide food, water and energy.
- It is the **only convention stemming from a direct recommendation** of the Rio Conference's Agenda 21.

UNITED NATIONS CONVENTION TO COMBAT DESERTIFICATION (UNCCD)

- It is called the Rio Convention along with its sister conventions:
  - United Nations Framework Convention on Climate Change (UNFCCC)
  - UN Convention to Combat Desertification.
- The **UNCCD is particularly committed to a bottom-up approach, encouraging the participation of local people** in combating desertification and land degradation.
- India is among the select few countries to have hosted the COP of all three Rio conventions on climate change (UNFCCC), biodiversity (UNCBD) and land (UNCCD).

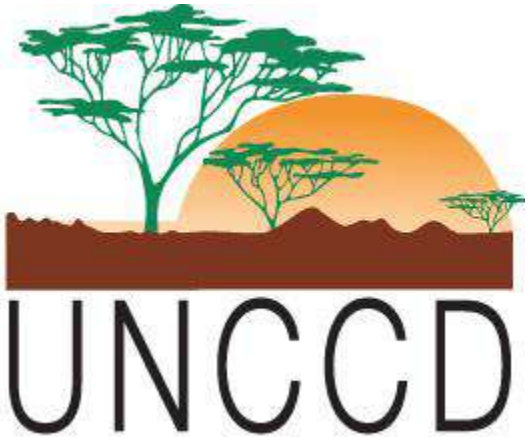
UNITED NATIONS CONVENTION TO COMBAT DESERTIFICATION (UNCCD)

- To help publicise the Convention, **2006 was declared "International Year of Deserts and Desertification".**
- **Focus areas**: The Convention addresses specifically the arid, semi-arid and dry sub-humid areas, known as the drylands, where some of the most vulnerable ecosystems and peoples can be found.
- **Nodal Ministry**: The Ministry of Environment, Forest and Climate Change is the nodal Ministry for this Convention.
- **UNCCD COP 14 (2019):** Held in Greater Noida, this was the first time that India hosted an edition of the UNCCD COP.



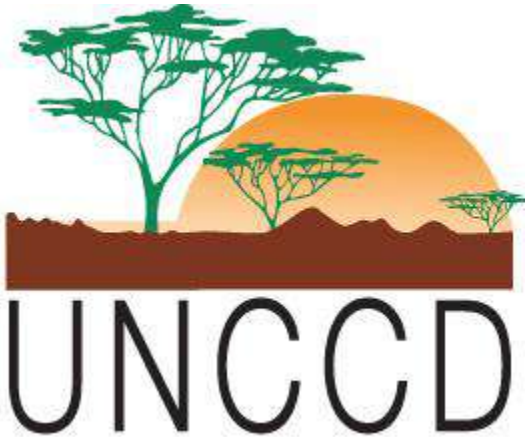
UNITED NATIONS CONVENTION TO COMBAT DESERTIFICATION (UNCCD)

- **Delhi Declaration**: Commitment for a range of issues, including gender and health, ecosystem restoration, taking action on climate change, private sector engagement, **Peace Forest Initiative** and recovery of five million hectares of degraded land in India.
- **Peace Forest Initiative**: It is an initiative of **South Korea** to use ecological restoration as a peace-building process. It aims at addressing the issue of land degradation in conflict-torn border areas.



UNITED NATIONS CONVENTION TO COMBAT DESERTIFICATION (UNCCD)

- **Drought Toolbox**: launched as a one-stop-shop for all actions on drought. It is a sort of knowledge bank which contains tools that strengthen the ability of countries to anticipate and prepare for drought effectively and mitigate their impacts.



UNITED NATIONS CONVENTION TO COMBAT DESERTIFICATION (UNCCD)

- **Global Efforts To Check Land Degradation:**
  - United Nations Convention to Combat Desertification (UNCCD)
  - Delhi Declaration of 2019, signed by 14th CoP of the UNCCD,
  - **The Bonn Challenge:** To bring 150 million hectares of the world's deforested and degraded land into restoration by 2020, and 350 million hectares by 2030.
  - **Great Green Wall**: Initiative by Global Environment Facility (GEF), where eleven countries in Sahel-Saharan Africa have focused efforts to fight against land degradation and revive native plant life to the landscape.

INTERNATIONAL WHALING COMMISSION (IWC)

- It is an **Inter-Governmental Organisation** set up by the terms of the International Convention for the Regulation of Whaling (ICRW) signed in **Washington, D.C in 1946.**
- **Aims**: to provide for the proper conservation of whale stocks and thus make possible the orderly development of the whaling industry.
- **Mandate:** to keep under review and revise as necessary the measures laid down in the Schedule to the Convention which governs the conduct of whaling throughout the world.

INTERNATIONAL WHALING COMMISSION (IWC)

- The body is the first piece of International Environmental Legislation established in 1946.
- **Commercial whaling was banned** by the IWC in 1986 after some species were almost driven to extinction.
- **89 countries have the membership** of IWC and all the member countries are signatories to this convention.
- **India** is a member state of the IWC.

THE WILDLIFE TRADE MONITORING NETWORK (TRAFFIC)

- TRAFFIC is a **NGO working globally on trade in wild animals & plants** in the context of both biodiversity conservation & sustainable development.
- Estb. in 1976, joint programme of WWF & IUCN.
- TRAFFIC is **complementary to CITES**.
- **Objective**: is to ensure that trade in wild plants & animals is not a threat to the conservation of nature.
- It investigates and analyses wildlife trade trends, patterns, impacts & drivers to provide the leading knowledge base on trade in wild animals & plants.

CONVENTION ON THE CONSERVATION OF MIGRATORY SPECIES (CMS) OF WILD ANIMALS

- It is an **international treaty**, concluded **under the aegis of UNEP**, signed in 1979.
- Also known as **"Bonn Convention"**.
- **Objective**: to conserve **terrestrial, marine & avian** migratory species throughout their range.
- It is the **only global convention specializing in the conservation of migratory species**, their habitats & migration routes.
- **Appendix-I:** Includes, the threatened migratory species
- **Appendix-II:** Includes, the migratory species requiring international cooperation.

CONVENTION ON THE CONSERVATION OF MIGRATORY SPECIES (CMS) OF WILD ANIMALS

- **Parties**: As of 1st November 2019, there were 129 countries plus European Union. Maldives is the latest country to join it (November 2019).
- **India has been a party** to the Convention since 1983.
- India has signed a **non-legally binding** MoU with CMS on conservation and management of Siberian Cranes (1998), Marine Turtles (2007), Dugongs (2008), and Raptors (2016).
- **India provides temporary shelter to**: Amur Falcons, Bar-headed Geese, Black-necked Cranes, Marine Turtles, Dugongs, Humpback Whales, etc.
- IUCN has observer & consultative status at the United Nations.

CONVENTION ON THE CONSERVATION OF MIGRATORY SPECIES (CMS) OF WILD ANIMALS

CMS: 13th CoP Feb-2020

- Held in **Gandhinagar**, India. **India will host presidency for next 3 years.**
- **CoP-13 Theme**: "Migratory species connect the planet & together we welcome them home"
- **Logo**: was inspired by the traditional 'Kolam' from Southern India, which has a profound significance in the context of living in harmony with nature.
- **Mascot**: The GIBI - Great Indian Bustard (IUCN-Critically Endangered).

CONVENTION ON THE CONSERVATION OF MIGRATORY SPECIES (CMS) OF WILD ANIMALS

CMS: 13th CoP Feb-2020

- 13th CoP has adopted the **"Gandhinagar Declaration"**, which calls for migratory species & the concept of 'Ecological Connectivity' to be integrated & prioritized in the new framework.
- COP 13, proposes to include ten new species for protection under CMS viz. **Three Indian Species**: Asian Elephant, Bengal Florican, Great Indian Bustard.

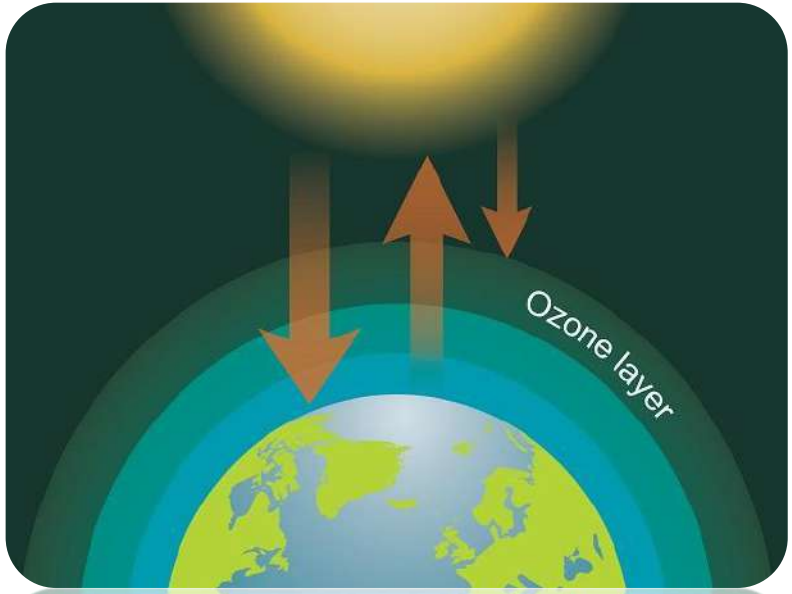
UNITED NATIONS FORUM ON FORESTS (UNFF)

- It is an **Intergovernmental** organization, **established by the United Nations Economic & Social Council (ECOSOC)** in 2000. HQ: New York, USA.
- **Objective**: to strengthen political commitment to the management, conservation & sustainable development of all types of forests.
- UNFF is **built on the "Forest Principles" together with the Agenda-21** of Rio Earth summit (1992).

United Nations FORUM ON FORESTS

VIENNA CONVENTION FOR THE PROTECTION OF THE OZONE LAYER

- It is one of the most successful treaties of all time, **ratified by 197 states**.
- It is a **multilateral environmental agreement** that was agreed upon by 1985 & entered into force in **1988**.
- **Not legally binding.**
- It acts as a framework for the international **efforts to protect the Ozone layer**.
- These are laid out in the **accompanying Montreal Protocol.**



VIENNA CONVENTION FOR THE PROTECTION OF THE OZONE LAYER

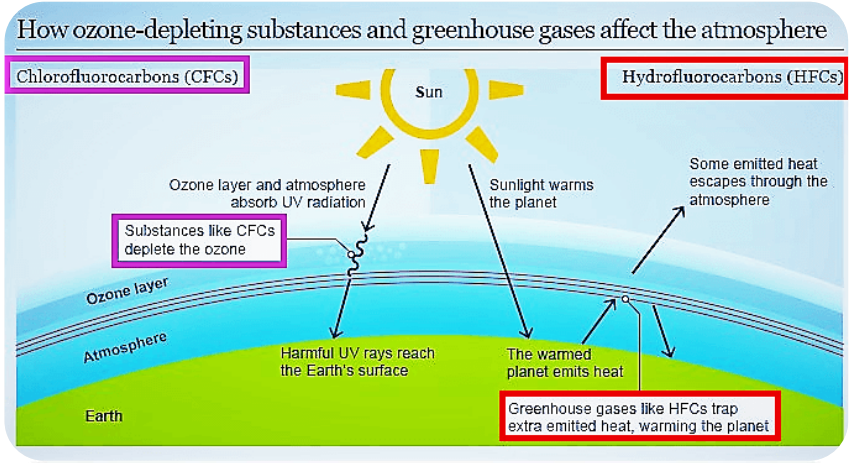
Montreal Protocol

- It is a **protocol to Vienna Convention** and it deals with the substances that deplete the Ozone Layer (ozone depleting substance-ODS).
- It was **first treaty to achieve universal ratification.**
- The protocol recognizes that all **nations should not be treated equally.**

VIENNA CONVENTION FOR THE PROTECTION OF THE OZONE LAYER

Kigali Agreement (2016)

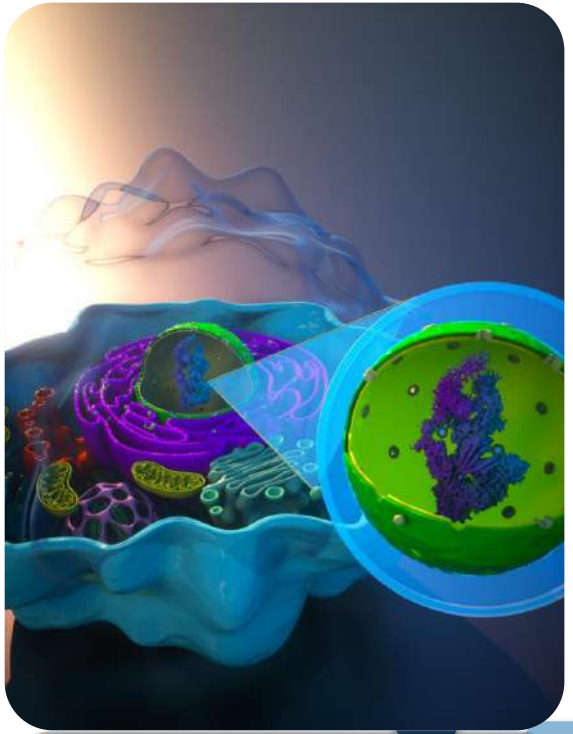
- On 1st January 2019, the **Kigali Amendment to the Montreal Protocol** came into force.
- This amends 1987 Montreal Protocol to reduce the use of HFCs by more than 80% by late 2040s.
- It is a **legally binding** international agreement.
- India recently achieved complete phase out of ozone depleting Hydro-Chloro-Fluoro Carbons (HCFC-141b). Also, India proactively phased out production & consumption of CFCs in 2008 before the timeline.
- **Note:** Though HFCs are not ODS they are included in Montreal Protocol through Kigali agreement due to their Global Warming potential.



VIENNA CONVENTION FOR THE PROTECTION OF THE OZONE LAYER

Helsinki Protocol, 1985

- Protocol to the 1979 Convention on Long-Range Trans-boundary Air Pollution on the Reduction of Sulphur Emissions.



MINAMATA CONVENTION ON MERCURY

- The Convention was **signed at Minamata, Japan in 2013** & entered into force in 2017.
- It is **an UNEP led international treaty** designed to protect Human health and the Environment from anthropogenic emissions & releases of Mercury and Mercury compounds.
- **India ratified** in 2018.
- Mercury is recognized as a substance producing significant adverse neurological & other health effects, with particular concerns expressed about its harmful effects on infants and unborn children.

GLOBALLY IMPORTANT AGRICULTURAL HERITAGE SYSTEMS (GIAHS)

- **Purpose**: to create public awareness, safeguard world agricultural heritage sites.
- It was **started in 2002 by UN-FAO** (Food & agricultural organization).
- GIAHS are **outstanding landscapes of aesthetic beauty that combine agricultural biodiversity, resilient ecosystems & a valuable cultural heritage.**
- They sustainably provide multiple goods & services, food & livelihood security for millions of small-scale farmers.

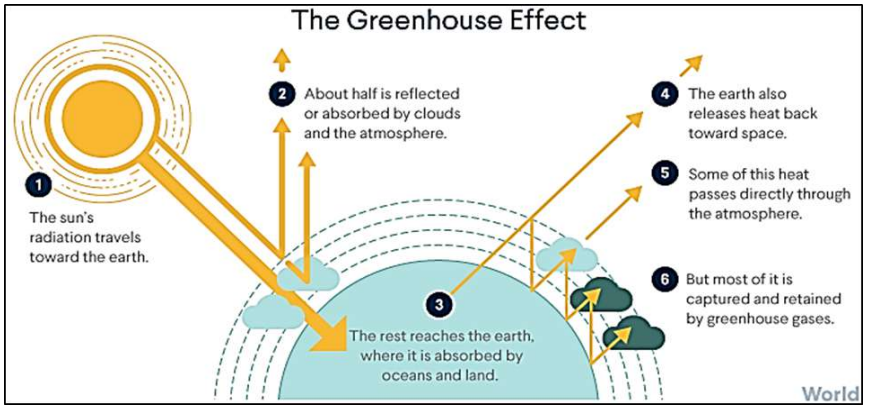
GLOBALLY IMPORTANT AGRICULTURAL HERITAGE SYSTEMS (GIAHS)

- GIAHS constitute the foundation for contemporary and future agricultural innovations and technologies.
- **Three regions of India which has been recognized as the GIAHS:**

1. Koraput Traditional Agriculture (Odisha)
2. Saffron heritage of Kashmir Valley.
3. Kuttanad below Sea level farming system (Kerala)

GLOBAL WARMING

- **Global warming**: "Global warming is a gradual increase in the earth's temperature generally due to the greenhouse effect caused by increased levels of carbon dioxide, CFCs, and other pollutants.
- **Reasons:** Greenhouse gases released; Fossil fuels combustion; Deforestation; Agriculture & livestock among others
- A **naturally occurring phenomenon** that blankets earth's lower atmosphere and warms it, maintaining temperature suitable for living things to survive (balance cooling and warming of the earth).



GLOBAL WARMING

- In its absence, earth surface temperature **would be -19 degrees Celsius instead of current 15 degrees Celsius**.
- Human-induced greenhouse gas emissions upset the natural balance & lead to increased warmth, otherwise called Global warming.
- **Impacts of Global Warming**: Rise in Sea level; Changes in rainfall patterns; Increased likelihood of extreme events such as heat wave, flooding, hurricanes; Melting of the ice caps and glaciers; Widespread vanishing of animal populations due to habitat loss; Spread of disease (like malaria, etc); Leaching of Coral Reefs; Loss of Plankton due to warming of seas.

GLOBAL WARMING

Topic	Climate Change	Global Warming
Definition/Meaning	Climate changes are the changes occurring in the globe or a region over a long period of time.	Global warming is the rising of the average temperature of the Earth over time.
Causes	Both humans caused and naturally occurring	Mainly due to human activities.
Major factors	Volcanic eruptions, plate tectonics changes in ocean, pollution, deforestation and releasing of greenhouse gases, etc.	Mainly due to the emission of greenhouse gases.
Major impact	New weather patterns, rise in earth temperature. Changes in sea level, melting of ice, more frequent drought, etc.	Rise of surface temperature of the Earth.

GLOBAL WARMING

State of Global Climate Report, 2020 by WMO:

- Emission of major greenhouse gases increased in 2019 and 2020.
- Concentrations of the major Greenhouse Gases in the air continued to increase in 2019 and 2020.
- Globally, averaged mole fractions of Carbon Dioxide (CO_2) could reach or exceed 414 ppm in 2021.
- Over 80% of the ocean area experienced at least one marine heatwave in 2020.
- In a large region of the Siberian Arctic, temperatures in 2020 were more than 3°C above average.

