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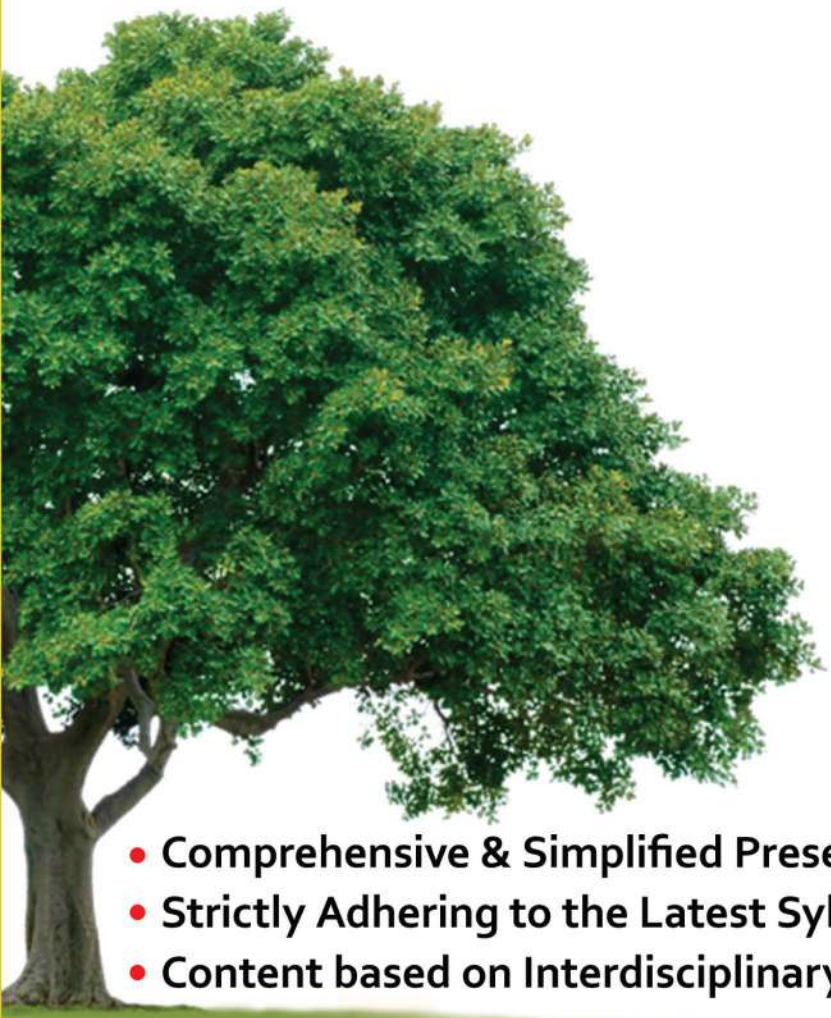
N.N. Ojha Master Series

ENVIRONMENT

for General Studies Prelims & Mains



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ENVIRONMENT

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- ➔ Fundamentals of Environment
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- ➔ Threats to Environment
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- ➔ Environment Conservation & Management
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Editor

N.N. Ojha

Guiding Civil Services Aspirants Since 33 Years

Written by

Chronicle Editorial Team

CHRONICLE

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Preface

Welcome to our inaugural edition of 'Master Series' for General Studies designed for UPSC and State PSC examinations. The Master Series has been conceptualised to cover entire syllabi of civil services examinations, focusing on both Preliminary and Mains stages. It contains curated content designed for beginners which will help them build their basics and will further enhance their understanding of the advanced concepts of the subject.

In the ever-evolving landscape of competitive exams, staying ahead of the curve demands a nuanced understanding of the subjects, particularly in areas like Environment, which have witnessed a paradigm shift in question patterns over the years.

Thus, this Environment Book has been designed to be an indispensable resource for aspirants preparing for the prestigious civil services examinations conducted by the Union Public Service Commission (UPSC) and State Public Service Commissions (SPSCs) as well as the Indian Forest Service (IFS) Exam. The book is a one-stop solution covering every aspect of the prescribed syllabus for Environment section of General Studies for both Prelims and Mains Examinations.

The book has been especially designed to provide a comprehensive and holistic understanding of environmental concepts, issues, policies, organisations, national and international frameworks, conventions and protocols, etc. Further in recent times, the nature of questions in environmental studies has transitioned from mere rote memorisation to a more dynamic and analytical format. The compendium addresses this shift by incorporating a blend of conceptual, factual, and analytical content, thus making it an essential companion for those aiming to excel in the UPSC/ State PSC examinations.

The language of the book is simple and the content is engaging which ensures readers do not face any difficulty while reading the book. Its distinctive design makes it easy to navigate and read. The content provided in the book is accurate, updated and reliable. The topics of questions from the Environment section asked in previous years' UPSC CSE Prelims and Mains examinations as well as related current events and issues have been integrated under relevant sections. This will help the readers develop the necessary skill of linking dynamic aspects with static content.

Covering a wide range of topics, the book provides comprehensive coverage of Environmental Ecology, Biodiversity, and Climate Change, spanning from basic to advanced levels. An easy-to-understand language, accompanied by various mind maps, figures, and flow charts, aid aspirants in grasping and retaining concepts more effectively. Thus, the book is a "must-have" for all aspirants preparing for UPSC/ State PSC civil services examinations and other related examinations.

This masterful endeavour is a collaborative effort of the versatile Chronicle editorial team, drawing on their rich experiences, research and subject matter expertise. Their valuable insights have transformed this edition into a comprehensive and holistic solution for students, providing them with a one-stop reference for mastering the intricacies of Environment subject.

Hence, as you embark on this learning adventure, let this book be your guiding light and help you navigate through the challenges of UPSC and state PSC examinations.

Best wishes for your preparation and the journey ahead, and simultaneously we invite your feedback/suggestions at editor@chronicleindia.in

—N.N Ojha (Editor)

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PART - A

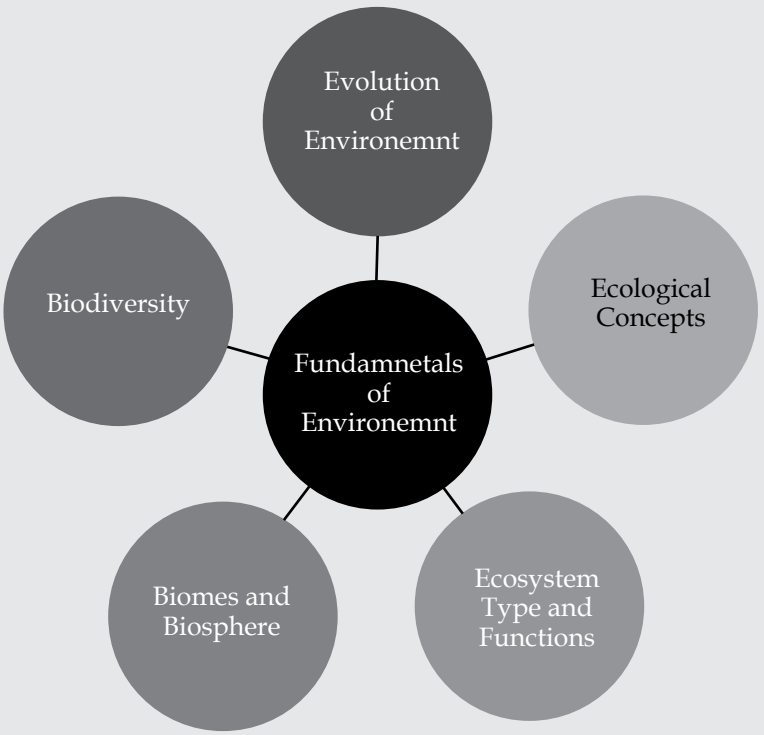
Fundamentals of Environment

Environment is the basis of human life. It is composed of biotic and abiotic components. With the advancing climate change, it has become necessary to understand and safeguard environment for sustenance of human life. This is possible if we have understanding of the evolution of environment, of interactions between abiotic and biotic components, of the hierarchical organization of life on Earth and the immense biodiversity that inhabits the planet Earth.

