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ENVIRONMENT AND ECOLOGY

Drishti Publications
(A Unit of VDK Publications Pvt. Ltd.)

641, First Floor, Dr. Mukherjee Nagar, Delhi- 110009
Telephone: 011-47532596, 8750184501

Website
www.drishtiias.com

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1 Introduction

ENVIRONMENT

- Environment is defined as the surroundings or conditions in which an organism lives or operates.
- It includes both living and non-living components.

Components of Environment

- **Abiotic/Non-living/Physical:** These include land, energy, water, climate (temperature and humidity), gases and winds, fire, gravity, soil, etc.
- **Biotic/Living:** Biotic components are all the living things in an ecosystem, such as plants, animals and micro-organisms.

ECOLOGY

- It is the study of organisms and environment; and how the organisms interact with each other and with their environment.
- The term was first coined by the German biologist *Ernst Haeckel*.
- Ecology not only deals with the study of the relationship of individual organisms with their environment, but also with the study of populations; communities; ecosystems; biomes; and biosphere.

Levels of Ecological Organization

Individual

- An organism that has the capability of acting or functioning independently is known as an individual.
- It can be an animal, bacteria, fungi or a plant.
- It is the basic unit of study.

Population

- It is defined as a group of freely interbreeding individuals of the same species present in a specific area at a given time.

Factors Impacting Population

- **Birth and Immigration:** Increase in population
- **Death and Emigration:** Decrease in population
- **Biotic and Abiotic Components:** Limit to growth of population

Population Growth	Percentage variation between the number of individuals in a population at two different times.
Population Density	Number of individuals of a population per unit area.

Community

- A group of organisms consisting of several different species that live in an area and interact with each other.

Types of Community

- **Major Community**: Depends only on the energy from the sun, hence, are independent units, e.g., tropical evergreen forests, grasslands, deserts, etc.
- **Minor Community:** Smaller community which is not a self-sustaining unit and is dependent on other communities for its existence, e.g., fungi decomposing a wooden log.

Ecosystem

- A community of organisms and their physical environment interacting as an ecological unit.
- It acts as a functional unit of nature and varies from a small pond to a large forest or a sea.

Biomes

- A large community unit, characterized by a major vegetation type and associated fauna, found in a specific climatic region. Examples include tundra, taiga, grasslands, savannas, deserts, tropical forests, etc.
- Temperature, soil, and the amount of light and water help determine what life exists in a biome. No two biomes can be alike.
- There are more than a dozen ways to classify biomes. One of the simplest classification systems has only two biomes: terrestrial (land) and aquatic (water).

Aquatic systems, however, are further divided into distinct life zones based on salinity. The classification of aquatic systems are as follows:

- **Freshwater Ecosystem:** Large lakes, polar freshwaters, tropical coastal rivers, river deltas, etc.
- **Marine Ecosystem:** Continental shelf, tropical coral, kelp forest, benthic zone, pelagic zone, etc.
- **Estuaries:** Tidal zone, coastal bays, river mouth, etc.

2 Ecosystem

ECOSYSTEM

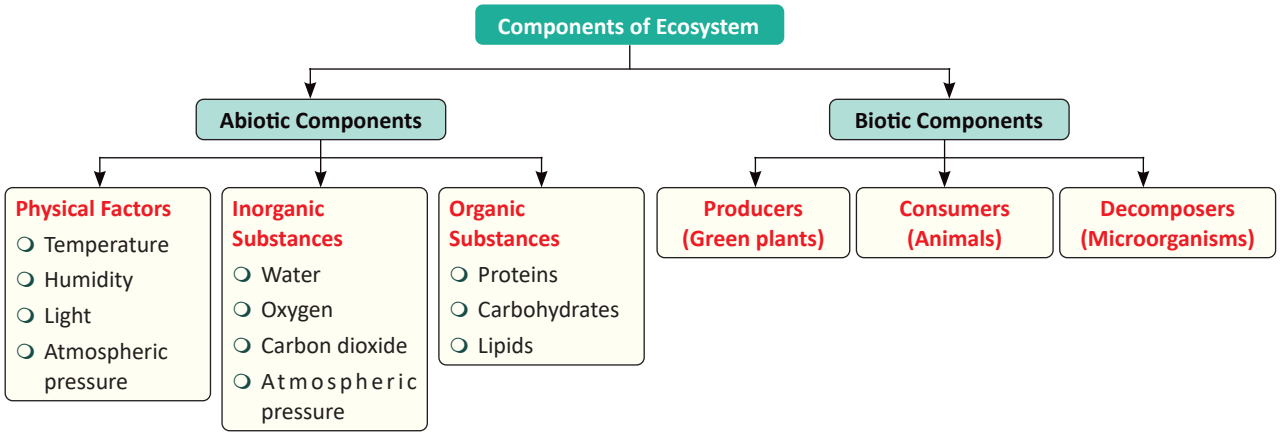
- An ecosystem can be visualized as a functional unit of nature, where living organisms interact among themselves and also with the surrounding physical environment.
- The ecosystem varies in spatial coverage. It may be as small as a cow-shed, a tree or even a part of a tree having certain microorganisms. The largest unit is the whole biosphere.

Features of Ecosystem

- Usually, it is an open system with a continuous, but variable influx and loss of material and energy.
- It is a functional unit capable of energy transformation, circulation and accumulation.

Structural Components of an Ecosystem

- Biotic Components
- Abiotic Components



Functions of Ecosystem

- Energy flow through the food chain;
- Nutrient cycling (biogeochemical cycles);
- Ecological succession or ecosystem development;
- Homeostasis (or cybernetic) or feedback control mechanisms.

Energy Flow through Food Chain

- Most ecosystems rely on supply of energy from sunlight.
- In the food chain, the energy flow is unidirectional, i.e., from producers to subsequent higher trophic levels.
  - However, during this process of transfer of energy, some energy is lost into the system as heat energy.
  - It is not available to the next trophic level. Therefore, the number of steps are limited in a chain to 4 or 5.
- Based on their roles in the food chain, organisms are classified into three groups: Producers, Consumers and Decomposers.
  - **Producers**: Produce their own food, also known as autotrophs. Two categories of Producers:
    - **Phototrophs:** Primary producers (green plants) which carry out photosynthesis to produce their own food.
    - **Chemotrophs:** Primary bacteria which produce their food energy through chemical processes wherein simple organic compounds are oxidised to obtain food energy.
    - The producers also include green plants, blue green algae, phytoplankton, etc., that contain chlorophyll.
  - **Consumers:** These are called heterotrophs, i.e., the species that cannot manufacture their own food and survive on primary producers or other organisms.

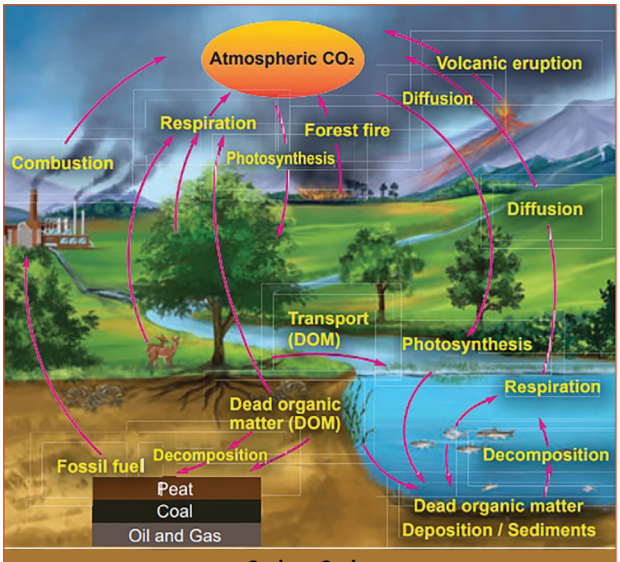
3 Biogeochemical Cycles

BIOGEOCHEMICAL CYCLES

- Biogeochemical cycle is a pathway by which a chemical substance moves through both biotic and abiotic components of Earth.
- Biogeochemical cycles are of two types:
  - **Gaseous Nutrient Cycle:** In this case, the reservoir is the air or the oceans (via evaporation), and it includes Oxygen, Carbon and Nitrogen cycles.
  - **Sedimentary Nutrient Cycle:** In this case, the reservoir is Earth's crust and it includes the cycles of Phosphorus, Sulphur and Calcium, which are present as sediments of Earth.

CARBON CYCLE

- Carbon cycle is the continuous exchange of carbon between the atmosphere and Earth through different processes such as photosynthesis, respiration, burning of fossil fuels, decomposition, etc.
- Cycling of carbon between organisms and atmosphere is a consequence of two reciprocal processes of photosynthesis and respiration.