GLOBAL WARMING

Gas	Natural Source	Human-Induced Source	Removal	Global Warming Potential	Atm. Lifetime (Yrs)
Water Vapour (Biggest contributor)	Evaporation from oceans etc. Amount of vapour in air related to amount of other greenhouse gases present	Humans not directly responsible CO2 and other GHGs present increase water vapour in air	---	---	---
Carbon Dioxide (Co2) (Primary GHG)	Ocean exchange, Animal/human respiration, Soil respiration, Volcanic eruptions and Wildfires	Combustion of fossil fuels, Industrial emissions, Chemical & mineral reactions	Reduce fossil fuel usage Carbon sequestration	1	50 - 200

GLOBAL WARMING

Gas	Natural Source	Human-Induced Source	Removal	Global Warming Potential	Atm. Lifetime (Yrs)
Methane (CH4)	Wetlands, (largest) Oceans, Volcanic eruptions and Wildfires	Agriculture, Industries, Landfills, Waste water	Reduce waste	21	10-15
Nitrous Oxide (N2O)	Earth's nitrogen cycle Bacteria breaking it down in soils and oceans	Agriculture, Transportation, Fossil fuel, combustion During production of nitric acid	Absorbed by certain bacteria Destroyed by UV rays or chemical reactions	310	120

GLOBAL WARMING

Gas	Natural Source	Human-Induced Source	Removal	Global Warming Potential	Atm. Lifetime (Yrs)
Fluorinated Gases: 1)Hydrofluorocarbons-HFCs. 2)Perfluorocarbons-PFCs 3)Sulphur Hexafluoride - SF6	---	Aluminium & semi-conductor manufacturing Refrigerants, Aerosol, propellants, Fire retardants, Magnesium processing, Circuit breakers	Destroyed by sunlight in far upper atmosphere	HFC - 150 to 11,700 PFC - 6,500 to 9,200 SF6 - 23,900	HFC - 1.5 to 209 PFC - 2,600 to 50,000 SF6 - 3,200

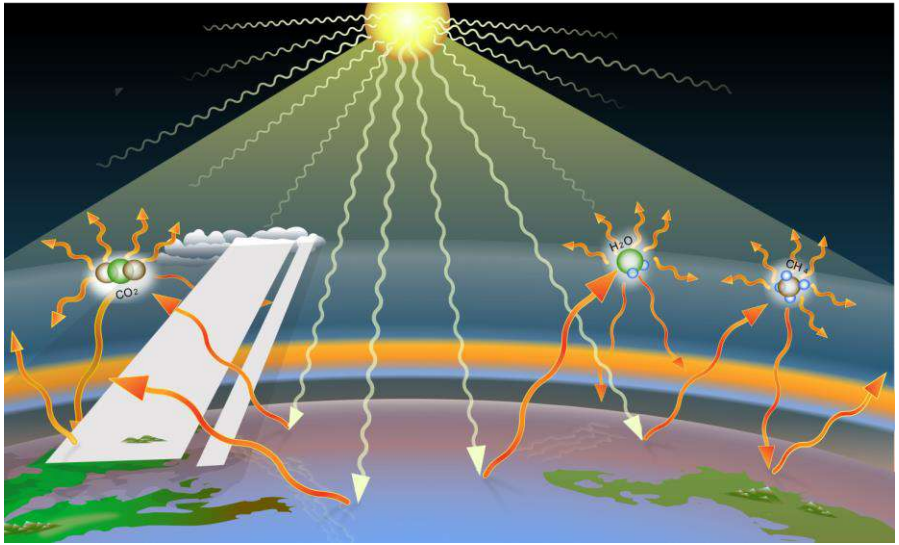
GREEN HOUSE GASES (GHG)

- Natural as well as anthropogenic gaseous constituents of the atmosphere which **absorb and re-emit infrared radiations**.
- **Two important characteristics of GHGs are:**
  - How well the gas absorbs energy – Warming potential
  - How long the gas stays in the atmosphere – Atmospheric Lifetime.
- **Global Warming Potential (GWP):** the total energy that the gas absorbs for a certain period of time, mostly 100 years. GWP **always compared to CO2 as its GWP is '1' and is baseline.**

Cryosphere: The cryosphere is the frozen water part of the Earth water system. Polar regions, snow caps of high mountain ranges are all part of cryosphere.

GREEN HOUSE GASES (GHG)

- **CFCs, HFCs, HCFCs and SF6 are called high-GWP gases** because they trap more heat that CO2.
- **Atmospheric gases**: Carbon Dioxide, Methane, Nitrous Oxide (N2O), Water Vapour, and Chlorofluorocarbons are capable of trapping the out-going infrared radiation from the earth's surface thereby causing greenhouse effect.
- Oxides of Nitrogen with general formula NOx – NO, NO2 – Nitrogen oxide, Nitrogen dioxide etc. are global cooling gasses while Nitrous oxide (N2O) is a greenhouse gas.



GREEN HOUSE GASES (GHG)

Green House Gas Protocol

- GHG Protocol is a developing standards, tools and online training that helps countries, cities and companies track progress towards their climate goals.
- GHG Protocol establishes frameworks to measure and manage greenhouse gas (GHG) emissions from private and public sector operations, value chains and mitigation actions.
- GHG Protocol arose when World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD) recognized the need for an international standard for corporate GHG accounting and reporting in the late 1990s.

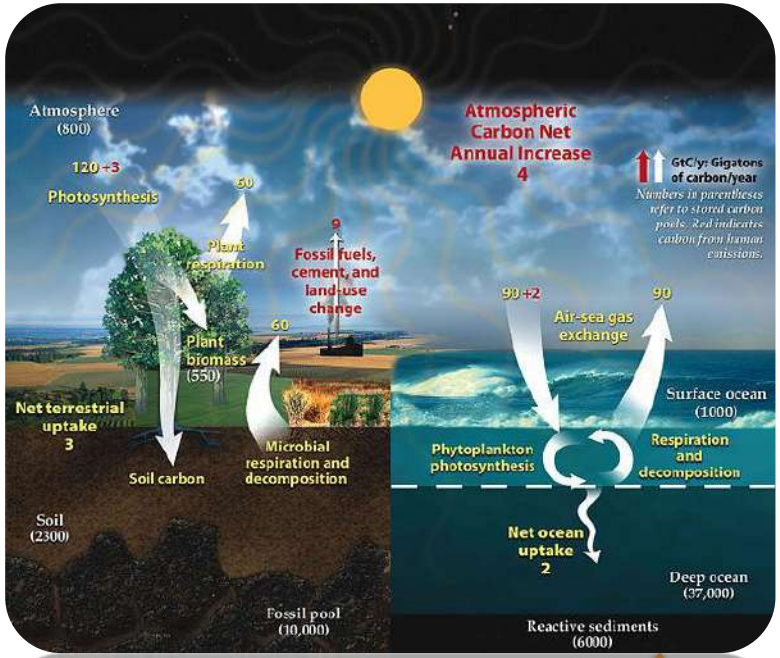
GREEN HOUSE GASES (GHG)

Black Carbon	• It is a component of fine particulate matter formed through the incomplete combustion of fossil fuels, biofuel, and biomass. • It is a short-lived pollutant with a lifetime of only days to weeks. • It is one of the main types of particles in soot. • This could lead to higher absorption of the sun's heat (reduced albedo) and potentially contributing to the increased melting of glaciers • Found in vehicular emissions.
Brown Carbon	• Brown smoke released by the combustion of organic matter. • It coexists with black carbon when released in the atmosphere. • It is one of the significant warming factors as it disturbs the temperature pattern of the atmosphere and the cloud forming process. • It also changes the solar absorption pattern and the nature of clouds. • Creates ground level ozone, found in smog.

GREEN HOUSE GASES (GHG)

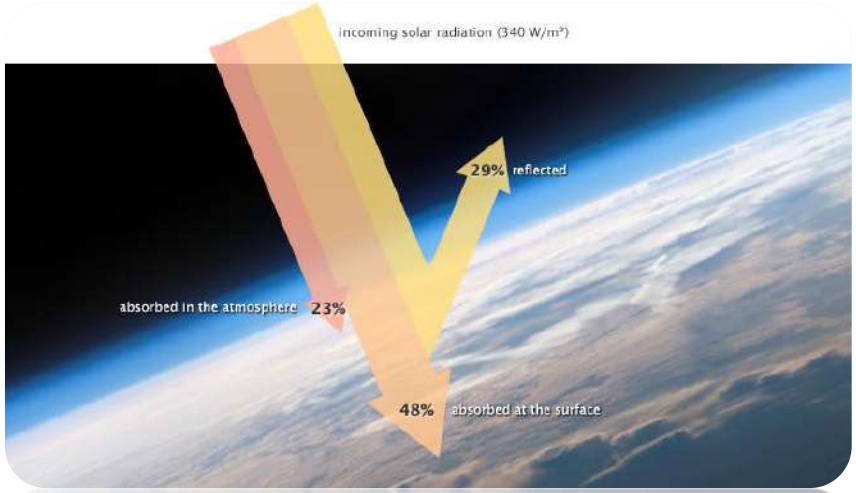
DETERIORATION OF CARBON SINKS:

- **High latitude forests store more carbon** than tropical rainforests.
- **One third** of the world's soil-bound carbon is in taiga and tundra areas.
- When the **permafrost melts due to global warming, it releases carbon** in the form of carbon dioxide and methane.
- In the 1970s the tundra was a carbon sink, but today, it is a carbon source, all because of global warming. (global warming leads to more global warming).



CLIMATE FORCING

- Climate forcing is the physical process of affecting the climate on the Earth through a number of forcing factors.
  - **Positive forcing:** GHGs **warm** the earth
  - **Negative forcing:** Aerosols & volcanic eruptions **cool** the earth.
- **Types:**
  - **Natural forcing**: do not harm climate or cause drastic global temperature variations.
  - **Human-made forcing**: GHGs, aerosols, etc.



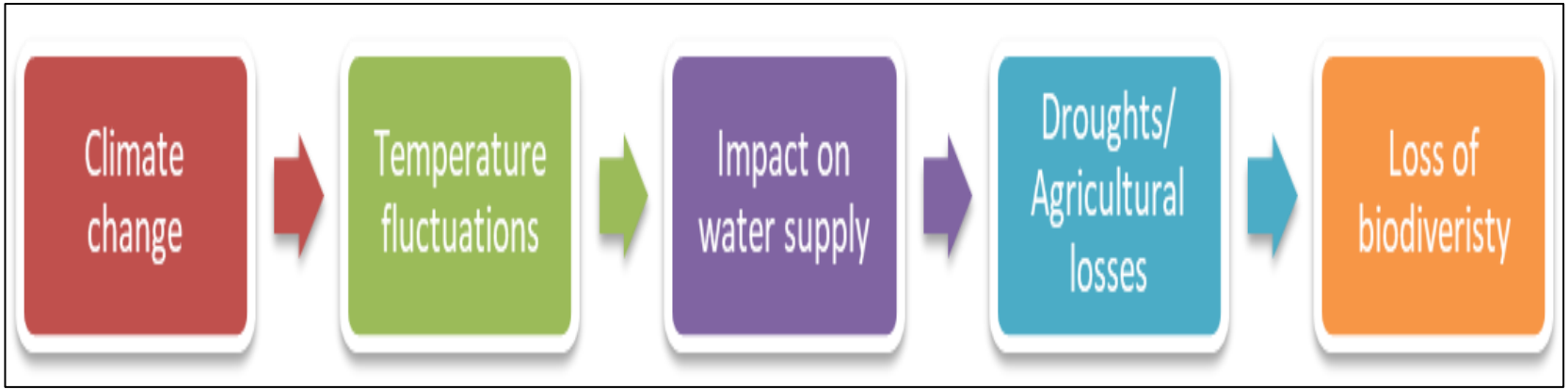
CLIMATE FORCING

Radiative Forcing	• **Change in earth's energy balance due to alterations in climate** • **Positive forcing - increases temperature** • **Negative forcing - reduces temperature**
Natural Forcing	• Changes in amount of energy emitted by sun. • Very slow variations in earth orbit • Slight increase in solar energy since industrial revolution
Human-Induced Forcing	• Due to greenhouse gases and aerosol emissions from fossil fuels • Modification of land surface due to deforestation, agricultural use, etc.
Human-Generated Greenhouse Gases	• Have warming effect, i.e. Positive climate forcing • Largest climate forcing agent is co2 emitted from combustion of fossil fuels
Human-Generated Aerosols	• Burning fossil fuels adds aerosols to atmosphere • Aerosols include water, ice, mineral dust, ash or acidic droplets • Aerosols have cooling effect • Aerosols deflect sun's energy & affect formation & life of clouds

RECEDING GLACIERS - A SYMPTOM OF GLOBAL CLIMATE CHANGE

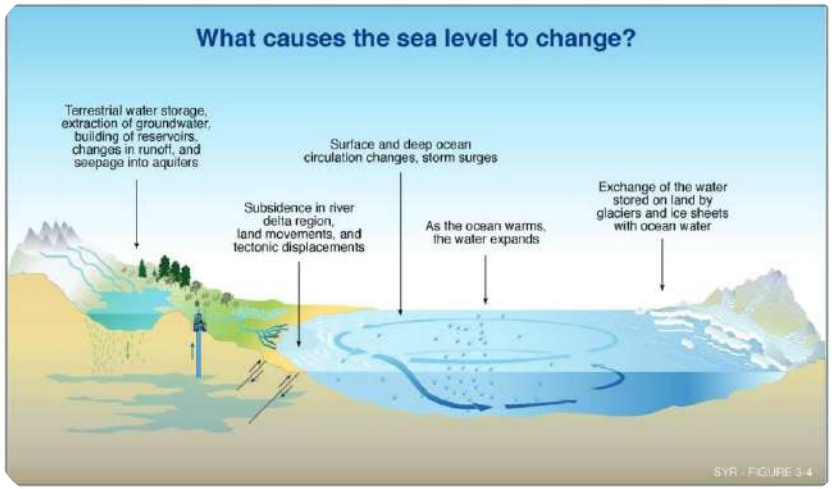
- **Arctic Pole**: Black line indicates spread of ice-sheet in the 20th century. It is evident that the glaciers have been receding ever since and melted ice is the result of the rising ocean levels.
- **Scientists predict** that by 2030, more glaciers will have melted resulting in potential threat to aquatic as well as terrestrial ecosystems.
- **Impact**: on agriculture and food security, health, pests and disease burden increase such as dengue, Malaria, atmospheric circulation (cyclones in Arabian sea), monsoon patterns, changing ecosystems (forest fires etc), impact on oceans, economic losses etc.

RECEDING GLACIERS - A SYMPTOM OF GLOBAL CLIMATE CHANGE



SEA LEVEL CHANGE

- Sea level change means the fluctuations in the mean sea level over a considerably long period of time.
- Changes in sea level occur over a broad range of temporal and spatial scales, with the many contributing factors making it an integral measure of climate change.
- As Sea Level Rise (SLR) is **not uniform across the world**, there is a need to differentiate regional SLR from the global rates.



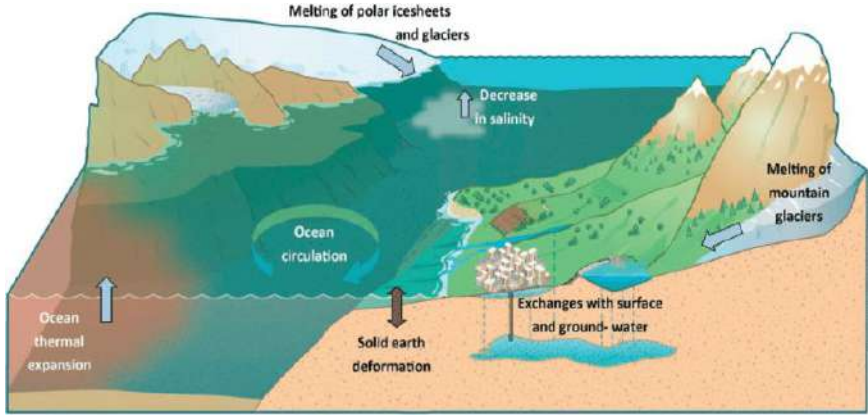
SEA LEVEL CHANGE

Types of Change in Sea Level:	• **Eustatic changes:** occur when the volume of sea water changes due to factors such as: ○ Global warming and melting of ice sheets (rise in sea level) or ice ages (fall in sea level) ○ **Changes in the volume of mid-oceanic ridges.** • **Tectonic changes: occur due to a change in the level of land**
India's Status	• India's **7,516-kilometre long coastline** includes 5,422 kilometres of coastline on the mainland and 2,094 kilometres on the islands belonging to **nine states and four UTs.** • The coastline accounts for 90% of the country's trade and it spans 3,331 coastal villages and 1,382 islands.

SEA LEVEL CHANGE

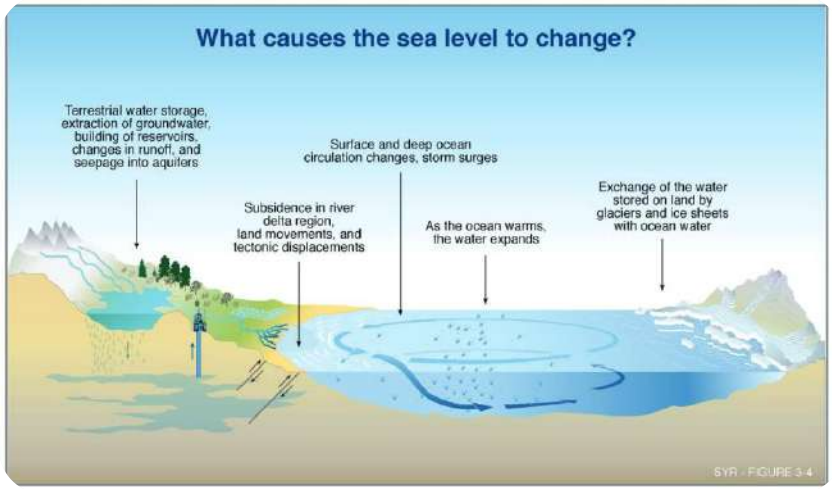
Factors Responsible for Sea-Level Rise:

- **Anthropogenic activity** is at the root of this phenomenon. Specifically, since the industrial revolution, carbon dioxide and other greenhouse gas emissions have raised temperatures even higher in the poles.
- **Burning of fossil fuels** has resulted in the build-up of greenhouse gases influencing the warming trend because they trap heat in the atmosphere.



SEA LEVEL CHANGE

- **Oil and gas drilling** that emits methane which is the main constituent of natural gas is another contributor.
- **Methane is more damaging to the environment than carbon dioxide,** locking in heat more efficiently and escalating global warming.
- **Deforestation,** on the rise, across the globe, has a lot of negative effects like a rise in sea levels.
- **In summer, Ice breaking ships** that head to the north in the Arctic Ocean leave trails of open waters, leaving the oceans with lesser ability to reflect back sun rays.



SEA LEVEL CHANGE

Impact of Sea Level Rise:	• Coastal Flooding; Destruction of Coastal Biodiversity; Dangerous Storm Surges; Lateral and Inland Migration; Impact on Infrastructure; Threat to Inland Life; Tourism and Military Preparedness; Coastal hazards.
Measures to Counter Sea Level Rise:	• Relocation; Building Sea Wall; Building Enclosures; Architecture to Steer Flow of Water

SEA LEVEL CHANGE

Sinking Chain of Atolls of India

- Due to constant rising sea level, many small atolls (circular coral colonies) of the Indian archipelago are sinking.
- Parali I Island of Lakshadweep has already sunk and Parali II has sunk almost 80% of its total area. Thinkara (14.38%) and Parali III (11.42%) are eroding at a fast pace.
- UNIPCC in its fifth report has stated that sea level in Lakshadweep has risen up to 0.6 m in the last 20 years.

CLEAN COAL USE

- Coal mined in India has **high ash content, high moisture and other impurities.**
- Coal is a major fossil fuel used worldwide. CO2 and CO (carbon monoxide) are the major greenhouse gas which are released during burning of coal.
- Along with the above gases, **nitrogen oxides (destroys ozone) and sulphur oxides (acid rains) are also released.**
- **Various technologies:** Coal preparation, coal washing, removes unwanted minerals by mixing crushed coal with a liquid and allowing the impurities to separate and settle.