This understanding helps us to conserve environment, optimally utilize scarce resources in an efficient manner and live up to 'One Health' approach of World Health Organization (WHO) which is an integrated, unifying approach to balance and optimize the health of people, animals and the environment.

This unit deals with basic concepts that are necessary for holistic understanding of the subject of Environment. It includes how the environment has evolved, the understanding of ecology, ecological organization from organism to biosphere and study of biodiversity.

This knowledge of the fundamentals of environment would aid in understanding ecological aspects, global environment issues, increasing environmental crisis, impact of human population on environment and provide us a strategy for judicious planning and conservation of resources.



01
CHAPTER

Evolution of Environment

Environment is defined as the sum total of living and non-living components, influences and events surrounding an organism. The relationship and interaction between organism and environment are highly complex. All organisms are intimately dependent on the environment from which they derive their sustenance. They are dependent on the environment for food, energy, water, oxygen, shelter and for other needs.

Environment is defined as the surroundings or conditions in which an organism lives or operates. It encompasses two components- living and non-living. However, the present state of environment which makes planet Earth the only place to sustain life is the culmination of sequence of steps involved in origin and evolution of Earth.

Earth is supposed to have been formed about 4.5 billion years back. Life appeared 500 million years after the formation of Earth, i.e., almost four billion years back.

Changes in Environment and Biological Evolution

Early Earth

The conditions on early Earth were inhospitable for life. There was no atmosphere. Water vapour, methane, carbon dioxide and ammonia released from molten mass covered the surface.

There was abundant water vapour in the atmosphere but there was no free oxygen. Thus, there was a reducing atmosphere on primitive Earth and no life existed at that time.

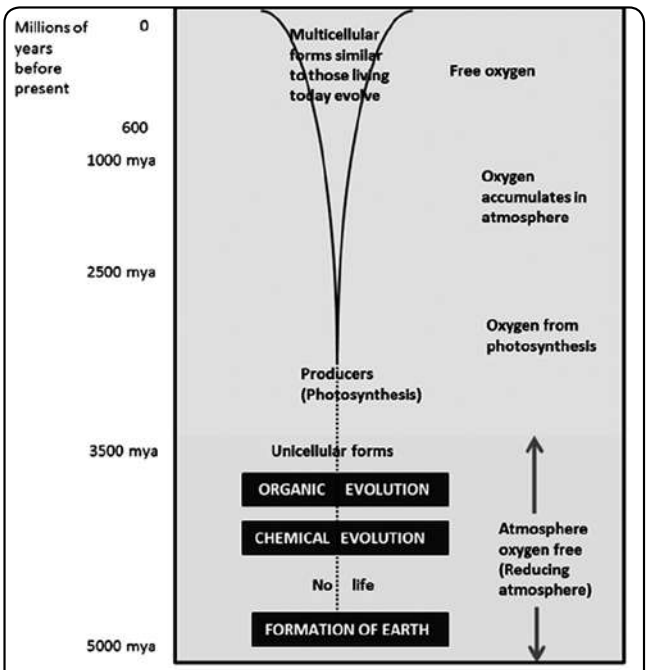
Molecules of Life

As Earth cooled, water vapour condensed to form liquid water. The UV rays from the Sun broke up water into Hydrogen and Oxygen and the lighter H2 escaped. Oxygen combined with ammonia and methane to form water, CO2 and other molecules. The ozone layer was formed.

As it cooled, the water vapour fell as rain, filling all the depressions and forming oceans. The molecules of life were formed in the water.

Evolution of Bacteria

The molecules of life evolved into bacteria, the earliest and simplest organisms. The oldest fossils of bacteria which were the first living organisms on Earth have been found in rocks that are 3-5 billion years old.



Diagrammatic representation of major events of life on earth (mya = millions of years ago)

Accumulation of Oxygen

For almost two billion years, different kinds of bacteria lived on Earth. One of these developed a green pigment called chlorophyll. These chlorophyll-containing bacteria used carbon dioxide and water and released oxygen through photosynthesis which started accumulating in the atmosphere.

From reducing to oxidizing Atmosphere

Continued photosynthesis by chlorophyll-containing bacteria progressively accumulated oxygen in the atmosphere. Thus the atmosphere gradually transformed from reducing to oxidizing.

This led to accumulation of 21% oxygen content in the atmosphere. Such changes were responsible for beginning and progress of biological evolution and this led to the invasion of land by living organisms.

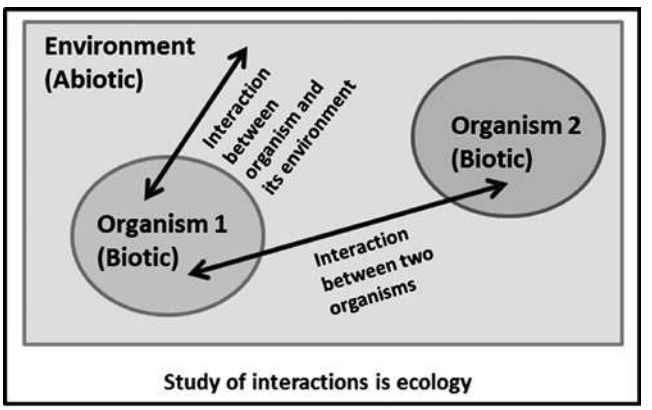
02
CHAPTER

Concepts of Ecology

Ecology refers to the study of the interactions among organisms and between the organisms and their physical environment. It is basically concerned with various levels of ecological organizations: Individual organisms, Populations, Communities, Ecosystems, Biomes, and Biosphere. This chapter explains ecology, its principles and ecology at organismic and population levels. It also describes the characteristics of the community.

Definition of Ecology

The term ecology has been derived from two Greek words, namely 'Oikos' meaning home or estate and 'logos' meaning study. Literally it means the study of the home or household of nature. Ecology is defined as 'the scientific study of the relationship of the living organisms with each other and with their environment.'



Study of interactions is ecology

There are three things that we study in Ecology-

(i) Living organisms (Biotic components)

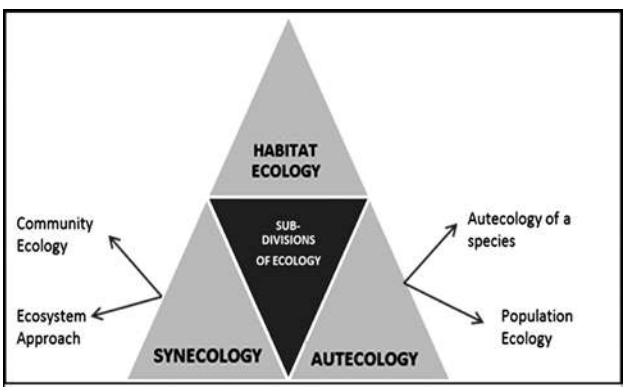
(ii) **Relationship & interactions with other organisms**. For example, whether there is symbiotic relationship like rhizobium and legume plant roots, or competition among herbivorous animals for food.