Carbon Cycle

- Carbon in the atmosphere increases due to burning of fossil fuels, deforestation, forest fires, volcanic eruptions and decomposition of dead organic matters.
- Some carbon also enters into long term cycle due to accumulation as undecomposed organic matter or as insoluble carbonates in the aquatic system.
- It also gets dissolved in the ocean and remains there for a long time.

NITROGEN CYCLE

- Nitrogen cycle refers to circulation of nitrogen in various chemical forms through the atmospheric, terrestrial and marine ecosystems.
- Our atmosphere contains nearly 78% of nitrogen, but it cannot be used directly by the majority of living organisms.
- There are five main processes which are essential for nitrogen cycle, viz., Nitrogen Fixation, Nitrification, Assimilation, Ammonification, and Denitrification.
  - **Nitrogen Fixation:** It is the conversion of gaseous nitrogen into ammonia, a form in which it can be used by plants.
    - **Atmospheric Fixation:** Lightening, combustion and volcanic activities help in the fixation of nitrogen.
    - **Industrial Fixation**: At high temperature and high pressure, molecular nitrogen is broken into atomic nitrogen which then combines with hydrogen to form ammonia.
    - **Bacterial Fixation**: There are two types of bacteria which helps to fix Nitrogen:
      (i) Symbiotic bacteria, e.g., Rhizobium in the root nodules of leguminous plants.
      (ii) Free living or Non-symbiotic, e.g., Nostoc, Azobacter, and Cyanobacteria can combine atmospheric or dissolved Nitrogen with hydrogen to form ammonia.
  - **Nitrification:** It is a process in which ammonia is converted into nitrates and nitrites by bacteria, e.g.,

4 Terrestrial Ecosystem

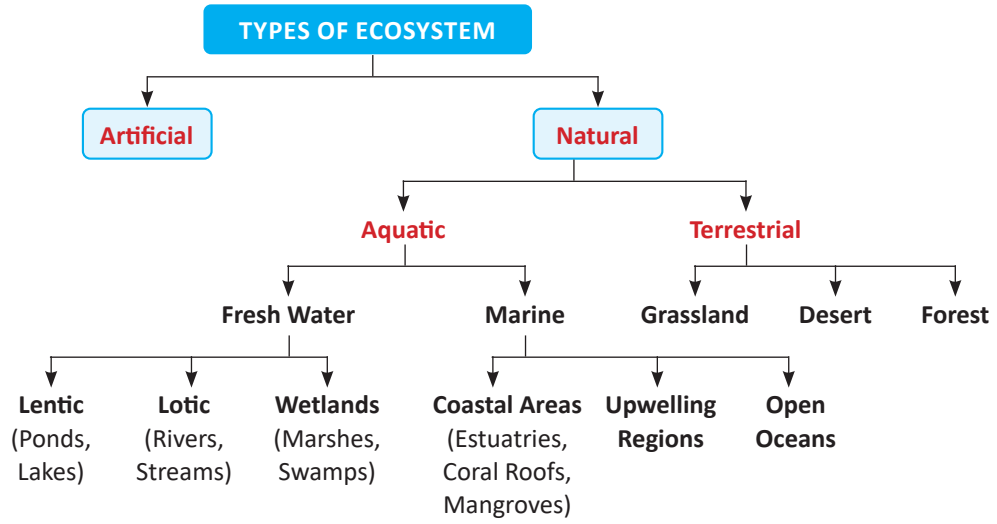
TYPES OF ECOSYSTEM

Natural Ecosystem

- It is an assemblage of plants and animals which functions as a unit and is capable of maintaining its identity such as forest, grassland, or an estuary. These ecosystems are totally dependent on solar radiation.
- **Main Categories of Natural Ecosystems**
  - **Terrestrial Ecosystem:** Ecosystems found on land, e.g., forests, grasslands, deserts, and tundra.
  - **Aquatic Ecosystem:** Plants and animal community found in water bodies, e.g., freshwater ecosystems like rivers, lakes and ponds; marine ecosystems like coral reefs, sea floor, etc.

Artificial or Man-made Ecosystem

- The artificial ecosystems do not possess a self-regulating mechanism and rely on the human efforts to sustain themselves.
- These can be agricultural lands or aquaculture ponds which are dependent on solar energy, or fossil fuel dependent ecosystems like urban settlements or industrial ecosystems.



FOREST ECOSYSTEM

- Forests are large areas supporting rich growth of trees and cover about 30% of land on the Earth.
- Depending on the climate and type of trees they are generally grouped into Tropical Rainforests, Boreal Forests, Tropical Deciduous Forests, Mediterranean Forests, Temperate Deciduous Forests, etc.

Tropical Rainforest

- **Distribution**
  - **Latitude:** 0°-10° North and South latitudes.
  - Found in northern part of South America, Congo, Malaysia, parts of east-Asia, the western coast of India, north-eastern India, Andaman and Nicobar islands, etc.
- **Rainfall:** Above 200 cm of rainfall per year, and rain should be uniform all year round.
- **Temperature:** Uniform temperature throughout the year, i.e., monthly temperature of around 25-26°C.
- **Soil:** Soil quality is quite poor due to high rate of leaching and this makes it unfit for agriculture.

5 Desertification

INTRODUCTION

- Desertification is reduction or destruction of the biological potential of the land which ultimately leads to the formation of deserts.
- Due to anthropogenic factors and climate change, the productive potential of dry lands (arid or semi-arid) falls by at least 10%.
- According to UNESCO, one third of the world's land surface is threatened by desertification and across the world it affects the livelihood of millions of people who depend on the benefits of ecosystems that dryland provides.

Land degradation
Land degradation is defined as the temporary or permanent decline in the productive capacity of the land, and the diminution of the productive potential, including its major land uses (e.g., rainfed, arable, irrigation, forests), its farming systems (e.g., smallholder subsistence), and its value as an economic resource. Land degradation can happen everywhere, but desertification occurs only in dry land ecosystems. A desert landscape supports a very limited growth of sparse vegetation and stunted growth of plants.

Factors Leading to Desertification

Some of the principal causes, which promote desertification, are:

Causes	Effect
Over Cultivation	❍ Every cycle of cultivation is preceded by ploughing to remove weeds. Weeding exposes soil to degradation. ❍ Deep ploughing exposes soil to land erosion and degradation further. ❍ Nutritive matters are lost due to repetitive monoculture. ❍ Ploughed soil loses more water by evaporation. ❍ The soil of the regions with slopes, and less vegetation is more susceptible to erosion.
Deforestation	❍ Forests are often cleared for agriculture, timber, construction wood, firewood, raw material for paper, etc. ❍ The process of denuding and degrading a forest land also contribute in desertification.
Overgrazing	❍ Animal grazing is a huge problem for many areas that are starting to become desert biomes. ❍ Overgrazing removes the protective vegetation and exposes the soil. ❍ Movement of grazing animals loosens the soil surface by their hoofs. Unprotected loose soil becomes highly susceptible to erosion by wind and water and leads to formation of desert.
Salinity due to over irrigation	❍ With demand for more land for agriculture, crops are grown in areas that have little access to natural water bodies. ❍ Intensive and uneconomic exploitation of water resources leading to fall in water table, seepage and problems of excessive salinisation of soil. ❍ Salt accumulation in soil retards plant growth. High salt concentration present in the water and soil will negatively affect the crop yields, degrade the land and pollute groundwater, which further lead to desertification.
Climate Change	❍ Higher temperatures resulting due to climate change have negative impacts through increased loss of water from soil and reduced rainfall in dry lands. ❍ This results into desertification and diminishes biological diversity. ❍ As the days get warmer and periods of drought become more frequent, there is a possibility of rapid desertification.
Fire	❍ Frequent and intensive fires can contribute to desertification when they affect natural vegetation. ❍ Frequent fires can turn savannas and forests into deserts.
Mining and Quarrying	Excessive mining and quarrying are responsible for loss of vegetal cover and destruction of conditions conducive to growth of vegetation.
Social, Economic, and Policy Factors	Policies leading to unsustainable resource use and lack of supportive infrastructure are major contributors to land degradation.

6 Forest Conservation

FOREST

- Forests are complex ecosystems consisting mainly of trees that support myriad forms of life.
- Trees are the most important component of forests.
- Tree helps to create a unique environment to support various kinds of animals and plants.
- Trees clean the air, cool it on hot days, conserve heat at night, and act as excellent sound absorbers.