CLEAN COAL USE

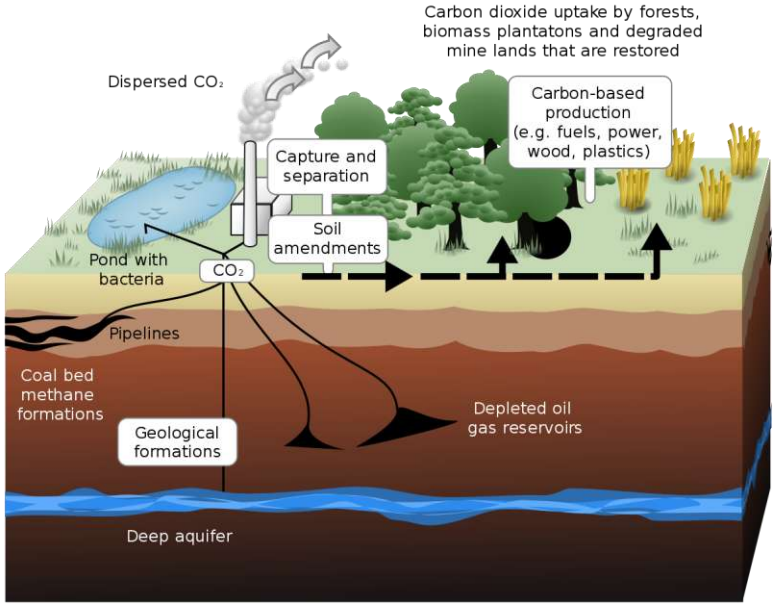
- Other systems control the coal burn to minimize emissions of sulphur dioxide, nitrogen oxides and particulates.
- **Gasification avoids burning coal altogether**. With gasification, steam and hot pressurized air or oxygen combine with coal to produce syngas.
- The **resulting syngas, a mixture of carbon monoxide and hydrogen, is then cleaned and burned in a gas turbine** to make electricity.

CLEAN COAL USE

- **Wet scrubbers, or flue gas desulfurization systems**, remove sulphur dioxide, a major cause of acid rain, by spraying flue gas with **limestone and water.**
- India is building **super-critical and ultra-super-critical thermal power plants** (15-20% increase in efficiency) to burn Indian coal more efficiently.

CARBON SEQUESTRATION

- Carbon sequestration is a **process to capture and store CO2 to curb global warming**. It is captured from the air, industries or power stations and stored permanently underground. This promotes:
  - Long-term reserve of CO2 or forms of carbon to control temperatures.
  - Lowering of amount of GHGs present in air due to combustion of fossil fuels.
- **Three main steps to Carbon Capture and Storage (CCS):**
  - Trapping & separating CO2 from other gases
  - Transporting captured CO2 to storage location
  - Storing CO2 far from atmosphere, either in deep ocean or underground.



CARBON SEQUESTRATION

Types of CO2 Sequestration:

Ocean sequestration	• **Through direct injection or fertilization**
Geological sequestration	• Natural pore spaces in geological foundation • Has largest potential
Terrestrial sequestration	• Stored in soils and vegetation through decomposed matter & photosynthesis respectively.

CARBON SEQUESTRATION

Geological sequestration trapping mechanism:

Hydrodynamic trapping	• **Trapped as gas under low-permeability cap rock** • **Combines with solubility trapping**
Solubility Trapping	• Dissolved in oil, water, etc. • Combines with hydrodynamic trapping
Mineral carbonation	• Forms stable compounds like iron, calcium by reacting with minerals/organic matter

CARBON SINKS

- Carbon sequestration is carried out by **pumping carbon into 'carbon sinks'.** This is an **age-old process**.
- Only recently, these sinks are also being used for capturing carbon for environmental reasons.
  - **Natural Sinks**: Oceans, forests, soil, mangroves etc.
  - **Artificial Sinks**: Depleted oil reserves, un-mineable mines etc.

CARBON SINKS

Green Carbon	Blue Carbon
Removed by photosynthesis	Removed by tidal marshes, mangroves, seagrass
Stored in plants & soil	Stored in marine organisms, plants & sediments
Forests accumulate large amounts of carbon	Coastal ecosystems accumulate large amounts of carbon, 5 times more than forests
Afforestation and reforestation can enhance it	Found in all continents except Antarctica

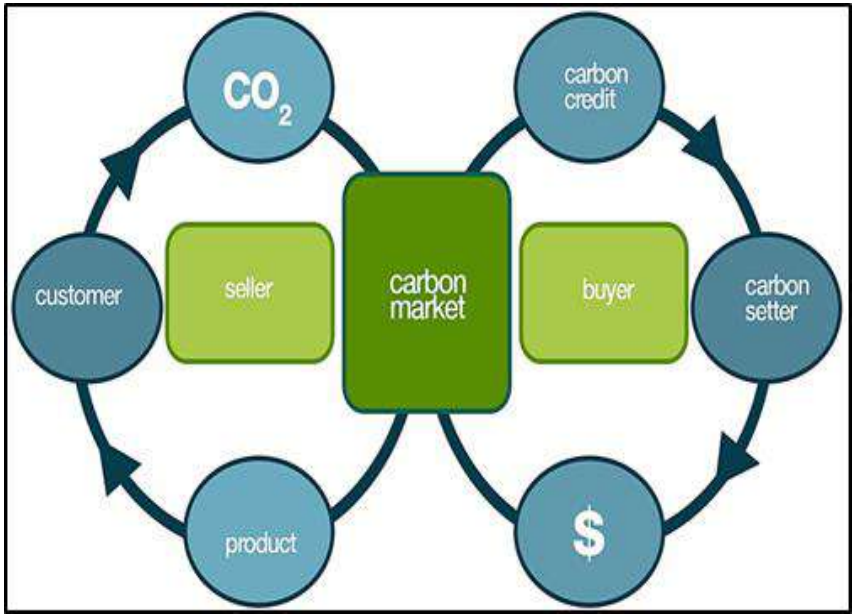
THE BLUE CARBON INITIATIVE

- Conservation International (CI), International Union for Conservation of Nature (IUCN) and the Intergovernmental Oceanic Commission (IOC) of UNESCO has collaborated with governments and organisations across the world to develop mechanisms for ensuring coastal Blue Carbon ecosystems.
- **It also comprises:**
  - Engagement of local, national and international organisations
  - Comprehensive methods for carbon accounting
  - Incentive mechanism
  - Scientific research for climate mitigation

CARBON CREDIT

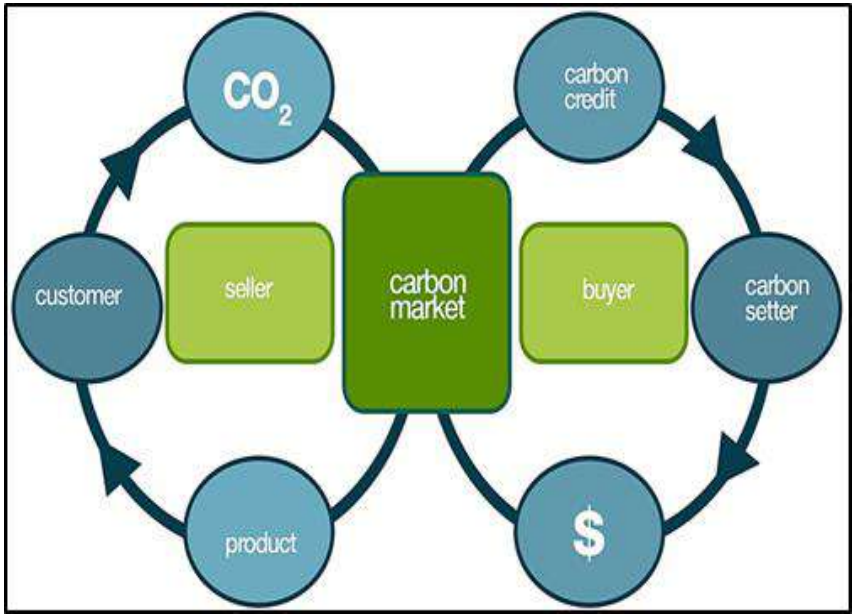
- A Carbon Credit is a **tradable permit that certifies the right to emit 1 ton of CO2 or its equivalent**.
- As per gas emissions norms laid down by signatories of the Kyoto Protocol under UNFCCC, companies have two ways to reduce emissions:

1. Reduce GHGs by adopting new technologies.
2. Connect with developing countries to set up eco-friendly technology to earn credits. This credit becomes permit for company to emit GHGs in its own country.



CARBON CREDIT

- **Status of developing nations:**
  - India and China are biggest sellers. Europe biggest buyer.
  - China is leading with 73% of market share, whereas India is second at 6%.
  - India's Multi Commodity Exchange (MCX) has become 1st exchange in Asia to trade carbon credits.



CARBON CREDIT

Kyoto Protocol (COP 3; UNFCCC Summit 1997)

- Adopted in Kyoto, Japan, in 1997. **India ratified Kyoto Protocol in 2002.**
- The Kyoto Protocol came into force in February 2005. There are **currently 192 Parties.**
- **USA never ratified** Kyoto Protocol. **Canada withdrew in 2012.**
- **Goal**: Fight global warming by reducing greenhouse gas concentrations in the atmosphere to "a level that would prevent dangerous anthropogenic interference with the climate system."

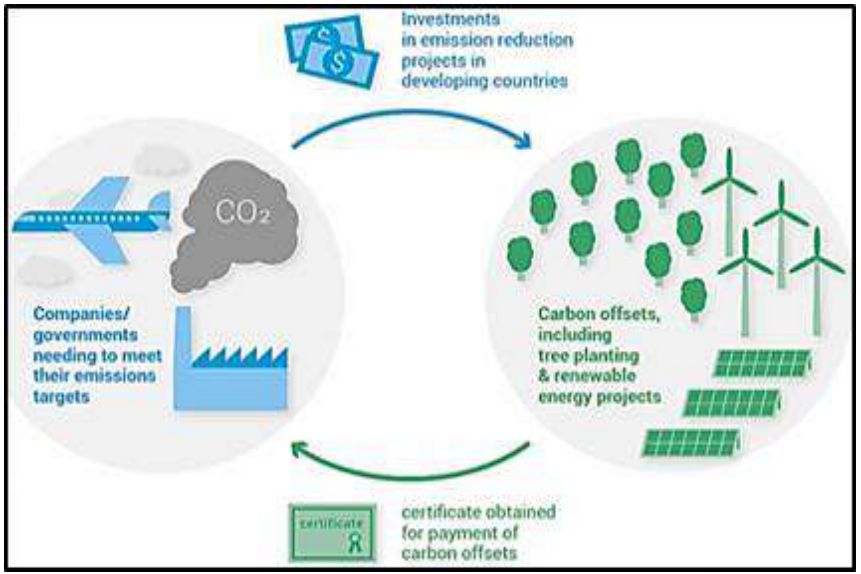
CARBON CREDIT

Kyoto Protocol (COP 3; UNFCCC Summit 1997)

- **Aimed**: to cut emissions of greenhouse gases across the developed world by about 5 per cent by 2012 compared with 1990 levels.
- The Protocol **is based on the principle of Common But Differentiated Responsibilities (CBDR).**
- Kyoto Protocol is the **only global treaty with binding limits on GHG emissions.**

CARBON OFFSETTING

- Credits for reductions in greenhouse gases made at another location.
- Sold in metric tonnes of carbon dioxide equivalent.
- Fastest way to achieve deepest reductions in business dealings.
- Provide employment opportunities, community development programmes, training, education.
- Must meet essential quality criteria.
- Cannot be double-counted.



GLOBAL CARBON EMISSIONS IN VARIOUS SECTORS

Sector	% Of Emissions
Power	25
Agriculture & land use	24
Industry	21
Transport	14
Other	10
Buildings	6

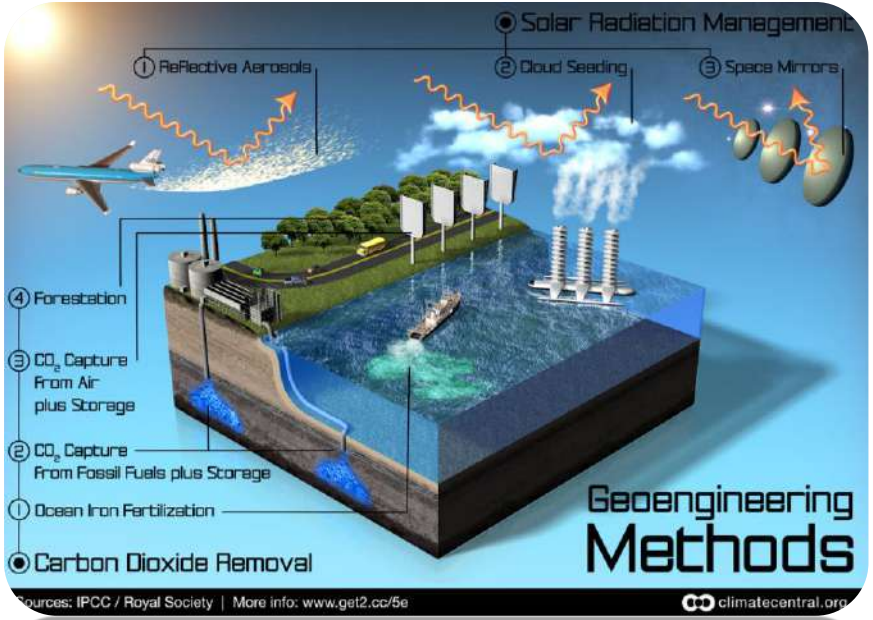
GLOBAL CARBON EMISSIONS IN VARIOUS SECTORS

Carbon Tax

- A carbon tax - levied on carbon content of fuels, generally in transport and energy sector.
- Carbon taxes intend to:
  - Reduce CO2 by increasing price of fossil fuels.
  - Decreasing the demand of CO2
  - Promote a form of carbon pricing

GEO - ENGINEERING

- Geo-engineering is a technology that strives to modify, improve and cool the earth's environment. The concept is still in its nascent stage.
- **Ideas under this technique and how it works:**



GEO - ENGINEERING

Copy a volcano	• **By infusing atmosphere with Sulphur-dioxide gas through volcanic eruption, scientist believe it will block solar radiation and cool the planet.** • **Sulphur doesn't heat stratosphere and has cooling effect.**
Shoot mirrors into space	• To deflect sunlight and bring earth's temperature back to pre-industrial levels. • Mirrors (size of Greenland) to be positioned between the planet and the sun.
Seed the sea with iron	• Phytoplankton prefer iron. Iron pulls carbon out of atmosphere during photosynthesis • Scientists believe stimulating phytoplankton growth will reduce global warming potential.

GEO - ENGINEERING

Whiten clouds with wind-powered ships	• Cloud tops reflect solar radiation. • Spraying sea-water into the sky through wind-powered ships will whiten clouds thus increasing reflection of solar radiation.
Build fake trees	• 'Artificial tree' is capable of capturing 1 ton of carbon in atmosphere per day • Panels of absorbent resin on tree surface react with CO2 to form a solid. • We can compare this to a furnace filter.

BIOFUELS

- Any hydrocarbon fuel that is **produced from an organic matter (living or once living material) in a short period of time** (days, weeks, or even months) is considered a biofuel.
- Biofuels are a **type of carbon capture and utilisation** where carbon is captured from the atmosphere, oceans and other sources to produce biofuels. Thus, the **net carbon emission is zero**.
- Biofuels may be solid (wood, animal & plant waste etc.), liquid (bioethanol, biodiesel etc.) or gaseous (biogas) in nature.

BIOFUELS

- **Can be use:** to replace or can be used in addition to diesel, petrol or other fossil fuels for transport, stationary, portable and other applications. Also, to generate heat and electricity.
- **Major types of Biofuels:** Bioethanol; Biodiesel; Biogas; Biobutanol; etc.

BIOFUELS

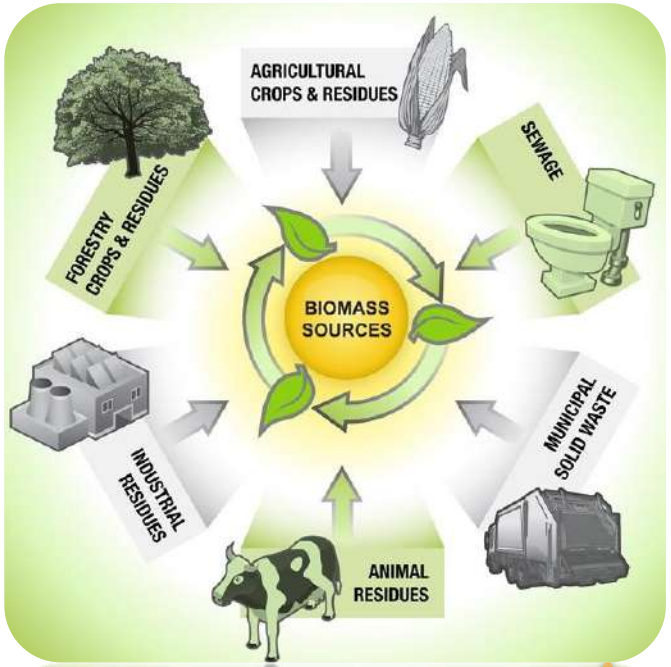
Categories	
First Generation Biofuels	• Made from food sources such as sugar, starch, vegetable oil, or animal fats using conventional technology. • **E.g.:** Bio alcohols, Biodiesel, Vegetable oil, Bio ethers, Biogas etc.
Second Generation Biofuels	• Produced from non-food crops or portions of food crops that are not edible and considered as wastes, e.g. stems, husks, wood chips, and fruit skins and peeling. • Thermochemical reactions or biochemical conversion process is used for producing such fuels. • E.g.: cellulose ethanol, biodiesel.

BIOFUELS

Categories	
Third Generation Biofuels	• Produced from micro-organisms like algae. • Micro-organisms like algae can be grown using land and water unsuitable for food production, therefore reducing the strain on already depleted water sources. • E.g.: Butanol
Fourth Generation Biofuels	• Production of these fuels, crops that are genetically engineered to take in high amounts of carbon are grown and harvested as biomass • The crops are then converted into fuel using second generation techniques.

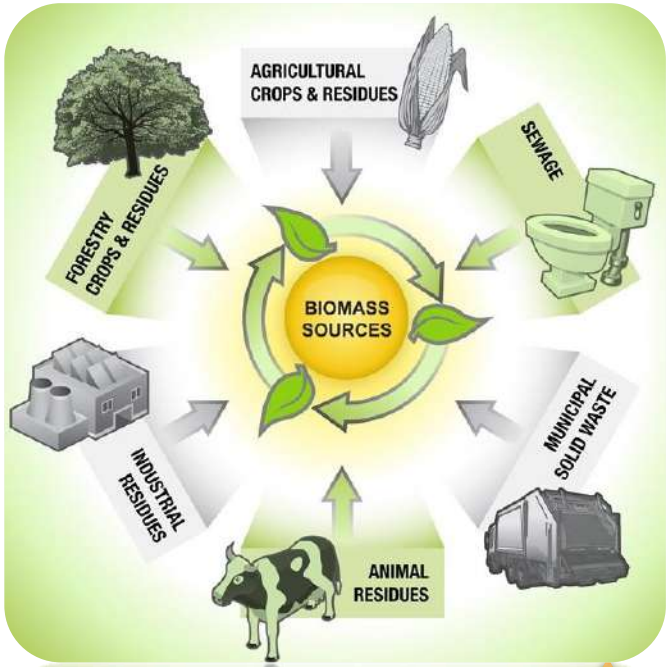
BIOMASS

- Biomass is a **renewable energy resource derived from the carbonaceous waste** of various human and natural activities.
- It is derived from numerous sources, including the by-products from the timber industry, agricultural crops, grassy and woody plants, residues from agriculture or forestry, oil-rich algae, and the organic component of municipal and industrial wastes.