(iii) **Relationship and interactions with surrounding environment.** It means how organisms respond to climate, soil, topography, water availability, and atmosphere. For example, animals in deserts have long ears to increase heat loss and keep themselves cool while animals in cold areas have small ears to prevent heat loss. It also includes energy flow (Food chains/Food web), nutrient cycles and ecological succession.

- The emphasis is on relationships between organisms and the components of the environment namely abiotic (non-living) and biotic (living).
- It was **Hanns Reiter** who in 1868 appears to have coined the term 'ecology' by combining the two Greek words Oikos (home) and Logos (study).
- In 1869, the German biologist Ernst Haeckel for the first time elaborated the definition of ecology.
  - He defined 'ecology' as follows: "By ecology we mean the body of knowledge concerning the economy of nature - the investigations of the total relations of animal both to its inorganic and to its organic environment; including above all, its friendly and inimical relation with those animals and plants with which it comes directly or indirectly into contact - in a word, ecology is the study of all the complex interrelations referred to by Darwin as the conditions of the struggle for existence."

Sub-Divisions of Ecology

- Ecology was earlier divided into plant and animal ecology. However, as plants and animals are intimately interconnected and interdependent amongst themselves and on their environment, modern ecology does not make any such distinction between plants and animals.
- Presently Ecology is sub-divided into- (a) Autecology, **(b)** Synecology and **(c)** Habitat Ecology.



Sub-divisions of Ecology

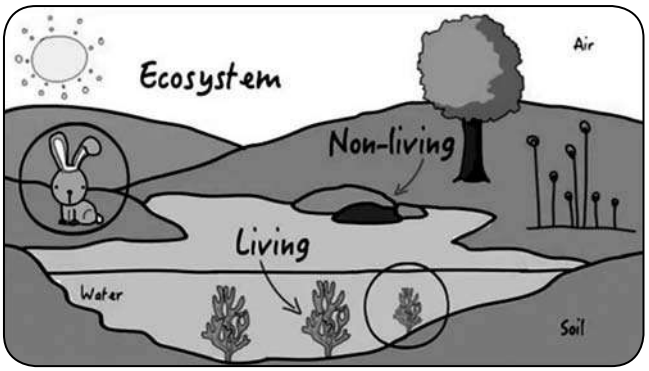
03
CHAPTER

Types of Ecosystem

An ecosystem is a natural unit consisting of all the living organisms in an area functioning together with all the non-living physical factors of the environment. The concept of ecosystem can apply to units of different sizes. Ecosystems are not closed, at least not in terms of energy. They depend on continuous inputs of energy from outside the system. This chapter explains ecosystem, its components, types, services and productivity. It also details out functions of ecosystem like energy flow, nutrient cycling and ecological succession.

Ecosystem and its Components

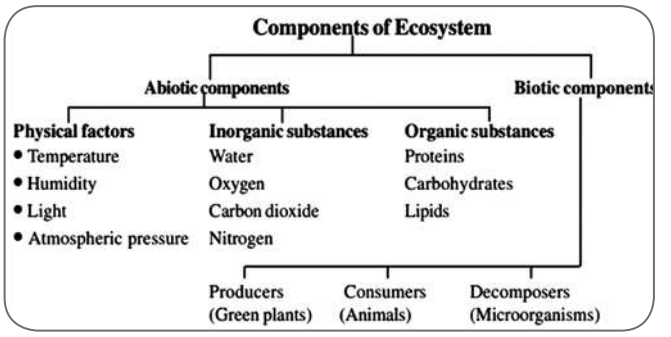
The living community of plants and animals in any area together with the non-living components of the environment such as soil, air and water, constitute the ecosystem.



- The term 'ecosystem' was coined by A.G. Tansley in 1935.
  - Tansley defined ecosystem as "the system resulting from the integration of all the living and non-living factors of the environment."
  - He further stated that "the whole system includes not only the organism complex but also the whole complex of physical factors forming what we call the environment of the biome-the habitat factors in the widest sense. It is the systems so formed which are basic units of nature on the face of the earth."
- An ecosystem is a functional unit of nature encompassing complex interaction between its biotic (living) and abiotic (non-living) components.
- **Example:** Pond
- Some ecosystems are fairly robust and are less affected by a certain level of human disturbance.
- Others are highly fragile and are quickly destroyed by human activities.
- **Example:** Mountain ecosystems are extremely fragile as degradation of forest cover leads to severe erosion of soil and changes in river courses.
- **There are two types of ecosystems, closed and open.**
  - (i) **Closed ecosystems** are ones that do not have any inputs (exchanges of energy from the surrounding environment) or outputs (exchanges of energy from within the ecosystem).
    - **Example:** The only ecosystem that can possibly be considered closed would be the sub-glacial Antarctic lakes, which have been found to harbour microbial life.
  - (ii) **Open ecosystems** are the ones that have both inputs and outputs. Open ecosystems are everywhere like a city (as an urban ecosystem), any forest, the Grand Canyon, the Mississippi and so on.

Components of Ecosystem

The components of ecosystem are broadly categorized into - Abiotic and Biotic components.



(a) Abiotic Components (Non-Living)

The abiotic components can be grouped into following three categories:

- (i) **Physical or Climatic Factors**: These are sunlight, temperature, rainfall, humidity and pressure. They sustain and limit the growth of organisms in an ecosystem.
- (ii) **Inorganic Substances**: Carbon dioxide, nitrogen, oxygen, phosphorus, sulphur, water, rock, soil and other minerals are the inorganic substances required in various processes of living organisms.

04
CHAPTER

Functions of Ecosystem

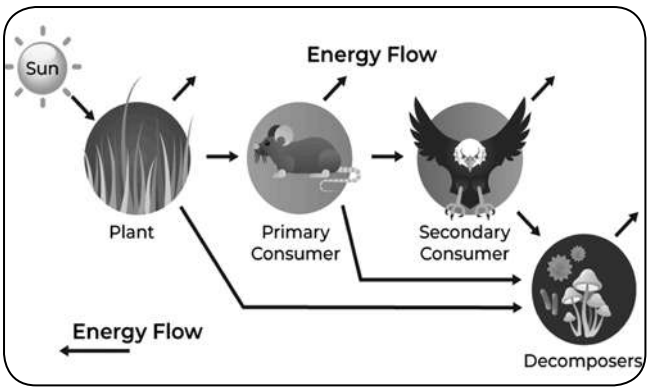
Ecosystem play major role in sustaining life. It regulates and promotes the essential ecological processes to support life on the Earth. Ecosystem maintains balance between different trophic levels. It regulates the interaction between biotic and abiotic components of ecosystem. Ecosystem maintains the flow of energy through the food chain, ensures nutrient cycling and ecological succession. It involves Homeostasis (or cybernetic) or feedback control mechanisms.

Ecosystems are complex dynamic systems. They play three major roles for sustaining life:

(A) Energy Flow
(B) Nutrient Cycling
(C) Ecological Succession

Energy Flow

Energy flow is an important function of ecosystem which makes them more dynamic.