Classification of Forest

- **Natural Forests:** These forests mainly comprise naturally grown indigenous (local) trees.
- **Plantations or Man-made Forests:** Theses forests are established by growing trees by humans.
- The FAO (Food and Agriculture Organization) has defined forest as land with tree crown cover (or equivalent stocking level) of more than 10% and area of more than 0.5 hectares. The trees should be able to reach a minimum height of 5m at maturity level.
- Forests currently cover about 30% of the world's landmass.
- According to the World Wildlife Fund (WWF), the earth loses 18.7 million acres of forests per year.
- It is estimated that 15% of all greenhouse gas emissions come from deforestation.

Importance of Forests

- We depend on forests for our survival, from the air we breathe and to the wood we use.
- Besides providing habitats for animals and livelihoods for humans, forests also offer watershed protection, prevent soil erosion and mitigate climate change.
- Forests provide habitats for diverse plants, animals and microorganisms. They are home to 80% of the world's terrestrial biodiversity.
- **Source of Livelihood:**
  - Forests form a source of livelihood for many different human settlements, including 60 million indigenous people.
  - According to World Bank estimates, more than 1.6 billion people depend on forests for their livelihoods with some 300 million living in them.
  - Forests provide jobs for more than 13 million people across the world.
  - The forest product industry is a source of economic growth and employment, with global forest products traded internationally is estimated to be around USD 327 billion.
  - Forests satisfy aesthetic needs of humans and have been a source of inspiration for the development of culture and civilization.
- **Ecosystem Services:**
  - Absorbing harmful greenhouse gasses that produce climate change. In tropical forests alone, a quarter of a trillion ton of carbon is stored above and below ground biomass.
  - Serving as a buffer in natural disasters like floods and rainfalls.
  - Providing habitat for more than half of the world's land-based species.

Ecosystem Services Provided by the Forest

Services	Benefits
Provisioning Services	Production of various types of woods, fruits and a wide range of compounds such as resins, alkaloids, essential oils, latex and pharmaceutical substances.
Proactive Services	Provide habitat for various organisms, conservation of soil and water, prevention of drought, shelter against wind, cold, radiation, noise, sounds, smells and sights.
Regulative Services	Absorption, storage and release of gases (most importantly CO_2 and oxygen), water, minerals, elements, and radiant energy.
Cultural Services	Bird watching, camping, wildlife tourism, etc.

7 Aquatic Ecosystem

AQUATIC ECOSYSTEM

- It refers to plant and animal communities occurring in water bodies.
- It is classified on the basis of salinity.

Types of Aquatic Ecosystem

- **Freshwater:** It has low salt concentrations
- **Marine:** It has a high salt concentration 35 ppt or above
- **Brackish Water:** Salt content is between freshwater and marine water, i.e., 5 to 35 ppt. They are estuaries, mangroves, salt marshes, etc.

Salinity

- Salinity refers to the concentrations of salts in water or soils.
- Forms of Salinity
  - **Primary salinity or Natural salinity:** It is caused by natural processes such the accumulation of salt from rainfall over many thousands of years or from the weathering of rocks.
  - **Secondary salinity or Dryland salinity:** It is caused where groundwater levels rise, bringing salt accumulated through 'primary' salinity processes to the surface.
  - **Tertiary salinity or Irrigation salinity:** It occurs when water is reapplied to crops or horticulture over many cycles, either directly or by allowing it to filter into the groundwater before pumping it out for re-application.

Salinity Status	Salinity (milligrams of salt per litre)	Purpose
Fresh	<500	Drinking and all irrigation
Marginal	500 – 1000	Most irrigation, adverse effects on ecosystems become apparent
Brackish	1000 – 2000	Irrigation certain crops only; useful for most stock
Saline	2000 – 10000	Useful for most livestock
Highly Saline	10000 – 35000	Very saline groundwater, limited use for certain livestock
Brine	>35000	Seawater; some mining and industrial uses exist

AQUATIC ORGANISM

Benthos

- The benthic organisms are those found living in the bottom of the water mass.
- Practically every aquatic ecosystem contains well developed benthos.
- **Examples:** Sponges, Bristle Worms, Mollusks, Cnidarians, Crustaceans, and Echinoderms.

Neuston

- These are unattached organisms which live at the air-water interface.
- Some organisms spend most of their lives on top of the air-water interface such as water striders, while others spend most of their time just beneath the air-water interface and obtain most of their food within the water.
- **Examples:** Beetles and Back-swimmers.

Periphyton

- These are organisms which remain attached to stems and leaves of rooted plants or substances emerging above the bottom mud.
- **Example:** Snails, Frogs, Aquatic insects, and Fish.

Nekton

- This group contains animals which are swimmers.
- The nektons are relatively large and powerful as they have to overcome the water currents.
- The animals range in size from the swimming insects (about 2 mm long) to the largest animals, the blue whale.
- **Example:** Sharks, Dolphins, Turtles, Sea cows, Crustaceans, Shrimp and Squid.

Plankton

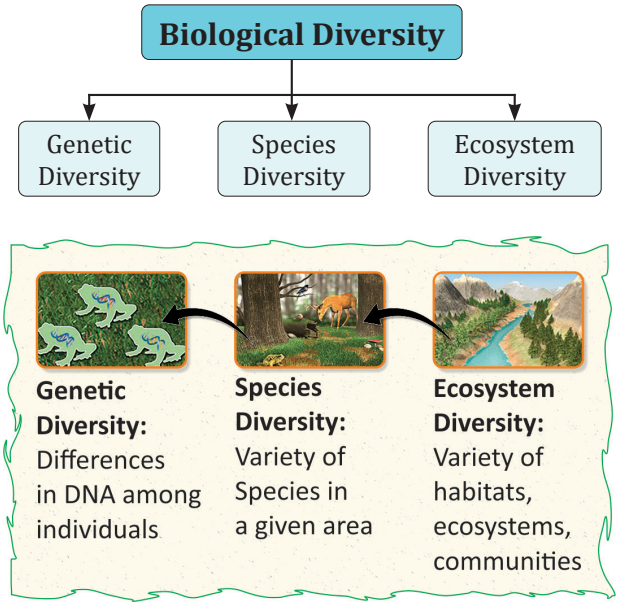
- They include plants and animals that float along at the mercy of the sea's tides and currents.
- Their name comes from the Greek meaning "drifter" or "wanderer."

8 Biodiversity

BIODIVERSITY

- Biodiversity or "biological diversity," is defined as the variety of life on Earth, in all its forms and all its interactions. The number and variety of plants, animals and other organisms that exist is known as biodiversity.
- According to 1992 United Nations Earth Summit, biological diversity is the variability among living organisms from all sources, including, inter alia, terrestrial, marine, and other aquatic ecosystems, and the ecological complexes of which they are a part. This includes diversity within species, between species and ecosystems.
- The United Nations designated 2011–2020 as the United Nations Decade on Biodiversity. To increase the understanding and awareness of biodiversity issues, May 22 was proclaimed as the International Day for Biological Diversity.

Types of Biodiversity



Genetic Diversity

- Genetic diversity refers to the variety of genes contained within species of plants, animals and microorganisms.
- New genetic variation in individuals occurs by gene and chromosomal mutation. In case of organisms with sexual reproduction, it may be spread across the population by recombination.

Vavilov Center of Diversity

- A Vavilov Center of Diversity is a region of the world first indicated by the Russian agro-botanist Nikolai Vavilov to be an original center for the domestication of plants.
- Vavilov centers are regions where a high diversity of crop's wild relatives can be found, representing the natural relatives of domesticated crop plants.
- Vavilov identified eight such centers of origin of cultivated plants around the world in 1935.
- India has a high genetic diversity and is regarded as a Vavilov's center of high crop genetic diversity.
- Vavilov proposed eight centers of origin of cultivated plants, fundamental and ancient centers of agriculture in the world.

The Eight centers are as following: 1. China; 2. India; 2a. Indo-Malayan region; 3. Central Asia, including Pakistan, Punjab, Kashmir, Afghanistan and Turkestan; 4. Near East; 5. Mediterranean; 6. Ethiopia; 7. Southern Mexico and Central America; 8. South America (8. Ecuador, Peru, Bolivia, 8a. Chile, 8b. Brazil-Paraguay).

