



Compilation of Daily Class Notes

Environment and Ecology



ONLYIAS
BY PHYSICS WALLAH





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DAILY CLASS NOTES

Environment and Ecology

Lecture - 01

Introduction to Environment and Ecology



Introduction to Environment and Ecology

Importance of Environment and Ecology in UPSC

- ❖ **Number of questions in Prelims:** 20 (average)
- ❖ **Number of questions in Mains (GS Paper III):** 5 (average)

Topics to be covered:

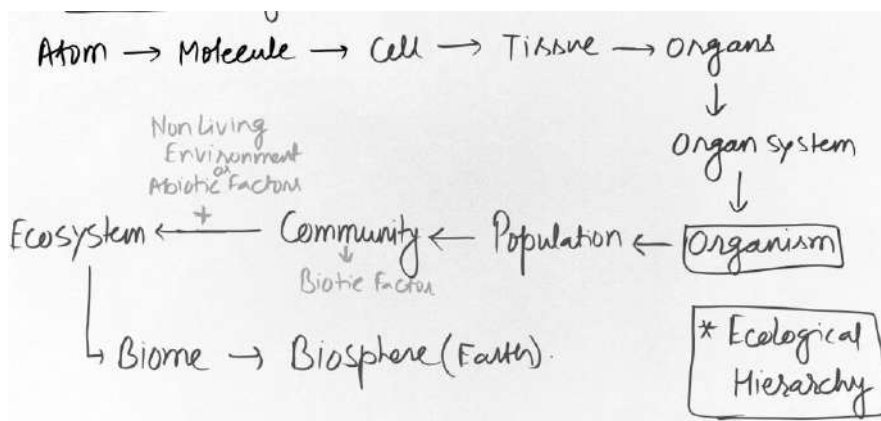
- ❖ Basic Concepts of Ecology
- ❖ Basic Concepts of Environment
- ❖ Biodiversity and its Conservation
- ❖ Environmental Degradation
- ❖ Pollution
- ❖ Climate Change
- ❖ Sustainable Development
- ❖ Environmental Impact Assessment
- ❖ Acts, Policies, and Institutions

Ecology:

- ❖ The term **Ecology** was first used in **1969** by **Ernst Hackel**, and it has been derived from 'oikos' meaning 'home' and 'logos' meaning 'study'.
- ❖ Ecology is the **study of the relationship of living organisms** with each other and the environment.
- ❖ It can be classified into two parts:
 - **Autecology:** Also known as **Population Ecology**, it is the **study of the relationship of single species with the environment**.
 - **Synecology:** Also known as **Community Ecology**, it is the **study of the relationship between multiple species with the environment**.

Levels of Organization:

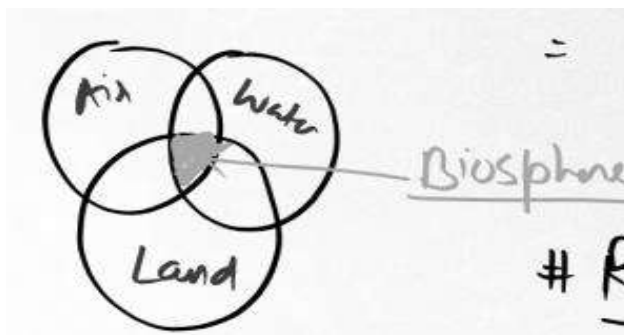
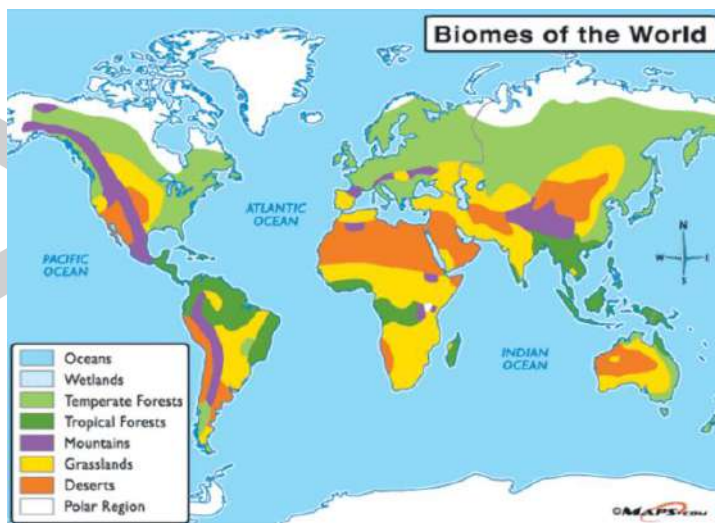
- ❖ **Atoms to molecules to cells:** Atoms combine to form molecules which further combine to form a cell.
- ❖ **Cells to tissues to Organs:** Different types of cells combine to form tissues which combine to form organs.



- ❖ **Organs to Organ System:** Many organs put together form an organ system.
- ❖ **Organ System to Organisms to Population:** An organ system forms an organism, and many organisms are put together to form a population.
- ❖ **Population to Community:** Many populations are put together to form a community.
- ❖ **Community to Ecosystem:** Community is a biotic factor. If we add abiotic factors or a non-living environment to a community, an ecosystem is formed.
- ❖ **Ecosystem to Biomes to Biosphere:** Many ecosystems form a Biome, and many biomes form the Biosphere which is the Earth.
- ❖ **Atoms to Molecules** is a **Chemical Organization**.
- ❖ **Cell to Organism** is a **Biological Organization**.
- ❖ **Organism to Biosphere** is **Ecological Organization** or **Ecological Hierarchy**.

Basic Terminologies in Environment and Ecology

- ❖ **Organisms:** They are the individual members of a species and the basic unit of study in Ecology.
- ❖ **Population:** It is a group of organisms belonging to the same species. The members of a species can interbreed and reproduce viable offspring.
- ❖ **Community:** Different populations living together in a defined area are called a Community. It is the biotic component of an ecosystem.
- ❖ **Ecosystem:** An ecosystem is a community of living organisms associated with non-living components of their environment. It is the biological community in combination with the physical environment. It is structural and the functional unit of the Biosphere (Earth).
- ❖ **Biome:** It is a region or an area or the landscape of the Biosphere, divided on the basis of climatic conditions and vegetation.



- ❖ **Biosphere:** It is the part of the Earth where life can exist. The range of the Biosphere is sea surface to 8 Km in the atmosphere. It is a highly integrated zone where the atmosphere (air), hydrosphere (water), and lithosphere (land) exist.
- ❖ **Environment:** It is the surrounding area around a species.
- ❖ **Habitat:** It is the physical place where a species lives.
- ❖ **Niche:** It is the functional role played by a species in the ecosystem.

Habitat	Niche
❖ It is a physical place or an area where a species lives, grows, and thrives.	❖ It is the functional role played by a species or an organism in the ecosystem.
❖ Many species can occupy one habitat.	❖ It supports only single species.
❖ It is a nutrient-providing area for many species. Examples of Habitat: Crop Fields, Ponds, Grassland, etc.	❖ It is the role and position of a species.



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CLASS NOTES

ENVIRONMENT AND ECOLOGY

Lecture – 02

Concepts of Ecosystem



Concepts of Ecosystem

Environment:

- ❖ It is derived from the French word ‘**Envoroner**’ which means **surrounding or encircling**.

Components of the environment:

- ❖ **Biotic:** It includes **plants, animals, and microorganisms**.
- ❖ **Abiotic:** It includes **Temperature, humidity, wind, water, landscape, sunlight, and soil**.
- ❖ **Energy:** It has **solar energy and chemical energy**.

Types of the environment:

- ❖ **Physical environment:** It includes **the lithosphere, hydrosphere, and atmosphere**.
- ❖ **Biological environment:** It includes **plants, animals, microbes, and the biosphere**.
- ❖ **Cultural environment:** It deals with the **economic and social environment**.

Importance of environment:

- ❖ **Basic of life:** It is the basis of life, and provides air, water, and food.
- ❖ **Provide shelter:** It provides shelter like a home or living place.
- ❖ **Provide resources:** It provides resources like medicines, firewood, energy, and clothes.
- ❖ **Acts as a Cleansing Action:** It acts as a cleansing action that cleans the surroundings. It happens by decomposition by microbes.

Environmental problem:

- ❖ **Environmental degradation:** It includes global warming, ozone depletion etc.
- ❖ **Environmental pollution:** It includes **air pollution, water pollution, soil pollution, sound pollution, light pollution, and radioactive pollution**.

Environmental adaptation:

- ❖ It can be categorized into:
 - Structural adaptation
 - Physiological adaptation
 - Behavioral adaptation

Structural adaptation:

- ❖ It refers to the **changes in the structure of a living organism** that enables it to adapt better to its environment.
- ❖ **For examples:**
 - **African elephants** are bigger with big ears for heat management.
 - **Black, brown, and white bears** in different altitudes blend with the particular environment for hunting and survival.
 - **Aquatic mammals** have flippers like seals and whales adapt to the environment.

(Notes: African Elephant is bigger in size as compared to Asia Elephant and it also has bigger ears as compared to African Elephant. This is because more temperature in Africa gives elephants a bigger surface area to dissipate heat in the environment.)

Physiological adaptation:

- ❖ It is an **internal body process to regulate and maintain homeostasis for an organism** to survive in the environment in which it exists.
- ❖ **For example:**
 - **Efficient kidney in a desert environment** is a type of this adaptation.
 - **Anti-blood clotting chemical called Hirudin in Leech** is an example of physiological adaptation.

Behavioral adaptation:

- ❖ It refers to a **behavior that an animal has developed or changed over time** in order to increase its chances of survival.
- ❖ **For example:**
 - **Migration** is the best example of behavioral adaptation.
 - **Hibernation** is another example. It is called winter sleep.
 - **Aestivation** is also called summer sleep.

(Note: Polar Bear is a luxuriant animal that keeps on eating delicious food till summer and for the next 6 months during the winter it completely sleeps with food in its body. This is called hibernation.)

Environmental adaptation in plants:

- ❖ **Tundra Vegetation:** Lichens, mosses, and grasses are found in this vegetation.
- ❖ **Taiga Vegetation:** Conifers are found in this vegetation.
- ❖ **Rainforest Vegetation:** In the rainforest, there are dense forests with big trees.
- ❖ **Desert Vegetation:** In the desert, cactus are found.
- ❖ **Mangroves:** They are Structural adaptations and these marshy areas have pneumatic roots. These are called air roots.
 - **Pneumatic roots** are such roots that come out of the soil so that the root can have air.

Ecosystem:

- ❖ A community of **living organisms in conjugation with non-living components of their environment interacting as a system**. It is nothing but a biological community in association with non-living components of the environment.

Concept of the ecosystem:

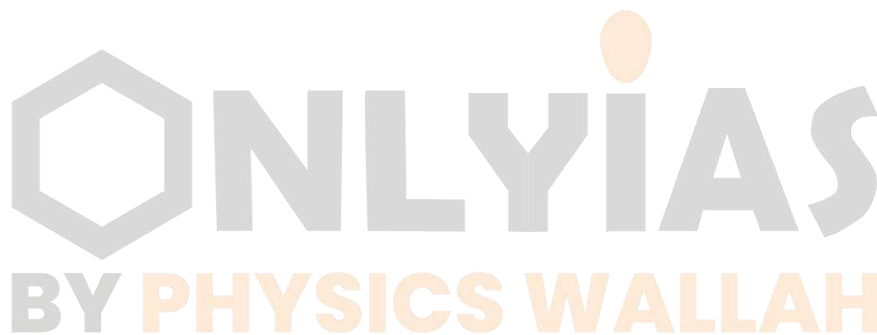
- ❖ There are two parts of the ecosystem:
- ❖ Biotic or biological community
- ❖ Abiotic or physical community

Components of an ecosystem:

❖ Biotic components:

- Producers are called **autotrophs**, such as **Plants**.
- Consumers do not produce food. These are called **heterotrophs**.
- **Decomposers** like bacteria and fungi decompose the environment. These are called **Saprotrophs**.

❖ Abiotic components: These include light, wind, water, atmospheric gasses, temperature, soil, and physiography (Landscape).



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CLASS NOTES

ENVIRONMENT AND ECOLOGY

Lecture – 03

Concepts of Ecosystem (Part-2)



Concepts of Ecosystem (Part-2)

Biotic component of an ecosystem:

Producer:

- ❖ They prepare food through the **process of photosynthesis**.
- ❖ They convert simple **inorganic substances into complex organic substances**.
- ❖ **Green vegetation is an example of the producer.**

Consumers:

- ❖ They eat food that is a **complex organic substance**.
- ❖ Consumers **can be herbivores, carnivores and omnivores**.

Decomposers:

- ❖ They convert complex **organic substances into simple inorganic substances**.
- ❖ This is also known as **the recycling of nutrients**.
- ❖ These are called **Saprotrophs or Detritivores**.

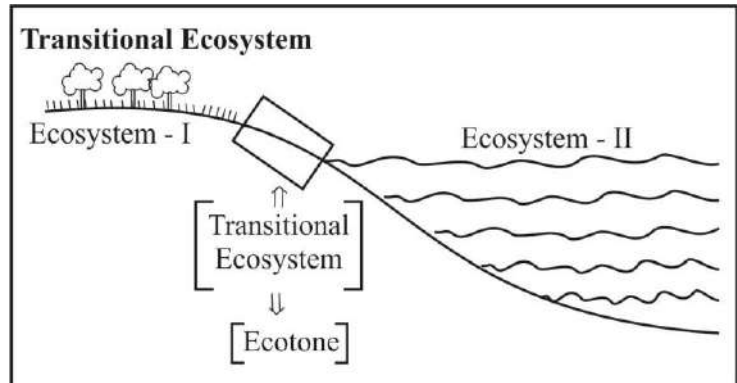
Types of ecosystem:

It is categorized into 3 types of ecosystem:

- ❖ **Terrestrial ecosystem:** It is a land-based community of organisms and the interactions of biotic and abiotic components in a given area.
 - **Major terrestrial ecosystems are:**
 - ✓ Tundra in the Arctic and Alpine region
 - ✓ Conifer forest
 - ✓ Temperate deciduous forest
 - ✓ Temperate grassland
 - ✓ Tropical grassland
 - ✓ Desert
 - ✓ Chaparral
- ❖ **Aquatic ecosystem:** It is an ecosystem found in and around a body of water. Aquatic ecosystems contain communities of organisms, that are dependent on each other and on their environment.
 - **It is divided into two:**
 - ✓ Marine Ecosystems
 - ✓ Freshwater ecosystems.
- ❖ **Marine ecosystem:** These are aquatic environments with high levels of dissolved salt.
 - **Types of Marine Ecosystems:**
 - ✓ Open ocean (Plagic)
 - ✓ Continental shelf

✓ Deep sea (Hydrothermal vent)

- ❖ **Freshwater ecosystem:** They are a subset of Earth's aquatic ecosystems. They include lakes, ponds, rivers, streams, springs, bogs, and wetlands.
 - Steady water (Lentic)
 - Running water (Lotic)
- ❖ **Transitional ecosystem:** These are complex human–environmental systems where environmental, economic, and social issues call for new integrated management perspectives. It includes Wetlands, Estuaries, Mangroves



Ecotone:

- ❖ A transitional ecosystem or **transitional zone between two adjacent ecosystems or biomes is known as an ecotone.**
- ❖ An ecotone is an area that **acts as a transition or a boundary between two or more ecosystems.**
- ❖ **Examples of ecotones are**
 - areas of marshland **between the river and river biome,**
 - mangrove forest **between terrestrial and marine ecosystems,**
 - thorny grassland **between forest and desert ecosystems,**
 - estuaries **between saltwater and freshwater.**

Characteristics of ecotone:

- ❖ It can be a **natural or man-made ecosystem.** (agro forest, man-made pond bank)
- ❖ It can be **wide or narrow.**
- ❖ It has intermediate conditions in the **adjacent ecosystem and is known as the zone of tension.**
- ❖ Some **new species** can be present in the ecotone.
- ❖ A greater number of series are found in this region (**Edge effect**). The total number of species and animals in the ecotone or transitional area is always higher than in the other area.
- ❖ Species found in ecotone are known as **edge species.**

Importance of ecotone:

- ❖ **Greater diversity of organisms** or species is found here.
- ❖ **A nesting place for birds:** It provides a good nesting place for birds and various other organisms.
- ❖ **Act as a Buffer Zone:** It acts as a buffer zone and protects the adjacent ecosystem from possible damage.
Example: wetland absorbs pollutants and stops them from getting into rivers.
- ❖ **Sensitive indicator of climate change** because of shifting of boundaries between ecosystems or due to climate change.

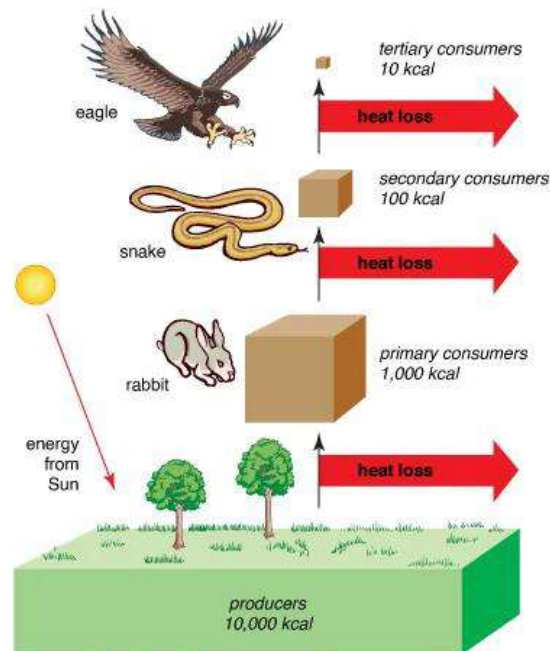
Functions of an ecosystem:

- ❖ **Ecosystems are open systems:** Transfer of energy and cycling of nutrients takes place in the open system.
- ❖ **Energy flow**
- ❖ It maintains the **Nutrient cycle (Biogeochemical cycle)**.
- ❖ **Ecological succession (Development of ecosystem)**

Energy flow:

- ❖ It is a basic force responsible for all metabolic activities (Life activities).
- ❖ The **Sun is the primary source of energy**.
- ❖ **Energy flow is unidirectional** and it is always from the **producer to the consumer to the decomposer**. For example, **grass is being eaten by grasshoppers** and grasshoppers are being eaten by **Frogs** which are eaten by **Snakes** and finally snakes are eaten by **Eagles**. These steps of the food chain are known as the **trophic level or relative position of the food chain or food web**.
- ❖ Energy flows through **trophic levels in the ecosystem**.

Energy flow and trophic levels



Food chain:

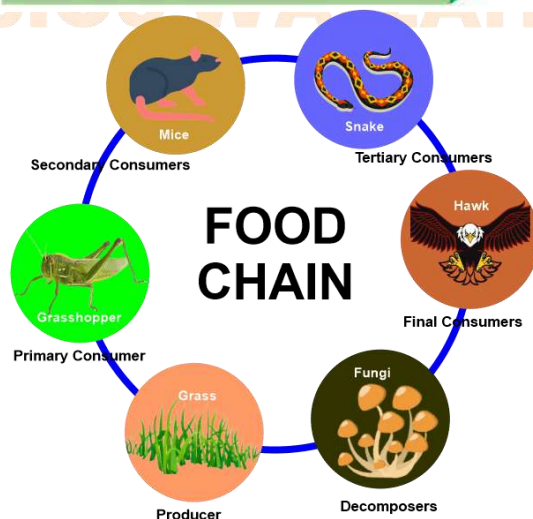
- ❖ It is the **sequence of eating and being eaten**.
- ❖ A **linear sequence of organisms** where nutrients and energy are transferred from one organism to the other.

Types of the food chain:

- ❖ **Grazing food chain:** It starts with plants.
- ❖ **The Detritus food chain:** It starts from **decaying matter (Dead organic matter)**. Example: Litter is being eaten by earthworms which are eaten by birds which in turn are eaten by Hawks.

Food web:

- ❖ An **interconnected food chain** is called a food web.
- ❖ **Importance of food web:**
 - More than one alternative for food is available.
 - It will increase the **chance of survival**.
 - It will **bring more diversity**.
 - It brings more **productivity due to many choices**.



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CLASS NOTES

ENVIRONMENT AND ECOLOGY

Lecture – 04

Concepts of Ecosystem (Part-3)



Concepts of Ecosystem (Part-3)

Energy flow:

Law of 10% energy:

- ❖ It was **given by Lindeman**.
- ❖ **The law says, only 10% of the energy is transferred** from one trophic level to the next in a food chain.
- ❖ **Rest 90% of the energy is utilized for respiration and other metabolic activities or it is released as heat.**
- ❖ **That's why trophic levels are limited up to 4-5 steps.**

Ecological pyramids: (Eltonian Pyramid)

- ❖ It is a graphical **representation of the ecosystem**.
- ❖ It can be of three types:
 - **Energy pyramid**
 - **Biomass pyramid**
 - **Number pyramid**

Energy pyramid:

- ❖ This pyramid is **always upright**.
- ❖ Bottom trophic level is producers and the top trophic levels are consumers.

Biomass pyramid:

- ❖ It will be **both upright and inverted** in nature.
- ❖ It will be **upright in the terrestrial ecosystem and inverted in the aquatic ecosystem**.

Number pyramid:

- ❖ This pyramid is **always upright except in tree ecosystem**
- ❖ In the **tree ecosystem this pyramid is inverted**.

Pollutants in Trophic level:

- ❖ Pollutants move through various trophic levels in the ecosystem because of **two main processes**.
- ❖ These two processes are known as:
 - **Bioaccumulation**
 - **Biomagnification**.
- ❖ **Bioaccumulation:** Bioaccumulation takes place **in a single trophic level or particular organism**. Here pollutants are **deposited in a single organism over time**. In bioaccumulation, accumulation of pollutant chemicals takes place from the environment.
- ❖ **Biomagnification:** Biomagnification occurs **across the trophic level** or in the entire food chain. Bioaccumulation in one organism leads to biomagnification in the food chain. Pollutants or chemical concentration will increase along the trophic level of the food chain.

Bioconcentration:

- ❖ It is an accumulation of **water-born chemicals** in organisms.

Biotic Interaction:

- ❖ It is the **interaction of different organisms in the community influencing each other.**
- ❖ **Types of Biotic Interaction:**
 - **Amensalism:** This is a negative association between two species in which **one species harms** or restricts the other species **without itself being adversely affected** or harmed by the presence of the other species. **For Example:** A small plant growing under a big tree, penicillium and bacteria.
 - **Commensalism:** In this relationship, **one of the species benefits while the other is neither harmed nor benefited.** **For Example:** Sucker fish attached to shark body, Cow dung and dung beetle.
 - **Neutralism:** Two in the association are **neither benefited or harmed from each other.** **For Example:** Rabbit and Deer living together.
 - **Mutualism:** This is a close association between two species in which **both species benefit.** **For Example:** Lichen (Algae and Fungi).
 - **Competition:** This is an interaction between two populations in which **both species are harmed** to some extent.
 - **Parasitism:** In this type of interaction, **one species is harmed, and the other benefits.**

Productivity of the Ecosystem:

- ❖ It is the **rate of formation of biomass (Dry mass without water)** or the rate at which **Biomass increases per unit area per unit of time** or the **rate at which energy is accumulated by Green plants in the form of organic substance (Biomass or chemical energy).**
- ❖ The unit of productivity of the ecosystem is **Kcal/ m²/year.**





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ENVIRONMENT AND ECOLOGY

Lecture – 05

**Productivity of ecosystem,
Ecological succession**



Productivity of ecosystem, Ecological succession

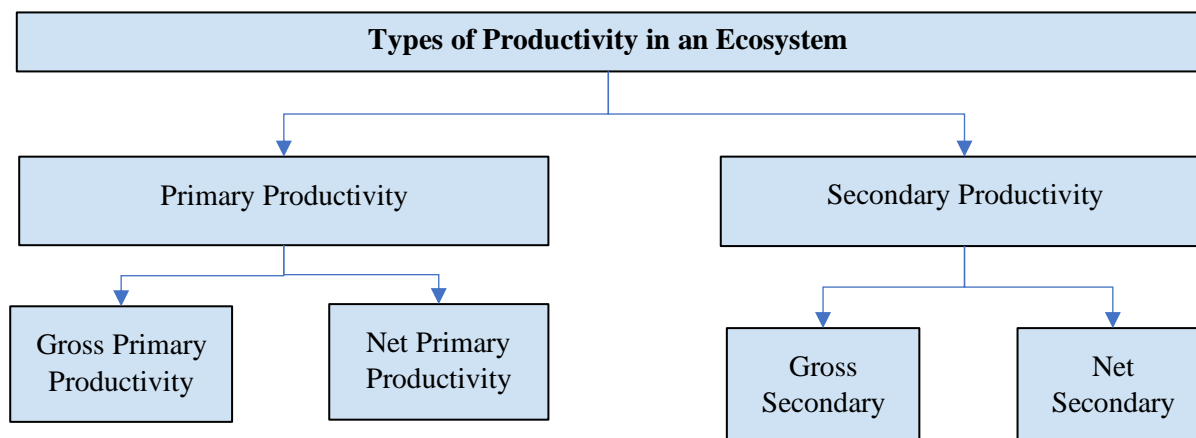
Productivity of the Ecosystem:

- ❖ It is the **rate of formation of biomass (Dry mass)** or the rate at which Biomass increases per unit area per unit of time or the rate at which energy is accumulated by Green plants in the form of organic substance (Biomass or chemical energy).
- ❖ The unit of productivity of the ecosystem is **Kcal/ m²/year**

Types of Productivity of Ecosystem

Primary Productivity

- ❖ It is in the productivity of **autotrophs or producers or green plants or the first trophic level**.
- ❖ It is an **outcome of photosynthesis** in an ecosystem.
- ❖ **Carbon dioxide (CO₂) and a water molecule (H₂O)** in the presence of sunlight form a **complex energy-rich molecule**, which is known as **Glucose (C₆H₁₂O₂)**.



Gross Primary Productivity (GPP):

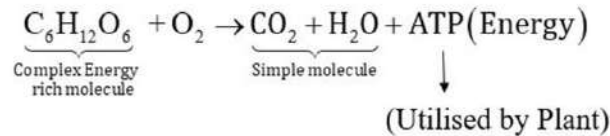
- ❖ **Gross primary production:** It refers to the total amount of solar energy fixed into organic matter by primary producers through photosynthesis.
- ❖ **Gross Primary Productivity:** The total energy accumulated in the plant during primary productivity is known as Gross Primary Productivity.
- ❖ A **considerable portion of the solar energy fixed by plants (GPP)** is utilized by plants in **respiration (R)** to get the energy needed for their metabolism and other vital functions.
- ❖ **Net Primary Productivity (NPP):** The amount of energy left after being consumed in respiration (R) is used for growth or producing new individuals i.e. reproduction. This is known as **Net Primary Productivity (NPP)**.

$$\text{GPP} - \text{R} = \text{NPP}$$

or

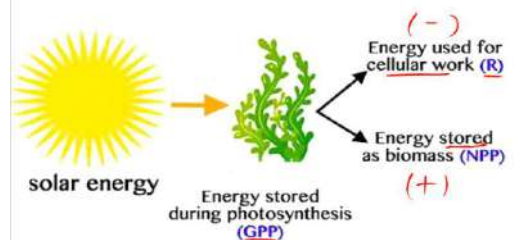
$$\text{GPP} = \text{NPP} + \text{R}$$

R – Respiratory Loss



Net Primary Productivity (NPP)

- ❖ It is the **amount of biomass available for herbivores or primary consumers or secondary trophic levels.**
- ❖ It is **energy or biomass stored in producers or plants.**
- ❖ The energy remaining after **respiration** is stored as **organic matter** and is called **net primary productivity (NPP).**
- ❖ The amount of biomass or organic matter accumulated by plants per unit area in a given period is called **Net primary production.**
- ❖ The overall relationship between GPP and NPP can be written as: **$\text{NPP} = \text{GPP} - \text{R}$** , where **R** is the energy used up in respiration, and GPP is the gross primary productivity.



$$\text{NPP} = \text{GPP} - \text{R}$$

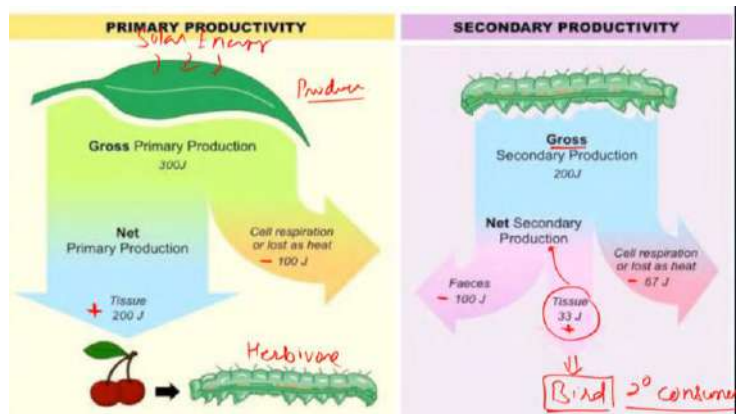
net primary productivity gross primary productivity respiration

Secondary Productivity of Ecosystem:

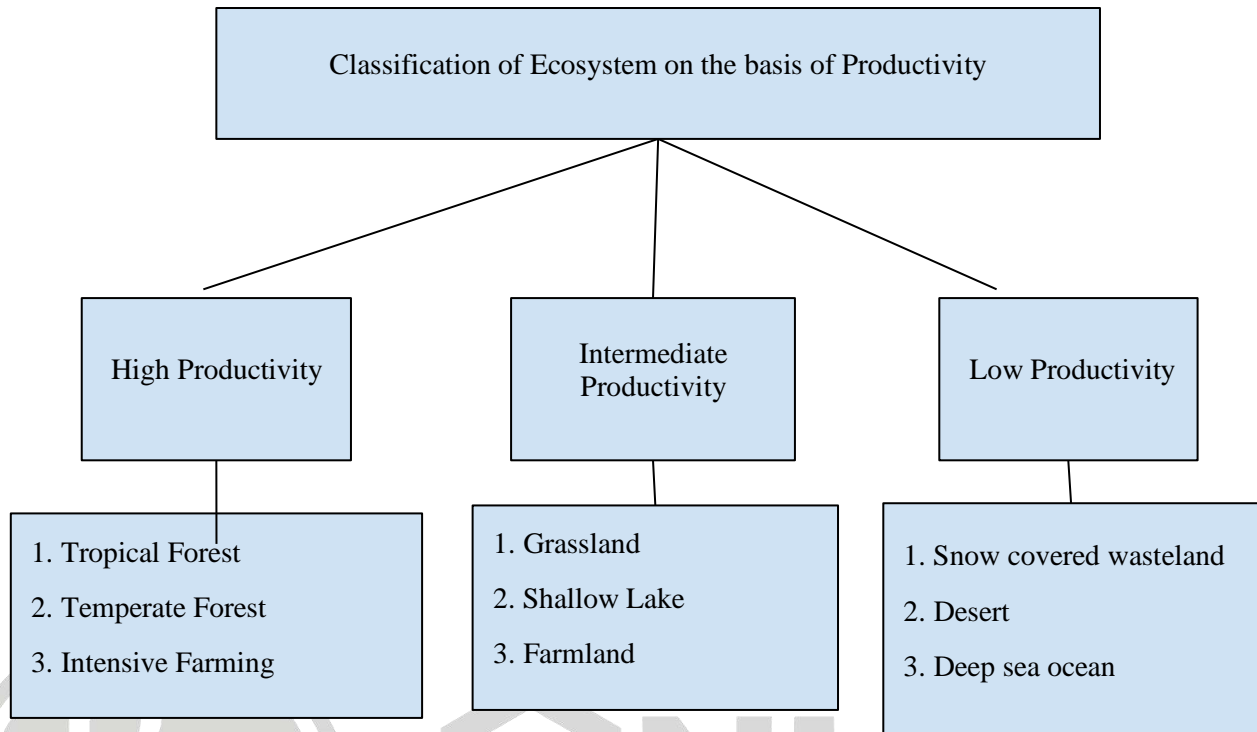
- ❖ This applies to **consumers of the ecosystem (food chain).**
- ❖ **Secondary Production:** The production of biomass, growth, or addition of new individuals is referred to as secondary production.
- ❖ Secondary productivity is the **rate of formation of new organic matter by heterotrophs.**
- ❖ The **amount of energy stored in tissues of primary consumers** and available to carnivores.
- ❖ The rate of biomass production by consumers in an ecosystem.