- Ecosystems are not exempt from the Second Law of thermodynamics. They need a constant supply of energy to synthesize the molecules they require, to counteract the universal tendency towards increasing disorderliness.
- Sun is the only source of energy for all ecosystems on Earth. There is unidirectional flow of energy from the sun to producers and then to consumers.
  - Of the incident solar radiation, less than 50 per cent of it is photosynthetically active radiation (PAR).
- In almost all ecosystems, photo synthesizers are the only "gateway" for energy to flow into food webs (networks of organisms that eat one another).
  - Plants and photosynthetic bacteria (autotrophs) fix Sun's radiant energy to make food from simple inorganic materials.
  - Plants capture only 2-10 per cent of the PAR and this small amount of energy sustains the entire living world.
  - Photoautotrophs like plants use light energy to build carbohydrate out of carbon dioxide. The energy is stored in the chemical bonds of the molecules, which are used as fuel and building material by the plant.
  - The energy stored in organic molecules can be passed to other organisms in the ecosystem when those organisms consume plants (or eat other organisms that have previously eaten plants).
  - If photosynthesizers were removed, the flow of energy would be cut off, and the other organisms would run out of food.
- The flow of energy is in one direction only and some energy is lost as heat at every successive step.
  - Only 10 per cent energy of a particular trophic level is incorporated into the tissues of the next trophic level.
  - Thus, if 1000 kcal of plant energy were consumed by herbivores, about 100 kcal would be converted into herbivore tissue, 10 kcal to the carnivores and 1 kilocalorie into the top carnivore tissues.

The energy transfer is inefficient because:

- Not all the organisms at a lower trophic level get eaten by those at a higher trophic level.
- Some molecules in the bodies of organisms that do get eaten are not digestible by predators and are lost in the predators' feces (poop).
- The dead organisms and feces become food for decomposers.
- Of the energy-carrying molecules that do get absorbed by predators, some are used in cellular respiration (instead of being stored as biomass).

- Energy flow is studied through interactions at different trophic levels, food chain, food web and ecological pyramids.

05
CHAPTER

Biomes & Biosphere

Ecologists study organisms and their environments at different levels. These levels are Individual, Population, Community, Ecosystem, Biome and Biosphere. In the previous chapter the levels of Individual, Population, Community and Ecosystem have been studied. This chapter deals with ecological organization at biome and biosphere levels.

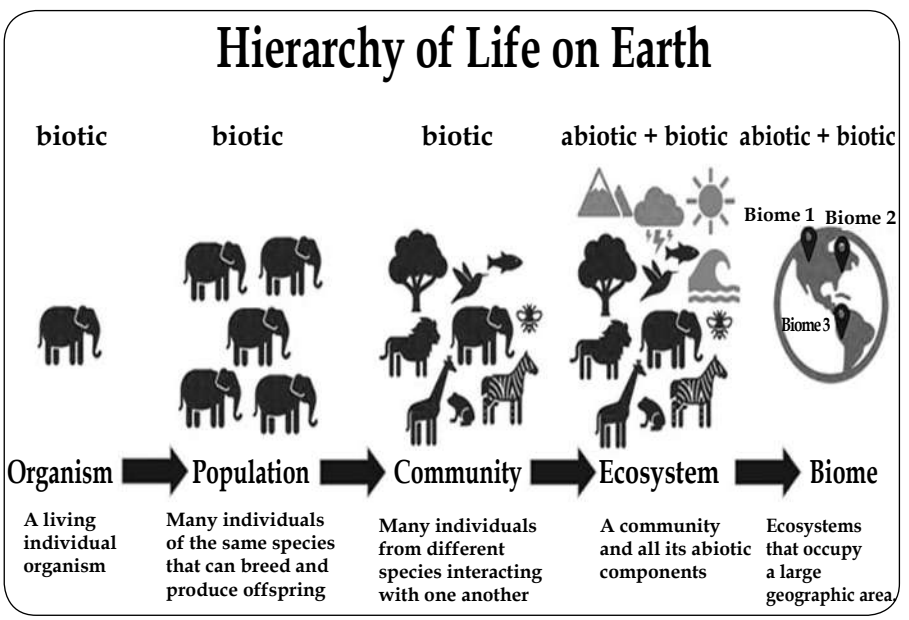
Biomes

The word 'biome' is derived from the Greek word 'bion', meaning "life." 'Biome' can be expanded as biological home.

- Biomes are defined as "the world's major communities, classified according to the predominant vegetation and characterized by adaptations of organisms to that particular environment."
- Biome is a major community that has been established by global climate (i.e., long-term temperature and precipitation patterns) and is defined by the organisms and vegetation that are adapted to live in this large geographical area.
- Biomes play a crucial role in sustaining life on earth.

Example:

- The aquatic biome is home to millions of fish species and the source of the water cycle. It also plays a very important role in climate formation.
- The terrestrial biomes provide foods, enrich the air with oxygen and absorb carbon dioxide and other gases from the air. They also help regulate climate and so on.



Factors Affecting Biomes

The boundaries of a biome are not defined by a single factor. There are various factors which affects the size, location, and character of a biome. These factors are as follows:

1. Climatic Factors

Climate is the most important factor affecting the formation of a biome. The important climatic elements are:

- **Precipitation:** The amount of precipitation determines whether a region will be dominated by xerophytes (plants that are able to live in dry habitats), mesophytes (plants that need an average, regular supply of water) or hydrophytes (plants that are able to live entirely or partially in submerged water or in very wet soil). Thus, precipitation plays an important role in determining the type of vegetation of a region.
  - Towards the equator, precipitation becomes increasingly important, producing communities of desert, grassland and forest in increasing order of precipitation.
  - In the tropical and subtropical biomes which occur in the equatorial latitudes there is a relatively smaller range of temperature during the year, and their variation is also determined by the amount of precipitation. Thus there are not only tropical forests but also tropical grasslands and tropical deserts.
  - Biomes with low precipitation and extreme temperatures cause short growing seasons and poor soil. Fewer kinds or amounts of plants and animals are going to grow with these conditions, and this would be defining an extreme biome like a desert or a permanent ice.

Temperature: Temperature plays a very important role in the distribution of vegetation. There is

06
CHAPTER

Environment Conservation: Traditional Indian Practices

The Indian civilization understood the importance of nature and our traditional practices are aligned with environment conservation. Ancient religious texts encouraged planting trees and termed animal killing as sin. The practice of nature worship is still present in our culture which shows our respect towards the services provided by nature.

Importance of sustainable lifestyle was understood by the world just few years ago but relationship between our lifestyle and impact over environment is deeply imbibed in Indian culture. The so called consumer and materialistic way of living is detrimental to the natural environment. For a sustainable environment human being should be a part of environment and should not exploit it to an extent from where recovery could not be possible.

Conservation of Environment as a Part of Indian Culture

The concept of conservation of nature is not new to people of India. Living in harmony with nature has been an integral part of Indian culture. This has been reflected in various traditional practices, religious beliefs, rituals, folklores, arts and crafts and in the daily lives of Indians.

The Vedic Hymn dedicated to the Earth in Atharva Veda, - 'Mata Bhumih Putroham Prithivyah' means 'Earth is my mother, I am her son.' Mother Earth is celebrated for all her natural bounties and particularly for her gifts of herbs and vegetation. Her blessings are sought for prosperity in all endeavours and fulfillment of all righteous aspirations.

According to Indian tradition, nature is a manifestation of the Divine. Brahman exists as the innermost Self (Atman) of not only humans, but also of all forms and beings in nature. Hence, a large number of pilgrim centers in India, are the sacred rivers, mountains, trees, forests and groves themselves.