BIOMASS

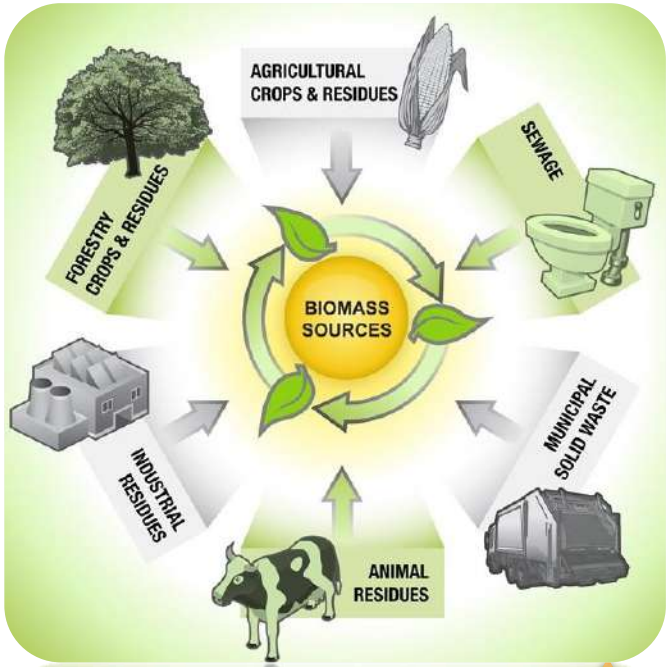
- **Burning biomass releases about the same amount of carbon dioxide** as burning fossil fuels. However, fossil fuels release carbon dioxide captured by photosynthesis over its formative years.
- Biomass releases carbon dioxide that is **largely balanced by the carbon dioxide captured in its own growth** (depending how much energy was used to grow, harvest, and process the fuel). Hence, **Biomass does not add carbon dioxide to the atmosphere as it absorbs the same amount of carbon in growing as it releases when consumed as a fuel.**



BIOMASS

Anaerobic Digestion / Bio-methanation

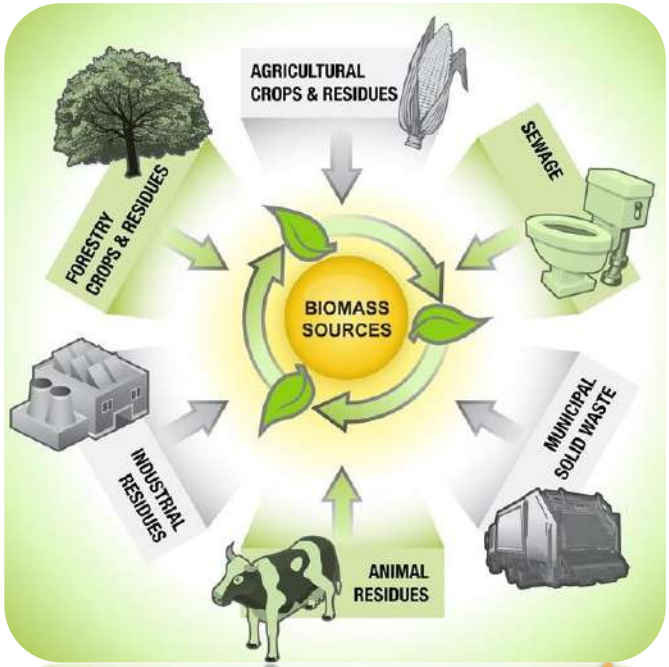
- Biomethanation, or methanogenesis, is a scientific process whereby anaerobic microorganisms in an anaerobic environment decompose biodegradable matter producing methane-rich biogas and effluent.
- The three functions that take place sequentially are hydrolysis, acidogenesis and methanogenesis.



BIOMASS

Combustion/ Incineration

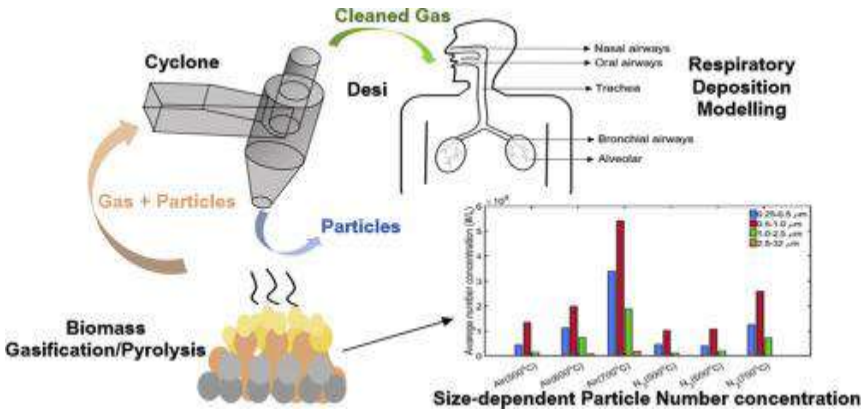
- In this process, **waste is directly burned in the presence of excess air (oxygen) at high temperatures (about 800°C),** liberating heat energy, inert gases and ash.
- Combustion results in transfer of 65–80% of heat content of the organic matter to hot air, steam and hot water.
- The **steam generated, in turn, can be used in steam turbines** to generate power.



BIOMASS

Pyrolysis/Gasification

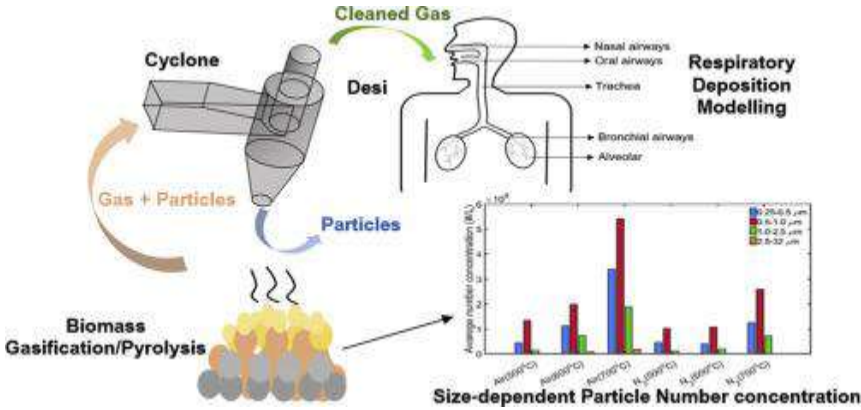
- Pyrolysis is a **process of chemical decomposition of organic matter brought about by heat**.
- In this process, the **organic material is heated in the absence of air** until the molecules thermally break down to become a gas comprising smaller molecules (known collectively as **syngas**).
- Gasification **can also take place as a result of partial combustion of organic matter in the presence of a restricted quantity of oxygen or air**. The gas so produced is known as **producer gas.**



BIOMASS

Pyrolysis/Gasification

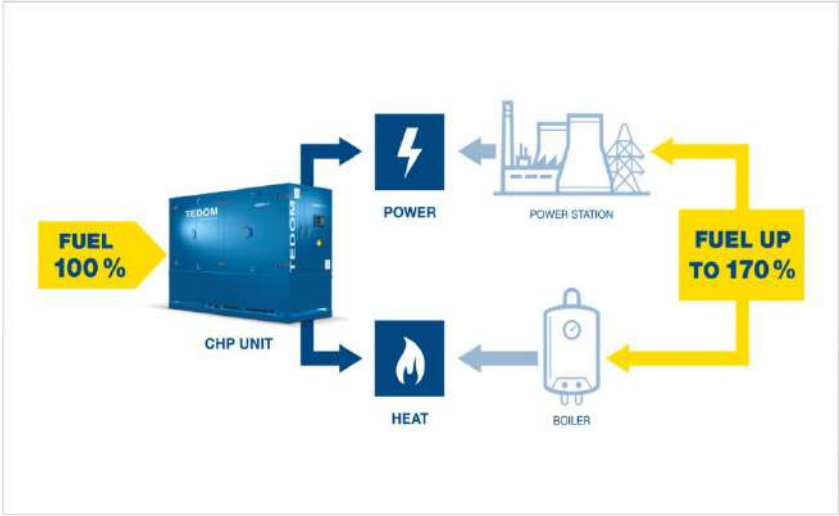
- The gases produced by pyrolysis mainly comprise **carbon monoxide (25%), hydrogen and hydrocarbons (15%), and carbon dioxide and nitrogen (60%).**



BIOMASS

Cogeneration

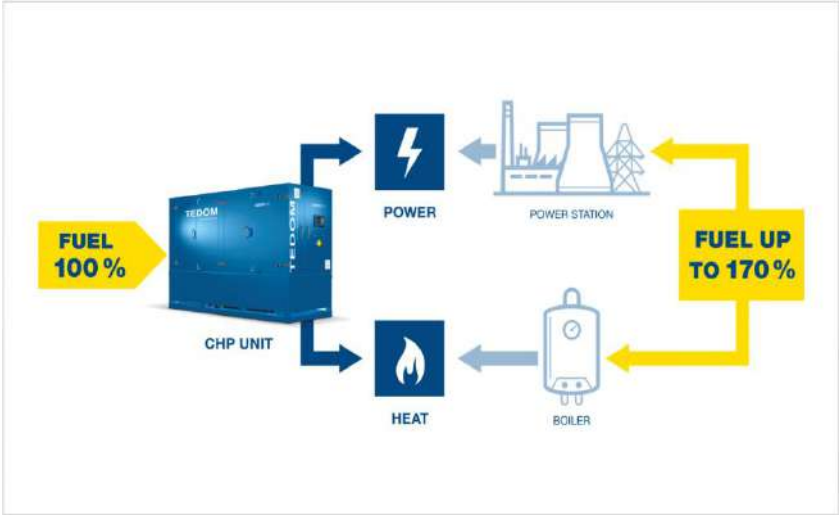
- Co-generation is **producing two forms of energy from one fuel.** One of the forms of energy must always be heat and the other may be electricity or mechanical energy.
- **Conventional power plant**: fuel is burnt in a boiler to generate high-pressure steam. This steam is used to drive a turbine, which in turn drives an alternator through a steam turbine to produce electric power.



BIOMASS

Cogeneration

- **Cogeneration plant:** the low-pressure exhaust steam coming out of the turbine is not condensed, but used for heating purposes in factories or houses and thus very high efficiency levels, in the range of 75%–90%, can be reached.
- The potential for cogeneration thus lies in facilities with joint requirement of heat and electricity, primarily sugar and rice mills, distilleries, petrochemical sector and industries such as fertilizers, steel, chemical, cement, pulp and paper, and aluminium.



ONLYIAS
Nothing Else

CLIMATE CHANGE ORGANIZATION

GLOBAL ENVIRONMENT FACILITY (GEF)

- It is a **unique partnership of multi agencies** including UN agencies, multilateral development banks, national entities and international NGOs.
- **GEF Trust fund (World Bank as Trustee)** is available to developing countries and countries with economies in transition.
- It was **established on the eve of Rio Earth Summit (1992)** to tackle the planet's biggest environmental issues.
- **Six Focal Areas**: Biological diversity; Climate change; International waters; Land degradation, primarily desertification and deforestation; Ozone layer depletion; and Persistent organic pollutants.

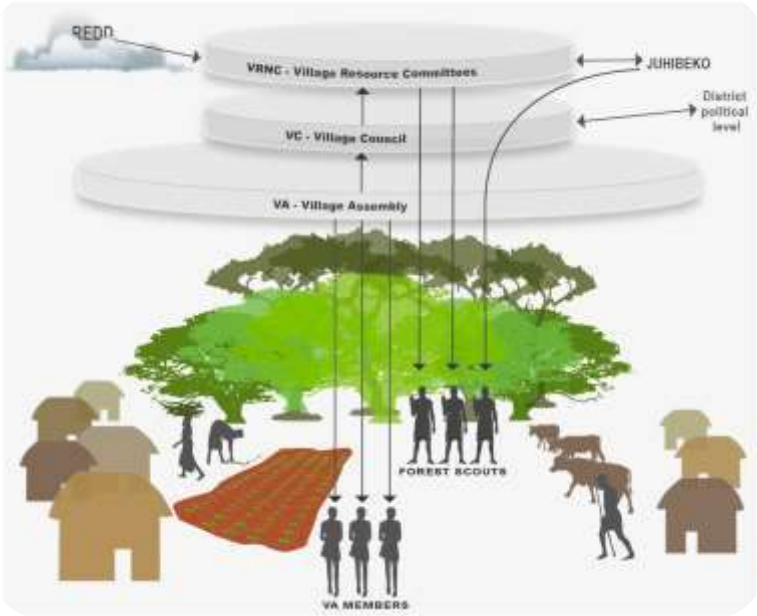
GLOBAL ENVIRONMENT FACILITY (GEF)

- **Financial mechanism for five major international environmental conventions:**

1. Minamata Convention on Mercury
2. Stockholm Convention on Persistent Organic Pollutants
3. UN Framework Convention on Climate Change (UNFCCC)
4. UN Convention on Biological Diversity (UNCBD)
5. UN Convention to Combat Desertification (UNCCD)

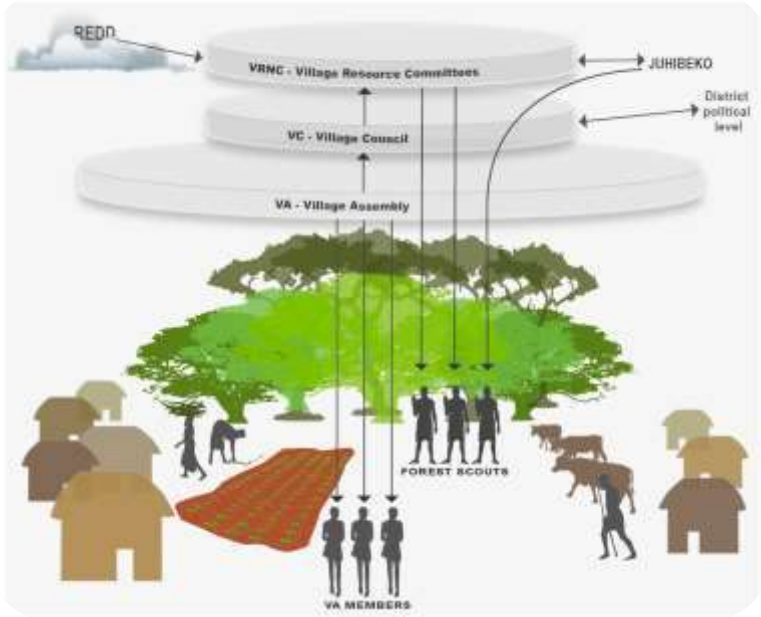
REDD+

- Reducing Emissions from Deforestation and Forest Degradation **(REDD+) is a mechanism developed by Parties of the UNFCCC.**
- It **creates financial value for the carbon stored in forests** to offer incentives for the developing nations to reduce emissions from forested lands and invest in low-carbon paths.
- The developing nations will receive **results-based payments for results-based actions.**



REDD+

- The REDD+ **goes beyond simply deforestation and forest degradation** by including the role of conservation, sustainable management of forests and enhancement of forest carbon stocks.
- This **improved North-South flow of funds** can ensure a significant reduction of carbon emissions and the promotion of inclusive development. It could also improve biodiversity conservation and secure vital ecosystem services.
- Forests are a vital carbon sink and thus, it is **vital to increase its resilience to climate change**.



IPCC – INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

- IPCC is the UN body, established by the **UNEP and WMO in 1988,** for assessing science related to climate change.
- **Objective**: To provide governments at all levels with scientific information that can be used to develop climate policies
- It does not conduct any research nor does it monitor climate related data.
- **Reports published by IPCC:** Assessment Report (AR) about the state of scientific, technical and socio-economic knowledge on climate change. Assessment report consists of:

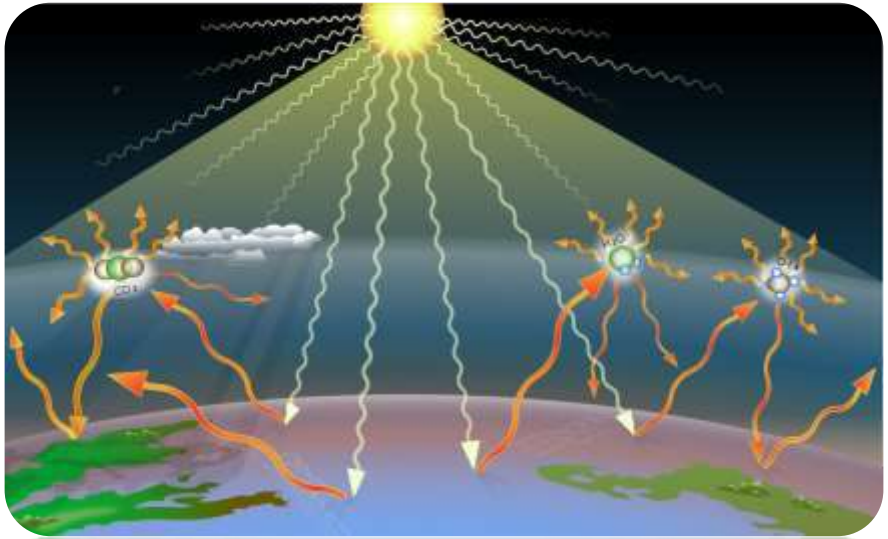
IPCC – INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

- Contributions from each working group
- Synthesis report
- Any Special reports prepared in that assessment years

- IPCC has so far **published 5 Assessment Reports**, currently **preparing its 6th Assessment Cycle.**
- The three Special Reports and Methodology Report (of 6th assessment cycle) have already been produced.

NATIONAL GREEN HOUSE GAS INVENTORIES PROGRAMME (NGGIP)

- The **IPCC established** the National Greenhouse Gas Inventories Programme (NGGIP)
- **Objective:** to provide methods for estimating national inventories of greenhouse gas emissions to, and removals from, the atmosphere.
- **Guidance of NGGIP:** used by countries that are Parties to the UN Framework Convention on Climate Change (UNFCCC) to estimate the emissions and removals that they report to the UNFCCC.
- **Mandate:** The NGGIP is mandated to carry out the work, as approved by the Panel, on inventory-related methodologies and practices.



GREEN ECONOMY

- Green Economy is defined as low carbon, resource efficient and socially inclusive. In a green economy, growth in employment and income are driven by public and private investment into such economic activities, infrastructure and assets that allow:
  - Reduced carbon emissions and pollution
  - Enhanced energy and resource efficiency
  - Prevention of the loss of biodiversity and ecosystem services.

GREEN ECONOMY

- **Green Economy focuses on:**
  - Economy and Investment
  - Positive social and environmental outcomes
  - Sustainable consumption and production
  - Employment and skills
  - Capital and Infrastructure

THE ECONOMICS OF ECOSYSTEMS AND BIODIVERSITY (TEEB)

- Launched by **Germany and the European Commission** in 2007
- Study led by **Pavan Sukhdev**
- **Objective**: Highlight the growing cost of biodiversity loss and ecosystem degradation and to draw together expertise from the fields of science, economics and policy to enable practical actions.

