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TEXT BOOK

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For Undergraduate students
As per NEP 2020 Syllabus for co-curricular course

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PREFACE

The text book **Environmental Education** is framed with various concepts of Environmental studies introduced as subject for all undergraduate students as per the National Education Policy 2020 (NEP-2020) Co-curricular course set down by the UGC for all disciplines. This textbook is intended to provide the core elements of a curriculum for teaching environmental science at the introductory level in colleges and universities of Uttarakhand.

It has been made extremely user-friendly for the undergraduate students and general aspirants. The aim of this book is not only to create an awareness of environmental issues, but also to bring about pro-environmental action. Every concept included in this book has been explained in simplified manner with the help of related pictures and flow diagrams wherever necessary. The matter in this text book has been selected from standard text. Some of the texts have been taken from the various environmental websites on internet.

Technical terms are explained in simplified manner. We ensure our readers they will get new, valid, contextual knowledge about our mother nature in all aspects, anthropogenic interferences and its impact on our planet. This knowledge creates a responsibility to be a part of the solution of environmental problems.

The contents in the book are well organized in **nine chapters**. **Chapter 1** deals with the natural resources that humans and all other species need to sustain their livelihoods. It also discusses about their effective management and the problems faced while conserving them. **Chapter 2** focuses on the concepts, structure and function of an ecosystem covering up the food chain, food web, ecological pyramids and the biogeochemical cycles while **Chapter 3** discusses in detail about the biodiversity, threats to biodiversity and different strategies adopted for its conservation. **Chapter 4** discusses about the different types of pollution, their causes, impact on the environment and the control measures adopted. **Chapter 5** covers the development from unsustainable to sustainable; the Sustainable Development Goal (SDGs),

circular economy and entrepreneurship. It also deals with human population, the causes of overpopulation and its impact on the society and environment. **Chapter 6** covers all the social issues with special reference to water and ozone layer depletion and the measures to overcome it. **Chapter 7** throws light on the understanding of natural hazards for preparedness, risk reduction, and mitigation strategies to protect lives and reduce economic losses. **Chapter 8** deals with International and National advances in Environmental Conservation including National Green Tribunal (NGT) **and** Environmental Audit. The last **Chapter 9** provides the knowledge about the Environmental Management system, the importance of Indian Traditional Knowledge on Environment and the bio-Assessment of Environmental Quality including Air Quality Index (AQI) and Environmental Impact Assessment (EIA).

The main attractive feature of the book is that it contains more than 200 solved multiple choice questions on environmental studies, this would be of great help for U.G/P.G students for their academic and competitive studies as well.

We hope that this book will meet the expectations of the students and the teachers. We shall be grateful to receive valuable suggestions and comments from the fraternity for further improvement of the book.

ACKNOWLEDGEMENTS

First and foremost, we would like to thank God, the Almighty who has granted countless blessings, knowledge and opportunities to us so that we have been finally able to accomplish this task.

Apart from our efforts, we are deeply grateful to everyone who have been instrumental in the successful creation of this book.

Our gratitude is beyond bounds for our beloved parents and family members for their blessings, love and consistent encouragement which gave us the strength to persevere, even when going was tough. We are indebted to our friends for their unwavering support and understanding during the ups and downs of the writing process.

Special thanks to Prof. N. K Joshi, Vice-Chancellor SDS University; Prof. M.S. Rawat, Director, Pt. L.M.S. Campus, Rishikesh; Prof. G.K. Dhingra, Dean Science and HOD Department of Botany for their motivation, encouragement, and invaluable generous support throughout this journey.

We gratefully acknowledge Dr. Anjani Prasad Dubey for his advice and suggestions. Thanks are due to Dr. Dinesh Singh and Dr. S.K. Kuriyal for their constructive criticisms which were really helpful to us for completion of the book in this shape. We like to express our special thanks to all colleagues of our campus especially from Department of Botany for their sincere cooperation in various ways whenever and wherever needed.

We would like to express our gratitude to the team at CRDEEP Publications, especially Dr. Pananjay Kartikey Tiwari, for his professionalism and expertise in bringing this book to publication. Your dedication and hard work are truly appreciated.

It would be impossible to list all names but several people deserve our sincere and special thanks for their encouragement and support.

Lastly, I want to thank my readers for their interest in this book. It is my sincere hope that you find it insightful and thought-provoking. Thank you all for being a part of this journey.

Shalini Rawat and Preeti Khanduri

CONTENTS

Chapter 1
Natural Resources

Natural resources are those that are obtained from the natural world and used mostly unaltered. This covers the origins of desirable traits including utility in commerce and industry, artistic merit, scientific curiosity, and cultural significance. It comprises the sun, the atmosphere, the water, the soil, all minerals, all types of plants, and all creatures on Earth. They provide sustenance for every living thing on the planet. All other creatures on Earth depend on plants (autotrophs) as their major natural resource (heterotrophs). Either directly or indirectly, plants provide sustenance for animals. Certain animals serve as food for other creatures. Natural resources are safeguarded in nature reserves and are a part of the natural legacy of humanity. Animals and plants both supply the raw resources needed to make manufactured goods. For instance, cotton clothing is made from plants, silk clothing is made from silkworms, and leather belts and purses are made from cows. In addition to being used as cooking fuel, natural resources like coal, gas, and oil also power nuclear power plants and generate electricity.

Thermal power plants are powered by water.
A natural resource can be something entirely different, like fresh water, air, or any living thing like fish, or it can be something that is created by extractivist industries and then needs to be processed in order to be used economically, like metal ores, rare-earth elements, petroleum, timber, and most forms of energy. Many extractive industries heavily rely on non-renewable resources that can only be exploited once, however certain resources are renewable, meaning they can be utilized at a specific pace and will be restored by natural processes.

The following are the top five natural resources:

1. Air: All life on Earth, including that of people and animals, depends on clean air. Thus, action to lessen air pollution is required.

2. Water: Just 2% of the water covering 70% of the Earth is freshwater. It is important to take action to control and educate about water usage.

3. Soil: Soil is made up of different nutrients and particles. It promotes plant growth.

4. Iron: Found in the mineral silica, iron is utilized to construct sturdy structures, vehicles, and weapons.

5. Forests: They maintain global ecosystem and offer clean air. Trees are being chopped down for building and residential use.

Natural Resource Categorization:

Natural resources are categorized according to their ownership, renewability, developmental stages, and place of origin.

Depending on the Source

• *Biotic:* Resources that come from the biosphere and are living things, such fisheries, livestock, plants, and animals. Since fossil fuels like coal and petroleum are made of decomposed biological matter, they also fall under this category.

• *Abiotic:* Resources derived from inorganic and non-living substances. Land, fresh water, air, rare-earth elements, and heavy metals, which include ores like gold, iron, copper, silver, and so on, are among them.

Depending on Development Stages

• Potential Resources: Resources that are known to exist but have not yet been put to use but could in the future. petroleum, for instance, which is present in sedimentary strata and is a prospective resource until it is removed and used.

• *Actual resources:* Currently being used in development, these are resources that have been surveyed, qualified, and measured. These mostly depend on technology and how feasible they are, like wood processing.

• *Reserves:* The portion of a real resource that may be used for future profitable development.

•*Stocks:* Resources assessed but rendered unusable by technological limitations, such as hydrogen-powered cars.

In light of Renewability

• *Renewable resources:* Natural replenishment is possible for these resources. Certain resources, such as water, wind, solar energy, and the like, are always there and their amounts are not significantly impacted by human use. Even while many renewable resources don't regenerate as quickly, overuse can nonetheless cause these resources to run out. As long as the rate of replenishment or recovery outpaces the rate of consumption, resources are considered renewable from the standpoint of human usage. When compared to non-renewable resources, they refill more readily. Perpetually renewable and intermediately renewable resources are the two categories of renewable resources. No matter how much energy we consume each day or over time, the Sun and Earth's natural processes continuously replenish renewable resources. One example is solar energy, which is used for nearly all activities, from growing food plants to powering windmills or ocean currents. Conversely, we can only use intermediate renewable resources wisely before they run out. They include things like the soil

in which humans live, freshwater for drinking, trees for lumber, and plants and animals for sustenance.

• *Non-renewable resources:* These are resources that are difficult to replenish since they were generated in the environment over a lengthy geological time period. The most frequent resource in this category is a mineral. When a resource's rate of use outpaces its rate of replenishment or recovery, it is considered non-renewable from a human perspective. Fossil fuels fall into this category due to their extraordinarily slow rate of formation—possibly millions of years. Radioactive elements like uranium naturally decay into heavy metals, making them one of the resources that naturally diminish in quantity without human influence. Of them, coal and petroleum cannot be recycled; nevertheless, metallic minerals may be recycled.

Table: 1.1 Difference between renewable and non-renewable resources.

Renewable resources	**Non-renewable resources**
It can be renewed as it is available in infinite quantity.	It cannot be renewed once consumed due to limited stock.
It is sustainable in nature.	It is exhaustible in nature.
It is of low cost and environment friendly.	It is high in cost and less environment friendly.
It can be replenished quickly.	It can not be replenished naturally.

Based on Ownership

- **Individual resources:** Resources owned privately by individuals. These include plots, houses, plantations, pastures, ponds, etc.
- **Community resources:** Resources which are accessible to all the members of a community. E.g.: Cemeteries.
- **National resources:** Resources that belong to the nation. The nation has legal powers to acquire them for public welfare. These also

include minerals, forests and wildlife within the political boundaries and Exclusive economic zone.

- **International resources:** These resources are regulated by international organizations. E.g.: International waters.

Depletion of Natural Resources

The UN's Agenda 21 Section Two, which describes the actions that nations must take to maintain their natural resources, makes clear that governments and organizations, including the UN, have made the depletion of natural resources a top priority in recent years. Natural resource depletion is regarded as a problem for sustainable development. The Brundtland Commission defined sustainable development as "ensuring that it meets the needs of the present without compromising the ability of future generations to meet their own needs." This definition is only one of the numerous ways that the term is used. Developing nations lose out on ecosystem services as a result of the depletion of natural resources. Both "indirect drivers of change" like demographics (such as population increase), the economy, society, politics, and technology, as well as "direct drivers of change" like mining, petroleum extraction, fishing, and forestry, contribute to the depletion of natural resources. A few agricultural techniques, such as shifting cropping, which results in the depletion of soil nutrients due to desertification, are another element contributing to the depletion of natural resources. Natural resource depletion is one of society's ongoing concerns. Because non-renewable natural resources like coal, oil, and natural gas have a sluggish rate of recovery, overuse of these resources might cause them to run out sooner. Therefore, in order to ensure the longevity of these resources, we must use and conserve them wisely. Additionally, we need to replace them with energy from renewable sources like sun, wind, and water.

Management of Natural Resources

Natural resource management is a discipline in the management of natural resources such as land, water, soil, plants, and animals—with a particular focus on how management affects quality of life for present and future generations. Hence, sustainable development is followed according to judicial use of resources to supply both the present generation and future generations. The disciplines of fisheries, forestry, and wildlife are examples of large subdisciplines of natural resource management.

Land Resources

India has an abundance of arable land, which has historically been essential to the socioeconomic advancement of the nation. India is the second most populous country in the world, although it ranks seventh in terms of area. Net seeded area, present fallow, previous fallow, and land used for tree crops are all considered arable land. A total of 167 million hectares, or 51% of the country's total area, are covered by arable land. India's physical characteristics are intricate and varied. Plains, hills, plateaus, and mountains all influence how people utilize the terrain and how they react to it. Mountains and hills make up around 30% of India's land area. For farming, these are either too cold or too steep. Topographically useful land makes up around 25% of this area, which is dispersed across the nation. Of the entire surface area, plateaus make up 28%, yet only 25% of it is suitable for farming. Of the total land, 43% is made up of plains, of which roughly 95% is suitable for farming. We can determine that around two thirds of the total land area is suitable for agriculture based on the variations in surface area proportions. Furthermore, the quality of arable land is governed by soils, terrain, moisture, and temperature, which all affect the boundaries of cultivability. Consequently, half of the surface is under cultivation. This ratio is among the highest globally.

Land Use Pattern

Land use refers to the use that humans make of the land that is accessible to them, or more specifically, the many purposes that people assign to the available land. The study of land use involves analyzing how land is used to meet human requirements. "Land use pattern" refers to the configuration or organization of the land's uses. The land can be utilized for livestock, farming, forestry, and other purposes. Physical elements like relief, topography, climate, soil, and vegetation, as well as socioeconomic elements like population density and technical proficiency, influence how land is used.

Land Degradation

Land degradation is the process by which the value of the biophysical environment is impacted by both natural disasters and human activity. The environment is negatively impacted by land degradation, which also indirectly impacts the production of food. The productivity of the vegetation's land capacity decreases as a result of ongoing land degradation. India's land resources are under tremendous strain as a result of the effects of climate change and the country's rapidly expanding population. Because of human requirements, there is an increasing demand for land resources. This strain on land has an effect on the ecology as well. Land deterioration is caused by all of these reasons. Soil erosion is the main cause of land deterioration, although water logging and high salinity can contribute. Deforestation is the biggest hazard to the soil. The soils are harmed by monsoon season heavy rains. Particularly in the western slopes of the Western Ghats and the southern slopes of the Himalayas, steep slopes promote fast runoff that causes soil erosion. The Himalayas are prone to erosion and landslides in many areas. Thirteen million hectares have already been affected by water logging and salinization, which is the second main hazard to soil. The majority of the impacted lands are found in irrigated regions with canals. The lack of proper drainage has caused

them to suffer. In several regions of the nation, mining operations can cause land degradation. Approximately 80,000 hectares of land are impacted by mining.

Land Resource Management

The main issues with land include urban encroachment on high-quality agricultural land, salinization, water logging, soil erosion, and mining operations. The nation has taken a two-pronged strategy to addressing these issues: social and physical. The process of physically reclaiming land involves creating subsurface drainage systems for flooded areas and then scientifically rotating crops. Similar to this, land that has been made unusable by river flooding and activity is recovered once the required care has been taken to restore its fertility and texture. Reclamation of desert areas physically requires longer-term work. It calls for the installation of appropriate native vegetation as well as irrigation from a canal, well, or even both. The water table is raised as a result. State legislation, on the other hand, reflects the social perspective and promotes agriculture and its production in particular, with the overarching goal of rural rehabilitation. Land holdings consolidation is one strategy among several. By verifying the rights of land tenure and ownership, it gives a tiller the required incentive and empowerment. Social exploitation components—such as absentee landlords—are immediately eliminated. Legislation is therefore employed to guarantee social fairness. In order to maximize the supply of a variety of ecosystem services, sustainable land management strategies involve the integrated management of crops (trees), animals, soil, water, nutrients, biodiversity, disease, and pests. The goal is to increase the resilience of land resources and the communities that depend on them while optimizing the providing of services (such as food, water, and electricity). Adopting low-cost, easily-implemented methods to halt land deterioration and spreading them globally can have a significant influence. Techniques like sustainable agriculture

and agroforestry can increase yields and stop further land deterioration. In order to meet the growing population's demand, productivity on land already used for agriculture should be increased through land restoration, laws and policies, and educational initiatives that enforce the preservation of natural ecosystems against indiscriminate grazing, firewood cutting, and other activities. This is a preferable option to adding new land under managed ecosystems. To reduce soil erosion, plant cover must be preserved and increased. Reforestation of degraded areas with tolerant plants is crucial for soil and water conservation, as well as for bolstering the nitrogen cycle. Since it is becoming increasingly apparent that local communities have a significant role to play in land management, community-based traditional techniques ought to be used.

The following is a list of some actions to stop deterioration and repair damaged land:
Sustainable mining practices; appropriate discharge of industrial effluents; appropriate management of wastelands; optimal use of water for irrigation; proper use of fertilizers and pesticides; cultivation of salt-tolerant soils in saline areas; reforestation and afforestation; sustainable pastures and livestock management; narrow strip planting; use of windbreaks and shelterbelts;

Forest Resources

Approximately 25% of the planet's surface area is covered by forests. In the dry tropical forests of sub-Saharan Africa, the trees are thinly spread and relatively tiny, whereas in the coastal forests of the Pacific Northwest, they are huge and densely packed. In addition to soils and decomposing organic waste, fungus, bacteria, herbs, shrubs, vines, lichens, ferns, insects, spiders, reptiles, amphibians, birds, mammals, and many more creatures are all found in forests, which are complex ecosystems. Together, these elements formed a complex network with

numerous links. In addition to providing a range of essential environmental services like regulating the climate, cleaning the air, supplying greenery and pharmaceuticals, filtering water, cycling nutrients, creating habitat, and producing paper and lumber, forests also yield a number of valuable products. A nation's woods are one of its greatest resources for its citizens. They are required:

Provide fodder (act as a reservoir of food), which is necessary for humans and animals leaving in close vicinity to forests; • Are the only source of lumber fuel with members and kinds of medicinal plants;

- Provide raw materials for the production of paper, panel goods, gums, resins, essential oils, and a variety of helpful shrubs that are used in the development of medications;
- Lower maximum temperature and rages lowest temperature.
- Absorb carbon dioxide from the atmosphere helps to prevent atmospheric pollution and preserve the natural balance of CO2 and O2; Filters airborne irritants like smoke, dust, and moving sand;
- Absorbs sound;
- Shelters wild animals;
- Induces rain;
- Controls floods and droughts;
- Preserves gene pools;
- Preserves the natural equilibrium between living things; and
- Forests yield wood, a significant renewable resource.

Some examples of the major forest types are:
Northern coniferous forests which connect Canada's chilly northern latitude with Europe's. Large stands of spruce, fir, and larch predominate, while species of birch, aspen, and pine are also found after fire and other disturbances.

Temperate mixed forest which are located in South Eastern Canada and the Eastern United States Europe Centrale East Asia, Japan, and portions of the Southern Hemisphere, including Australia, New Zealand, Argentina, and Chile. They include a wide range of broadleaf species (e.g., eucalyptus and southern beech in the southern hemisphere, and oak, hickory beech, and maple in the northern hemisphere); subregions, like the South Eastern United States, may also have significant amounts of pine or mixed pine broadleaf forest.

Temperate rainforest They are found in the Pacific Northwest, Southern Chile, South Eastern Australia, and Tasmania's damp coastal areas. Large conifers such Redwood Douglas-fir, spruce, cedar, and hemlock are usually the dominant species in the northern hemisphere, whereas broadleaf species like eucalyptus, acacia, casuarina, and araucaria are often found in the southern hemisphere.

Tropical rainforest which may be found in Southeast Asia (such as Thailand, Malaysia, and Indonesia), the equatorial parts of Central and South America (such as Costa Rica, Brazil, and Ecuador), and the West Coast of Africa (such as Congo, Ivory Coast, and Nigeria). They are distinguished by a wide variety of broadleaf trees, arranged in a multilayered canopy, including teak, mahogany, lauan, and meranti, as well as accompanying vegetation, including shrubs, vines, and other flora.

Dry forests occur in the Mediterranean area of Sub-Saharan Africa, the South Western United States, and the semi-arid regions of Mexico, India, Central America, and South America. They are distinguished by the comparatively scarce growth of chaparral, scrub woodland savanna, oak, olive, acacia, mesquite, and other drought-resistant plants.

Mountain forests Those are features of mountainous areas around the

globe. There may be a wet side and a dry side to the mountain chain due to orographic weather patterns, with distinct flora associated with each. The vegetation varies greatly depending on the location, but tends to follow an elevational gradient from open Woodland at lower elevations to mixed conifer broadleaf forest at middle elevations to relatively pure conifer forest at subalpine elevations.

Twenty-six percent of India's land area is covered by forests and other trees. 7,13,789 sq km, or 21.71% of the country's total area, are covered by forests. Although the country's tree cover makes about 2.91% of its total area.

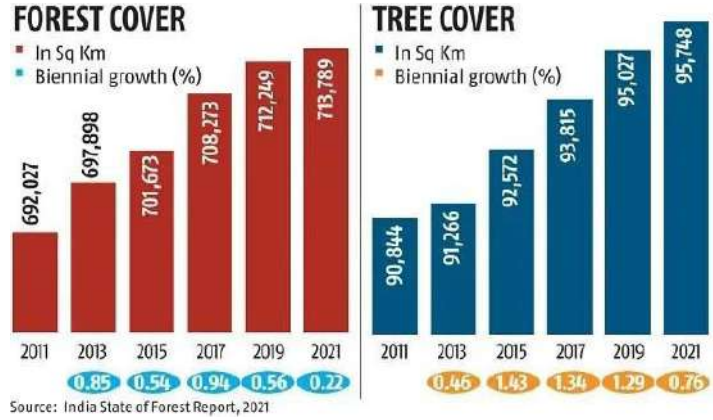

Fig. 1.1. Forest and Tree Cover In India

Soil

The top layer of the ground made up of loose surface particles is known as soil. It is a blend of numerous elements, such as water, air, minerals of countless kinds, and remains of plants and animals. It is the result of ongoing interactions between the parent material, the local climate, the creatures that are plants and animals, and the land's elevation. Soils

vary from place to place because each of the components varies with space. Because it provides nutrients and acts as an anchor for plants, soil is a crucial component of our environment. Soil serves as a plant's seat, medium, and primary source of basic materials. It influences man's economic activity and determines our nation's future through its relative fertility. Property and culture are also gone with the soil. As such, it is an important national and essential earth resource for the nation.

Soil Conservation

A single inch of soil forms naturally over thousands of years, yet human involvement may degrade the same inch of soil in a few of years. Restoring soil is difficult if it is lost or washed away. The goal of soil conservation is to stop erosion from removing the topmost layer of the soil or to stop fertility from being harmed by overuse, acidification, salinization, or other chemical soil pollution.

Holding the soil in place is a crucial stage in soil maintenance. This is made feasible by enhanced farming methods in various areas. Typically, terracing and contour plowing are done on the Himalayan hill slopes. These are the most basic approaches to conservation. In Rajasthan's desert areas, crops are shielded from wind erosion by rows of trees, or shelter belts. Many regions of India have adopted the practice of reforestation on steep slopes and in the places that capture rivers. It binds the soil and lessens surface drainage. Ravines are characterized by their massive dimensions, steep slopes, and depth. To provide suggestions for the reclamation of ravine lands, the Central Soil Conservation Board built three research stations: (1) Kota in Rajasthan, (2) Agra in Uttar Pradesh, and (3) Valsad in Gujarat.

Applying fertilizers and manures helps stop the decline of soil fertility. There are several ways to conserve soil, including: 1. Constantly

planting new trees. 2. Applying novel farming techniques. 3. Lessening flooding in rivers. 4. Constructing little check dams to reduce water runoff in gullies. 5. Excavating ditches to reroute water on farm hills. 6. Guarding against erosion-prone locations. monitoring the loss of forests. 8. Terrace farming with contour plowing. 9. Bring back the marshes 10. Establishing vegetative cover and restoring forests 11. Putting up buffer zones at the banks of streams 12. Windscreens 13. Correct handling and disposal of trash.

Water

Information on precipitation, surface and groundwater storage, and hydropower potential are all included in India's water resources. India receives 1,170 millimeters (46 in) of precipitation on average yearly, or over 4,000 cubic kilometers (960 cu mi) of rain. About 4% of the world's water resources and 18% of the world's population reside in India. India's monsoon seasons, which run from June to September, are when most of the rain falls, with the northeast and north getting significantly more rain than the west and south.

The northern rivers receive variable amounts of nourishment from the melting of snow over the Himalayas following the winter season, in addition to rainfall. Throughout the year, there is greater unpredictability in the flow of the southern rivers. This results in flooding in certain months and water scarcity in others for the Himalayan basin. India has a vast network of rivers, but it still lacks sufficient supplies of irrigation water for sustainable agriculture and safe, clean drinking water. This is partly because only a tiny portion of India's surface water resources have been used up to this point.

Chapter 2
Ecosystem: Structure and Functions

An ecosystem is an ecological unit in nature where various populations of species coexist and interact with their physical surroundings as well as one another. The fundamental and operational unit of ecology is the ecosystem. In 1935, British ecologist A.G. Tansley introduced the idea of an ecosystem, defining it as "a system resulting from the integration of all living and non-living factors of the environment." "Any unit that includes all of the organisms (i.e., the community) in a given area interacting with the physical environment so that a flow of energy leads to clearly defined trophic structure, biotic diversity, and material cycles (i.e., exchange of materials between living and non-living parts) within the system is an ecological system or ecosystem," according to E.P. Odum's definition of an ecosystem in 1971.

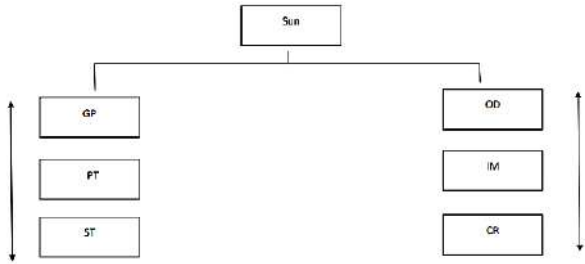

Fig: 2.1: A complete ecosystem (GP= Green plants; PT=Phagotrophs; ST= Saprotrophs; OD=Organic dead remains; IM=Inorganic material; CR=Climatic regime) Note that some ecosystems may be devoid of one or more components of the above. E.g., Abysmal ecosystem, cave ecosystem etc (After EP Odum, 1972)

Structure of Ecosystem

Every ecosystem is composed of two types of components where they are mutually reactive and interdependent.