Factors Affecting the Productivity of the Ecosystem:

- ❖ Sunlight (the most important factor).
- ❖ Water
- ❖ Carbon dioxide
- ❖ Mineral nutrition
- ❖ Temperature
- ❖ Biotic activities like grazing, predation, parasitism, etc.
- ❖ Impact on the human population.



Classification of Ecosystem on the Basis of Productivity:



Ecological Successions or Biotic Successions:

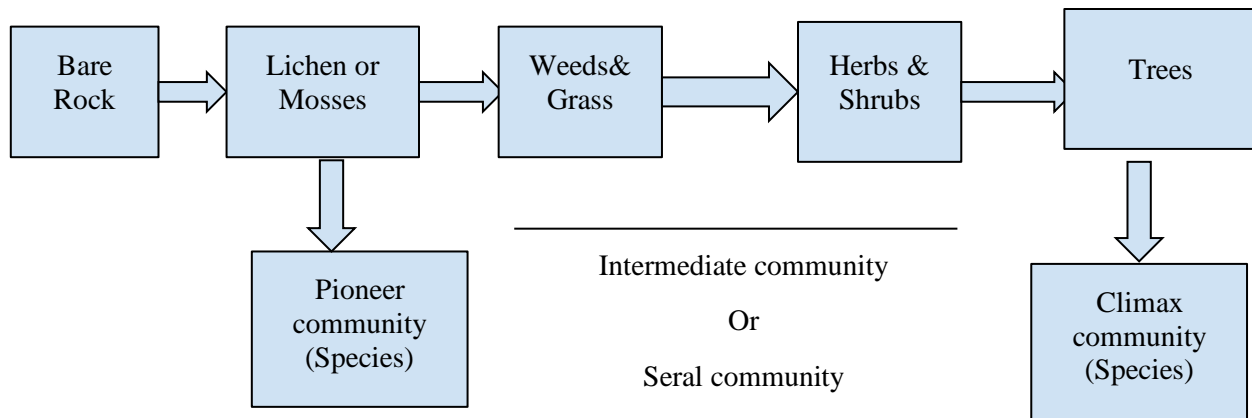


- ❖ The process by which **communities of plant and animal species in an area are replaced or changed into another community of plant or animal species over a period of time** is known as **ecological succession**.

OR

- ❖ It is the ecosystem's development process **through a series of directional changes**.
- ❖ It occurs when a **series of communities replace one another due to large-scale destruction** either natural or man-made.

- ❖ Ecological succession is a **multi-step process**.
- ❖ **Examples:**



Process of Ecological Successions:

- ❖ It is a **multi-step process**.
- ❖ It is a **unidirectional process**.
- ❖

- ❖ **Primary community** \Rightarrow **Intermediate community** \Rightarrow **Climax community**
 (It brings first life form on the lifeless area.) (It is the stable and most suitable community.)
- ❖ The entire community sequence (at the intermediate level) is called **Sere**.

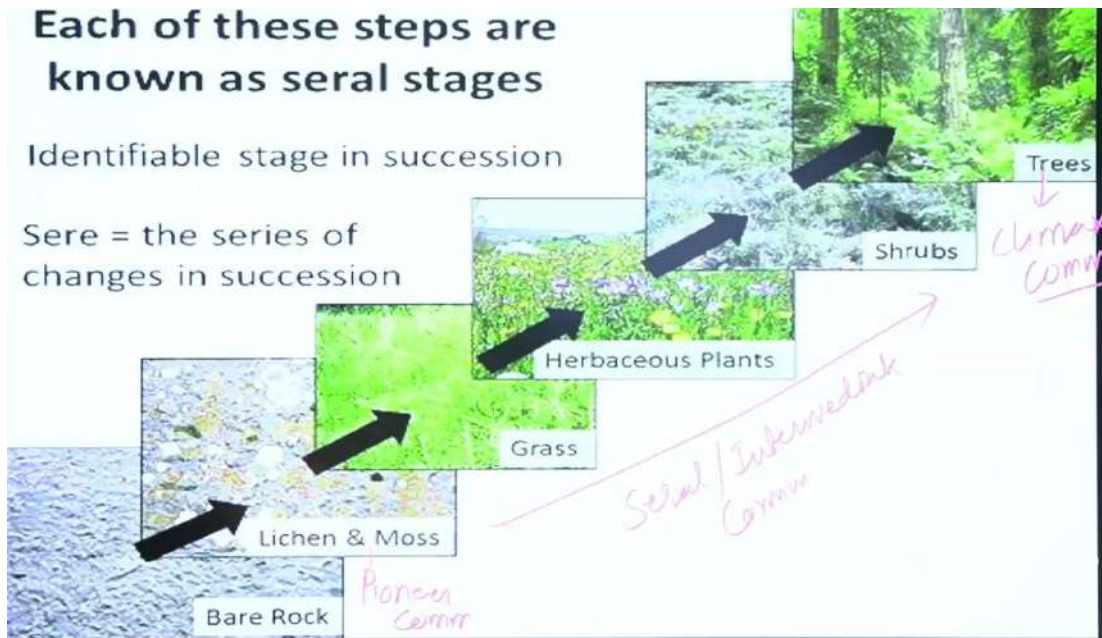
Types of Sere:

Name of Sere	Area of succession
Hydrosere	Aquatic areas
Xerosere	Dry areas
Lithosere	Bare rock
Psammosere	Sandy areas
Halosere	Saline areas

Each of these steps are known as seral stages

Identifiable stage in succession

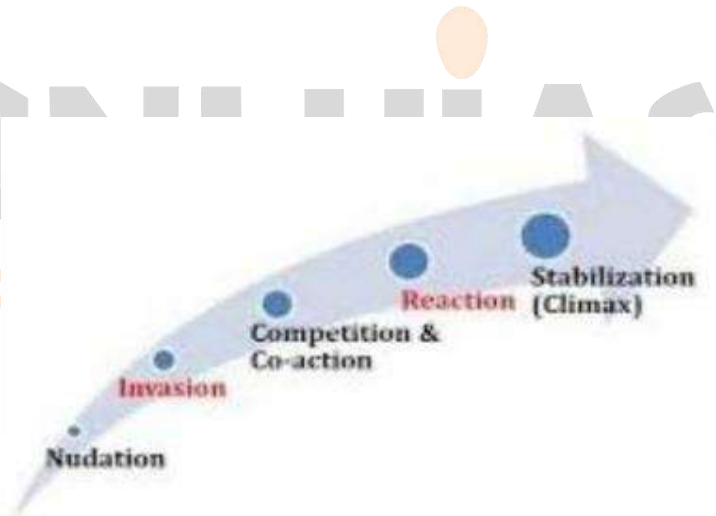
Sere = the series of changes in succession



Stages of Ecological Succession:

There are five stages of Ecological Succession:

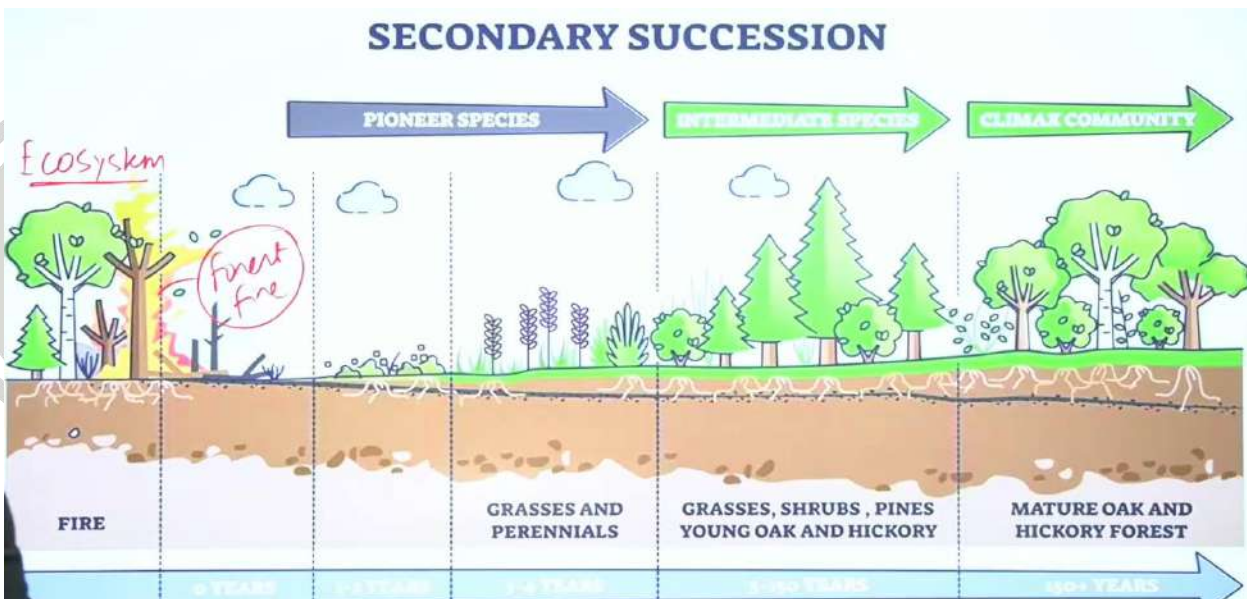
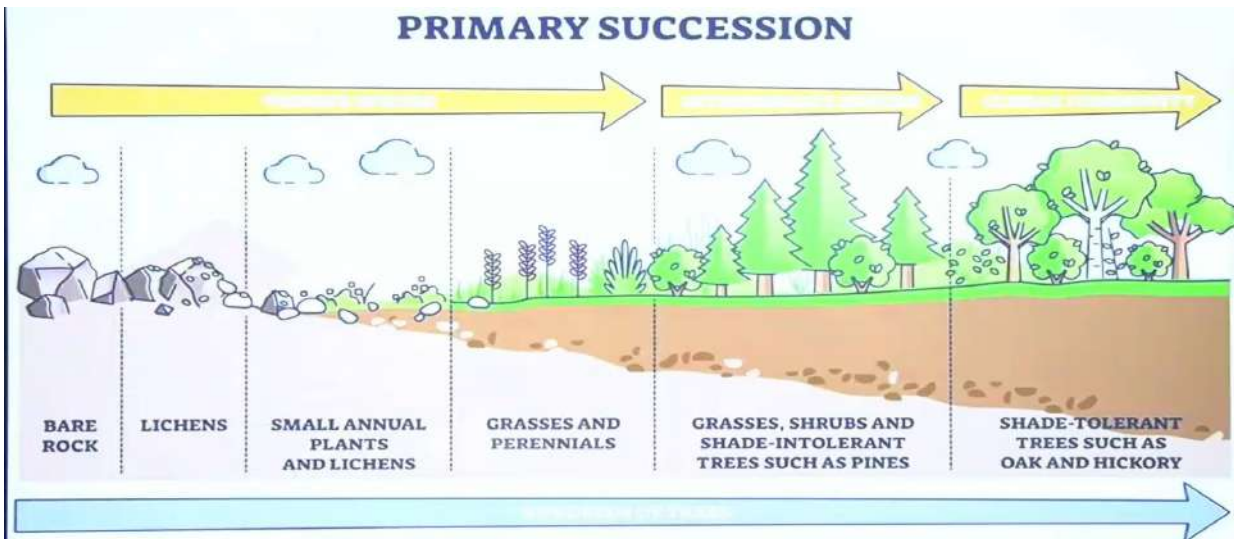
1. **Nudation:** Formation of the **nude or bare area** by flooding, erosion, landslide, volcano, etc.
2. **Invasion:** Arrival of different species.
3. **Competition:** Growth of species in limited areas resulting in competition for food and space.
4. **Reactions:** Modification of the environment due to the influence of organisms such as changes in soil structure, pH, temperature, etc.
5. **Stabilization:** It means the arrival of the final stage or climax community. It maintains the equilibrium of the ecosystem.



Types of Ecological Successions:

- ❖ There are two types of succession
 - (i) Primary succession
 - (ii) Secondary succession

Primary Succession	Secondary Succession
❖ In this, life starts in a lifeless area where the soil is absent.	❖ It occurs when the primary ecosystem gets destroyed .
❖ It is a slower process .	❖ It is faster due to the presence of soil.



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CLASS NOTES

Environment and Ecology

Lecture - 06

Ecological Succession and Biogeochemical Cycle



Ecological Succession and Biogeochemical Cycle

Other types of Ecological Successions:

Autogenic Succession	Allogenic Succession
<ul style="list-style-type: none"> ❖ It is driven by biotic factors or living organisms of the community. ❖ Secondary succession starts with autogenic succession. ❖ Examples: Dead organic material in the soil changes the structure of the soil. 	<ul style="list-style-type: none"> ❖ It is driven by abiotic factors or external factors. ❖ Primary succession begins with allogenic succession and proceeds to autogenic succession. ❖ Examples: Volcanic eruption, flood, etc.

Importance of ecological succession:

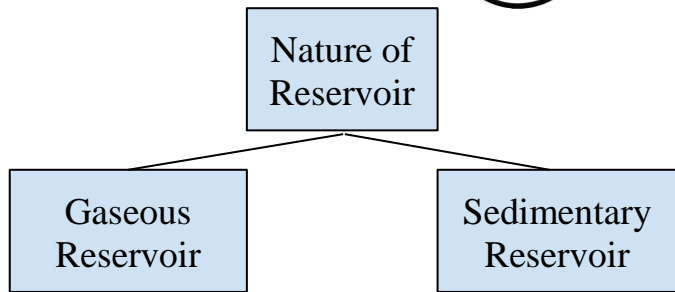
- ❖ **Biodiversity and Species Interactions:**
 - Succession leads to changing species compositions over time.
 - New species colonize and replace existing ones, promoting biodiversity.
 - It supports ecological interactions like predation, competition, and mutualism.
- ❖ **Ecosystem Development and Stability:**
 - Succession leads to the development and maturation of ecosystems.
 - It creates complex and specialized species assemblages.
 - Mature ecosystems are more stable and resilient to disturbances.
- ❖ **Nutrient Cycling and Soil Formation:**
 - Early successional species contribute to soil formation.
 - Nutrient availability and cycling become more efficient over time.
 - It supports the growth of diverse plant species.
- ❖ **Habitat for Wildlife:**
 - Successional changes create varied habitats.
 - Provides niches for diverse animal species.
 - Enhances ecosystem health and wildlife populations.

Biogeochemical Cycle:

- ❖ It is the **movement of nutrients between abiotic and biotic factors of an ecosystem**.
- ❖ In this cycle, **energy flows in a unilateral direction**, and **nutrients flow in a cyclic direction**.

Types of Biogeochemical Cycle:

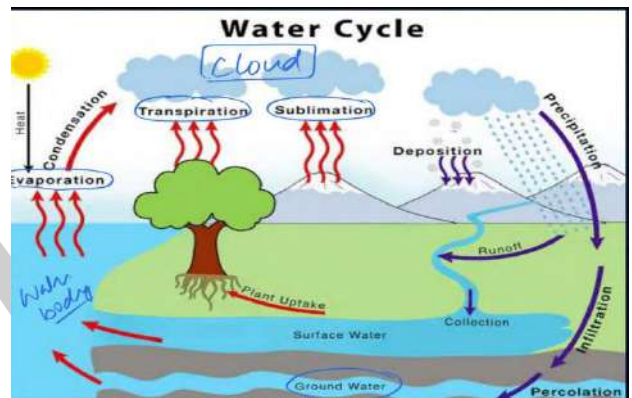
Based on the nature of reservoirs the biogeochemical cycle can be classified into two types:



- ❖ **Gaseous Reservoirs:** Its examples are as follows:
 - Water cycle or Hydrologic cycle
 - Oxygen cycle
 - Carbon cycle
 - Nitrogen (N_2) cycle
- ❖ **Sedimentary Reservoir:** Its examples are as follows:
 - Phosphorus cycle
 - Sulfur cycle

Water Cycle:

- ❖ It is a cycle where water keeps going from one component of an ecosystem to another component in a cyclic manner.

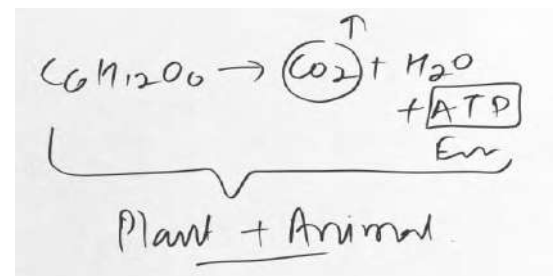


Importance of the Water Cycle:

- ❖ **Freshwater Availability:** The water cycle ensures a continuous supply of fresh water for human use and ecosystem health.
- ❖ **Ecosystem Vitality:** It supports diverse aquatic habitats and maintains water quality essential for various species.
- ❖ **Agriculture and Food Security:** The water cycle is vital for crop irrigation and stable food production.
- ❖ **Climate Regulation:** Evaporation and water vapor influence temperature, weather patterns, and global climate.
- ❖ **Weather Patterns:** The water cycle drives weather phenomena like precipitation, clouds, and storms.
- ❖ **Nutrient Cycling:** It transports nutrients through ecosystems, supporting plant growth and biodiversity.
- ❖ **Hydroelectric Power:** Moving water generates renewable energy through hydroelectric power plants.

Carbon Cycle:

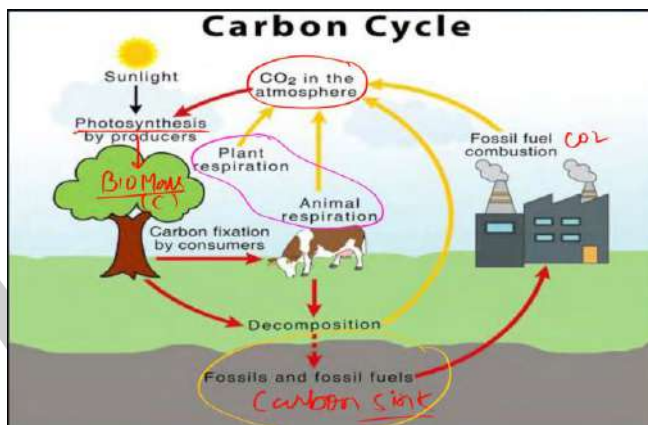
- ❖ It is a **biogeochemical cycle** by which **carbon is exchanged** between the soil, water, and atmosphere (air) of the earth.
- ❖ It is the most important cycle of the Earth and allows for carbon to be recycled by all of its organisms.
- ❖ If the concentration of carbon dioxide increases it leads to the **global warming** phenomena.



- ❖ If the concentration of carbon dioxide decreases it causes a global cooling phenomenon.
- ❖ Carbon is an important molecule of protein, DNA, RNA, lipids, carbohydrates, etc.
- ❖ At the time of the formation of Earth there was a **high concentration of carbon dioxide** and the temperature was also high, at the same time oxygen was absent.
- ❖ Due to photosynthesis the present **Earth witnessed a decrease in the concentration of carbon dioxide** and an increase in the concentration of oxygen in the atmosphere and temperature has attained its optimum level.

Advantages of the Carbon Cycle

- ❖ **Regulate Climate:** The carbon cycle regulates Earth's climate by controlling the amount of carbon dioxide in the atmosphere, influencing global temperatures and weather patterns.
- ❖ **Forms essential organic molecules:** It forms the basis of organic molecules essential for life, including carbohydrates, proteins, lipids, and nucleic acids, crucial for all living organisms.
- ❖ **Convert Carbon Dioxide into energy:** The carbon cycle drives photosynthesis, allowing plants to convert carbon dioxide into energy-rich compounds, and respiration, releasing energy for growth and maintenance.
- ❖ **Carbon Storage:** It stores carbon in various reservoirs, including forests, oceans, soils, and fossil fuels, helping to balance atmospheric carbon levels.
- ❖ **Soil Fertility:** Carbon cycling in soils enhances fertility by promoting nutrient availability and supporting diverse microbial communities.



Disadvantages of the Carbon Cycle

- ❖ **Influence ocean health:** The carbon cycle affects ocean acidity and marine life, as oceans absorb and release carbon dioxide, influencing the health of aquatic ecosystems.
- ❖ **Fossil Fuel Impact:** The cycle's disruption through fossil fuel burning leads to increased carbon dioxide levels, contributing to global warming and climate change.
- ❖ **Carbon Sequestration:** Natural carbon sinks like forests and wetlands sequester carbon, mitigating the effects of human activities on atmospheric carbon levels.

The concept of different types of carbon, such as **blue, black, brown, and green carbon**, refers to various forms of carbon found in different ecosystems and their roles in carbon sequestration and storage.

Blue Carbon:

- ❖ Blue carbon refers to the **carbon stored in coastal and marine ecosystems**, primarily mangroves, seagrasses, and tidal marshes.
- ❖ These ecosystems are **highly efficient at capturing and storing carbon dioxide** from the atmosphere, mainly in the form of organic matter in their soils.

- ❖ Blue carbon habitats are **vital for mitigating climate change** by sequestering carbon and providing other ecosystem services, such as coastal protection and habitat for marine life.

Black Carbon:

Black carbon, often referred to as "**elemental carbon**," is a type of particulate matter produced from incomplete combustion of fossil fuels, biomass, and other organic materials.

- ❖ It has a **significant impact on air quality** and can contribute to climate change by absorbing sunlight and altering the reflectivity of surfaces.
- ❖ Black carbon can settle on snow and ice, reducing their reflectivity and accelerating melting.

Brown Carbon:

- ❖ Brown carbon is a complex mixture of organic compounds formed through the chemical reactions of **volatile organic compounds (VOCs)** and sunlight.
- ❖ It is often associated with the **color of particulate matter in the atmosphere** and can influence climate by scattering and absorbing sunlight.
- ❖ Brown carbon has been recognized for its role in atmospheric processes and its potential effects on air quality, visibility, and climate.

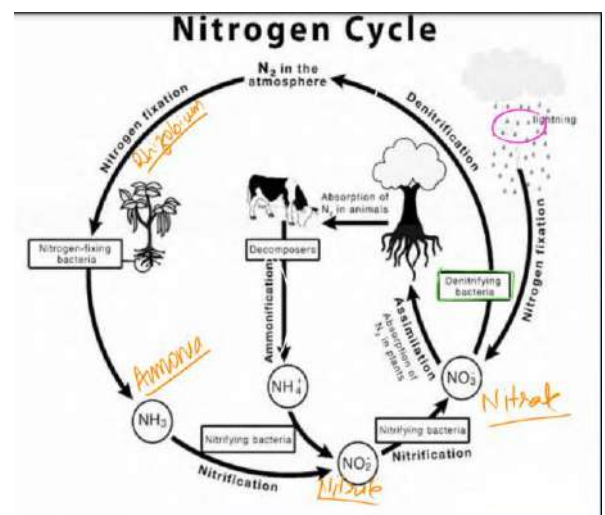
Green Carbon:

- ❖ Green carbon refers to **carbon stored in terrestrial ecosystems**, particularly in vegetation such as forests, grasslands, and wetlands.
- ❖ **Plants capture carbon dioxide from the atmosphere during photosynthesis** and store it as biomass, helping to mitigate climate change.
- ❖ **Conservation and restoration of green carbon ecosystems** are essential for maintaining carbon sinks and preserving biodiversity.

Nitrogen Cycle:

- ❖ Air comprises **78% of nitrogen**.
- ❖ Nitrogen gas has a **nitrogen-nitrogen triple bond**. **Nitrogen is an inert gas**.
- ❖ Nitrogen compound is the base of **DNA, RNA, and Protein (Amino acid)**.
- ❖ Nitrogen cycle is the biogeochemical cycle that describes the transformation of nitrogen and nitrogen-containing compounds in nature.
- ❖ **Atmospheric nitrogen** is the biggest source of nitrogen.
- ❖ Green plants absorb nitrogen in the form of nitrates and nitrites from the soil and water.
- ❖ Animals get nitrogen when they feed on plants.
- ❖ Nitrogen is an **essential component of proteins and nucleic acids in living organisms**.

The Nitrogen Cycle can be Studied in Five Steps:



- ❖ **Nitrogen Fixation:** As we can see in the figure. above, nitrogen can be fixed in two ways:
 - **Lightening during cloud formation:** Nitrogen and oxygen combine with each other to form oxides of nitrogen in the atmosphere by lightning. These nitrogen oxides then dissolve in rainwater and on reaching the earth's surface becomes a part of the soil and water.
 - **Free-living microorganisms:** Microbes like blue-green algae and bacteria fix the atmospheric nitrogen into nitrites and nitrates. These nitrogenous compounds are then released into the soil.
 - **Industrial fixation:** Ammonia is created by industrial processes to convert it into fertilizers. **For example, Urea.**
- ❖ **Nitrogen Assimilation:** Plants absorb nitrogen in the form of nitrates to prepare **amino acids**. This nitrogen is then taken up by the animals in the form of proteins through the food chain.
- ❖ **Ammonification:** The proteins in the body of the animals are broken down into simpler forms like **urea and ammonia**. These are then removed from the body along with urine and excreta. Dead plants and animals also return nitrogen to the soil as **ammonium compounds**. These ammonium compounds are then converted to ammonia by ammonifying bacteria.
- ❖ **Nitrification:** The conversion of ammonia into nitrates is called nitrification. Nitrifying bacteria like **Nitrobacter** and **Nitrosomonas** found in the soil convert ammonia into nitrate. Some other bacteria present in the soil convert ammonia into nitrites. Some of these nitrates and nitrites are again taken up by the plants for their nutrition.

Nitrifying bacteria → Convert Ammonia to Nitrate
(Nitrobacter, Nitrosomonas)

- ❖ **Denitrification:** Denitrifying bacteria like **Pseudomonas** and **Clostridium** living in the soil reduce the soil nitrites and nitrates into nitrogen which is returned back into the atmosphere.

