CPA COLLEGE OF GLOBAL STUDIES, PUTHANATHANI

DEPARTMENT OF BOTANY

ENVIRONMENTAL SCIENCE

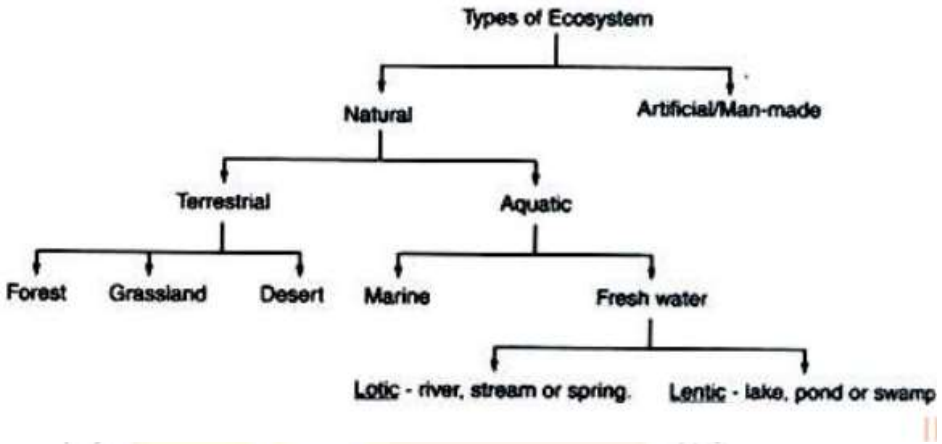
Semester notes – 6th semester Botany

Module - I:

Chapter 1:

Ecosystem/biogeocoenosis/biogeocoenose- it is a complex, self supporting dynamic system of mutually depending and regularly interacting abiotic and biotic components.

- Term coined by Transley 1835
- Kinds of ecosystem



- **Components of ecosystem- abiotic and biotic factors**

  Abiotic factors-physical and chemical characteristics

  1. Physical factors
     a. Climatic factors- eg. Air, heat, light, temperature etc
     b. Edaphic factors-eg-soil water, soil air, etc
     c. Topographic or physiographic factors-eg. Attitude, latitude, etc
  2. Chemical factors- eg. atmospheric gases, pH, water, nutrients, etc.

  Biotic factors- living organisms and their interaction

  1. **Producers or autotrophs** - make their own food through a process called photosynthesis. This food is used by the plant for its own energy or may be eaten by consumers.
     a. Phototrophs
     b. Chemotrophs

- **Ecological roe of autotrophs**
    - Energy fixation and organic production
    - Incorporation of minerals into protoplasm
    - Serve as the source of food energy for heterotrophs
    - Provide habitats
    - Environmental modification

2. **Consumers or heterotrophs** - need to eat food that autotrophs have produced. There are different types of consumers. Herbivores eat plants. Carnivores eat animals. Omnivores eat both plants and animals.
    1. Phagotrophs
    2. Saprotrophs or osmotrophs
    3. Parasites

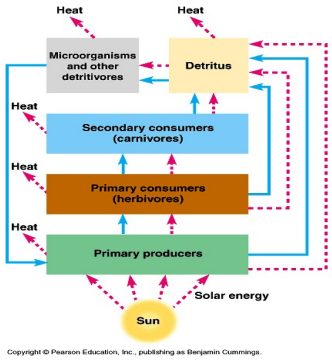
- **Ecological role of heterotrophs**
    - Cycling of minerals
    - Energy utilization
    - Control population growth and maintain nature's balance

3. **Decomposers/ reducers-** that break down the dead tissue and waste products. They play a very important role in the ecosystem because they recycle the nutrients. Bacteria and fungi

- **Ecological role of decomposers**
    - Return minerals to the environment and thereby enable the re-cycling of essential elements b/w organisms and the environment

4. **Transformers/converters**- are certain types of bacteria. They attack on materials excreted by other living organisms (even dead plants and animals).