A. Biotic components

B. Abiotic components

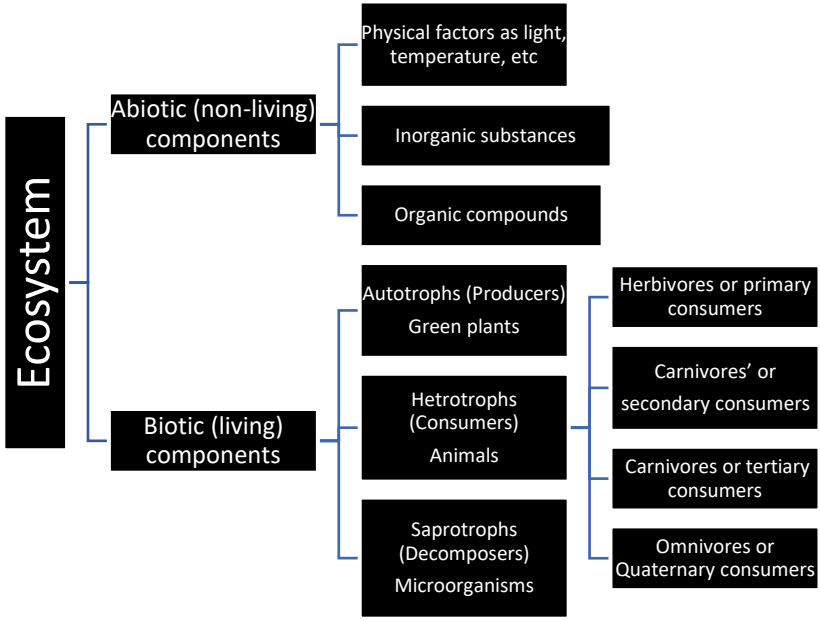

Fig: 2.1: Structure of an Ecosystem (After Tiwari, SC 1992)

A. Biotic Components – All living organisms are included in this component. In the ecosystem, communities of animals and plants live together which are interrelated mainly on the basis of nutrients etc. From the point of view of nutrients, biological components can be divided into three categories –

1. Autotrophs or Producers
2. Heterotrophs or Consumers
3. Decomposer or Saprophyte

1. **Autotrophs or Producers:**

Autotrophs are all living things in the environment that can use photosynthesis or bacterial photosynthesis and chemosynthesis to produce their own organic food for nourishment. such as chemical and photosynthetic microorganisms, trees, and plants. Because they transform the light energy from sunlight into chemical potential energy and store it as organic matter, autotrophic members are also known as producers. Heterotrophic living creatures utilise these organic materials as nourishment, either directly or indirectly.

2. **Heterotrophs or Consumers:**

Those living members of the ecosystem which do not have the ability to produce their own organic food and depend directly or indirectly on the food produced by producers, are called heterotrophs or consumers.

These can further be divided into three categories.

•Primary Consumer: Those organisms which depend on plants for their food. Such as – cow, goat, rabbit, elephant, deer etc.

•Secondary Consumer: Those organisms which depend on the primary consumer (herbivores) for their nutrition (food). Such as – snake, wolf etc.

•Tertiary Consumer: Those organisms which depend on primary and secondary consumers for their nutrition. Like – Hawk, lion, tiger etc.

3. **Decomposer or Saprophyte**:

This mainly includes bacteria and fungi, which depend on dead and organic matter for their food.

B. Abiotic components

Since the physical environment of an ecosystem forms its abiotic component, all non-living entities are referred to as abiotic components.

From the point of view of structure, the abiotic components of the ecosystem are divided into the following two parts.

1. Chemical factors 2. Physical factors.

1. Chemical factors:

(a) Inorganic substances:

(b) This comprises necessary minerals such as calcium, potassium, and magnesium; salts such as phosphate, nitrate, and sulfate; and gases like as nitrogen, carbon dioxide, and oxygen, among others. These are the raw resources or nutrients that all autotrophs and productive elements (green plants) need to exist. These are used in the synthesis of organic compounds.

(c) Organic substances:

These substances can be divided into three categories.

A. The first group consists of naturally occurring chemicals that are found in the environment in free form, such as inorganic substances, such as proteins, lipids, and carbohydrates, as well as the products of their breakdown, such as urea and humus.

B. Organic materials that are exclusive to living things fall into the second group. such as ATP, or adenosine triphosphate.

C. Substances that serve as a connection between the first two categories are included in the third. like DNA and chlorophyll. These chemicals serve as a bridge between organic and inorganic compounds.

2. Physical factors:

Physical elements like air, light, rain, temperature, humidity, and so on are included in this. The quantity of producers and consumers in a

given ecosystem is determined by its climatic conditions. It also establishes the rate of nutrient circulation.

Functions of Ecosystem

Abiotic and biological elements of the environment are interdependent. Basically, the ecosystem is undergoing two processes at once..

1. Energy flow. 2. Bio-geo-chemical cycle.

Energy flow:

Energy cannot be used eternally since it is consumed and utilized at every trophic level. P lants are the major source of energy for all organisms in an ecosystem, and energy moves from the primary to the secondary levels. They transform light energy into chemical energy, which is stored in plants in the form of ATP and transferred from one trophic level to another.

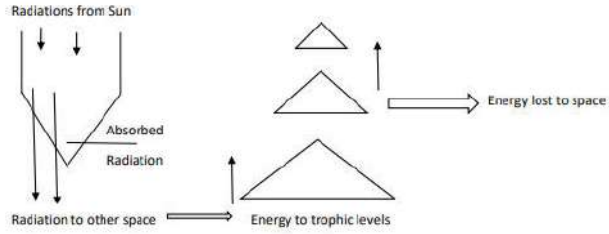

Fig. 2.2 : Energy flow in an Ecosystem (Lindeman 1942; After Tiwari SC, 2014)

When herbivores consume plants, the chemical energy they have stored is transferred into them. In order to transfer energy to the next trophic level, the herbivores are fed by the carnivores. Throughout the entire process, the organism uses a portion of the energy for its

metabolic functions and loses the remaining energy as heat. Typically, only 10% of the total energy is transferred to the following trophic level at each level, with 90% of the energy wasted. The 10% law, proposed by R.L. Lindemann in 1942, argues that only 10% of the total energy in a food chain gets transmitted from one trophic level to another. Some of the remaining energy is emitted as heat and is used for other metabolic activities.

Productivity of Ecosystem:

The rate of biomass or organic matter generation per unit of time is referred to as an ecosystem's productivity. It is affected by a number of variables, including water and nutrient availability as well as temperature. Ecological productivity offers insight into how various ecosystems operate. There are two categories of productivity: primary productivity, which describes the productivity of autotrophs or producers, and secondary productivity, which describes the output of heterotrophs or consumers. The rate at which producers create organic material from inorganic molecules is known as primary productivity. Net Primary Production (NPP) and Gross Primary Production (GPP) are two more categories for primary production.

(A) The total rate of photosynthesis, including the organic matter used up in respiration during the measurement period, is known as gross primary production, or GPP. It can be computed as the photosynthetic number (amount of CO2 fixed/gm chl/hr) or as the chlorophyll concentration (Chl/gm dry weight/unit area).

(b) Net Primary Production (NPP), which excludes organic molecules broken down by biological processes like cellular respiration, also counts the quantity of carbon absorbed into organic molecules by primary producers. Thus, **Net Primary Production (NPP) = Gross Primary Production (GPP) – Respiration (R).**

Secondary productivity is the rate of storage of organic matter at consumer level. It keeps on moving from one trophic level to other and represents the quantity of new tissues created through the use of assimilated food.

Net Productivity: It refers to the rate of storage of organic matter not used by the consumers. Or the rate of increase of organic matter of producers which is left over by the consumers, and is expressed as C $g/m^2/day$.

Food chain:
A food chain is a group of organisms where each one consumes the one in its trophic level below it and then provides food for the ones above it. Thus, a food chain illustrates how creatures in any environment rely on one another for sustenance. The ecosystem's food energy flow results from this. There are two kinds of food chains in general.

1.Grazing Food Chain:
Producers are at the top of the grazing food chain, followed by herbivores, carnivores, and omnivores. Every stage of life loses energy due to breathing, emissions, and decomposition. Green plants, or producers, are the first in this food chain and are eaten by primary consumers, or herbivores. Carnivores, or secondary or tertiary consumers, eat these in turn.

• Example: Grass → Locust → Lizard → Snake

2.Detritus Food Chain:
Detritus food chain begins after the organisms in the grazing food chain die. When the organisms of the grazing chain die, the decomposers like bacteria, fungi etc. act on them by releasing enzymes which decompose the dead material and convert them into simple

substances. This food chain starts from the dead organic matter of decaying animals and plant bodies and reaches the microorganisms and from the microorganisms to the detritus-eating organisms and other predators.

• Example: Garbage → Springtail (insect) → Small spiders (carnivores).

Therefore, the food chain in any ecosystem is the arrangement of many living forms that consume other organisms and are themselves consumed, and it is through them that energy flows continuously in the same direction. Because they are related as food eaters and because they eat the same things, primary producers (green plants), first, second, and third order consumers, and decomposers (fungi and bacteria) come together to form a food chain. Energy and chemical compounds enter the food chain in a sequential manner through producers, consumers, decomposers, and non-living entities. The cycle of entry and exit is maintained.

According to another opinion, there are three types of food chains –

1. Predator food chain - This food chain starts from green plants and goes from small animals to big animals. In this, the body size of the predator also increases with each trophic level.

2. Parasitic food chain – This food chain goes from big animals to small animals. In this, big animals are called hosts and small animals are called parasites. Parasites depend on living host for food.

3. Saprophytic food chain – This food chain goes from dead organisms to microorganisms. In this, the flow of energy moves from dead organic matter to micro-organisms like bacteria etc.

Food web

The term "food web" refers to the network of interconnected food chains that make up the ecosystem. Food energy moves in several directions in this. There is a relationship between two food chains, and the food comes from varying nutritional sources. A food web illustrates how life processes flow between plants and animals and are a component of a broader ecosystem, making it particularly significant in natural environments. The preservation of natural food webs and food chains is crucial to maintaining the equilibrium of our surroundings. These allow us to depict the food chains that connect organisms and preserve the natural equilibrium.

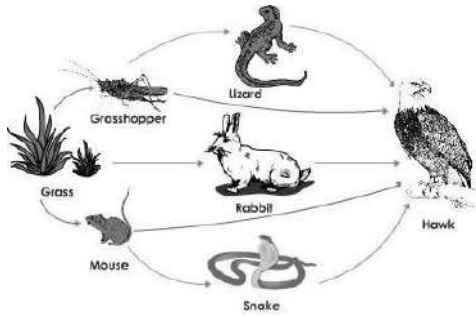

Fig. 2.3: Food Web

There can be a maximum of five trophic levels in a food chain. The ultimate source of energy is the Sun. 90% of the total energy is lost at each level and only 10% of the energy is passed on to the next level (Lindemann ten percent law); Pyramid of Energy.

Ecological pyramids (trophic levels)

Charles Elton proposed the ecological pyramid, commonly referred to as the Eltonian pyramid, in 1927. Each ecosystem's food chain is made up of producers, which are all trees and plants; primary consumers, which are herbivorous animals like grasshoppers, goats, deer, and cows; secondary consumers, which are carnivores that eat herbivorous

animals like frogs, cats, and foxes; and tertiary consumers, which are higher level carnivores that eat primary and secondary consumers. These relationships between the numbers, biomass, and energy levels among the various consumers can be shown using accounting diagrams. Ecological pyramids are the term for these visual aids. Ecological pyramids come in three different varieties: 1. Pyramid of Numbers 2. Energy Pyramid 3. The Biomass Pyramid.

1. **Pyramid of Numbers**:

The pyramid of numbers is a diagram that shows the quantities of producers, consumers, and decomposers in any ecosystem. At its base are producers, or plants, that use photosynthesis to create food. The proportions of primary, secondary, and tertiary consumers steadily decline above this. At the summit of the pyramid are higher carnivorous animals. The type of habitat determines whether the pyramid is upright or inverted. Example: The number pyramid is erect in the grassland ecology. The number of consumer creatures gradually declines from herbivores to greater carnivores, while the producers, or grasses, have the maximum number. **(Fig. 2.4 A)**

Fig. 2.4: Pyramid of number (individuals per unit area)

Similarly, the pyramid of number is upright in a pond ecosystem also. Phytoplankton, the producers of pond/aquatic ecosystem are maximum in number. The primary consumers (the herbivores) are lesser in number than the producers but higher in number of the secondary consumers (carnivores). Finally, the tertiary consumers

which occupy the apex of the pyramid (the bigger fish) are least in number

In a forest habitat, the pyramid of numbers has a somewhat different shape. The producers, who make up the base of the pyramid and are fewer in number, are the huge trees. There are more fruit-eating birds and other herbivores (primary consumers) than producers. The number of secondary and tertiary consumers, or carnivores, decreases once more, changing the geometry of the pyramid.

A parasitic food chain always has the number pyramid reversed. Many fruit-eating birds (herbivores) can be fed by a single tree, which in turn acts as a host for numerous parasites (secondary consumers), which in turn sustain numerous hyperparasites (tertiary consumers).

2. Pyramid of Energy

The ecological pyramid formed as a result of flow of energy from one trophic level to another is known as the **pyramid of energy.** The producers situated at the base of the pyramid of energy have the highest amount of energy whereas the topmost consumer at the top has the least amount of energy. The pyramid of energy is always upright. As only 10% of the energy gets transferred from one level to another and almost the 90% is lost as heat energy which is utilized in different metabolic processes and the rest is utilized by decomposers (Lindeman's 10% law).

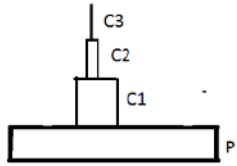

Fig. 2.5: Pyramid of Energy

3. Pyramid of Biomass:

This ecological pyramid demonstrates the total weight of every trophic level in a specific food chain in an ecosystem. The pyramid of biomass can be both upright and inverted depending upon the type of ecosystem. In grassland and forest ecosystems, the pyramids are upright, as the biomass of producers is maximum and decreases at successive trophic levels**.** However, in pond ecosystem, the producers are mostly phytoplankton which have very less biomass, which keeps on increasing at successive trophic levels. This makes the pyramid inverted in shape.

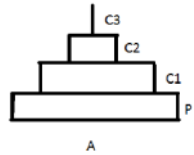

Fig 2.6 Pyramid of Biomass (Terrestrial). Upright pyramid with three consumer levels, P=producer; C1-C3=Consumers

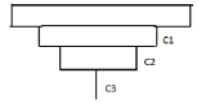

Fig 2.7 Pyramid of Biomass (Aquatic). Inverted pyramid with three consumer levels, P=producer; C1-C3=Consumers

Biogeochemical Cycles

Energy moves in the form of a cycle in the biogeochemical cycle. The consumer consumes the organic materials that the producers manufacture. After a while, the decomposer converts all of the organic materials in the deceased consumer's body into inorganic materials, which the consumer can then employ for further synthesis. It is the transfer and alteration of ions and molecules between the abiotic and

biotic parts of a system. As a result, they are essential to ecosystems' existence. There are essentially two types of biogeochemical cycles: sedimentary and gaseous.

Table 2.1: Types of Bio-geochemical cycles

Gaseous Cycle	Sedimentary Cycle
Nitrogen cycle	Sulphur cycle
Oxygen cycle	Phosphorus cycle
Carbon dioxide cycle	
Water cycle	

Nitrogen Cycle

In its molecular state, nitrogen makes up around 78% of the atmosphere. Nitrogen fixation is the process of converting inaccessible forms of nitrogen into forms that plants can use. It is possible to convert nitrogen through both biological and physical processes. Important processes like ammonification, nitrification, and denitrification are a part of the biological nitrogen fixation process. The majority of fixation is carried out by symbiotic bacteria (Rhizobium species) or free-living bacteria (Azotobacter) using their nitrogenase enzyme, which changes nitrogen into ammonia. Through their root hairs, plants can take up ammonium or nitrate from the soil. In order to be incorporated into amino acids, nucleic acids, and chlorophyll, nitrate that is absorbed must first be reduced to nitrite ions and subsequently ammonium ions. Ammonification is the process by which bacteria or fungi convert organic nitrogen from dead plants or animals into ammonium ions (NH_4^+). Nitrosomonas species and other bacteria carry out the oxidation of ammonium (NH_4^+), converting ammonia to nitrites (NO_2^-). Nitrobacter and other bacterial species oxidize nitrites (NO_2^-) to nitrates (NO_3^-). The process known as denitrification, which

is triggered by bacterial species like Pseudomonas, converts the nitrates back into nitrogen gas, completing the nitrogen cycle (Fig. 2.8).

Fig. 2.8: Nitrogen Cycle

Oxygen Cycle

When photosynthesis occurs, all green plants emit oxygen back into the atmosphere as a byproduct. Free oxygen is necessary for breathing for all aerobic organisms. Carbon dioxide is recycled by plants during photosynthesis and is released back into the atmosphere by animals. The oxygen cycle in nature is formed by this mechanism, which keeps the atmospheric concentration of oxygen balanced (Fig. 2.9)

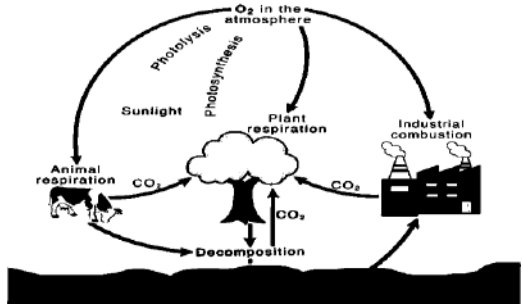

Fig. 2.9: Oxygen cycle

Carbon Cycle

The flow of carbon compounds between the Earth's biosphere, geosphere, pedosphere, hydrosphere, and atmosphere is known as the carbon cycle. Plants use the carbon in the atmosphere to perform photosynthesis. Animals eat these plants, which causes the carbon to bioaccumulate in their bodies. As these plants and animals perish and decay, carbon is released back into the atmosphere. the carbon residue that eventually turns into fossil fuel. Human activity uses these fossil fuels, which releases more carbon dioxide into the atmosphere. (Fig. 2.10)

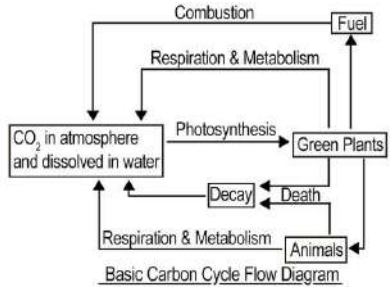

Fig. 2.10: Carbon cycle

Water Cycle

Water from different bodies of water on Earth evaporates because of the Sun's heat. At a specific altitude, water vapor cools and condenses to create clouds. However, excessive water accumulation causes clouds to thicken and eventually produces precipitation in the form of rain, snow, or hail. After that, this water gathers to form lakes, ponds, or seas. The water eventually evaporates, restarting the cycle (Fig. 2.11)

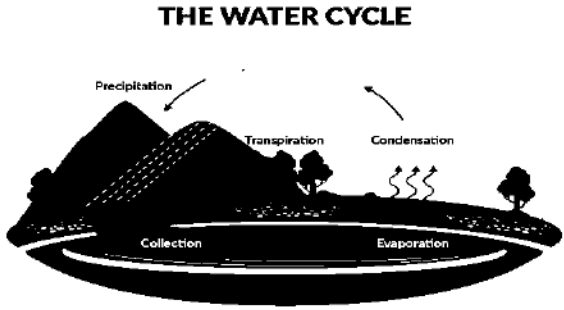

Fig. 2.11: Water Cycle

Sulphur Cycle

Sulfur is transferred between rocks, rivers, and biological systems by the sulfur cycle. Sulfur is a necessary element (C H O N P K Mg Ca S), present in a large number of cofactors and proteins. Additionally, sulfur compounds are employed in microbial respiration as reductants or oxidants. The cycle of sulfur entails the change of sulfur via several oxidation states, which are crucial for biological and geological activities. (Fig. 2.12)

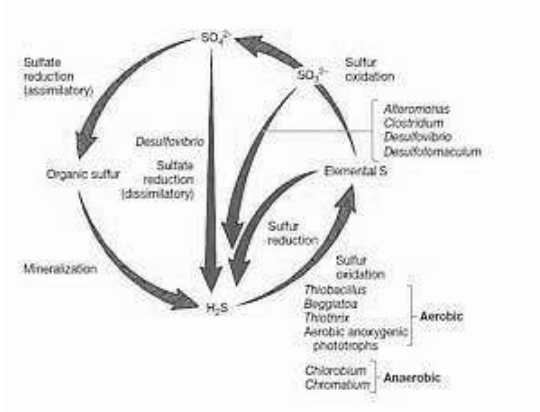

Fig. 2.12: Sulphur Cycle

Phosphorus Cycle

Soil phosphorus is utilized as organic matter to meet the body's need for protein, which allows it to move up the food chain. Phosphorus is produced during the decomposition of plant and animal excreta, and this phosphorus is combined with the soil. This produced phosphorus is either recycled by plants and trees or is washed away by rainwater, combining with river water to make ocean sediment. Phosphorus rises to the top of the ocean and joins the food chain in regions where water boils from the bottom to the top

Chapter 3

Biodiversity Conservation

The range of life on Earth, from genes and microbes to entire ecosystems, is known as biological diversity. "Variety and variability of species of all living beings in a given habitat" is its definition. It speaks of the entirety of a region's species, genes, and ecosystems. It was Walter G. Rosen who first coined the word biodiversity in 1985. "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 part," according to the UN Convention on Biological Diversity, "includes diversity within species, between species, and of ecosystems" (UNEP 1992). There are three categories of biodiversity: Three types of diversity exist: genetic, species, and community/ecosystem..

Types of Biodiversity

Genetic Diversity

Genetic diversity refers to the diversity of the gene pool of a given species, or diversity at the DNA level, both among geographically separated populations and among individuals within a single population. The variation in genes can be in the alleles (different variants of same genes), in entire genes (the traits determining particular characteristics) or in chromosomal structures. The population gets adapted to its environment due to genetic diversity and so responds to natural selection. New species are formed due to genetic variation.

Species Diversity

Species diversity is based on the number of different species present in a community (species richness) and the role they perform in the community. It includes full range of species on earth from microorganism to the multicellular organisms. It is measured by species richness (number of species perunit area) and evenness or equitability (evenness in the number of individuals of a species).

Community/Ecosystem Diversity

Ecosystem diversity refers to variability in habitats within a geographic area. It describes the number of niches, trophic levels and various ecological processes that sustain energy ow, food webs and the recycling of nutrients. It also focusses on several biotic interactions and the role and function of keystonespecies.

Community/Ecosystem Diversity has three perspectives-alpha, beta and gamma diversity. Alpha diversity is a local measure and refers to the average species diversity in a habitat or specific area. Beta diversity is the ratio between alpha diversity and regional diversity i.e., the diversity of species between two habitats or regions. Gamma diversity is a combination of both alpha and beta diversity e.g., the total diversity of a landscape.

Uses of Biodiversity

Humans depend on the biodiversity for several direct and indirect benefits:

Consumptive use value

It includes food, medicine, fuel, timber, clothing, etc. obtained from plants. About 90% of the crops have been domesticated from wild tropical plants. 85% of the world population depends upon plants for medicines. About 25 percent of the medicines used today are

taken from or modelled on chemicals found in plants, animals, or other living things. For example, Morphine (*Papaver somniferum*) used as an analgesic; Penicillin from a fungus name *Penicillium;* Quinine from a plant *Cinchona ledgeriana*, used for the treatment of malaria; Taxol, an anticancer drug obtained from the bark of the yew tree *Taxus baccata, Taxus brevifolia*; tetracycline from a bacterium and cancer-curing drugs like Vinblastine and Vincristine from a plant *Catharanthus roseus* are obtained.

Table: 3.1 Certain plant derived substances developed into valuable drugs (compiled from various sources, see Singh and Khurana, 2002)

Substance	**Use**	**Original Source**
Codeine, Morphine	Analgesic, Antitussin	*Papaver somniferum*
Digitalin	Cardiotoxin, Antimalarial	*Digitalis purpurea*
Vinblastine and Vincristine	Alkaloids good for the treatment of Hodgkinson's disease and lymphocytic leukaemia	*Catharanthus roseus*
Quinine	Antimalarial	*Cinchona ledgeriana*
Taxol	Ovarian cancer	*Taxus brevifolia*
Castanospermine	Anti HIV activity	*Castanospermum australis*
Artemisinin	Antimalarial agent	*Artemisia annua*
Theokal	Arrhythmic	Hawthorn
Thisilyn	Liver damage	Milk thistle

Productive use value

The products are commercially usable. The plants are harvested from their habitats and are sold in the market because of their commercial value. New cultivars and varieties of plants and animals are developed through breeding programmes to get better yielding and disease resistant crops. The products commercially used are fuel, timber, musk, tusk, ivory, honey, fibre, gums, resins, medicines, silk, wool etc.

Aesthetic and Cultural value

Biodiversity provides a good deal for fun and recreation. It includes ecotourism which generates billion dollars as income per year. Other aesthetic rewards include wildlife, gardening, bird watching etc. Biodiversity in India is related to religious, cultural and spiritual uses. Many plants like *Ocimum sanctum* (Tulsi), *Ficus religiosa* (Pipal), *Datura stramonium* (Datura), *Prosopis cineraria* (Khejri) and several other plants are considered to be sacred and are worshipped by the people. Various animals are worshipped as they are considered as vehicles of Gods and Goddesses like Eagle (Lord Vishnu), Dog (Bhairav), Peacock (Kartikeya) etc. Also, the plants and animals are recognized as national pride and symbols of cultural heritage.

Social Value

It includes conservation of soil and water and productivity of various ecosystems. The aim of social value is to inculcate awareness among the people about the sustainable use of natural resources, thus protecting our nature.

Biodiversity hot spots

The areas serving as the richest and most threatened reservoir spots of plant and animal life on earth are termed as *biodiversity hotspots.* The term 'biodiversity hotspot' was coined by Norman Myers (1988), who recognized ten tropical forests as "hotspots" according to the level of

plant endemism and high level of habitat loss. Two years later, he added eight more hotspots, thus increasing the hotspots in the World to 18. The systematic update of the hotspots was made by the Conservation International (CI) in association with Myers introducing two strict quantitative criteria for a region to be classified as a hotspot as:

(a) Species Endemism: According to this criterion, it should contain at least 1500 species of vascular plants (>0.5% of the world's total) as endemics.
(b) Degree of threat: It must have lost more than 70 percent of its original native habitat.