Denitrifying bacteria → Reduce Nitrates and Nitrites to Nitrogen
(Pseudomonas, Clostridium)

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DAILY

CLASS NOTES

ENVIRONMENT AND ECOLOGY

Lecture – 07

Biogeochemical cycle



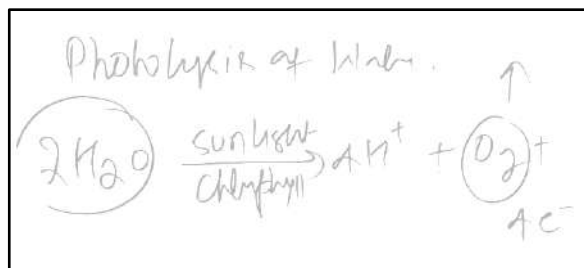
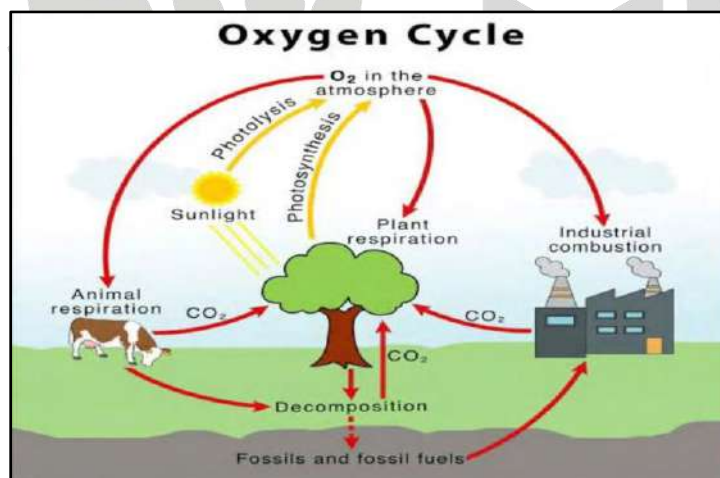
Biogeochemical cycle

Oxygen Cycle:

- ❖ The movement of **Oxygen through the Atmosphere (air), Biosphere (plants and animals), and Lithosphere (the Earth's crust)** is known as **Oxygen Cycle**.
- ❖ **21%** of Oxygen is found in the elemental form in the atmosphere.
- ❖ It also **occurs extensively in the combined form in the Earth's crust** as well as also in the air in the form of carbon dioxide.
- ❖ It is found as the oxides of most metals and Silicon, and also as Carbonate, Sulphate, Nitrate, and other minerals in the earth's crust.
- ❖ It is also an essential component of most biological molecules like **Carbohydrates, Proteins, Nucleic Acids, And Fats (or Lipids)**.

Process of Oxygen Cycle:

- ❖ Oxygen from the atmosphere is used by the processes like **combustion, respiration, and the formation of oxides of nitrogen**.
- ❖ **All aerobic organisms use free oxygen** to respire. However, animals exhale CO_2 back into the atmosphere.
- ❖ **Photosynthesis:** Plants release oxygen into the atmosphere as a by-product of photosynthesis.
- ❖ **Phytoplankton** (floating algae or plants on oceanic water) produce maximum oxygen on the earth.
- ❖ Oxygen gets **decomposed into fossils and fossil fuels**.



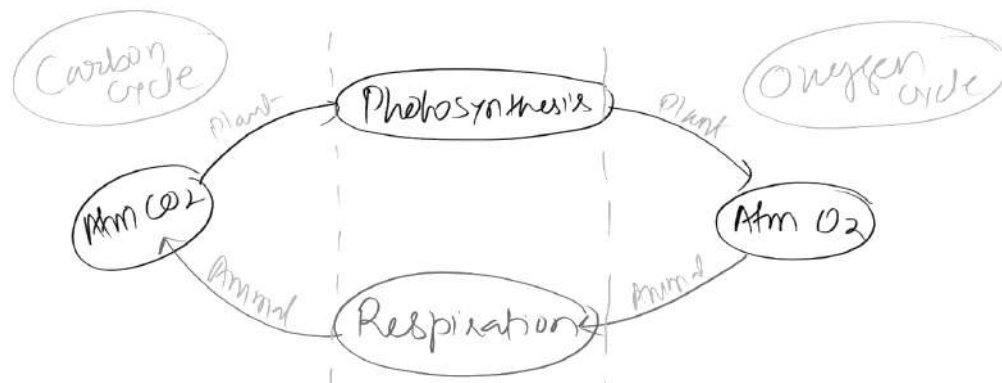
Importance of Oxygen:

- ❖ **Release necessary energy for various cellular activities:** During cellular respiration, oxygen is used by cells to **break down** glucose and other nutrients, **releasing** energy that is necessary for various cellular activities and functions.
 - This process occurs in both plants and animals, highlighting the **central role** of oxygen in sustaining life.

- ❖ **Helps in Combustion:** Oxygen is a key component of combustion reactions, serving as the **oxidizing agent** that facilitates the breakdown of fuel molecules (such as **hydrocarbons**) and their conversion into **carbon dioxide, water, and energy**.
 - This process is **fundamental for various industrial, transportation, and energy generation** processes, including burning fossil fuels to produce electricity and power vehicles.
 - Combustion is a **chemical reaction** that involves the rapid combination of a substance with oxygen, typically resulting in the release of **heat and light**.
- ❖ **Helps in the Decomposition of Organic Waste:** Oxygen is essential for **aerobic decomposition**, a natural process that breaks down organic matter into **simpler substances** through the activity of microorganisms.
 - These microorganisms, including **bacteria and fungi**, require oxygen to carry out their **metabolic processes**, which involve breaking down complex organic molecules into smaller compounds.
 - Aerobic decomposition helps **recycle nutrients** and return them to the ecosystem, **contributing to soil fertility** and nutrient cycling.
- ❖ **Supports Aquatic Ecosystems:** Oxygen is crucial for aquatic ecosystems, as it **dissolves** in water and provides the necessary conditions for the survival of **aquatic organisms**.
 - Aquatic plants, algae, and **phytoplankton** release oxygen through **photosynthesis**, which supports the respiration of aquatic animals.
 - Dissolved oxygen levels in water bodies are crucial indicators of the **health** of these ecosystems, as inadequate oxygen can lead to fish kills and disruption of the aquatic food chain.

Interconnection of the Carbon Cycle and Oxygen Cycle:

- ❖ Plants use carbon dioxide for photosynthesis and release oxygen.
- ❖ Oxygen is used by Animals for respiration and releases carbon dioxide.
- ❖ Again that carbon dioxide is used for photosynthesis by plants and they release oxygen. That is how the interconnection of cycles goes on.

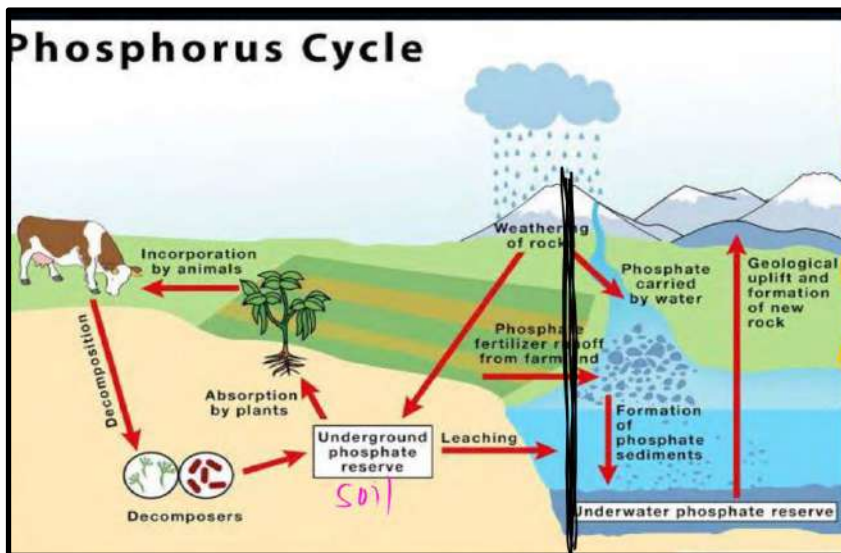


Phosphorus Cycle:

- ❖ The phosphorus cycle (unlike the carbon and nitrogen cycles) **lacks an atmospheric component**.
- ❖ **Phosphorus** is one of the most important nutrients in biological systems since it is a fundamental ingredient of nucleic acids, phospholipids, and several phosphorylated compounds.

Process of Phosphorus Cycle:

- ❖ **Weathering of Rocks:** Rain and weathering cause rocks to release **phosphate ions and other minerals over time**. This inorganic phosphate is subsequently distributed in soils and water.
- ❖ **Absorption by Plants:** Plants take up inorganic phosphate from the soil and then these plants are consumed by animals. Phosphate is incorporated into organic molecules such as DNA in plants and animals. When the plants and animals die, it decays and the **organic phosphate is returned to the soil**.
- ❖ **Absorption by Animals:** In the soil, organic forms of phosphate can be made available to plants by bacteria that break down organic matter into inorganic forms of phosphorus. **This process is known as mineralization.**
- ❖ **Return to the Environment by decomposition:** Phosphorus from the soil can enter streams and eventually the seas. It can then be absorbed into sediments over time.



Human impact on the Phosphorus cycle

- ❖ Phosphorus **fertilizer** is raising the **phosphorus level** in the soil and overuse of it is **decreasing soil fertility** and detrimental to soil **microbes**.
- ❖ Washed-out fertilizers are posing **threats** to aquatic life.
- ❖ It promotes **Eutrophication** (It is a process that is characterized by an **excessive accumulation** of nutrients, primarily **nitrogen**, and **phosphorus**).
- ❖ These nutrients often come from **human activities** like agricultural runoff, industrial discharge, and sewage discharge.
- ❖ When these nutrients enter the water, they can lead to **accelerated growth** of aquatic plants, especially **algae**, in a phenomenon known as **algal bloom**.

Sulfur Cycle:

- ❖ In the Sulphur cycle, there is a circulation of sulfur in various forms throughout nature.
- ❖ Sulfur is found in all living things as a **constituent of some amino acids**.
- ❖ The sulfur cycle is mostly sedimentary in nature except for two of its compounds, **hydrogen sulfide (H₂S)** and **Sulphur dioxide (SO₂)**, which add a gaseous component.

Process of the Sulphur cycle:

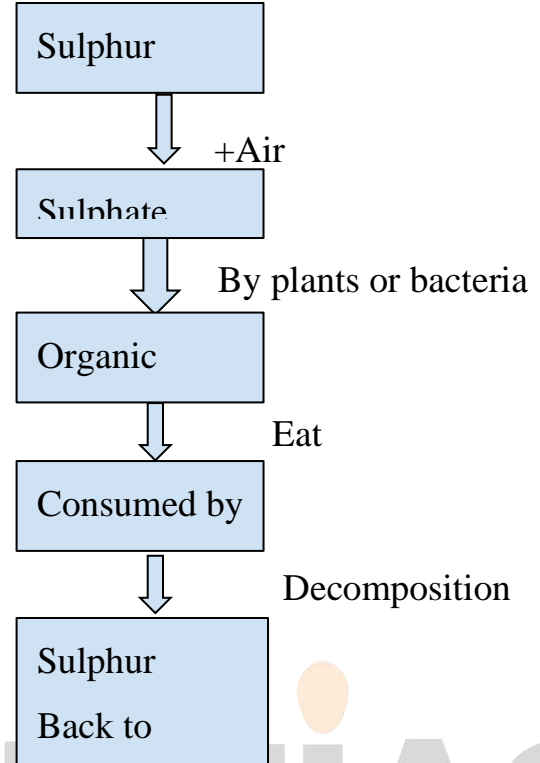
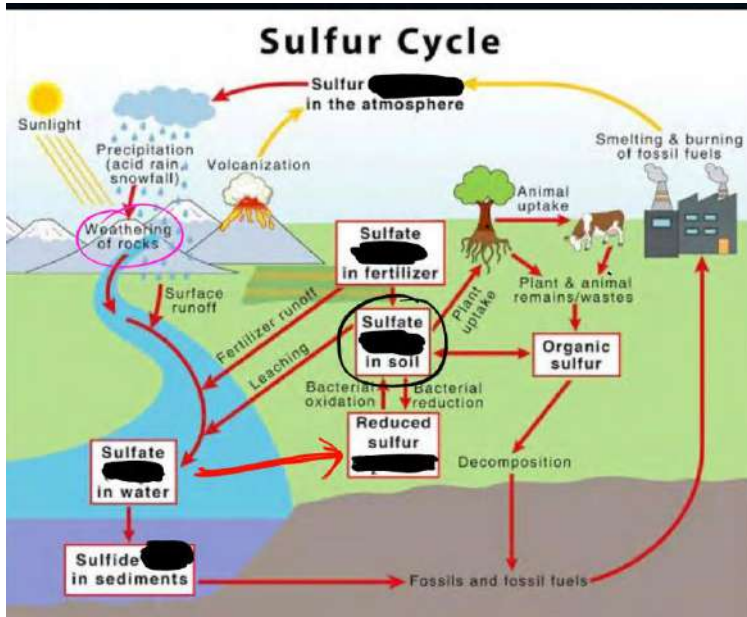
- ❖ **Production of Sulfur Dioxide:** The primary source of sulfur in the environment is **sulfur dioxide**. It is caused by both human and volcanic activity.

- Another source is hydrogen sulfide gas, which is created mostly by microorganisms acting on dead and decaying organic materials. When hydrogen sulfide is oxidized sulfur dioxide is produced..
- ❖ **Assimilation of Sulfur in Biosphere:** The sulfur then enters the biosphere, either through rock weathering or through the atmosphere. Sulfur can be found in three forms in the biosphere:
 - **Elemental Sulfur:** It can be found in sulfur deposits and sulfide ores.
 - **Inorganic Sulfur:** Sulphate in aerobic soils and sulfide in anaerobic soils are the two forms of inorganic sulfur.
 - **Organic Sulfur:** Organic sulfur can be found in amino acids as well as plants and animals.
- ❖ **Migration of Sulphur and conversion into sulfate:** The presence of sulfur in the atmosphere **aids in the formation of clouds by increasing the quantity and size of cloud droplets.**
 - As a result, sulfur dissolves in rainwater and enters the biosphere as droplets of mild sulphuric acid.
 - Moreover, during the process of **pedogenesis**, chemical weathering allows sulfur to migrate from the rocks to the soil and water.
 - Some sulfur is converted to sulfate during the weathering process and released into the environment.
- ❖ **Sulfur absorption by living organisms:** Sulphur is absorbed by **plants** through their **roots** from the soil. Several soil **microorganisms** help to produce sulfur for plant uptake.
 - Sulfur is absorbed indirectly by animals, including humans, via plant **ingestion**. Sulfur is needed in the biosynthesis of biomolecules such as nucleotides and proteins in living organisms.
- ❖ **Sulfur into Sulfides and back to the atmosphere:** Sulphur in the biosphere moves through the food chain via consumers feeding on producers and eventually **reaching the decomposers**. During the **breakdown process**, this sulfur is converted from its sulfate form into sulfides and released back into the atmosphere. **Sulfur that does not enter the food chain** accumulates in the deep sea and terrestrial rocks.

There are some natural sources that contribute to the sulfur cycle such as volcanic eruption and evaporation of water.

Human impact on the sulfur cycle

- ❖ **Use of sulfate in fertilizer** -Sulfur is an essential nutrient for plant growth, and **sulfate** is one of the forms in which plants can uptake sulfur.
 - In agriculture, sulfur-containing fertilizers, such as **ammonium sulfate** and **gypsum**, are commonly used to replenish soil sulfur levels and improve crop yields. While these fertilizers can enhance **agricultural productivity**, their excessive use can lead to impacts on the sulfur cycle.
- ❖ **Burning of fossil fuels is increasing the sulfur level in the atmosphere**-The combustion of fossil fuels, such as coal, oil, and natural gas, releases **sulfur dioxide** and other sulfur-containing compounds into the atmosphere. This has profound effects on the sulfur cycle and the environment



Major Ecosystems of the World:

Types of

Terrestrial

1. Tundra
2. Desert
3. Grassland
4. Forests

Aquatic

1. Freshwater
2. Marine

Tundra Biome/ Tundra Ecosystem:

- ❖ It is the World's **coldest Ecosystem**.
- ❖ It is characterized by **low rainfall**.
- ❖ The soil in Tundra is **permafrost** and lacks Nutrients.

❖ **Distribution:**

- Found south of the Arctic Ice Cap.
- It covers Canada & Alaska.
- At Peaks of North America, Europe & Siberia.

❖ **The temperature** here is as low as **-40 to -50 degrees Celsius**.

❖ **Precipitation** is in the form of Snow. Convectional rainfall is rare.

❖ **Biotic factors:**

- **Flora:** Mosses, Lichens, and Bushes
- **Fauna:** Wolves, Foxes, Polar Bear, Arctic hare, Seal, Walrus, etc.

Biotic components of tundra

❖ **Producers - Mosses and Lichens:**

Mosses and lichens are primary producers in the tundra biome. These organisms are well-suited to cold conditions and play a crucial role in the ecosystem by initiating the food chain. They can survive in the thin layer of soil and often form intricate carpets that help insulate the ground, preventing erosion and aiding in nutrient cycling.

❖ **Absence of Trees:**

One of the defining features of the tundra is the absence of tall trees. The cold temperatures, short growing seasons, and permafrost (permanently frozen ground) limit the growth of trees in this biome. Instead of trees, the tundra landscape is dominated by low-lying vegetation, such as grasses, sedges, small shrubs, and dwarf willows.

❖ **Birds and Seasonal Migration:**

Many bird species are present in the tundra, and some of them undertake long migrations, often traveling northward to breed in the Arctic tundra during the summer. These migratory birds take advantage of the brief period of warmer weather and abundant insects for nesting and raising their young. Examples of migratory birds in the tundra include shorebirds, waterfowl, and passerines.

❖ **Summer Growth of Small Bushes and Grasses:**

During the relatively warmer summer season, a limited amount of plant growth occurs in the tundra. While large trees cannot survive, some small shrubs, grasses, and herbs are able to grow, albeit with a short lifespan. These plants take advantage of the brief period when the ground is not frozen and the sunlight is available to support photosynthesis.



DAILY CLASS NOTES

ENVIRONMENT

Lecture – 08

Major Terrestrial Ecosystems



Major Terrestrial Ecosystems

Taiga Forests:

- ❖ Taiga Forest is also called **Boreal Forest** or **Coniferous Forest**.
- ❖ **Taiga** is found between temperate forests in the south and tundra in the north.
- ❖ Taiga is characterized by conifer forests, which produce **tall, straight, and uniform trees**.
- ❖ The leaves of this tree can last for many years, and the **bark is thick**.
- ❖ Coniferous trees are **conical in shape**, so snow does not accumulate .
- ❖ **Leaves are tiny, thick**, and needle shaped to minimize transpiration or water loss.
- ❖ Taiga is characterized by **low temperatures and heaviest snowfall in winter** .
- ❖ There is **evenly distributed precipitation**.
- ❖ **The soil** in this ecosystem may be **acidic, accessible leached and mineral deficient**.
- ❖ In taiga **fox, wolf, bear**, and other medium size and small animals are present, usually large predators are absent like tigers etc.
- ❖ A small percentage of coniferous forest in **Canada, Russia** and other countries are being utilized for commercial purposes.
- ❖ Timber is used to make wood pulp, which is further used as the raw material for the paper and pulp industries for the production of papers.
- ❖ **The softwood produced** by this forest is used for furniture and wood carving.
- ❖ **Evergreen Plants like spruce, fir, pine etc.**



Spruce



Fir



Animals of the Coniferous Forest



Beaver



Wolf



Hawk owl



Lynx



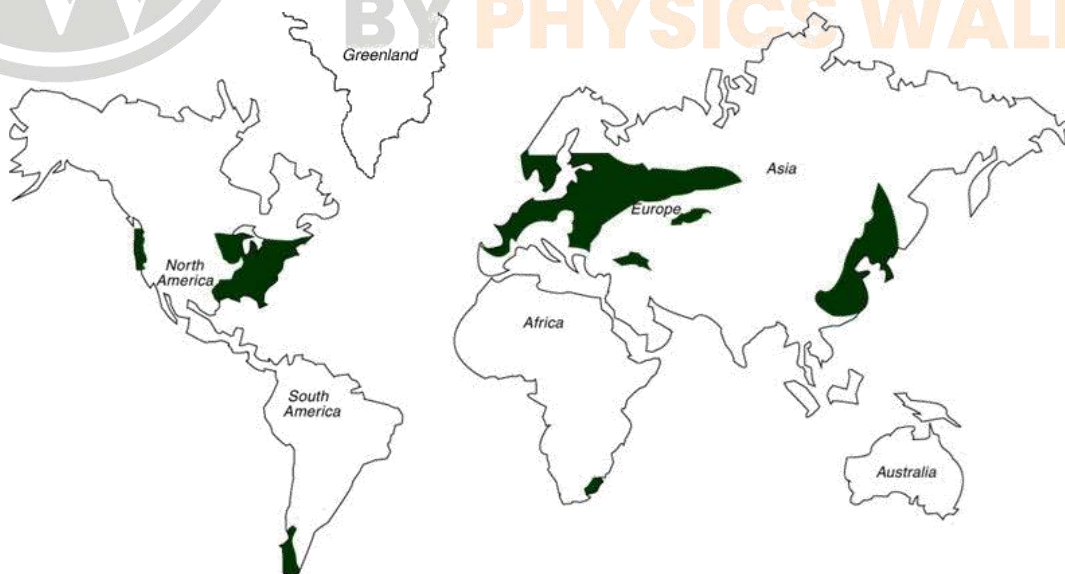
Black Bear



Red squirrel

Temperate Forest:

- ❖ Two types of Temperate Forest are:
- ❖ Temperate deciduous forest
- ❖ Temperate evergreen forest.
- ❖ Temperate deciduous forest
 1. Trees lose their leaves in fall (autumn) and winter
 2. All four seasons will be there.





DAILY CLASS NOTES

ENVIRONMENT

Lecture – 09

Major Ecosystems



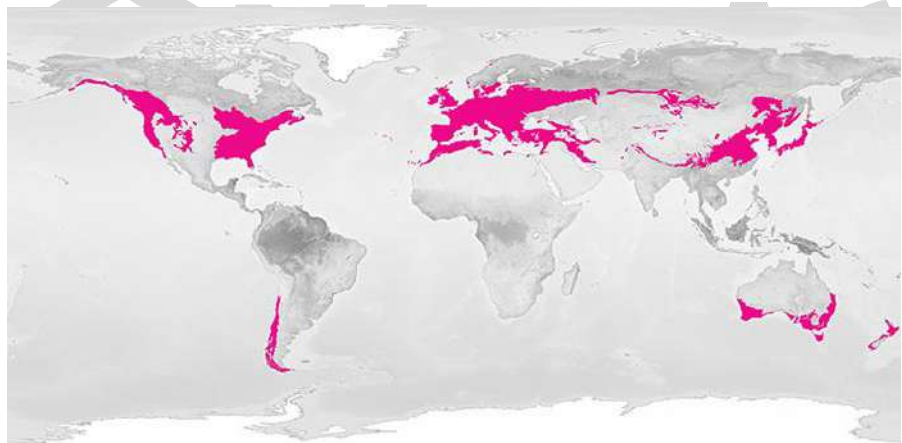
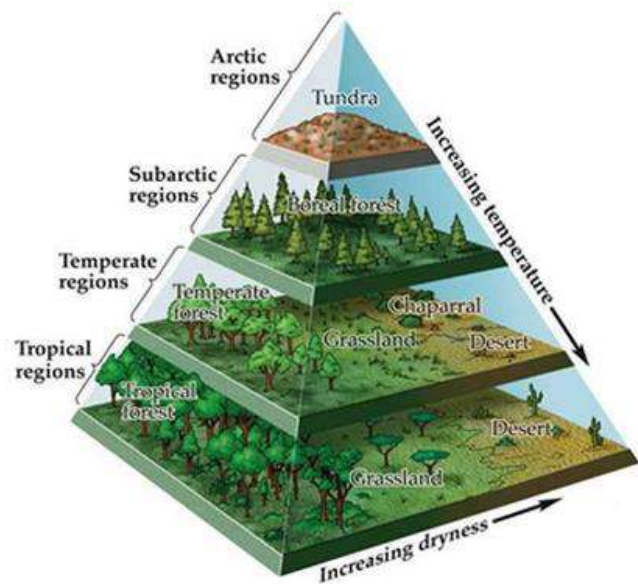
Major Ecosystems

Temperate Forest:

- ❖ Three types of Temperate Forests are:
 - Temperate deciduous forest
 - Temperate evergreen forest
 - Temperate rainforest

Temperate deciduous forest

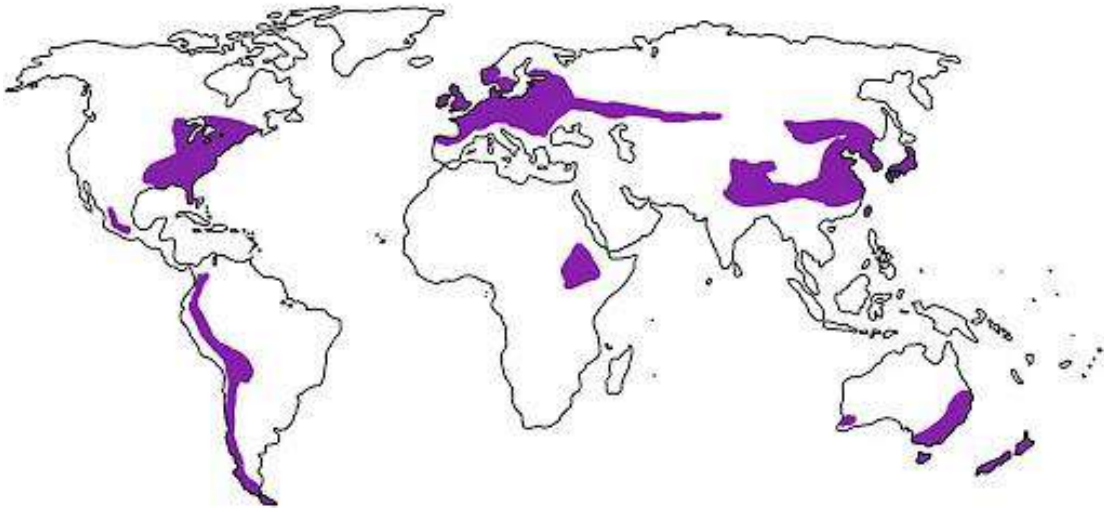
- ❖ Temperate deciduous forests experience all four seasons, with **trees losing their leaves in the fall and winter.**
- ❖ **The World's largest** deciduous forest is typically present in the **Northern Hemisphere**, but a small portion of it is present in the **Southern Hemisphere.**
- ❖ In the Northern Hemisphere, it is present in regions of **North America, Europe, Russia, China, and Japan.**
- ❖ Temperate deciduous forests are **distributed all over the world**, so their temperatures will differ based on their location.
- ❖ The average temperature of deciduous forests is roughly **10 degrees Celsius**, whereas **average annual rainfall** is between **30 and 60 inches.**
- ❖ In **India**, temperate deciduous forests are found in the **Himalayan Foothills and Western Ghats.**



Temperate evergreen forest

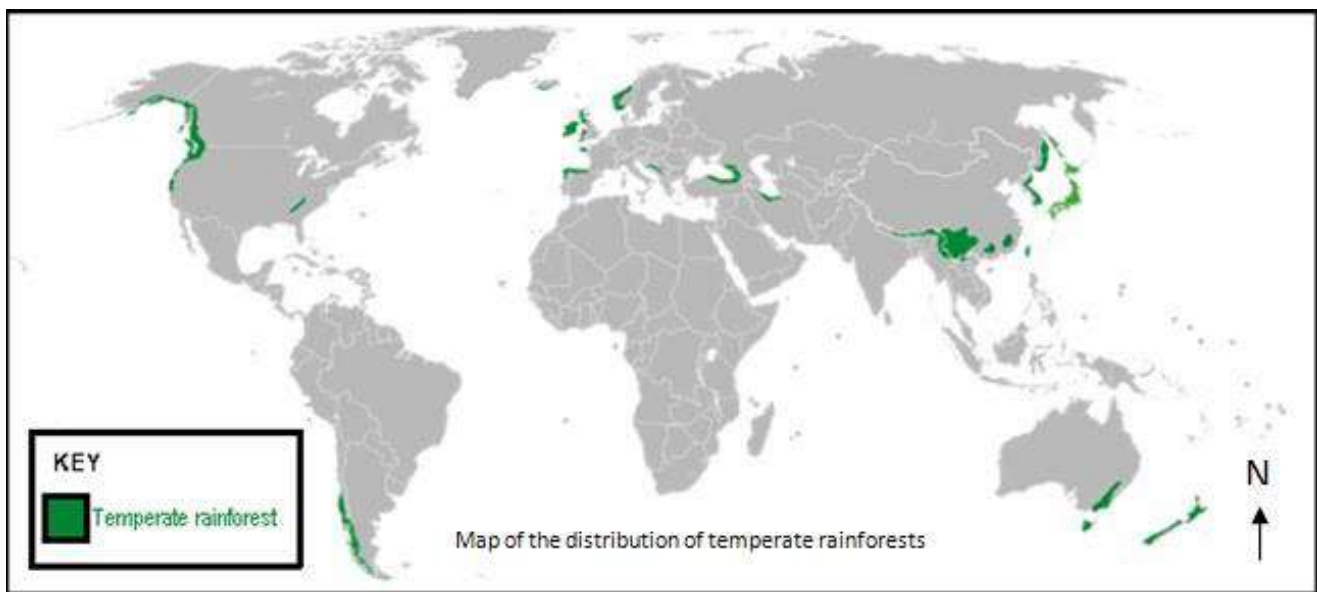
- ❖ Temperate evergreen forests can be **found in both hot and cold climatic conditions.**
- ❖ Temperate evergreen forests are spread across the northern and southern hemispheres.
- ❖ They can be found throughout North **America, Canada, Europe, and Asia.**
- ❖ The northern and southern evergreen forests have different climates
- ❖ The **northern part** will have typically **lengthy, cold, snow-dominated winter**
- ❖ The **average annual rainfall** is **30 to 90 cm**, and the **temperature range** is between **-40 and 20 degrees centigrade.**

- ❖ Temperate evergreen forests in India lie in the **Western Ghat, Islands of Lakshadweep, Andaman and Nicobar, Coastal Area of Tamil Nadu, and Assam.**



Temperate rainforest

- ❖ Temperate rainforests exist in temperate climates where they **receive a lot of rain** but the **average temperature is lower.**
- ❖ The **Pacific Coast** of North America is the **world's largest** temperate rainforest.
- ❖ **Southeast coast of chilly South America.** Some areas in the **United Kingdom, New Zealand, Japan, Norway, and South Australia** are temperate rainforests.
- ❖ The climatic conditions are **mild**, which means not too cold or too hot.
- ❖ The average temperature is around **0 to 20 degrees**, whereas this forest receives good rainfall as much as 350 cm but the annual **average rainfall is around 200 cm.**



Tropical rainforest

- ❖ In India, temperate rainforests are **present at higher altitudes** in hilly regions.
- ❖ In terms of structure and diversity, the **tropical rainforest is the most complex ecosystem** or biome in the world.
- ❖ They receive plenty of rain, and the temperature is high all around the year.
- ❖ Tropical rainforest is **present between 28 degrees north and south of the equator**, and it is just spread over **Asia, Australia, South America, Central America, and the Pacific Islands**.
- ❖ Tropical rainforests cover about **6 to 7 percent of the earth's surface** and it contain half the world's biodiversity (rich in diversity)
- ❖ South America's Amazon rainforest is the world's largest rainforest.
- ❖ The average temperature in tropical rainforests is between 20 and 30 degrees Celsius, whereas annual rainfall is between 180 and 250 cm.
- ❖ Rainforests help in balancing the global climate. They are home to many plants and animals and are extremely rich in biodiversity.
- ❖ They are a good source of medicine and food.
- ❖ They are interesting tourist attractions.