Vavilov centers

9 Classification of Species

KEYSTONE SPECIES

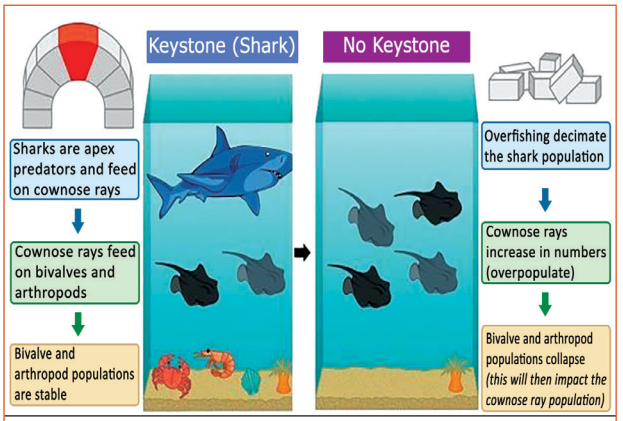
- Keystone species are those which have an extremely high impact on a particular ecosystem relative to its population.
- Such species are known to play a critical role in maintaining the structure of an ecological community, affecting many other organisms in an ecosystem, and helping to determine the types and numbers of various other species in the community.
- An ecosystem may experience a dramatic shift if a keystone species is removed, even though that species could have been a small part of the ecosystem by measures of biomass or productivity.
- Some of the keystone species are Bengal tiger, Lion, Crocodile, and Elephant. If tigers go extinct in the ecosystem, the population of deer and other herbivores increase exponentially, which will reduce grazing plants, and ultimately all the animals would go extinct due to lack of food.
- All keystone species need not be apex predators, though.

Benefits of Keystone Species

- Enhances Habitats
- Removes Genetic Weakness
- Regulates Animal Population
- Recycles Nutrients Waste
- Pollination

Examples of Keystone Species

- Sea Otters is considered as keystone species because of their critical importance to the health and stability of the nearshore marine ecosystem. They eat sea urchins and other invertebrates that graze on giant kelp. Without sea otters, these grazing animals can destroy kelp forests and consequently the wide diversity of animals that depend upon kelp habitat for survival.
- Salmon is the keystone species in Pacific sea as a large number of species depend on it for survival.
- Phytoplankton and krill on which blue whale feed are also keystone species.
- Mangrove forests and coral reefs are also keystone species.
- Certain plant species like ebony tree and Indian-laurel exclusively depend upon bats for their pollination. If the bat population is reduced, then regeneration of these particular plants would become more difficult.



Role of Keystone Species

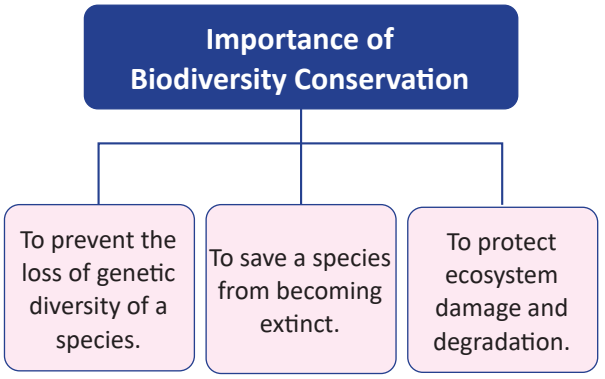
Engineer Species

- An engineer species or ecosystem engineers is the one that creates, changes, or destroys a habitat.
- The terms 'keystone' and 'engineer' are used interchangeably but the latter is better understood as a subset of keystone species.
- In North America, the prairie dog is an ecosystem engineer. Prairie dog burrows provide nesting areas for mountain plovers and burrowing owls.
- Similarly, in the African savannas, the larger herbivores, especially the elephants, shape their environment. The elephants destroy trees, making room for the grass

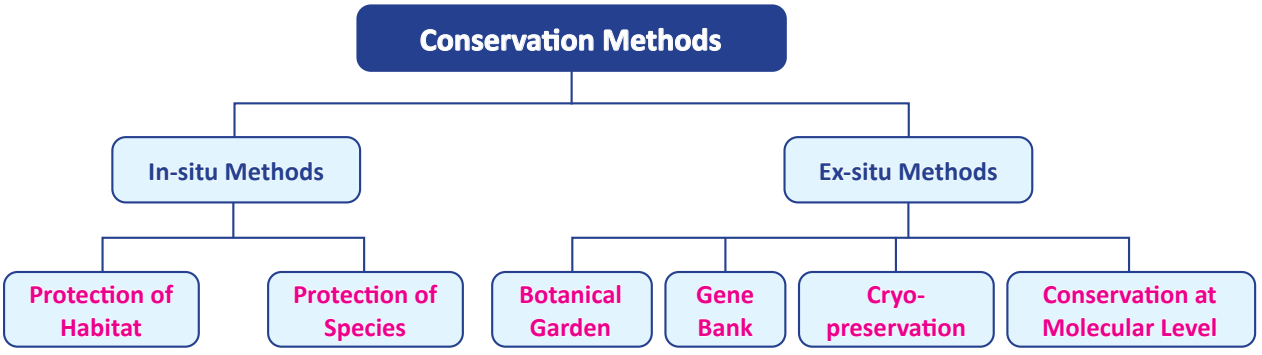
10 Biodiversity Conservation

INTRODUCTION

- Biodiversity Conservation is the planned management of biotic resources, to maintain the balance in nature and retain its diversity.
- It is the proper management of the biosphere by human beings in such a way that it gives maximum benefit to the present generation, and also develops its potential to meet the needs of future generations.
- It also includes wise use of biotic resources in such a way that the needs of the present generation are met and at the same time leaving enough for future generations.



CONSERVATION STRATEGIES AND METHODS



In-Situ Methods

- It is the process of preserving the species and populations of living organisms in a natural state in the habitat where they naturally occur.
- It includes the preservation of plants and animals within their natural habitats or in protected areas.

Protection of Habitat

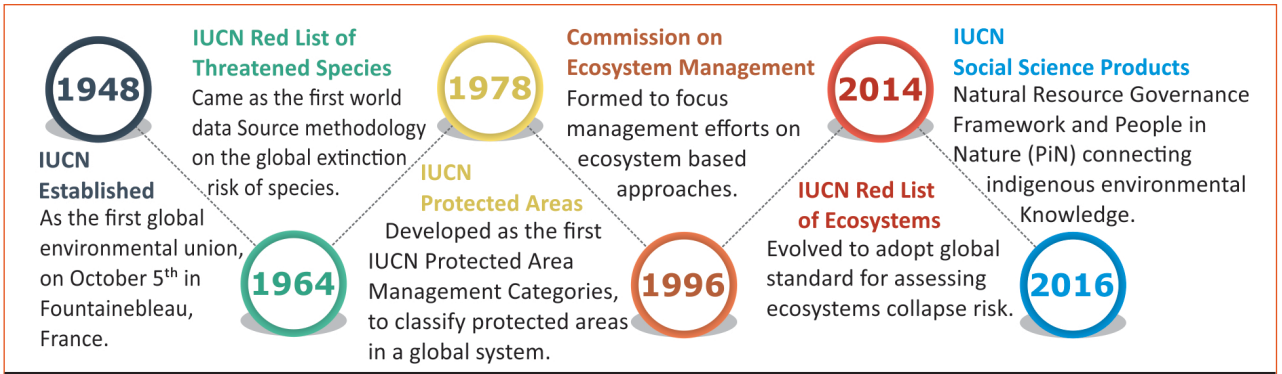
- It is the main method for conservation of biodiversity.
- The adoption of National Policy on Wildlife in 1970 and enactment of the Wildlife (Protection) Act in 1972 led to a significant growth in protected areas network.
- These include, National Parks; Community Reserves; Wildlife Sanctuaries; Biosphere Reserves; and Conservation Reserves. Other protected areas are marine protected areas, sacred groves, lakes and wetlands.
- Wildlife Protection Act, 1972 provides for setting of the National Parks; Community Reserves; Wildlife Sanctuaries; and Conservation Reserves.
- Biosphere reserves are declared under UNESCO's Man and Biosphere (MAB) programme.

- **National Parks**
  - National Parks are notified by the State governments under Section 35 of the Wildlife (Protection) Act of 1972. They can also be notified by the central government.
  - These sites are declared for the purpose of protection and propagation or development of wildlife therein or its environment.