It has been estimated by the scientists that about 8.8 million species of flora and fauna are currently in existence on the planet earth out of which 1.77 million different species have been identified which represents only a small portion of the total number of species on earth. Still many more species are yet to be discovered and classified. The hotspots provide useful services for the humankind besides supporting rich biodiversity like providing clean water, pollinators and regulating the climate. The hotspots are a home for several 'endemic species' which are confined to a specific ecological spot **a**nd are not found anywhere else on the planet. Thus, each biodiversity hot spot represents a remarkable universe of extraordinary floral and faunal endemism struggling to survive in rapidly shrinking ecosystems. There are a total of 35 **Biodiversity Hotspots in the World** which occupy 1.4% of the earth's surface and 20% of worlds the human population lives in these areas.

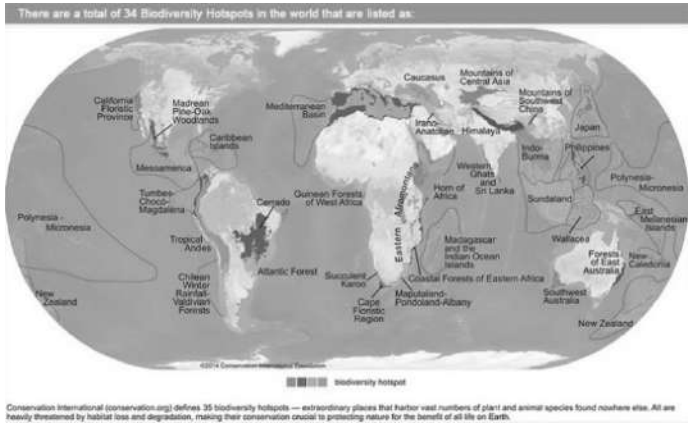

Fig. 3.1. Biodiversity hotspots in the World (Source: Conservation International Foundation)

The 35 biodiversity hotspots are listed as:

Table: 3.2. Listing of Biodiversity hotspots of the World.

World's 35 Biodiversity Hotspots

I. Africa	**III. Europe and Central Asia**
1. **Cape Floristic Region**	23. **Caucasus**
2. **Coastal Forests of Eastern Africa**	24. **Irano-Anatolian**
3. **Eastern Afromontane**	25. **Mediterranean Basin**
4. **Guinean Forests of West Africa**	26. **Mountains of Central Asia**
5. **Horn of Africa**	
6. **Madagascar and the Indian Ocean Islands**	**IV. North and Central America**
7. **Maputaland-Pondoland-Albany**	27. **California Floristic Province**
8. **Succulent Karoo**	28. **Caribbean Islands**
	29. Madrean Pine-Oak Woodlands
II. Asia-Pacific	30. **Mesoamerica**
9. **East Melanesian Islands**	
10. **Himalaya**	**V. South America**
11. **Indo-Burma**	31. **Atlantic Forest**
12. **Japan**	32. **Cerrado**
13. **Mountains of Southwest China**	33. **Chilean Winter Rainfall-Valdivian Forests**
14. **New Caledonia**	34. Tumbes-Chocó-Magdalena
15. **New Zealand**	35. **Tropical Andes**
16. **Philippines**	
17. Polynesia-Micronesia	
18. Southwest Australia	
19. Forests of Eastern Australia (new)	
20. Sundaland	
21. Wallacea	
22. Western Ghats and Sri Lanka	

Biodiversity hotspots in India

India is recognised as one of the leading countries in terms of biodiversity richness, ranking within the top 10 or 15 nations. This distinction is attributed to the extensive array of plant and animal species present in India, many of which is exclusive to the region and cannot be found elsewhere. There is a total of 350 distinct mammalian species. There are a total of 1,224 avian species. There are a total of 408 reptile species identified. Additionally, the plant kingdom comprises 45,000 species, with the majority being angiosperms. The region has notably elevated levels of species variety, particularly in the case of ferns (1022 species) and orchids (1082 species).

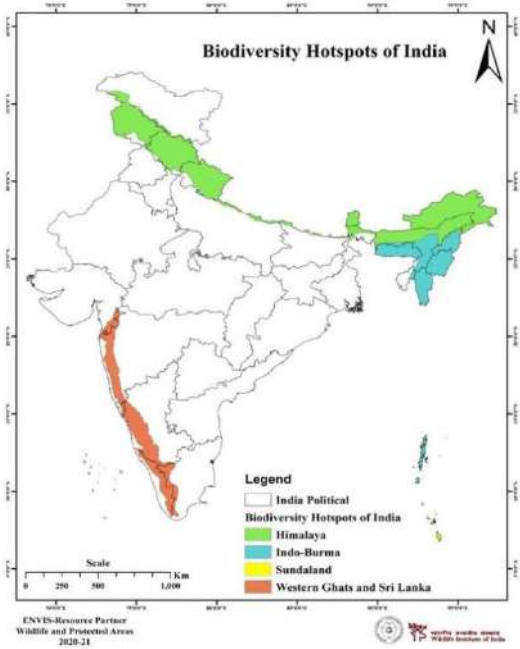

Fig. 3.2. Biodiversity hotspots of India (Source: Wildlife Institute of India, August 2020)

There are around 50,000 documented species of insects, which

encompasses a subset of 13,000 species specifically classified as butterflies and moths. Approximately 18% of plant species in India exhibit endemism, meaning they are exclusively confined to the geographical boundaries of the country and do not occur naturally anywhere else in the world.

Out of the 35 biodiversity hotspots in the world, 4 are in India which includes the Himalayas, the Western Ghats, the Indo-Burma region, and the Sundaland.

The Himalayas

Overall, the Himalayas comprise North-East India, Bhutan, and Central and Eastern parts of Nepal. These Himalayan Mountains are the highest in the world and host some of the highest peaks in the world including Mount Everest and K2. It also includes some of the major rivers of the world like Indus and Ganga. Himalayas hosts almost 163 endangered species including one-horned rhinoceros, wild Asian water buffalo, and as many as 45 mammals, 50 birds, 12 amphibians, 17 reptiles, 3 invertebrates, and 36 plant species.

The Western Ghats

These hills are found along the western edge of peninsular India. As the region is mountainous and oceanic, it receives a good amount of rainfall. Around 77% of the amphibians and 62% of the reptiles are endemic. Moreover, the region is also home to around 450 species of birds, 140 mammals, 260 reptiles, and 175 amphibians.

Indo-Burma region

This region consists of various countries including North-Eastern India (to the south of the Brahmaputra River), Myanmar, China's Yunnan provinces, Lao People's Democratic Republic, Vietnam, Cambodia, and Thailand. Almost 13,500 plant species can be spotted in the region, half

of which are endemic and cannot be found in any other place in the world. Although this region is quite rich in biodiversity, the situation has been worsening over the past few decades.

Sundaland

This region lies in Southeast Asia and includes Thailand, Singapore, Indonesia, Brunei, and Malaysia. Nicobar region represents India in this hotspot. UNESCO declared this region as the World Biosphere Reserve in 2013. These islands have a rich terrestrial and marine ecosystem including mangroves, seagrass beds, and coral reefs.

Loss of Biodiversity:

The anthropogenic activities are the major threat and have greatly accelerated the rate of loss of biodiversity. Some of the main causes of loss of biodiversity are as follows:

Habitat destruction and fragmentation

The expansion of human populations and human activities are the main cause of loss of biodiversity. The conversion of natural habitats into agricultural land, urban areas and infrastructure development leads to the destruction and fragmentation of habitats. The humans take over previously wild lands for the construction of roads, canals, towns, industries etc., the available space for native species to live, feed and reproduce gets reduced which also disrupts the connectivity among different ecosystems.

Habitat degradation and pollution

Physical degradation of forest habitat by uncontrolled fires has adverse effect on the plant and animal communities. Pollution whether air, soil or water harms the species by degrading their habitats, either physically or by increasing their vulnerability to diseases or predation. Some pollutants, such as pesticides and heavy metals, can be passed up

the food chain, therefore contaminating many levels of the ecosystem (Biomagnification). Air pollution leads to increase in the concentration of carbon dioxide which is responsible for the acidification of oceans, making difficult for marine organisms to survive. The result is a decline in these species' populations, as well as those of species that rely on them for food and shelter.

Climate change:
Global warming has altered the natural habitats, making it challenging for organisms to perform their natural functions or adapt to new conditions. Changes in temperatures or rain patterns, make it different for certain plants to grow or survive, which also affects the species that depend on them.

Overexploitation:
Exploitation including hunting, collecting fisheries and illegal trade of species and their parts constitute a major threat for the threatened species. Overhunting of a species to meet high demand for meat or animal byproducts, for sport etc. is one of the main cause of species extinction. The overexploitation of a species results in the deterioration of the rest of the ecosystem also. Unsustainable methods of fishing, like bottom trawling, have also destroyed sea-floor habitats, which serve as important nursery areas for many species. Species of several trophic levels depend on a single tree species, as it provides habitat and food for several insects and birds.

Introduction of Alien Invasive species
As ecosystems have evolved to maintain a relative stability of species populations, non-native species introduced to new environments can outcompete native species for resources, prey on them, or can even transmit diseases. Thus, the introduction of invasive species may cause disappearance of native species through changed biotic interactions.

Disease:
Human activities may increase the incidence of diseases in wild species which can devastate their populations. Organisms have developed natural defences against disease-inducing microbes native to their region. However, when human activity contaminates ecosystems with non-native microbes, indigenous species are not equipped to combat them.

Genetic pollution:
The release of genetically modified organisms or the hybridization of closely related species leads to loss of genetic diversity, which is crucial for species' adaptability and resilience.

Shifting or Jhum cultivation:
A type cultivation practiced by many indigenous communities in the tropics which involves cutting and burning a patch of forest or grassland, and then planting crops in the ash-enriched soil. The crops are typically grown for a few years until the soil becomes depleted, after which the land is left fallow for several years to allow the forest or grassland to regenerate. Though this shifting cultivation provides food security for many indigenous communities and has been a sustainable agricultural practice for centuries. However, jhum cultivation has come under increasing criticism in recent years due to its negative impact on biodiversity, the chief one being habitat loss. As the practice involves clearing forest or grassland to create agricultural land, this leads to the destruction of important habitats of a range of species. It also leads to soil erosion, loss of nutrients, and changes in microclimates, which can have further impacts on biodiversity. The traditional practice of jhum cultivation involves the cultivation of crops such as rice, maize, and vegetables, which are not native to the region. As a result, the natural vegetation is replaced by crops that are not adapted to the local environment. This has led to a decline in the diversity of plant species,

as many of the native plant species are not able to compete with the introduced crops.

Effects of loss of Biodiversity:

Biodiversity loss has a very adverse effect on ecosystems and the environment, leading to a decline in ecosystem services and reduced resilience to disturbances. Some of the consequences include:

- **Loss of ecosystem stability**: The ecosystems which are rich in biodiversity are more stable and resilient to disruptions. Loss of biodiversity can reduce an ecosystem's ability to recover from the disturbances like disease outbreaks, change in climate and increase the risk of ecosystem collapse.
- **Decline in ecosystem services**: Loss in biodiversity can leads to impairment of the ecosystem services provided by it like carbon sequestration and climate regulation, purification of air and water etc. thus, declining the quality of the environment.
- **Loss of genetic resources**: Biodiversity is a reservoir of genetic resources that can be used for the development of new crops, medicines and for cultural expression.
- **Altered biogeochemical cycles**: Biodiversity loss can affect the regulation of biogeochemical cycling of nutrients, such as carbon, nitrogen and phosphorus, in ecosystems. This leads to changes in ecosystem productivity, water quality, and greenhouse gas emissions.
- **Increased risk of species extinction**: The loss of individual species can have cascading effects on other species within the same ecosystem, leading to further declines in biodiversity and increasing the risk of extinction for multiple species. This is because in nature one species is dependent upon the other for survival.

The loss of biodiversity has negative impacts on human health, their well-being and economic development. Some of the consequences are:

- **Reduced food security**: Biodiversity is essential for food production, as it provides genetic resources for crop and livestock

improvement, pollination services and natural pest control. Declining biodiversity can reduce agricultural productivity and increase the vulnerability of food systems to pests, diseases and climate change.

- **Decline in human health**: Biodiversity plays a significant role in the development of new medicines, as many plants or animals serve as a source of pharmaceuticals and homoeopathic remedies. Loss of biodiversity reduces the sources of new treatments for diseases. Additionally, the decline in ecosystem services, such as water and air purification, can lead to increased exposure to pollutants and pathogens, negatively affecting human health.
- **Economic losses**: Biodiversity supports many industries, including agriculture, forestry, fisheries and tourism. Loss of biodiversity can reduce the productivity and sustainability of these industries, leading to economic losses and reduced employment opportunities.
- **Loss of cultural values**: Biodiversity has cultural and spiritual significance for many people, particularly indigenous communities. The loss of species and ecosystems can result in the loss of cultural heritage, traditional knowledge and spiritual connections to nature.
- **Reduced resilience to climate change**: Loss of biodiversity can reduce the capacity of ecosystems to adapt to changing climate conditions, posing negative impacts on human societies.

IUCN Red Data List or Red Book :

IUCN (International Union for the Conservation of Nature and Natural Resources) now known as The World Conservation Union, is an international organization working in the field of nature conservation and sustainable use of natural resources. It is involved in data gathering and analysis, research, field projects, advocacy, lobbying and education. The organization is best known for compiling and publishing the IUCN Red List, which assesses the conservation status of species worldwide. Its headquarters are in Gland, Switzerland.

The IUCN Red List of Threatened Species, founded in 1964, is the world's most comprehensive inventory of the global conservation status of biological species. It is a critical indicator of the health of the World's biodiversity. It serves as a powerful tool to inform and catalyse action for biodiversity conservation and policy change, critical to protecting the natural resources needed for the survival. When discussing the IUCN Red List, the official term *"threatened"* is a grouping of three categories: *Critically Endangered, Endangered, and Vulnerable.*

Extinct (EX) – No known individuals remaining.

Extinct in the wild (EW) – Known only to survive in captivity, or as a naturalized population outside its historic range.

Critically endangered (CR) – Extremely high risk of extinction in the wild.

Endangered (EN) – High risk of extinction in the wild.

Vulnerable (VU) – High risk of endangerment in the wild.

Near threatened (NT) – Likely to become endangered in the near future.

Least concern (LC) – Lowest risk. Does not qualify for a more at-risk category. Widespread and abundant taxa are included in this category.

Data deficient (DD) – Not enough data to make an assessment of its risk of extinction.

Not evaluated (NE) – Has not yet been evaluated against the criteria.

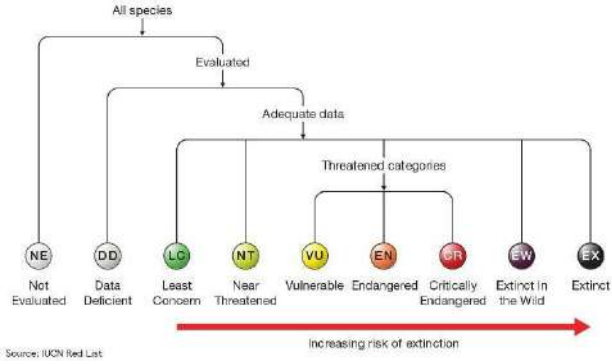

Fig: 3.3. Categories of IUCN (Source: IUCN Red List)

The total number of tree species on the IUCN Red List is over 40,000. This means 70% of trees now have a published IUCN Red List assessment. We continue to see trends found in the State of the World's Trees, with one third of tree species being threatened with extinction and major threats of land use change for agriculture and logging impacting global tree diversity. Therefore, it is still as important as ever to take action to save the world's threatened tree species (Source: Botanic Gardens Conservation International). The latest comprehensive assessment of the world's freshwater fish species, reveals that 25% (3,086 out of 14,898 assessed species) are at risk of extinction. At least 17% of threatened freshwater fish species are affected by climate change, including decreasing water levels, rising sea levels causing seawater to move up rivers, and shifting seasons (Source: IUCN red list).

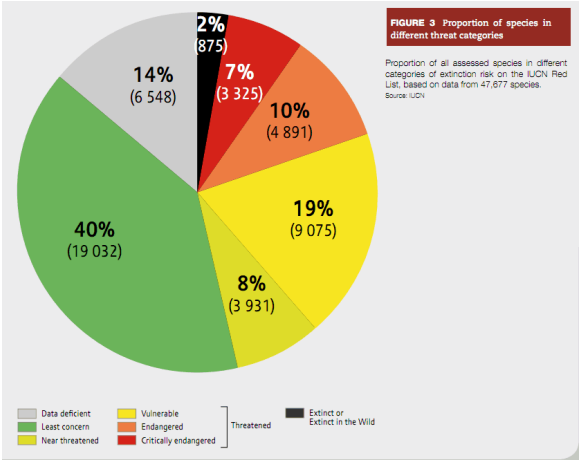

Fig. 3.4. Proportion of all assessed species in different categories on IUCN red list, Source: IUCN

The IUCN Green Status of Species

The IUCN Red List of Threatened Species is the global standard for assessing the risk of extinction that individual species of animal, fungus, and plant faces. But an optimistic vision of species conservation is also needed that presents a road map for recovery. To achieve this, the Red List assessment process has been expanded to include new classifiers of species recovery and conservation impact, known as **the Green Status of Species.** The IUCN Green Status of Species complements the Red List by providing a tool for assessing the recovery of species' populations and measuring their conservation success. In 2020, Green Status of Species assessments became an optional part of Red List assessments.

The Green Status assesses species against three essential facets of recovery *(adapted from Akçakaya* et al*. 2018)*

A species *is fully recovered if it is present in all parts of its range***,** even those that are no longer occupied but were occupied prior to major human impacts/disruption;
It is **viable** (i.e., not threatened with extinction) in all parts of the range; AND

It is performing its **ecological functions** in all parts of the range. These factors contribute towards a "**Green Score**" ranging from 0–100%, which shows how far a species is from its "fully recovered" state.

The Green Status will complement the Red List to provide a more comprehensive look at species conservation status. The Green Status of Species also highlights the impact of past conservation and the dependence of many species on continued conservation efforts. For example, past conservation has had a major role to play in keeping these three species **(Fig. 3.5)** from extinction, even though they are still considered Critically Endangered. With continued conservation efforts, some have the potential to recover substantially in the future.

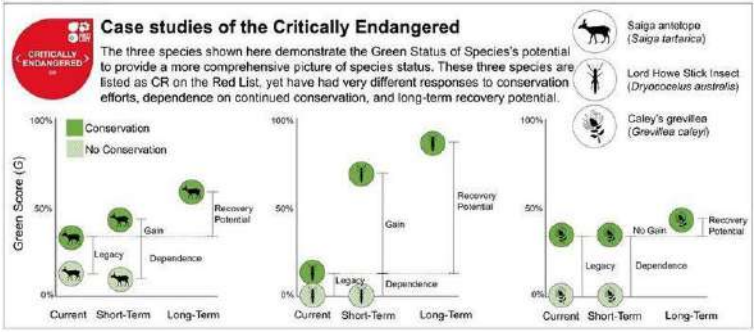

Fig. 3.5 Case studies of three Critically Endangered species (Source: https://www.iucnredlist.org, IUCN 2024). The IUCN Red List of Threatened species. Version 2023-1. ISSN 2307-8235

Conservation of Biodiversity:

In order to protect our earth, small but serious attempts should be made by us so that we can pass it to our future generations in a good health. This way we will not deprive our future generations from the economic, ecological and aesthetic benefits provided by our nature earth.

The more scientific way of conserving biodiversity is by adopting two ways: - In-situ Conservation and Ex-situ Conservation.

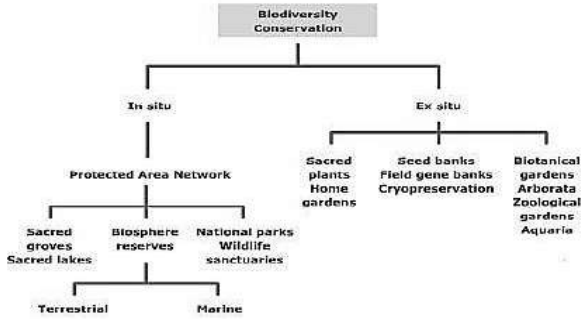

Fig. 3.6. Conservation Strategies

In-situ Conservation strategies

It is the method of conservation of genetic resources in natural populations and habitats of plant or animal species. It involves the reduction of biotic pressure rehabilitation and helps in the multiplication of the species through the process of evolution and adaptation. The faunal species are more adaptable to this kind of conservation process as it supports the species mobility with a larger habitat area.

Examples include:

- National Parks
- Biosphere Reserves

- Wildlife Sanctuaries
- Protected Areas

The areas of land and/or sea concerned with the protection and maintenance of biodiversity and of natural resources and the resources of cultural heritage are called protected areas. UNEP has recognized six management categories of protected areas:

IUCN Protected Area Management Categories:

- Category Ia — Strict Nature Reserve
- Category Ib — Wilderness Area
- Category II — National Park
- Category III — Natural Monument
- Category IV — Habitat/Species Management Area
- Category V — Protected Landscape/Seascape
- Category VI – Protected Area with sustainable use of natural resources.

The fundamental goals of national parks and wildlife sanctuaries in India, which are designated as protected places by the government, are to safeguard wildlife, save flora and animals, and restore the natural ecological balance. A network of over 880 protected areas, totalling about 1,66,550 square kilometres, is covered in India. There are total106 national parks and 568 wildlife sanctuaries in India, 2024.

National Parks

National parks in India are IUCN category II protected areas. India's first national park was established in 1936 as Hailey National Park, now known as Jim Corbett National Park, now in Uttarakhand. By 1970, India only had five national parks. In 1972, India enacted the Wildlife Protection Act and Project Tiger to safeguard the habitats of conservation reliant species. As of 2024, there are 106 national parks. A national park has a defined boundary, through which no

person can get into it without an approval. The park cannot be used for any reason viz. firewood, timber, fruits…etc. The key difference here when compared to a sanctuary is that a national Park allows no human activities inside the buffer or core zone. There may be limited activities (other than tourism) within the tourism zone of a national park. Livestock grazing is not allowed in a National Park, but it can be allowed in a regulated manner in a Sanctuary.

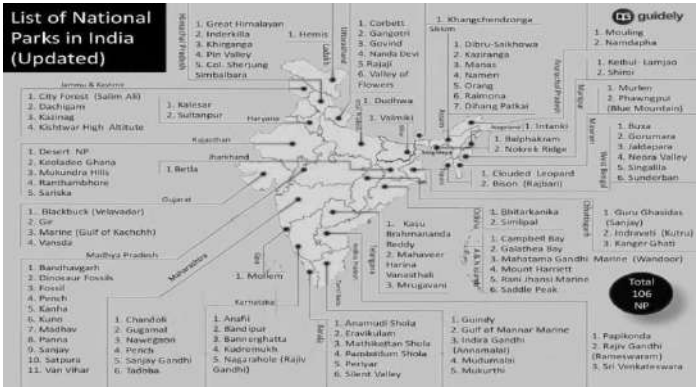

Fig: 3.7. National parks in India (adapted from guidely.com)

Uttarakhand enjoys the possession of six National Parks; the details are given in the table below.

Table 3.3: National Parks with reference to Uttarakhand**.**

National Parks in Uttarakhand	**Establishment Year**	**Area (Km²)**
Corbett National Park	1936	520.82
Nanda Devi National Park	1982	624.6
Valley of Flowers National Park	1982	87.5
Rajaji National Park	1983	820
Gangotri National Park	1989	2390.02
Govind National Park	1990	472.08

Wildlife Sanctuaries:

The Wildlife Sanctuaries falls under the category IV of the IUCN classification. A wildlife sanctuary is a space that is maintained exclusively for the use of wild animals, which are protected when they roam or live in that area. It is similar to a national park but it is not physically fenced to restrict the public. People can collect firewood, fruits, medicinal plants and other stuff in small scale. A sanctuary may also be established for the purpose of maintaining biodiversity, or preserving a nation's unique natural environment. It is a protected area of importance for flora**,** fauna, or features of geological or other interest, which is reserved and managed for conservation and to provide opportunities for study or research.

There are currently 565 wildlife sanctuaries in India, totalling 122560.85 km2, or 3.73% of the nation's land area **(National Wildlife Database, May 2022).** The government enacted the **Wildlife (Protection) Act of 1972** with the aim of effectively protecting the wildlife of this country and controlling poaching, smuggling, and illegal trade in wildlife.

Table 3.4: National Parks with reference to Uttarakhand**.**

S.No.	Wildlife Sanctuary	Establishment Year	Area (Km^2)
1	Govind wildlife sanctuary	1955	485.89
2	Kedarnath wildlife sanctuary	1972	975.20
3	Askot wildlife sanctuary	1986	599.93
4	Sonanadi wildlife sanctuary	1987	301.18
5	Binsar wildlife sanctuary	1988	47.07
6	Mussoorie wildlife sanctuary	1993	10.82
7	Nandhaur wildlife sanctuary	2012	269.95

Biosphere Reserves:

This is a Category V under IUCN but includes Categories II, III, IV in it. These are notified areas which cover a larger area of land which may cover multiple National Parks, Sanctuaries and reserves as well. Ex. the Nilgiri Biosphere covers: Bandipur NP, Mudumalai Tiger Reserve, Silent Valley NP, Wyanad WLS, Nagarhole NP, Mukurthi NP, Sathyramangalam WLS & Reserve Forest and is usually a contiguous area.

Biosphere Reserve (BR) is an international designation by United Nations Educational, Scientific and Cultural Organization (UNESCO) for representative parts of natural and cultural landscapes extending over large areas of terrestrial or coastal/marine ecosystems or a combination of both. It tries to balance economic and social development and maintenance of associated cultural values along with the preservation of nature. These provide living examples of as to how the human beings and nature can co-exist while respecting each other's needs.

The three main zones of a Biosphere Reserve are: Core zone, buffer zone and the transition zone.

Core Zone: It is the most protected area of a biosphere reserve. It may contain endemic plants and animals. It conserves the wild relatives of economic species and also represent important genetic reservoirs having exceptional scientific interest. A core zone is a protected region, like a National Park or Sanctuary/protected/regulated mostly under the Wildlife (Protection) Act, 1972**.** It is kept free from human interference.