THE ECONOMICS OF ECOSYSTEMS AND BIODIVERSITY (TEEB)

- **Aim**: To assess, communicate and mainstream the urgency of actions through its five deliverables –
  - Science and economic foundations, policy costs and costs of inaction,
  - Policy opportunities for national and international policy-makers,
  - Decision support for local administrators,
  - Business risks, opportunities and metrics,
  - Citizen and consumer ownership

GLOBAL CLIMATE FINANCE ARCHITECTURE

Special Climate Change Fund (SCCF)	• SCCF was established in response to guidance from the COP7 to finance projects relating to– • Adaptation, Technology transfer and Capacity building • Energy, transport, industry, agriculture, forestry, waste management and economic diversification. • **Operating entity:** Global Environment Facility (GEF) • It is open to all vulnerable developing countries.
Least Developed Countries Fund (LDCF)	• It was designed to address the special needs of Least Developed Countries (LDCs) under the UNFCCC. • It helps LDCs in preparing and implementing National Adaptation Programs of Action (NAPAs). • **NAPAs:** They are country-driven strategies that identify the most immediate needs (such as water, agriculture, food security, health etc.) to adapt to climate change. • **Operating entity:** GEF

GLOBAL CLIMATE FINANCE ARCHITECTURE

Strategic Priority on Adaptation Program (SPA)	• SPA sought to reduce vulnerability and increase resilience to the adverse effects of climate change by targeting each of the GEF focal areas. • Besides, it also encouraged cross-sectoral approaches - Biodiversity, Climate change, Ozone layer depletion, International waters, Land degradation.
Climate Investment Fund (World Bank as Trustee)	• It is implemented with the Multilateral Development Banks (MDBs) to bridge the financing and learning gap. • It is additional to existing Official Development Assistance and aims to enable countries to meet their multilateral development goals. • **2 types:** Clean Technology Fund and Strategic Climate Fund

GLOBAL CLIMATE FINANCE ARCHITECTURE

Green Climate Fund (GCF)	• It is a financial instrument under UNFCCC, discussed **in Cancun Summit 2010** and finally adopted in **Durban Summit 2011.** • GCF's activities are aligned with the priorities of developing countries through the principle of country ownership. • It aims to make an ambitious contribution to attaining the mitigation and adaptation goals of the international community.
Adaptation Fund (AF)	• It was established to finance concrete adaptation projects and programmes in developing countries that are vulnerable to adverse effects of climate change. • AF-funded projects are implemented around the world through accredited implementing entities. • Established under the **Kyoto Protocol of UNFCCC**.

GLOBAL CLIMATE FINANCE ARCHITECTURE

Capacity Building Initiative for Transparency (CBIT)	• It was created at the request of Parties to help strengthen the institutional and technical capacities of non-Annex I countries to meet the enhanced transparency requirements defined in Article 13 of the **Paris Agreement.**
Biocarbon Fund	• Administered by the **World Bank** • **Area of focus**: Adaptation, Mitigation - general, Mitigation - REDD • Supports developing countries' efforts to reduce emission through testing jurisdictional approaches that integrate reducing deforestation and degradation, sustainable forest management with the climate smart agricultural practices to green supply chains.

GLOBAL CLIMATE FINANCE ARCHITECTURE

Global Climate Change Alliance	• Global Climate Change Alliance (GCCA) is an **initiative of the European Union.** • **Area of focus**: Adaptation, Mitigation - general, Mitigation – REDD • **Objective:** to build a new alliance on climate change between the European Union and the poor developing countries
Global Energy Efficiency and Renewable Energy Fund	• It is a Public-Private Partnership (PPP) designed to maximize the private finance leveraged through public funds • **Funded by:** European Commission • **Managed by:** European Investment Bank

GLOBAL CLIMATE FINANCE ARCHITECTURE

Clean Technology Fund	• Administered by The World Bank • Area of focus - Mitigation - general • Date operational – 2008 • The Clean Technology Fund (CTF), one of two multi-donor Trust Funds within the Climate Investment Funds (CIFs), promotes scaled-up financing for demonstration, deployment and transfer of low-carbon technologies with significant potential for long-term greenhouse gas emissions savings. • Channelled through: African Development Bank, Asian Development Bank, European Bank for Reconstruction and Development, Inter-American Development Bank, and World Bank Group, the CTF finances 12 country programmes and one regional programme.

WORLD METEOROLOGICAL ORGANISATION (WMO)

- It is a **specialized agency of the UN** for meteorology (weather and climate), hydrology and related geophysical sciences.
- **Established by**: the ratification of the WMO Convention on 23rd March 1950
- **Secretariat**: Geneva, headed by the Secretary-General
- **Supreme Body**: World Meteorological Congress (WMC).
- **WMO Report**: State of Global Climate Report 2020.

WORLD METEOROLOGICAL ORGANIZATION

WORLD METEOROLOGICAL ORGANISATION (WMO)

- **Hottest Year:** 2020 will be one of the three hottest years just behind 2016 and 2019.
- **Rise in Global Temperature:** The global mean surface temperature for January-October 2020 was 1.2 degree Celsius higher than the pre-industrial baseline (1850-1900). For that period, 2020 is the second-warmest year on record.
- **High Temperature over Ocean Surfaces:** 80% of ocean areas have experienced at least one marine heat wave (MHW) so far in 2020.

WORLD METEOROLOGICAL ORGANIZATION

WORLD METEOROLOGICAL ORGANISATION (WMO)

- **Global sea-level** rise was also similar to 2019 value. This was mainly due to the increased melting of the ice sheets in Greenland and Antarctica.
- **Consequences:** Extreme weather events such as tropical cyclones, floods, heavy rainfall and droughts were the consequence of global warming that impacted many parts of the world.

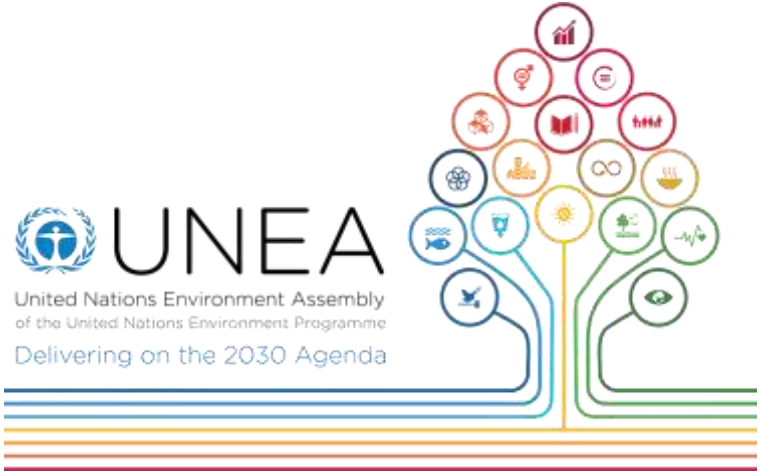
WORLD METEOROLOGICAL ORGANIZATION

UNDP-UNITED NATIONS DEVELOPMENT PROGRAMME

- It is a UN's global development network which promotes technical and investment cooperation among nations to help people build a better life for themselves.
- **Parent organisation**: United Nations Economic and Social Council
- **Headquarter**: New York
- **Founded**: 1965
- **Sector**: Development and Poverty Reduction
- **Report**: Human Development Report

UNEA-UNITED NATIONS ENVIRONMENT ASSEMBLY

- UNEA is the governing body of UN Environment Program
- **Headquarter**: Nairobi, Kenya
- **Founded**: June 2012, during the United Nations Conference on Sustainable Development, also referred to as RIO+20.
- It is the **world's highest-level decision-making body on the environment.**
- It addresses the critical environmental challenges facing the world today.
- The **Environment Assembly meets biennially** to set priorities for global environmental policies and develop international environmental law.



UNEP-UNITED NATIONS ENVIRONMENT PROGRAMME

- It is the **leading global environmental authority** that sets the global environmental agenda, promotes the coherent implementation of the environmental dimension of sustainable development within the United Nations system.
- **Founded:** 5th June 1972 (Environment Day)
- **Founder:** Maurice Strong
- **Headquarter:** **Nairobi, Kenya**

UN environment programme 50 1972-2022

UNEP-UNITED NATIONS ENVIRONMENT PROGRAMME

- **Initiative**: Faith for Earth Initiative
- **Mission**: "To encourage, empower and engage with faith-based organizations as partners, at all levels, toward achieving the Sustainable Development Goals and fulfilling the 2030 Agenda."
- **Report**: Emission Gap Report, Global Environment Outlook.

UN environment programme 50 1972-2022

FOREST CARBON PARTNERSHIP FACILITY

- It is a **global partnership** of governments, businesses, civil society, and Indigenous Peoples focused on reducing emissions from deforestation and forest degradation, forest carbon stock conservation, the sustainable management of forests, and the enhancement of forest carbon stocks in developing countries (activities commonly referred to as REDD+).
- The **World Bank** assumes the functions of trustee and secretariat.
- The World Bank, the Inter-American Development Bank and UNDP are Delivery Partners under the Readiness Fund and responsible for providing REDD+ readiness support.

FOREST CARBON PARTNERSHIP FACILITY

- **Objectives:**
  - To assist countries in their REDD+ efforts by providing them with financial and technical assistance.
  - To pilot a performance-based payment system for REDD+ activities.
  - To test ways to sustain or enhance livelihoods of local communities and to conserve biodiversity.
  - To disseminate broadly the knowledge gained in Emission Reductions Programs (ERPs).

CLIMATE AND CLEAN AIR COALITION (CCAC)

- **2012**: a few nations, along with the United Nations Environment Programme (UNEP), came together to form the Climate & Clean Air Coalition.
- It is a partnership of governments, public and private sector, scientific institutions, civil society organizations, etc. committed to protecting the climate through actions to reduce short-lived climate pollutants.

CLIMATE & CLEAN AIR COALITION

CLIMATE AND CLEAN AIR COALITION (CCAC)

Short-Lived Climate Pollutants (SLCPS)

- SLCPs have relatively short lifetime in the atmosphere – a few days to a few decades. Though short-lived, their potential to warm the atmosphere can be many times greater than CO2.
- SLCPs are responsible for up to 45% of current global warming, only next to CO2.
- SLCPs include black carbon, methane, tropospheric ozone, and hydrofluorocarbons.

ARCTIC COUNCIL

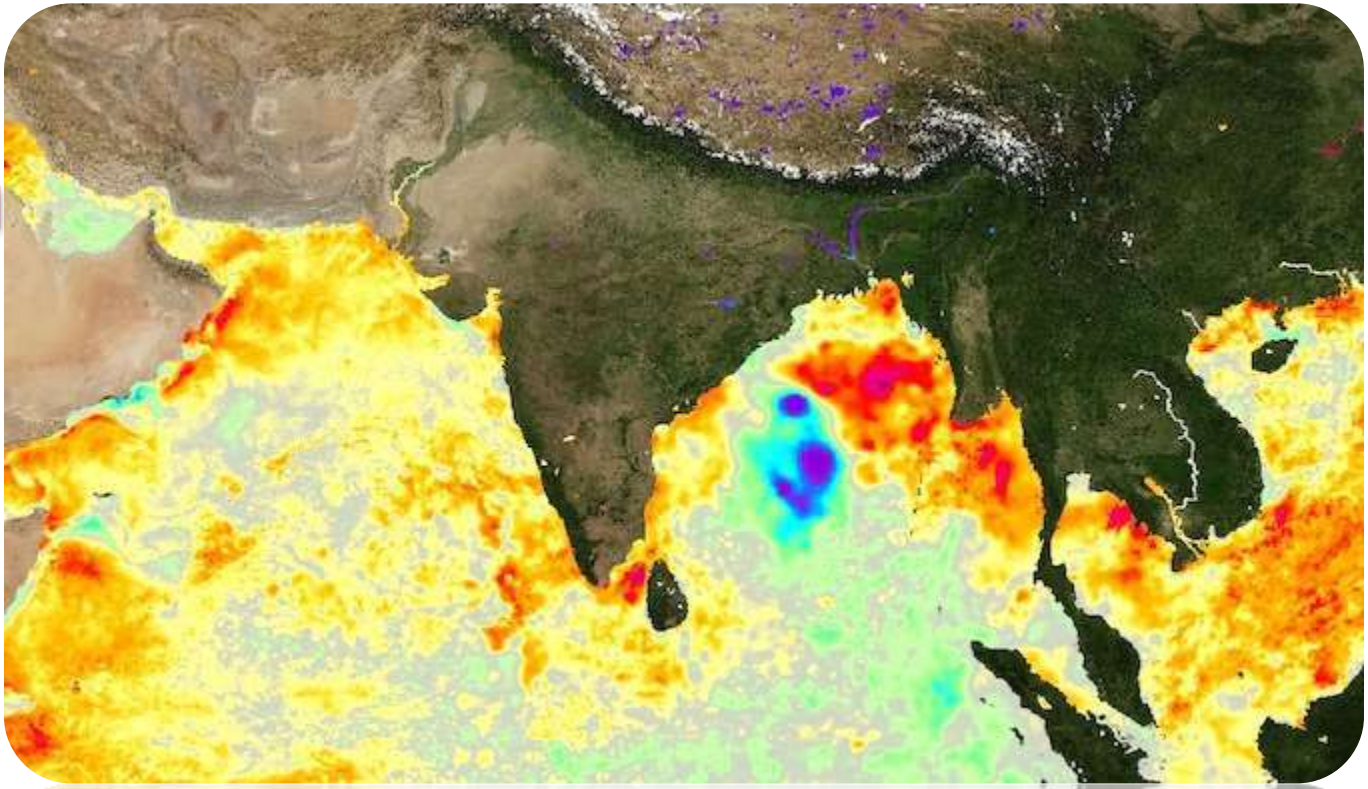
- Arctic Council is an **intergovernmental forum promoting cooperation, coordination and interaction among the Arctic states, Arctic Indigenous communities and other Arctic inhabitants** on common Arctic issues, in particular on issues of sustainable development and environmental protection in the Arctic.
- **Arctic Council consists of the eight Arctic States**: Canada, the Kingdom of Denmark (including Greenland and the Faroe Islands), Finland, Iceland, Norway, Russia, Sweden and the United States.

NATIONAL CLEAN ENERGY FUND (NCEF)

- The National Clean Energy Fund (NCEF) is a **fund created in 2010-11.**
- The Fund is designed as a **non-lapsable fund under Public Accounts** and with its **secretariat in Department of Expenditure, Ministry of Finance.**
- An **Inter-Ministerial Group chaired by the Finance Secretary in Ministry of Finance recommends projects eligible** for funding under NCEF.
- **Funding of NCEF**: The Fund has been created out of cess on coal produced / imported under the "polluter pays" principle.

NATIONAL CLEAN ENERGY FUND (NCEF)

- **Usage of Fund**: For funding research and innovative projects in clean energy technologies of public sector or private sector entities, upto the extent of 40% of the total project cost.
- **Features:**
  - Any project/scheme relating to Innovative methods to adopt to Clean Energy technology and Research & Development are eligible for funding under the NCEF.
  - Assistance is available as a loan or as a viability gap funding, as deemed fit by the Inter-Ministerial group, which decides on the merits of such projects.



CLIMATE CHANGE AND INDIA

INDIA'S POSITION ON CLIMATE CHANGE

- **One of the Largest Emitters:** India is world's third largest emitter of greenhouse gases (GHGs), after China and the US.
- **Emissions Gap Report 2020:** over the last decade, China, USA, EU27+UK and India combined, have contributed to 55% of the total GHG emissions.
- **Carbon Neutrality Target:** India has announced that it will reach carbon neutrality by 2070 as part of a five-point action plan that included reducing emissions to 50% by 2030.
- **Major sources of emissions**: Coal power plants, rice paddies, cattle.

INDIA'S POSITION ON CLIMATE CHANGE

- **Displacement and extinction of animal population** due to habitat loss adds more species to 'threatened' and 'extinct' list.
- **Spread of diseases** like malaria, etc. puts stress on health sector.
- **Increase tree cover** to create an additional cumulative carbon sink of 2,500-3,000Mt CO2 by 2030.
- **India also aims** to install 5GW of offshore wind by 2022 and 30GW by 2030. None has yet been installed.

INDIA'S POSITION ON CLIMATE CHANGE

- **India has doubled the Clean Energy Cess** on coal, which very few countries have, and the Clean Energy Fund already has over 3 billion US dollars to be used for promoting clean technologies
- **India's National Solar Mission** is being scaled up five-fold from 20,000 megawatts to 100,000 megawatts.
- **The country could integrate 390GW of low-cost wind and solar generation** into its grid by 2030, according to the Climate Policy Initiative (CPI).

INDIA'S POSITION ON CLIMATE CHANGE

- **India's climate pledge** notes that around 70% of its population depends on traditional biomass energy, which is inefficient and causes high levels of indoor air pollution.
- **India is targeting 10GW** of such bioenergy by 2022.
- **India has around 4.5GW** of small hydro plants (below 25MW), against a 5GW target for 2022.

INDIA'S POSITION ON CLIMATE CHANGE

- **Action Plan for cleaning one of the longest rivers** in the world, River Ganga will bring multiple benefits of pollution reduction and climate adaptation. We have also taken initiatives for protecting coastal, Himalayan, and forest areas.
- **India has initiated preparations** to develop a National Air Quality Index and have launched a National Air Quality Scheme.
- **Setting-up of Ultra Mega Solar Projects**: Tamil Nadu, Rajasthan, Gujarat, Andhra Pradesh and Ladakh to promote renewable energy.

CURRENT ACTIONS FOR ADAPTATION & MITIGATION

Adaptation	• **Actions taken to reduce negative consequences of climate changes.** • **E.g. Switching to drought-resistant crops, creating coastal buffer zone, early warning system, etc.**
Mitigation	• Actions taken to lower Greenhouse Gas (GHG) concentrations. • Eliminate emissions at source. • E.g. Wind farms, afforestation, energy-efficient vehicles, sequestering GHGs etc.

ATIONAL ACTION PLAN ON CLIMATE CHANGE (NAPCC)

- Launched in 2008. Outlines existing and future policies and programs addressing climate change. Plan identifies 8 core national missions. **9th mission (*) recently added**.

ATIONAL ACTION PLAN ON CLIMATE CHANGE (NAPCC)

National Solar Mission

- To promote development & use of solar energy for power generation & other uses.
- **Inaugurated in 2010 with a target of 20GW by 2022,** later increased to **100 GW in 2015.**
- MNRE has **proposed to achieve 60 GW from large and medium scale solar projects, and 40 GW through rooftop solar projects.**

ATIONAL ACTION PLAN ON CLIMATE CHANGE (NAPCC)

National Solar Mission

- Committed to Nationally Determined Contributions (Paris Accord), **India made a pledge that by 2030, 40% of installed power generation capacity shall be based on clean sources**.
- It was determined that **175 GW of renewable energy capacity will be installed by 2022** - includes 100 GW from solar, 60 GW from wind, 10 GW from bio-power and 5 GW from small hydro power.
- India is at **5th global position** for overall installed renewable energy capacity.

ATIONAL ACTION PLAN ON CLIMATE CHANGE (NAPCC)

National Mission for Enhanced Energy Efficiency (NMEEE)

- NAPCC recognizes energy efficiency as an important lever to address the issue of climate change.
- Aimed to **promote the market for energy efficiency** by fostering innovative policies and effective market instruments.
- **Energy Conservation Act led to the creation of a statutory body, the Bureau of Energy Efficiency (BEE)** with dedicated powers and responsibilities to promote energy efficiency and conservation in different sectors of the economy.