The 'Bhisma Parva' of Mahabharata refers to the Earth as an 'ever-yielding cow' provided its resources are developed and managed with balance and control.

The sacred grove tradition was an intrinsic part of the Indian ecological conservation and resource management. There was the Kovilkādu in Tamil Nadu, Kāvu in Kerala, Nandavana or Daivavana in Karnataka and Andhra Pradesh, Deorai in Maharashtra.

The vegetarianism deep rooted in Indian culture has also contributed towards the conservation of Nature.

Respect to Nature

The early Indian people were aware of invaluable role of trees and forests in ecosystem services like purifying the air, hydrological services, as a provider of food and material, climate, rain, and soil. To show their respect they worshipped a number of trees and animals. They also worshipped the protector deity of forests 'Vanadevi'.

Sacred groves were found in abundance in India, which was protected by local communities and which goes to show that forest resources were precious. In sacred groves trees and plants were allowed to grow undisturbed and reptiles, birds and animals could have free living without fear of poaching or interference by man.

The archaeological evidences obtained from the various sites of Indus Valley Civilization suggest that they were nature worshipper. The images of trees like pipal, banyan, etc. and animals such as humped bull, buffalo, goat, tiger, and elephants, etc. show the respect of Harappan people towards nature.

In Indian religious tradition animals are vahanas or vehicles of the Gods and Goddesses and are equally worshipped as their riders. Some vahanas were treated equal to their Gods; some were their companions and some friend – Garuda (Eagle) is the vehicle of Vishnu, the Bull that of Shiva, the mouse that of Ganapati. This shows that we respect the utility of animals by not considering them as mere resources for exploitation.

The Vedic deities are connected with deep symbolism and have many layers of existence. One such association is with ecology. Thus, Surya is associated with the Sun, the source of heat and light that nourishes everyone; Indra is associated with rain, crops, and abundance; and Agni is the deity of fire and transformation and controls all changes.

In Vedic period entire society was centered around the Cow (go), gopura was the entrance to the village, gotra was the clan to which a person belonged, goshti was an assembly of good men, gosarga and godhuli represented dawn and dusk, while gopa and govalla were officials.

PART - B

Biodiversity

India is among the 17 megadiverse countries of the world. With only 2.4 per cent of the world's land area, India harbours 7-8 per cent of all recorded species, including nearly 49,000 species of plants and over 1, 00,000 species of animals. India also has a long coastline of about 7,517 km.

The country's remarkable biological diversity includes a mosaic of natural and cultural habitats, and its economy and the livelihoods of millions of people are dependent on the conservation and sustainable use of these biological resources.

Due to uncontrolled growth of urbanization, industrialization, massive intensification of agriculture, rapid growth of population, pesticides and fertilizers, vehicles and industry emissions and deforestation, the natural resources of India are deteriorating rapidly resulting in land degradation, soil erosion, water stress, water pollution, poor air quality and depleting forest cover. These activities are also a threat to the abundant species diversity found in India.

The unit gives a glimpse of biogeographic zones, realms and biogeographic provinces of India, natural vegetation of India, status of forest cover in India, utilization of land, land degradation, water availability, water quality, air quality, and species diversity of India. The unit also presents findings of few reports and indices to highlight the problem of environment degradation.

01
CHAPTER

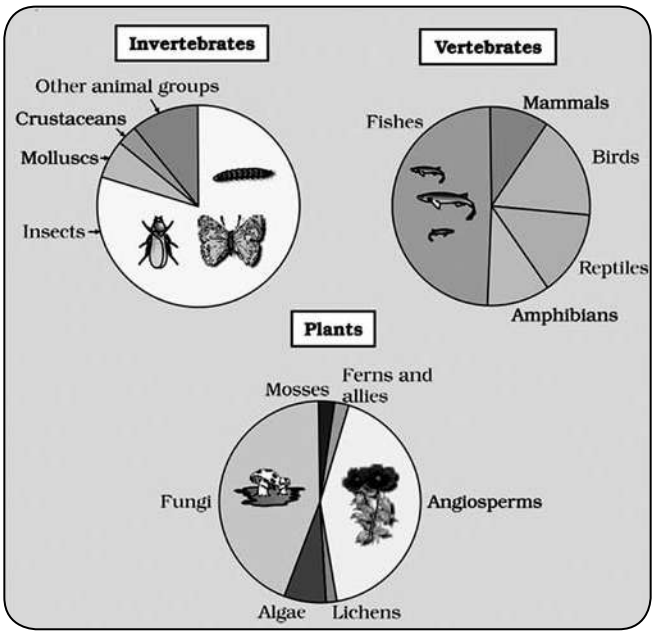
Fundamentals of Biodiversity

Biodiversity or biological diversity is that part of nature which includes the differences in genes among the individuals of a species, the variety and richness of all the plant and animal species at different scales in space, locally, in a region, in the country and the world, and various types of ecosystems, both terrestrial and aquatic, within a defined area. This chapter defines biodiversity, its types and patterns; reasons for loss of biodiversity and approaches for conservation of biodiversity.

Biological diversity or biodiversity refers to the number, variety, and variability of living organisms and ecosystems.

The term 'biodiversity' includes all terrestrial, marine, and other aquatic life forms. It also covers diversity within species, between species, as well as the variations among ecosystems.

- The term biodiversity was introduced by Walter Rosen in 1986.
- Biodiversity is the term popularized by the socio-biologist Edward Wilson to describe the combined diversity at all the levels of biological organization.
- More than 70 per cent of all the species recorded are animals, while plants (including algae, fungi, bryophytes, gymnosperms and angiosperms) comprise no more than 22 per cent of the total.
- Among animals, insects are the most species-rich taxonomic group, making up more than 70 per cent of the total.



- The number of fungi species in the world is more than the combined total of the species of fishes, amphibians, reptiles and mammals.
- Biodiversity boosts ecosystem productivity where each species, no matter how small, has an important role to play.

Example

- A larger number of plant species means a greater variety of crops.
- Greater species diversity ensures natural sustainability for all life forms.
- Healthy ecosystems can better withstand and recover from a variety of disasters.

Types of Biodiversity

In our biosphere immense diversity (or heterogeneity) exists not only at the species level but at all levels of biological organization ranging from macromolecules within cells to biomes.

In this context, some of the important aspects are:

1. Genetic Diversity

- It refers to variation of genes within species.

Example: The number of genes is about 450-700 in mycoplasma, 4000 in bacteria (eg. Escherichia coli), 13,000 in Fruit-fly (Drosophila melanogaster); 32,000 – 50,000 in rice (Oryza sativa); and 35,000 to 45,000 in human beings (Homo sapiens sapiens).