Buffer Zone: It surrounds the core zone. The activities include restoration, limited tourism, fishing, grazing, etc., which are permitted

to reduce its effect on the core zone and therefore helps in the protection of the core zone in its natural condition. Research and educational activities are also encouraged.

Transition Zone: It is the outermost part of the biosphere reserve and is the zone of cooperation where human ventures and conservation are done in harmony. It includes settlements, croplands, managed forests and areas for intensive recreation and other economic uses characteristics of the region.

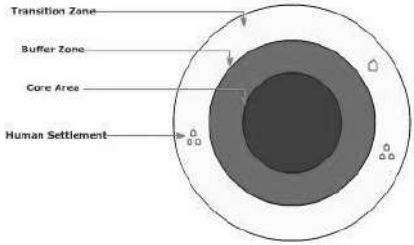

Fig. 3.8. Zonation of Biosphere Reserve

The Indian government has established 18 Biosphere Reserves of India.

1-Nilgiri Biosphere Reserve (connected to MAB)
2-Gulf of Mannar (connected to MAB)
3-Sunderbans (connected to MAB)
4-Nanda Devi National Park & Biosphere Reserve (connected to MAB)
5-Nokrek (connected to MAB)
6-Pachmarhi Biosphere Reserve (connected to MAB)
7-Similipal (connected to MAB)
8-Achanakmar- Amarkantak (connected to MAB)
9-Great Nicobar Island Biosphere Reserve (connected to MAB)
10-Agasthyamalai Biosphere Reserve (connected to MAB)

11-Manas, Assam
12-Dibru-Saikhowa, Assam
13-1Dehang-Dibang, Arunachal Pradesh
14-Khangchendzonga, Sikkim
15-Great Rann of Kutch, Gujarat
16-Cold Desert, HP
17-Seshachalam Hills, Andhra Pradesh
18-Panna, MP

Functions of Biosphere Reserve:
Conservation of genetic resources, endemic species, ecosystems, and landscapes. Along with the wildlife, culture and customs of tribals are also protected.

Promoting economic and human growth that is sustainable on a sociocultural and ecological level. It **seeks to strengthen the three pillars of sustainable development:** social, economic and protection of the environment.

Promoting research activities, environmental education, training and monitoring in the context of local, national and international conservation and sustainable development.

Reserve & Protected Forest:
These are IUCN category IV or VI protected areas. These are forested lands where logging, hunting, grazing and other activities may be permitted on a sustainable basis to members of certain communities. In reserved forests, explicit permission is required for such activities whereas, in protected forests, such activities are allowed unless explicitly prohibited. Thus, in general reserved forests enjoy a higher degree of protection with respect to protected forests.

Conservation Reserves & Community Reserves

These are IUCN category V and VI protected areas. Unlike National Parks and Wildlife Sanctuaries, a conservation Reserve is declared by state governments. Usually, the area will be owned by the government and lies near to Wildlife Sanctuaries or National Parks. These often function as a buffer zone for a protected area or a link which connects two protected areas together. However, an area will be declared as Conservation Reserve only after holding adequate consultations with the local people. There are no regulations on the rights of the people living inside a Conservation Reserve.

Again, declared by state government, a Community Reserve can even be privately or community owned land declared so when an individual or community volunteers to conserve the area and its natural fauna and flora. Apart from protecting the natural habitat and environment, Community Reserves may also protect cultural values and practices related to the area. There are no regulations on the rights of the people living inside a Community Reserve.

Sacred grooves are tracts of forested land that are protected by the community living around them. The community attaches some religious or cultural significance to the protected forest land. It helps protect many rare, threatened, and endemic plant and animal species found in a region—for example, Khasi and Jantia hills in Meghalaya, Aravalli Hills of Rajasthan, Western Ghat regions of Karnataka and Maharashtra and the Sarguja, Chanda and Bastar areas of Madhya Pradesh.

Advantages of in-situ conservation

- The wildlife species are preserved within their natural habitat. They easily adjust and adapt to their surroundings.
- It conserves the entire ecosystem, not just one particular species.

- It is a more economical and convenient method.
- Useful in conserving large populations of a species.
- The chances of recovery are high.

Disadvantages of in-situ conservation

- Conditions that threaten the survival of the organism will still be present.
- The genetic diversity of the region may already have decreased.
- Endangered habitats may be fragmented and may affect the survival of the species.

Ex-situ Conservation strategies

It is the process of conservation of living organisms outside of their natural habitat through genetic conservation including both captive propagation of species and their eventual release into the natural or restored ecosystem. In this conservation process, artificial conditions are created to make their habitat almost like a natural habitat. This method enhances the probability of reproductive success for endangered species. The faunal species, in this method, have less mobility owing to the smaller habitat area.

Examples include:

- Zoos
- Botanical Gardens
- Gene Banks
- Cryopreservation

Zoos:

A zoological park is a facility where animals are kept within enclosures for public display and are often bred for conservation purposes. Zoological parks increase the public interest in the understanding of wildlife and are centres for recreation and education like the National Zoological Park, Delhi.

Botanical Gardens

It is a garden specially meant for the collection, cultivation, preservation, and display of a wide variety of plants, which are typically labelled with their botanical names. They serve the purpose of scientific research, conservation, display, and education like the National Botanical Garden, Lucknow.

Gene Bank

A gene bank is a biorepository that preserves the genetic material. It is a collection of seeds, plants, tissue cultures, etc., of potentially valuable species. It conserves the genetic diversity of wild and domesticated plants and animals like the National Animal Gene Bank, Karnal. Seeds of different genetic strains of commercially important plants can be kept for long periods in seed banks. The national gene bank at National Bureau of Plant Genetic Resources (NBPGR), Delhi is primarily responsible for conservation of unique accessions on long-term basis, as base collections for posterity, predominantly in the form of seeds.

Cryopreservation

It is the long-term process of keeping live cells, tissues, and other biological samples frozen at sub-zero temperatures for storage and preservation. The sample is commonly kept at −196°C. It preserves the biological material, and the genetic integrity of the material is stored like the one present in IARI, New Delhi.

Advantages of Ex-situ conservation

- It protects endangered species from external threats like predation and poaching.
- Selective breeding programs can be implemented.
- It is a focused approach, as the health of individual animals can be monitored.
- The genetic diversity of the population is preserved.

- It is invaluable for research and public education.
- It has the potential to reintroduce organisms back into their natural habitat.

Disadvantages of Ex-situ conservation

- The individual is living outside its natural habitat.
- Animals may not adjust to the new environment.
- Captive animal populations have limited genetic diversity.
- It is expensive to maintain.
- Animals may not survive reintroduction into the wild.

World Heritage Sites

The sites of various areas or objects inscribed on the United Nations Educational, Scientific, and Cultural Organization (UNESCO) World Heritage List are enlisted as World Heritage Sites. They have an outstanding universal value under the Convention concerning the Protection of the World Cultural and Natural Heritage. This Convention, which was adopted by the UNESCO in 1972 (and enforced in 1975) provides a framework for international cooperation in preserving and protecting cultural treasures and natural areas throughout the world. The first list of World Heritage state was published in 1978. The convention defines the kind of sites which can be considered for inscription of the World heritage list (ancient monuments, museums, biodiversity and geological heritage), and sets out the duties of the State Parties in identifying potential sites and their role in protecting them.

Eco Sensitive Zones

The National Wildlife Action Plan (2002–2016) of Ministry of Environment, Forest and Climate Change (MoEFCC) stipulated that state governments should declare land falling within 10 km of the boundaries of national parks and wildlife sanctuaries as eco fragile

zones or Eco sensitive Zones (ESZ) under the Environmental (Protection) Act, 1986. The purpose of the ESZ was to provide more protection to the parks by acting as a shock absorber or transition zone. Eco-Sensitive Zones would minimise forest depletion and man-animal conflict. The protected areas are based on the core and buffer model of management. The core area has the legal status of being a national park. The buffer area, however, does not have legal status of being a national park and could be a reserved forest, wildlife sanctuary or tiger reserve.

Project Tiger (1973)

Project Tiger is a wildlife conservation movement initiated in India in 1973 to protect the Bengal tiger. During the tiger census of 2006, a new methodology was used extrapolating site-specific densities of tigers, their co-predators and prey derived from camera trap and sign surveys using GIS. Based on the result of these surveys, the total tiger population was estimated at 1,411 individuals ranging from 1,165 to 1,657 adult and sub-adult tigers of more than 1.5 years of age. It was claimed that owing to the project, the number of tigers increased to 2,603–3,346 individuals by 2018. In 2023, the 55th tiger reserve in India was declared in Dholpur-Karauli, Rajasthan, being the State's fifth tiger reserve.

The main objectives of Project Tiger are to:

- To reduce factors that lead to the depletion of tiger habitats and to mitigate them by suitable management. The damages done to the habitat shall be rectified to facilitate the recovery of the ecosystem to the maximum possible extent.

- To ensure a viable tiger population for economic, scientific, cultural, aesthetic and ecological values.

The various tiger reserves were created in the country based on the 'core-buffer' strategy.

CITES (1975)

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) also known as the Washington Convention is a multilateral treaty drafted as a result of a resolution adopted in 1963 at a meeting of members of the International Union for Conservation of Nature (IUCN). It entered into force in 1975. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten the survival of the species in the wild, and it accords varying degrees of protection to more than 35,000 species of animals and plants.

Citizen Movements to conserve Biodiversity:

Chipko Movement

It is a social-ecological movement that practiced the Gandhian methods of satyagraha and nonviolent resistance, through the act of hugging trees to protect them from falling. The modern Chipko movement started in the early 1970s in the Garhwal Himalayas of Uttarakhand, with growing awareness towards rapid deforestation. The landmark event in this struggle took place on March 26, 1974, when a group of peasant women in Reni village, Hemwalghati, in Chamoli district, Uttarakhand, India, acted to prevent the cutting of trees and reclaim their traditional forest rights that were threatened by the contractor system of the state Forest Department. By the 1980s the movement had spread throughout India and led to formulation of people-sensitive forest policies, which put a stop to the open felling of trees in regions as far reaching as Vindhyas and the Western Ghats.

Appiko Movement

Appiko movement was a revolutionary movement based on environmental conservation in India. The Chipko movement in Uttarakhand in the Himalayas inspired the villagers of the district of Karnataka province in southern India to launch a similar movement to save their forests. In September 1983, men, women and children of Salkani 'hugged the trees' in Kalase forest. (The local term for 'hugging' in Kannada is appiko). The movement gave birth to a new awareness all over southern India.

Chapter 4

Environmental Pollution

Pollution is the addition of any substance (solid, liquid, or gas) or any form of energy (such as heat, sound or radioactivity) to the environment at a rate faster than it can be dispersed, diluted, decomposed, recycled, or stored causing adverse change in the natural environment. The major kinds of pollution, usually classified are air pollution, water pollution and land pollution Noise Pollution. Other types of pollution are thermal pollution, light pollution, and radioactive pollution. Pollution of all kinds can have negative effects on the environment and wildlife and often impacts human health and well-being.

Air Pollution

Air pollution may be defined as an atmospheric condition in which certain substances are present in concentrations which can cause undesirable effects on man and his environment The Air (Prevention and Control of Pollution) Act, 1981 has defined "air pollutant" as any solid, liquid or gaseous substance (including noise) present in the atmosphere in such concentration as may be injurious to human beings or other living creatures or plants or property or environment.

Basically there are two sources of air pollution.

1. Natural sources: Natural sources of pollution are those that are caused due to natural phenomena. e.g. Volcanic eruptions, Forest fires, Biological decay, Pollen grains, Marshes, Radioactive materials.
2. Artificial sources are those which are created by man. e.g.: Thermal

power plants, Vehicular emissions, Fossil fuel burning, agricultural activities etc.

Another classification is based on the form of pollutants present in the environment, they are classified as: 1. Primary pollutants are those that are directly emitted in the atmosphere in the harmful form e.g.: CO, NO, CO_2, SO_2 etc. 2.Secondary pollutants are those that are formed by reacting with other components or some basic component of the atmosphere to form new pollutants. e.g.: Oxides of Nitrogen (NO_2 or NO_3) react with moisture in the atmosphere to give Nitric acid. The air pollution inside buildings, offices, and houses is called indoor air pollution. Indoor air pollutants are primary air pollutants. Sources of indoor air pollutants are: Radon gas is emitted from building materials like bricks, concrete, tiles, etc. Radon is also found in natural gas and ground water and is emitted while being used. Burning fuel in the kitchen and cigarette smoke release pollutants like CO, SO_2, HCHO (Formaldehyde) and BAP (Benzo-(A) pyrene).

Harmful effects of air pollution

Effects on Human Health

Sulphur oxides causes irritation of eyes, nose, throat; Damage to lungs, Acute and Chronic Asthma, Bronchitis and Emphysema

Nitrogen oxides causes chronic obstructive pulmonary diseases, infant and cardiovascular diseases. Carbon monoxide induces headaches, dizziness, loss of vision, decreased muscular coordination and severe effects on the baby of a pregnant woman. Photochemical smog causes respiratory problems and irritation to eyes. Volatile organic compounds (VOCs) cause tiredness, drowsiness, bone marrow disease, Skin cancers, leukemia, cardiovascular disease.

Dust particles induces stuffy noses, sinusitis, sore throats, dry cough, burning eyes, chest pain, Lead damages the brain and central nervous

system, kidneys and brain. Mercury brings nervous disorders, insomnia, memory loss, excitability, irritation, tumor and minamata disease

Effects on Plants: Air pollutants affect plants by entering through stomata and destroy chlorophyll. Damages the leaf structure and causes necrosis (dead areas of leaf), loss of chlorophyll content causing yellowing of leafs (Chlorosis) or down ward curling of leaf (epinasty) and dropping of leaves (abscission). PAN (Peroxyacetyl nitrate) causes silvering of lower surface of leaf, damage to young and more sensitive leaves and suppressed growth Atmospheric ozone causes flecks on leaf surface, premature ageing, necrosis and bleaching.

Global Warming- It is the rise in the average temperature of the earth's climatic condition; it occurs when CO_2 and other pollutants in the air including greenhouse gases accumulate in the atmosphere and absorb sunlight and radiations to cause heating up.

Acid Rain- It is the rain or precipitation that is acidic unusually because of increased levels of hydrogen ions. It is a result of sulfur dioxide and nitrogen oxides that react with water molecules to produce acids in the atmosphere. It is harmful to plants, animals, and infrastructure.

Depletion of Ozone- When disrupting gases like CFC and halons in the air cause chemical reactions to break down ozone molecules, depletion of ozone takes place. Ozone plays an important role in absorbing ultraviolet rays.

Hazards to Wildlife- When the air is contaminated, it is obvious to affect lives including wildlife that has to inhale pollutants and risk their lives in danger.

Control measures of Air pollution: Following are the measures one should adopt to control air pollution:

- Prefer public modes of transport to travel from one place to another. This not only prevents pollution, but also conserves energy.
- A large number of fossil fuels are burnt to generate electricity. Therefore, do not forget to switch off the electrical appliances when not in use. Use of energy-efficient devices such as CFLs also controls pollution to a greater level.
- Fuel substitution is another way of controlling air pollution. In many parts of India, petrol and diesel are being replaced by CNG (Compressed Natural Gas fueled vehicles). Process control equipment to control the pollution.
- The use of solar, wind and geothermal energies reduce air pollution at a larger level. Various countries, including India, have implemented the use of these resources as a step towards a cleaner environment
- Since industrial emissions are one of the major causes of air pollution, the pollutants can be controlled or treated at the source itself to reduce its effects
- Plants and trees reduce a large number of pollutants in the air. Ideally, planting trees in areas of high pollution levels will be extremely effective.

Water Pollution

Earth has 75% of water. It is a universal solvent and 70 percent of the human body is made up of water. It is the only substance that exists in all 3 forms of matter on this planet. Today, the United Nations have recognized water as a basic human right, besides considering it as an economic commodity. Water pollution is one of the types of environmental pollution that has harmful effects widely. It is caused when water bodies like rivers, seas, and lakes get polluted with toxic

matter at the extreme levels of pollutants (hazards) so that it is no longer suitable for regular human usages such as bathing, cooking or drinking.

Sources of Water Pollution

There are many sources of water pollution. The surface water get contaminated by seepage of harmful chemicals from the surface either by 'point' source pollution, which means that the source of the pollution originates from a specific place and by 'nonpoint' source pollution as contamination from diffuse options. Common causatives for water pollution include are as follows :

Industrial Waste: Many regular industrial activities release enormous amount use this contaminated product for regular purposes. It also affects the biodiversity of the water bodys of toxic chemicals such as lead and mercury. They spread to other living species when humans
Sewage and Waste: Tonnes of sewage waste is dumped into water bodies. This not only causes pollution but also releases dangerous disease-causing pathogens.
Mining: Mining in today's generation is key to the major lake and river pollution. This process brings out harmful chemicals that are buried deep under the earth's surface. When this comes in contact with water, the effects are dangerous to any living creature.
Marine Dumping: The garbage generated every day is dumped into the seas and oceans going as far as to give rise to garbage islands. An easy step of throwing waste products only in the bin can reduce more than half of the water pollution levels.
Agricultural Activities: The use of chemical fertilizers, pesticides, and other runoffs during irrigation flows into the water bodies. These chemicals cause pollution to water bodies in a short span of time.
Radioactive Wastes: After usage of radioactive materials for nuclear wagons or as an energy source, they are mostly dumped into water

bodies or in glaciers that will immediately mix with water when the temperature rises.

Urbanization and Population Growth: Cities are unable to meet the water demand of their growing population. This has caused contamination and loss of water due to overuse.

Adverse Effects of Water Pollution

Disruption of aquatic life is the primary effect of water pollution. Polluted water contains many disease-causing elements such as bacteria and viruses which trigger other harmful diseases, namely cholera, giardia, and typhoid. It can even lead to chronic conditions, including hormonal imbalances, hepatitis, altered brain function to cancer. Swimming in polluted water is a high risk as it can cause skin and eye allergies.

The environment is also disturbed as it slowly kills animals and plants' life that is dependent on them for nourishment. It also supports the growth of harmful organisms that destroy the biodiversity of the water body. Certain algae growth reduces the level of oxygen in the water, killing everything in it. In some areas, pollution is so severe that it causes "dead zones" where there is no life.

The 1932's Minamata Incident is the worst record case in the history of water pollution. Methylmercury and its effluents started to flow from a factory in Japan. Methylmercury is one of the key sources of causing neurological disorders in human beings.

The 6th most polluted river in the world is India's Ganges (Ganga). Cremating dead bodies of humans along with other religious practices, quickly developed water contaminated into the river. This river is also the major cause of cholera and typhoid.

Even the fauna of this river has been adversely affected, and notable ones include the Ganges River Dolphin and Ganges River Shark. Nearly 1000 children die each year due to water pollution in India. Currently, there are a few steps taken to drive away from this level and address these issues properly.

Control Measures of Water Pollution

Prevention and control of water pollution could be done in so many ways. Some important points are summarized below.

- Industries should treat their wastes carefully before disposing of chemicals and other materials into water bodies directly. Sewage treatment plants and wastewater treatment plants in industries are established to treat the water used so it can be safely mixed into the river streams. It also enables water recycling.
- Using natural fertilizers and pesticides as substitutes for chemical ones is good for plants and water.
- 'Water Hyacinth', a plant that absorbs dissolved toxic substances like cadmium and mercury from water bodies, thus actively removing pollutants from water.
- Chemical processes such as coagulation, ion exchange method, reverse osmosis, etc. will greatly reduce the level of water pollution.
- Lastly, it is better to reduce the consumption of water in our daily activities and reuse water c

Noise Pollution

The word noise is derived from the Latin word 'Nausea', which means sickness in which one feels the need to vomit. Noise is the unpleasant and undesirable sound which leads to discomfort in human beings. **The intensity of sound is measured in decibels (dB)**. The faintest sound that the human ear can hear is 1 Db. Due to increasing noise around the civilizations, noise pollution has become a matter of concern. Some of its major causes are vehicles, aircraft, industrial machines,

loudspeakers, crackers, etc. When used at high volume, some other appliances also contribute to noise pollution, like television, transistor, radio, etc.

Types of Noise Pollution

Following are the three types of pollution:

- Transport Noise
- Neighbourhood Noise
- Industrial Noise

Effects of Noise Pollution on Human Health

Noise pollution can be hazardous to human health in the following ways:

- **Hypertension:** It is a direct result of noise pollution which is caused due to elevated blood levels for a longer duration.
- **Hearing loss:** Constant exposure of human ears to loud noise that are beyond the range of sound that human ears can withstand damages the eardrums, resulting in loss of hearing.
- **Sleeping disorders:** Lack of sleep might result in fatigue and low energy level throughout the day affecting everyday activities. Noise pollution hampers the sleep cycles leading to irritation and an uncomfortable state of mind.
- **Cardiovascular issues:** Heart-related problems such as blood pressure level, stress and cardiovascular diseases might come up in a normal person and a person suffering from any of these diseases might feel a sudden shoot up in the level.

Prevention of Noise Pollution

Some noise pollution preventive measures are as follow

- Honking in public places like teaching institutes, hospitals, etc. should be banned.

- In commercial, hospital, and industrial buildings, adequate soundproof systems should be installed.
- Musical instruments' sound should be controlled to desirable limits.
- Dense tree cover is useful in noise pollution prevention.
- Explosives should not be used in forest, mountainous and mining areas.

Land pollution/Soil Pollution

Land pollution refers to the deterioration of the earth's land surfaces at and below ground level. It is caused by the accumulation of solid and liquid waste materials that contaminate groundwater and soil. These waste materials are often referred to as municipal solid waste (MSW), which includes both hazardous and non-hazardous waste. As different waste materials and pollutants like heavy metals, pesticides, plastic, litter and pharmaceuticals sit on top of and leach into our soil, they change and degrade its natural composition. Over time, some pollutants can also go through a chemical transformation, creating secondary pollutants like fumaric and phthalic acids.

The permeability of the soil formations below the waste can increase or reduce the risk of land pollution. The higher the permeability of the soil, the more likely that land pollution will occur. Extreme weather events like hurricanes and floods can exacerbate the effects of land pollution as they disperse or concentrate certain pollutants.

Causes of Land Pollution

While there are many causes of land pollution, the main contributors include litter, waste, urbanization, construction, mining, extraction and agriculture. Let's dive into how these different issues lead to increased land pollution.

1. Litter and Waste**:** Littering, the improper disposal of waste products, is unfortunately common. Illegal dumping also contributes to land pollution. Oftentimes people will dump waste illegally in places such as forests, open fields and ditches rather than in approved dumping areas. Common types of illegally dumped waste include asbestos waste, cars and waste that can be recycled or reused. All litter, When not managed properly, waste can also contribute to land pollution.

2. Urbanization and Construction: Large quantities of people living close together, producing trash and littering in a dense area does inevitably lead to land pollution. To accommodate our increasing population, construction activities also occur, which result in large waste materials, such as metal, plastic, wood and bricks.

3. Mining and Extraction: Mining is the extraction of minerals and other geological materials from the ground, which are then used for a wide range of purposes. This extraction and the methods used, however, deplete the earth of its natural resources and cause damage and land pollution in its wake.

4. Agriculture

Agriculture is foundational for both everyday life,. Agricultural pollution occurs when contamination created as a by-product of raising livestock and growing food crops is released into the environment and the contamination is vast. Major contributors to agricultural-related land pollution include run-off from pesticides, herbicides, fertilizer and animal waste.

Unsustainable farming practices such as intensive cultivation and overgrazing can also strip the land of its natural nutrients, leaving it no longer viable for future crops unless it is restored.

Effects of Land Pollution

Land pollution touches essentially every area of the living world, including:

- Contamination of drinking water
- Polluted soil, which leads to a loss of fertile land for agriculture and a reduction in the availability of food
- Climate change, which causes an onslaught of disastrous problems, including flash floods and irregular rainfalls
- The endangerment and extinction of species in wildlife
- Habitat destruction, where animals and plants wiped out in certain areas
- Habitat shifting, where animals are forced to flee where they live in order to survive
- An increase in wildfires due to polluted areas often becoming very dry
- Increased air pollution, which burning waste contributes to
- Increased soil pollutants can enter the body through the food chain and cause health issues
- Increased human health issues, including cancer, respiratory illnesses and congenital disabilities, caused by exposure to harmful chemicals

Preventive measures of Land Pollution

Following preventive measures can reduce the impact of land pollution but it will require efforts on multiple fronts.

Sustainable Agricultural Practices

The use of pesticides and chemicals in farming and agriculture greatly contributes to land pollution, finding alternatives will help to reduce the environmental impact.

Reforestation

Reforestation involves replanting an area with tree.This process helps to bind the soil, which helps to protect it from land pollution and prevents soil erosion and flooding.

Solid Waste Treatments

When solid waste is not properly treated it can increase the level of toxic chemicals and hazardous substances in soil. Chemical treatment methods under a controlled environment can help reduce land pollution. Solid waste treatment method includes neutralization, which alters the pH level of waste before it gets dumped into landfills.

Reduce, Reuse and Recycle

At the individual level our contribution to lessen land pollution that to reduce, reuse or recycle items. By doing this we aren't creating waste out of a material or item that still has a purpose.

Composting

Another way to reduce land pollution is through composting. According to the United States Environmental Protection Agency, food scraps and yard waste together currently make up more than 30% of what we throw away and could be composted instead

Radioactive Pollution / Radioactive Contamination

Radioactive contamination is defined as the deposition or introduction of radioactive substances into the environment, where their presence is unintended, or the levels of radioactivity are undesirable. Such type of pollution is harmful to life due to the emission of ionizing radiation. This type of radiation is potent enough to cause damage to tissues and DNA in genes.

Sources of radioactivity:
Natural radioactivity occurs naturally in our environment. Some radioactive elements such as uranium and thorium are present in rocks and soil, albeit in trace quantities. Interestingly, humans and all other living organisms contain nuclides such as carbon-14, which are created by cosmic rays.