- **Dynamics of the ecosystem with energy flow and mineral cycling**



- **Trophic structure**- The hierarchial organization of the different trophic levelsof a food chain in regular succession is called trophic organization or trophic structure.
- Each step in the food chain is called trophic level
- **Food chain-** Transfer of food energy from green plants (producers) through a series of organisms with repeated eating and being eaten link is called a food chain

  E.g. Grasses → Grasshopper → Frog → Snake → Hawk/Eagle

  Types of Food Chains:

  1) Grazing food chain and

  2) Detritus food chain
- **food web-**Complex meshwork of interconnecting and interacting food chains
- **Significance of food web-** enables the transfer of energy and cycling of nutrients, ensures maximum species interaction.
- **Ecological pyramids**- graphic representation of the trophic structure and function of an ecosystem with special reference to number of individual organisms, biomass and energy level.
  - **Inverted ecological pyramids**- eg. parasitic food chain
  - **Kinds of ecological pyramids**
    a) **Pyramid of energy**
    b) **Pyramid of biomass**
    c) **Pyramid of numbe**
- **Energy flow**-orderly and step by step linear flow or transfer of energy from producers to decomposers
  - **Lindeman's law of Ten Per Cent**
  - **Energy flow of thermodynamics**
- **Productivity of ecosystems**-rate of production of biomass or organic matter per unit of time and area.

  3 Fundamental concepts

  1. **Standing crop**
  2. **Materials removed**
  3. **Production rate**

  Kinds of productivity- organic production occur at two major levels

a) **Primary productivity**
    1. Gross primary productivity (GPP)
    2. Net primary productivity (NPP)
    3. Net community productivity (NCP)

b) Secondary productivity (SP)

Chapter 2:

Biogeochemical cycles (Carbon, Nitrogen, Phosphorous)

- **Biogeochemical cyclic**- The cyclic back and forth regenerative movement of chemical elements between organisms and environment
- **Reservoir pool** – store house of primary sources of the element
- **exchange pool**- quick and active transfer of element from one source to another
- Based on nature of reservoir pool, two kinds of nutrient cycles
    1. Gaseous cycles – eg: Nitrogen, oxygen, carbon, water cycles
    2. Sedimentary cycles- eg: sulphur, phosphorous, calcium cycles
- Perfect cycle and imperfect cycles
- Open cycles and closed cycles
- Recycling pathways
    1. Decomposition pathway
    2. Excretory and respiratory pathway
    3. Solar energy mediated pathway
    4. Fossil fuel mediated pathway
    5. Autolytic pathway
    6. Volcanic pathway
- **Recycling index**

$$\mathbf{CI=TST_C/TS_T}$$

Where,

CI- the Recycling index

TSTC- the portion of the total flux or total throughflow that is recycled

TST- the total flux or total throughflow of the nutrient in the whole system

- **Nitrogen cycle-** the cyclic back and forth movement of nitrogen between atmosphere and living organisms
    - **Chemical process of nitrogen cycle-** involves several process as follows

1. Nitrogen fixation (N_2 to NH_3/ NH_4^+ or NO_3^-)
    a) Industrial nitrogen fixation
    b) Non biological nitrogen fixation
    c) Biological nitrogen fixation
        i. Non symbiotic or free living nitrogen fixers – eg: bacteria, Nostoc, Azotobactor, etc
        ii. Symbiotic nitrogen fixers- eg: blue green algae, lichens, some bacteria (Rhizobium)
2. Ammonifcation (organic nitrogen compounds to NH_3)
3. Bacterial nitrification (NH_3 to NO_3^-)
4. Nitrate assimilation (Incorporation of NH_3 and NO_3^- into biological tissues)
5. Replenishment of soil nitrogen
6. Bacterial denitrification (NO_3^- to N_2)

- **Carbon cycle –** is a perfect gaseous cycle. The **carbon cycle** is the biogeochemical **cycle** by which **carbon** is exchanged among the biosphere, pedosphere, geosphere, hydrosphere, and atmosphere of the Earth.

  ➢ **Oceanic Carbon Cycle-** Ecologically, oceans take in more carbon than it gives out. Hence, it is called a "carbon sink." Marine animals convert carbon to calcium carbonate and this forms the raw building materials require to create hard shells, similar to the ones found in clams and oysters.

  ➢ **Carbon Cycle on Land-** Carbon in the atmosphere is present in the form of carbon dioxide. Carbon enters the atmosphere through natural processes such as respiration and industrial applications such as burning fossil fuels. The process of photosynthesis involves the absorption of CO_2 by plants to produce carbohydrates
- **Phosphorous cycle-** the excellent examples of sediment cycle
    - ➢ It is an essential constituent of nucleic acid, energy rich phosphates, bone, teeth etc
    - ➢ Principal reservoir of phosphorous- phosphate rocks, fossil deposits of the bones of animals etc

- ‘Phosphorous pool’- through soil erosion and running water, some phosphorous from these reservoirs getting distributed in the soil
- Plants absorbs
- Enters into food chain and food web
- Small amount of phosphorous enters into soil by the excreta of animals
- To soil by death and decaying of animals and plants and recycled

3. Plant adaptations- morphological, anatomical, physiological and behavioral specifications of organisms to ensure their survival.