- A single species might show high diversity at the genetic level over its distributional range.
- Each member of any animal or plant species differs widely from other individuals in its genetic makeup because of the large number of combinations possible in the genes that give every individual various characteristics.
- The variation of genes, not only of numbers but of structure also, is of great value as it enables a

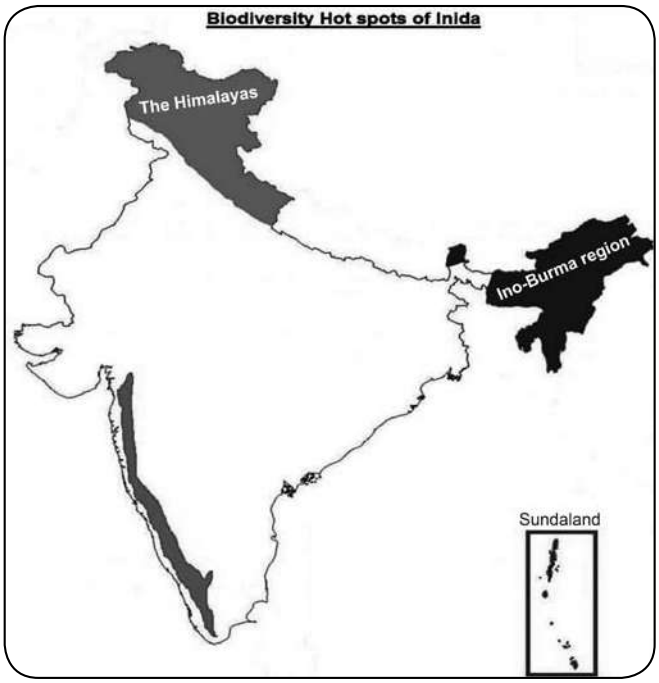
02
CHAPTER

Biogeographic Classification of India

Biogeographic classification of India is the division of India according to biogeographic characteristics. Biogeography is the study of the distribution of species (biology), organisms, and ecosystems in geographic space and through geological times.

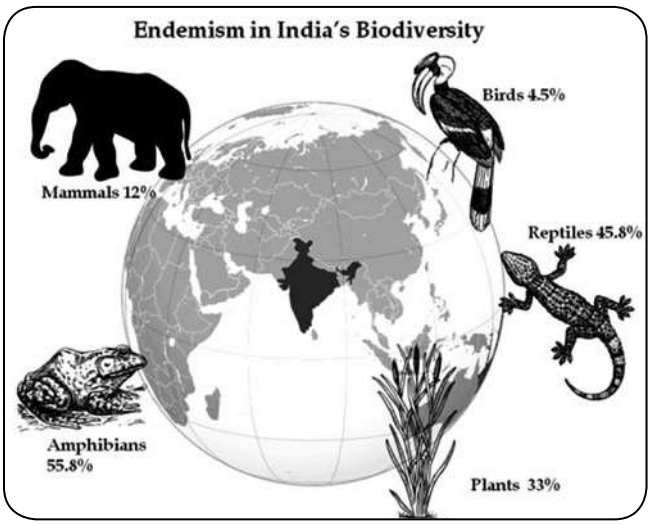
India, with 2.4% of the world's area, has over 8% of the world's total biodiversity, making it one of the 17 mega-diversity countries in the world.

- India ranks eighth in the world and fourth in Asia among the mega-diverse countries in the world.
- India represents 4 of the 36 globally identified biodiversity hotspots (Himalaya, Indo-Burma, Western Ghats and Sri Lanka, Sundaland).
- India is situated at the tri-junction of the Afro-tropical, the Indo- Malayan and the Paleo-Arctic realms, which display significant biodiversity.
- This diversity can be attributed to the vast variety of landforms and climates, resulting in habitats ranging from tropical to temperate and from alpine to desert.



So far, over 91,200 species of animals and 45,500 species of plants have been documented in the ten biogeographic regions of the country.

Of these 12.6% of mammals, 4.5% of birds, 45.8% of reptiles, 55.8% of amphibians and 33% of Indian plants are endemic, being found nowhere else in the world.



Hottest, Coldest, Wettest and Driest Places in India

- **Hottest –** Phalodi town is in the buffer zone of the Thar Desert in Rajasthan holds the world record for the highest verified temperature in 2016 at 51 Degree Celsius.
- **Coldest –** Dras, Jammu & Kashmir broke all records in January 1995, when it recorded a temperature of -60 Degree Celsius as per a BRO signboard.
- **Wettest –** Mawsynram in Meghalaya is believed to be the wettest place on earth and had recorded a whopping 26,000 mm of rainfall in 1985 by the Guinness Book of World Records.
- **Driest –** The town of Leh, located at an elevation of 11,500 feet is the driest place in India, receiving an average of 102 mm of rainfall annually.

- In terms of endemic vertebrate groups, India's global ranking is tenth in birds, with 69 species; fifth in reptiles with 156 species; and seventh in amphibians with 110 species. Endemic-rich Indian fauna is manifested most prominently in Amphibia (61.2%) and Reptilia (47%).
- India is rich in fauna, and nearly 62 per cent of the recorded amphibian species are endemic to India, which is majorly found in the Western Ghats.

04
CHAPTER

Floral Diversity of India

In terms of plant diversity, India ranks tenth in the world and fourth in Asia. India is home to nearly 11% of the world's known floral diversity. India's flora is one of the richest in the world due to the country's diverse climate, topography, and habitat. Over 18,000 flowering plant species are estimated to exist in India, accounting for 6-7 per cent of all plant species worldwide. India is home to over 50,000 plant species, including a number of endemics.

The word "Flora" comes from the Latin, Flora – the goddess of plants (floris means flower). Floral diversity refers to the diversity of plants occurring in a specific region during particular era. It generally refers to the diversity of naturally occurring indigenous or native plants.

In terms of plant diversity, India ranks tenth in the world and fourth in Asia. India is home to nearly 11.4% of the world's known floral diversity and about 28% of the plants are endemic. The flora of India is one of the richest in the world due to the wide range of climate, topology and habitat in the country.

In India, the floral diversity is concentrated in four phytogeographically unique regions, viz., Himalayas, Western Ghats, Northeast India and Andaman and Nicobar Islands.

Angiosperms are the largest plant group in India comprising a total of 21,849 species, constitutes 39.92% of floral diversity of the entire country, followed by fungi comprised of 15,504 species, representing 28.33%.

The bryophytes (Mosses and Liverworts) are also significantly rich in the Himalayas, Nilgiris, Western Ghats, Eastern Ghats and Andaman and Nicobar Islands. Algae and Fungi have widespread distribution in India.

Most of the ferns and gymnosperms (including cycads, pines, firs, junipers, etc.) grow in cool temperate zones of the Himalayas, and in the mountainous regions of southern India, especially in the Western Ghats.

Classification of Plants

Based on the growth habits plants can be classified as following:

(i) Herbs: Herbs are short-sized plants with soft, green, delicate stems without woody tissues. Its height is less than 1 meter and has very few branches.

- Herbs play an important role in conservation of soil moisture and soil erosion.
- In summers due to absence of moisture they become dry and a potential cause of forest fires.

(ii) Shrubs: Shrubs are medium-sized, woody plants taller than herbs and shorter than a tree. In shrubs branching starts near base. Its height is less than 6 meters.

- Shrubs also help in environment conservation by preventing soil erosion, water wastage and help in restoring the green cover of the planet.
- They provide shelter to smaller organisms in the ecosystem.

(iii) Tree: Trees are big and tall plants having very thick, woody and hard stems called the trunk and a definite crown. The lifespan of a tree is very long.

- Trees act like scrubbers, removing pollutants from the soil and air and help purify freshwater streams and reservoirs.
- As trees grow up, they also grow down. Tree roots are fundamental in the prevention of soil erosion and flooding.

(iv) Parasites: Parasite plants draw a part or whole of its nutrition from another plant. They grow on another living plant called host and penetrate the sucking root haustoria, into the host plants.

- Some parasitic species are known to increase the diversity of other plant in community by suppressing the dominant species they parasitize and so allowing other plants to flourish.