Man-made radioactivity is the result of nuclear weapon discharge or a nuclear reactor containment breach. In such scenarios, all living organisms in the vicinity of the nuclear event will become contaminated by fission products and remnants of nuclear fuel. This can be in the form of radioactive dust or even particles that are found on various surfaces

One of the most infamous cases that resulted in radioactive pollution was the Chernobyl disaster. Other examples include Fukushima Daiichi Nuclear Disaster Nuclear fallout after atmospheric nuclear explosions).

Some preventive measures to mitigate radiation pollution are:
Proper disposal of radioactive wastes, proper labeling of contents, banning nuclear tests, and using alternative eco-friendly sources of energy.

How Individual can Help in Prevention of Pollution?
In order to tackle the menace of pollution, urgent steps have to be taken not only at global or country level, but also at local level. In fact, the role of individuals in prevention of pollution is of critical importance, because it is the individuals that make a community or country. It has been aptly said “charity begins at home”. Aware and inspired individuals are strongest tool to tackle pollution. It is better and more viable to prevent pollution by educating individuals than

controlling pollution. Individuals should encourage to modify their lifestyle and living habits if that are not healthy for environment

- Individuals should minimize wastage of resources such as electricity. Every unit of electricity saved is equivalent unit of electricity produced as it not only saves the fuel that would be used to produce that electricity, but also help to prevent pollution that is accompanied by burning of that fuel. Therefore, person should always switch off appliances when not in use.
- Individuals should prefer walking or use cycles instead of using motor vehicles, especially when distances to be travelled are small.
- Individuals can make considerable contribution by using mass transport (buses, trains, etc) instead of using personal vehicles.When going to workplace, colleagues from nearby localities should pool vehicles instead of going in individual personal vehicles.Taking personal vehicles for periodic pollution checks at centres approved by authorities.
- Individuals should reuse items whenever possible.
- Products that are made of recycled material should be given preference.
- Use gunny bags made of jute instead of plastic bags.
- Take part in environment conservation drives such as tree planting drives.
- Use water resources efficiently.
- Use renewable resources by installing equipment such as solar heaters and using solar cookers.
- Dispose potentially harmful products such as cells, batteries, pesticide containers, etc properly.
- Use of refrigerators should be minimised wherever possible as they are main source of CFC, which is responsible for Ozone layer depletion.

- Follow and promote family planning, as more population means more resources utilized and more resources utilized imply more pollution.
- Avoid making noise producing activities such as listening to loud music.
- Use handkerchiefs instead of paper tissues.
- Organize drives to clean streets and clean drains with help of other people of locality.
- Spread awareness and inspire other people to prevent pollution. Individuals should be encouraged to acquire information and innovations from world over and implement them locally.

Chapter 5
Unsustainable to Sustainable Development

Human Population Growth

A population is the complete set group of individuals, whether that group comprises a nation or a group of people with a common characteristic. Population study is done by sample which is a random selection of members of a population. It is a smaller group drawn from the population that has the characteristics of the entire population. There are several ways to obtain samples (known as sampling) from a population. These include a simple random sample, stratified sampling, representative sampling, and convenience sampling. Researchers and analysts employ a range of statistical techniques to infer information about the broader population using just the smaller sample chosen. The observations and conclusions made against the sample data are attributed to the population as a whole. The information obtained from the statistical sample allows statisticians to develop hypotheses about the larger population. In statistical equations, the population is usually denoted with an uppercase *N* while the sample is usually denoted with a lowercase *n.*

Population growth and overpopulation

The world's population reached 8 billion people on 15 November 2022. It took 12 years the global population to grow from 7 to 8 billion while it will take approximately 15 years until 2037 to reach 9 billion, a sign that the overall growth rate of the global population is slowing. Yet levels of fertility remain high in some countries. Countries with the highest fertility levels tend to be those with the lowest income per capita. Global population growth has therefore over time become

increasingly concentrated among the world's poorest countries, most of which are in sub-Saharan Africa.

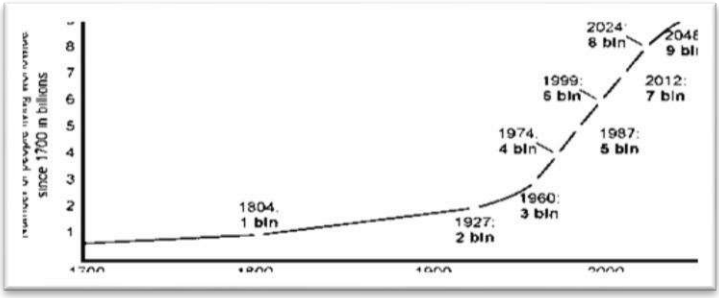

Fig 5.1 Population growth over three centauries

According to UN estimates, India is the most populous country in the world with one-sixth of the world's population. India's population now stands at slightly over 1.428 billion edging past China's population of 1.425 billion people.

Fig 5.1 depicts that the earth's population in 1800 was 1 billion, having taken all of human history to reach that mark. Only 2 centuries later, the global population is 6 billion, half of which lives in cities. The impact that this population explosion has had on the environment has been just as striking, as seen by changes in greenhouse gas emissions, rates of soil erosion, and the extinction of species. Nature reserves currently comprise about 10% of land area globally, but most are small, disconnected from other reserves, and subject to tremendous human pressures. Population size is clearly an important factor in measuring environmental Impact.

Demographic growth is not equally distributed around the globe. In the first half of the 19th centuary human numbers were growing rapidly in most developing countries such as India and China. In some African countries the growth was also significant. In contrast, in the developed

world population growth had slowed down. The population explosion first occurred on a small scale and with a relatively moderate intensity in Europe and America, more or less between 1750 and 1950. From 1950 on, a much more substantial and intensive population explosion started to take place in Asia, Latin America and Africa. Asia already represented over 55% of the world population in 1950 with its 1.4 billion citizens and by the year 2010 this had increased to 4.2 billion people or 60%. Of those people, more than 1.3 billion live in China and 1.2 billion in India, together accounting for more than one third of the world population.

Though population growth shows a general global decline, there are variations in the rate of decline in different countries. By the 1990s the growth rate was decreasing in most countries such as China and India. The decline in the 90s was greatest in India. However, fertility continues to remain high in sub Saharan African countries. There are cultural, economic, political and demographic reasons that explain the differences in the rate of population control in different countries. It also varies in different parts of certain countries and is linked with community and/ or religious thinking. Lack of Government initiatives for Family Welfare Program and a limited access to a full range of contraceptive measures are serious impediments to limiting population growth in several countries.

The growth of the world population goes hand in hand with global urbanization. In 1950 less than 30% of people lived in the cities, this proportion has increased to more than 50%. It is expected that this proportion will continue to grow to two thirds around 2050. Latin America is the most urbanised continent (84%), closely followed by North America (82%) and at a distance by Europe (73%).

Overpopulation in India: India is the world's most populous country, with over 1.3 billion people. It overtakes China to become the world's most populated country. Overpopulation is a major problem in India, as the country's population is growing at an unsustainable rate. The population is expected to exceed 1.5 billion by 2030, and 2 billion by 2050. This rapid growth is putting immense pressure on India's resources, and is contributing to environmental degradation, poverty, and social unrest. The government has taken some steps to address the problem, but much more needs to be done.

Causes of Over Population: The common causes leading to over population are:

- The birth rate is still higher than the death rate. We have been successful in declining the death rates due to improved medical facilities but the same cannot be said for birth rates.
- The fertility rate due to the population policies and other measures has been falling. It is even higher in the developing countries then in developed countries.

The above two causes are interrelated to the various social issues in our country which are leading to over population.

- **Early Marriage and Universal Marriage System:** Even though the marriageable age of a girl is legally 18 years, the concept of early marriage still prevails. Getting married at a young age prolongs the child bearing age. Countries such as in India, marriage is a sacred obligation and a universal practice, where almost every woman is married at the reproductive age.
- **Poverty and Illiteracy:** Another factor for the rapid growth of population is poverty. Impoverished families have this notion that more the number of members in the family, more will be the numbers to earn income. Some feel that more children are needed to look after them in their old age. Also hunger can be cause of death of their children and hence the need for more children.

- **Problem of mind-set**: Generally, illiterate and uneducated children inherit their father's behaviour and choose to give birth to as many children as is necessary to increase the income of their family. As a son is supposed to be the bread earner of the family, the poor do not mind producing any number of girl children in their desire to be ultimately blessed by a male child.
- **Immigration:** Immigration continuously increased the population density of the particular area.

Impacts of Over Population:

Some major impacts of high population are as follows:

- **Unemployment:** Generating employment for a huge population in a country like India is very difficult. The number of illiterate persons increases every year. Unemployment rate is thus showing an increasing trend.
- **Manpower utilization:** The number of jobless people is on the rise in India due to economic depression and slow business development and expansion activities.
- **Pressure on infrastructure:** Development of infrastructural facilities is unfortunately not keeping pace with the growth of population. The result is lack of transportation, communication, housing, education, healthcare etc. There has been an increase in the number of slums, overcrowded houses, traffic congestion etc.
- **Resource utilization:** Land areas, water resources, forests are over exploited. There is also scarcity of resources.
- **Decreased production and increased costs:** Food production and distribution have not been able to catch up with the increasing population and hence the costs of production have increased. Inflation is the major consequence of over population.
- **Inequitable income distribution:** In the face of an increasing population, an unequal distribution of income and inequalities within the country widen.

• **Migration of Population:** Migration is a natural human trait. When the burden of population in any area becomes imbalanced compared to the available financial resources, people tend to move away from their original location.

Food and nutrition problems; housing problems; starvation and famine; infectious diseases and epidemics; increasing population pressure on the cities and development of slums; heavy burden on most resources; decrease in agricultural areas; continuous destruction of forests; threat to environment including wildlife; political instability, war, social evils and corruption, etc. are some other overpopulation related issues.

Preventive measures of Overpopulation

Preventing the rapid growth of the population is the key to the victory over poverty, illiteracy, unemployment, economic backwardness, etc in the modern world.

• **Family Planning:** For a good, prosperous nation, it is necessary that its residents are healthy and their numbers are in sync with the country's wealth. For this, modern methods and measures of family planning should be adopted. They should be propagated in a proper manner by the government, NGOs and civil society.

• **Increase in marriage age:** Minimum age of marriage of boys and girls should be increased. The age of marriage in India has been fixed for girls at 18 years and for boys at 21 years. It should be complied with firmly in all the states.

• **Balanced ratio:** It is also necessary to make qualitative improvement in the population. The gap between the children should be at least five years and the number of offspring should not exceed two children per family.

• **Improvement in public health services**: It is necessary to pay attention to public health and cleanliness to increase man's economic

capacity. In each state, emphasis should be on pollution-free and clean environment in urban and rural areas.

- **Proper utilization of land:** To reduce the burden of the growing population, what is required is the scientific and proper planning of the land. To achieve this aim, it is necessary to emphasize on certain parameters: In the interest of the nation, small areas of land should also be used to their optimum limit.

Impact of Human population on the environment

There are many ways in which our large and growing human population impacts the global environment. Using resources faster than natural processes can replenish them is just part of the issue. Over the past 50 years, humans have altered ecosystems more rapidly and extensively than in any other comparable period in history, primarily to meet the rapidly growing demands for food, freshwater, timber, fiber, and fuel.

Climate Change: Our global temperature is on the rise due to the ever-increasing amount of greenhouse gases that are emitted through human activities, including fossil fuel use, deforestation, and livestock grazing. This warming is causing sea-level rise from Arctic ice melt, more extreme weather, and loss of habitat, including coral reefs. Population growth only exacerbates climate change, as more people demand more food and energy. With renewable energy supplying only a small fraction of total energy use, fossil fuel use is expected to expand for the foreseeable future.

Water Scarcity: About 35 percent of the world's people already face chronic water shortages. As the population grows, we need more water for agriculture and industry, as well as for domestic uses. A child born in the developed world consumes 30-50 times as much water as one born in the developing world. The worldwide supply of clean,

accessible water is further reduced by pollution. In 2017, over 785 million people lacked access to basic water and sanitation services and over 884 million people did not have safe water to drink (CDC).

Biodiversity Loss: Nearly all the world's ecosystems are shrinking to make way for more humans and their homes, farms, factories, and shopping centers. Globally, 13 million hectares of forest (about the size of Costa Rica) were lost each year from 2000 to 2010, as much of it was cleared or degraded by human activities. Forests play an important part in climate change mitigation. Forests store a vast amount of carbon. When we cut down a forest to convert it for another use, we release carbon back into the atmosphere. The World Wildlife Fund's Living Planet Index shows a 30 percent decline in Earth's biodiversity since 1970; a 60 percent decline in the tropics. According to the World Conservation Union, 1 in 3 amphibians, 1 in 4 mammals, 1 in 8 seabirds, and 70 percent of plants are at risk of extinction due primarily to human alteration of their habitats.8 Humans depend on rich biodiversity for survival—food, medicines, climate regulation, and more.

Sustainable development

Sustainable development is an organizing principle that aims to meet human development goals by enabling natural systems to provide necessary natural resources and ecosystem services to humans. Sustainable development tries to find a balance between economic development, environmental protection and social well-being.

The Brundtland Report in 1987 defined "sustainable development as development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs".

The United Nations created 17 world development goals called the **Sustainable Development Goals** (**SDGs**). They were created in 2016 with the aim of "peace and prosperity for people and the planet, now and into the future. The short titles of the 17 SDGs are: No poverty (SDG 1), Zero hunger (SDG 2), Good health and well-being (SDG 3), Quality education (SDG 4), Gender equality (SDG 5), Clean water and sanitation (SDG 6), Affordable and clean energy (SDG 7), Decent work and economic growth (SDG 8), Industry, innovation and infrastructure (SDG 9), Reduced inequalities (SDG 10), Sustainable cities and communities (SDG 11), Responsible consumption and production (SDG 12), Climate action (SDG 13), Life below water (SDG 14), Life on land (SDG 15), Peace, justice, and strong institutions (SDG 16), and Partnerships for the goals (SDG 17).

Sustainable development goal in India

India has committed to the United Nations Sustainable Development Goals (SDGs), which are a universal call to action to end poverty, protect the planet, and ensure that all people enjoy peace and prosperity by 2030. The SDGs consist of 17 goals, which include areas such as poverty alleviation, education, gender equality, clean water and sanitation, affordable and clean energy, and climate action, among others. India's approach to the SDGs is critical given its large population, economic diversity, and status as one of the world's fastest-growing major economies. Here are some key points regarding India's engagement with the SDGs:

Government Initiatives and Policies

The Government of India has entrusted the National Institution for Transforming India (NITI) Aayog with the task of coordinating and overseeing the implementation of the SDGs at the national and sub-national levels. NITI Aayog works in partnership with state governments, local authorities, and other stakeholders. India has

presented its progress on SDGs at the United Nations High-Level Political Forum (HLPF) through the Voluntary National Review process, showcasing its efforts and challenges in implementing the SDGs.

Major area of Focus

Poverty and Hunger (SDGs 1 & 2): Initiatives like the Pradhan Mantri Jan Dhan Yojana (PMJDY) for financial inclusion, and the Public Distribution System (PDS) for food security are examples of India's efforts to address poverty and hunger.

Health and Well-being (SDG 3): The Ayushman Bharat program aims to provide health insurance to economically vulnerable families, and the Swachh Bharat Mission focuses on improving sanitation and hygiene.

Quality Education (SDG 4): The Sarva Shiksha Abhiyan (SSA) and the Right to Education Act aim to provide universal access to quality elementary education.

Gender Equality (SDG 5): The Beti Bachao Beti Padhao (BBBP) scheme aims to address gender bias and improve the education and welfare of girls.

Clean Water and Sanitation (SDG 6): The Jal Jeevan Mission aims to provide safe and adequate drinking water through individual household tap connections by 2024.

Affordable and Clean Energy (SDG 7): The International Solar Alliance (ISA), initiated by India, aims to promote solar energy globally, especially in solar resource-rich countries.

Economic Growth and Decent Work (SDG 8): The Make in India initiative aims to boost manufacturing, promote skill development, and create job opportunities.

Climate Action (SDG 13): The National Action Plan on Climate Change (NAPCC) outlines policies and programs to address climate change and its impacts.

While India has made significant progress in some areas, challenges

remain, including disparities between urban and rural areas, gender inequality, environmental degradation, and the impacts of climate change. Additionally, the COVID-19 pandemic has posed new challenges .

Circular Economy

A circular economy is a systemic approach to economic development designed to benefit businesses, society, and the environment. In contrast to the traditional linear economy, which has a 'take, make, dispose' model of production, a circular economy is regenerative by design and aims to gradually decouple growth from the consumption of finite resources. The circular economy model is underpinned by the principles of designing out waste and pollution, keeping products and materials in use, and regenerating natural systems.

Implementing a circular economy requires collaboration across all levels of society, including governments, businesses, and consumers. Governments can create regulatory frameworks and incentives to encourage circular practices. Businesses can redesign their products and business models to align with circular principles. Consumers can support the circular economy by choosing sustainable products and participating in sharing and recycling schemes.

Concept of circular economy and entrepreneurship

The concept of a circular economy offers a transformative approach to entrepreneurship and business innovation, reshaping traditional linear models of 'take, make, dispose' into more sustainable, regenerative, and profitable practices. Circular economy entrepreneurship involves creating businesses that are not only economically viable but also reduce waste, minimize resource consumption, and improve the sustainability of products and services throughout their lifecycle. This approach is increasingly seen as a critical pathway for achieving

economic growth while addressing pressing environmental challenges and promoting social well-being.

Key Aspects of Circular Economy Entrepreneurship

Innovation in Product Design and Business Models: Entrepreneurs in a circular economy innovate by designing products that are durable, repairable, and recyclable, and by developing business models that promote product-as-a-service, sharing, and leasing. This shifts the focus from selling as many products as possible to providing value through services and product longevity.

Value Creation from Waste: Circular entrepreneurs see waste as a resource. By finding new uses for by-products and transforming waste into new materials or products, businesses can create additional revenue streams while reducing environmental impacts.

Collaboration Across the Value Chain: Successful circular economy ventures often involve collaboration with suppliers, customers, waste management companies, and even competitors to create closed-loop systems where materials are continuously cycled through the economy.

Leveraging Technology for Circular Solutions: Technology plays a crucial role in enabling circular economy entrepreneurship. Digital platforms, the Internet of Things (IoT), blockchain, and material science innovations are among the technologies that facilitate product tracking, sharing, and the efficient use of resources.

Chapter 6
Social Issues and the Environment

Our large and growing human population impacts the global environmental changes such as pollution, climate change, biodiversity loss, and freshwater decline which affect people worldwide, with impacts that are not just physical, but also social and economic. Consequences of global changes affect family and community stability, social relationships health and sometimes survival.

Water conservation

We are facing a shortage of the resource. Water conservation is a process of saving water for future utilization.Climate change and cutting of trees and forests (deforestation) are some of the reasons behind this scarcity. An increase in population has increased the water demands and thus the usage of water by people. Increase in pollution in the water bodies through various human activities like industrialization. Following are some strategies of water conservation

- Reducing evaporation losses : can place asphalt below the soil surface
- Reducing irrigation losses : sprinkling, drip irrigation, irrigation in early Morning / later evening reduces evaporation
- Re use of water : treated waste water from washings, bathrooms can be used for gardening
- Preventing of wastage of water : closing taps when not is use, repairing leakage, using small capacity taps etc
- Decreasing run-off losses : Can be done by using contour cultivation or terrace farming
- Avoid discharge of sewage.: discharge of sewage into water resources should be prevented

Water conservation method

Basically there are two methods of water conservation

1. Rain water harvesting
2. Watershed management

Rain water harvesting

Rainwater harvesting is the simple process or technology used to conserve rainwater by collecting, storing, conveying and purifying of rainwater that runs off from rooftops, parks, roads, open grounds, etc. for later use. It the best methods practised and followed to support the conservation of water. Today, scarcity of good quality water has become a significant cause of concern. Rainwater, which is pure and of good quality, can be used for irrigation, washing, cleaning, bathing, cooking ,etc.

The process of rainwater harvesting involves the collection and the storage of rainwater with the help of artificially designed systems that run off naturally or man-made catchment areas like- the rooftop, compounds, rock surface, hill slopes, artificially repaired impervious or semi-pervious land surface.

Advantages of Rainwater Harvesting

It has less cost. It helps in reducing the water bill and the need for imported water. Promotes both water and energy conservation. It improves the quality and quantity of ground water. Such water does not require filtration system for landscape irrigation. Rain water technology is relatively simple,
easy to install and operate. It reduces soil erosion, storm water runoff, flooding, and pollution of surface water with fertilizers, pesticides, metals and other sediments. It is an excellent source of water for landscape irrigation with no chemicals, dissolved salts and free from all minerals.

Watershed management:

It is defined as land area bounded by divide line from which water drains under influence of gravity in to stream, lakes, reservoir. *e.g.* Pits, dams, Farm, ponds etc , The management of rainfall & resultant runoff. To minimize of risk of floods & for improving the economy for developmental activities, generate huge employment opportunity, promote forestry & to protect soil from erosion**.**

Advantages of Watershed projects-

Improved access to drinking water in project areas during drought- Increase in cultivation area leading to increase in employment- Increase in crop yield, resulting better income to rural population- Improved availability of fodder for animals and increase in milk yield Increase in employment & involvement of women- Increase in net returns from all crops Decrease in soil erosion. Restoration of ecological balance.

Green House Effect and Global Warming:

Over the last century, the level of carbon dioxide in the atmosphere has increase by 25%, the level of nitrous oxide by 19% and the level of methane by 100%. These 3 major global warming gases are released into the atmosphere by burning of fossil fuels, industrialization, mining, deforestation, exhaust from increasing automobiles and other anthropogenic activities. The progressive warming of earth surface due to blanketing effect of man made CO2 in the atmosphere is green house effect. Green house gases - causing global warming are CO_2, CH_4, N_2O, CFCs. CO_2 is the most important green house gas. Human activities increase the green house effect & raise the atmospheric temperature & this is called global warming.

Effect on global warming

- Glacial melting & thermal expansion of ocean raise the sea level

- Climatic pattern shifts, rainfall is reduced, soils are dried, result in drought, less crop production
- Rainfall pattern change, Drought & Floods will become common. Rise in temperature will increases water demand
- Animals & plants will have problems in adapting. They will be in Risk of extinction
- As earth become warmer, floods & droughts become frequent.
- This increase waterborne disease, infectious diseases caused by mosquitoes.

Preventive Measures of Global Warming:

- Reducing CO2 emission by reducing use of fossil fuels
- Utilizing renewable resources like wind, solar, hydro power etc.
- Plant more trees
- Adopt sustainable agriculture.
- Use natural gas instead of coal
- Stabilize population growth
- Remove CO2 by photosynthetic algae.

Climate change

Climate change is the rise in average surface temperatures on Earth, mostly due to the burning of fossil fuels. Climate change, also called global warming, refers to the rise in average surface temperatures on Earth. An overwhelming scientific consensus maintains that climate change is due primarily to the human use of fossil fuels, which releases carbon dioxide and other greenhouse gases into the air. The gases trap heat within the atmosphere, which can have a range of effects on ecosystems, including rising sea levels, severe weather events, and droughts that render landscapes more susceptible to wildfires.

Kyoto Protocol

1997, Kyoto, Japan developed countries agreed to specific targets for cutting their emissions of greenhouse gases Industrialized countries committed to an overall reduction of emissions of greenhouse gases to 5.2% below 1990 levels for the period 2008 - 2012 Objective is the stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system

Acid Rain

Normal rain is slightly acidic due to CO_2 gas. The pH of the rain water is further acidic due to SO_2 & NO_2 gases. This type of precipitation of water is called acid rain. Thermal power plants, industries, & vehicles release nitrous oxide & sulphur dioxide into atmosphere When these gases react with water vapour they form acids

$SOx + H2O \rightarrow H2SO4$

$NOx + H2O \rightarrow HNO3$

On Human beings Adversely affects nervous, respiratory and digestive system Causes premature death from heart and lung disorders like asthma & bronchitis.

On Buildings Taj Mahal in Agra suffer due to H2SO4 acid fumes released from Mathura refinery. ,British Parliament building suffered due to H2SO4 rain Acid rain reduce the value of building, bridges, cultural objects etc. This increases the maintenance cost.

On terrestrial and Lake Ecosystem

By Clean combustion technologies
Using pollution control equipments
Replacement of coal by natural gas
Liming of lakes and soils.

Coal with lower sulphur content can be used
Emission of SO2 & NO2 from industries can be reduced

Ozone layer depletion

Ozone is an important chemical species present in the stratosphere. Its concentration is about 10ppm. It acts as a protective shield for the life on the earth. It protects us from the Ultraviolet radiation of the sun. Ozone is produced and also broken down by photochemical reactions, thus maintaining equilibrium. Recent evidence shown that ozone layer is becoming thinner & holes have developed

Causes for ozone layer depletion:

Chlorine released from CFC and Bromine released from halogens are the most important chemicals associated with ozone layer depletion The halogens are used in fire extinguishers and CFC are extensively used in air conditioners and refrigerators.. Methyl bromide used during packaging of fruits to prevent bacterial action flows out into the atmosphere as soon as the packing is opened. This cause heavy damage to ozone.

Ozone depleting chemicals

In 1970 it was found that ozone layer was attacked by CFCs. Each Chlorine atom attack ozone molecule. Loss in ozone increases the UV radiation reaching the earth surface.

Chloro Fluro carbon (CFC) - Used in refrigerators, propellent, spray cans, blowing agent, foam agent],
Hydro chloro fluoro carbon (HCFC) - Used in refrigerants, blowing agents
Bromo fluoro Carbon (BFC) - Used in fire extinguisher

Formation of Ozone:

$O_2 + h\nu \rightarrow O\bullet + O\bullet$ Ozone is formed by photochemical reaction

$O\bullet + O_2 \rightarrow O_3$ atomic oxygen reacts with molecular oxygen to form ozone

Mechanism of Ozone layer depletion:

$CF_2Cl_2 + h\nu \rightarrow Cl + CF_2Cl$

$CF_2Cl + O_2 \rightarrow CF_2O + ClO$

$Cl + O_3 \rightarrow ClO + O_2$

$ClO + O\bullet \rightarrow Cl + O_2$

Effects of ozone depletion of earth

- Marked rise in cause skin cancer
- Damage immune system
- Eye ailment such as cataract
- Shorter life of paints and plastics
- Restricted growth and crop damage
- Destruction of aquatic life

Control Measures

- Replacing CFCs by less damaging materials
- Use of methyl bromide – crop fumigant should be controlled
- Manufacturing & using of ozone depleting chemicals should be stopped.