ATIONAL ACTION PLAN ON CLIMATE CHANGE (NAPCC)

National Mission for Enhanced Energy Efficiency (NMEEE)

- Ministry of Power, GoI through BEE, looks over the progress of the NMEEE mission.
- Mandating energy consumption decreases in large energy-consuming industries with trade of energy-saving certificates.
- Energy incentives, including taxes on energy efficient appliances.
- **4 new initiatives under this:**

1. **Perform Achieve & Trade (PAT):** Assigning energy reduction targets to large energy intensive industries and distributing Energy Saving Certificates (ESCerts) on achievement of the targets.

ATIONAL ACTION PLAN ON CLIMATE CHANGE (NAPCC)

2. **Market Transformation for Energy Efficiency (MTEE):** Promoting adoption of energy efficient equipment and appliances through innovative business models.
3. **Energy Efficiency Financing Platform (EEP):** Catalyzing the finances for energy efficiency sector by addressing the barriers and challenges in market development and project implementation.
4. **Framework for Energy Efficient Economic Development (FEEED):** To protect the confidence of banks and investors in energy efficiency projects and to avoid the stalling of projects due to lack of funds.

ATIONAL ACTION PLAN ON CLIMATE CHANGE (NAPCC)

National Mission on Sustainable Habitat

- To **promote energy efficiency as core component of urban planning**. Extending existing Energy Conservation Building Code
- Waste management, recycling, including power production from waste. Incentives to use public transport.
- Use of automotive fuel economy standards & pricing measures.

ATIONAL ACTION PLAN ON CLIMATE CHANGE (NAPCC)

National Mission on Sustainable Habitat

- Mission is being implemented through the following programmes of Ministry of Urban Development:

1. Atal Mission on Rejuvenation and Urban Transformation (AMRUT)
2. Swachh Bharat Mission
3. Smart Cities Mission
4. Urban Transport Programme

ATIONAL ACTION PLAN ON CLIMATE CHANGE (NAPCC)

National Water Mission

- To ensure integrated water resource management helping to conserve water, minimize wastage and ensure more equitable distribution both across and within states.
- Ensure that a considerable share of the water needs of urban areas are met through recycling.
- Ensure that the water requirements of coastal cities are met through modern desalination technologies.
- Increase storage both above and below ground, rainwater harvesting.

ATIONAL ACTION PLAN ON CLIMATE CHANGE (NAPCC)

National Mission for Sustaining Himalayan Ecosystems

- To conserve biodiversity, forest cover & study traditional societies where global warming has resulted in receding of glaciers. Building human & institutional capacities.
- Network knowledge systems & develop coherent database.
- Detect & decouple natural & anthropogenic global environment changes.

ATIONAL ACTION PLAN ON CLIMATE CHANGE (NAPCC)

National Mission for A Green India

- Aims at protecting; The mission has a **cumulative target of increasing forest cover on 5 million hectares of land while improving the forest cover on additional 5 hectares.**
- **Objective**: fulfilling India's Nationally Determined Contribution (NDC) target of sequestrating 2.5 Billion tonnes of "Carbon emissions" by 2020-30, which it submitted to UNFCCC.
- Goals include **afforestation of 10 million hectares of** land, **expanding forest cover from 23% to 33%.**

ATIONAL ACTION PLAN ON CLIMATE CHANGE (NAPCC)

National Mission for A Green India

- Increase forest-based livelihood income of **about 3 million households.**
- **Enhanced annual CO2 sequestration by 50 to 60 million tons** in the year 2020.
- Eco-restoration of shifting cultivation areas, cold deserts, mangroves, ravines and abandoned mining areas.
- Increase wage labour opportunities during the lean agriculture season, especially communities living in remote forest areas.

ATIONAL ACTION PLAN ON CLIMATE CHANGE (NAPCC)

National Mission for A Green India

- A **sub-mission on Cold Dessert Ecosystems under this mission is 'National Sea buckthorn Initiative' launched** by MoEF&CC and DRDO to fix atmospheric nitrogen.
- Sea buckthorn, popularly known as Leh berries, called the **"Wonder plant"** and **"Ladakh gold"** has medicinal properties & prevents desertification.

ATIONAL ACTION PLAN ON CLIMATE CHANGE (NAPCC)

National Mission on Sustainable Agriculture

- **Aim**: to develop climate-resilient crops, expansion of weather insurance & agricultural practices especially in rain-fed areas.
- **60% of the country's net sown area is rainfed** and accounts for 40% of the total food production.
- **Promote 'laboratory to land' research** through model village & farm units.
- **Link panchayat-level Automatic Weather Station Networks** to existing insurance mechanisms.

ATIONAL ACTION PLAN ON CLIMATE CHANGE (NAPCC)

National Mission on Sustainable Agriculture

- **Key dimensions by NMSA**: Improved crop seeds, livestock and fish cultures; Water Use Efficiency; Pest Management; Improved Farm Practices; Nutrient Management; Agricultural insurance; Credit support; Markets; Access to Information; Livelihood diversification; Soil Health Management (SHM) - Soil Health Card Scheme.

ATIONAL ACTION PLAN ON CLIMATE CHANGE (NAPCC)

National Mission on Strategic Knowledge for Climate Change

- **Formation of knowledge networks among the existing knowledge institutions** engaged in research and development relating to climate science.
- Research networks in the areas of climate change impacts on important socio-economic sectors like agriculture, health, natural ecosystems, biodiversity, coastal zones, etc.
- **Data sharing & exchange** through policy framework & institutional support.
- Strengthen indigenous capacity build partnerships through global collaboration.

ATIONAL ACTION PLAN ON CLIMATE CHANGE (NAPCC)

National Bioenergy Mission*

Aim:

- To push sustainable development of the renewable energy sector.
- Improving energy efficiency in traditional biomass consuming industries, seek to develop a bioenergy city project and provide logistics support to biomass processing units
- **Proposal**: GIS-based National Biomass Resource Atlas to map potential biomass regions in the country
- **As per estimates**: biomass from agro and agro-industrial residue can potentially generate 25,000 MW of power in India.

ATIONAL ACTION PLAN ON CLIMATE CHANGE (NAPCC)

Net Metering

- Net Metering is billing mechanism for grid connected Home Rooftop Solar Installation where
  - The electricity generated by the solar panels is fed into the utility grid
  - Household draws electricity from the utility grid
- The household pays only for the difference between the energy units it consumes from the grid and the energy units fed into the grid. This is measured by a bi-directional meter called Net Meter.

NATIONAL COMMUNICATION (NATCOM)

- In partnership with MoEFCC, funded by Global Environment Facility, the project aims to enable India undertake activities to prepare its Third National Communication to the UNFCCC according to the guidelines provided by the Conference of Parties (COP).

NATIONAL COMMUNICATION (NATCOM)

Indian Network on Climate Change Assessment

- Launched by MoEFCC in an effort to promote domestic research on climate change.
- Reports prepared by the INCCA will form a part of India's National Communication (Nat Com) to the United Nations Framework Convention on Climate Change (UNFCCC).

NATIONAL ACTION PROGRAMME TO COMBAT DESERTIFICATION

- **India is a party to the UN Convention to Combat Desertification (UNCCD)** and **MoEF&CC is the National Coordinating Agency** for the implementation of the UNCCD in the country.
- As an affected party, a 20 year comprehensive National Action Programme (NAP) to combat desertification in the country has been prepared.
- **Objectives:**
  - Community based approach to development,

NATIONAL ACTION PROGRAMME TO COMBAT DESERTIFICATION

- Activities to improve the quality of life of the local communities,
- Drought management preparedness and mitigation,
- R&D initiatives and interventions which are locally suited,
- Strengthening self-governance leading to empowerment of local communities

- It is proposed to initiate activities that include, among others, assessment and mapping of land degradation, drought monitoring and early warning system groups, drought preparedness contingency plans, and on-farm research activities for development of indigenous technology etc. will be taken up.

GREEN BUILDINGS

- A ‘green’ building is a building that, in its design, construction or operation, reduces or eliminates negative impacts, and can create positive impacts, on our climate and natural environment. Green buildings preserve precious natural resources and improve our quality of life.
- Practice of creating structures & using processes that are environmentally responsible & resource-efficient throughout a building’s life-cycle from design to construction, operation, maintenance, renovation, deconstruction.
- Designed to reduce overall impact of built environment on human & environmental health.

NET ZERO ENERGY BUILDINGS (NZEB)

- A net-zero energy building is one that **relies on renewable sources to produce as much energy as it uses**, usually as measured over the course of a year.
- The **Indian Green Building Council (IGBC) has come out with Net Zero Energy Buildings rating system** in collaboration with the **World Green Building Council** and the **United States Agency for International Development (USAID).**
- Solar panels, heat recovery systems, geothermal heating and wind turbines are among the other technologies used to achieve net-zero status.
- **Indira Paryavaran Bhavan in New Delhi is India's first net zero energy building** that has been constructed with the adoption of solar passive design and energy-efficient building materials.

PERFORM ACHIEVE AND TRADE (PAT) SCHEME

- Perform Achieve and Trade Scheme (PAT) is a **market based mechanism to enhance the cost effectiveness** in improving the Energy Efficiency in Energy Intensive industries through certification of energy saving which can be traded.
- It is a **part of the National Mission for Enhanced Energy Efficiency (NMEEE),** which is one of the eight missions under the National Action Plan on Climate Change (NAPCC).

STANDARDS AND LABELING PROGRAM (BEE STAR LABEL)

- The scheme was **launched in 2006**
- **Objectives:** to provide the consumer an informed choice about the energy saving.
- **Mandatory Appliances**: Room Air Conditioners; Frost Free Refrigerators; Tubular Florescent Lamp; Distribution Transformer; Room Air Conditioner (Casettes, Floor Standing); Direct Cool Refrigerator; Color TV; Electric Geysers; Variable Capacity Inverter Air conditioners; LED Lamps; Agricultural Pumpset.

ENERGY CONSERVATION BUILDING CODE (ECBC)

- It was developed for **new commercial buildings in 2007.**
- It sets **minimum energy standards for new commercial buildings** having a connected load of 100kW (kilowatt) or contract demand of 120 KVA (kilovolt-ampere) and above.

ECO NIWAS SAMHITA 2021

- It is an **Energy Conservation Building Code for Residential Buildings (ECBC-R)** to give a further fillip to India's energy conservation efforts.
- It specifies code compliance approaches and minimum energy performance requirements for building services, and verification framework with **Eco Niwas Samhita 2021.**
- The **building sector is the second largest consumer of electricity after industry** but it is expected to become the largest energy consuming sector by 2030.
- These initiatives will **help enhance the energy-efficiency levels in residential buildings** across the country, thereby leading to sustainable habitation.

GRIHA - GREEN RATING FOR INTEGRATED HABITAT ASSESSMENT

- **Conceived by TERI** (The Energy & Resources Institute), developed by **Ministry of New & Renewable Energy.**
- **Rating tool**: that helps assess ecological impact of building against nationally acceptable benchmarks.
- **Objective**: to help evaluate 'greenness' of buildings.

GRIHA - GREEN RATING FOR INTEGRATED HABITAT ASSESSMENT

- **Benefits of GRIHA buildings:** Reduced energy consumption without sacrificing the comfort levels; Reduced destruction of natural areas, habitats, and biodiversity, and reduced soil loss from erosion etc.; Reduced air and water pollution (with direct health benefits); Reduced water consumption; Limited waste generation due to recycling and reuse; Reduced pollution loads; Increased user productivity; Enhanced image and marketability.

GRIHA - GREEN RATING FOR INTEGRATED HABITAT ASSESSMENT

Bureau of Energy Efficiency (BEE)

- BEE is a statutory agency under the Ministry of Power.
- It was created in March 2002 under the provisions of the nation's 2001 Energy Conservation Act.
- BEE's function is to develop programs which will increase the conservation and efficient use of energy.
- It mandatory for certain appliances in India to have BEE ratings.

NATIONAL INITIATIVE ON CLIMATE RESILIENT AGRICULTURE (NICRA)

- **Launched by:** Indian Council of Agricultural Research (ICAR) in 2010-2011.
- **Objective:** To primarily enhance resilience of crops, livestock & fisheries through development of production & risk management.
- **Project components:**
  - Strategic research on adaptation and mitigation
  - Technology demonstration on farmers' fields to cope with current climate variability
  - Sponsored and competitive research grants to fill critical research gaps
  - Capacity building of different stake holders.

SECOND GREEN REVOLUTION FOR SUSTAINABLE LIVELIHOOD

- The second Green Revolution aims at creating sustainable agriculture by leveraging advancements in technology
- **Need:**
  - With the growing population and over-exploitation of land resources, the pressure on food security will continue and rise.
  - 65% of the population is still living in the villages and over 70% of the rural people are dependent on agriculture for their livelihood.
  - The Green Revolution has made us self-sufficient in food grains, but the environmental consequences and ecological costs are offsetting the progress made.

SECOND GREEN REVOLUTION FOR SUSTAINABLE LIVELIHOOD

- The ground water is depleted and polluted. The lakes and ponds are becoming life less due to eutrophication – a direct consequence of Green Revolution.
- Growth in the agricultural sector has been almost stagnant.
- GM Crops are marred in various controversies related to intellectual property, ecological consequences, health consequences etc.
- Global warming is said to engulf productive coastal lands due to rise in sea levels. This creates an urgent need to raise agricultural productivity.
- It is necessary to develop a suitable strategy to improve agricultural development in India.

BRINGING GREEN REVOLUTION IN EASTERN INDIA (BGREI)

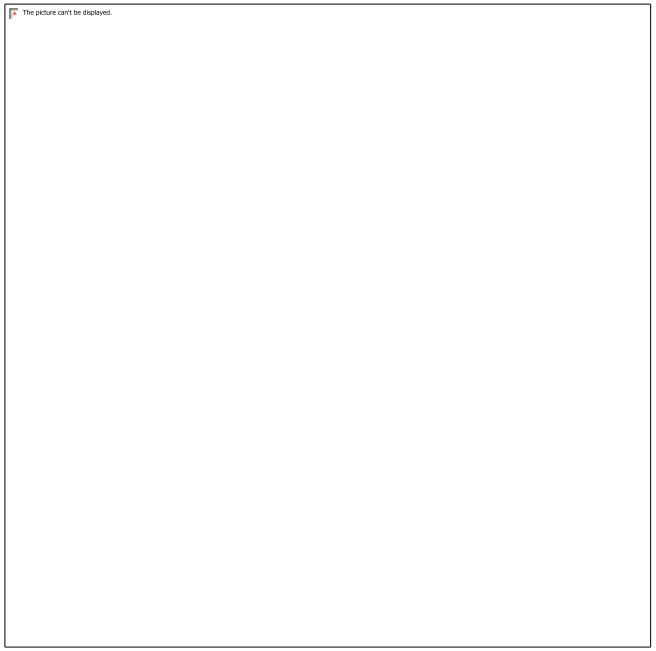
- Green Revolution that **turned India from 'begging bowl' to leading producer of food-grains.**
- BGREI is about **bringing similar benefits to eastern India** that largely remained untouched of the wonder that converted the north-west into a ‘grain bowl’.
- BGREI is **flagship programme under Rashtriya Krishi Vikas Yojana (RKVY).**
- It is intended to address the constraints limiting the productivity of “**rice based cropping systems**”.
- The BGREI program was **announced in the Union Budget, 2010-11.**

BRINGING GREEN REVOLUTION IN EASTERN INDIA (BGREI)

- **Seven States**: Assam, Bihar, Chhattisgarh, Jharkhand, Odisha, West Bengal and eastern Uttar Pradesh (Purvanchal).
- **Government Initiatives:**
  - The ICAR has established IARI, Hazaribagh in Jharkhand and Indian Institute of Agricultural Biotechnology, Ranchi.
  - It has also established National Research Centre for Integrated Farming at Motihari in Bihar to further strengthen the agricultural research for the eastern region.

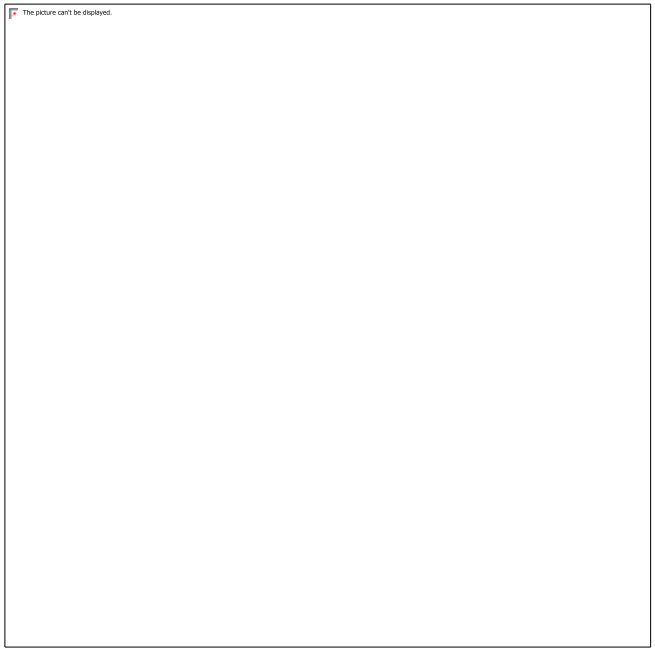
TAKACHAR: HARVESTING VALUE FROM AGRICULTURAL WASTE

- Takachar is a **social enterprise founded by Vidyut Mohan in 2018.**
- It enables farmers **to prevent open burning of their waste farm residues and earn extra income** by converting them into value-added chemicals.
- It is a **meaningful and immediate solution to the triple planetary crises** of climate change, biodiversity loss and pollution.
- **Strategy/Method**: Takachar buys rice husks, straw and coconut shells from farmers and turns them into charcoal, saving the debris from the fires, which are also a driver of climate change.



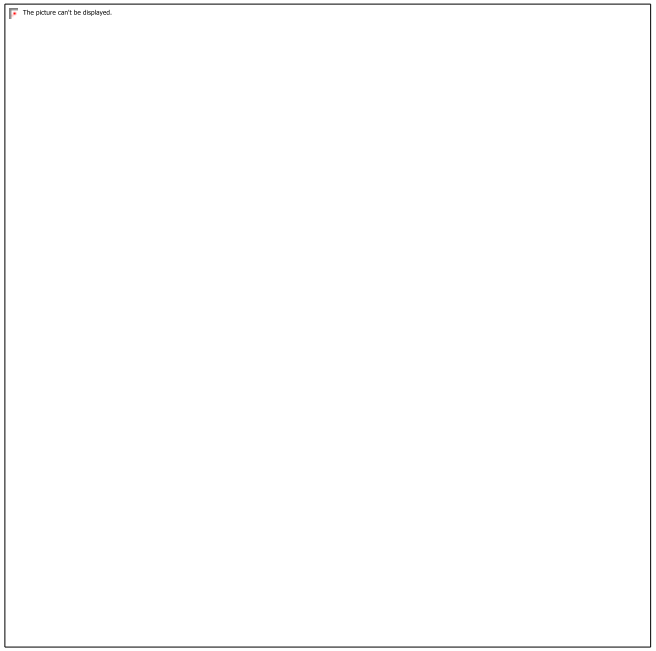
TAKACHAR: HARVESTING VALUE FROM AGRICULTURAL WASTE

- **Importance**:
  - **Open burning of agricultural residues** is a big source of air pollution in many parts of the world.
  - **This innovative technology can help farmers** turn what is currently thought of as waste into a valuable resource while helping clean up our environment.
  - **Enables rural farmers to earn 40% more by converting their crop residues** into fuels, fertilisers and value-added chemicals like activated carbon (AC) on-site.