11 International Union for Conservation of Nature

THE INTERNATIONAL UNION FOR CONSERVATION OF NATURE (IUCN)

- IUCN is an organization working in the field of nature conservation and sustainable use of natural resources. It is located in Gland, Switzerland and is also known as the World Conservation Union.
- IUCN was founded in October, 1948 as the International Union for the Protection of Nature (or IUPN) following an international conference in Fontainebleau, France. The organisation changed its name to the IUCN in 1956.
- It is a membership union, composed of both government and civil society organisations.
- It is involved in data gathering and analysis, research, field projects and education on conservation, sustainable development and biodiversity.
- **IUCN Red List**: In 1964, IUCN established the IUCN Red List of Threatened Species, which put forth a comprehensive data source on the global extinction risk of species and their conservation status in the world.
- **IUCN Protected Areas**
  - In 1978, IUCN developed a preliminary system of Protected Area Management Categories to help make sense of the world's growing protected area network, aiming both to define and record the resources.
- Protected Areas Categories
  - Ia (Strict Nature Reserve)
  - Ib (Wilderness Area)
  - II (National Park)
  - III (Natural Monument or Feature)
  - IV (Habitat/Species Management Area)
  - V (Protected Landscape/Seascape)
  - VI (Protected area with sustainable use of natural resources)
  - These categories are recognised by international bodies such as the United Nations and by many national governments as the global standard for defining and recording protected areas and as such are increasingly being incorporated into government legislation.
- **The IUCN Red List of Ecosystems Categories and Criteria**
  - It is a global standard for assessing the status of ecosystems, applicable at local, national, regional and global levels.
  - Assessments determine whether an ecosystem is not facing imminent risk of collapse, or whether it is vulnerable, endangered, or critically endangered.
- **People in Nature (PiN)**
  - It is an IUCN knowledge basket on the interrelationships between people and nature.
  - PiN will provide a systematic approach to working with communities and others to document the



Evolution of IUCN

12 Biodiversity in India

INTRODUCTION

- India, a megadiverse country with only 2.4% of the world's land area, accounts for 7-8% of all recorded species, including over 45,000 species of plants and 91,000 species of animals.
- **India represents:** Two Realms; Five Biomes; Ten Biogeographic Zones; and Twenty-five Bio-geographic provinces.

REALM

- A realm is a continent or subcontinent sized area with unifying features of geography, and fauna and flora.
- **Realms in Indian Region**
  - Himalayan region is represented by Palearctic Realm.
  - Rest of the subcontinent is represented by Malayan Realm.
- In the world, eight terrestrial biogeographic realms are typically recognised.
- **World Biogeographic Realms**
  - Nearctic Realm
  - Palaearctic Realm
  - Afrotropic Realm
  - Oceania Realm
  - Australasia
  - Australian Realm
  - Antarctic Realm
  - Neotropic Realm

BIOME

- A biome is often referred to as a global-scale community of plants and animals and is the largest subdivision of the biosphere.
- It may contain many different kinds of smaller ecosystems.
- Biomes are typically distinguished on the basis of the characteristics of their vegetation because it makes up the largest portion of biomass.
- **Biomes of India**
  - Tropical humid forests
  - Tropical dry or deciduous forests
  - Warm deserts and semi-deserts
  - Coniferous forests
  - Alpine meadows

BIOGEOGRAPHIC ZONES

- Biogeographic zone is defined as large distinctive units of similar ecology, biozone representation, community and species, for example the Himalaya, and the Western Ghats.
- Biogeography deals with the geographical distribution of plants and animals.
- In India, conservation planning has been taken up on the basis of biogeographic classification.
- Within India, the biogeographic classification recognizes 10 zones, divided into 25 provinces.

BIO-GEOGRAPHIC PROVINCES

- The biotic province is defined as secondary units within a zone, giving weight to particular communities separated by dispersal barriers or gradual change in environmental factors such as North West and West Himalaya on either side of the Sutlej River.
- There are 25 bio-geographic provinces in India.

THE LAND REGION

A tertiary set of units within a province, indicating different landforms, for example Aravalli Mountains and Malwa Plateau in Gujarat Rajwada Province.

BIO-GEOGRAPHICAL REGIONS OF INDIA

Trans Himalayan Region

- It is situated in the north of the Great Himalayas. The area is very cold and arid.
- **Flora:** The only vegetation is a sparse alpine steppe. Extensive areas consist of bare rock and glaciers.
- **Fauna:** Wild Sheep and Goats, Ibex, Snow Leopard, Marbled Cat, Marmots and Black-Necked Cranes.
- **Threats:** Livestock pressure, tourism, exotic plantations, extraction of medicinal poaching, human-animal conflict, climate change.

13 International Efforts for Biodiversity Conservation

WORLD CONSERVATION STRATEGY

- It is an intellectual framework and practical guidelines for conservation measures.
- It was jointly developed by the United Nations Environment Programme (UNEP), the International Union for Conservation of Nature (IUCN), and WWF International in 1980. It demarcated the priority activities of conservation efforts.
- **Objectives of World Conservation Strategy**
  - To maintain ecological processes and ecosystems that are important to human activities, like soil regeneration, nutrient cycling, water cleansing, etc.
  - To preserve genetic diversity of species on Earth.
  - To ensure sustainable use of species and ecosystems which support communities and industries.
- In 1991 UNEP, IUCN and WWF International published a document titled "Caring for the Earth", which came to be known as the successor of the World Conservation Strategy.

UN CONFERENCE ON ENVIRONMENT AND DEVELOPMENT RIO DECLARATION, 1992

- In 1992 the United Nations organised Conference on Environment and Development (UNCED) at Rio de Janeiro, Brazil, informally known as the Earth Summit.
- Rio Declaration of 1992 was the outcome of the UNCED. It was signed by around 175 countries.
- The Rio Declaration consisted of 27 principles intended to guide countries in future sustainable development.
- **Key Declarations**
  - **Agenda 21**
    - Agenda 21 is a non-binding, voluntarily implemented action plan of the United Nations with regard to sustainable development.
    - Agenda 21 and Statement of principles for the sustainable management of forest were adopted by more than 178 governments.
  - **Convention on Biodiversity (CBD)**
    - It is dedicated to promoting sustainable development.
    - It was conceived as a practical tool for translating the principles of Agenda 21 into reality.
    - **Main Objectives of CBD**
      - The conservation of biological diversity.
      - The sustainable use of the components of biological diversity.
      - The fair and equitable sharing of the benefits arising out of the utilization of genetic resources.
  - **Conference of the Parties (COP):** It is the governing body of the Convention, and advances implementation of the Convention through the decisions it takes at its periodic meetings.

AICHI BIODIVERSITY TARGETS

- It was adopted at COP 10 by the Convention on Biological Diversity (CBD) at its Nagoya conference.
- **Outcome of the COP**
  - Nagoya Protocol on Genetic Resources
  - Aichi Targets for biodiversity
- At this meeting, the parties agreed to a plan, officially known as "Strategic Plan for Biodiversity 2011-2020", to save biodiversity.
- This plan provides a set of 20 ambitious yet achievable targets, collectively known as the Aichi Targets.
- Classification of Targets
  - **Strategic Goal A:** Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society.

14 India's Efforts Towards Biodiversity Conservation

BIODIVERSITY CONSERVATION

- As required by the Convention on Biological Diversity (CBD), a National Biodiversity Strategy and Action Plan (NBSAP) for India was finalised by 2004.
- NBSAP was carried out by the Ministry of Environment, Forests, and Climate Change (MoEF & CC). Kalpvriksh, an NGO, undertook technical coordination.
- **Objectives of Action Plan**
  - Restoration and regeneration of degraded ecosystems.
  - Recognition of community rights.
  - Development of alternative intellectual property right systems appropriate for indigenous knowledge.
  - Balancing of local, national and international interests related to biodiversity.
  - Preventing deprivation of indigenous knowledge of natural resources.

The Biological Diversity Act, 2002

- The Biological Diversity Act, 2002 covers conservation, sustainable use of biological resources and associated knowledge occurring in India for commercial or research purposes or for the purposes of bio-survey and bio-utilisation.
- It provides a framework for access to biological resources and sharing the benefits arising out of such access and use.
- The Act also includes in its ambit the transfer of research results and application of intellectual property rights (IPRs) relating to Indian biological resources.
- The Act was enacted to meet the obligations under the Convention on Biological Diversity (CBD), to which India is a party.
- The Act also defines Biological resources as "plants, animals and micro-organisms or parts thereof, their genetic material and by-products (excluding value added products) with the actual or potential use or value, but does not include human genetic material.
- The National Biodiversity Authority (NBA), a Statutory Autonomous Body, was established in 2003 to implement this Act.
  - The monetary benefits, fees and royalties, as a result of approval by NBA are to be deposited in the National Biodiversity Fund, which will be used for conservation and development of areas from where the resource has been accessed, in consultation with local self-government.
- The Act covers foreigners, non-resident Indians, body corporate, association or organization that is either not incorporated in India or incorporated in India with non-Indian participation in its share capital or management.
  - These individuals or entities require the approval of the NBA when they use biological resources and associated knowledge occurring in India for commercial or research purposes or for the purposes of bio-survey or bio-utilisation.
  - Indians and Indian institutions do not require the approval of the National Biodiversity Authority when they engage in the above mentioned activities.
    - However, they would need to inform the State Biodiversity Boards prior to undertaking such activities.
- The Act excludes Indian biological resources that are normally traded as commodities. Such exemption holds only so far the biological resources that are used as commodities and for no other purpose.
- The Act also excludes traditional uses of Indian biological resources and associated knowledge when they are used in collaborative research projects between Indian and foreign institutions with the approval of the central government.