Chapter 7
Natural hazards

Natural hazards are severe and extreme weather and environmental conditions that pose potential threats to human life, property and the natural environment. Understanding natural hazards is crucial for preparedness, risk reduction, and mitigation strategies to protect lives and reduce economic losses. These hazards can be categorized into several types based on their origin and characteristics.

Classification of the Natural hazard

A. Geological Hazards: These are events associated with Earth's processes following are its type

- **Earthquakes**: Sudden ground movements caused by the shifting of Earth's tectonic plates.
- **Volcanic Eruptions**: The eruption of molten rock, ash, and gases from a volcano.
- **Landslides and Avalanches**: The rapid movement of a large mass of earth, rock, or snow down a slope.
- **Sinkholes**: The sudden collapse of ground into a void, often caused by erosion or the dissolving of underlying limestone.

B. Hydrological Hazards: These involve water movement

- **Floods**: Overflow of water onto land that is normally dry, often caused by heavy rain, storm surges, or melting snow.
- **Tsunamis**: Large sea waves caused by underwater earthquakes, volcanic eruptions, or landslides.
- **Mudflows or Debris Flows**: Rapid downhill movement of water-saturated earth material, causing destructive flows of mud.

C. Meteorological Hazards: These are related to weather and atmospheric conditions

- **Tropical Cyclones (Hurricanes, Typhoons)**: Powerful storms with strong winds and heavy rain.
- **Tornadoes**: Highly destructive, rapidly rotating columns of air that are in contact with both the Earth's surface and a cumulonimbus cloud.
- **Blizzards**: Severe snowstorms with strong winds and low visibility.
- **Droughts**: Extended periods of deficient rainfall leading to water shortages.
- **Heat waves**: Prolonged periods of excessively hot weather, which may be accompanied by high humidity.

D. Climatological Hazards: These are related to climate processes

- **Wildfires**: Uncontrolled fires that spread through vegetation and can cause widespread damage.
- **Extreme Temperatures**: Unusually cold or hot temperatures that can cause harm to ecosystems, agriculture, and human health.

E. Biological Hazards: These involve processes of organic origin or conveyed by biological vectors:

- **Pandemics and Epidemics**: Widespread outbreaks of infectious diseases.
- **Invasive Species**: Non-native species that cause significant harm to the environment, economy, or human health.

F. Extraterrestrial Hazards: These include space-related events like:

- **Asteroid Impacts**: The collision of an asteroid with Earth, causing significant damage.
- **Solar Flares**: Sudden eruptions of energy on the sun's surface that can disrupt satellite communications and power grids on Earth.

Earthquakes

Earthquakes are caused by the sudden release of slowly accumulated strain energy along a fault in the earth's crust. Earthquakes and volcanoes occur most commonly at the collision zone between tectonic plates. Earthquakes represent a particularly severe threat due to the irregular time intervals between events, lack of adequate forecasting, and the hazards associated with these:

Causes of Earthquakes

1. Tectonic Movements: The most common cause of earthquakes. The Earth's outer shell is divided into several large and small tectonic plates that are constantly moving. Earthquakes typically occur along the boundaries of these plates. The movement can be divergent, convergent, or transform, leading to varying intensities and depths of earthquakes.
2. Volcanic Activity: Earthquakes can also be caused by volcanic activity when magma moves towards the Earth's surface, causing the crust to crack and create volcanic earthquakes.
3. Human Activities: Certain human activities, such as mining, reservoir-induced seismicity (due to the filling of large reservoirs behind dams), and the injection or extraction of fluids from the Earth, can also trigger earthquakes.

Effects of Earthquakes

Ground Shaking: The most noticeable effect, which can lead to the collapse of buildings and other structures, landslides, and ground rupture.

Tsunamis: Undersea earthquakes can displace a large volume of water, leading to tsunamis that can cause devastation in coastal areas.
Soil Liquefaction: Water-saturated granular soil temporarily loses strength and behaves like a liquid, often leading to significant ground

deformation.

Fires: Earthquakes can rupture gas lines and electrical connections, leading to fires that may cause additional damage.

Faulting, or breaches of the surface material, occurs as the separation of bedrock along lines of weakness.

Landslides occur because of ground shaking in areas having relatively steep topography and poor slope stability.

Subsidence occurs in waterlogged soils, fill, alluvium, and other materials that are prone to settle.

Measurement of earthquake

Magnitude: The energy released by an earthquake is measured on the Richter scale or, more commonly now, the moment magnitude scale (Mw). This scale is logarithmic, where each whole number increase represents a tenfold increase in measured amplitude and roughly 31.6 times more energy release.

Intensity: The effects of an earthquake on the Earth's surface, humans, and man-made structures are measured by the Modified Mercalli Intensity (MMI) scale. This scale ranges from I (not felt) to XII (total destruction).

Preparedness and Mitigation

- Developing and enforcing building codes designed to withstand earthquakes.
- Earthquake education and emergency preparedness programs for residents.
- Early warning systems that can provide a few seconds to minutes of warning before the shaking starts.
- Understanding earthquakes and their potential impact is crucial for reducing risks and enhancing community resilience to these natural disasters.

Landslides

Landslides are a type of natural disaster characterized by the movement of rock, earth, or debris down a slope due to gravity. They can occur in any geographical location but are more common in areas with steep topography, such as mountainous regions, and can be triggered by several factors, both natural and human-induced. Understanding the causes, types, impacts, and mitigation strategies associated with landslides is crucial for minimizing their damage and protecting vulnerable communities.

Causes of Landslides

Landslides can be triggered by various factors, often involving a combination of natural processes and human activities:

1. Heavy Rainfall:Saturated soil loses strength and cohesion, making it more susceptible to gravity.
2. Earthquakes: Seismic activity can destabilize slopes, leading to landslides.
3. Volcanic Activity: Eruptions can produce loose ash deposits that are prone to landslides, especially when mixed with water.
4. Human Activities: Deforestation, mining, construction, and the alteration of land surfaces can increase landslide risk.
5. Melting Snow or Ice: Rapid melting can saturate soil and rock, triggering landslides.
6. Water Level Changes: Erosion from rivers or a rapid drawdown of reservoirs can destabilize slopes.

Types of Landslides

Landslides can occur in several forms, depending on the material involved, the mechanism of movement, and the water content:

Rockfalls: The free fall of rock from a steep slope or cliff.

Rockslides: The movement of rock down a slope.

Slumps: A rotational movement of material along a curved surface.

Mudflows or Debris Flows :Rapid flow of water-saturated earth material, which moves down slopes and channels.

Impacts of Landslides

Landslides can have devastating effects on communities, infrastructure, and the environment:

Loss of Life: Landslides can bury homes and buildings under debris, leading to fatalities.

Property Damage: The destruction of houses, roads, and infrastructure can have significant economic impacts.

Disruption of Transportation: Landslides can block roads and railways, isolating communities and disrupting trade.

Environmental Damage**: Landslides can destroy habitats, change drainage patterns, and lead to further erosion and sedimentation in rivers and streams.

Mitigation and Preparedness

Effective management and mitigation of landslide risks require a comprehensive approach that combines scientific understanding, engineering solutions, community engagement, and policy initiatives.

Risk Assessment: Identifying and mapping areas at high risk for landslides.

Land-Use Planning : Avoiding construction in high-risk areas and implementing zoning regulations.

Engineering Solutions**: Building retaining walls, improving drainage, and stabilizing slopes can reduce landslide risk.

Vegetation Management**: Planting trees and vegetation can help stabilize soil and absorb water.

Early Warning Systems: Monitoring rainfall, ground movement, and other indicators can provide advance warning of possible landslides, allowing for evacuations and other preparatory actions.

Public Awareness and Education: Informing communities about the

risks and signs of landslides can help individuals take proactive measures to protect themselves and their properties.

Cloudburst

Cloudbursts are extreme weather events characterized by a sudden and intense rainfall, typically more than 100 millimeters (about 4 inches) of rain within an hour over a small area. These events can lead to flash floods and landslides, especially in mountainous regions like Uttarakhand, India.

Causes of Cloudbursts

Monsoon Winds: The Indian monsoon plays a significant role. As moist winds ascend the Himalayas, they cool and condense rapidly, leading to intense rainfall over a small area.

Local Climatic Conditions: Specific local conditions, such as temperature variations and humidity, can also contribute to the development of cloudbursts.

Impacts of Cloudbursts

The effects of cloudbursts can be devastating, with immediate and long-term impacts:

Flash Floods: The intense rainfall can lead to sudden and severe flooding in valleys and low-lying areas, often with little to no warning.

Landslides: The heavy rain can saturate soil on slopes, leading to landslides and mudslides, which can cause extensive damage to infrastructure and settlements.

Loss of Life and Property: Cloudbursts can result in significant loss of life, displacement of communities, and destruction of homes and property.

Agricultural Damage: Sudden floods can wash away fertile topsoil and destroy crops, affecting the livelihoods of rural communities.

Infrastructure Damage: Roads, bridges, and buildings can be

damaged or destroyed, leading to isolation of affected areas and disrupting emergency response and recovery efforts.

Mitigation and Preparedness

- **Early Warning Systems**: Implementing advanced meteorological monitoring and forecasting systems can help provide early warnings to vulnerable communities.
- **Infrastructure Resilience:** Building resilient infrastructure, such as flood defenses and landslide barriers, and ensuring that constructions adhere to safety standards can reduce damage.
- **Reforestation and Soil Conservation:** Encouraging vegetation cover on slopes and implementing soil conservation measures can help reduce the risk of landslides and soil erosion.
- **Community Engagement:** Involving local communities in disaster risk reduction efforts through education and training can enhance resilience and response capacity.

Volcanoes

Volcanoes are perforations in the earth's crust through which molten rock and gases escape to the surface. Volcanic hazards stem from two classes of eruptions.

- Explosive eruptions which originate in the rapid dissolution and expansion of gas from the molten rock as it nears the earth's surface. Explosions pose a risk by scattering rock blocks, fragments, and lava at varying distances from the source.
- Effusive eruptions where material flow rather than explosions is the major hazard. Flows vary in nature (mud, ash, lava) and quantity and may originate from multiple sources. Flows are governed by gravity, surrounding topography, and material viscosity.

Hazards associated with volcanic eruptions include lava flows, falling ash and projectiles, mudflows, and toxic gases. Volcanic activity may also trigger other natural hazardous events including local tsunamis,

deformation of the landscape, floods when lakes are breached or when streams and rivers are dammed and tremor-provoked landslides.

Tsunamis

Tsunamis are long-period waves generated by disturbances such as earthquakes, volcanic activity, and undersea landslides. The crests of these waves can exceed heights of 25 meters on reaching shallow water. The unique characteristics of tsunamis (wave lengths commonly exceeding 100 km, deep-ocean velocities of up to 700 km/hour, and small crest heights in deep water) make their detection and monitoring difficult. Characteristics of coastal flooding caused by tsunamis are the same as those of storm surges.

Chapter 8
Advances in Environmental Conservation

Environmental conservation means protecting and preserving natural resources and ecosystems to maintain their health and sustainability. Environmental conservation is essential for sustaining human life, as it relies on a healthy environment. This ensures the protection of nature's elements such as plants, animals, air and water. Conservation efforts aim to protect these resources and maintain their delicate balance. Various environmental challenges, such as overpopulation, water scarcity, ozone depletion, deforestation, desertification, and pollution, pose significant threats to human well-being. Neglecting environmental conservation and management will only worsen these issues. Therefore, promoting widespread awareness and engagement in environmental protection, facilitated by various institutions including governments, NGOs, the internet, print media, and social media, is vital for driving positive change.

Importance of environmental conservation

In present-day civilization, the importance of environmental conservation has become increasingly apparent. Adopting sustainable development practices is crucial for ensuring the long-term health of the environment and promoting human prosperity. Some of the key reasons highlighting the significance of environmental conservation are listed below:

- Safeguarding biodiversity is necessary to maintain ecosystem balance and preserve valuable genetic diversity.
- Preserving natural resources is essential for the well-being of future generations, emphasizing the significance of sustainable practices.

- Mitigating air, water, and land pollution is crucial due to the threats they pose to human health and ecosystem integrity.
- Efforts to restore ecological balance are crucial to counteract damage inflicted on fragile ecosystems.
- Combating global warming and its adverse effects is paramount for ensuring a habitable environment for current and future generations.

International Advances in Environmental Conservation

Over time, numerous individuals and institutions have contributed to environmental conservation. As time has progressed, these efforts have evolved and advanced, particularly with the emergence of innovations and increased awareness. The 20th century witnessed the growth of the environmental movement globally, spurred by events like industrial pollution, drinking water scarcity and the development of nuclear weapons. Even the G20 countries reaffirmed their leadership role in tackling climate change and committed to ambitious action across all pillars of previous environmental agreements during the 18th G20 Summit held at Bharat Mandapam in New Delhi on 9–10 September 2023. Topics like ecological restoration, marine spatial planning, and circular economy were addressed in detail for the first time in the G20 discussions. Meanwhile, climate change and global warming remain prominent and undeniable subjects in all international summits, particularly following the first international Earth Summit held in 1992 in Rio de Janeiro, Brazil. During this summit, the heads of more than 100 countries convened to address urgent issues related to environmental protection and socio-economic development.

Here are some significant international advancements that evolved over the 20th century in the field of environmental conservation:

Technological innovations:

- *Remote sensing:* Satellite-based technologies allow for monitoring changes in land use, deforestation, and habitat loss on a global scale.
- *Geographic information systems (GIS):* GIS tools help in spatial analysis, planning conservation efforts, and monitoring biodiversity hotspots.
- *Drones:* Unmanned aerial vehicles aid in surveying inaccessible areas, monitoring wildlife populations, and assessing environmental damage.
- *Advanced camera:* These are utilized to survey, monitoring and surveillance large areas of land and water, allowing conservationists to monitor changes in ecosystems, land use, and wildlife populations. They provide detailed imagery and data that can reveal patterns of deforestation, habitat loss, illegal activities such as poaching or logging, and changes in biodiversity.

Policy frameworks:

- *International agreements:* Treaties such as the United Nations Framework Convention on Climate Change (UNFCCC), Kyoto Protocol, Convention on Biological Diversity (CBD), Paris Agreement, Montreal Protocol, Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Ramsar Convention on Wetlands, and others establish targets aimed at reducing greenhouse gas emissions and conserving biodiversity.
- *Sustainable development goals (SDGs):* In 2015, the United Nations member states adopted the Sustainable Development Goals (SDGs) with the aim of fostering a more equitable, sustainable, and peaceful world by 2030. Goal 13 focuses on climate action, while Goal 15 aims to protect, restore, and promote sustainable use of terrestrial ecosystems.
- *Environment protection act, 1986*: The main objective of the Environment Protection Act in India is to safeguard and improve the quality of the environment, encompassing air, water, and land, while also aiming to prevent and manage environmental pollution.

Conservation strategies:

- *Protected areas:* Expansion and effective management of protected areas, including national parks, marine reserves, and wildlife sanctuaries, contribute to habitat conservation and species protection.
- *Habitat restoration:* Efforts to restore degraded ecosystems, such as reforestation, wetland restoration, and coral reef rehabilitation, enhance biodiversity and ecosystem services.
- *Sustainable agriculture:* Adoption of practices like agroforestry, organic farming, and precision agriculture minimize environmental impacts while ensuring food security.

Community engagement:

- *Indigenous knowledge:* Incorporating traditional ecological knowledge into conservation plans enhances understanding of ecosystems and fosters community participation.
- *Community-based conservation:* Empowering local communities to manage natural resources promotes sustainable livelihoods and strengthens conservation efforts.

Techno-economic solutions:

- *Renewable energy:* Transitioning to renewable sources like solar, wind, and hydropower reduces reliance on fossil fuels and mitigates climate change.
- *Circular economy:* Embracing principles of recycling, resource efficiency, and waste reduction minimizes environmental degradation and fosters economic resilience.

Cross-sector collaboration:

- *Public-private partnerships*: Collaborations between governments, businesses, NGOs, and academia facilitate resource mobilization, knowledge sharing, and implementation of conservation projects.

• *International funding mechanisms:* Initiatives like the Green Climate Fund and the Global Environment Facility provide financial support for environmental conservation and climate adaptation projects in developing countries.

Research and education:

• *Scientific research:* Advances in fields like ecology, conservation biology, and environmental science generate knowledge essential for evidence-based decision-making.

• *Environmental education:* Raising awareness and fostering environmental stewardship through formal education, outreach programs, and public campaigns promote sustainable behavior change.

Climate resilience:

• *Climate adaptation measures:* Implementing strategies such as building resilient infrastructure, enhancing disaster preparedness, and promoting nature-based solutions helps communities cope with climate impacts.

National Green Tribunal (NGT)

The National Green Tribunal (NGT) in India is a **specialized judicial body** dedicated to handling cases related to environmental protection and conservation. As a special authority with expertise in various environmental disputes, the NGT operates differently from regular courts, not strictly adhering to the procedures outlined in the Civil Procedure Code of 1908 but relying on principles of natural justice.

The NGT's primary focus is to deliver speedy environmental justice and reduce the workload of higher courts dealing with similar cases. It aims to resolve applications or appeals within six months of filing. Initially, the NGT was set up in five locations, with New Delhi being the main location and Bhopal, Pune, Kolkata, and Chennai as additional locations for hearings. The idea is to make the NGT more accessible to people

across different regions.

Establishment and objectives

The National Green Tribunal (NGT) was established on October 18, 2010, under the National Green Tribunal Act 2010. The primary objective of the NGT is to quickly and effectively handle cases related to protecting the environment, conserving forests, and managing natural resources. This includes enforcing environmental rights, providing relief and compensation for any harm to people or property due to environmental issues.

The National Green Tribunal, comprising both judicial (Supreme Court judges) and expert members in environmental matters, functions with the overarching goals of protecting the environment, promoting sustainable development, and ensuring the effective enforcement of environmental laws and regulations. The NGT holds authority over a range of matters, including forest conservation, biodiversity, air and water pollution, climate change, and the enforcement of environmental rights.

Role of National Green Tribunal

The functions and powers of the National Green Tribunal (NGT) are outlined in the National Green Tribunal Act of India, 2010. The key responsibilities of the NGT include:

- *Adjudication of environmental disputes*: The NGT is responsible for hearing and resolving disputes related to environmental issues, encompassing the enforcement of environmental laws and regulations.
- *Handling of appeals*: The NGT is authorized to hear appeals against orders or decisions made by environmental authorities or other courts concerning environmental matters.

- *Enforcement of environmental laws*: The NGT has the authority to enforce environmental laws and regulations, including issuing orders, injunctions, and directions to safeguard the environment.
- *Monitoring environmental compliance*: The NGT oversees compliance with environmental laws and regulations, taking appropriate action in the event of violations.
- *Expert advice provision*: The NGT maintains a panel of experts in various environmental fields to offer specialized advice on environmental issues.
- *Promotion of environmental justice*: The NGT is dedicated to promoting environmental justice, ensuring that all citizens have the right to a clean environment, and advocating for transparent and participatory decision-making on environmental issues.

Environmental Audit

An environmental audit is a systematic evaluation of how well an organization is performing in terms of its environmental policies, practices, and compliance with environmental regulations. The purpose of an environmental audit is to assess the impact of an organization's activities on the environment and identify areas for improvement in order to enhance environmental performance.

Establishment and objectives

The concept of environmental auditing emerged in the late 20th century as a response to growing environmental concerns. The establishment and formalization of environmental auditing practices can be traced back to the 1970s and 1980s when awareness of environmental issues increased globally.

The primary objective of an Environmental Audit is to assess and ensure compliance with environmental laws, regulations, and standards while identifying areas for improvement in environmental management systems. Simultaneously, it aims to enhance

environmental performance, reduce operational inefficiencies, and demonstrate corporate responsibility, fostering stakeholder confidence and sustainable business practices.

The features of environmental audit include its role as a management tool for assessing and managing a company's environmental performance, aiming to control adverse impacts of economic activities. It is a systematic, documented, and periodic process with an objective evaluation, emphasizing the need for external audits to enhance objectivity and ensure compliance with environmental goals and regulatory standards.

Types of Environmental audits

There are three essential types of environmental audits:

Environmental compliance audits:

Compliance audits assess and verify aspects related to or undertaken by an organisation against a specific objective. These compliance commitments can be found in various regulatory approvals such as an Environmental Authorisation or a specific management licence (related to waste, water, the atmosphere and more). The approval document sets specific legal management measures for the activity in order to prevent environmental harm. Compliance audits inherently determine aspects (or risks to the continued operations) requiring direct intervention, be it from a management viewpoint or a specific job title, to prevent environmental harm and indirectly, ensure continued operations of the activity as undertaken.

Environmental management audits:

Environmental Management system (EMS) Audits refer to an audit process of evaluating an EMS to ensure that the system is working effectively and showing continual improvement of the systems

functioning. The EMS audit assists organisations to follow the project management cycle of plan, do, check and act and continual improvement.

Functional environmental audits:

Functional Environmental Audits are conducted to determine compliance of a specific aspect undertaken by an organisation for instance, the specific management of waste in accordance with a Waste Management Plan, or the review of the implementation of an Atmospheric Emissions Management Plan in accordance to air quality monitoring requirements.

Functional audits relates both to compliance and Environmental Management System audits as it fills a verification & check role within these. Functional audits can also be incorporated into a combined audit programme to determine specific compliance or aspects of a system requiring improvement.

These audits ensure that quick action can be taken on a specific aspect without waiting for a regulatory process to run.

Procedure of Environmental Auditing

The environmental audit process includes the following steps as a minimum:

1. Planning the audit, including activities to be conducted and responsibilities for each activity
2. Review the company's environmental protection policy and the applicable requirements, federal, state, and local requirements.
3. Assessment of the organization, its management, and equipment.
4. Gather data and relevant information.
5. Evaluate overall performance.
6. Identify areas needing improvement.

7.Report findings to management.

Role of environmental auditing

- *Enhances efficiency*: Improves the Environmental Management System's (EMS) efficiency by identifying deficiencies and supporting environmental improvement plans.
- *Ensures compliance*: Facilitates cost-effective adherence to environmental laws, industry guidelines, and company policies.
- *Risk mitigation*: Acts as a risk management tool, helping avoid legal issues and reputational damage related to environmental breaches.
- *Meets stakeholder expectations*: Builds trust with stakeholders by demonstrating environmental responsibility and addressing potential hazards.
- *Reduces inefficiencies*: Highlights operational inefficiencies, allowing for cost reduction and improved environmental performance.
- *Encourages continual improvement*: Identifies strengths and weaknesses, promoting ongoing enhancement of environmental management systems.
- *Certification compliance*: Supports obtaining certifications like ISO 14001, Energy Star, LEED, etc.
- *Employee awareness*: Increases employees' awareness of corporate environmental policies, fostering commitment and morale.
- *Decision support*: Assists management in decision-making regarding plant modifications, new projects, market opportunities, and compliance with environmental legislation.

Chapter 9
Environmental Management and Assessment

Environmental Management System (EMS)

An Environmental Management System (EMS) is a structured tool for managing an organization's environmental impacts, requiring commitment from top management and all staff. EMS Recognize global environmental trends, increase stakeholder satisfaction, improve long-term corporate profitability, and seek competitive advantages through minimizing environmental impact.

Key components of an EMS include:

- *Environmental policy*: A statement outlining the organization's environmental objectives, ensuring alignment with overall goals.
- *Environmental impact identification*: Identification and documentation of actual and potential environmental impacts through activities like environmental audits.
- *Objectives and targets*: Environmental audit findings form the foundation for establishing objectives and targets, with regular reviews for continual improvement.
- *Consultation*: Staff and community consultations are essential for involvement and commitment to the EMS, contributing to improved public perception.
- *Operational and emergency procedures*: All procedures are reviewed to align with environmental objectives, with changes documented.
- *Environmental management plan*: Detailed methods and procedures to meet organizational objectives and targets.

- *Documentation*: Documentation of objectives, targets, policies, responsibilities, and procedures aids in verifying environmental performance to stakeholders.
- *Responsibilities and reporting structure*: Clear allocation of responsibilities to staff and management ensures effective EMS implementation.
- *Training*: Staff undergo environmental awareness training to familiarize them with EMS responsibilities, policies, and objectives.
- *Review audits and monitoring compliance*: Ongoing reviews and audits ensure the EMS achieves its objectives, refining operational procedures as needed.
- *Continual improvement*: Ongoing assessment and improvement of procedures contribute to the effective implementation of the EMS.
- *Future of EMS*: The EMS describes approaches for improving environmental performance and integrating environmental considerations into management decisions.
- *Applicability*: Concepts and techniques in the EMS are applicable to organizations in various sectors, including business, services, government entities, and both large and small organizations.
- *Environmental strategies*: Integral part of EMS, changing management practices and systems based on the business implications of environmental issues.

Importance of Indian Traditional Knowledge on Environment

Traditional knowledge

Traditional knowledge encompasses information, methods, processes, and practices passed down from ancestors through customs, folklore, literature, and ways of living. It is integral to India's heritage and holds significant potential to shape the country's journey towards prominence. India, being one of the world's oldest civilizations, possesses a vast reservoir of traditional knowledge that can significantly contribute to reshaping and rebuilding the country's

journey towards prominence.