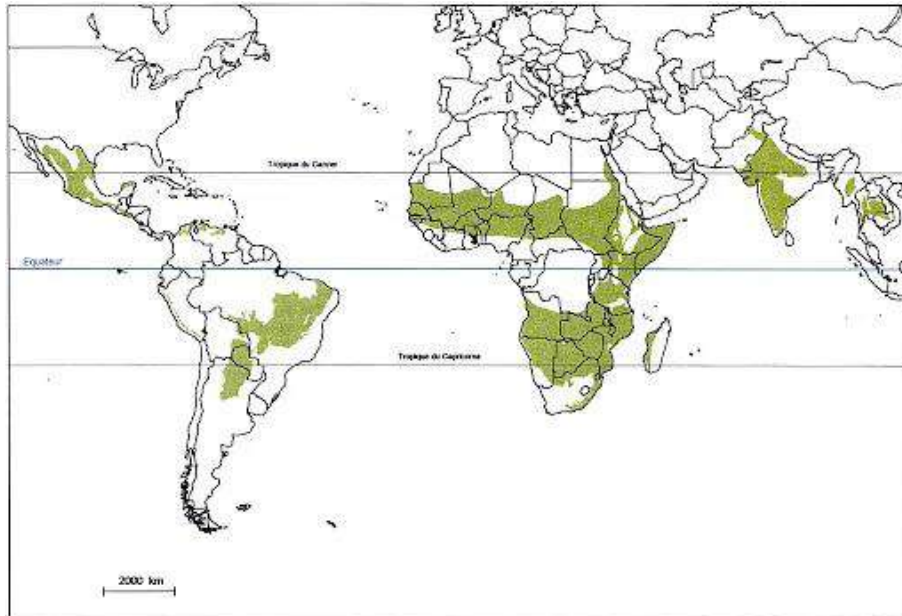


Tropical seasonal forest

- ❖ **Distribution:**
 - Tropical seasonal forest is found in areas with a long dry season.
 - In India, tropical seasonal forests can be found in Western Ghats and on the Deccan Plateau.
- ❖ It is different from rainforests because it has less tree strata.
- ❖ There are different names given for tropical seasonal forests, such as moist deciduous forests, semi-evergreen seasonal forests, tropical mixed forests, or monsoon forests.
- ❖ In tropical seasonal forests, summer is the wet season and winter is the dry season

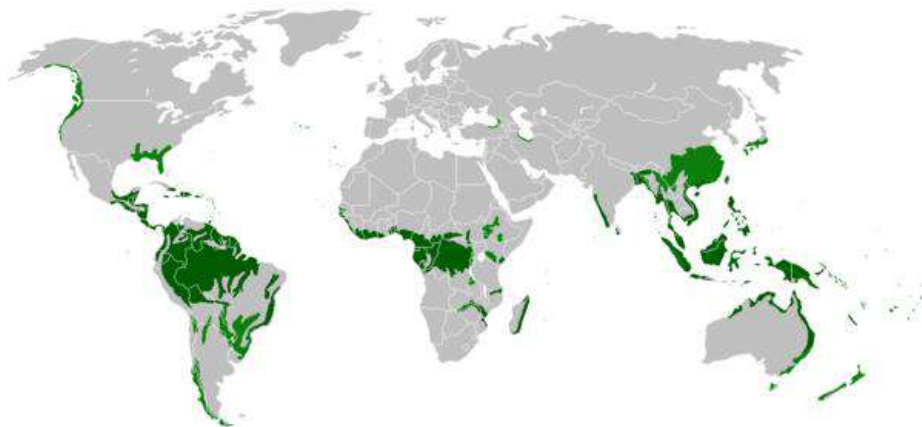


- ❖ The average temperature of tropical rainforest is 18 degrees Celsius



Sub tropical rainforest

- ❖ Subtropical rainforests have the characteristics of both tropical and temperate rainforests.
- ❖ They are distributed along **Central America, the West Indies, Madagascar, Southeast Asia, and the Philippines**
- ❖ The average temperature in this area is 21 to 30 degrees Celsius
- ❖ They are characterized by thick vegetation around the ground, which makes it difficult to navigate in this forest.
- ❖ The tropical rainforest is home to **more than half of the world's plant and animal species.**





DAILY CLASS NOTES

Environment

Lecture - 10

Grassland and Desert Ecosystem



Grassland and Desert Ecosystem

Grassland Ecosystem:

- ❖ Dominated by grasses and **Herbaceous plants**(non woody plants).
- ❖ Grasslands are present on every continent **except Antarctica**.
- ❖ Grasslands can be **found in both Tropical and Temperate regions** where rainfall is insufficient.
- ❖ Grasslands are found in places with **minimum rainfall and poor soil quality**.
- ❖ **Low rainfall hinders the growth of big trees**, but it is enough to support growth of grass and herbaceous plants.
- ❖ Grasslands make up about **20 to 40 % of the World's land surface**.
- ❖ The Annual rainfall in grassland is between **25 and 75 cm**.
- ❖ Grassland plays **important role** in ecosystems and **World Economics**
- ❖ **Wheat, Rice, and Corn** are three main plants that grow over grasslands all over the World.
- ❖ Grasslands also provide food and fodder for animals.
- ❖ Grasslands create an efficient system for water absorption and reduce erosion.
- ❖ Some grasslands are designated as nature reserves and **National Parks** and they are being promoted as Tourist destinations because of their biodiversity and hunting activities. Eg- Savanna





Grasslands of the world:

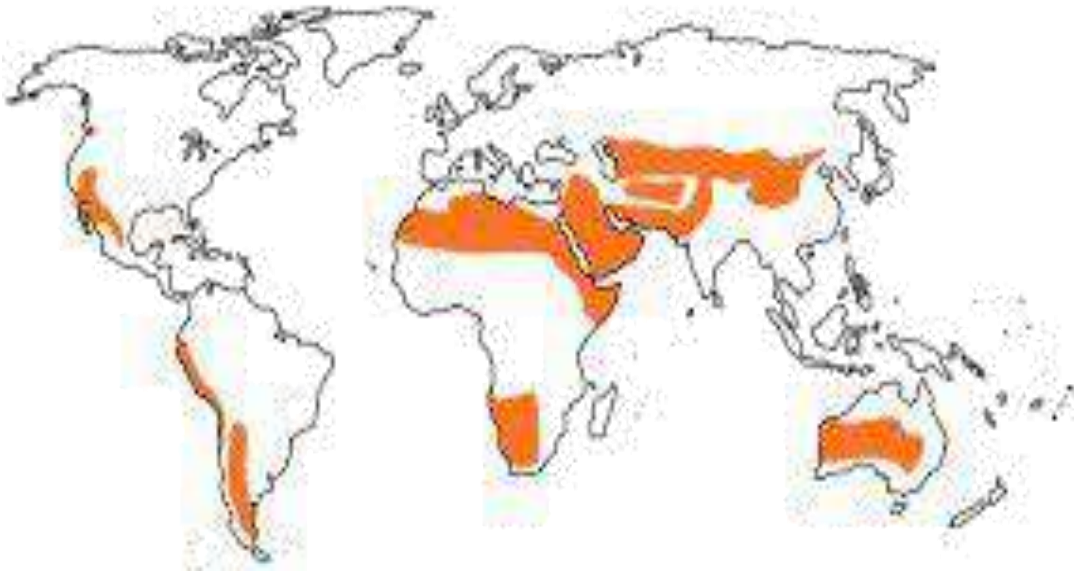
- ❖ North America- Prairies
- ❖ South America-Pampas
- ❖ Africa- Savanna
- ❖ South Africa - Veld
- ❖ Australia- Down
- ❖ Europe and Asia-Steppes
- ❖ Brazil- Campos
- ❖ Venezuela- Lanos
- ❖ India - Savanna
- ❖ Savanna is known as Tropical Grassland
- ❖ Steppes is known Temperate Grassland

Grassland in india: 25 % of india

- 1) **Semi Arid Zone Grassland**- Rainfall is less -**Gujarat,Rajasthan (except Aravali range), West Uttar Pradesh, Punjab, and Delhi.**
- 2) **Dry sub humid zone grassland**- Characterized by unpredictable rainfall patterns all **Peninsular India except Nilgiri.**
- 3) **Moist sub humid zone grassland** - Rainfall is more than **Dry Sub Humid area.**
Ganga Alluvial Plain in Northern India
 - Characterized by dense growth of Grassland
- 4) **Humid montane zone grassland**
It is found in **Assam, Manipur, West Bengal, East Uttar Pradesh, Himachal Pradesh, and Jammu and Kashmir.**
 - This area will have more rainfall, and some of them are at **high elevation.**

Desert ecosystem

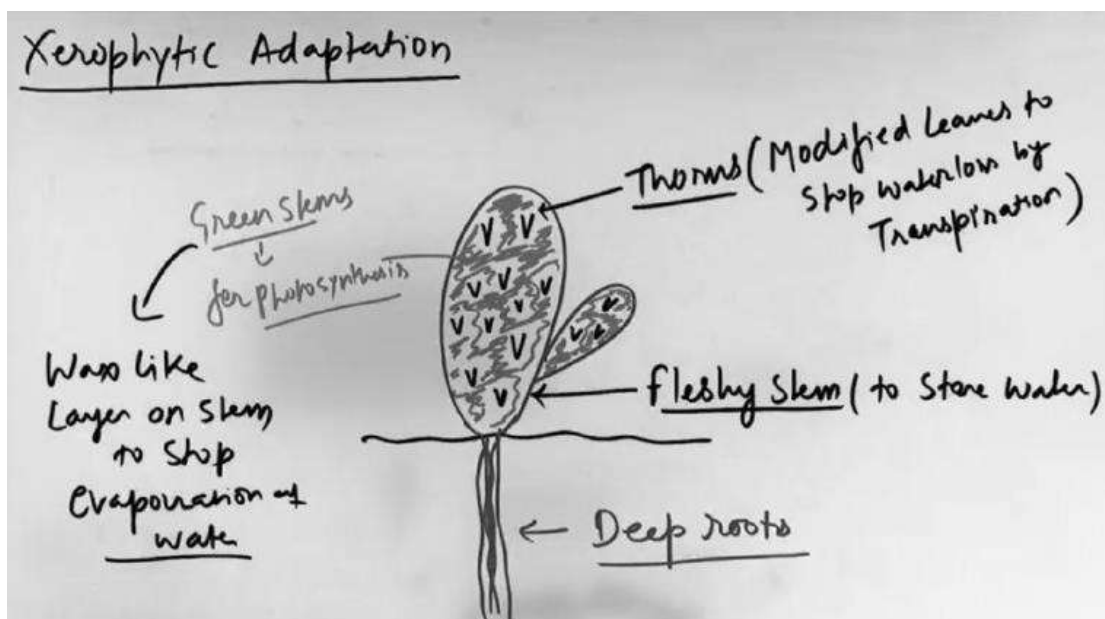
- ❖ The desert ecosystem covers around **17 % of earth's surface.**
- ❖ Desserts are found in regions with **less than 25 cm** of Annual rainfall



Hot desert/thar desert

- ❖ **The climate** is extremely **hot and dry**, and it receives very little rainfall.
- ❖ The temperature in the daytime can go up to **45 to 50 degrees Celsius**.
- ❖ Nighttime temperatures can go up to **0 degrees Celsius**.
- ❖ The soil type is **Saline, Sandy, and has low water holding capacity**.
- ❖ Plants and animals are adapted to dry and hot climatic conditions, where the plants will be known as **Xerophytic Plant (Cactus, Palm, Acacia, Scrubs)**.
- ❖ **Animals - Reptiles, Mammals (Camel, Hedgehog, Hyenas)**

Xerophytic adaptation:





Adaptation of desert animals

- ❖ Most of them are **Nocturnal** (active in night)
- ❖ Excrete concentrated **urine to save water**.
- ❖ **Thick fur** to save from extreme temperature variation.
- ❖ **Seal their Nostril in the sandy wind**.
- ❖ A camel's hump can store **water and fat**.
- ❖ Small animals have **burrowing nature**.

Cold desert/temperate desert

- ❖ Eg: **Gobi desert in Mongolia, Ladakh desert in India**.
- ❖ Found in **high altitude (cold) temperate** regions.
- ❖ The condition is cold and dry with very **little rainfall (dry)**
- ❖ Summer temperatures are barely above **zero degrees in the daytime**, and they can go up to **-30 in the night**.
- ❖ The desert ecosystem supports a diverse range of plant and animal species and many of them are **Endemic**
- ❖ Sand in the desert has a variety of bacteria, and these **bacteria can store Carbon dioxide** and serve as a **Carbon sink by preventing Carbon dioxide from entering the atmosphere**.
- ❖ Deserts are **rich in mineral resources, such as natural gas**.

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DAILY CLASS NOTES

ENVIRONMENT

Lecture – 11

Aquatic ecosystem



Aquatic ecosystem

Aquatic Ecosystem

- ❖ **Freshwater ecosystem**-Salt concentration is less than 5 parts per thousand (PPT)
- ❖ **Marine ecosystem**-Salt concentration is more than 35 ppt .
- ❖ Water is the main habitat in aquatic ecosystems, where aquatic organisms are classified according to their zone of occurrence.
- ❖ **Neuston**: Organism living in water air interface.
Eg.-Beetles and floating insects.
- ❖ **Periphyton**: Organism attached to stem and leaves of aquatic plants
Eg- Insects, Labeotropheus, Trewavasae, and Pseudotropheus zebra.
- ❖ **Planktons**-Microscopic plants (Phytoplanktons) and animals (Zooplanktons) moving with water current.



Additional Information: Phytoplankton

- ❖ Microscopic plant-like organisms called phytoplankton are the base of the marine food web, and they play a key role in removing carbon dioxide from the air.
- ❖ **Phytoplankton live in watery environments, both salty and fresh.**
- ❖ **Some phytoplankton are bacteria, some are protists, and most are single-celled plants.** Among the common kinds are **cyanobacteria, silica-encased diatoms, dinoflagellates, green algae, and chalk-coated coccolithophores.**

cyanobacteria



diatom



dinoflagellate



green algae



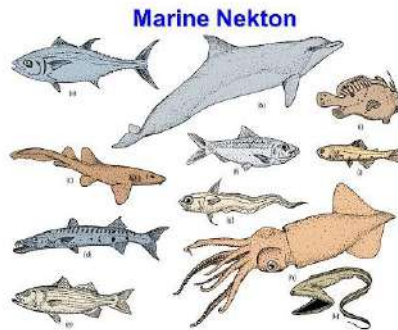
coccolithophore



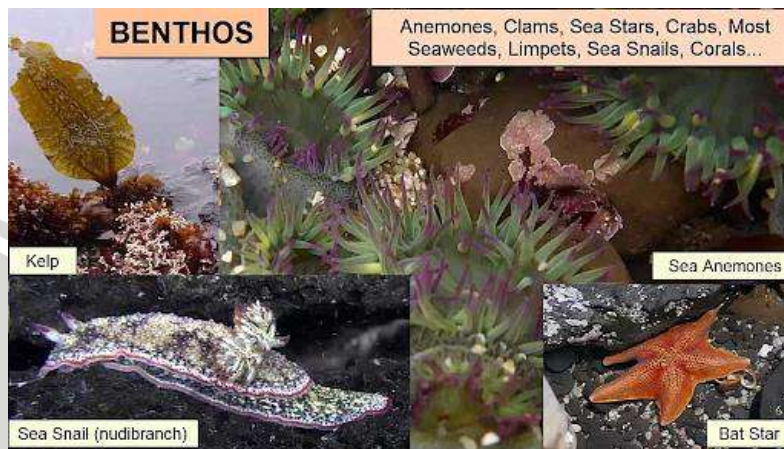
- ❖ Phytoplankton are extremely diverse, varying from **photosynthesizing bacteria (cyanobacteria), to plant-like diatoms, to armor-plated coccolithophores**

Source: NASA

- ❖ **Nekton**-Swimming animals (Frogs,Fish)



- ❖ **Benthos**: Organism at the bottom of water mass (Fish, Worms)



Freshwater Ecosystem

- ❖ Home to 41 % of all fish species
- ❖ Occupies 20 % of the earth's surface
- ❖ Contains 0.8% of all water.

Types Of Freshwater Ecosystems

- ❖ **Lentic Ecosystem** -Static water Ecosystem. Eg- **Lakes and Ponds**, also known as Still Water Ecosystems.
- ❖ **Lotic Ecosystem**- Running Water Ecosystem, eg-**Rivers and Streams**, and also known as **Riverine Ecosystem**.

Significance of Freshwater Ecosystem:

- ❖ It is crucial for the survival of our Planet.
- ❖ It is a source for storing and purifying water.
- ❖ Source of drinking water-growing Crops, water for irrigation,water for industry, Hydroelectric power plants, and even Transportation.
- ❖ Freshwater ecosystems help in prevention of erosion and waste disposal.
- ❖ It acts as a natural flood protection system.





Threats to Freshwater Ecosystem:

- ❖ Over exploitation of freshwater resources
- ❖ Freshwater ecosystems are being impacted from water pollution.
- ❖ Habitat destruction and degradation
- ❖ **(World Wildlife Fund Report, -WWF**
- ❖ **From 1970 to 2014, there was an 83% decline in freshwater vertebrates)**
- ❖ Threats from invasive foreign species.
- ❖ For example:
 - The introduction of Nile Perch into Lake Victoria. Nile perch can be called an alien species or an invasive species, and when they are introduced, they flourish very well. Eg-
 - **Introduction of Amazon Catfish in Kolkata wetlands, it is also an invasive species.**



Marine Ecosystem:

- ❖ It covers 70% of the Earth's surface.
- ❖ It met the needs of 97% of the planet's water supply.
- ❖ 90% of the space is habitable space.
- ❖ Though average temperature of marine ecosystems is 4 degrees celsius, Marine Climate = Tropical to Polar.

Sunlight in the Marine Ecosystem (most important abiotic factor)

- ❖ **There are three zones.**
- ❖ **Euphotic Zone-**
 - It's top layer is up to 200 meters .
 - It will have enough light.
 - Presence of most of the marine life ecosystem.
- ❖ **Disphotic Zone**
 - It is middle layer and extends from 200 to 1000 meters.
 - This zone helps in diffusing lights
 - It has less photosynthesis
 - It has lesser biodiversity in terms of animal and plant life.
- ❖ **Aphotic Zone**
 - It is the lowest layer below 1000 meters.
 - Absence of photosynthetic process in this zone..
 - It has less life diversity.



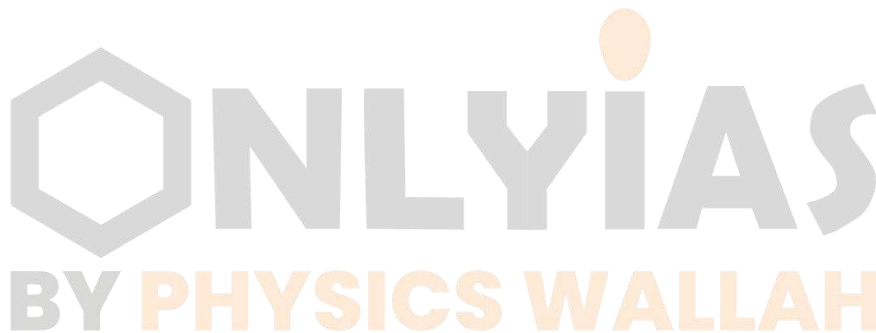


Significance of Marine Ecosystems

- ❖ It helps balance the global climate .
- ❖ It contributes to the water cycle process.
- ❖ It sustains and supports biodiversity
- ❖ It acts as an important food source for the global population .
- ❖ It is a source of energy such as wave energy, tidal energy, and ocean thermal energy

Threats to Marine ecosystem

- ❖ Overfishing
- ❖ Habitat loss
- ❖ Alien or invasive species
- ❖ Ocean acidification
- ❖ Ocean pollution-oil spillage
- ❖ Ocean warming





DAILY CLASS NOTES

Environment

Lecture - 12

Biodiversity



Biodiversity

Definition: Biodiversity is the variety and variability of life on earth.

The term is made up of two things: biological and variety of life.

- ❖ As per **UNEP (United Nations Environment Programme)**- Biodiversity is defined as the sum of the total number of genes, species, and ecosystems on the earth.
- ❖ According to **IUCN (International Union for Conservation of Nature)**, there are around 1.5 million plant and animal species.
- ❖ In India we have **2.3% of global land** and **8 % of all known species**.

Types of Biodiversity:

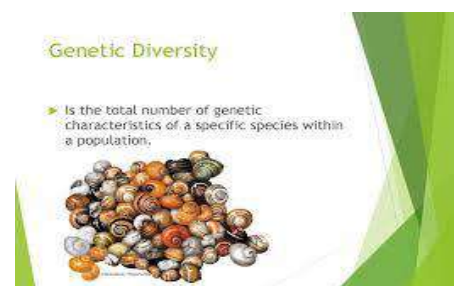
- ❖ Genetic diversity
- ❖ Species diversity
- ❖ Ecosystem diversity

3 types of Biodiversity



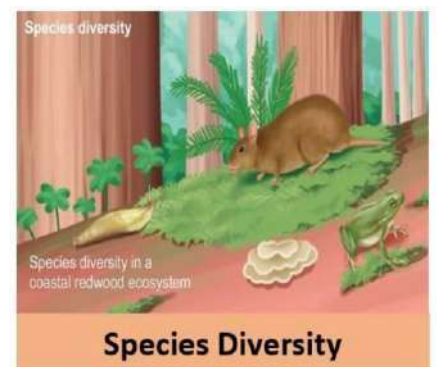
Genetic Diversity

- ❖ It is defined as a variation of genes within the individuals
- ❖ of the same species. or The sum total of all genes present in a species.
- ❖ Variety of unique genetic features are found in a species.
- ❖ {(genes → characters(traits)}



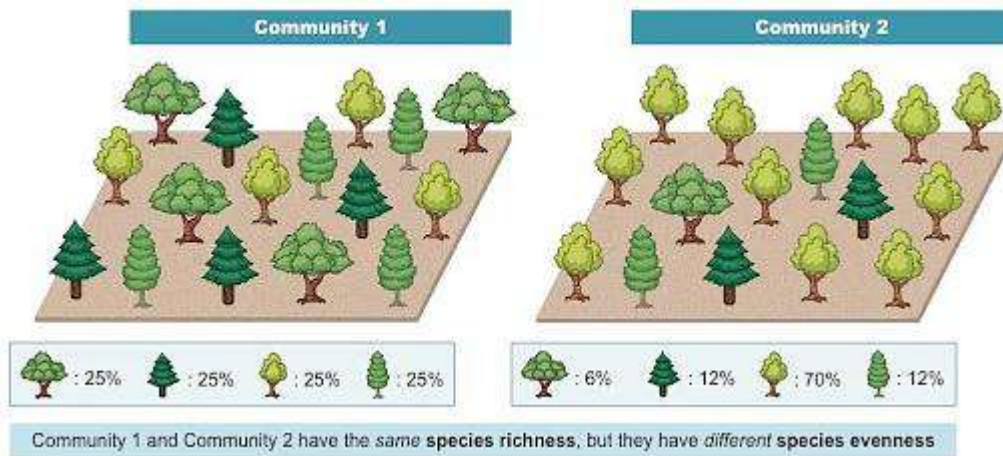
Species Diversity

- ❖ The variety of species found in a given area or environment
- ❖ Is referred to as species diversity.
 - Both the natural system and the agricultural ecosystem include this kind of diversity



Ecosystem Diversity/Community Diversity

- ❖ There are a wide variety of habitats with unique species and habitats, this ecosystem is different from one Another. A particular geographic area, a nation or a state may include this environmental variety. **Forests, Meadows, Deserts, Mountains** are further example of this type of Diversity.
- ❖ It is defined as a community of interacting groups of different species living in a single habitat.
 - It has two components
 - One is ‘Species Richness’ and one is “Species Evenness”.



Species Richness - Number of different species per unit area .

- ❖ Biodiversity is the **level of variation present within a given ecological system**. The number of species on Earth as a whole is widely used to measure the planet's biodiversity.
- ❖ One of the most often used techniques for measuring biodiversity takes into consideration the **species richness** of an environment.
- ❖ The number of species in a given area is measured as the species richness. Since more species equals greater species richness, an ecosystem with more species will be more stable.

Species Evenness- Relative abundance of the individuals of different species per unit area.

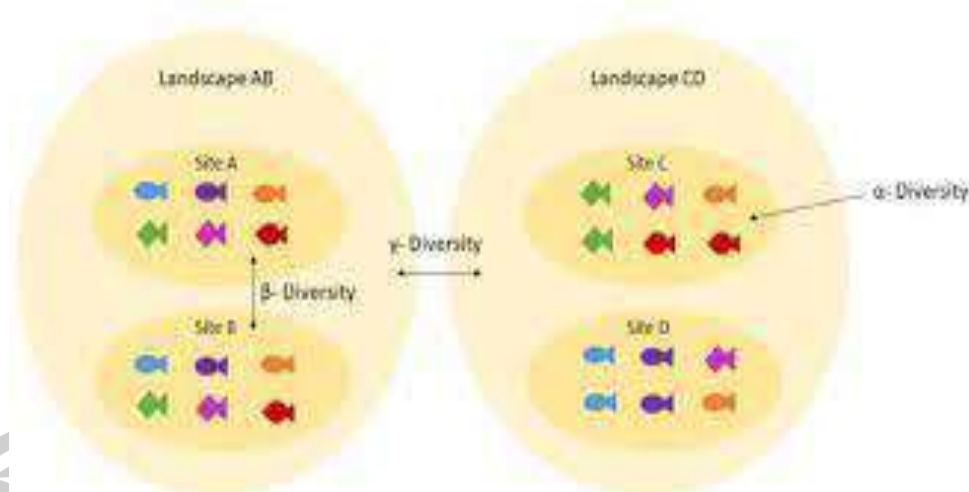
- ❖ The relative abundance of different species in a certain area is gauged by the concept of species evenness.
- ❖ The presence of all species in about similar numbers is a sign of greater species evenness.
 - These are also known as components of species diversity

MEASUREMENT OF BIODIVERSITY:

- 1) Species Richness
- 2) Species Evenness
- 3) Alpha Diversity
- 4) Beta Diversity

5) Gamma Diversity

- **Alpha diversity**- Number of species found in an area. It is related to the richness of species.
- **Beta diversity**- Species diversity between ecosystems
- **Gamma diversity** -Total species diversity of all the ecosystems.



Services Provided By Biodiversity:

- ❖ Biodiversity provides a variety of services that are critical at local, regional, and global levels. These services can be classified as :

1. Ecosystem Services:

- ❖ It helps in the water cycle preservation.
- ❖ It helps in soil formation and preservation of soil fertility.
- ❖ It helps in storage and cycling of nutrients.
- ❖ It helps in waste management and breakdown of pollution.
- ❖ It helps in climate regulation and carbon sequestration

2. Biological Services:

- ❖ We get drugs and medicine (Anti-Malaria drugs, Penicillin, etc.)
- ❖ Food : The prerequisites for food cultivation, **collection, hunting, and harvesting** are present in almost all environments.
- ❖ Ecosystems produce a variety of raw resources, **including wood, biofuels, and fibers** made from cultivated or wild plant and animal species.
- ❖ Along with a number of complex procedures that support other ecosystem services, ecosystems also provide **habitat for plants and animals**. Animals for breeding and domestication

3. Socio Cultural Services:

- ❖ It provides us with variety of research and education

- ❖ It gives us recreational activities (**Leisure, Hobby, Tourism**)
- ❖ Humankind draw inspiration for art, culture, and design.
- ❖ It is significant in human culture: Tradition and Values.