Biodiversity Heritage Sites (BHS)

- Under Section 37 of Biological Diversity Act, 2002 the State Government in consultation with local bodies may notify the areas of biodiversity importance as Biodiversity Heritage Sites.

15 Renewable Energy

INTRODUCTION

- The rising consumption of energy has resulted in the country becoming increasingly dependent on fossil fuels such as coal, oil and gas. However, rising prices of oil and gas and their deleterious effect on the environment has raised reservations about the future of fossil fuels.
- Energy sources like solar, wind, hydro, geothermal and biomass are sustainable, renewable, more equitably distributed, environmentally friendly and cheaper than conventional sources. They are obtained from the regular and repetitive flows of energy happening in the natural environment.
- The alternative sources of energy have become especially relevant in the wake of climate change.

HYDROELECTRIC ENERGY

Hydroelectric energy is a form of energy that harnesses the power of water in motion, such as water flowing over a waterfall to generate electricity. It uses hydroelectric power plant which consists of a high dam that is built across a large river to create a reservoir, and a station where the process of energy conversion to electricity takes place.

Steps in the Generation of Hydro Power

- Collection of run-off water of seasonal rain and snow in lakes, streams and rivers, during the hydrological cycle.
- Flow of collected water to dams downstream and then into the turbine of the hydropower plant.
- The turbine converts the energy of falling water into mechanical energy to drive the generator. The generator connected to the turbine generates electricity and this is transmitted through the transmission lines to the end user.

Advantages

- It uses but does not consume the water for generation of electricity in an open cycle.
- No consumable involved; there is very little recurring cost and hence, no high long term expenditure.
- It is cheaper as compared to electricity generated from coal and gas fired plants.
- It also reduces the financial losses due to frequency fluctuations and it is more reliable as it is inflation free due to non-usage of fossil fuel.
- Due to its unique capabilities of quick starting and closing, hydropower stations are found to be economical choice to meet peak loads in the grids.

Classification of Hydro Projects based on Installed Capacity

- **Micro:** Up to 100 KW
- **Mini:** 101 KW to 2 MW
- **Small:** 2 MW to 25 MW
- **Mega:** Hydro projects with installed capacity more than or equal to 500 MW.

Hydroelectric Dams Emit a Billion Tonnes of Greenhouse Gases a Year

- According to a study published in Bio-Science, Hydroelectric dams contribute more to global warming than previously estimated. Researchers found that rotting vegetation in the water means that the dams emit about a billion tonnes of greenhouse gases every year. This represents 1.3% of total annual anthropogenic (human-caused) global emissions. Methane stays in the atmosphere for only around a decade, while CO_2 stays several centuries, but over the course of 20 years, methane contributes almost three times more to global warming than CO_2.
- Methane is produced at the bottom of the reservoirs, where oxygen is low and bacteria decompose organic material, like trees and grasses, which is already present or carried by watercourse. Part of the methane becomes CO_2; the rest is carried to the surface as bubbles.

Disadvantages

- **Resettlement and Rehabilitation Problems:** Hydroelectric projects involve submergence causing displacement of project area. Many times, it is one of the main reasons for the delay in the execution resulting in time and cost overruns.

16 Pollution

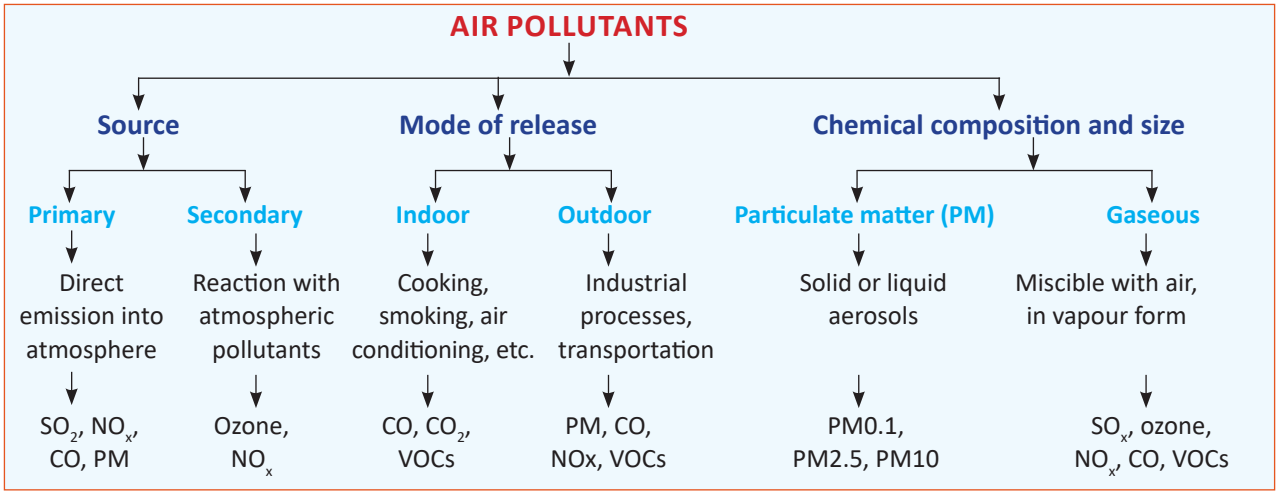
POLLUTION

It may be defined as addition of any physical substance such as solid, liquid, or gas or any form of energy such as heat, sound, or radioactivity in the environment at a rate greater than its conversion into some harmless form. As per the Environment Protection Act (EPA), 1986, "Environmental Pollution, is the presence of any pollutant in the environment."

Pollutants

- Pollutants are the agents, which cause environmental pollution.
- "Environmental pollutant" means any solid, liquid or gaseous substance present in such concentration as may be, or tend to be, injurious to the environment.

Classification of Pollutants



On the Basis of their Existence in Nature	
Quantitative Pollutants	Substances which normally occur in the environment get the status of a pollutant, when their concentration increases due to anthropogenic activities, for example, Carbon dioxide, when its concentration increases, causes harmful effects on the flora and fauna.
Qualitative Pollutants	Substances which do not normally occur in nature but are added by humans, for example, insecticides, pesticides, etc.
On the Basis of the Form in which they Persist in the Environment	
Primary Pollutants	Pollutants which persist in the environment in the same form in which they are released into the environment like plastics, DDT, etc.
Secondary Pollutants	Formed from the primary pollutants by chemical interaction with some constituent present in the atmosphere such as PeroxyAcetyl Nitrate(PAN) Aldehydes, Ketones, Ozone etc.
On the Basis of their Nature of Disposal	
Biodegradable pollutants	Pollutants that are quickly degraded by natural means, i.e., microbial action for instance, domestic sewage is decomposed by natural processes or by engineered systems such as municipal treatment plants etc.
Non-biodegradable Pollutants	Pollutants which are not decomposed by natural processes such as plastics, glass, DDT, radioactive substances, etc.

17 Climate Change

CLIMATE CHANGE

- Climate change is the long-term alteration of temperature and normal weather patterns in a region.
- It refers to the broad range of changes that are happening on our planet such as rising global warming, rise of sea levels, shrinking mountain glaciers, accelerating ice melt in Greenland, Antarctica and the Arctic, and shifts in flower/plant blooming times.