(v) Epiphytes: These plants grow on the host plant but not draw food from the host. The host plants help them to get access to light. The aerial roots of plant draw moisture from the air.

(vi) Creeper and Climbers: Creepers have very fragile, long, thin stems that can neither stand erect nor support all their weight.

Whereas, herbaceous or woody plant that climbs trees or other supports by twining around them or holding on to them with trendrills, hooks, aerial roots, or other attachments.

05
CHAPTER

Faunal Diversity of India

India displays significant biodiversity. One of seventeen megadiverse countries, it is home to 7.6% of all mammalian, 12.6% of all avian, 6.2% of all reptilian, 4.4% of all amphibian and 11.7% of all fish species in the world. This chapter provides details like habitat of critically endangered, endangered and vulnerable species found in India, their distribution and threats associated with their survival.

India is home to a large variety of wildlife. It is a biodiversity hotspot with its various ecosystems ranging from the Himalayas in the north to the evergreen rain forests in the south, the sands of the west to the marshy mangroves of the east. India lies within the Indo-Malayan realm and is the home to about 7.6% of all mammalian, 12.6% of all avian, 6.2% of all reptilian, 4.4% of all amphibian and 11.7% of all fish.

India has a great variety of fauna, with about 500 species of mammals and 2,100 species of birds and reptiles. Some rare and extinctive species are found in certain pockets in India important among them are the Asiatic lion, now confined to the Gir forest; the one horned rhinoceros, a vanishing species in Assam and the great Indian bustards, now rarely seen in Rajasthan.

Threatened Species Classification by IUCN

The International Union for Conservation of Nature (IUCN) is the world's oldest and largest global environmental organization.

- Founded in 1948, today IUCN the largest professional global conservation network. IUCN has more than 1,200-member organizations including 200+ government and 900+ non-government organizations.
- The Union's headquarters are located in Gland, near Geneva, in Switzerland.
- Governance structure of IUCN comprises Council elected by member organizations every four years at the IUCN World Conservation Congress.
- It is funded by governments, bilateral and multilateral agencies, foundations, member organisations and corporations.
- Official Observer Status at the United Nations General Assembly.

What does IUCN do?

Conserving biodiversity is central to the mission of IUCN. The main areas of function are:

- **Science** – the IUCN Red List of Threatened Species

Different Categories of Species in India

- **Normal Species:** Species whose population levels are considered to be normal for their survival.
  Example: Cattle, sal, pine, rodents, etc.
- **Endangered Species:** These are species which are in danger of extinction. The survival of such species is difficult if the negative factors that have led to a decline in their population continue to operate.
  Example: Black buck, crocodile, Indian wild ass, Indian rhino, lion tailed macaque, sangai (brow anter deer in Manipur), etc.
- **Vulnerable Species:** These are species whose population has declined to levels from where it is likely to move into the endangered category in the near future if the negative factors continue to operate.
  Example: Blue sheep, Asiatic elephant, Gangetic dolphin, etc.
- **Rare Species:** Species with small population may move into the endangered or vulnerable category if the negative factors affecting them continue to operate.
  Example: Himalayan brown bear, wild Asiatic buffalo, desert fox and hornbill, etc.
- **Endemic Species:** These are species which are only found in some particular areas usually isolated by natural or geographical barriers.
  Example: Andaman teal, Nicobar pigeon, Andaman wild pig, mithun in Arunachal Pradesh.
- **Extinct Species:** These are species which are not found after searches of known or likely areas where they may occur. A species may be extinct from a local area, region, country, continent or the entire earth.
  Example: Asiatic cheetah, pink head duck.

PART - C

Threats to Environment

Human population has grown enormously over the last hundred years. As per the latest projections by the United Nations, the global population could grow to around 8.5 billion in 2030, 9.7 billion in 2050 and 10.4 billion in 2100. The increase in population means increase in demand for food, water, home, electricity, roads, automobiles and numerous other commodities.

These demands are exerting tremendous pressure on our natural resources, and are also contributing to environmental degradation. These pose threats to environment as they lead to exploitation beyond carrying capacity of the environment. These threats manifest themselves in following forms:

- ***Rise in Global Mean Temperature:*** As per State of Climate Report 2021, global mean temperature in 2021 was 1.11 + 0.13 degrees Celsius above 1850-1900 average.
- Rise in sea level.
- ***Species Extinction:*** As per Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Service (IPBES), around 1 million animal and plant species are threatened with extinction.
- ***Land Degradation:*** Upto 40 % of Earth's land is degraded.
- ***Unprecedented Ice Loss:*** For example, Thwaites and Pine island glaciers in West Antarctic Ice Shelf have experienced immense ice loss over past 5500 years.
- ***Disease Burden:*** Poor health of humans; rise in premature deaths; increase in skin and respiratory diseases. Increase in zoonotic diseases like COVID, Monkey pox, Nipah virus, etc.

The need of the hour is to check the degradation and depletion of the natural resources; curb increasing pollution and address poor waste management approaches without halting the process of development.

This unit describes the environmental crises the world is witnessing in the present era. It also details out the impact these crises have on different components of the environment.

01
CHAPTER

Deforestation, Land Degradation and Desertification

Deforestation means abolishing or decreasing geographic landscape consisting of aggregate of trees, bushes and grasses caused by human activity. Land degradation is a process in which the value of the biophysical environment is affected by combination of human-induced processes acting upon the land. Desertification is the process of fertile irrigated lands transforming into deserts with loss of fertility and vegetation.

Deforestation

Deforestation is defined as the conversion of forested areas to non-forested areas for uses such as crop production, pastures and human settlements.

Causes of Deforestation

Conversion of Forest Land into Agricultural Land: Population growth has put enormous pressure on forested land as forests have to be converted into agricultural land so that agricultural production can be substantially increased and food security may be provided to human population.

Jhum or Shifting Cultivation: It is a major cause of forest loss in the hilly and mountainous areas of north-eastern states. In shifting cultivation forest dwellers clear a patch of land and start cultivation. Once the productivity of land decreases they shift to new place. The land left behind becomes a patch which cannot support any vegetation.

Transformation of Forests into Pastures: The woodlands are being converted into pasture land to meet needs of expanding dairy farming and cattle ranching.

Overgrazing: Overgrazing of forests of moderate cover by animals mainly in the tropical and subtropical and arid and semi-arid areas has resulted into large-scale degradation of natural vegetation. The deforested areas have been worst affected by grazing animals because no fresh regeneration of plant has been allowed by large herds of grazing animals.

Forest Fires: Forest fires, whether natural or manmade, are effective destroyers of forest covers. Besides destroying vegetation, forest fires harden the ground surface which decreases the porosity of the soils and consequently there is little infiltration of rainwater.

Thus most of the rainwater becomes effective surface runoff which accelerates the rate of soil erosion. Also the frequent forest fires destroy the leaf litters on the ground and thus the soil nutrients and humus contents are reduced.

Mining: Exploration of Oil and mining of minerals require a large amount of forest land. Development of infrastructure near the mine also contributes in deforestation.

Lumbering: Lumbering for domestic and commercial purposes is responsible for large-scale destruction of forest covers. Ever-increasing demand of timber for various purposes due to industrial expansion, urban growth and rapidly increasing human population has led to destruction of natural forest covers.

Multi-Purpose River Projects: Multi-purpose river projects require large areas to be submerged for the reservoirs constructed behind the dams. Thus submergence of forested riverine areas completely destroys the natural forests.