BIODIVERSITY LOSS CAUSES

The four primary causes of biodiversity loss are referred to as **"The Evil Quartet."**

1. Habitat destruction
2. Over exploitation
3. Alien species invasion
4. Coexistence of species

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DAILY CLASS NOTES

Environment

Lecture - 13

Biodiversity Conservation

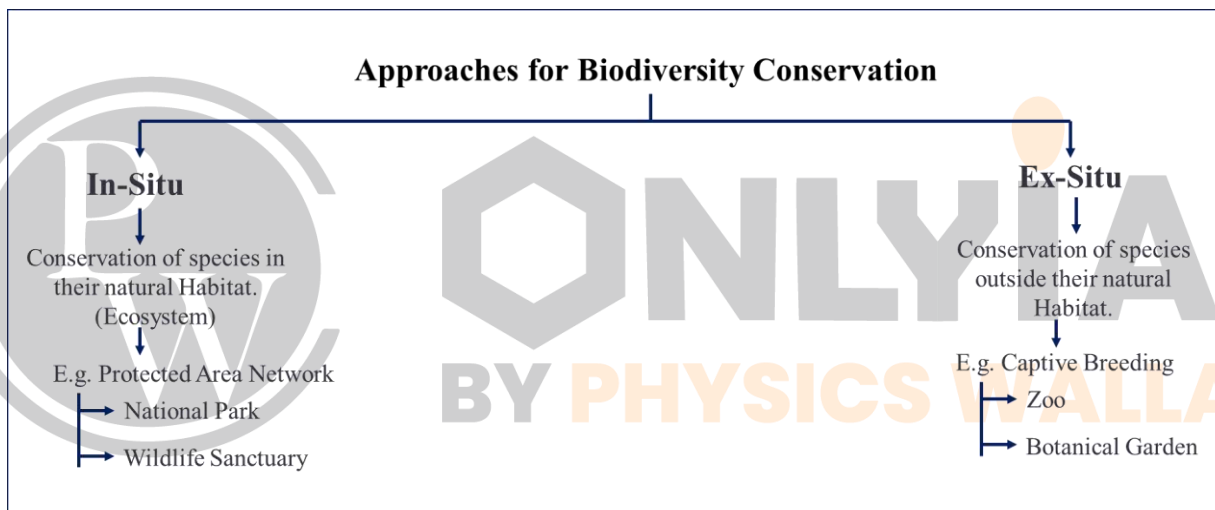


Biodiversity Conservation

Biodiversity Conservation:

Need for Biodiversity Conservation:

- ❖ **To make people aware** of the importance of biodiversity and the consequences of its loss, fostering a sense of responsibility and commitment to its protection.
- ❖ **To achieve sustainable development** by ensuring that current and future generations have access to the resources and services provided by diverse ecosystems, without depleting them beyond their capacity to regenerate.
- ❖ **To save species from extinction and overexploitation** by implementing measures and policies that regulate hunting, fishing, and habitat destruction.
- ❖ **To safeguard endangered species** and prevent their disappearance from the planet, thereby preserving the biodiversity and ecological balance of our ecosystems.



Captive Breeding

- ❖ Captive breeding is a **conservation strategy that involves the controlled breeding and maintenance of wild animals or plants** within a controlled environment, such as a **zoo, aquarium, botanical garden, or dedicated breeding facility**.
- ❖ **The primary goal of captive breeding programs** is to increase the population size of endangered, threatened, or vulnerable species with the aim of eventually reintroducing them into their natural habitats or supplementing wild populations.
 - **Vulture:** The **Jatayu Conservation Breeding Centre (JCBC) in Pinjore, Haryana** is the world's largest facility for the breeding and conservation of Indian vultures. It was established in 2001 by the **Haryana Forest Department and the Bombay Natural History Society (BNHS)** in response to the dramatic decline in the vulture population in India due to a range of factors, including the use of the

veterinary drug diclofenac, habitat loss, and other threats. The vulture is a **critically endangered species**. The centre has successfully bred all three species of vultures found in India: the white-backed vulture, the long-billed vulture, and the slender-billed vulture.



- **Pygmy Hog:** The Pygmy Hog Conservation Programme is a joint initiative of the Wildlife Trust of India (WTI) and the Assam Forest Department. It was established in 1996 to conserve the pygmy hog, a **critically endangered** pygmy-sized wild pig found in the forests of Assam. The programme has been successful in increasing the pygmy hog population in captivity.



Protected Area Networks (PAN)

- ❖ Protected Area Networks are **specially demarcated geographical areas for long term conservation of nature**. India has about **5% of total geographical area as Protected Area Network**.
- ❖ There are **more than 100 National Parks** and **more than 550 Wildlife Sanctuaries** in the country.
- ❖ **Both National Parks and Wildlife Sanctuaries** are declared by the State Government based upon their ecological significance as per the provisions of **Wildlife Protection Act 1972**.
- ❖ Both National Park and Wildlife Sanctuaries **aim at In Situ conservation of Biodiversity by regulating human activities and restricting human presence inside**.
- ❖ Other Protected Area Networks are **Protected Forest and Reserved Forest**.
 - **Protected Forest:** Protected forests are those forests in which hunting and grazing activities are allowed to communities residing in such areas.
 - **Reserve Forest:** Reserve forests are those forests in which hunting and grazing activities are banned and can be allowed in some situations.

❖ In terms of protection:

- National Park (Most protected)
- Wildlife Sanctuary
- Reserve Forest
- Protected Forest (Least protected)

National Park:

- ❖ National Parks are areas where the whole ecosystem is protected. In national parks many species of plants and animals are protected.
- ❖ In the **National Park, no rights are allowed**, because this is the most protected area.
- ❖ **No grazing of livestock or firewood collection is allowed in it.**
- ❖ **No settlement is allowed in the core area** of the national park.
- ❖ There are **106 National Parks in India.**

Wildlife Sanctuary:

- ❖ Wildlife Sanctuaries are the home to various endangered species where they are safe from hunting, predation and competition.
- ❖ Certain rights of people can be permitted, for example **grazing and firewood collection by tribals are allowed**, but it is strictly regulated.
- ❖ **Human settlements are not allowed** in the Wildlife sanctuary, **except for a few tribal settlements.**
- ❖ It is **maintained by the state government.**
- ❖ There are **567 wildlife sanctuaries in India.**
- ❖ Wildlife sanctuary can be **declared even for one endangered species.**
- ❖ **Wildlife sanctuaries can be promoted to National Park.**

Reserve Forest:

- ❖ In Reserve Forest, **right to all activities like hunting, grazing, etc. are banned** unless specific orders are issued otherwise.
- ❖ Typically **Reserve Forests are upgraded to a status of Wildlife Sanctuaries.**

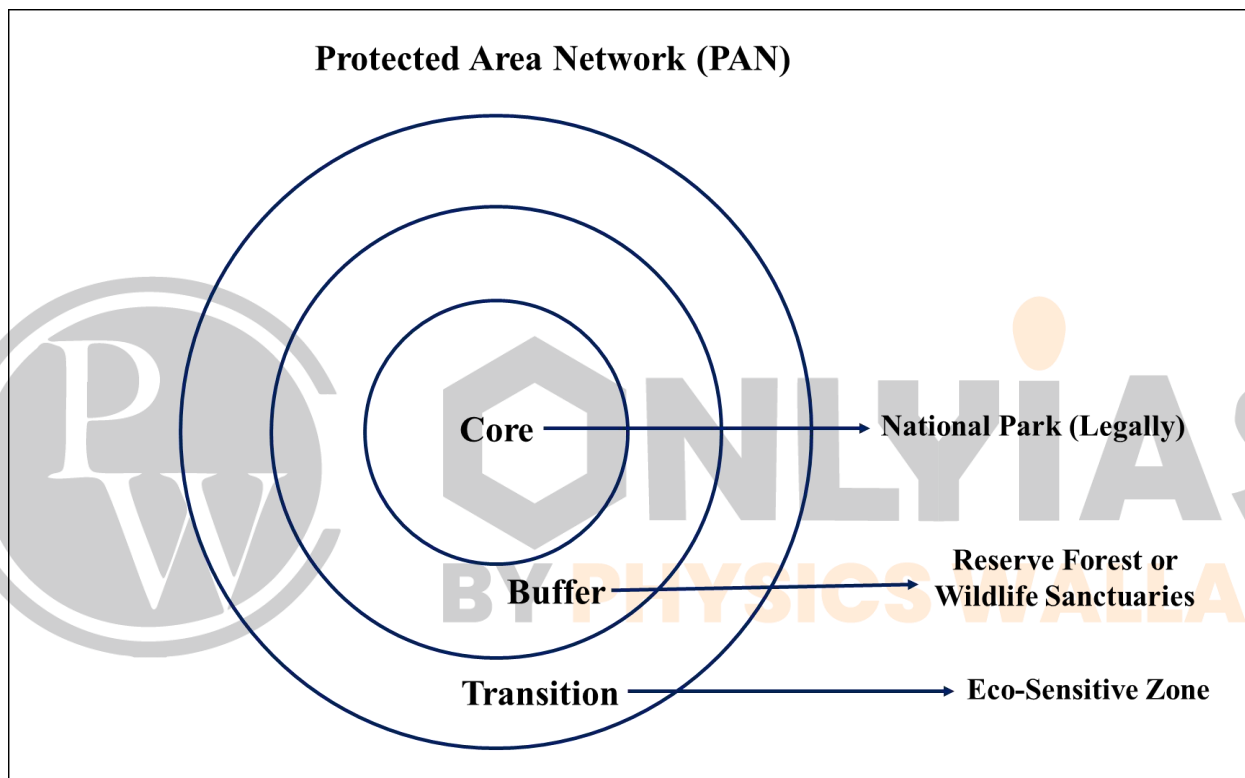
Protected Forest:

- ❖ In Protected Forests, **right to activities like hunting and grazing are allowed to communities** living on the fringes of the forests, who sustain their livelihood from forest resources.
- ❖ The Protected Forests can be **upgraded to Reserve Forests.**

Eco-Sensitive Zones (ESZ):

- ❖ The **National Wildlife Action Plan (2002-2016)** of the **Ministry of Environment, Forest and Climate Change (MoEFCC)** says that the State Government should declare land falling within **10 km of the boundaries of National Parks and Wildlife Sanctuaries** as Eco Sensitive Zones under **Environmental Protection Act 1986.**

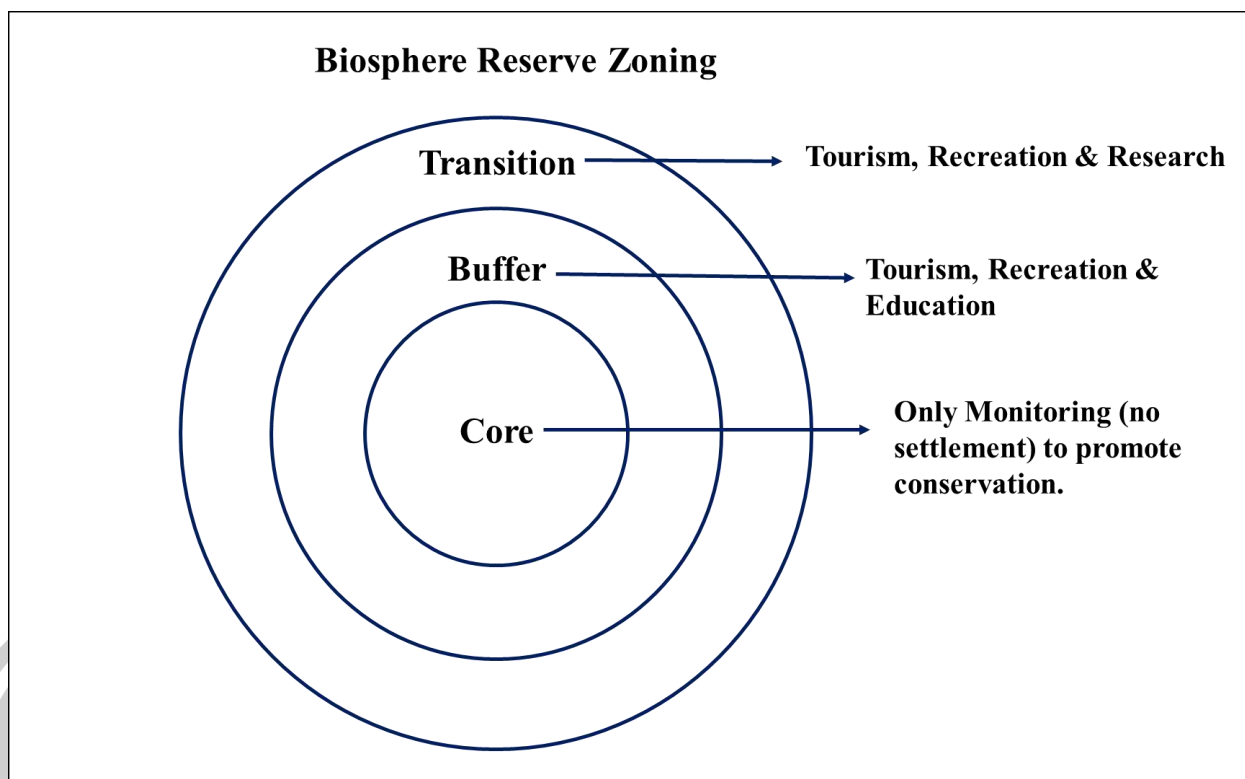
- ❖ Eco-sensitive zones provide more protection and act as “**shock absorber**” and transition zones, it also minimizes forest depletion and man-animal conflict. These zones are also known as **ecologically fragile zones**.
- ❖ The core area has the **legal status of being a National Park**.
- ❖ Buffer area does not have the legal status of being a national Park. It can be a wildlife sanctuary, Tiger reserve.
- ❖ **As a general principle, the width of the ESA could go up to 10 km around the protected area.** However, if these sensitive and ecologically important corridors span beyond 10 km, then the width of the ESZ and type of regulation may vary from area to area.



Biosphere Reserve:

- ❖ Biosphere Reserve (BR) is an **international designation as per UNESCO’s Man and Biosphere (MAB) Programme**.
- ❖ Man and Biosphere (MAB) Programme is an **inter-governmental scientific programme** which was started in **1971** to improve the relationship between **man and its environment**.
- ❖ Biosphere Reserves have three main objectives:
 1. **Conservation**
 2. **Research and Monitoring**
 3. **Development (Sustainable Development of tribal people)**
- ❖ Biosphere Reserve are large areas of protected land for **conservation of wildlife, plants and animal resources and traditional life of tribals living in the area**.

- ❖ A biosphere reserve may have one or more national parks and wildlife sanctuaries in it.
- ❖ There are 18 biosphere reserves in India.



Criteria of Biosphere Reserve by UNESCO for designation of Biosphere Reserve:

- ❖ Minimally disturbed core area.
- ❖ Preserve of Primitive Tribal Groups.
- ❖ Preserve certain endemic species.

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DAILY CLASS NOTES

ENVIRONMENT

Lecture – 14

International Conventions for Biodiversity Conservation



International Conventions for Biodiversity Conservation

- ❖ There are 18 biosphere reserves in India. Out of which 12 biosphere reserves have been internationally recognised by UNESCO.

➤ Image credit: Indian Express

- ❖ The latest biosphere reserve from India to get international recognition is the **Panna Biosphere Reserve in Madhya Pradesh**.

- ❖ The Union government designates biosphere reserves in the country, and the Ministry of Environment, Forest and Climate Change appealed to UNESCO for international recognition.

- ❖ Globally, there are around 750 Biosphere Reserves in 134 countries.

- ❖ A biosphere reserve can be across international borders, and they are known as intercountry biosphere reserves.



Benefits Of International Recognition of the Biosphere Reserve by UNESCO

- ❖ It acts as a source of soft power, leading to international recognition.
- ❖ Ecotourism will be promoted, and the prospects will be high. It will also increase economic activity.
- ❖ It provides scientific knowledge and helps in research.
- ❖ It helps a country to get UNESCO conservational and functional assistance but not financial assistance.
- ❖ It helps in giving a holistic conservation approach along with tribals.

Difference Between National Park, Wildlife Sanctuary, and Biosphere Reserve

National Park and Wildlife Sanctuary	Biosphere Reserve
1. Under the jurisdiction of the state government. 2. Statutory designation as per the Wildlife Protection Act 3. It is an exclusive approach to conservation.	1. Under the jurisdiction of the central government. 2. International designation by UNESCO (There is no law in the country). 3. It has an exclusive conservation approach.

❖ International Conventions for Biodiversity Conservation

(A) Convention on Biological Diversity (CBD)

- It is an internationally binding treaty.
- The Convention on Biological Diversity opened for signature in 1992 (Earth Summit).
- Came into force in 1993.
- **Three main goals:**
 - 1) Conservation and biodiversity
 - 2) Sustainable use of biodiversity
 - 3) An equitable and fair share of the benefits derived from the use of genetic resources .

Additional Information: Earth Summit

The United Nations Conference on Environment and Development (UNCED), also known as the 'Earth Summit', was held in Rio de Janeiro, Brazil, from 3-14 June 1992. This global conference, held on the occasion of the 20th anniversary of the first Human Environment Conference in Stockholm, Sweden, in 1972, brought together political leaders, diplomats, scientists, representatives of the media, and non-governmental organizations (NGOs) from 179 countries for a massive effort to focus on the impact of human socio-economic activities on the environment.

Climate change, desertification and biodiversity loss are heavily interlinked and pose existential challenges to humanity. In response to these challenges, governments founded three sister “Rio Conventions” at the 1992 Earth Summit in Rio de Janeiro, Brazil.

These are:

- ❖ the United Nations Framework Convention on Climate Change (UNFCCC, also known as UN Climate Change)
- ❖ the Convention on Biological Diversity (CBD, also known as UN Biodiversity)
- ❖ the United Nations Convention to Combat Desertification (UNCCD)

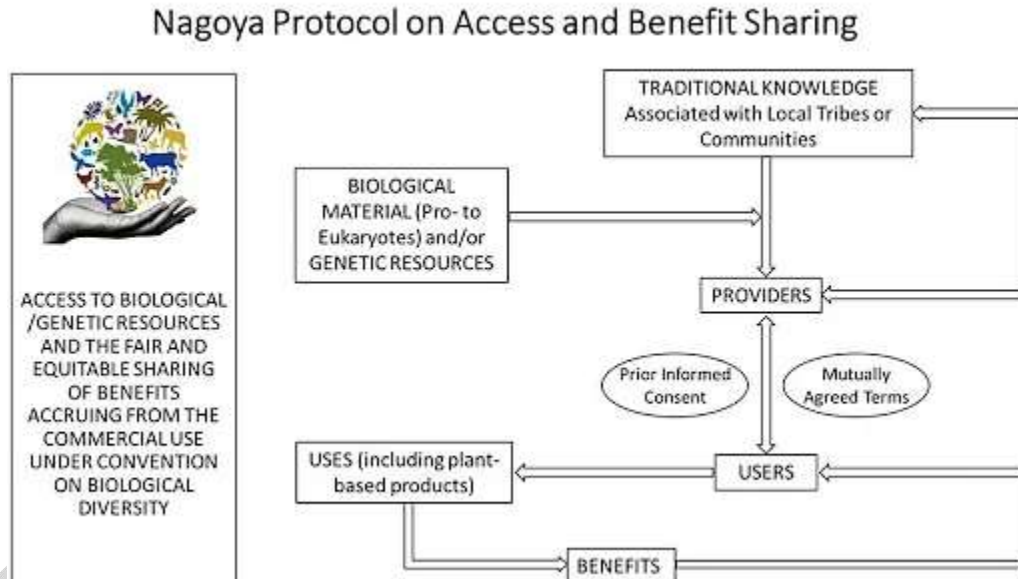
❖ Supplementary agreement to the Convention on Biological Diversity.

1) Cartagena Protocol on Biosafety (2003)

- It is an international treaty governing the movement of “**Living Modified Organisms**” or **genetically modified organisms (GMOs)**.
- According to this protocol, exporters cannot export GM varieties without approval from importers.

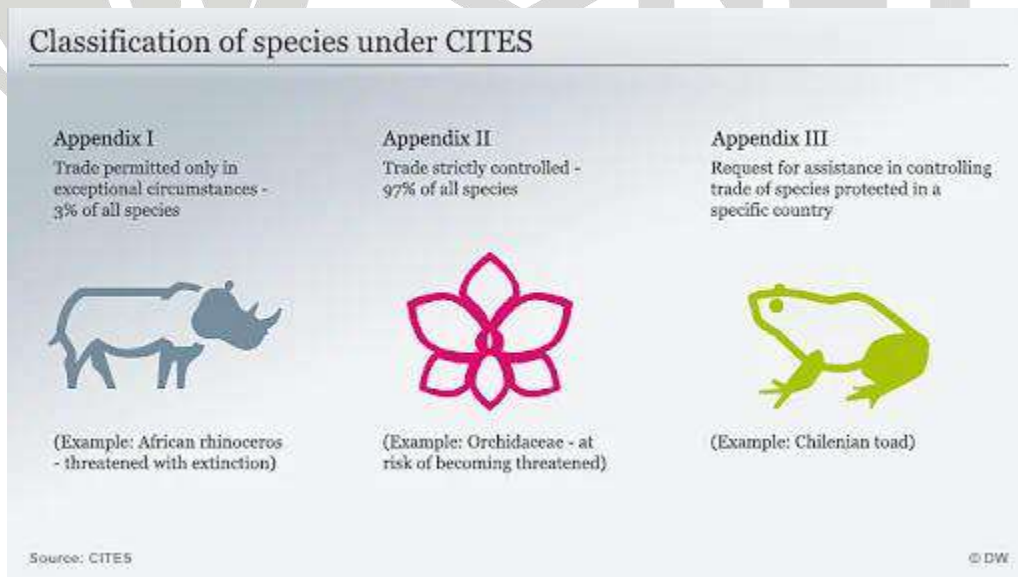
2) Nagoya Protocol on Access and Benefit Sharing (2014)

- It provides a transparent legal framework for the effective implementation of the third objective of the CBD.



(B) CITES (1975)

- The Convention on International Trade in Endangered Species of Wild Fauna and Flora.
- Its aim is to ensure that the international trade of white animals and plants does not threaten their survival.



(C) Convention on Conservation of Migratory Species of Wild Animals

- It is the only global convention for the conservation of migratory species and their habitats and migration routes.
- COP-13 of CMS was hosted by India 2020 (adopted Gandhi Nagar Declaration)

- It emphasizes the need for greater protection of migratory species throughout their ecological or migratory range.
- At COP-13, three species from India got listed on Appendix 1.
 - a. **Bengal Florican**
 - b. **Great Indian Bustard**
 - c. **Indian Elephant**

CONVENTION ON MIGRATORY SPECIES OF WILD ANIMALS (BONN CONVENTION)

- aims to conserve terrestrial, marine and avian migratory species throughout their range (global scale)
- aim to conserve populations of:
 - European Bats; Cetaceans of the Mediterranean Sea;
 - Black Sea and Contiguous Atlantic Area;
 - Small Cetaceans of the Baltic, North-East Atlantic, Irish and North Seas;
 - Seals in the Wadden Sea; African-Eurasian Migratory Waterbirds;
 - Albatrosses and Petrels;
 - Gorillas and their Habitats

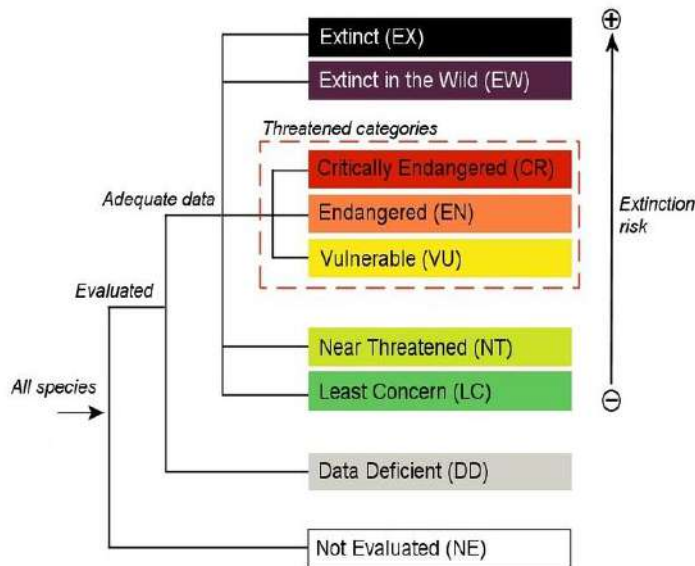


Additional Information:

- ❖ **The Convention on the Conservation of Migratory Species of Wild Animals (CMS), also known as the Bonn Convention.**
- ❖ **As an intergovernmental treaty under the aegis of the United Nations Environment Programme (UNEP), CMS brings together the governments of the countries through which migratory species pass - the Range States;**
- ❖ **It lays the legal foundation to conduct conservation measures on a global scale. The legal instruments under CMS may range from legally binding Agreements to less formal Memoranda of Understanding and can be adapted to fit the requirements of each region.**
- ❖ **Signed in 1979 in Bonn, Germany, the convention entered into force in 1983.**
- ❖ **As of September 2020, there are 131 Member States to the convention.**
- ❖ **The depositary is the Government of the Federal Republic of Germany.**

(D) IUCN Red List or Threatened Species (International Union for Conservation of Nature)

- It is the world's largest data source for global extinction risk raised by species.



Additional Information: IUCN

- ❖ Governments and civil society organisations with a shared goal to protect nature established the International Union for the Protection of Nature (IUPN), the **first global environmental union, on 5 October 1948 in Fontainebleau, France.**
- ❖ The Union **officially changed its name to International Union for Conservation of Nature in 1956.**
- ❖ **In 1964, IUCN established the IUCN Red List of Threatened Species™, which has since evolved into the world's most comprehensive data source on the global extinction risk of species.**
- ❖ **The Convention on Wetlands of International Importance (Ramsar Convention) comes into force, and its secretariat is administered from IUCN's headquarters.**





DAILY CLASS NOTES

ENVIRONMENT

Lecture – 15

Wetlands and Mangrove



Wetlands and Mangrove

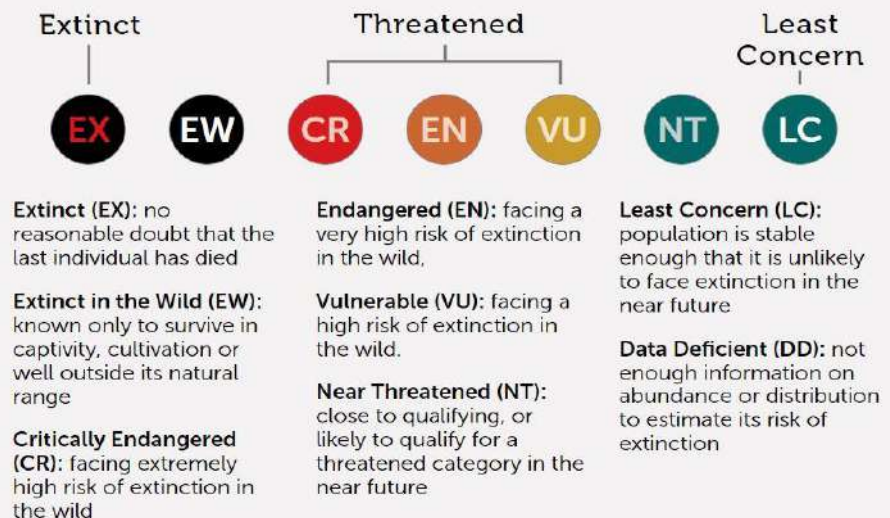
CITES: There Are Three Appendices.

- ❖ Appendix 1: It includes threatened species, trade is prohibited (permission can be given only in exceptional conditions).
- ❖ Appendix 2: Species are not threatened, but trade is controlled.
- ❖ Appendix 3: Species are protected in at least one country (CITES parties will help in controlling the trade).

CMS (Conservation of Migratory Species): There Are Two Appendices.

- ❖ Appendix 1: Species facing a high risk of extinction in the near future. They are given the highest degree of protection.
- ❖ Appendix 2: It includes other migratory species.