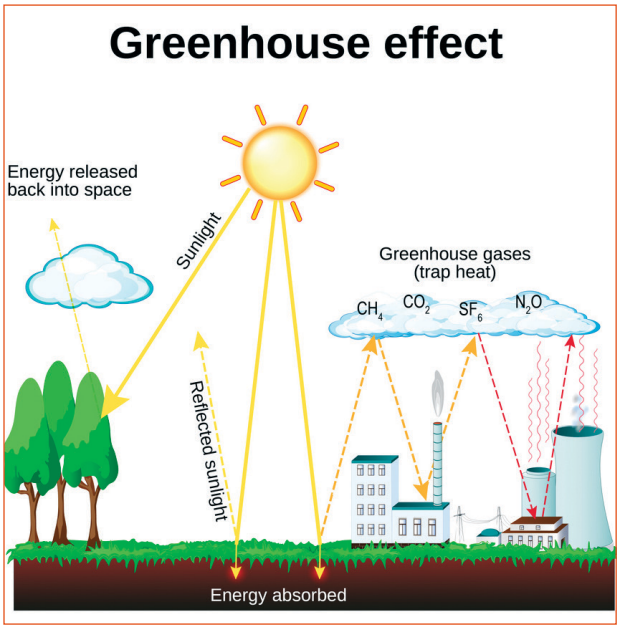
Causes of Climate Change

Factors	Sources
Natural Factors	❍ Changes in the Sun's intensity. ❍ Volcanic eruptions. ❍ Natural processes within the climate system such as changes in ocean current circulation.
Anthropogenic Factors (produced by humans)	❍ Emission of Carbon dioxide (CO_2) due to burning of fossil fuels such as coal, oil and gas. ❍ Emission of Methane (CH_4) and Nitrous oxide (N_2O) from agriculture. ❍ Emissions through land use changes such as deforestation, reforestation, urbanization, desertification, etc.

Factors Controlling Climate Change

Greenhouse Effect

- When sunlight reaches the Earth's surface, it can either be reflected back into space by bright surfaces such as ice and clouds, or can be absorbed by Earth's surface and atmosphere.
  - Once absorbed, the planet releases some of the energy back into the atmosphere as long wave infrared radiation.
  - Greenhouse gases (GHGs) like water vapor (H_2O), Carbon dioxide (CO_2), and Methane (CH_4) absorb the heat energy, slowing or preventing the loss of heat to space.
  - In this way, GHGs act like a blanket, making Earth warmer than it would otherwise be. This process is commonly known as the 'Greenhouse Effect'.
- Life on earth has been possible because of this natural greenhouse effect which is due to water vapour and small particles present in the atmosphere. Without this phenomenon, average global temperatures might have been around –170°C and at such a low temperature life would not have been possible.
- Since the Industrial Revolution began around 1750, human activities have contributed substantially to climate change by adding CO_2 and other heat-trapping gases to the atmosphere.
- These greenhouse gas emissions have increased the greenhouse effect and caused earth's surface temperature to rise, further resulting in 'Global Warming'.
- The primary human activity affecting the amount and rate of climate change is greenhouse gas emissions from the burning of fossil fuels.



18 India and Climate Change

IMPACT OF CLIMATE CHANGE

On Agriculture

- Agriculture sector in India is vulnerable to climate change.
- Rainfed agriculture and irrigated crops will be affected due to rainfall variability, eventually reducing yield across agro-ecological regions.
- Analysis of impact of climate change under National Innovations in Climate Resilient Agriculture (NICRA) project has found that climate change is expected to affect yields, particularly in crops like rice, wheat and maize.
- Climate change is also predicted to lead to boundary changes in areas suitable for growing certain crops. Eastern regions are predicted to be most impacted by increased temperatures and decreased radiation, resulting in relatively fewer grains and shorter grain filling durations.
- With increase in drought, crop failures and cattle mortality have become common. This has an adverse impact on farmers' lives.
- It also has a negative impact on commercial poultry due to heat stress.

On Environment

- India is one of the most vulnerable countries in the world because of climate change.
- Impacts of climate change, include water stress, heat waves and drought, severe storms and flooding, and associated negative consequences on health and livelihoods.
- At the national level, an increase of –0.4°C has been observed in surface air temperatures over the past century.
- Warming trend has been observed along the west coast, in central India, the interior peninsula, and north-eastern India.
- Cooling trends have been observed in north-west India and parts of south India.

On Biodiversity

- Climate change is likely to have a number of impacts on biodiversity from ecosystem to species level.
- The most obvious impact is the effect that temperature and precipitation have on species, ranges and ecosystem boundaries. Those species living at the edge of their ranges may need to move due to climate change.
- Habitat loss and climate related stressor have led to species extinction or on the verge of extinction for example, Cheer pheasants with a range primarily in Northern and Western Himalayas, are declining due to loss of the habitat.
- Increased temperature will raise sea level and mangrove will be affected leading to catastrophic effect of disasters like tsunami.

On Weather

- India is already experiencing a warming climate.
- Unusual and unprecedented spells of hot weather are expected to occur far more frequently and cover much larger areas.
- Under 4°C warming, the west coast and southern India are projected to shift to new, high temperature climatic regimes.

On Marine Life

- Marine life faces challenges from warming waters and ocean acidification.
- Warming waters alter the latitude and depth at which certain species are able to survive. Many species are moving deeper or farther north in the Atlantic to find cold water.
- More acidic oceans hinders the development of crustaceans, coral, and other organisms.
- Coral bleaching, coral disease, and coral mortality events are increasing due to high water temperatures attributed to climate change.
- Changes in the breeding season in marine fisheries with the shift in seasonal catch is also observed in the marine ecosystem.

19 Sustainable Development

ORIGIN

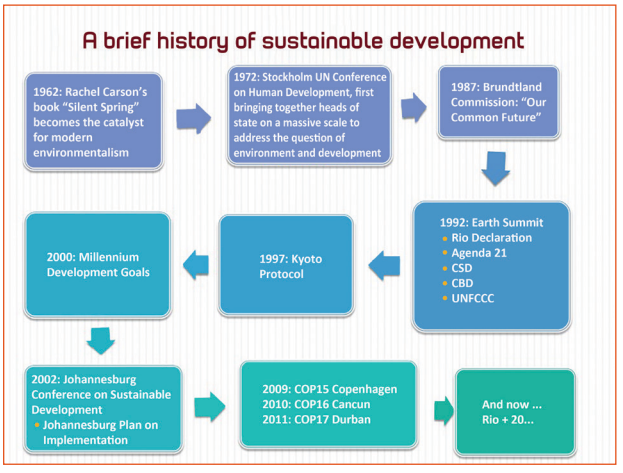
- One of the first uses of the term 'sustainable' in the contemporary sense was by the Club of Rome in 1972 in its classic report on 'Limits to Growth'.
- In 1983, the United Nations (UN) set up the World Commission on Environment and Development (WCED) with Gro Harlem Brundtland as the chairperson.
  - The WCED Report (Brundtland Report), also known as 'Our Common Future', was published in 1987.
  - The report emphasized the need for an integration of economic and ecological systems.
  - The Brundtland Report defined Sustainable Development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

- Sustainable Development consists of two key concepts:
  - The concept of 'needs', in particular, the essential needs of the world's poor, to which overriding priority should be given.
  - The idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.

GLOBAL EFFORTS FOR SUSTAINABLE DEVELOPMENT

Rio Earth Summit

- In 1992 in Rio de Janeiro, Brazil, the UN Conference on Environment and Development published the Earth Charter, which outlined the building of a just, sustainable, and peaceful global society in the 21st century.
- The main outcomes of Rio meet were:
  - Rio Declaration on Environment and Development listing 27 Principles of Sustainable Development
  - The Convention on Biological Diversity (CBD)
  - United Nations Framework Convention on Climate Change (UNFCCC) – a climate change agreement that led to the Kyoto Protocol and now Paris Accord.
  - United Nations Convention to Combat Desertification (UNCCD)
  - Global Environment Facility (GEF)
  - Agenda 21



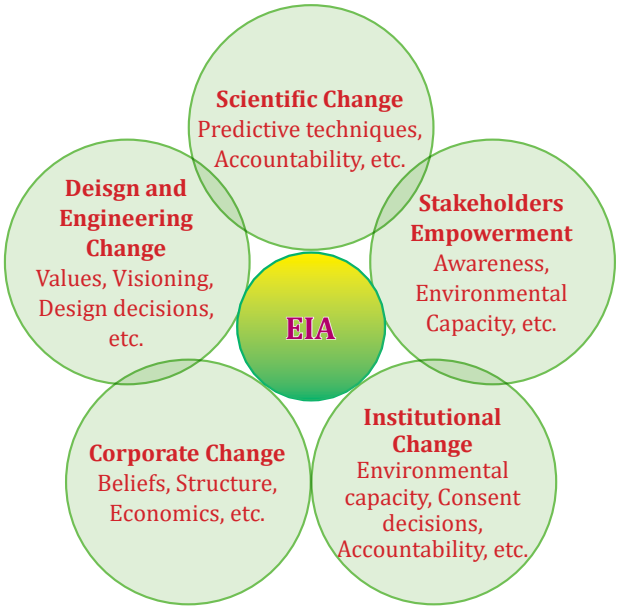
Agenda 21

- The action plan Agenda 21 for sustainable development identified information, integration, and participation as the key building blocks to help countries achieve development that recognizes these interdependent pillars.