Impact of Deforestation

Deforestation leads to several problems encompassing environmental degradation through accelerated rate of soil erosion, increase in the sediment load of the rivers, siltation of reservoirs and river beds, increase in the frequency and dimension of floods and droughts, changes in the pattern of distribution of precipitation, intensification of greenhouse effects, increase in the destructive force of the atmospheric storms, etc.

Soil Erosion: Deforestation exposes the ground surface to falling raindrops with full kinetic energy. This results into maximum erosion of soils because the infiltration of rainwater is markedly reduced and surface runoff is increased.

Accelerated rate of soil erosion, through rain splash, rain-wash, sheet wash, rill erosion and gully erosion, consequent upon deforestation, increases sediment load of the rivers. Increased suspended and bed loads of the rivers cause rapid rate of siltation of alluvial rivers which results in gradual rise of the river beds.

Thus increased surface run-off and reduced water accommodation capacity of the river valleys due to siltation increase the frequency and dimension of floods

PART - I

Appendix

National Parks in India					
Sl No.	**Name of Protected Area**	**Region**	**Rivers and lakes inside the National Park**	**Fauna**	**Flora**
Andaman & Nicobar Islands					
1	Campbell Bay NP	Nicobar	-	Hawksbill, Olive Ridley, Leatherback, Malayan box and Giant leatherback Turtles. Eagle species include Nicobar serpent eagle and white-bellied sea eagle. Crab-eating macaque, megapode, crocodiles, deer, wild pig and bat are also found.	Orchids like bravura, Trees like ferns, Evergreen forests and mangrove forests.
2	Galathea Bay NP	Nicobar	-	Megapode, Green Imperial Pigeon, Nicobar pigeon, Nicobar scrub-fowl, Edible nest swiftlet, Fruit bat, etc.	Moist Broadleaf forests such as Dendrocalamus, Calophyllum Inophyllum, Guettarda Speciosa, Albizia Lebbeck, Mesua Ferrea and Pterocarpus Indicus.
3	Mahatama Gandhi Marine (Wandoor) NP	Andaman	-	Marine Fauna include Jellyfish, Starfish and varieties of sea anemone, sea cucumber, and sea urchin, Critically endangered Dugong, Dolphins, Sharks etc. Land Fauna includes Civets, Spotted Deer, Whistling Teal, Reef Herons etc.	Species of Coral reefs such as Stag Horn Coral, Boulder Coral, Knob Coral, Mushroom Coral, Star Coral etc. Plant species include Gurjan and Padauk.
4	Middle Button Island NP	Andaman	-	Spotted Deer, water lizards and monitor lizards. Marine fauna include dugongs, dolphins, sea turtles, Blue Whales etc.	It comprises of moist deciduous trees such as Rattan palm Calamus palustris, The climbing bamboo Dinochloa andamanica etc.
5	Mount Harriett NP (It was renamed as Mount Manipur National Park in 2021.)	Andaman	-	It consists of several threatened species such as Andaman Wood Pigeon, Andaman Cuckoo Dove, Andaman Scops-owl, Andaman Drogo, Andaman Woodpecker, Andaman Treepie. Asian Elephant, Chital and Ferals are also found. Fishes such as Eel, Catfish, Gobies, Snakeheads are also found.	Tropical evergreen, hilltop tropical evergreen and littoral forest are found. Species include Dipterocarpus gracilis, Dipterocarpus kerrii, Endospermum chinensis, and Hopea odorata, Canarium manii, Cratoxylum formosum, and Dipterocarpus costatus.
6	North Button Island NP	Andaman	-	Dugong, Water Lizard, Monitor Lizard etc.	It is covered with various species of deciduous forests.
7	Rani Jhansi Marine NP	Andaman	-	Fruit eating bat, Dugong, Olive RIdley Turtles etc.	It is mostly dominated by coral reefs and mangroves.

GLOSSARY

A

Adaptation: Any species puts its efforts to make full use of the available nutrient pool and other environmental conditions prevailing in the area of its growth. It ensures its own protection against adverse conditions of the habitat. This all is accomplished by the development of some characteristics.

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. Organisms that secrete antibiotics and the species that get inhibited by the antibiotics are examples of amensalism.

Activated Carbon: A highly adsorbent form of carbon used to remove odors and toxic substances from liquid or gaseous emissions. In waste treatment, it is used to remove dissolved organic matter from wastewater. It is also used in motor vehicle evaporative control systems.

B

Biological Spectrum: The percentage distribution of species among the various life forms of a flora is called the biological spectrum of that place.

Bioconcentration: The accumulation of a chemical in tissues of an organism (such as fish) to levels that are greater than the level in the medium (such as water) in which the organism resides.

Bioaccumulative: Substances that are very slowly metabolized or excreted by living organisms and thus increase in concentration within the organisms as the organisms breathe contaminated air, drink contaminated water, or eat contaminated food

Biomass: Biomass is the standing crop expressed in terms of weight (i.e. organism mass) of the living matter present.

Biogeochemical Cycles: More or less circular pathways, through which the chemical elements, including all the essential elements of the protoplasm, circulate in the biosphere from environment to organisms and back to the environment, are known as the biogeochemical cycles.

Bioremediation: Refers to treatment processes that use microorganisms (usually naturally occuring) such as bacteria, yeast, or fungi to break down hazardous substances and pollutants. Bioremediation can be used to clean up contaminated soil and water.

Bioventing: An in-situ remediation technology that combines soil vapor extraction methods with bioremediation. It uses vapor extraction wells that induce air flow in the subsurface through air injection or through the use of a vacuum. Bioventing can be effective in remediating releases of petroleum products, such as gasoline, jet fuels, kerosene, and diesel fuel.

Bioassay: Using living organisms to measure the effect of a substance, factor, or condition by comparing before-and-after data; often used to mean cancer bioassays

C

Chlorofluorocarbons (CFC): A family of inert, nontoxic, and easily liquefied chemicals used in refrigeration, air conditioning, packaging, insulation, or as solvents and aerosol propellants.

Climax: In the natural process of succession, one community continues to follow another, until a stage comes when a type of community cannot be displaced under the prevailing environmental conditions. This final, terminal community, that can maintain itself more or less indefinitely in equilibrium with the prevailing environment, is known as the climax community and the stage is said to be the climax.

Competition: This is an interaction between two populations in which both species are harmed to some extent. Competition occurs when two populations or species, both need a vital resource that is in short supply. The vital resource could be food, water, shelter, nesting site, mates or space. Such competition can be: (i) interspecific competition-occurring between individuals of two different species occurring in a habitat and (ii) intraspecific competition-occurs between individuals of same species. Intraspecific competition occurs between members of the same species and so it is very intense.

Commensalism: In this relationship one of the species benefits while the other is neither harmed nor benefited. Some species obtain the benefit of shelter or transport from another species. For example sucker fish, remora often attaches to a shark by means of its sucker which is present on the top side of its head. This helps the remora get protection, a free ride as well as meal from the left over of the shark's meal. The shark does not however get any benefit nor is it adversely affected by this association.

E

Environment: The sum of all factors constitute environment. It thus becomes indeed a complex of so many factors, better referred to as environmental complex.

ECAD: Some of the species have more than one kind of populations spread over wide range of habitat conditions. An ecad of a plant species is a population of individuals which although belong to the same genetic stock, but differ markedly in vegetative characters such as size, shape, number of leaves, stems, etc. These variations are simply environmentally induced, and thus are temporary