THE RED LIST CATEGORIES



Biodiversity hotspot:

- ❖ It is a biogeographic region that contains a high level of species diversity, many endemic species (species not found anywhere else in the world), and where a significant level of biodiversity is threatened by human habitation.
- ❖ As per Conservation International a biodiversity hotspots must have two strict criteria:
 - **Species Endemism:** It must contain 1500 species of vascular plants.
 - **Degree of threat:** There must be loss of at least 70 percent of natural habitat.
- ❖ **Indian Biodiversity Hotspot:**
 - The Himalayas
 - Indo Burma
 - The Western Ghat
 - Sunderland



Biodiversity coldspot:

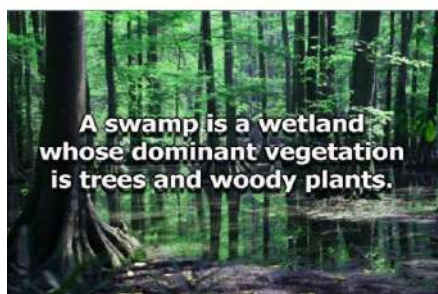
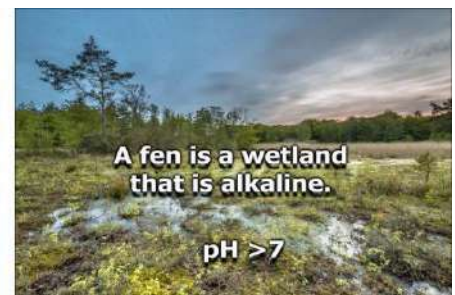
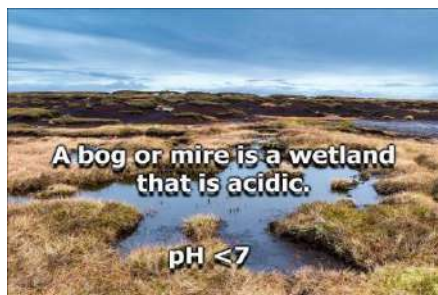
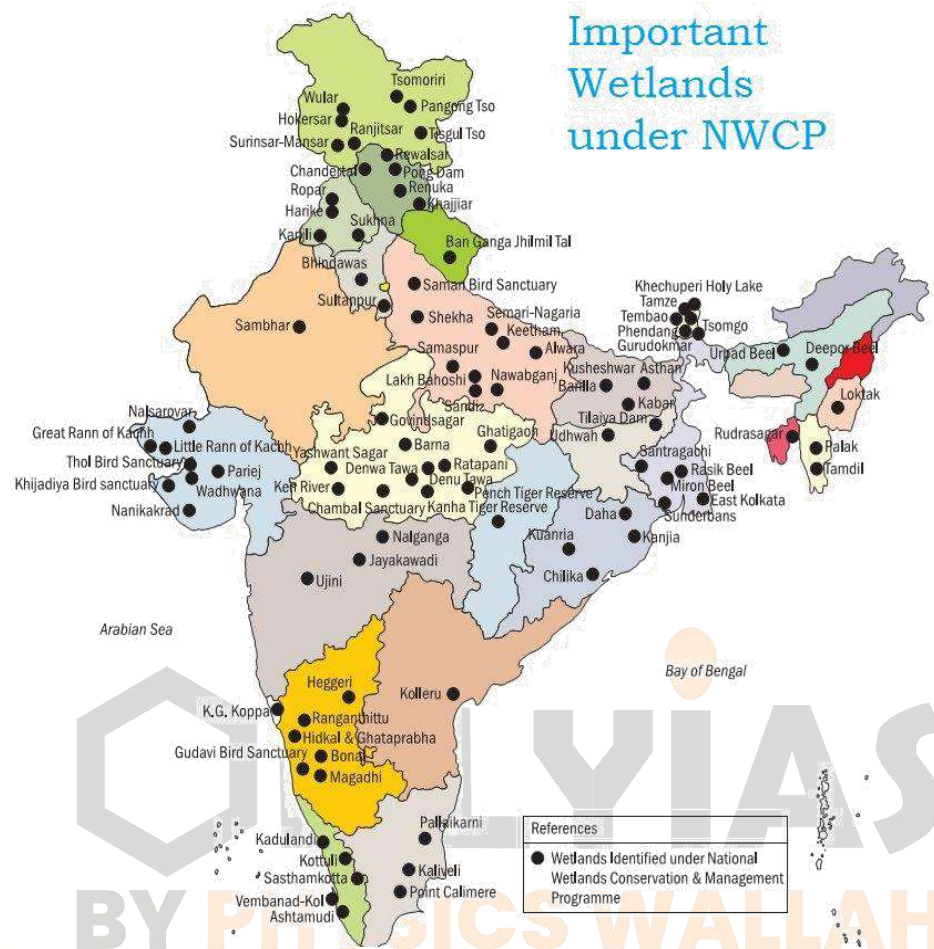
- ❖ A region with a small population of living creatures, such as plants, animals, fungi, and bacteria, is referred to as a "biodiversity cold spot". Such biogeographical areas have relatively low biological diversity but experience a high rate of habitat loss.

Wetlands:

- ❖ Wetlands are those areas where the soil is covered with water at ground level throughout the year.
- ❖ **Wetland ecosystems are transitional zones between terrestrial and aquatic ecosystems;** they can be considered as "Ecotones", and they support both terrestrial and aquatic species.
- ❖ The vegetation of wetlands is adapted to soil saturation conditions and is known as **Hydrophytes**.

Types of wetlands:

- ❖ Coastal Wetlands
- ❖ River Wetlands
- ❖ Lake Wetlands
- ❖ Swamps and Marshes
- ❖ Bogs and Fen



1. **Marshes:** These are wetlands with non-woody vegetation, like grasses.
 2. **Swamp Wetlands :** These wetlands are with woody vegetation, like trees.
 3. **Bogs-** These wetlands are present in North America, and are rich in peat and mosses with acidic water, and they are low in nutrients, so they can't support plant growth.
- ❖ **Fen** -These wetlands have less peat and more nutrients.



BOGS



PEATS

Significance of Wetlands:

- ❖ They are rich in biodiversity and enrich ecosystem services.
- ❖ They play a vital role in the nutrient cycle.
- ❖ They also play an important role in water recharge.
- ❖ They act as carbon sinks.
- ❖ Wetlands store more carbon than any other ecosystem.
- ❖ They act as a bioshield, protecting against urban flooding.
- ❖ They are natural shock absorbers because they act as a buffer and protect us from extreme weather events like floods and droughts.
- ❖ Wetlands can supply a divergent quantity of plants, animals, and minerals.

Major Threats Faced By Wetlands:

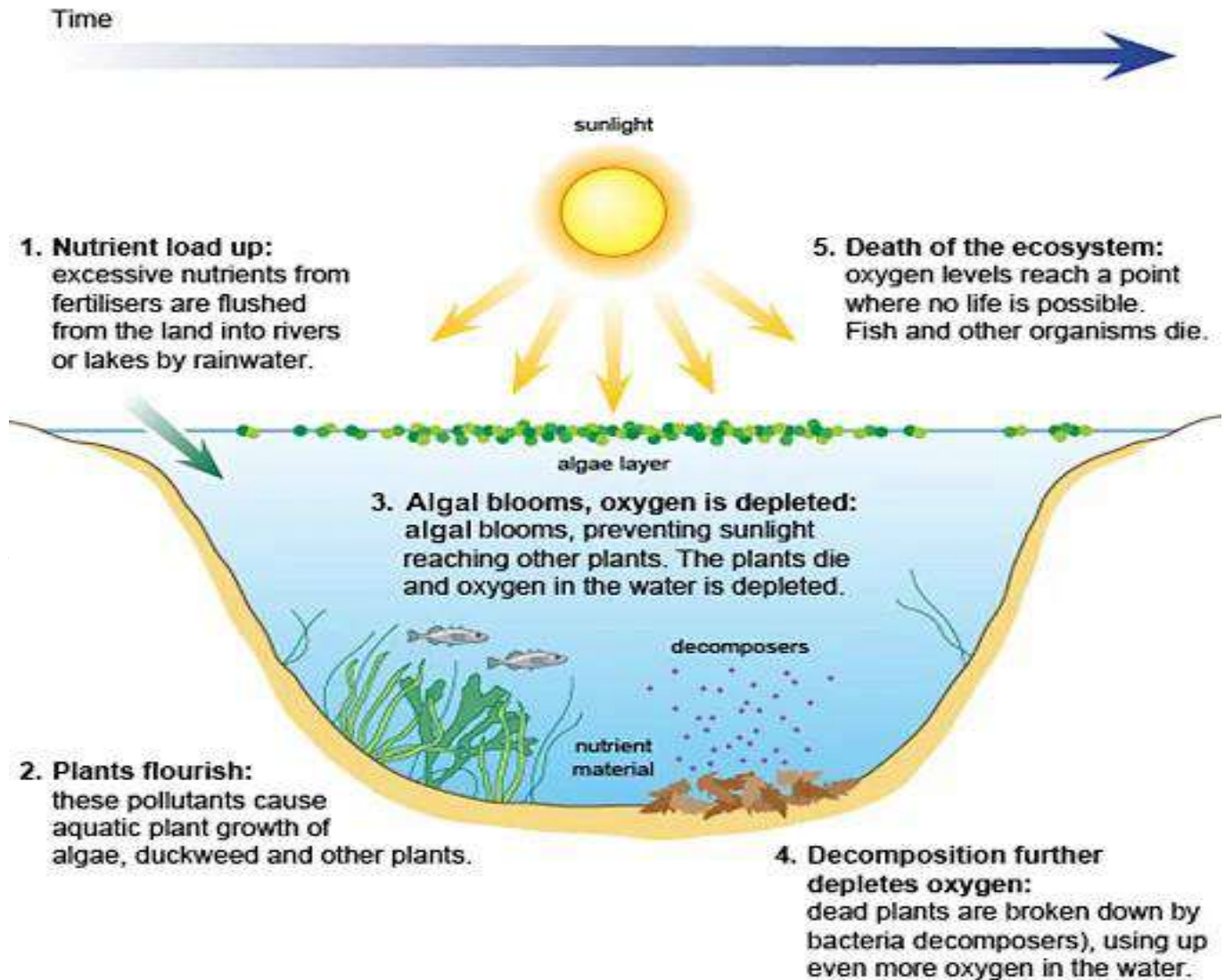
- ❖ Encroachment due to unplanned and unscientific urbanization.
- ❖ Overexploitation of wetlands in agriculture.
- ❖ Pollution from various sources :
 - Due to solid waste disposal
 - Industrial discharge
 - Agri-runoff water
- ❖ Due to overgrazing .
- ❖ Impact due to climate change.

Biological Oxygen Demand:

- ❖ It is defined as the amount of oxygen eaten by bacteria or decomposers, or its own respiration and decomposition of dead organic materials.

Eutrophication and Algal Bloom:

- ❖ The pollutant in a wetland will add problematic nutrients to the wetland; this nutrient is rich in nitrogen and phosphorus.
- ❖ Such a supply of problem nutrients is known as eutrophication.
- ❖ Eutrophication will result in an overgrowth of algae known as an algal bloom. Which ultimately results in an increase in BOD (Biological Oxygen Demand) and a decrease in dissolved oxygen in the water body.



DAILY CLASS NOTES

Environment

Lecture - 16

**Mangrove and Ramsar
convention**



Mangrove and Ramsar convention

- ❖ **COD- Chemical Oxygen Demand** is defined as the amount of oxygen required for chemical degradation or oxidation of organic and inorganic material.
- ❖ **BOD-Biological Oxygen Demand** is the amount of oxygen required for biological decomposition by bacteria.

RAMSAR CONVENTION:

- ❖ The Ramsar Convention on Wetlands establishes guidelines for the **preservation and judicious use of all wetlands through local, national, and international collaboration.**
- ❖ It was adopted in the **Iranian city of Ramsar in 1971 and entered into force in 1975.**
- ❖ The Ramsar Convention is an international environmental agreement that addresses wetlands.
- ❖ **Approximately 170** contracting parties are there in convection, including India.
- ❖ The Ramsar Convention promotes the designation of wetlands that are vital for **preserving biological diversity, and the conservation and wise use of wetlands.**
- ❖ Wetlands of international importance are **known as Ramsar sites** once they have been recognised.

RAMSAR CONVENTION: CRITERIA FOR IDENTIFICATION OF WETLANDS

1) Wetlands supporting rich biodiversity:

- 20,000 or more aquatic birds should be there.
- Large percentage of native fish subspecies
- It should have **1 percent of the individuals of an aquatic bird population.**

2) A rare or unique wetlands:

- It should support threatened species.
- It should provide habitat for plants and animals vital to the ecosystem of that area.
- It should provide nesting, sparrowing, migration, and food.



Additional Information: The Ramsar Sites Criteria

The nine criteria for identifying Wetlands of International Importance

Group A of the Criteria. Sites containing representative, rare or unique wetland types

Criterion 1: A wetland should be considered internationally important if it contains a **representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.**

Group B of the Criteria. Sites of international importance for conserving biological diversity

Criteria based on species and ecological communities

Criterion 2: A wetland should be considered internationally important if it supports **vulnerable, endangered, or critically endangered species or threatened ecological communities.**

Criterion 3: A wetland should be considered internationally important if it **supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.**

Criterion 4: A wetland should be considered internationally important if it supports **plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.**

Specific criteria based on waterbirds

Criterion 5: A wetland should be considered internationally important if it regularly supports **20,000 or more waterbirds.**

Criterion 6: A wetland should be considered internationally important if it regularly supports **1% of the individuals in a population of one species or subspecies of waterbird.**

Specific criteria based on fish

Criterion 7: A wetland should be considered internationally important if it supports a significant proportion of **indigenous fish subspecies, species or families, life-history stages, species interactions** and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biological diversity.

Criterion 8: A wetland should be considered internationally important if it is an important source of food for **fishes, spawning ground, nursery and/or migration path on which fish stocks**, either within the wetland or elsewhere, depend.

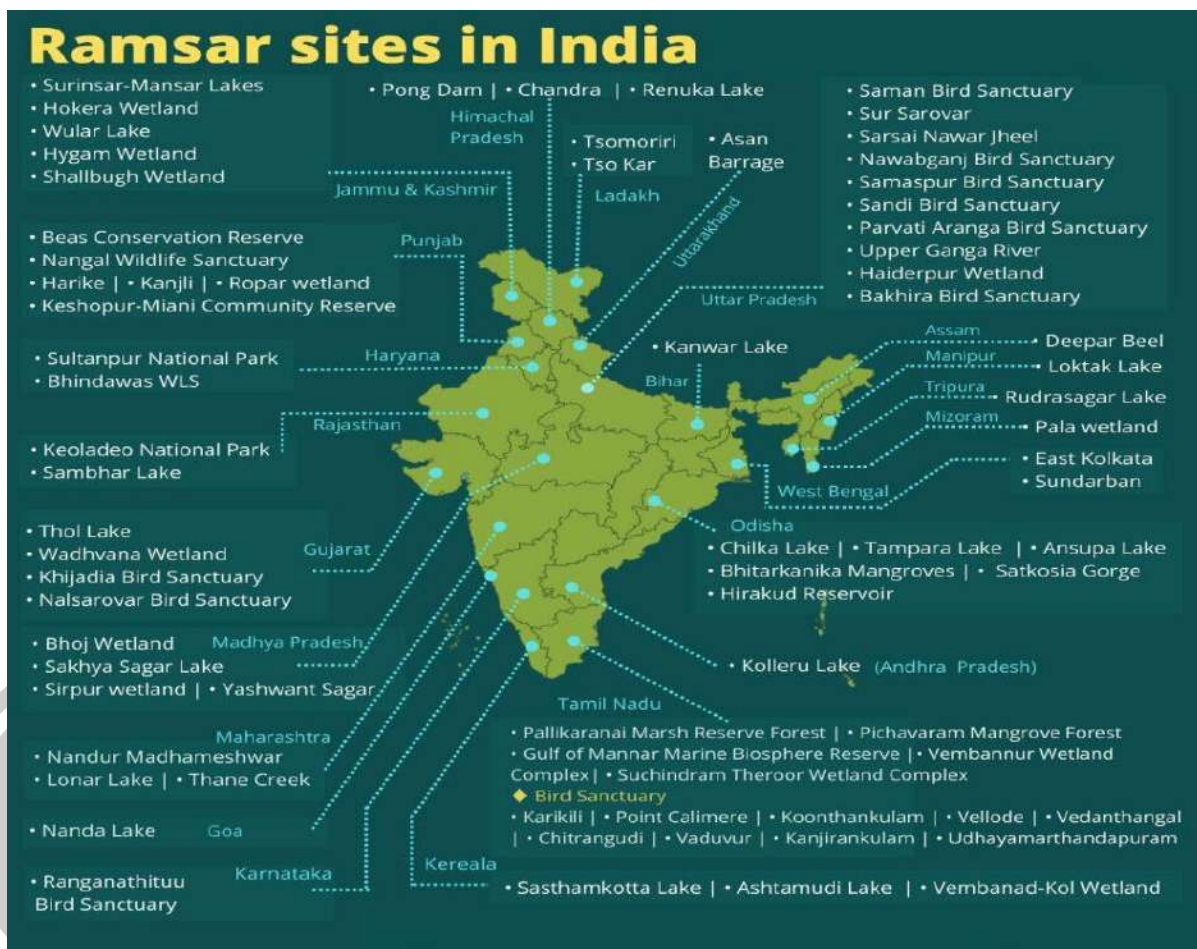
Specific criteria based on other taxa

Criterion 9: A wetland should be considered internationally important if it regularly supports **1% of the individuals in a population of one species or subspecies of wetland-dependent nonavian animal species**

Source: Ramsar Site

INDIA AND RAMSAR CONVENTION

- ❖ In 1982, India became a party to the Ramsar Convention for Wetlands, or Ramsar Convention, and at present, **there are 75 Ramsar sites present in India.**
- ❖ Presently, **the largest Ramsar site is Sundarban.**
- ❖ In terms of the number of authorised sites, **India is at rank 1 in South Asia and third in Asia.**



THE MONTREUX RECORD

- ❖ The Montreux record is a database of wetland sites for the list of wetlands of international importance that have experienced, are experiencing, or are projected to experience a change in ecological character as a result of technological advancement, pollution, or other human activities.
- ❖ Keoladeo National Park in Rajasthan and Loktak Lake in Manipur were included in the Montreux Record in 1993.

INDIA'S INITIATIVE TO PROTECT WETLANDS

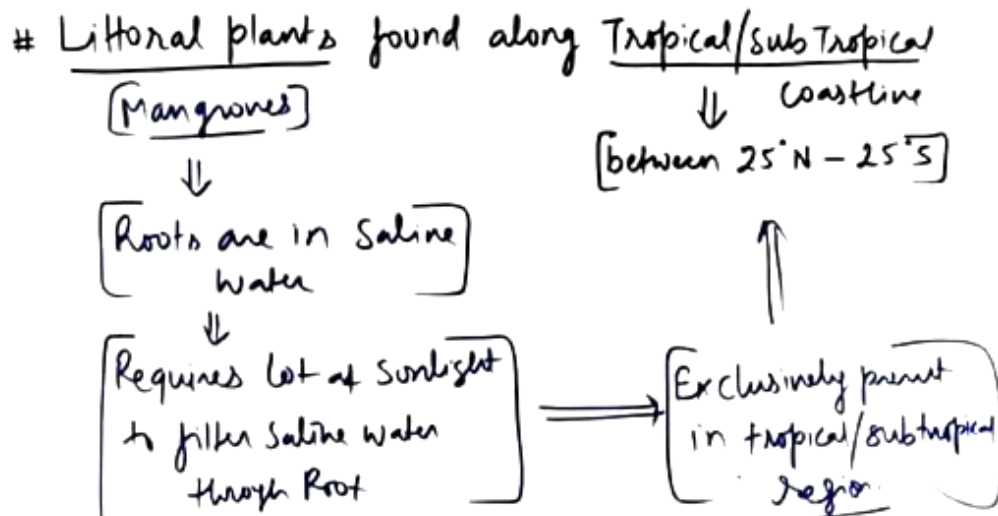
1. National wetland conservation programme by the Ministry of Environment, Forest and Climate Change (1985–86)
 - This ensures the judicious use and conservation of wetland in India for the benefit of local people.
 - Wetland management is the responsibility of the state government because land resources belong to them.
 - **Criteria for identifying wetland under the NWCP (National Wetland Conservation Programme) are the same as the Ramsar Convention on wetland.**
 - Under NWCP, overall coordination is done by the central government.
2. Wetland Conservation and Management Rule (2017)

- The Wetlands (Conservation and Management) Rules, 2017 have been made official by the Ministry of Environment, Forests, and Climate Change (MoEF&CC) in accordance with the provisions of the Environment (Protection) Act, 1986.
- The legal framework for the preservation and management of wetlands in India is provided by these regulations.

MANGROVES



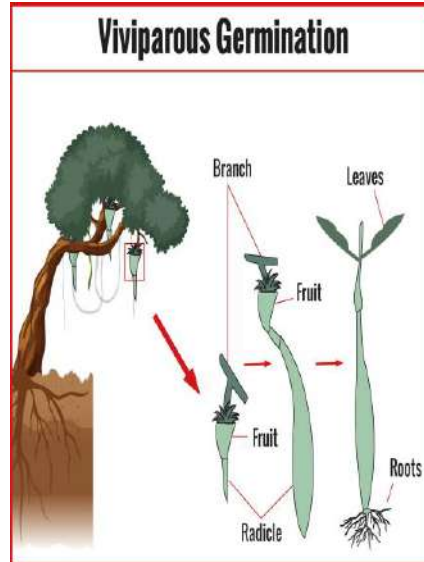
- ❖ A mangrove is a **small tree or shrub that grows along coastlines, taking root in saline water.**
- ❖ The term mangrove also refers to the environment as a whole.
- ❖ Mangroves are a type of **littoral plant found along tropical and subtropical coastlines.**
- ❖ Mangroves are a salt-resistant and heat-resistant plant group.
- ❖ Mangroves are more prevalent in areas with high rainfall and temperatures.



CHARACTERISTICS OF MANGROVE:

- ❖ Mangroves have a complex root system where the root can filter salt, and they are present over the surface and known as **breathable roots**.
- ❖ They have special breathable roots, or **pneumatophores**.
- ❖ Because the oxygen content in the soil is low in mangrove habitats, the root system absorbs the oxygen from the atmosphere.

Plant vivipary



- ❖ Mangrove forests have a **viviparity mode of reproduction** where seed germinates on the tree before falling. This is an adaptation to overcome the saline water germination challenge.
- ❖ **Succulent leaves:** Mangroves, like desert plants, store fresh water in their flashy and thick leaves. A waxy covering on leaves reduces evaporation.

BENEFITS OF MANGROVE

- ❖ Mangroves act as **buffers between marine and terrestrial ecosystems**.
- ❖ Mangroves protect beaches from **storms, waves, and flooding** and help prevent coastal erosion.
- ❖ They play an important role in improving water quality by **filtering pollutants and trapping sediments from the land**.
- ❖ Mangroves are highly productive ecosystems, and they provide locals with wood, firewood, medicinal plants, food, etc.
- ❖ Mangroves are rich in biodiversity.
- ❖ Mangroves provide habitat and breeding grounds for fish and birds.
- ❖ Mangroves are **less than 2 percent of marine ecosystems, but they account for 10 to 15% of carbon sinks as blue carbon storage**.



Additional information: Benefits of Mangroves

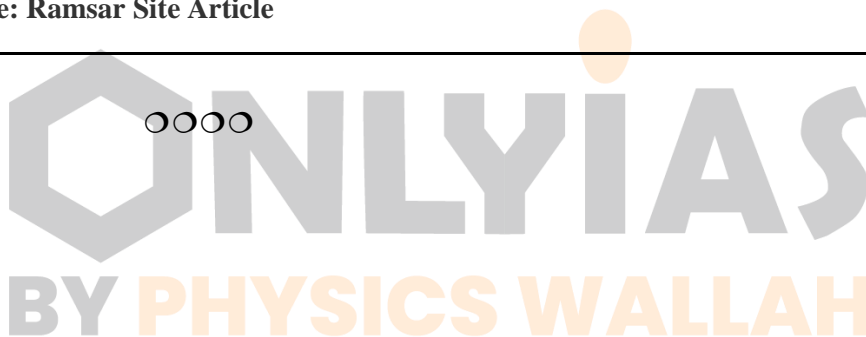
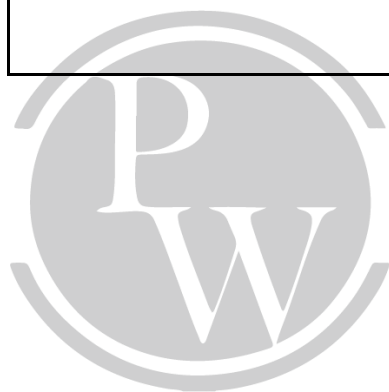
Natural coaster buffer

- ❖ Mangroves are a natural buffer from erosion, tsunamis, and storm-driven wind and waves.
- ❖ Mangroves are an active regulator for almost all natural processes, including nutrient cycle, silt deposit, water quality, and water cycle, highly-efficient carbon sink.
- ❖ Mangroves are Important habitats for species diversity.
- ❖ Communities and livelihoods: animals and humans rely on mangroves for food and natural resources.
- ❖ Mangroves create habitat that sustains the production of commercially important fish, crustaceans, and molluscs and supports an estimated 4.1 million small scale fishers globally.
- ❖ Ecosystem linkages: essential components that links coastal habitats and ecosystems.

Carbon storage of mangroves and sequestration

- ❖ Due to waterlogged soil environment, mangroves are estimated to hold up to four times the amount of carbon as some other forested ecosystems (e.g. temperate and boreal forests)

Source: Ramsar Site Article



PW Web/App: <https://smart.link/7wwosivoicgd4>

DAILY CLASS NOTES

Environment

Lecture - 17

Acid Rain and Ozone Depletion



Acid Rain and Ozone Depletion

THREATS TO MANGROVE:

- ❖ Biotic pressure and natural disasters have a significant negative impact on mangrove ecosystems.
- ❖ Natural disasters, such as flooding and draught-like conditions.
- ❖ These forests are in danger because of the increase in land acquisition for agriculture and industry near the coast, as well as the discharge of untreated domestic sewage, industrial effluents, and pesticide residues from agricultural fields.
- ❖ Industrial pollution and agricultural pesticides are threats to mangroves.
- ❖ Shrimp farming is currently responsible for the majority of mangrove cultivation, endangering the mangrove environment.

MANGROVES IN INDIA:

- ❖ International Day for Conservation of Mangrove Ecosystems is celebrated every year on July 26.
- ❖ As per the Indian state report, IFSR 2021, mangrove cover in India is 4992 square kilometers. Which is 0.15 percent of the total geographical area (India).
- ❖ The Sunderbans (West Bengal) are the largest mangrove forest in the world. and it is listed as a world heritage site.
- ❖ The deltas of the Ganges, Mahanadi, Krishna and Godavari and kaveri river contain mangrove forest.
- ❖ Top 5 states that contain mangroves: West Bengal (40% of India's mangroves), Gujarat, Andaman and Nicobar, Andhra Pradesh, Maharashtra, and Odisha
- ❖ In India, mangroves are protected by the Environmental Protection Act of 1986.



Not to Scale*



MISHTI INITIATIVE FOR MANGROVES:

- ❖ Mangrove initiative for shoreline habitats and tangible income. This initiative was announced in the Union Budget 2023–24.
- ❖ Under this initiative, education and awareness will be spread, and mangrove plantations along the coastline will be encouraged.

MANGROVES ALLIANCE FOR CLIMATE:

- ❖ Mangrove Alliance for Climate is an initiative led by the UAE and Indonesia.
- ❖ It was later joined by India, Sri Lanka, Australia, Japan, and Spain. This alliance was launched during Cop 27 in Egypt.
- ❖ This is an intergovernmental project with no binding targets.
- ❖ Member of this alliance will support each other for research management and protection of coastal areas and mangroves.
- ❖ Members of this alliance will support each other in research, management, and protection of coastal areas and mangroves.
- ❖ This alliance will spread awareness among the people regarding the benefits of mangroves and their contribution to the environment.

ACID RAIN:

- ❖ It is the precipitation of acid in the form of rain.
- ❖ The acid rain formed as a result of air pollution, particularly a large amount of sulphur and nitrogen in the atmosphere.

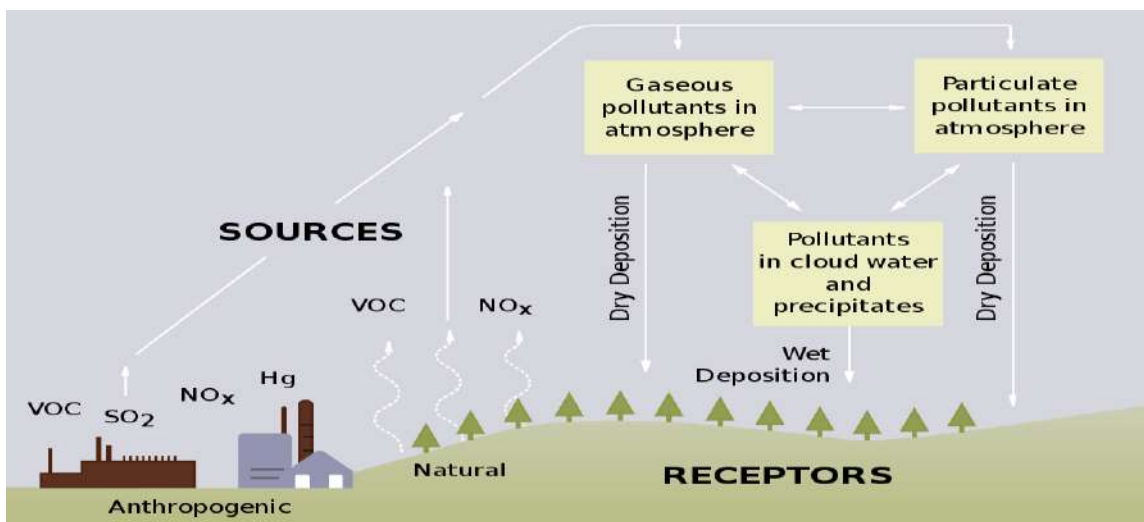
TYPES OF ACID RAIN:

Wet deposition: Sulfuric and Nitric acids combine with rain, snow, fog, and hail, and then they fall to the ground.

Dry deposition: An acidic compound in dry weather conditions that will directly settle down on the surface

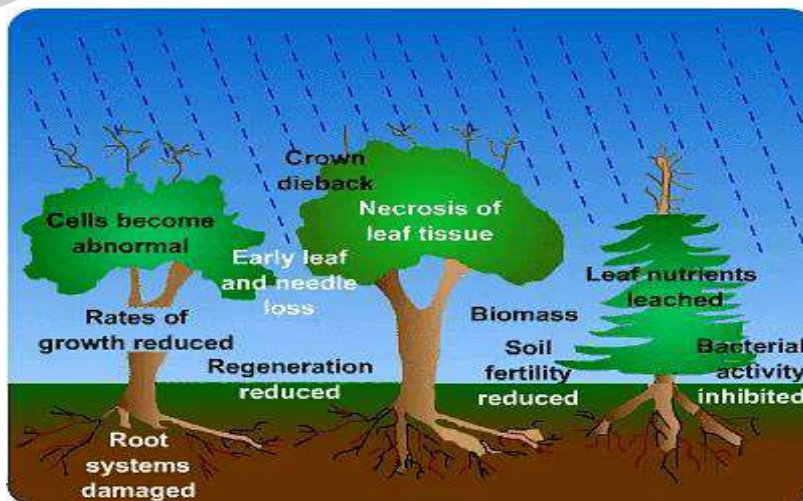
SOURCES OF ACID RAIN:

- ❖ **Sulphur:**
 - **Natural sources:** Volcanic eruption, decomposition of organic material in soil
 - **Manmade sources** include burning coal and petroleum, the smelting of metal sulphide ore, and sulfuric acid in fertilisers
- ❖ **Nitrogen:**
 - **Natural sources:** lightning, volcanoes, and biological activities
 - **Manmade sources** include forest fires, the burning of fuel, and industrial releases.