20 Environmental and Social Impact Assessment

ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

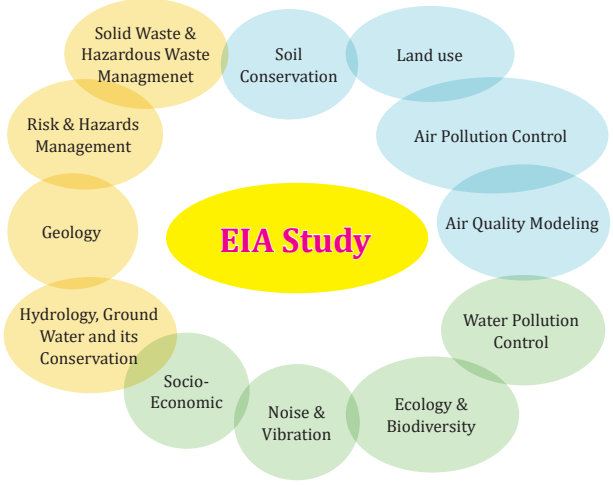
- Environmental Impact Assessment (EIA) is a process of evaluating the likely environmental impacts of a proposed project or development, taking into account interrelated socio-economic, cultural and human-health impacts, both beneficial and adverse.
- The United Nations Environment Programme (UNEP) defines Environmental Impact Assessment (EIA) as a tool used to identify the environmental, social and economic impacts of a project prior to decision-making.
- EIA aims to predict environmental impacts at an early stage in project planning and design, find ways and means to reduce adverse impacts, shape projects to suit the local environment and present the predictions and options to decision makers.



- Both environmental and economic benefits can be achieved by using EIA, such as reduced cost and time of project implementation and design, less treatment/ clean-up costs and implementation of laws and regulations.
- The core values of EIA include integrity, which ensures that the environmental project is in accordance with the standard principles; sustainability, which provides for an environmentally sound development so that resources are not compromised for future generations.

Need for EIA

- Almost every human activity has some impact on the environment, and more often than not these impacts are harmful to the environment.
- But infrastructural and other developments are even necessary to fulfill the ever increasing needs of food, security and other essential human needs.
- So, it is necessary that these developmental effects are environmentally sustainable and hence, there is a need to consider environmental concerns related to a project which should be incorporated at the beginning of the project cycle so that it could be accounted for in the project design.



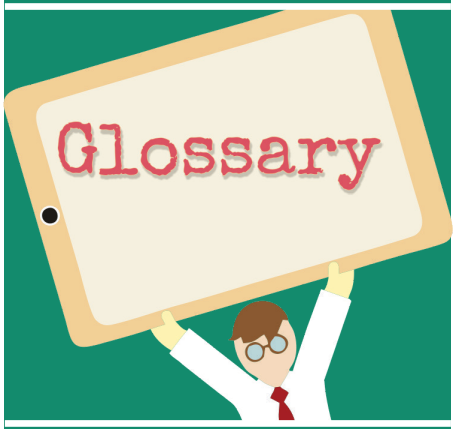
Fundamental Components of EIA

- **Screening**
  - It is done to determine which projects or developments require a full or partial impact assessment study.

Appendix

Ramsar Sites in India					
S. No.	Ramsar Sites	State/Union Territories	S. No.	Ramsar Sites	State/Union Territories
1.	Ashtamudi Lake	Kerala	22.	Pong Dam Lake	Himachal Pradesh
2.	Beas Conservation Reserve	Punjab	23.	Renuka Wetland	Himachal Pradesh
3.	Bhitarkanika Mangroves	Odisha	24.	Ropar Lake	Punjab
4.	Bhoj Wetlands	Madhya Pradesh	25.	Rudrasagar lake	Tripura
5.	Chandertal Wetland	Himachal Pradesh	26.	Saman	Uttar Pradesh
6.	Chilka Lake	Odisha	27.	Samaspur	Uttar Pradesh
7.	Deepor Beel	Assam	28.	Sandi	Uttar Pradesh
8.	East Calcutta Wetland	West Bengal	29.	Sarsai Nawar	Uttar Pradesh
9.	Harike Lake	Punjab	30.	Sambhar Lake	Rajasthan
10.	Hokera Wetland	Jammu & Kashmir	31.	Sasthamkotta Lake	Kerala
11.	Kanji Lake	Punjab	32.	Sunderbans Wetland	West Bengal
12.	Keoladeo Ghana NP	Rajasthan	33.	Surinasar-Mansar Lakes	Jammu & Kashmir
13.	Keshopur-Miani	Punjab	34.	Tsomorirl Lake	Ladakh
14.	Kolleru Lake	Andhra Pradesh	35.	Vembanad Kol Wetland	Kerala
15.	Loktak Lake	Manipur	36.	Upper Ganga River (Brijghat to Narora Stretch)	Uttar Pradesh
16.	Nalsarovar Bird Sanctuary	Gujarat	37.	Wular Lake	Jammu & Kashmir
17.	Nandur Madhameshwar	Maharashtra	38	Asan Conservation Reserve	Uttarakhand
18.	Nangal	Punjab	39	Lonar Lake	Maharashtra
19.	Nawabganj	Uttar Pradesh	40	Sur Sarovar	Uttar Pradesh
20.	Parvati Agra	Uttar Pradesh	41	Tso Kar Wetland Complex	Ladakh
21.	Point Calimere	Tamil Nadu	42	Kabartal Wetland	Bihar

MIKE Sites in India			
Chirang Ripu	Assam	Garo Hills	Meghalaya
Dihing Patkai	Assam	Shivalik	Uttarakhand
Eastern Dooars	West Bengal	Wayanad	Kerala
Deomali	Arunachal Pradesh	Mayurbhanj	Odisha
Nilgiri	Tamil Nadu	Mysore	Karnataka



- **Adventitious Roots**: Roots that grow from any part of a plant other than the radicle or its branches.
- **Aerosol:** An aerosol (abbreviation of "aero-solution") is a suspension of fine solid particles or liquid droplets in air or another gas. Aerosols can be natural or anthropogenic.
- **Agenda 21:** It is a non-binding, voluntarily implemented action plan of the United Nations with regard to sustainable development.
- **Alley Cropping:** Alley Cropping is planting rows of trees at wide spacings with a companion crop grown in the alleyways between the rows.
- **Alpha Biodiversity:** It refers to the average species diversity in a habitat or specific area. Alpha diversity is a local measure.
- **Amensalism:** It is a biological interaction among two species. In this contact between two organisms, one is destroyed or inhibited, and other remains unaffected.
- **Appiko Movement:** It was launched in September 1983 by the representatives of a Yuva Mandali to save the Western Ghats in Southwest India.
- **Aquaponics:** Aquaponics is a combination of aquaculture (which is growing fish and other aquatic animals) and hydroponics (which is growing plants without soil).
- **Assimilation:** It is referred to as the process in which the living organisms integrate the nutrients from various external resources in their body and utilize them to satisfy the energy demands.
- **Bamako Convention:** The Bamako Convention is a treaty of African nations prohibiting the import into Africa of any hazardous (including radioactive) waste. The convention came into force in 1998.
- **Benthos:** Benthos (in Greek meaning "depth of the sea"), also known as benthon, is the community of organisms that live on, in, or near the seabed, river, lake, or stream bottom (called benthic zone).
- **Bio-intensive Farming:** It is an organic agricultural system that focuses on achieving maximum yields from the minimum area of land, while simultaneously increasing biodiversity and sustaining the fertility of the soil.
- **Biomagnification:** Biomagnification (also known as bioamplification) is any concentration of a toxin, such as pesticides, in the tissues of organisms at successively higher levels in a food chain.
- **Biological Oxygen Demand (BOD):** It is defined as the amount of dissolved oxygen required by aerobic microorganisms to breakdown the organic materials in one litre of water at a specific temperature & time-frame.
- **Blue Carbon:** Blue carbon is the carbon stored in coastal and marine ecosystems. Coastal ecosystems such as mangroves, tidal marshes and seagrass meadows sequester and store more carbon per unit area than terrestrial forests and are now being recognised for their role in mitigating climate change.
- **Bog:** A bog is a freshwater wetland of soft, spongy ground consisting mainly of partially decayed plant matter called peat. Bogs are generally found in cool, northern climates.
- **Bonn Challenge:** The Bonn Challenge is a global goal to bring 150 million hectares of degraded and deforested landscapes into restoration by 2020 and 350 million hectares by 2030.
- **Brackish Water:** Brackish water is water with salinity levels (5 to 35 ppt) between seawater and freshwater. It occurs where surface or groundwater mixes with seawater.