TAKACHAR: HARVESTING VALUE FROM AGRICULTURAL WASTE

- **Importance**:
- It is estimated that by 2030, Takachar will impact 300 million farmers affected by this problem, create USD 4 billion/year equivalent in additional rural income and jobs, and mitigate one gigaton/year of CO2 equivalent.



BSE - GREENEX

- **25th dynamic index hosted on the Bombay Stock Exchange**; it is **India's first carbon-efficient live index** developed by BSE in collaboration with IIM Ahmedabad in 2012.
- **India's first objective green equity index** to employ index constituent weight capping.
- g-Trade Carbon Ex Ratings Services Private Limited has co-developed with BSE.
- The index seeks to assess and quantify the energy efficiency of firms, based on energy and financial data.

BSE - GREENEX

- It follows a sector-specific algorithm whereby a firm's performance is measured in comparison to others in the same sector.
- The index carries weight for two major criteria that together indicate long-term sustainability of businesses:
  - Energy efficiency measured by gauging reduction in the amount of energy consumed, reduced wastage, renewable energy adoption and costs incurred on energy.
  - Profitability

FAME - INDIA PROGRAMME

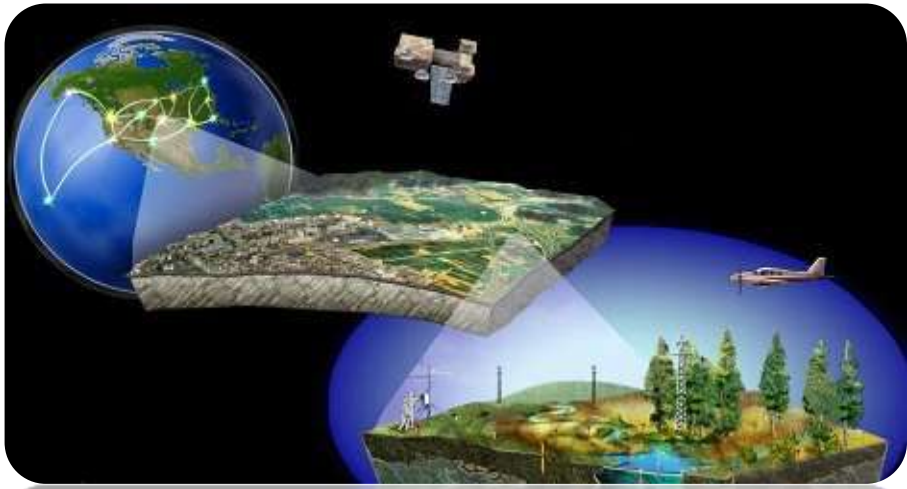
- National Electric Mobility Mission Plan (NEMMP) 2020 is a National Mission document providing the vision and the roadmap for the faster adoption of electric vehicles and their manufacturing.
- Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India (FAME India), 2015
- By Department of Heavy Industry to promote manufacturing of electric and hybrid vehicle technology under NEMMP 2020.
- **1st Phase of FAME India Scheme was implemented in 2015 through four focus areas:** Demand Creation; Technology Platform; Pilot Project; Charging Infrastructure.

FAME INDIA SCHEME PHASE II - 2019-2020

- Aims to generate demand by way of supporting 7000 e-Buses, 5 lakh e-3 Wheelers, 55000 e-4 Wheeler Passenger Cars (including Strong Hybrid) and 10 lakh e-2 Wheelers.
- Applicable mainly to vehicles used for public transport or those registered for commercial purposes in e-3W, e-4W and e-bus segments. Privately owned registered e-2Ws also covered under the scheme.
- Construction of electric charging stations to be carried out.

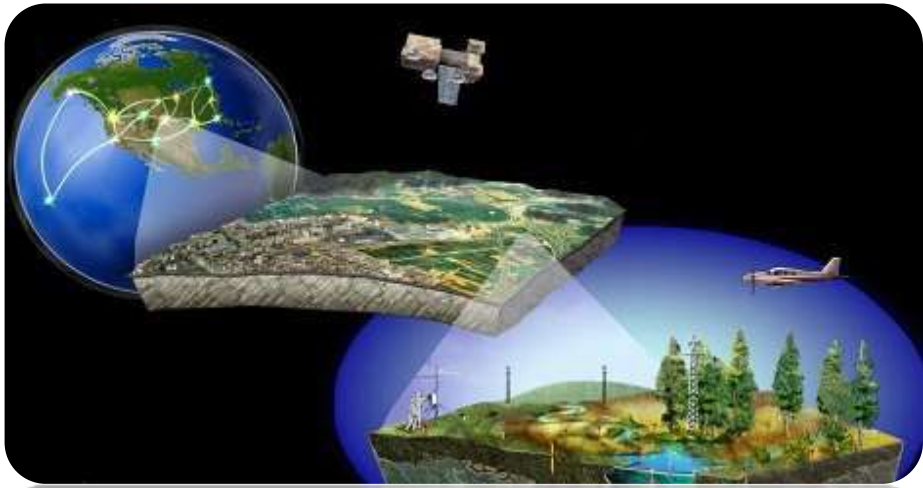
LONG TERM ECOLOGICAL OBSERVATORIES (LTEO)

- Under **'Climate Change Action Programme'**.
- A science plan of LTEO was **released during 21st COP to the UNFCCC at Paris in December 2015.**
- **1st phase includes health assessment of**: Western Himalaya, Eastern Himalaya, North-Western Arid Zone, Central Indian Forests, Western Ghats, Andaman & Nicobar Islands, Jammu & Kashmir, Sundarbans.



LONG TERM ECOLOGICAL OBSERVATORIES (LTEO)

- **Aims**: to understand biophysical & anthropogenic drivers in select biomes & effects on socio-ecological responses.
- **Activities include:** assessment of change of structure & function in natural ecosystems, monitoring population of species, animal movements, soil processes, biophysical variables, etc.

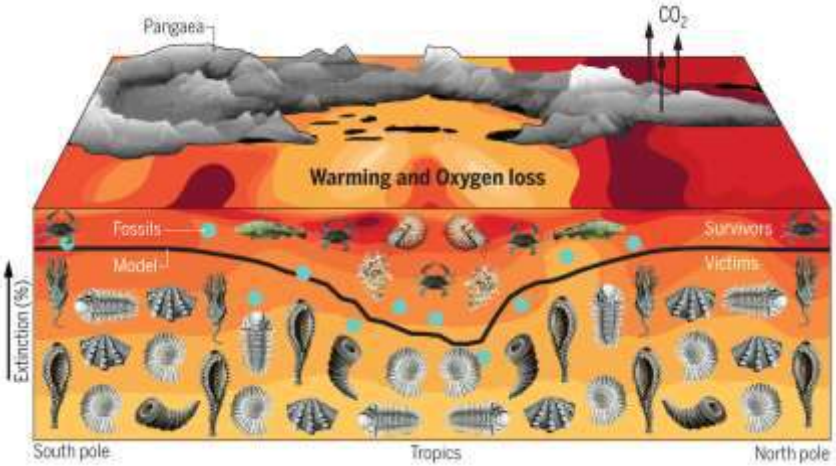


NATIONAL ADAPTATION FUND FOR CLIMATE CHANGE (NAFCC)

- Introduced in **2015-16**. Was to be **revised in 2020**.
- Fund meant to assist national & state level activities for areas vulnerable to climate change.
- Central Sector Scheme with **NABARD** as National Implementing Entity.
- **Aim** - Support adaptive activities which are not covered under ongoing government schemes.

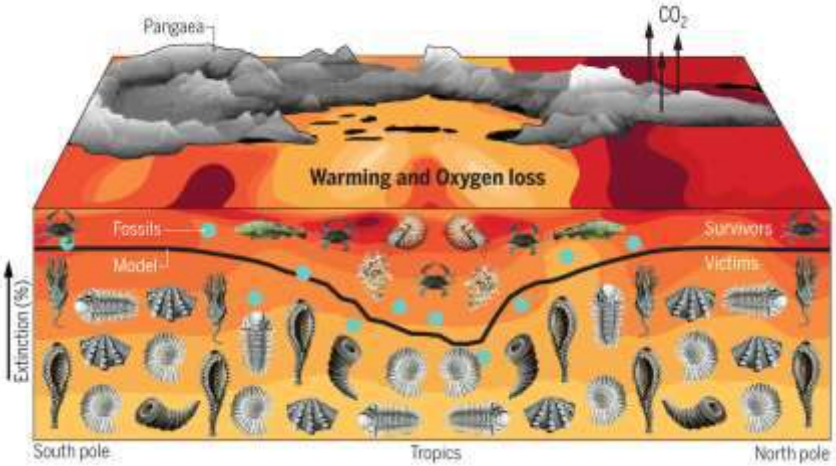
6TH MASS EXTINCTION DUE TO CLIMATE CHANGE

- The Holocene extinction, otherwise referred to as the sixth mass extinction or Anthropocene extinction, is an ongoing extinction event of species during the present Holocene epoch.
- Human beings are causing this event on the planet.
- It's irreversible: the researchers have found that populations on the brink go extinct 94% of the time.



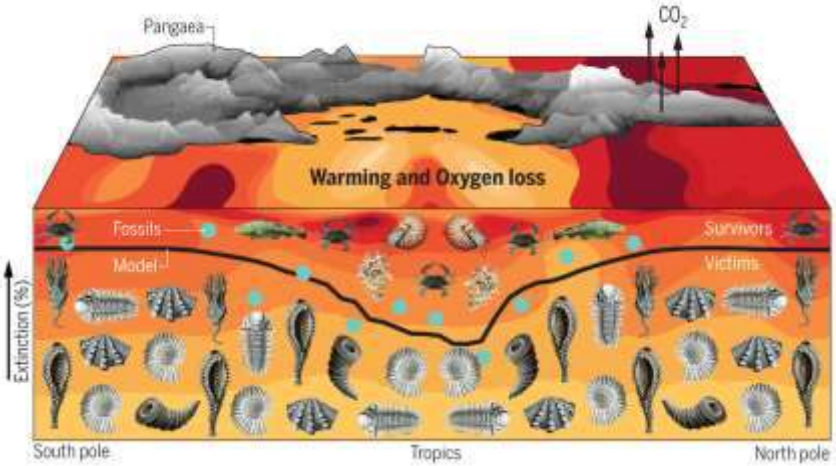
6TH MASS EXTINCTION DUE TO CLIMATE CHANGE

- **Ways to control mass extinction:** Scientists propose classifying all species with less than 5000 individuals as critically endangered on the IUCN list; Implement a global comprehensive binding agreement requiring parties to address the extinction crisis; Tackling the illegal and legal wildlife trade; Stop the land-grabbing and devastating deforestation.



6TH MASS EXTINCTION DUE TO CLIMATE CHANGE

- **Causes of extinction:**
  - Increasing population and consumption rates
  - Meat consumption, overhunting, overfishing, and ocean acidification and the decline in amphibian populations Breakage of food web/species links
  - Population boom of urchins on kelp forests in the Bering sea, leading to the extinction of the kelp-eating steller's sea cow.
  - Massive volcanic eruptions, depletion of ocean oxygen or collision with an asteroid.



CONSERVATION EFFORTS

PROJECT TIGER

- **Tiger Reserve**: Tiger reserves are areas that are notified for the protection of the tiger and its prey, and are governed by Project Tiger which was launched in the country in 1973.
- **Launched** in 1973 (from **Jim Corbett** National Park of Uttarakhand) as Centrally Sponsored Scheme.
- **Objective**: to protect 'Endangered' Tiger population from extinction by ensuring a viable population in their natural habitats.

Tiger can be killed under two conditions:

1. Diseased or disabled beyond recovery
2. The threat to human life

PROJECT TIGER

- Tiger is an **Umbrella species.** Protection of these species indirectly protects the many other species that make up the ecological community of its habitat.
- **Schedule 1 animal** as per Wildlife Protection Act, 1972
- The tiger, Panthera tigris, is listed as **'Endangered'** on the IUCN Red List of Threatened Species.
- In no case, the **tiger can be declared vermin**.
- The scientific name for the tiger is **Panthera Tigris.**

PROJECT TIGER

- **Eight subspecies of tiger**: among the eight, at present five subspecies are present in the wild. They are - Bengal, South China, Indochinese, Sumatran, and Siberian. Three subspecies of tiger—Caspian, Bali, and Javan—are extinct.
- **Rajasthan has become the first state to launch project Leopard** to conserve it by improving their prey base, mitigating man and leopard conflict and controlling poaching.
- There are **53 tiger reserves in India (Oct 2021)** that are governed by Project Tiger, administrated by the NTCA.

PROJECT TIGER

- In October 2021, NTCA designated the combined areas of the **Guru Ghasidas National Park** (last known habitat of the Asiatic cheetah) and **Tamor Pingla Wildlife Sanctuary in Chhattisgarh** as the 53rd Tiger Reserve of the country.
- **Largest Tiger Reserve in India: Nagarjunsagar-Srisailam Tiger Reserve (Andhra Pradesh, Telangana).**
- **Smallest Tiger Reserve in India: Bor Tiger Reserve (Maharashtra)**
- A tiger reserve is demarcated on the basis of **'core-buffer strategy'** which includes:

PROJECT TIGER

Core zone

- Critical tiger habitat areas established, on the basis of scientific and objective criteria.
- These areas are required to be kept as inviolate for the purposes of tiger conservation, without affecting the rights of the Scheduled Tribes or such other forest dwellers.
- These areas are notified by the State Government in consultation with an Expert Committee (constituted for that purpose)
- Critical Wildlife Habitats (CWHs) **have been envisaged in Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006.**

PROJECT TIGER

Buffer zone

- **Peripheral area** to critical tiger habitat or core area, where a lesser degree of habitat protection is required to ensure the integrity of the critical tiger habitat with adequate dispersal for tiger species.
- **Aims at promoting co-existence** between wildlife and human activity with due recognition of the livelihood, developmental, social and cultural rights of the local people.

PROJECT TIGER

Buffer zone

- The **limits of such areas are determined on the basis of scientific and objective criteria** in **consultation with the concerned Gram Sabha and an Expert Committee.**
- **No alteration in the boundaries** of a tiger reserve shall be made **except on a recommendation of the NTCA and the approval of the National Board for Wild Life.**

PROJECT TIGER

Tiger Census 2018

- **Tiger census:** Every 4 years, NTCA conducts a tiger census across India. First was conducted in 2006, followed by 2010, 2014 and in 2018.
- **Tiger census uses:** Pugmark technique, Camera trapping, M-STrIPES (Monitoring System for Tigers-Intensive Protection & Ecological Status) etc.
- India is home to 80 percent of tigers in the world. In 2006, there were 1,411 tigers which increased to 1,706 in 2010, 2,226 in 2014 and 2967 in 2018.
- **Top 3 States:** Madhya Pradesh - 526 Karnataka -524 & Uttarakhand - 442 Tigers.
- **Census did not record any** Tigers in Buxa (West-Bengal), Palamau (Jharkhand) & Dampa (Mizoram) TRs.

PROJECT TIGER

Global Tiger Initiative - 2008	• **An initiative of the World Bank to bring global partners together to strengthen Tiger conservation.**
Petersburg Tiger Summit 2010 (TX2)	• **Leaders of 13 tiger range countries** resolved to double Tiger numbers in the wild, with a popular slogan **'Tx2'. The base year is 2006.** • Goal has been set by the **World Wildlife Fund (WWF)** through the Global Tiger Initiative, Global Tiger Forum, and other critical platforms. • **India achieved** its 'St. Petersburg declaration' target by doubling Tiger population (in 2019) ahead of 2022 target
13 Tiger Range Countries	• India, Bangladesh, Bhutan, Cambodia, China, Indonesia, Lao PDR, Malaysia, Myanmar, Nepal, Russia, Thailand & Vietnam [all are in Asia].

PROJECT TIGER

Conservation Assured | Tiger Standards [CA|TS] Asia	• CA|TS is a conservation tool that sets best practice & standards to manage Tigers. • Started in 2013, Implemented by WWF. • **At present, only 2 sites are CA|TS compliant:** ○ Chitwan National Park in Nepal & ○ Sikhote - Alin Nature Reserve in Russia. • India became the 1st among the 13 tiger range countries to nationally adopt CA|TS.
Global Tiger Forum (GTF)	• GTF is an inter-governmental international body established in 1993; HQ: New Delhi • **Objective: to** protect the Tigers in their habitats. • It is the **only Inter-Governmental body** to save the tiger worldwide. • Tiger range countries are its members.

PROJECT TIGER

Tiger Task Force

- On the basis of the recommendations of the **National Board for Wild Life**, a **Task Force was set up to look into the problems of tiger conservation in the country.**
- The recommendations of the **Task Force** include strengthening Project Tiger by giving it statutory and administrative powers.

PROJECT ELEPHANT

- Launched in 1992 as Centrally Sponsored Scheme.
- **IUCN status:** Asian elephant: **Endangered** & African elephant: Vulnerable.
- **Objectives:** to protect elephants, their habitat & corridors; to prevent man-animal conflict; Welfare of captive elephants.
- MoEF&CC **provides financial & technical support** to wildlife management efforts by states.

Elephants are described as **"Ecological Engineers"** because they **create** & **maintain ecosystems** by physically changing habitats. Elephant society is **matriarchal**.

PROJECT ELEPHANT

- **Project is being mainly implemented in 16 States**: Andhra Pradesh, Arunachal Pradesh, Assam, Chhattisgarh, Jharkhand, Karnataka, Kerala, Maharashtra, Meghalaya, Nagaland, Orissa, Tamil Nadu, Tripura, Uttarakhand, Uttar Pradesh, West Bengal.
- **GoI in the year 2010 declared Elephant as the National Heritage Animal** of the country on the recommendations of the standing committee of the National Board For Wildlife.

PROJECT ELEPHANT

- As notified by the government, there are **around 32 elephant Reserves in India**. The very first elephant reserve or elephant sanctuary was the **Singhbhum Elephant Reserve of Jharkhand**.
- Indian elephant **Elephas maximus** occurs in the central and southern Western Ghats, North-east India, eastern India and northern India and in some parts of southern peninsular India.
- Elephants have the **longest gestation period of any mammal—22 months**. Females give birth every four to five years.

PROJECT ELEPHANT

Asian Elephants:

- There are three subspecies of Asian elephant which are the Indian, Sumatran and Sri Lankan.
- The Indian subspecies has the widest range and accounts for the majority of the remaining elephants on the continent.
- **Global Population:** Estimated 20,000 to 40,000.
- **Protection Status:**
  - **IUCN Red List: Endangered.**
  - Wildlife (Protection) Act, 1972: Schedule I.
  - CITES: Appendix I

PROJECT ELEPHANT

African Elephants:

- There are two subspecies of African elephants, the Savanna (or bush) elephant and the Forest elephant.
- **Global Population**: Around 4,00,000.
- Earlier in July 2020, Botswana (Africa) witnessed the death of hundreds of elephants.
- **Protection Status:**
  - **IUCN Red List Status:**
    - African Savanna Elephant: Endangered.
    - African Forest Elephant: Critically Endangered
    - **CITES**: Appendix II

PROJECT ELEPHANT

- Recently, the Supreme Court (SC) upheld the 2011 order of the Madras High Court (HC) on the Nilgiris elephant corridor, affirming the **right of passage of the animals** and the closure of resorts in the area.