Conservation of environment by tribal groups

- ***Plants as Food source:*** Tribes conserve diverse plants for edible purposes, such as wild fruits, seeds, bulbs, roots, and tubers.
- ***Medicinal plants:*** Indigenous communities cultivate and utilize medicinal plants like *Centella asiatica, Curcuma longa, Ocimum tenuiflorum* and *Nardostachys jatamansi* for treating various ailments such as muscular pain, fever, headache, and swelling.
- ***Conservation during jhum cultivation:*** Tribal groups practice shifting cultivation without completely felling trees, conserving horticulturally important species like *Syzygium cumini*, *Grewia asiatica*, *Mangifera indica*, *Citrus* spp., and *Musa* spp.
- ***Plants as abode of gods:*** Certain plants are conserved in their natural habitat due to cultural significance, being associated with ancestors or considered abodes of gods, as seen in Peepal (*Ficus religiosa*), Aam (*Mangifera indica*), Arjun (*Terminalia arjuna*), Tulsi (*Ocimum tenuiflorum*), and Bel (*Aegle marmelos*).
- ***Endangered species conservation in sacred groves:*** Ethnic communities preserve biodiversity in sacred groves dedicated to deities or ancestral spirits, protecting flora and fauna, including endemic and endangered species.
- ***Climate change adaptation:*** Indigenous communities, particularly in the Himalayan region, possess extensive traditional knowledge related to climate change adaptation. This knowledge includes forecasting weather patterns, managing water resources, and developing resilient agricultural practices.
- ***Biocriteria and water quality management:*** Biologists and natural resource scientists use accepted scientific principles to derive biocriteria from bioassessment data. Biocriteria are descriptions or numerical values that can be adopted into water quality standards to describe the desired condition for aquatic life in designated waters.

These standards are used alongside chemical and physical criteria to better manage water resources.

Bio Assessment of Environmental Quality

Bio assessment refers to the use of biological organisms (such as plants, animals, and microorganisms) to evaluate the health and quality of an ecosystem. It provides a holistic view of environmental conditions, as biological organisms integrate the effects of various environmental stressors over time.

Traditional chemical and physical assessments alone may not capture the full extent of environmental degradation or ecosystem health. Biological indicators can offer early warning signs of environmental changes and help in the formulation of effective management strategies. Bioassessment is often used in monitoring programs for water bodies, terrestrial habitats, and air quality.

Bioindicators

Bioindicators are species or groups of organisms whose presence, abundance, health, or behavior can reflect the condition of the environment. These are organisms or biological parameters that are sensitive to changes in environmental conditions. They can be categorized into different groups based on their sensitivity to environmental changes, such as sensitive, tolerant, or indicator species. Examples of bioindicators include macroinvertebrates in freshwater ecosystems, lichens in air quality assessment, and indicator plants in terrestrial habitats.

Applications:

- Bioassessment is used in various environmental management contexts, including:
- Regulatory compliance and environmental impact assessments.

- Restoration and conservation planning.
- Early warning systems for pollution incidents or ecological disturbances.
- Assessing the ecological status of protected areas or designated conservation sites.

Air Quality Index (AQI)

Air

Air is the invisible mixture of gases that makes up Earth's atmosphere. Air is primarily composed of nitrogen (about 78%) and oxygen (about 21%). The remaining 1% consists of trace gases such as argon, carbon dioxide, neon, helium, and hydrogen, as well as varying amounts of water vapor. Air possesses various properties including composition, density, pressure, temperature, humidity, heat capacity, transparency, compressibility, and conductivity, while also playing a crucial role in supporting life on Earth through providing oxygen and carbon dioxide for respiration and photosynthesis respectively, and affecting weather phenomena and heat transfer within the atmosphere. Additionally, air is essential for sustaining life on Earth, providing the oxygen needed for respiration by plants, animals, and other organisms, and playing a crucial role in regulating the planet's climate and weather patterns.

Air Quality Index (AQI)

The **Air Quality Index (AQI)** is a numerical scale used to communicate the quality of the air in a specific area and its potential impact on health, providing valuable information about pollution levels and associated health risks. It typically ranges from 0 to 500, with lower values indicating better air quality and higher values indicating poorer air quality. It categorizes air quality into levels ranging from "Good" to "Hazardous," reflecting potential health concerns associated with pollution exposure over short periods. The AQI is calculated based on concentrations of pollutants like particulate matter, ozone, nitrogen

dioxide, Sulphur dioxide, and carbon monoxide, providing valuable information to the public about air quality and associated health effects, along with recommendations for minimizing exposure to pollution.

There are six AQI categories, namely Good, Satisfactory, moderately polluted, Poor, Very Poor, and Severe. Each of these categories is decided based on ambient concentration values of air pollutants and their likely health impacts (known as health breakpoints).

Table 9.1 Air Quality Index, AQI category, colour scale and their possible health impacts**.**

AQI	**AQI Category**	**Colour code**	**Possible Health Impacts**
0–50	Good		Air pollution poses little or no risk to health
51–100	Satisfactory		Minor health concerns for sensitive individuals, such as those with respiratory conditions or the elderly
101–200	Moderate		People with respiratory or heart conditions, children, and the elderly may experience health effects
201–300	Poor		Everyone may experience breathing discomfort, with sensitive groups experiencing more severe symptoms
301–400	Very poor		Health warnings of emergency conditions, as everyone may experience more serious health effects

401–500	Severe		Affects entire population, and immediate actions to reduce exposure are necessary

National Ambient Air Quality Standards (NAAQS)

NAAQS set by the Central Pollution Control Board (CPCB) define the permissible levels of various air pollutants in the ambient air to safeguard human health and the environment. These standards cover pollutants such as sulfur dioxide (SO_2), nitrogen dioxide (NO_2), particulate matter (PM10 and PM2.5), carbon monoxide (CO), ozone (O_3), and lead (Pb). The NAAQS provide maximum allowable concentrations for these pollutants over specified averaging periods (e.g., annual, 24-hour, and hourly).

Environmental Impact Assessment (EIA)

Environmental Impact Assessment (EIA) is an anticipatory, participatory, and systematic process aimed at identifying and assessing the environmental and social impacts of proposed activities, facilitating early prediction of impacts, and offering solutions for mitigating adverse effects. Through its multidisciplinary approach, EIA contributes to informed decision-making, promoting sustainable development by considering environmental concerns and minimizing potential negative consequences on air and water quality, biodiversity, ecosystems, and human health.

Establishment and objectives

The concept of Environmental Impact Assessment (EIA) originated from the National Environmental Policy Act (NEPA) of 1969 in the USA, gaining prominence in European countries with the adoption of sustainable development principles in 1987. In India, EIA was introduced in the late 1970s, made mandatory in 1994, and serves both legal and educational roles, ensuring minimal environmental impact

throughout the lifecycle of development projects and contributing to public awareness and understanding of environmental considerations.

The necessity for Environmental Impact Assessment (EIA) arises from the inherent environmental impacts of anthropogenic activities, which are often more detrimental than beneficial. As human development is reliant on these activities for sustenance and security, there is a crucial need to reconcile development with environmental considerations. EIA serves as a vital tool for planners to assess and harmonize developmental activities with environmental concerns, ensuring sustainability by characterizing and accounting for environmental consequences early in the project cycle.

The immediate goals of EIA are to:
- enhance the proposal's environmental design;
- ensure that resources are used effectively and wisely;
- choose appropriate actions to lessen the proposal's potential negative effects; and
- support informed decision-making, including establishing the environmental terms and conditions for implementation.

The long-term goals of EIA are to:
- maintain priceless resources, natural regions, and ecosystem components;
- protect human health and safety;
- prevent permanent changes and major environmental harm; and
- enhance the social aspects of the proposal.

Principles of EIA process in India

The entire EIA process in India is governed by the following eight guiding principles. They are as follows:

Participation:
The procedure should offer suitable chances for informing and including the interested and affected publics, and it should expressly take into account their suggestions and worries in the documentation and decision-making. It is crucial that interested parties have appropriate and prompt access.

Transparency:
The procedure should contain clear, understandable requirements for EIA content, guarantee public access to the information, describe the variables considered in decision-making, and admit limitations and challenges. EIA assessment decisions should be transparent and easy to access.

Efficient:
The Process should place the least amount of financial and time demands on participants and proponents while still achieving the goals and standards of an EIA.

Accountability:
The decision-maker should consider all relevant factors before making a choice that will adequately safeguard the environment and the well-being of the community.
Decision-makers ought to take accountability for their choices and actions.

Credibility:
The procedure must be conducted with professionalism, strictness, fairness, objectivity, impartiality, and balance, and it must be open to independent inspection and verification.

Cost-effectiveness:
The procedure should accomplish the EIA's goals within the constraints of the information, time, resources, and methodology at hand.

Integrated:
The procedure should take into account how social, economic, and biophysical factors are interconnected.

Practicality:
The process should result in information and outputs which assist with problem solving and are acceptable to and able to be implemented by proponents.

Environmental Components of EIA
The components of EIA have been described on the basis of MoEF manual (2001):

Air environment-
- Predicted and actual ambient air quality.
- Weather information, such as wind speed, direction and humidity etc.
- The projected number of emissions.
- The area's exposure to the emissions.
- Air quality standards and need to control pollution.

Water environment-
- Water resource effects of the proposed project.
- The quality and quantity of surface and ground water resources that are already present in the area.

Noise environment-
- Level of actual and anticipated noise.

- Approaches to reduce noise pollution.

Biological environment-

- Possible harm resulting from the project, including damage from emissions, effluents and landscaping.
- Impact zone flora and fauna.
- Biological stress (prediction).

Land environment-

- Effects and impacts on heritage sites and historical monuments.
- Study of the project's potential negative effects and the features of the soil, the use of the land and the drainage pattern.

The EIA process in India

The environment impact assessment consists of eight steps with each step equally important in determining the overall performance of the project. The eight steps of the EIA process are presented in brief below:

1. Screening
2. Scoping and consideration of alternatives
3. Baseline data collection
4. Impact prediction
5. Assessment of alternatives, delineation of mitigation measures and environmental impact statement
6. Public hearing
7. Environment Management Plan
8. Decision making
9. Monitoring the clearance conditions

Screening:

- *Purpose*: To determine if a project requires environmental clearance based on criteria such as investment scale, type of development, and location.

• *Criteria*: Project requires clearance if covered by specific statutory notifications related to environmental impact.

Scoping and consideration of alternatives:

• Process: Defines terms of reference for EIA in consultation with the project proponent and guidance from the Impact Assessment Agency.
• Alternatives: Identifies and evaluates project location and process technologies, considering a 'no project' option.

Baseline data collection:

• Purpose: Describes existing environmental conditions in the study area using primary and secondary data.
• Parameters: Monitors site-specific data for identified parameters related to air, noise, water, land, biological, and socio-economic aspects.

Impact prediction:

• *Method*: Maps environmental consequences of the project and its alternatives.
• *Impacts*: Assesses effects on air, noise, water, land, biological diversity, and socio-economic aspects.

Assessment of alternatives, delineation of mitigation measures, and environmental impact statement:

• *Evaluation*: Ranks alternatives for optimum economic benefits and environmental sustainability.
• *Mitigation*: Develops a mitigation plan for the selected option, supplemented by an Environmental Management Plan (EMP).

Public hearing:

• *Requirement*: Law mandates informing and consulting the public on the proposed development after completing the EIA report.

• *Participants*: Affected persons, local residents, associations, and environmental groups have the right to provide suggestions to the State Pollution Control Board.

Environment management plan (EMP):

• *Preparation*: Developed by the Impact Assessment Authority after compliance with previous steps.

• *Purpose*: Guides the project proponent in implementing environmental improvements.

Decision making:

• *Process*: Involves consultation between the project proponent, assisted by a consultant, and the impact assessment authority, assisted by an expert group if necessary.

• *Basis*: Decision on environmental clearance is made through the evaluation of EIA and EMP.

Monitoring the clearance conditions:

• *Timing*: Conducted during both construction and operation phases.

• *Purpose*: Ensures compliance with commitments and assesses the accuracy of predictions in the EIA reports. Corrective action is taken if impacts exceed predicted levels.

Fig. 9.1 EIA process (Source: The manual in perspective, EIA Training Resource Manual, United Nations Environment Programme, 2002).

SAMPLE SET QUESTIONS 1
MCQs on Environment Science

1. English word "Environment" is derived from which language
a) German
b) Latin
c) French
d) Greek

2. The functional aspects of the ecosystem are:
a) Energy cycles
b) Nutrient cycles
c) Food chains
d) All of the above

3. Deforestation leads to
a) Soil erosion
b) Habitat destruction
c) Drought
d) All of the above

4. Environment is formed with the
a) Biotic components
b) Geomorphic components
c) Abiotic components
d) All of the above

5. Which layer of the atmosphere contains the ozone responsible for the absorption of UV (Ultra-Violet) light?
a. Stratosphere
b. Troposphere
c. Mesosphere
d. None of these

6. Integrated Crop Management is defined as a process to:
a) Use of traditional methods for growing crops.
b) Using alternatives to inorganic fertilizers and pesticides.
c) Both (a) and (b)
d) None of the above

7. What are the two forms of alcohol are included in biofuels?
a) Ethanol and methanol
b) Ethanol and propanol
c) Methanol and propanol
d) None of the above

8. Which of the following is also called Detrivores?
a) Herbivores
b) Decomposers
c) Carnivores
d) None of the above

9. What are 'keystone' species in an ecosystem?
a) The species whose elimination can seriously affect the ecosystem
b) The species whose elimination can benefit the ecosystem.
c) The species whose elimination would not affect the ecosystem.
d) None of the above

10. A large number of interlinked chains in an ecosystem together forms a:
a) Nitrogen cycle
b) Carbon cycle
c) Food web
d) Food chain

11. The type of forests grown in the Himalayan Mountain region is called:
a) Broad-leaved forests
b) Coniferous forests
c) Deciduous forests
d) None of the above

12. Brackish water ecosystems are found in which of the following:
a) In Streams
b) In Wetlands
c) In Coastal shallows
d) In Deltas

13. Which of the following factors leads to Eutrophication?
a) Excessive use of fertilizers
b) Increase of plant nutrients
c) Both (a) and (b)
d) None of the above

14. Which of the following is not a Biogeographic zone of India?
a) Thar Desert of Rajasthan
b) The Brahmaputra Plains
c) South-east zone
d) North-east zone

15. Which day is celebrated as World Environment day?
a) June 10^{th}
b) June 5^{th}
c) July 5^{th}
d) October 20^{th}

16. A group of living organisms of the same kind living in the same place and at the same time refers to a
a) Community
b) Species
c) Population
d) Consumers

17. Which of the following element is responsible for groundwater pollution in various states?
a) Chlorine
b) Fluoride
c) Chemicals
d) None of the above

18. Which of the following gases are not permitted to release by the Government Prevention and Control of Pollution Act?
a) Nitrogen Oxide
b) Sulfur Dioxide
c) Carbon monoxide

d) All of the above

19. UNCED stands for:
a) United Nations Corporation on Environment and Development
b) United Nations Conference on Environment and Development
c) United Nations Corporation on Environment and Disasters
d) United Nations Conference on Environment and Disasters

20. The species restricted to be present in one region are called
a) Extinct species
b) Endemic species
c) Endangered species
d) Keystone species

21. Biosphere is
a) The solid shell of inorganic materials on the surface of the earth
b) The thin shell of organic matter on the surface of the earth comprising of all the living things
c) The sphere which occupies the maximum volume of all the spheres
d) All the above

22. Environmental impact assessment
a) is the study of feasibility of a project
b) is a study of bio-physical characteristics of the environment that may result from a human action
c) Both a and b
d) None of the above

23. Which of the following is the most environment friendly agricultural practice
a) Using chemical fertilizers
b) Using insecticides
c) Organic farming
d) None of the above

24. A herbivore is also known as a
a) Producer
b) First order consumer

c) Second order consumer.
d) Third order consumer

25. Primary source of energy in a food web is/are
a) Green plants
b) Sun
c) Inorganic nutrients
d) Animals

26. The second trophic level in a lake is
a) Phytoplankton
b) Zooplanktons
c) Fishes
d) Benthos

27. Pyramid of energy in a pond ecosystem is always
a) Inverted
b) Upright
c) Linear
d) Irregular

28. The final stable community in ecological succession is
a) Climax
b) Pioneer
c) Sere
d) Carnivores

29. Which of the following can act as a pioneer species in a xerarch succession
a) Lichens
b) Humans
c) Herbs
d) Animals

30. Which of the ecological pyramid is always upright
a) Pyramid of number
b) Pyramid of biomass
c) Pyramid of energy

d) All of the above

31. A resource that cannot be replaced in a reasonably short time is usually referred to as
a) Renewable resource
b) Non-renewable resource
c) Natural resource
d) Man-made resource

32. Which of these is not a fossil fuel?
a) Coal
b) Oil
c) Natural gas
d) Uranium

33. Which is a list of renewable resources?
a) Petroleum, geothermal energy, wind energy
b) Biomass, geothermal energy, hydropower
c) Natural gas, wind energy, biomass
d) Hydropower, solar energy, wind energy

34. The process of restoring forests that once existed but was removed at some time in the past is known as
a) Afforestation
b) Reforestation
c) Deforestation
d) None of these

35. Red data book contains data of
a) All plant species
b) All animal species
c) Threatened species
d) Economically important species

36. IUCN Headquarters is at
a) Morges, Switzerland
b) Paris, France
c) Vienna, Austria

d) New York, USA

37. Conservation within the natural habitat is
a) Ex-situ conservation
b) In-situ conservation
c) Ex-vivo conservation
d) In-vivo conservation

38. Which one of the following is not included under in situ conservation
a) Zoo
b) National Park
c) Wild life Sanctuary
d) Biosphere Reserve

39. Ex-situ conservation includes
a) Zoo
b) Botanical Garden
c) Germplasm Bank
d) All of the above

40. Hotspots are regions of high
a) Rareism
b) Endemism
c) Diversity
d) Critically endangered population

41. Which one of the following regions in India is a hotspot of biodiversity
a) Sundarbans
b) Western Ghats
c) Eastern Ghats
d) Gangetic plains

42. The discharge of warm/hot water directly into rivers is known as
a) Water pollution
b) Thermal pollution
c) Marine pollution
d) None of the above

43. Yellowing of Taj Mahal is an effect of
a) Acid rain
b) Global warming
c) Ozone depletion
d) All of the above

44. Increase in concentration of toxic level in each trophic level is referred to as
a) Eutrophication
b) Biomagnification
c) Bioaccumulation
d) Bioconcentration

45. The supersonic jets cause air pollution by the thinning of
a) Carbon dioxide layer
b) Sulphur dioxide layer
c) Ozone layer
d) Oxygen layer

46. A river with high BOD value means
a) Highly polluted
b) Highly clean
c) Highly productive
d) None of the above

47. Noise is measured by sound meter and the unit is
a) Hertz
b) Joule
c) Decibel
d) Seconds

48. Ozone Day is observed on
a) 3rd January
b)16th September
c)10th November
d) 26th March

49. Thickness of ozone layer is measured in

a) Decibels
b) Dobson unit
c) Meter
d) Armstrong unit

50. Study of trends in human population growth and prediction of future growth is called
a) Demography
b) Psychology
c) Biography
d) Kalography

51. Which of the following is the best indicator of SO_2 pollution
a) Bryophytes
b) Pteridophytes
c) Lichens
d) Algae

52. Major aerosol pollutant present in the jet plane emission is
a) SO_2
b) Fluorocarbon
c) CCl_4
d) CO

53. Who is known as Father of Green Revolution
a) Chidambaram
b) M.S Swaminathan
c) Mahatma Gandhi
d) J.C Bose
54. Fly ash is an environmental pollutant produced by
a) Thermal power plant
b) Oil refinery
c) Fertilisation plant
d) Strip mining

55. CO is a pollutant because it
a) Inactivates nerves
b) combines with oxygen

c) Combines with haemoglobin
d) Inhibits growth

56. Kyoto conference is concerned with
a) Limiting production of SO2
b) Developing alternative to ODS (ozone depleting substances)
c) Reduce emission of greenhouse gases
d) Reduction in use of energy

57. CPCB stands for –
a) Control Pollution Control Board
b) Central Pollution Central Board
c) Control Pollution Central Board
d) Central Pollution Control Board

58. CNG stands for –
a) Common Natural gas
b) Compressed National gas
c) Compressed Natural gas
d) Certified National gas

59. Which of the following is the first National Park in India?
a) Gir National Park
b) Kanha National Park
c) Jim Corbett National Park
d) Ranthambore National Park

60. Which of the following device is used to measure the atmospheric humidity?
a) Photometer
b) Auxanometer
c) Hygrometer
d) None of the above

61. In which year the "project tiger" was launched in India
a) 1973
b) 1983
c) 1993

d) 1972

62. Chipko Movement was started to conserve
a) Soil
b) Deserts
c) Grasslands
d) Forests

63. Which of the following has maximum biodiversity
a) Desert
b) Polar region
c) River
d) Tropical region

64. El Nino is
a) Warm ocean current
b) Sea storm
c) Tropical disturbance
d) Another name of Typhoon

65. The method of soil conservation in which different crops are grown in alternate rows and are sown at different times to protect the soil from rain wash is called
a) Mulching
b) Intercropping
c) Rock Dam
d) Terrace farming

66. The first protocol to ban the emissions of chlorofluorocarbons in the atmosphere was made in
a) Montreal
b) Osaka
c) Geneva
d) Florida

67. What is the main benefit of rainwater storage
a) Recharging groundwater level
b) Respite from floods

c) Reduce the scarcity of water
d) Protection from soil erosion

68. Rio Summit is associated with
a) Convention on biological diversity
b) Greenhouse gases
c) Ozone depletion
d) Wetlands

69. Which of the following aquatic plant is effective in preventing the water pollution caused by Industrial waste
a) Water hyacinth
b) Elephant grass
c) Parthenium
d) None of the above

70. What does the phrase “anthropogenic CO2 emissions” mean
a) Natural CO2 emissions
b) Human made CO2 emissions
c) Industrial CO2 emissions
d) All of the above

71. In which of the following process earthworms decompose biodegradable solid waste
a) Composting
b) Landfills
c) Shredding
d) Vermicomposting

72. The objective of environment studies is
a) To raise consciousness about environment conditions
b) To teach environmentally appropriate behaviour
c) To create an environmental ethics sensitive society
d) All of the above

73. DDT is a
a) Non-pollutant
b) Non-biodegradable pollutant

c) Biodegradable pollutant
d) None of the above

74. Bhopal gas tragedy of 1984 was caused by the leakage of
a) methyl isocyanate
b) 2-4 dichlorophenoxyacetic acid
c) ammonia
d) hydrogen cyanide

75. Nitrogen percentage in atmosphere is approximately
a) 78%
b) 90%
c) 60%
d) 55%

76. The main gases that produce acid rain are:
a) sulphur dioxide and nitrogen oxides
b) ozone and oxygen gas
c) chlorofluorocarbons
d) None of the above

77. Biogeochemical cycle includes
a) Nutrient cycling through biotic components
b) Nutrient cycling through abiotic components
c) Nutrient cycling through both biotic and abiotic components
d) None of the above

78. The term ecosystem was first introduced by
a) Utpary
b) Earnest Haeckel
c) Sir Arthur Tansley
d) Sukachev

79. In India brown Revolution is related with the production of
a) Solar energy
b) Fish production
c) Milk production
d) Biogas production

80. Which of the following agency published the Red data book
a) IUCN
b) NEERI
c) NWAP
d) CITES

81. National Environmental Engineering Research Institute is situated at ____
a) Delhi
b) Mumbai
c) Kolkata
d) Nagpur

82. Minamata is a disease caused by water pollution due to presence of …..
a) Lead
b) Mercury
c) Tin
d) Methylisocyanate

83. Which are the following strategies for sustainable development
a) Adopting 3-R approach
b) Environmental education and awareness
c) Using appropriate technology and Sustainable agriculture
d) All of the above

84. World AIDS Day is celebrated on
a) 1st December
b) 1st January
c) 10th December
d) 10th November

85. IPCC stands for
a) Information Processing Command and Control
b) Information Communication and Control
c) Intergovernmental Panel on Climate Change
d) Industrial Panel on Climate Change

86. CAZRI (Central Arid Zone Research Institute) Institute of India studies one of the following problems
a) Floods
b) Droughts
c) Desertification
d) Earthquakes

87. Which one is the correct food chain
a) Phytoplankton —» Zooplankton —» Fish
b) Zooplankton —» Phytoplankton —» Fish
c) Zooplankton —» Protozoans —» Fish
d) Grass —» Fish —» Zooplankton

88. Van Mahotsav includes
a) Planting and protecting trees
b) Destruction of trees should be curtailed
c) Restoration of green cover
d) All of the above

89. Process of burning of non-biodegradable solid waste is called
a) Composting
b) Incineration
c) Segregation
d) Sanitary land filling

90. World Water Day is celebrated on
a) March 12
b) March 22
c) March 25
d) March 30

91. Which of the following is an aquatic disaster
a) Tropical cyclone
b) Earthquake
c) Landslide
d) Tsunami

92. IUCN Stands for

a) International Union for Conservation of Nations.
b) International Union for Conservation of Nature and Natural Resources
c) International Union Council for Nature
d) International Union council for Conservation of Nature and Natural Resources

93. Which one of the following diseases is **not** water borne disease
a) Malaria
b) Dysentery
c) Diarrhoea
d) Cholera

94. Biodiversity comprises
a) Genetic diversity
b) Species diversity
c) Ecosystem diversity
d) All of the above

95. Which oil can be used as a substitute for diesel?
a) Castor oil
b) Jatropha oil
c) Cotton seed oil
d) Flax seed oil

96. What is full form of CFC
a) Chloroflurocarbon
b) Chlorineflurocarbon
c) Chlorofluridcarbon
d) Chromateflurocarbon

97. The chief ingredients of photochemical smog are
a) Acetylene
b) Acetyl
c) Oxidants
d) Hydrocarbons

98. Organisms obtaining food from dead organisms are called
a) Saprophytes

b) Autotrophs
c) Symbionts
d) None of the above

99. Soil infertility is caused by
a) Shifting cultivation
b) Industrialisation
c) Overgrazing
d) All of the above

100. The environmental problems related to population explosion are
a) Over exploitation of energy and mineral resources
b) Reduction in arable land and water crisis
c) Deforestation and global warming
d) All of the above

101. Think about the following statement(s) about sustainability.
I. It describes a process or situation that can last endlessly.
II. Natural resources must be used in a way that does not result in ecological debts due to overexploitation of the Earth's carrying and productive capacities.
III. Keeping the whole natural capital base above its current level is crucial for long-term sustainability.
a) Only I
b) Only II
c) Only II & III
d) I, II & III

102. Which one of the above is/is not a sustainable growth goal(s)?
a) Maintain the family planning program's implementation.
b) Maintain dynamic stability of arable land of at least 123 million hectares, as well as an agricultural development strategy.
c) Preserve a dynamic water resource balance by lowering water usage per unit of gross domestic product (GDP and agricultural additional value).
d) To lead about such a substantial, though not always disastrous, change in the environment.