IMPACT OF ACID RAIN:

- 1) Acid rain will release hydrogen ions, which can replace potassium and magnesium in the soil, causing nutrient leaching and making the soil infertile.
- 2) The alkalinity of the soil will be replaced by acidic soil, which will further decrease the soil fertility.
- 3) Acid rain can release metals from the soil into aquatic environments, create toxic substances, and enter the food chain.
- 4) Acid rain has a lot of negative impacts on human health; it may cause bronchitis, emphysema, and skin and eye irritation.
- 5) Acid rain damages buildings and monuments. Metals, limestone, and marble exposed to acid rain degrade at a faster rate. e.g., Tajmahal has been adversely impacted in the past due to acid rain.



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DAILY

CLASS NOTES

Environment

Lecture - 18

Ozone Depletion



Ozone Depletion

STRATOSPHERIC OZONE DEPLETION

- ❖ In 1980, the discussion started about stratospheric ozone depletion.

WHAT IS OZONE

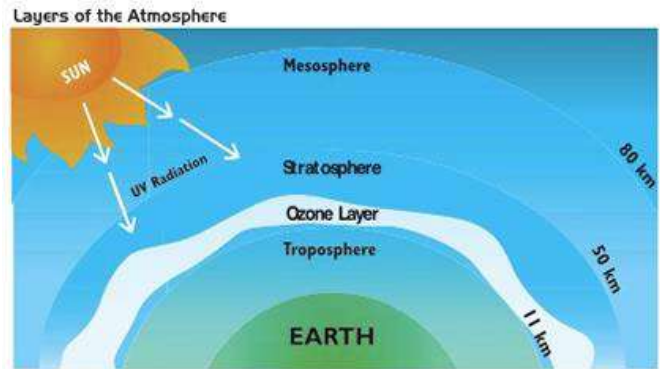
- ❖ Ozone is (O_3) and is an allotrope of oxygen.
- ❖ Ozone can be of two types.
 - Good Ozone
 - Bad Ozone

Good Ozone is Stratospheric Ozone.

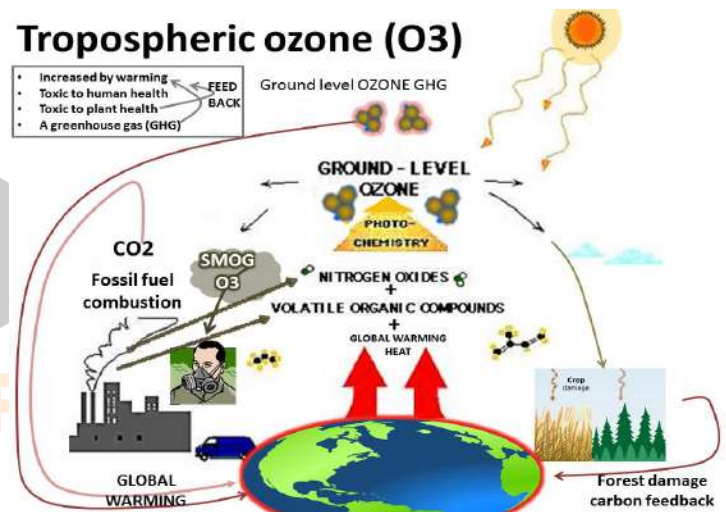
- It absorbs harmful UV radiation.
- It is vital for the survival of life on earth.

Bad Ozone, or Tropospheric Ozone

- It is potential Greenhouse Gas (GHGs)
- It acts as a secondary pollutants- it may create smog.

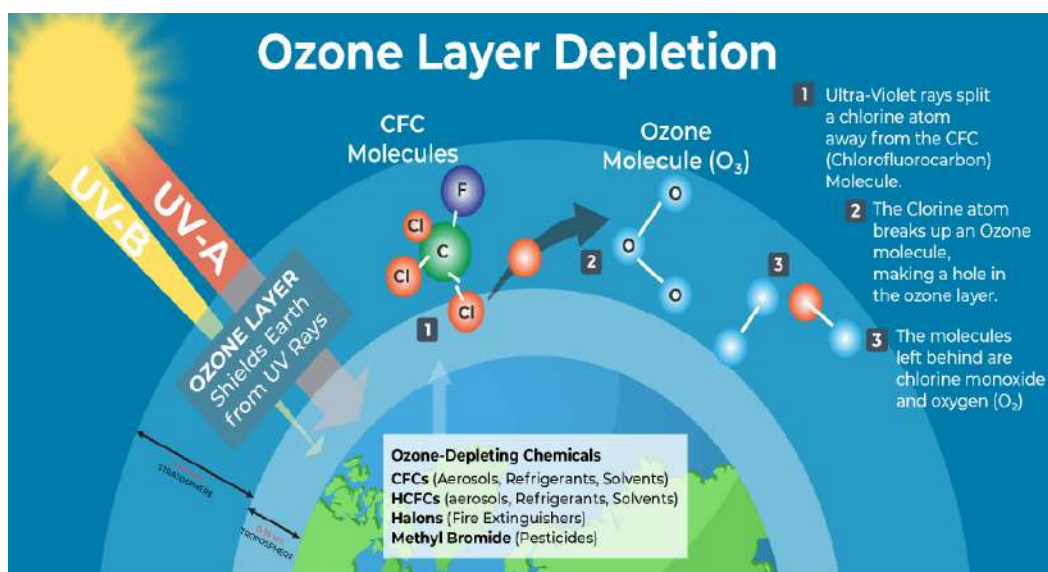


Tropospheric ozone (O_3)



OZONE DEPLETION

- ❖ It is a gradual thinning of the stratospheric ozone layer caused by the release of some chemicals known as ozone depleting substances, or ODS.
- ❖ The first ODS are:
 1. CHLOROFLUOROCARBON (CFCs)
 2. HYDROFLUOROCARBON (HCFCs)
 3. HALONS
- ❖ All these contain halogens like chlorine and bromine.
- ❖ They are all used in the refrigerator and ACs.
- ❖ ($O_3 \rightarrow O_2 + O$)



CONDITION CAUSING DEPLETION IN STRATOSPHERE:

- ❖ The first condition required is a very low temperature of less than minus 78 degrees Celsius. It is found over the polar stratospheric cloud (PSC).
- ❖ There should be a good supply of sunlight.
- ❖ This condition will occur in the late winter or early spring
- ❖ In the polar region, there will be no ozone depletion in the winter or summer because of the following two reasons:
 - In the winter time, there will be no sunlight, and
 - In the summer time, there will be high temperatures.
 - Therefore, conditions occur in the late winter or early spring.
- ❖ Polar stratospheric clouds play an important role in stratospheric ozone depletion during late winter and early spring.
- ❖ In polar stratospheric clouds, particles serve as sites for reactions that convert stable chlorine to radicals or reactive particles that destroy ozone; in other words, they convert less dangerous chlorine into an active free radical.

- ❖ Ozone depletion is occurring over both the north and south polar regions, but it is more severe over the south pole. Because of the low temperature, less than minus 78 °C is easily reached.

EFFECTS OF OZONE DEPLETION

- ❖ Its effects can cause eye disease and skin cancer due to ultraviolet B.
- ❖ Can impact the physiological processes and growth of plants due to ultraviolet rays.
- ❖ Impact on aquatic ecosystems: phytoplankton gets damaged.

ULTRAVIOLET CAN BE OF THREE TYPES

1. UV-A is the least harmful and reaches the earth.
2. UV-B is harmful and is absorbed by ozone.
3. UV-C is the most dangerous, but it never reaches the earth.

OZONE MEASUREMENT

- ❖ Stratospheric ozone is measured in the Dobson units.
- ❖ One Dobson unit = 2.69×10^{20} moles / m^2 .

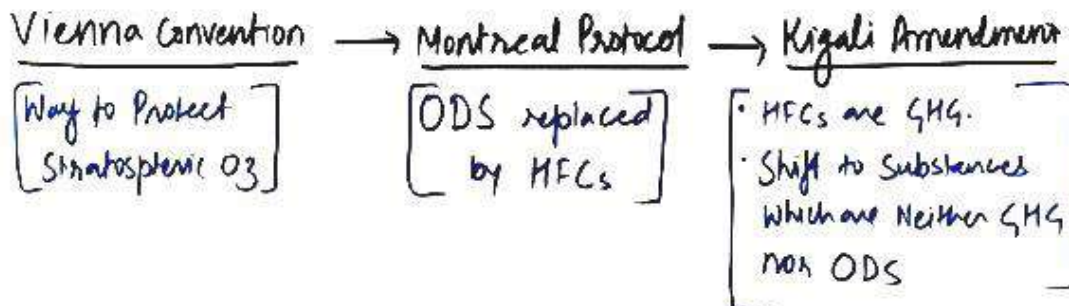
GLOBAL EFFORTS TO TACKLE OZONE DEPLETION

(1) VIENNA CONVENTION(1985)

- It was an international agreement that aimed to protect the stratospheric ozone layer from human activities.
- In 1991, India became a signatory of the Vienna Convention for the protection of stratospheric ozone.

(2) MONTREAL PROTOCOL

- It was adopted in 1987.
- It was supplementary to the Vienna Convention.
- The aim of this protocol was to control and regulate the global consumption and production of ozone-depleting substances.
- Under the Montreal Protocol, ozone-depleting substances were replaced by hydrofluorocarbons, which do not cause ozone depletion, and recent satellite images revealed the recovery of the stratospheric ozone layer.
- India became part of this in 1992.
- However, they are potent greenhouse gasses and are responsible for considerable global warming. Its global warming potential (GWP) is 100 to 1000 times greater than that of carbon dioxide



(3) KIGALI AMENDMENT

- It was adopted in 2016 and came into force in 2019.
- The aim of this amendment is to achieve this by increasing global consumption of HFC by 80 to 85 percent by 2040.
- It is a legally binding agreement, and HFC will be replaced by compounds that neither cause global warming nor ozone depletion.
- This is based on the principle of CBDR—"Common But Differentiated Responsibility". where different countries have different timelines to achieve the target of the Kigali Amendment.
- It must be operational by 2047 for India and the Gulf countries, by 2015 for China, and by 2034 for the United States and the European Union.
- China is responsible for 25% of global HFC.
- The US alone is responsible for 30% of HFC.

REPLACEMENT OF HFCs By HFOs (Hydrofloro-olefins)

- ❖ **Problems with acceptance of HFOs**
- ❖ Companies in the USA have patent rights on HFOs.
- ❖ After achieving the target set by the Kigali Amendment, the global average temperature rise can be limited to 0.5 degrees Celsius by the end of the century.
- ❖ The Kigali Amendment was ratified by the Union Cabinet in 2021.

Additional Information: HFOs (Hydrofloro-olefins)

- ❖ HFOs (hydrofluoro-olefins) are the fourth generation of fluorine-based gases. HFC refrigerants are composed of hydrogen, fluorine, and carbon atoms connected by single bonds between the atoms. HFO refrigerants are composed of hydrogen, fluorine, and carbon atoms but contain at least one double bond between the carbon atoms.
- ❖ The first HFO, jointly developed by DuPont and Honeywell, is HFO 1234yf which is sold under the brand names Opteon YF and SOLSTICE yf.
- ❖ This is a low GWP (Global Warming Potential) replacement for R134a for use in mobile air conditioning (MAC) systems in the automotive sector.
- ❖ HFO refrigerants are categorised as having zero ODP (Ozone Depletion Potential) and low GWP and so offer a more environmentally friendly alternative to CFCs, HCFCs and HFCs.

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PW Web/App: <https://smart.link/7wwosivoicgd4>

DAILY CLASS NOTES

Environment

Lecture - 19

Its Coral Reefs and Coral Bleaching



Its Coral Reefs and Coral Bleaching

INTRODUCTION

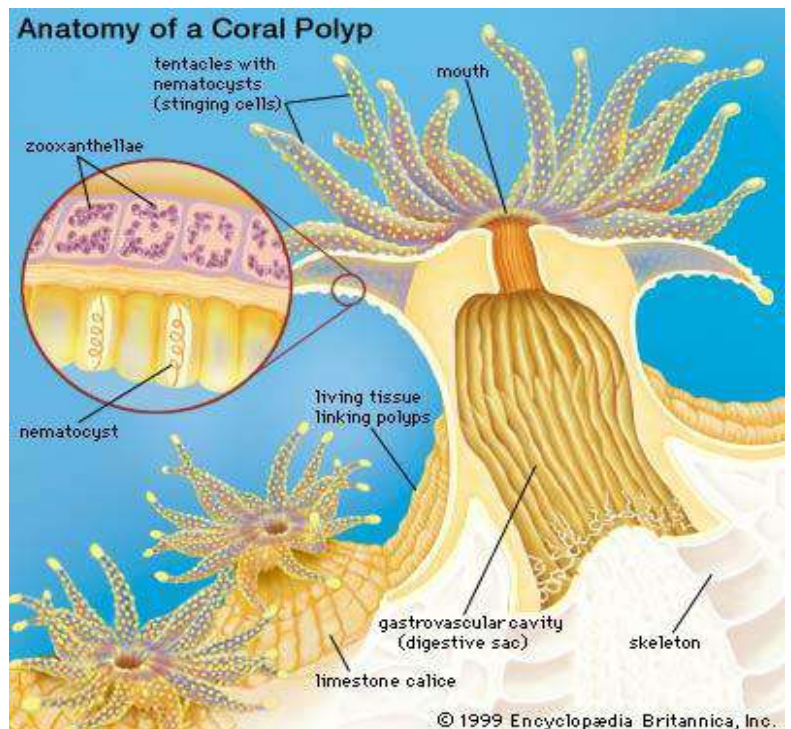
- ❖ Coral reefs are marine ecosystems that are found in warm tropical seawater.
- ❖ Geographical distribution covers only 1 percent of the entire marine area.
- ❖ It provides habitat for more than 25% of marine species.
- ❖ Because of this huge diversity, they are known as the tropical rainforests of the ocean.

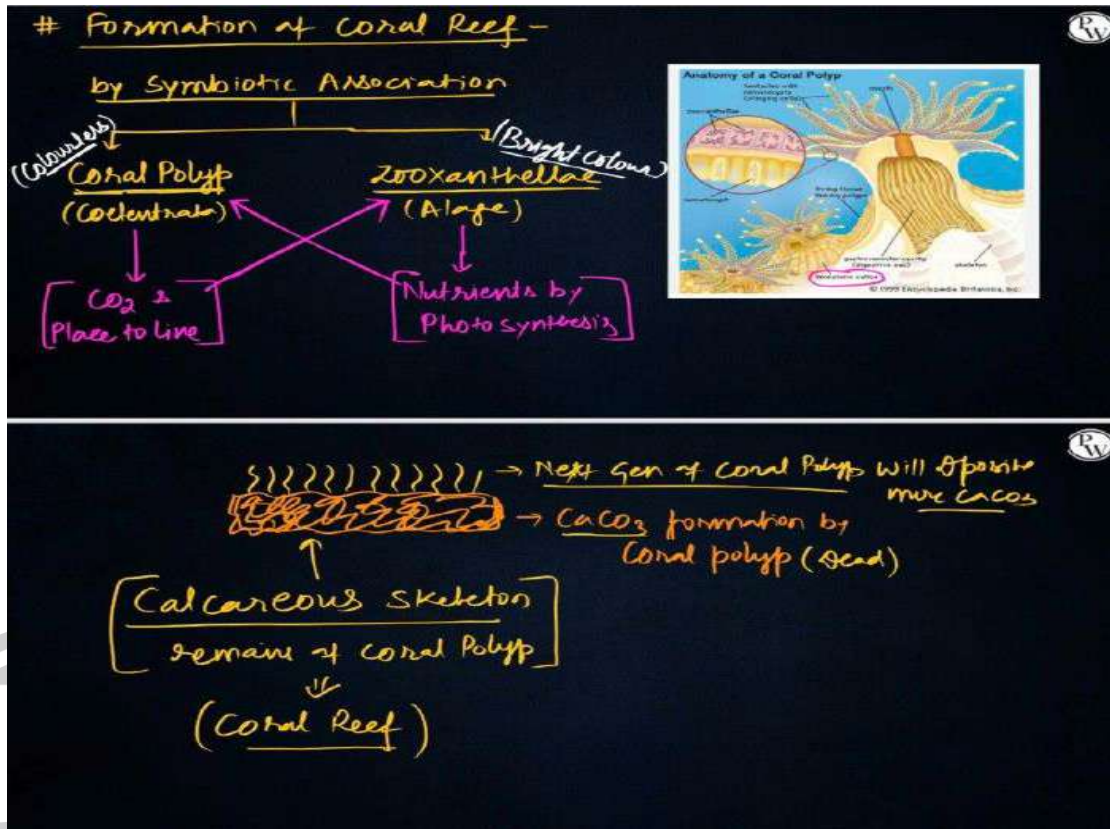


FORMATION OF CORAL REEF

Coral reefs are formed by gradual

- ❖ accumulation of calcareous skeleton
- ❖ remains of coral polyps over the longduration of time.
- ❖ After millions of years of calcium carbonate
- ❖ deposition by coral polygeneration, a
- ❖ calcareous rock will form, which will create, land for an ecosystem known as the coral reef.
- ❖ This coral reef ecosystem provides a habitat for rich biodiversity, and it also provides many ecosystem services.
- ❖ Coral plays a remarkable role in the in situ conservation of marine biodiversity.





ECOSYSTEM SERVICES BY CORAL REEF

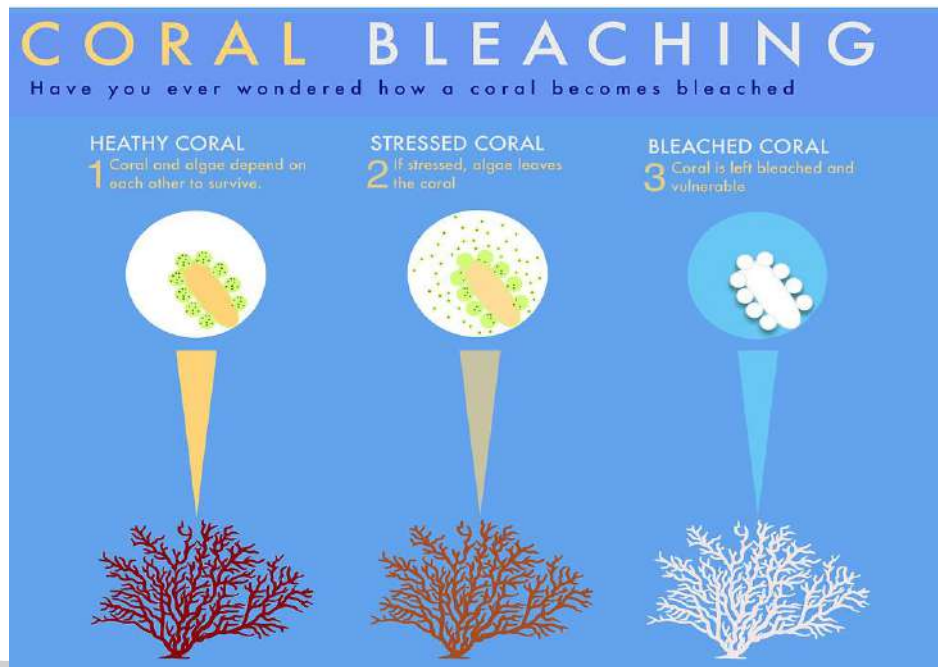
- ❖ They are also a source of food and new medicines.
- ❖ They protect coastlines from the damaging effects of wave action and tropical storms.
- ❖ They provide habitat and shelter for many marine organisms.
- ❖ The fishing industry depends also on coral reefs
- ❖ Act as a source destination for the tourism industry.

IDEAL CONDITION FOR CORAL REEF

- ❖ Coral reefs are fragile ecosystems that can only survive in a narrow range of environmental conditions.
- ❖ The temperature range should be 25 to 27 degrees Celsius in the tropically warm seawater.
- ❖ Corals thrive in tropical waters at $30^\circ N$ and $30^\circ S$ latitudes.
- ❖ Ocean water salinity should be around 32 to 35 parts per thousand.
- ❖ The ocean's water depth should be 60 to 80 metres.
- ❖ Presence of clean and unpolluted water.

CORAL BLEACHING

- ❖ Whenever environmental conditions degrade coral polyps, they will expel the zooxanthellae algae from their tissue. This causes discoloration of the coral reef ecosystem, and it is known as coral bleaching. Therefore, coral bleaching indicates degrading marine environmental conditions.



CORALS ARE INDICATOR SPECIES

- ❖ Indicator species are those that are the first to indicate degradation in the ecosystem.
- ❖ **Indicator species**—the ones that indicate degradation of their ecosystem
- ❖ **Other examples of indicator species:**
 - **Lichens:** Indicators of air pollution (if air pollution is high, then lichens will decrease)
 - **Gangetic dolphins** are an indicator of the freshwater ecosystem of the **Ganga-Brahmaputra** river system.

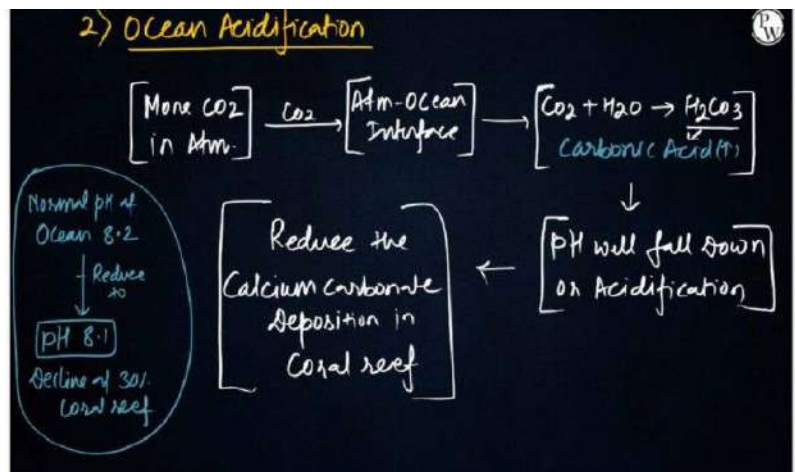
MAJOR REASON FOR CORAL BLEACHING

❖ CLIMATE CHANGE

- An increase in ocean water temperature will lead to heat stress for corals.
- There will be an increase in tropical cyclones.
- There will be fluctuations in ocean water salinity.

❖ OCEAN ACIDIFICATION

- Oceans absorb more carbon dioxide due to a rise in CO₂ levels.
- This increases the acidity of ocean water
- This inhibits the coral's ability to create calcareous skeletons that are essential for their survival.

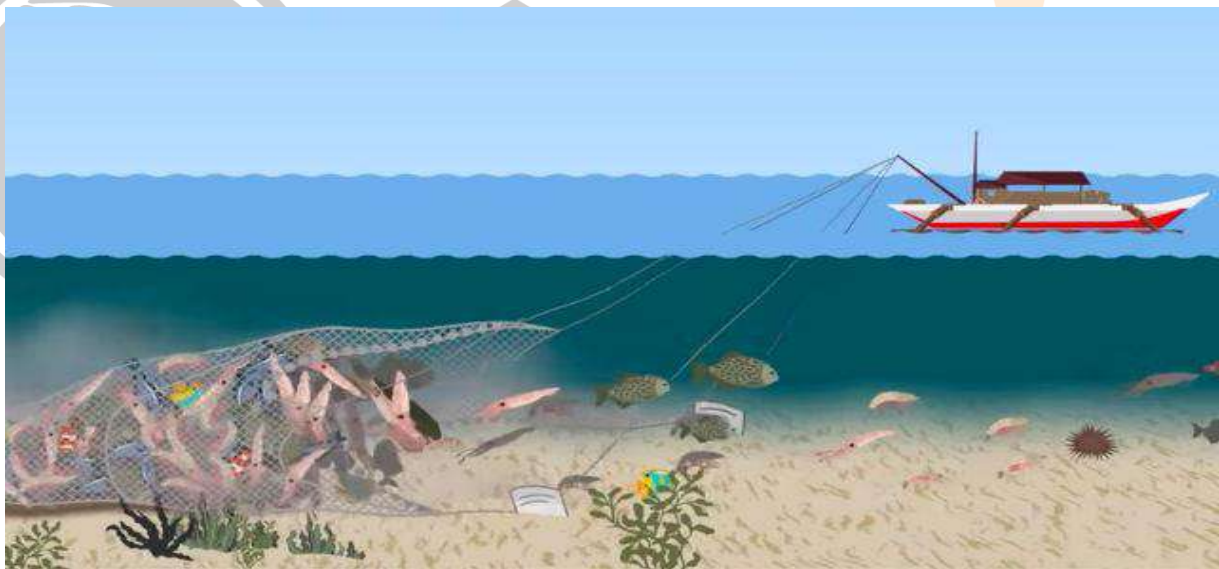
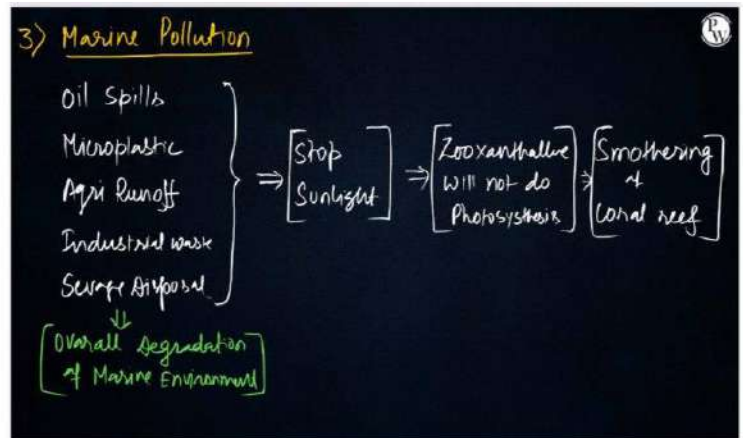


❖ MARINE POLLUTION

- Oil spills, microplastics, agricultural runoff, industrial waste, and sewage discharge.
- It can block sunlight, which will prevent algae or Zooxanthellae from Photosynthesising and lead to the smoothening of coral reefs.

❖ DESTRUCTIVE FISHING PRACTISES

- **Cyanide fishing:** To catch the fish live, sodium cyanide is used. This will also block the photosynthesis process.
- **Ocean bottom trawling:** It is a method of fishing that involves dragging heavy, weighted nets across the sea floor in an effort to catch fish.
 - ✓ It is a favoured method by commercial fishing companies as it can catch large quantities of product in one go.



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DAILY CLASS NOTES

ENVIRONMENT

Lecture – 20

**Global Warming and
Climate Change**



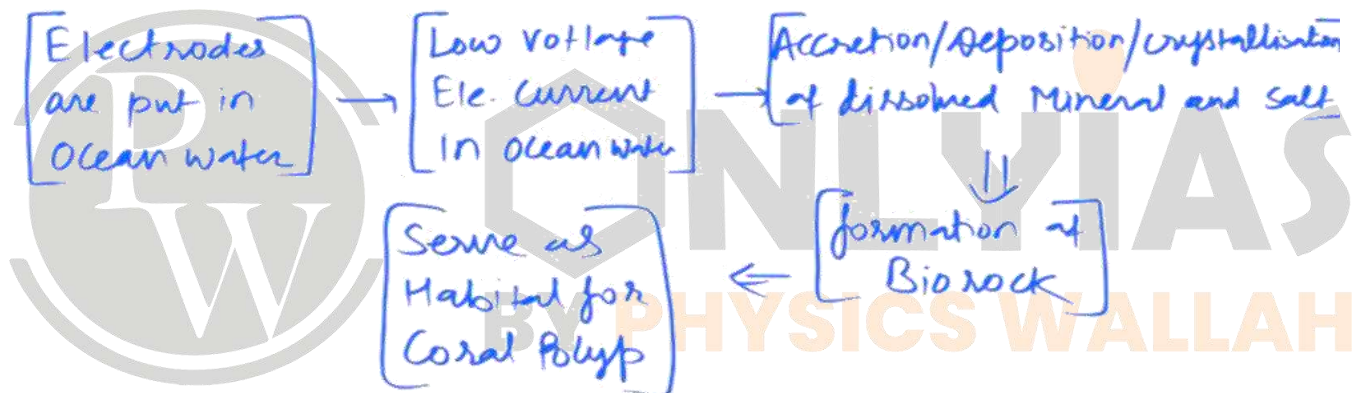
Global Warming and Climate Change

MAJOR INITIATIVE FOR CORAL REEF CONSERVATION:

- ❖ **UNFCCC:** United Nations Framework Convention on Climate Change and Paris Agreement and **CBD** (Convention for Biodiversity). are two initiatives that are indirectly useful for coral reef conservation.
- ❖ **ICRI:** International Coral Reef Initiative. This is an informal and voluntary partnership between countries to conserve coral reefs around the world.
- ❖ **Coral Triangle Initiative:** The Coral Triangle is a marine area located in the western Pacific Ocean, and it is spread across six countries known as CT6: **Indonesia, Malaysia, Philippines, Papua New Guinea, Solomon Islands, and Timor Leste** (the "CT6" countries).
- ❖ **Bio Rock Technology or Mineral Accretion Technology.**



5) Biorock Tech on Mineral Accretion Tech.