PROJECT ELEPHANT

Elephant census	• **Elephant census, is conducted once in 5 years under the aegis of Project elephant.** • **In 2017 a population of 27312 elephants has been estimated from 23 states in India.** • **Karnataka has the highest number of elephants (6,049), followed by Assam (5,719) and Kerala (5706) - as per Census of 2017.**
Elephant Corridors	• Narrow strips of land that allow elephants to move from one habitat to another. • **Meghalaya** has maximum Intra-state elephant corridors. • Jharkhand and Odisha share maximum inter-state corridors. • Maximum International corridors India shares with Bangladesh. • Out of the total of 88 corridors, 20 are in south India.
Gaj Yatra	• Aims at **securing 100 elephant corridors** across India. • It is an initiative of **MoEF&CC and the Wildlife Trust of India (WTI).**

PROJECT ELEPHANT

Monitoring of Illegal Killing of Elephants (MIKE)	• **Started in 2003 by CITES.** • **Objective: to measure levels and trends in the illegal hunting of elephants.** • **India has 10 MIKE sites: Chirang-Ripu, Dihing Patkai, Eastern Dooars, Deomali, Garo Hills, Mayurbhanj, Shivalik, Mysore, Nilgiri, Wayanad Elephant Reserve.**
'Haathi Mere Saathi' Campaign	• Launched by the **MoEF&CC** and the **Wildlife Trust of India (WTI) at the Elephant-8 Ministerial meeting Delhi, in 2011.** • E-8 countries: India, Botswana, Congo, Indonesia, Kenya, Sri Lanka, Tanzania, and Thailand.

PROJECT ELEPHANT

Project RE-HAB	• **A pilot project RE-HAB (Reducing Elephant-Human Attacks using Bees) has been launched in Karnataka which entails installing bee boxes along the periphery of the forest and the villages to mitigate human-elephant conflict.** • **Implementing Agency: Initiative of Khadi and Village Industries Commission (KVIC).**
Elephant Task Force	• The Union government constituted an Elephant Task Force (ETF) in **2010** under the leadership of **historian Mahesh Rangarajan** to review the existing policy of elephant conservation in India and formulate future interventions. • The task force came out with a comprehensive report in August that year, called **Gajah: Securing the Future for Elephants in India.**

VULTURE CONSERVATION

- A vulture is a bird of prey that **scavenges** on carrion, live predominantly in the **tropics** and **subtropics**.
- Vultures, also known as **nature's clean-up crew**.
- **India is home to 9 species of Vulture**: the Oriental white-backed, Long-billed, Slender-billed, Himalayan, Red-headed, Egyptian, Bearded, Cinereous and the Eurasian Griffon.

VULTURE CONSERVATION

- Bearded, Long-billed, Slender-billed, Oriental white-backed are protected in the **Schedule-1 of the WPA 1972.** Rest are protected under **'Schedule IV'.**
- Vultures in south Asia, mainly in **India** and Nepal, have **declined dramatically** since the early 1990s.
- **Cause of the decline**: diclofenac, a veterinary nonsteroidal anti-inflammatory drug (NSAID) in 2004, which is used to treat pain and inflammatory diseases such as gout in carcasses that vultures would feed off.

VULTURE CONSERVATION

- Drug **Diclofenac** implicated as the main cause of vulture decline. It is banned and replaced by **Meloxicam.**
- Vultures die of **kidney (Renal) failure** caused by Diclofenac poisoning.
- **Towers of silence**: Zoroastrians give their dead “sky burials.” They built circular, flat-topped towers called dakhmas, or towers of silence. There corpses were exposed to the local vultures.

VULTURE CONSERVATION

Action Plan for Vulture Conservation 2020 -2025:

- Approved by National Board for Wildlife (NBWL).
- **To set up Vulture conservation & breeding centers at:** Uttar Pradesh, Tripura, Maharashtra, Karnataka & Tamil Nadu.
- Establishment of at least one **Vulture Safe zone** in each state.
- Establishment of four rescue centres, in Pinjore (Haryana), Bhopal (Madhya Pradesh), Guwahati (Assam) and Hyderabad (Telangana).

VULTURE CONSERVATION

Vultures found in India

- Out of 23 species of vultures in the world, 9 are found in India. These include:

1. White Rumped vulture (**CR**- Critically Endangered)
2. Slender billed vulture (**CR**)
3. Long billed vulture (**CR**)
4. Red headed vulture (**CR**)
5. Egyptian vulture (Endangered)
6. Himalayan Griffon (**NT**-Near Threatened)
7. Cinereous vulture (**NT**)
8. Bearded vulture (**NT**)
9. Griffon Vulture (Least Concern).

VULTURE CONSERVATION

The Vulture Conservation Breeding Centre (VCBC)

- VCBC is a joint project of the Haryana Forest Department & the Bombay Natural History Society (BNHS).
- **Aims to save the three species of vultures from extinction:**

1. The White-backed vulture,
2. Long-billed vulture &
3. Slender-billed vulture.

VULTURE CONSERVATION

The Vulture Conservation Breeding Centre (VCBC)

- **Vulture Care Centre (VCC):** set up at Pinjore, Haryana in 2001 to study the cause of deaths of vultures in India.
- **Jatayu Conservation Breeding Centre in Pinjore is the world's largest facility** within the state's Bir Shikargah Wildlife Sanctuary for the breeding and conservation of Indian vulture species.

VULTURE CONSERVATION

SAVE (Saving Asia's Vultures from Extinction)

- The consortium of like-minded, regional and international organizations, created to oversee and coordinate conservation, campaigning and fundraising activities to help the plight of south Asia's vultures.
- **Objective:** To save three critically important species from extinction through a single programme.
- **SAVE partners:** Bombay Natural History Society, Bird Conservation Nepal, RSPB (UK), National Trust for Nature Conservation (Nepal), International Centre for Birds of Prey (UK) and Zoological Society of London.

VULTURE CONSERVATION

Vulture Safety Zones

- Aim of developing **VSZs is to establish targeted awareness activities surrounding 150 km radius of vultures' colonies** so that no diclofenac or the veterinary toxic drugs are found in cattle carcasses, the main food of vultures (**to provide safe food**).

VULTURE CONSERVATION

Vulture Safety Zones

- The VSZ is **spread around in several hundred kilometers covering the Jim Corbett in Uttarakhand, Dudhwa and Kartarniaghat forest reserves in UP** which is adjoining the Indo-Nepal border. **Nepal has already set up VSZ** on the Indian borders.
- VSZ provides **safe source of food that is free of contamination from veterinary drugs, poisons and other agricultural chemicals.**

INDIAN (ONE HORN) RHINO VISION (IRV) 2020

- Launched in **2005**, supported by WWF India, the International Rhino Foundation (IRF).
- Implemented by Assam State Government with the Bodo autonomous council as an active partner.
- **Aim:** to attain a wild population of **at least 3,000** one-horned rhinos spread over seven protected areas in state of **Assam** by 2020.
- **Seven protected areas:** Kaziranga, Pobitora, Orang National Park, Manas National Park, Laokhowa wildlife sanctuary, Burachapori wildlife sanctuary and Dibru Saikhowa wildlife sanctuary.

INDIAN (ONE HORN) RHINO VISION (IRV) 2020

- Only the Great One-Horned Rhino is found in India. Also known as **Indian rhino is the largest of the rhino species**.
- **In India, rhinos are mainly found in**: Assam, West Bengal and Uttar Pradesh.
- Assam has an estimated **2,640 rhinos in four protected areas**, i.e. **Pabitora Wildlife Reserve**, Rajiv Gandhi Orang National Park, Kaziranga National Park, and **Manas National Park.**
- **Protection Status:**
  - **IUCN Red List:** Vulnerable.
  - **CITES: Appendix I** (Threatened with extinction)
  - **Wildlife Protection Act, 1972:** Schedule I.

INDIAN (ONE HORN) RHINO VISION (IRV) 2020

New Delhi Declaration on Asian Rhinos 2019	• The **five rhino range nations** (India, Bhutan, Nepal, Indonesia and Malaysia) have signed a declaration for the **conservation and protection** of the species. • **Objective:** to conserve & review the population of the Greater one horned, Javan and Sumatran rhinos every 4 years to reassess the need for joint actions to secure their future. • **Note:** 3 species of Rhino - Black, Javan, & Sumatran are Critically endangered.
National Rhino Conservation Strategy	• It was launched in 2019 to conserve the greater one-horned rhinoceros.

PROJECT SNOW LEOPARD

- Launched in **2009,** to promote an inclusive and participatory approach to conserve snow leopards and their habitat.
- **Objective**: to safeguard & conserve India's unique natural heritage of high-altitude wildlife populations.
- Most of the Snow leopards are found in **China** followed by Mongolia and India.
- Snow leopards **act as an indicator of the health of the mountain ecosystem** in which they live, due to their position as the top predator in the food web.

PROJECT SNOW LEOPARD

- **Geographical range encompasses:**
  - Mountainous regions of central and southern Asia.
  - **Western Himalayas**: Jammu and Kashmir, Himachal Pradesh.
  - **Eastern Himalayas**: Uttarakhand and Sikkim and Arunachal Pradesh.
- **Snow Leopard capital of the world**: Hemis, Ladakh. Hemis National Park is the **biggest national park in India**.

PROJECT SNOW LEOPARD

- **Conservation Status:**
  - **IUCN Red List**: Vulnerable
  - **CITES: Appendix I**
  - **WPA (1972):** listed in **Schedule I**
  - Also listed in the **Convention on Migratory Species (CMS)**
- **HimalSanrakshak**: It is a community volunteer programme, to protect snow leopards, launched in October 2020.
- **SECURE Himalaya: Global Environment Facility (GEF)-UNDP** funded the project on conservation of high altitude biodiversity and reducing the dependency of local communities on the natural ecosystem.

PROJECT SNOW LEOPARD

- **Global Snow Leopard and Ecosystem Protection (GSLEP) Programme:** GSLEP is a high-level inter-governmental alliance of all the 12 snow leopard range countries. The snow leopard countries namely, India, Nepal, Bhutan, China, Mongolia, Russia, Pakistan, Afghanistan, Kyrgyzstan, Kazakhstan, Tajikistan, and Uzbekistan.
- Snow Leopard is **on the list of 21 critically endangered species for the recovery programme** of the MoEF&CC
- Snow Leopard conservation breeding programme is undertaken at **Padmaja Naidu Himalayan Zoological Park, Darjeeling, West Bengal.**

PROJECT SNOW LEOPARD

- Species such as Snow Leopard, Asiatic Ibex, Tibetan Argali, Ladakh Urial, Chiru, Takin, Serow and Musk Deer will particularly benefit from this project.

PROJECT SECURE HIMALAYA

- Launched in 2017 by Govt. of India in association with UNDP, the GEF -Global Environment Facility.
- **Objective:** to secure livelihoods, conserve, restore & sustainably use Himalayan ecosystems.
- It covers the high **Himalayan Ecosystem** spread over: Uttarakhand, Sikkim, Jammu & Kashmir and Himachal Pradesh.
- **Project Implemented in Specific Landscapes:**

PROJECT SECURE HIMALAYA

1. **Changthang**: Jammu and Kasmir
2. **Lahaul**: Pangi and Kinnaur (Himachal Pradesh)
3. **Gangotri**: Govind & Darma Byans Valley (Uttarakhand)
4. **Kanchenjunga**: Upper Teesta Valley (Sikkim).

- Also, **focused on** the protection of **snow leopard** & **other endangered species** and their habitats in Himalayas.
- Govt. also launched India Wildlife mobile App and released the National Wildlife Action Plan for the period 2017-2031.

PROJECT SEA TURTLE

- **Launched** in **2005** by MoEF&CC in association with UNDP.
- **Implemented by** Wildlife Institute of India, Dehradun.
- **Protection:** In India, sea turtles are protected under the WPA of 1972, under the **Schedule I Part II.**
- **Turtles in India:** Leatherback tortoise, Haskabile tortoise, Lagerhead tortoise, Green turtle, Olive Ridley tortoise.

PROJECT SEA TURTLE

- **Olive Ridley Turtles:**
  - **Status in IUCN Red List**: Vulnerable
  - Largest Mass Nesting Site of Olive Ridley Turtles**:** Odisha Coast
  - **Habitat**: Warm Waters of Pacific Ocean, Atlantic Ocean and the Indian Ocean

PROJECT SEA TURTLE

Operation Kachhapa	• **Launched in 1998 by The Wildlife Protection Society of India.** • **Objective: to reduce turtle mortality and try to safeguard the future of Olive Ridley Sea Turtle.** • **Arribada: Unique mass nesting of Olive Ridley Turtles (female turtles assemble on the same beach to lay eggs)** • **Operation Save Kurma: The operation was conducted to combat the proliferating illegal trade of live turtles and its parts from the country to destinations abroad.**
Facts	• Leatherback sea turtles can travel more than 10,000 miles every year. • Female turtles lay their eggs at the same beach on which they were born. • Green turtles can hold their breath for up to 5 hours.

PROJECT CROCODILE

- **Launched** in 1975 by **GoI** in association with **UNDP, FAO.**
- **Objectives:**

1. To protect the remaining population of crocodilians.
2. To enhance their population through 'rear & release' technique.
3. To promote captive breeding.

- Central Crocodile Breeding & Management Training Institute is located at Hyderabad, Telangana.
- There are **three crocodilians** species found in **India.**

PROJECT CROCODILE

Mugger or Marsh Crocodile:

- The **mugger** is an egg-laying and hole-nesting species. mugger is also known to be dangerous. It is already **extinct in Bhutan and Myanmar.**
- Protection Status:
  - IUCN: **Vulnerable**
  - CITES: **Appendix I**
  - Wildlife Protection Act, 1972: **Schedule I**
  - Habitat: It is mainly restricted to the Indian subcontinent where it may be found in a number of freshwater habitat types including rivers, lakes and marshes.

PROJECT CROCODILE

Estuarine or Saltwater Crocodile:

- It is considered as the Earth's largest living crocodile species. The **estuarine crocodile** is infamous globally as a known **man-eater.**
- **Protection Status:**
  - **IUCN: Least Concern**
  - **CITES: Appendix I** (except the populations of Australia, Indonesia and Papua New Guinea, which are included in Appendix II).
  - **Wildlife Protection Act, 1972: Schedule I**
  - **Habitat:** It is found in Odisha's **Bhitarkanika National Park**, the **Sundarbans** in West Bengal and the Andamans and Nicobar Islands. It is also found across Southeast Asia and northern Australia.

PROJECT CROCODILE

Gharial

- **Gharials**, sometimes called gavials, are a type of Asian crocodilian. The population of Gharials are a good indicator of clean river water. The gharial is known to be a relatively harmless.
- **Protection Status:**
  - **IUCN: Critically Endangered**
  - **CITES: Appendix I**
  - **Wildlife Protection Act, 1972: Schedule I**
  - **Habitat:** The gharials are mostly found in fresh waters of the himalayan rivers. **chambal river** in the northern slopes of the Vindhya mountains (Madhya Pradesh) is known as the primary habitat of gharials. Other Himalayan rivers like Ghagra, Gandak river, Girwa river, Ramganga river and the Sone river are secondary habitats for gharials.

PROJECT HANGUL (KASHMIR STAG)

- Launched in 1970s by Govt. of Jammu, IUCN and WWF.
- **IUCN status**: Critically Endangered.
- **Habitat**: It is found in dense riverine forests in the high valleys & mountains of the Kashmir and northern Chamba district in Himachal Pradesh.
- Hangul being granted protection status under **Schedule I of the Wildlife (Protection) Act, 1972**.
- Hangul is a **state animal of Jammu and Kashmir.**

PROJECT HANGUL (KASHMIR STAG)

- In Kashmir, it's found in the Dachigam National Park, Rajparian Wildlife Sanctuary, Overa Aru, Sind Valley, Kishtwar & Bhaderwah.
- **Wildlife Conservation Fund**: founded in 2010 to save the wildlife and Wilderness in Jammu and Kashmir. Hangul Conservation Project was launched by Wildlife Conservation Fund. WCF aims at resolving issues related to various species of Hangul in Kashmir, particularly in the Dachigam National Park.

PROJECT HANGUL (KASHMIR STAG)

- Hangul is the **only surviving species of the Asiatic member of the red deer family**. Hangul society is matriarchal & only male member has antlers.

CONSERVATION BREEDING PROGRAMME

- This involves the **captive propagation of endangered species.**
- **Aim**: To help maintain genetic diversity, produce viable individuals to mitigate species' extinction.
- Important ongoing Conservation Breeding Programme in India:

CONSERVATION BREEDING PROGRAMME

Name of the Species	Name of the Zoo
Red panda & Snow leopard	Padmaja Naidu Himalayan Zoological Park, Darjeeling
Hoolock gibbon	Biological Park, Itanagar
Clouded leopard	Sepahijala Zoological Park, Agartala
Indian pangolin	Nandankanan Biological Park, Bhubaneswa
Lion-tailed macaque	Ariganr Anna Zoological Park, Chennai
Grey jungle fow	Sri Venkateswara Zoological Park, Tirupati
Dolphin	Vikramshila Gangetic Dolphin Sanctuary, Bhagalpur.
Crocodile	Madras Crocodile Bank, Chennai

DOLPHIN CONSERVATION

- PM announced the government's plan to launch a Project Dolphin in his Independence Day Speech (15th August 2020).
- **Conservation Status**:
  - **IUCN status**: Endangered
  - **WPA 1972**: Schedule-I
  - **CITES**: Appendix I
  - **Convention on Migratory Species (CMS):** Appendix II
- **Ganges River Dolphins can only live in freshwater**, are **blind** and catch their prey using **ultrasonic sound** waves. It makes **sound while breathing** called the **Su-Su**.

DOLPHIN CONSERVATION

The Other Three Freshwater Dolphins:

1. **Bhulan (Indus River Dolphin): National Mammal** of **Pakistan** and State aquatic animal of **Punjab**, India.
2. **Baiji:** now functionally **extinct** from the **Yangtze river** in China
3. **Boto:** Amazon River in Latin America.

DOLPHIN CONSERVATION

- It is a reliable **indicator of the health of the entire river ecosystem**.
- It was recognised as the **National Aquatic Animal in 2009**, by the Government of India.
- **Habitat**: found mainly in the Indian subcontinent, particularly in Ganga-Brahmaputra-Meghna and Karnaphuli-Sangu river systems. It is also found in the Ganga's tributaries.

DOLPHIN CONSERVATION

- **Need for conservation**: They once lived in the Ganges-Brahmaputra-Meghna & Karnaphuli-Sangu river systems of **Nepal, India, and Bangladesh**, but are now mostly extinct from many of its early distribution ranges.
- **In India they are distributes across 7 states**: Assam, Uttar Pradesh, Madhya Pradesh, Rajasthan, Bihar, Jharkhand and West Bengal.
- **Vikramshila Ganges Dolphin Sanctuary** was established in Bihar under WPA, 1972.

SOUTH ASIA WILDLIFE ENFORCEMENT NETWORK (SAWEN)

- Launched in **2011** in Paro Bhutan; **Secretariat**: Kathmandu, Nepal.
- SAWEN is an inter-government wildlife law enforcement support body of South Asian countries.
- **Objective**: to promote & co-ordinate regional co-operation for **curbing illegal wildlife trade** in wild flora and fauna of South Asia.
- **Member countries**: Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka.
- **Wildlife Crime Control Bureau** is the nodal point for SAWEN in India.


THANK YOU