103. What are all the main sustainability objectives?

I. Poverty and hunger eradication.
II. Higher education and healthcare standards, notably in terms of water quality and sanitation.
III. Gender equality
IV. Long-term economic growth that promotes employment and strengthens communities
a) I, II & III
b) I, III & IV
c) I & III
d) I, II, III & IV
104. When did the phrase "Sustainable Development" first appear?
a) 1987
b) 1980
c) 1978
d) 1992

105. In December————-, the General Assembly created the United Nations Council on Environmental Sustainability (CSD).
a) 1992
b) 1993
c) 1994
d) 1995

106. Which one of the following United Nations commissions is in charge of monitoring progress on Agenda 21 as well as the Rio Agreement on Environmental issues?
a) The Disarmament Commission of the United Nations
b) UN Statistical Commission (United Nations Statistical Commission) B. United Nations Statistical Commission
c) Committee on Environmental Sustainability of the United Nations (CSD)
d) Human Rights Tribunal of the United Nations

107. The 21st-century notion of sustainable growth places a greater emphasis on
a) Economic progress
b) Social progress
c) Protection of the environment

d) All of the preceding.

108. Sustainability Science is the application of concepts such as __ and sustainable development.
a) Environmental science
b) Science in general
c) Social science
d) Geoscience

109. According to the United Nations, the following are the significant issues of social progress:
a) Instruction
b) Public health
c) Living standards
d) All of the preceding

110. The United Nations has established a total Sustainable Development Goals (SDGs)
a) 15
b) 16
c) 17
d) 18

KEY SAMPLE SET QUESTION 1

1. c) French
2. d) All of the above
3. d) All of the above
4. d) All of the above
5. a) Stratosphere
6. c) Both (a) and (b)
7. a) Ethanol and methanol
8. b) Decomposers
9. a) The species whose elimination can seriously affect the ecosystem
10. c) Food web
11. b) Coniferous forests
12. d) In Deltas
13. c) Both (a) and (b)

14. c) South-east zone
15. b) June 5th
16. c) Population
17. b) Fluoride
18. d) All of the above
19. b) United Nations Conference on Environment and Development
20. b) Endemic species
21. b) The thin shell of organic matter on the surface of the earth comprising of all theliving things
22. c) Both a and b
23. c) Organic farming
24. b) First order consumer
25. b) Sun
26. b) Zooplanktons
27. b) Upright
28. a) Climax
29. a) Lichens
30. c) Pyramid of energy
31. b) Non-renewable resource
32. d) Uranium
33. d) Hydropower, solar energy, wind energy
34. b) Reforestation
35. c) Threatened species
36. a) Morges, Switzerland
37. b) In-situ conservation
38. a) Zoo
39. d) All of the above
40. c) Diversity
41. b) Western Ghats
42. b) Thermal pollution
43. a) Acid rain
44. b) Biomagnification
45. c) Ozone layer
46. a) Highly polluted
47. c) Decibel
48. b)16th September
49. b) Dobson unit

50. a) Demography
51. c) Lichens
52. b) Fluorocarbon
53. b) M.S Swaminathan
54. a) Thermal power plant
55. c) Combines with haemoglobin
56. c) Reduce emission of greenhouse gases
57. d) Central Pollution Control Board
58. c) Compressed Natural gas
59. c) Jim Corbett National park
60. d) Hy
62. d) Forests
63. d) Tropical region
64. a) Warm ocean current
65. b) Intercropping
66. a) Montreal
67. a) Recharging groundwater level
68. a) Convention on biological diversity
69. a) Water hyacinth
70. b) Human made CO2 emissions
71. d) Vermicomposting
72. d) All of the above
73. b) Non-biodegradable pollutant
74. a methyl isocyanate
75. a) 78%
76. a) sulphur dioxide and nitrogen oxides
77. c) Nutrient cycling through both biotic and abiotic components
78. c) Sir Arthur Tansley
79. d) Biogas production
80. a) IUCN
81. d) Nagpur
82. b) Mercury
83. d) All of the above
84. a) 1st December
85. c) Intergovernmental Panel on Climate Change
86. c) Desertification
87. a) Phytoplankton —» Zooplankton —» Fish

88. d) All of the above
89. b) Incineration
90. b) March 22
91. d) Tsunami
92. b) International Union for Conservation of Nature and Natural Resources
93. a) Malaria
94. d) All of the above
95. b) Jatropha oil
96. a) Chloroflurocarbon
97. d) Hydrocarbons
98. a) Saprophytes
99. d) All of the above
100. d) All of the above
101. d) I, II & III
102. d) To lead about such a substantial, though not always disastrous, change in the environment.
103. d) I, II, III & IV
104. b) 1980
105. a) 1992
106. c) Committee on Environmental Sustainability of the United Nations (CSD)
107. d) All of the preceding.
108. a) Environmental science
109. d) All of the preceding
110. c) 17

SAMPLE QUESTION SET-2

1. CNG stands for –
(A) Common Natural gas
(B) Compressed National gas
(C) Compressed Natural gas
(D) Certified National gas

2. Which of the following is a renewable source of energy?
(A) Ocean currents (B) Solar energy
(C) Biomass (D) All of the above

3.Who is known as father of Indian Ecology

(A) R Mishra (B) M S Swaminathan

(C) Odhum (D) None of the above

4. World Environment Protection Day is celebrated on

(A) 5 June

(B) 22 April

(C) 26 November

(D) 16 September

5. The year declared as the "water year" by the Indian Government is

(A) 2010 (B)2005

(C) 2006 (D) 2007

6. CPCB stands for –

(A) Control pollution control board

(B) Central pollution central board

(C) Control pollution central board

(D) Central pollution control board

7. Pyramid of energy is

(A) Always upright

(B) Always upright

(C) Sometimes upright sometimes inverted

(D) Irregular

8. Which of the following is the first national park in India?

(A) Gir National park

(B) Kanha National park

(C) Jim Corbett National park

(D) Ranthambore National park

9. All herbivores are called

(A) Primary consumers (B) Secondary consumers

(C) Tertiary consumers (D) Producers

10. In which year the "project tiger" was launched in India?

(A) 1973 (B) 1983

(C) 1993 (D) 1972

11. In a food chain there are plant, deer, wolf and lion, whose energy will be highest
(A) Lion (B) Wolf
(C) deer (D) Plant

12. Which cycle will be affected most if all decomposers of an ecosystem vanished
(A) Seasonal cycle
(B) Water cycle
(C) Bio-geochemical cycle
(D) Gaseous cycle

13. Replacement of one community of living organisms by another is known as
(A) Ecological succession
(B) Bio-geochemical cycle
(C) Ecological invasion
(D) Ecological pyramid

14. Pedology is the study of
(A) Rocks (B) Soils
(C) Diseases of crops (D) Locomotion of animals

15.The ozone layer is present in
(A) Mesosphere (B) Thermosphere
(C) Stratosphere (D) None of the above

16. Types of ecological pyramids are
(A) 2 (B) 3 (C) 4 (D) 5

17. Maximum genetic biodiversity is found in
(A) Tundra region (B) Taiga region
(C) `Tropical evergreen Forest (D) Deciduous forest

18. Which of the following gas destroys the chlorophyll present in the plant leaves?

(A) SO_3 (B) H_2S
(C) SO_2 (D) CO_2

19 . Biodiversity at local level is known as
(A) Gama Biodiversity (B) Beta Biodiversity
(C) Alpha Biodiversity (D) X- Biodiversity

20. World's known number of species of living organisms is Approximately
(A) 14 lakh (B) 24 lakh
(C) 34 lakh (D) 44 lakh

21. Nations which are extremely rich in biodiversity are categorized in
(A) Multi diversity Country (B) Super diversity Country
(C) Mega diversity Country (D) Mass diversity Country

22 .Ranthombore national park is situated at
(A) Maharashtra (B) Uttar Pradesh
(C) Gujrat (D) Rajasthan

23. A sensitive area which is extremely rich in biodiversity and endemic species is known as
(A) Cold spot (B) Hot spot
(C) Green spot (D) Red spot

24. Which one is considered as Hot spot of India
(A) Eastern Ghats (B) Western Ghats
(C) East coast (D) West coast

25. A book enlisting endangered species is known as
(A) Red Data book (B) Black Data Book
(C) Yellow Pages book (D) Blue data book

26. I.U.C.N. is an organization which is associated with
(A) Water Conservation
(B) Living Organism Conservation

(C) Soil Conservation (D) Food Conservation

27. In India where combination of Mangroves forest, Evergreen forest and Deciduous forest occur
(A) North coatal Andhra Pradesh (B) South-West Bengal
(C)Southern Saurashtra (D) Andaman and Nicobar Islands

28. Dianasour comes in of which Category
(A) Rare species
(B) Endangered species
(C) Extinct species
(D) Monstor species

29. Petroleum is which type of source
(A) Non-renewable (B) Renewable
(C) Synthetic (D) Non-convinient

30. Which of the following is an example of *In-situ* conservation
(A) Tiger Project (B) Aquarium
(C) Zoo (D) Green House

31. DDT is
(A) Antibiotic
(B) Bio-degradable Pollutant
(C) Non-bio-degradable Pollutant
(D) None of the above

32. Area totally prohibited for anthropogenic activities
(A) Sanctuary
(B) National Park
(C) Biosphere Reserve
(D) Tiger Project

33. Biotic component of Environment and Ecology is
(A) Soil(B) Water (C) Air (D)Plants

34. Study of the Relationship between living organism and environment is

(A) Life Sciences (B) Bio Geography
(C) Physics (D) Ecology

35. Who used Word Ecology for the first time
(A) Odum (B) Tansely
(C) Tailor (D) Darwin

36.Which one is the example of Artificial ecosystem
(A) Coral Reefs
(B) Wetlands
(C) Field
(D) River

37.Which one is the example of Salty water ecosystem
(A) River (B) Coral Reefs (C) Dam (D) Pond

38. Soil erosion can be prevented by
(A) Overgrazing by the animals
(B) Eradication of the plants
(C) Afforestation
(D) By increasing bird's population

39. Who converts light energy to chemical energy is
(A) Bacteria (B) Decomposers
(C) Secondary Consumers (D) Green Plants

40. Which one is the example of Decomposers.
(A) Algae (B) Planktons
(C) Fungi (D) Frog

41. Which one is included in Biomass
(A) Producers (B) Consumers
(C) Decomposers (D) All living organisms

42. In an Ecosystem the main source of energy is
(A) Geotherm (B) Sun
(C) Green house Gases (D) All living beings

43. In an Ecosysterm energy is
(A) Transformed
(B) Formed
(C) Remains constant
(D) Destroyed

44. If peacock eats snake, snake eats insect and insect eats plant, the peacock is known as
(A) Primary consumer
(B) Primary decomposer
(C) Final decomposer
(D) Top of the food Pyramid

45. How much of energy reached to herbivore from plants
(A) 10% (B) 20%
(C) 30% (D) 1%

46. Level of Energy Flow in an ecosystem is always
(A) Higher level to lower level
(B) Higher level to More higher level
(C) Low level to high level
(D) At equal level

47. Flow of different chemical elements in an ecosystem is
(A) Unidirectional (B) Longitudinal
(C) Cyclic (D) Horizontal

48, Non- conventional source of energy is
(A) Petroleum (B) Coal
(C) Solar Radiation (D) Electricity of Nuclear energy producing Centres

49. Which one is flowed in Sedimentary Cycle
(A) Water (B) Minerals
(C) Air (D) Energy

50. In a Food chain each link is called

(A) Production level (B) Food level
(C) Trophic level (D) Absorption level

51. What is produced by connecting more than one food chains at any level
(A) Food cycle (B) Food Web
(C) Food connection (D) Food tree

52. Sound which has jarring effect on ears is
(A) Noise (B) music
(C) pleasant sound (D) soul music

53. Weakest link of the food chain is
(A) Primary consumers (B) Producers
(C) Secondary consumers (D) Top consumers

54. Name the place where World Environment Summit of 2 June ,1972 held
(A) Geneva
(B) Rio de Janeiro
(C) Stalkhom
(D) London

55. In which summit it was declared that every 5^{th} June of the year will be celebrated as world's environment day.
(A) Stalkhom summit (B) Rio de Janeiro summit
(C) Quato summit (D) None of them

56. World Ozone day is celebrated on
(A) 5 September (B) 16 September
(C) 16 October (D) 5 December

57. Temperature, Soil, Light are come under which component of the Environment
(A) Biotic component
(B) Abiotic component/Physical component
(C) Anthropogenic component

(D) None of them

58. Sound is measured in which unit
(A) kilometer (B) decibel
(C) hertz (D) Armstrong

59. Level of noise recommended in most countries is
(A) 40-65 dB (B) 85-90 dB
(C) More than 120dB (D) None of the above

60. Which sphere is spread on Two third part of the earth
(A) Mesosphere (B) Atmosphere
(C) Hydrosphere (D) None of the above

61. What is the range of the intensity scale used in measuring earthquakes
(A) 1 to 5 (B) 1 to 12
(C) 1 to 7 (D) 1 to 8

62. Decomposers of the earth is/are
(A) Animals (B) Birds (C) Bacteria and Fungi (D) Soil and Water

63.Global biodiversity is known as
(A) Alpha (B) Beta (C) Gamma (D) Nano

64. What is the main source of oxygen in earth
(A) Green plants (B) Environment
(C) Rain Water (D) None of them

65. for environmental education touring method is
(A) Entertaining
(B) Practical
(C) Useful for life
(D) All of the above

66. Valley of Flowers is situated at

(A) Uttarakhand (B) Karnataka
(C) Goa (D) West Bengal

67. 'Jhoom method' of cultivation is practiced in
(A) Himachal Pradesh
(B) Mid High lands
(C) Coastal Tamilnadu
(D) Nagaland

68.Which one of the following is most responsible for green house effect
(A) Carbon dioxide (B) Methane
(C) Nitrous oxide (D) Chloroflorocarbon

69. Kyoto Protocol is an agreement between different countries
(A) to save water
(B) Protection of the ozone layer
(C) methods to implement to reduce global warming
(D) to protect plants

70. Ozone hole is widest
(A) Above Antarctica
(B) Above Africa
(C) Above Asia
(D) All of the above

71.Montreal Protocal is concerned with
(A) Protection of the ozone layer
(B) Methods to implement to reduce global warming
(C)To save water (D) All of the above

72. Which pigment protect plants from adverse effects of Ultra violet rays
(A) Chlorophyll a (B) Carotenoides
(C) Phycocyanin (D) All of the above

73. UNEP stands for
(A) United Nations Ecological Program
(B) United Nations Environment Protection

(C) United Nations Environment Program
(D) United Nations Environment Protection

74. In which year Nmami Gange Programme was lauched
(A) June 2015
(B) May 2015
(C) June 2014
(D) May 2014

75. Ecomark is given to Indian Products which are
(A) Hazardous
(B) Plastics
(C) food items
(D) which are environment friendly

76. Which green house gas is produced by Grazing animals .
(A) Nitrogen (B) Carbon dioxide
(C) Methane (D) Carbon monooxide

77. Which of the following is the cause of Melanomia (skin cancer)?
(A) Acid rain (B) Allergens
(C) Ozone depletion (D) None of the above

78. Which is known as 'Oran'?
(A) Sacred Plant (B) Sacred Animal
(C) Sacred Mountain (D) Sacred Forest

79. Plants growing of alkaline soil are known a
(A) Xerophytes (B) Mesophyte
(C) Hydrophyte (D) Halophyte

80. How much percentage of land is targeted for Biodiversity conservation by United Nation Organization
(A) 7 (B) 17
(C) 25 (D) 33

81.Which one of the following is enlisted in Endangered plant species of India

(A) Mango (B) Shisham
(C) Saagaun (D) Sandal

82. Evergreen Forest of Western Ghats are known as
(A) Aaranyak (B) Sola
(C) Tega (D) Selva

83. Which causes water pollution
(A) By accumulation of the salts
(B) By Industrial effluents
(C) By death of the aquatic animals
(D) By rain

84. Where is Kajiranga National Park situated
(A) Uttarakhand (B) Aasam
(C) Arunachal Pradesh (D) Nagaland

85. Which one of the following is more responsible for Global Climate Change
(A) Increase in green house gases
(B) Less Rainfall
(C) Atomic weapon
(D) Population explosion

86. Which gas is an atmospheric Pollutant
(A) Sulphur dioxide (B) Oxygen
(C) Ozone (D) Nitrogen

87. Which gas contributed more as green house gas
(A) CFCs (B) Carbon dioxide
(C) Nitrous oxide (D) Methane

88. What is the main source of emission of carbon di oxide
(A) Combustion of the fossil fuel
(B) Respiration by living organisms
(C) Volcanic activities D) Marshy Lands

89. Which gas has maximum life period among greenhouse gases

(A) Carbon dioxide (B) Nitrous oxide
(C) Methane (D) CFCs

90. By which industry maximum emission of the Nitrous oxide occur
(A) Nylon (B) Cement
(C) Cloth (D) Paper

91. When did National Disaster Management Authority formed (NDMA)
(A) 2000 (B) 2008
(C) 2005 (D) 2003

92. Which home appliance is harmful for ozone layer
(A) Computer (B) Television
(C) Air conditioner (D) Cooler

93. At present scenario, what is the major risk factor for the survival of living organisms
(A) Radiation
(B) Desertification
(C) Deforestation
(D) Glaciations

94. How forests are helpful to control drought
(A) Forest prevents soil erosion (B) Forest causes rain
(C) Many aquatic plants found in Forest (D) Forest act as water shield

95. How much percentage of landmass is prone to earth quake in India
(A) 58% (B) 60%
(C) 63% (D) 65%

96. Which one of the following is free living nitrogen fixing soil borne bacteria
(A) *Azotobacter* (B) *Nitrosomonas*
(C) *Rhizobium* (D) *Pseudomonas*

97. Who is associated with 'Chipko Movement'.
(A) Chandi Prasad Bhatt (B) Sunderlal Bahuguna

(C) Gaura Devi (D) All of th above

98. Percentage forest cover in India is
(A) 23.54% (B) 21.23%
(C) 33% (D) 22.16%

99. World's only carbon free country is
(A) Sweden (B) New Zealand
(C) Finland (D) Canada

100. On climate change scenario, whose production is more emphasized in National Action Plan issued by the Central Government
(A) Water Conservation (B) Green India Plan
(C) Sustainable Development (D) Solar Energy Production

101. The ability of a population to increase under ideal environmental conditions is called
(A) Natality (B) Carrying capacity
(C) Biotic potential (D) Absolute natality

102. Lincoln index measures
(A) Population mortality rate (B) Population natality rate
(C) Population size (D) Population density

103. dB is the abbreviation used for the quantitative expression of
(A) Density of bacteria in a medium (B) A Particular Pollutant
(C) Dominant Bacillus in a culture (D) A pesticide

104. The United Nations Conference on Sustainable Development (UNCSD) is also known as
(A) Rio 2010 (B) Rio 2011
(C) Rio 2012 (D) Rio 2013

105. Which of the following statements is true about the Air Quality Index?
A. It indicates the colour of the air.
B. It predicts ozone levels in your area.
C. It determines the intensity of sound and sound pollution.
D. It estimates air pollution mainly sulphur content in the air.
106. In which year did the word 'sustainable development' come into existence?
(A) 1992 (B) 1978
(C) 1980 (D) 1987

107. Which option is true if just two of the three foundations of Sustainable Development are encountered?
(A) Viable = Economic + Ecological Sustainability
(B) Bearable = Social + Ecological Sustainability
(C) Equitable Social + Economical Sustainability
(D) None of the preceding

108. In the year, the U.N. General Assembly constituted a Committee on Sustainability (CSD).
(A) 1995 (B) 1994
(C) 1993 (D) 1992

109. The vast holes left behind after mining are utilised for
(A Wastewater storage (B) Domestic wastewater storage
(C) Waste disposal (D) Waste storage

110. Mercury and lead are poisonous substances that contribute to
(A) Noise exposure (B) Poor air quality
(C) Water contamination (D) Soil pollution

111. The alternative name for landscaping is
(A) Decrease (B) Restoration,
(C) Topsoil removal (D) Soil pollution
.
112. Which of the following options is not included in the sustainable development parameters?
(A) Gender inequality and diversity (B) Inter-generational and

intr-agenerational equity
(C) Growing annually (D) None of the above

113. What is the definition of sustainable development?
(A) The growth that satisfies current demands without jeopardising future generations' ability to fulfil their own needs.
(B) Conserve mineral wealth and explore alternative energy sources while decreasing pollution and environmental impact.
(C). It is the process of creating land and building projects in such a way that they have a lower environmental effect by enabling them to produce fuel-efficient self-sufficiency patterns.
(D) All the preceding

114. If we only accomplish two of the three foundations of Sustainable Development, which of the preceding is correct?
A. Social + Financial Longevity = Fairness
B. Bearable = Economic + Ecological Sustainability
C. Viable = Socio + Ecological Sustainability
D. All of the preceding.

115. The component (s) of sustainable farming are as follows:
(A) Permaculture (B) Agroforestry
C) Mixed farming (D) All of the preceding

116. An indicator of a company's long-term viability
(A) Environmental friendliness (B) Socio-economic efficiency
(C) Both a and b are true (D) None of the preceding

117. The United Nations uses four sectors of sustainability rings.
A. Monetary, environmental, political, and cultural factors
B. Monetary, social, political, and cultural factors
C. Economic, environmental, social, and cultural factors
D. Economic, environmental, political, and social factors

118. The Un-Conference for Environmental Sustainability is often recognized by the United Nations World Summit held on-
A. Rio de Janeiro, 2010.

B. Rio de Janeiro, 2011.
C. Rio de Janeiro, 2012
D. Rio de Janeiro, 2013

119. The human activity that creates the environmental damage with regional and global consequences is:
(A) Industrialization (B) Urbanization
(C) Agriculture (D) Mining

120. Where did the first move toward sustainable development occur?
A. Stockholm Conference (Stockholm)
B. Conference in Bangkok
C. Conference in San Francisco
D. All of the preceding

121. What would "Agenda-21" mean?
A. Agenda 21 is a Sustainable Development Goal Action Plan that is non-binding and implemented voluntarily.
B. It's a climate change pact involving 20 poor countries throughout the world.
C. It's a worldwide free trade pact including seven developed countries.
D. None of these is true.

122. Whichever of the below is the seventh of the United Nations' eight-millennium goals?
A. To end extreme poverty and hunger;
B. To ensure environmental sustainability;
C. To minimise child mortality; and
D. To establish global development cooperation.

123. Which of the following statement with respect to National Green Tribunal is incorrect?
A. NGT has been established under National Green Tribunal Act, 2011.
B. It consists of a full-time chairperson, judicial members and expert members.
C. The Tribunal has Original Jurisdiction on matters of substantial question relating to environment.
D. None of the above

124. Which of the following pollutants are considered when measuring air quality?
(A) CO, O_3, $PM_{2.5}$ (B) NH_3, PM_{10}, Pb
(C) NO_2, SO_2 (D) All of the mentioned

125. What range of air quality index has the most severe impact on human health?
(A)101-200 (B) 201-300 (C)301-400
(D) 401-500

126. When the National Environmental Policy Act was signed into law?
(A) January 1 1971 (B) January 2 1970
(C) January 1 1970 (D) January 1 1972

127. Number of babies produced per thousand is known as
(A) Immigration (B) Mortality (C)Natality
(D) Emigration

128. Mitigation measures may be public awareness programme.
(A) lead agency (B) correction (C) preventive
(D) aspect

129. ISO 14000 standards are for the:
(A) Quality Management System (B) Environmental Management System
(C) Administration (D) Supply chain

130. Which of the following pair of ISO 14000 standards fall under the category of Environmental Management System?
(A) ISO 14001 and ISO 14004
(B) ISO 14010 and ISO 14001
(C) ISO 14011 and ISO 14001
(D) ISO 14011 and ISO 14004

Answer Key of Sample questions set-2

Q	Ans	Q.	Ans	Q.	Ans	Q.	Ans	Q.	Ans	Q.	Ans
1	C	26	B	51	B	76	C	101	C	126	C
2	D	27	D	52	A	77	C	102	C	127	C
3	A	28	C	53	D	78	D	103	B	128	C
4	C	29	A	54	C	79	D	104	C	129	B
5	D	30	A	55	A	80	B	105	D	130	A
6	D	31	C	56	B	81	D	106	C		
7	A	32	B	57	B	82	B	107	D		
8	C	33	D	58	B	83	B	108	D		
9	A	34	D	59	B	84	B	109	C		
10	A	35	B	60	C	85	A	110	C		
11	D	36	C	61	B	86	A	111	B		
12	C	37	B	62	C	87	C	112	D		
13	A	38	C	63	C	88	A	113	D		
14	B	39	D	64	A	89	B	114	D		
15	C	40	C	65	D	90	A	115	D		
16	B	41	D	66	A	91	C	116	D		
17	C	42	B	67	D	92	C	117	A		
18	C	43	A	68	A	93	C	118	C		
19	C	44	D	69	C	94	B	119	A		
20	A	45	A	70	A	95	A	120	A		
21	C	46	A	71	A	96	A	121	A		
22	D	47	C	72	B	97	D	122	B		
23	B	48	C	73	C	98	A	123	A		
24	B	49	B	74	C	99	A	124	D		
25	A	50	C	75	D	100	D	125	D		