- ❖ A biorock experiment was done by scientists at the coast of the Gulf of Kutch Recently,



GLOBAL WARMING

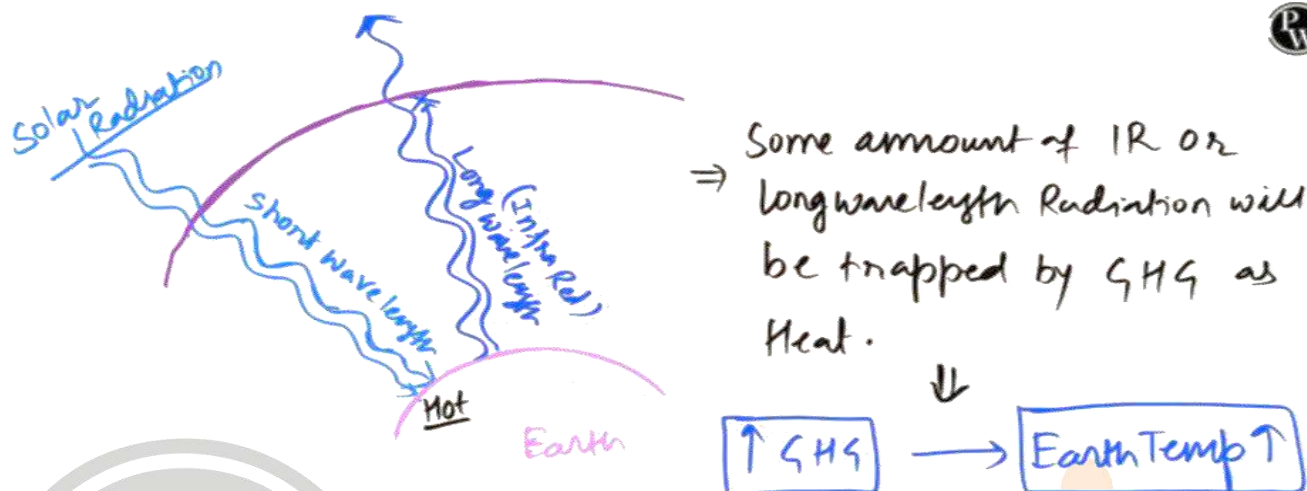
- ❖ A gradual rise in earth's temperature is usually due to the greenhouse effect.

GREENHOUSE EFFECT

- ❖ It is due to an increased amount of CO₂, CFCs, and other pollutants.



- ❖ It can be natural or anthropogenic.
- ❖ **Natural atmospheric** gases act as a blanket to maintain the earth's temperature at 15 degrees Celsius on average. In the absence of the greenhouse effect, the earth's temperature can drop to minus 18 degrees Celsius.
- ❖ An anthropogenic increase in greenhouse gases like CO_2 , CH_4 , and N_2O is leading to global warming due to the fact that the average temperature of the earth is increasing.



- ❖ Some amount of infrared or long Wavelength radiation will be trapped by greenhouse gases as heat, and that will lead to a rise in the earth's temperature.

GREENHOUSE GASES

WATER VAPOUR:

- ❖ This is the most significant overall contributor to the greenhouse effect.
- ❖ Humans are not directly responsible for water vapour.
- ❖ It is part of the natural water cycle.
- ❖ It is the most abundant greenhouse gas in the atmosphere.

CARBON DIOXIDE

- ❖ This is considered to be a significant heat-trapping gas.
- ❖ Natural sources: respiration, volcanic eruptions, forest fires, etc.
- ❖ Anthropogenic: fossil fuel burning, industry, thermal power plants, etc.
- ❖ Global warming potential (GWP) is the amount of energy or heat trapped by gases.
- ❖ Life span: it is how long the gas will stay in the atmosphere, i.e., 50 to 100 years.

METHANE (CH_4)

- ❖ It is a very potent greenhouse gas.
- ❖ It has some natural sources: wetlands, the ocean, and volcanic eruptions.
- ❖ Anthropogenic: agriculture (paddy fields), cattle waste, waste water, etc.
- ❖ Global warming potential (GWP): It traps 25 percent more heat and energy than carbon dioxide
- ❖ Life span: 10 to 25 years

NITROUS OXIDE

- ❖ It comes from the **nitrogen cycle and bacterial decomposition**.
- ❖ Anthropogenic emissions include vehicle emissions, agricultural chemicals, industrial production of nitric acid, and the burning of biomass.
- ❖ GWP can absorb 300 times more energy than carbon dioxide.
- ❖ Lifespan: Its life span is about 100 to 120 years.

CFC (Chlorofluorocarbon)

- ❖ It is entirely produced by humans.
- ❖ Anthropogenic- refrigeration, air conditioners, aerosols
- ❖ Global Warming Potential (GWP): It's very high, in the range of 5000 to 8000.
- ❖ Lifespan: 50 to 500 years

FIUORINATED GASES

- ❖ It consists of HFC, PFC, and SF₆.
- ❖ Hydrofluorocarbons: Global warming potential- its range is 11000 and its life span is around 14 to 200 years.
- ❖ Perfluorocarbons: Global warming potential -its in range of 7000 and life span is in the range of 50000 years
- ❖ Sulphur hexafluoride: Global warming potential- it is 25000 and life span is 32000 years.
- ❖ Fluorinated gases are considered to be the most potent and long-lasting.
- ❖ These are used in semiconductors, aerosols, propellants, and fire retardants.
- ❖ Fluorinated gas is entirely anthropogenic.

EFFECT OF INCREASED GREENHOUSE GASSES.

1. Global warming leads to climate change.
2. Ozone layer depletion
3. Air pollution and smog
4. Acidification of water bodies

PREVENTION OF GREENHOUSE EFFECT AND GLOBAL WARMING

1. Afforestation
2. Conservation of energy
3. Public transport
4. Policy intervention.

GLOBAL INITIATIVE TO REDUCE GREENHOUSE GAS EMISSION

1. The IPCC (Intergovernmental panel on climate change) was established in 1988.
2. UNFCCC: United Nations Framework Convention on Climate Change (1992)
3. The Kyoto Protocol (1997)
4. Greenhouse Gas Protocol (1990)



DAILY CLASS NOTES

Environment

Lecture - 21

Climate Change (Part 2)



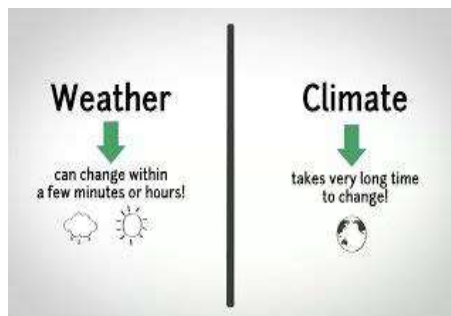
Climate Change (Part 2)

INTRODUCTION

Some basic terms:

- ❖ **Climate is the long-term weather pattern in a region**, typically averaged over 30 years.
- ❖ Weather is the culmination of the present meteorological variables, such as temperature, wind speed and direction, precipitation amount and kind, sunshine hours, etc.

The weather dictates a short period of time, up to several days



CLIMATE CHANGE:

- ❖ Climate change is a long-term change in temperature and weather patterns.
- ❖ Climatic variability in temperature, precipitation, wind, etc. is on a time scale longer than 10 years.

CAUSES OF CLIMATE CHANGE:

NATURAL CAUSES

- ❖ Due to Continental Drift.
- ❖ Due to Plate Tectonics
- ❖ Due to Volcanic activities
- ❖ Due to Ocean Currents
- ❖ Due to Variation in the earth's orbit

ANTHROPOGENIC CAUSES

- ❖ Due to Greenhouse gases
- ❖ Due to Power generation
- ❖ Due to Deforestation
- ❖ Due to Atmospheric aerosol
- ❖ Due to Transportation

FUNDAMENTAL REASONS FOR CLIMATE CHANGE

- ❖ Increased greenhouse gas emissions lead to an increase in the greenhouse effect, which traps more heat in the atmosphere.
- ❖ After the industrial revolution, there was an increase in greenhouse gases and a decrease in carbon sinks. According to the **World Meteorological Organisation**,
- ❖ The World Meteorological Organisation has divided the data into two parts: pre-industrial time and the post-industrial revolution.

- ❖ The concentration of carbon dioxide was 280 ppm in pre-industrial times, and now, in the present time, it is 410 ppm. 280 ppm was constant for 8 lakh years.
- ❖ The concentration of methane has increased by 25% compared to pre-industrial times.
- ❖ Nitrogen oxide has increased by 13% compared to pre-industrial times.
- ❖ As per the IPCC special report, the rise in global average temperature due to human activities is 1 degree Celsius as compared to pre-industrial levels.

EFFECTS OF CLIMATE CHANGE

1. Impact on the Natural System

- Increase in frequency and intensity of climatic disasters
- It will lead to a rise in sea level.
- It will lead to a loss of biodiversity.
- It will also lead to environmental degradation.
- There will be melting of the ice cap and glaciers.
- It will lead to the ocean acidification.

2. Impact on The Human System

- This impact will lead to the loss of life and assets.
- It will create environmental migration and climatic migration.
- It will have an adverse impact on agriculture.
- Adverse impact on human health caused by the rise in vector-borne disease.
- It will also lead to water and food scarcity.
- As per the IPCC, the current rate of sea level rise is 3 mm/year.
- The future projection of sea level rise is 2–3 m by the end of this century, and it will lead to the **submergence of low-elevation coastal zones**.
- This will lead to climatic and environmental migration.
- This will lead to another problem, which is climate change or environmental refugees.

3. ADVERSE IMPACT ON AGRICULTURE.

- According to an economic survey for 2017–2018, crop yields of rabi and kharif crops will decrease due to **temperature and precipitation shocks** caused by climate change.
- Here, the temperature shock is a heatwave, and the precipitation shock means a drought and more rain, which leads to floods.
- climate change will impact and compromise sustainable development goals by 2030

STRATEGIES FOR CLIMATE ACTION

- ❖ Mitigation is how to reduce the atmospheric concentration of carbon dioxide and greenhouse gases
 - A reduction in the atmospheric concentration of greenhouse gases will help mitigate:
 - ✓ By afforestation (Biological Sequestration).
 - ✓ By promoting renewable energy.

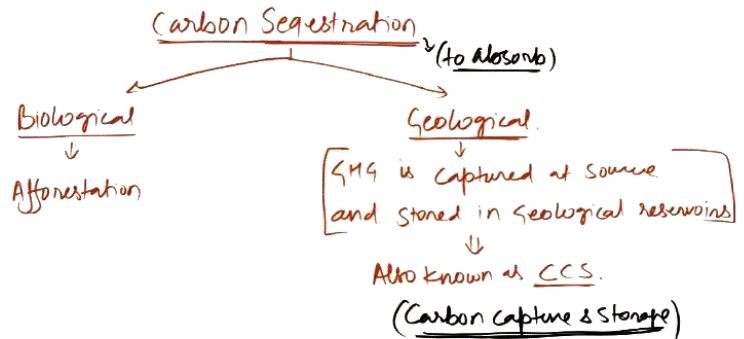
- Mitigation can be done by geological sequestration

ADAPTATION

- ❖ Adaptation is modifying human ways of life so that their impact can be absorbed.
 - By minimising the adverse impact of climate change
 - By effective disaster management.
 - By using a microirrigation system.

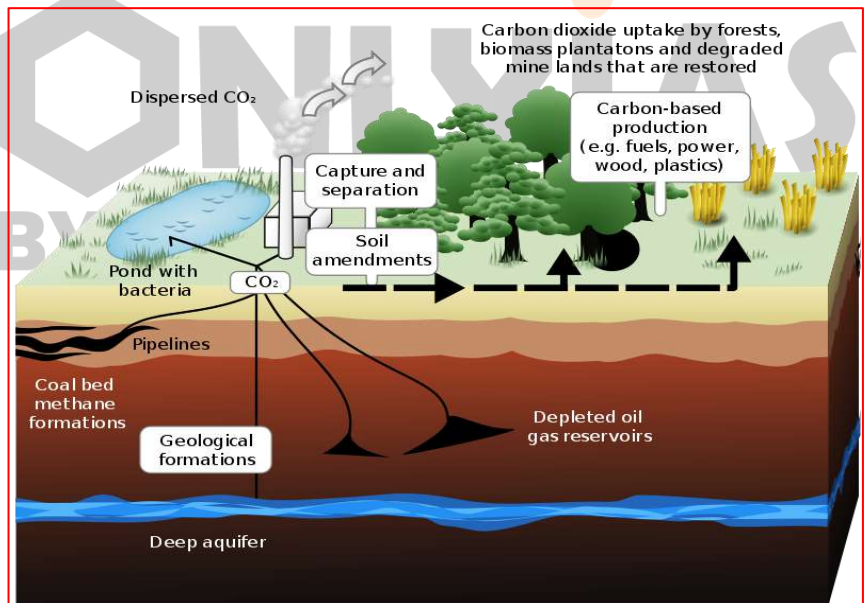
CARBON SEQUESTRATION:

- ❖ It is of two types one is biological (afforestation), and another is geological.
- ❖ Sequestration means to absorb.
- ❖ Geological: Greenhouse gas is captured at source and stored in geological reservoirs, also known as **carbon capture and storage (CCS)**.



Measures to Control Climate Change

- ❖ Less use of fossil fuels
- ❖ Investment in renewable energy
- ❖ Environment-friendly transportation
- ❖ Protection of forests
- ❖ Promoting afforestation
- ❖ Conservation of oceanic ecosystems
- ❖ Reduce human consumption.
- ❖ Lowering the carbon footprint
- ❖ Less use of plastic
- ❖ Natural method of home heating and cooling



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DAILY CLASS NOTES

Environment

Lecture - 22

Climate Change (Part 3)



Climate Change (Part 3)

INTERNATIONAL EFFORTS FOR CLIMATE ACTION

INTRODUCTION:

- ❖ In 1992, the UN Conference on Environment and Development was held.
- ❖ It was held in Rio de Janeiro.
- ❖ It adopted the United Nations Framework Convention on Climate Change (UNFCCC), which came into force in 1994.
- ❖ The objective of the UNFCCC was to stabilise the atmospheric concentration of greenhouse gases.
- ❖ Under UNFCCC, there are conferences of parties (COP).

Major conference of parties:

In 1997: Third session of the Conference of the Parties (COP 3)

- 1) Under the Kyoto Protocol, they have set legally binding targets for developed nations to reduce greenhouse gas emissions.
- 2) A 5% reduction in emissions of greenhouse gases compared to the 1990s level was recorded. The time period was set from 2008 to 2012.

In 2012 : COP - 18

1. The Doha Amendment was adopted at this conference of parties.
2. It was an 8-year extension period of the Kyoto Protocol from 2013 to 2020. But it never came into force.



In 2015: COP - 21

1. In 2015, a Paris agreement was adopted.
2. The target of the Paris agreement is to limit the global average temperature rise to 2 degrees Celsius compared to pre-industrial areas. To make it even more workable, we promised to put in more effort to limit it to 1.5 degrees Celsius by the end of the century.
3. The Paris agreement was for both developed and developing countries.
4. In this agreement, there were self-determined commitments by countries to reduce greenhouse gases. It was called a Nationally Determined Contribution. (NDC).
5. The problem of Paris agreement was:
 - All countries have to submitted nationally determined contributions (NDC), irrespective of their historical contribution
 - All countries should meet their NDC, Even after meeting NDC, the temperature would rise by 3 degrees Celsius.

- The initial NDC submitted by the countries was found to be inadequate to meet the target as per the UN emission gap report.



Wayforward

- ❖ As per the IPCC special report, the target of 1.5 degrees Celsius can be met by the following ways:
 - By a global emission reduction of 45% (compared to the 2010 level) by 2030.
 - Net zero emissions by 2050.
 - India announced at COP 26 that it will achieve net zero emissions by 2070.
 - The emission will be compensated by absorption through carbon capture and storage or a carbon sink like a forest.

Important terms related to climate actions

❖ Climate Finance:-

It refers to money given by developed countries to developing countries for their climate action. Climate finance was adopted in 2009 in Copenhagen at COP 15.

❖ CBDR (common but differentiated responsibilities):

- It implies that both developed and developing countries have collective responsibilities towards climate action, but the efforts of the countries should be proportionate to the damage caused by them.
- Therefore, the efforts of developed countries should be greater than those of developing countries.
- It is based on the principles of climate equity and justice.

❖ Carbon Market Waste Mechanism

There are three types of it:

1. Emission trading
2. Clean development mechanisms
3. Joint implementation

1 tonne of carbon dioxide = 1 carbon credit, and it can be traded in three ways:

(1) Emission Trading

- let's say the target for developed countries is to reduce carbon dioxide emissions by 10 units. and developing countries have a target of 8 units. developed countries could achieve 8, and developing countries could achieve 10. it means the +2 unit of developing countries can be sold to developed countries. so that it can meet the target, and after selling it, both countries are at the actual target.

HOW CARBON TRADING WORKS



Carbon credits are received from auctions, or given for free to firms by governments



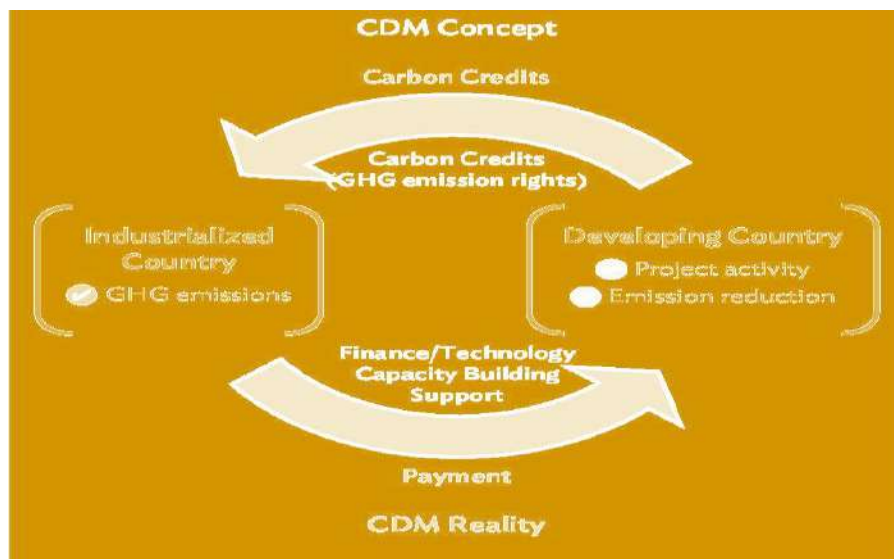
Carbon credits are used as greenhouse gases are emitted



Unused carbon credits can be sold, and more credits can be bought

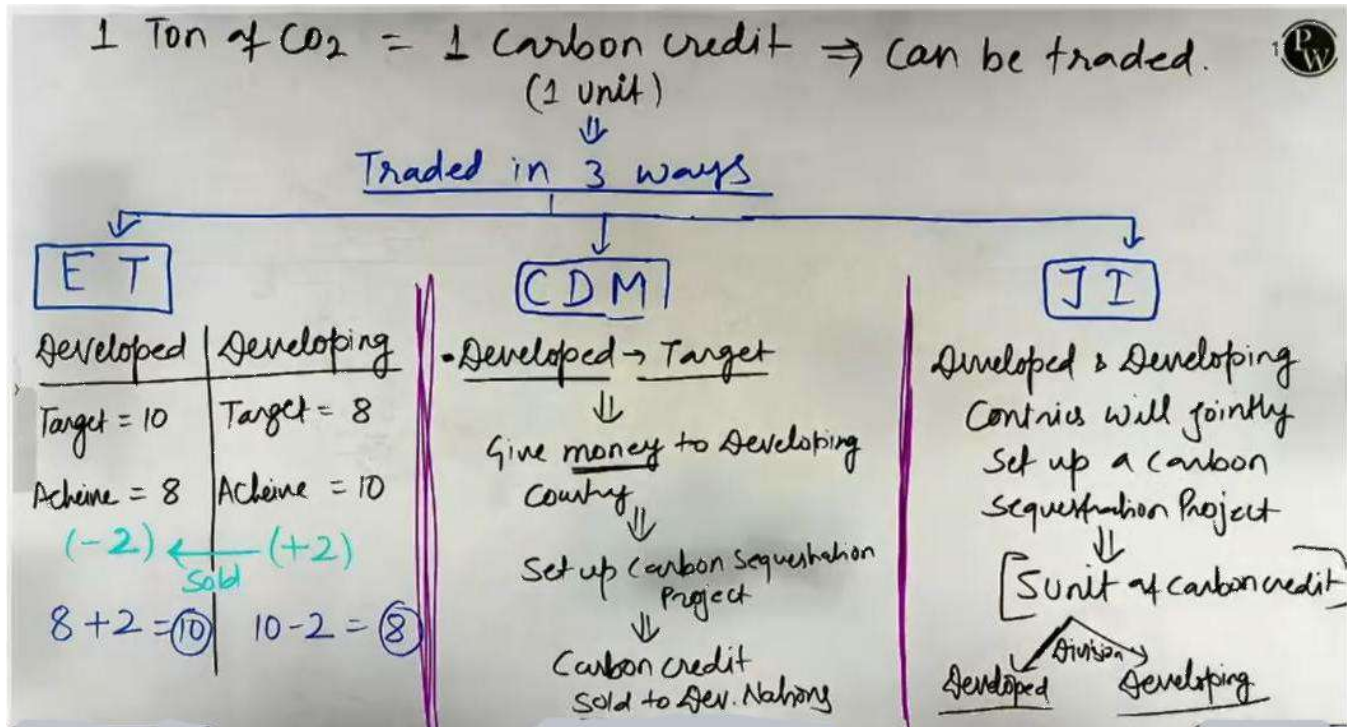
(1) Clean Development Mechanism

- Let's say a developed country has a target to meet, and there is no target to meet in a developing country. A developing country sets up a carbon sequestration project, and with this, they get 5 units of carbon credit per year. These 5 units can be sold to developed countries, which will help the developed country achieve its target.
- Here, the developed country will first pay the money.
- Developing countries will use this money to set up a carbon sequestration project, and then the carbon credit it has earned will be sold to developed countries, and the money will be compensated.



(1) Joint Implementation

- Developed and developing countries will jointly set up a carbon sequestration project; let's say 5 units of carbon credit are there, and now the carbon credit earned will be divided between the two countries.
- This project will be set up in developing countries.



BY PHYSICS WALLAH

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DAILY CLASS NOTES

Environment

Lecture - 23

India and Climate Change



India and Climate Change

Topics To Be Covered:

- ❖ India and Climate Change
- ❖ Important Initiative of India for Climate Action
 - Panchamrit/Five Nectar Elements
- ❖ India's Panchamrit Supported By
 - International Solar Alliance
 - National Hydrogen mission
 - Ethanol Blending Programme
- ❖ National Action Plan for Climate Change (NAPCC)
- ❖ Environmental Impact Assessment (EIA)
- ❖ EIA Process
 1. Screening: Category A, Category B1 and Category B2 projects
 2. Scoping: Terms of Reference (ToR)
 3. Public Consultation: Environmental Management Plan (EMP)
 4. Appraisal
 5. Decision Making
- ❖ Exceptions

India and Climate Change

- ❖ Per Capita Global Emission = 4.76 tonnes.
- ❖ India's Per Capita Emission = 2 tonnes approximately.
- ❖ In absolute terms, **India is the third largest emitter in the world.** The **largest** emitter is **China** whereas the **second largest** is **US**.
- ❖ India is one of the climate change vulnerable countries of the world. Being a **developing country**, a large population of India is dependent upon **agriculture and forestry** which put them at high risk of climate change. Although India is the third largest emitter in absolute terms, but **per capita emission is below global average**.
- ❖ The number of initiatives has been undertaken from time to time for climate action in India.

Important Initiative of India for Climate Action

- ❖ At COP 26 in 2021 in Glasgow, India presented **Panchamrit, or 5 Nectar Elements**, to deal with the challenges of climate change.
- ❖ The 5 Nectar elements are:

- (a) 500 gigawatts of renewable energy by 2030
- (b) 50% of the energy requirement will come from renewable energy by 2030.
- (c) Reduction of 1 billion metric tonnes of carbon dioxide emissions by 2030.
- (d) Reduction of the carbon intensity of the economy by 45% in 2030.
Carbon intensity is not clearly defined, but basically it means a carbon based economy.
- (e) Net zero emissions by 2070.

India's Panchamrit/5 Nectar Elements Supported By

❖ International Solar Alliance

❖ National Hydrogen Mission

- Under this mission, the Government of India aims for development of green hydrogen production capacity of at least **5 MMT (Million Metric Tonne) per annum** with an associated renewable energy capacity addition of about 125 GW in the country by **2030**.

❖ Ethanol Blending Programme

- The target is to achieve **12%** ethanol blending by **2025**.

Additional Information:

International Solar Alliance

- ❖ The ISA was conceived as a joint effort by **India and France** to mobilise efforts against climate change through deployment of solar energy solutions.
- ❖ It was conceptualised on the sidelines of the **21st Conference of Parties (COP21)** to the United Nations Framework Convention on Climate Change (UNFCCC) held in **Paris** in **2015**.
- ❖ With the amendment of its Framework Agreement in 2020, all member states of the **United Nations** are now eligible to join the ISA.
- ❖ At present, **116 countries** are signatories to the ISA Framework Agreement, of which **94 have** become full members.
- ❖ Its headquarters is located in **Gurugram, India**.
- ❖ The International Solar Alliance (ISA) is an action-oriented, member-driven, collaborative platform for increased deployment of solar energy technologies.
- ❖ It **aims** for bringing energy access, ensuring energy security, and driving energy transition in its member countries.

National Action Plan for Climate Change (NAPCC)

- ❖ It is an **umbrella programme** launched in **2008**.
- ❖ Its various components are:
 - **National Solar Mission** (for solar energy)
 - **National Water Mission** (for reservoirs, etc.)
 - **National Mission for Green India** (for forestation and afforestation)

- **National Mission for Sustainable Agriculture** (for agriculture without much carbon dioxide emission)
- **National Mission for Enhanced Energy Efficiency** (to minimise greenhouse gas emissions)
- **National Mission for Sustaining Himalayan Ecosystem** (for sustaining glaciers, etc.)
- **National Mission for Sustainable Habitat**
- **National Mission for Strategic Knowledge on Climate Change**

Environmental Impact Assessment (EIA)

- ❖ EIA is a study to predict the potential impact of a proposed project on the environment. It is a decision making tool that compares various alternatives for the project and identifies the one that has the best combination of socio-environmental cost and economic benefit.
- ❖ EIA is notified under the **Environmental Protection Act, 1986**.

EIA Process

The EIA process in India comprises the following steps:

❖ STEP I: Screening

- It is done to determine whether the project requires EIA or not.
- The project is categorised into:
 - ✓ **Category A:** environmental clearance by the Central Government after conducting EIA.
 - ✓ **Category B:** environmental clearance by the State Government after conducting EIA.
- Category B projects are further divided into:
 - ✓ **Category B1:** project will get environmental clearance after conducting EIA
 - ✓ **Category B2:** project does not require EIA and directly gets environmental clearance

❖ STEP II: Scoping

- The **Terms of Reference (ToR)** is decided.

- ❖ The ToR are the key issues of the project that need to be investigated.

❖ STEP III: Public Consultation

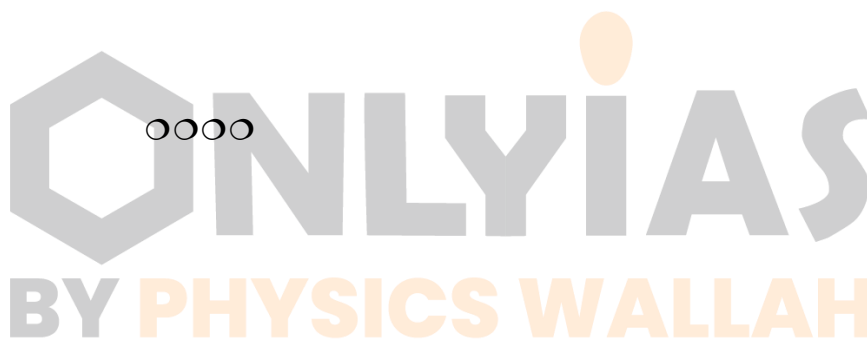
- **Public hearing** is organised by the **State Pollution Control Board** to take into account concerns of local people.
- Based upon public consultation, EIA reports are finalised and an **Environmental Management Plan (EMP)** is prepared.
- ❖ EMP is a list of commitments by the project proponents for more responsible environment management.

❖ STEP IV: Appraisal

- The critical scrutiny of the final EIA report and EMP is done.
- **Category A** projects are scrutinised by the **Expert Appraisal Committee, controlled by the Central Government**.
- **Category B1** projects are scrutinised by the **State Expert Appraisal Committee, controlled by the Central Government in consultation with the State Government**.

❖ STEP V: Decision Making

- The respective committee will give recommendations to the decision making body.
 - The decision making body for **Category A** projects will be the **Ministry of Environment, Forest and Climate Change under the Central Government.**
 - The decision making body for **Category B1** projects will be the **State Environmental Impact Assessment Authority.**
- ❖ After decision making, **environmental clearance** will be granted, and the proposed project will start. Once the project has started, monitoring of the project will be done, and the project proponent will have to submit **half-yearly compliance report** to decision making authority.
- ❖ All Category A and B1 projects shall undergo **public consultation except** the following:
- Modernisation of irrigation projects.
 - All projects and activities are located within industrial estates and industrial parks.
 - Expansion of roads and highways that do not require any further acquisition of land.
 - All building, construction, area development projects, and townships
 - Project related to national defence.



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