- **Hydrophytes**
  - Aquatic plants
  - Based on the nature of roots and the position of foiages and flowers, into **5 groups**
    1. **Free floating hydrophytes-** eg: *Wolffia, Lemna, Azolla, Salvinia* etc
    2. **Rooted hydrophytes with floating leaves- eg:** T*rapa, Nymphaea, Marsilea,* etc
    3. **Submerged floating hydrophytes-** eg: *Utricularia, Cratophyllum*, etc
    4. **Rooted submerged hydrophytes-** eg: *Hydrilla, Vallisneria, Chara*, etc
    5. **Rooted emergent hydrophytes-** eg: *Ranunculus, Cyperus*, etc
- **Adaptations of hydrophytes**
  1. **Morphological adaptations**
     a) Morphological modifications of roots
     b) Morphological modifications of stem
     c) Morphological modifications of leaf
  2. **Anatomical modifications**
     a) Anatomical modifications of leaves
     b) Anatomical modifications of stem
     c) Anatomical modifications of roots
  3. **Physiological adaptations**
- **Xerophytes-** plants growing n dry habitats, desert or semi desert regions

- **Classification of xerophytes-** based on their morphology and anatomy, drought resisting powers, and the nature of substratum
    a) **Classification based on the morphology, anatomy and life cycles**
        i. **Ephemerals**- small sized and short living plants- eg: *Solanum xanthocarpum, Cassia tora, etc*
        ii. **Succulents**- plants with fleshy and swollen stems, roots, or leaves. Eg: *Opuntia*, *Euphorbia, Aloe*
        iii. **Non succulent perennials**- true drought resistant xerophytes. Eg: *Casuarina, Nerium, Acacia nelotica, Calotropis procera, etc*
    b) **Classification based on drought resistance**
        i. **Drought escaping xerophytes-** eg: *Argemone mexicanum*
        ii. **Drought enduring xerophytes-** eg: *Solanum surattense, etc*
        iii. **Drought resistant xerophytes-** eg: *Bryophyllum tradescantia*
    c) **Classification based on substratum-** *eg: Lichens, Linaria*
- **Adaptations of xerophytes**
    1. **Morphological adaptations**
        a) Morphological modifications of roots
        b) Morphological modifications of stem
        c) Morphological modifications of leaf
    2. **Anatomical modifications**
        d) Anatomical modifications of leaves
        e) Anatomical modifications of stem
        f) Anatomical adaptations of root
    3. **Physiological adaptations**
- **Halophytes**

    Classification based on the substractum

    1. Lithophilous halophytes
    2. Psammophilous halophytes
    3. Pelophilous halophytes
    4. Helophilous halophytes

    Classification based on salt tolerance

    1. Salt escaping halophytes
    2. Salt evading halophytes

3. Salt resistant halophytes
4. Salt enduring halophytes

Classification based on response to salinity

1. Obligatory halophytes
2. Preferential halophytes
3. Occasional or accidental halophytes
4. Supporting halophytes

Morphological adaptations

g) Morphological modifications of roots
h) Morphological modifications of stem
i) Morphological modifications of leaf

Anatomical modifications

j) Anatomical modifications of leaves
k) Anatomical modifications of stem
l) Anatomical adaptations of root

Physiological adaptations

- **Epiphytes**

  Classification

  1. **Proto-epiphytes**
  2. **Hemi- epiphytes**
  3. **Nest epiphytes**
  4. **Tank epiphytes**

- **Parasites**

  a) **Obligatory root parasites**
     1. **Rafflesia**
     2. **Orobanche**
     3. **Balanophora**
  b) **Facultative root parasites**
  c) **Stem parasites**
  d) **Obligatory stem parasites**
  e) **Facultative stem parasites**

Chapter 4:

- **Plant Succession: Definition-** appearance and disappearance of communities in regular succession in a particular area, until a final stable community emerges.
  - Mechanisms of succession
    1. Nudation
    2. Invasion
    3. Ecesis and aggregation
    4. Competition and coaching
    5. Reaction
    6. Stabilization
- **Primary and Secondary succession**
  - Primary succession
    - Succession occurring in primitive
    - Succession on rocks, clay, or sand dune etc.
  - Secondary succession
    - Occurring in previously establishing communities
    - In harvested or ploughed fields
- **Autogenic and allogenic succession;**
  - On the mode of environmental modification
  - The existing vegetation modifies the environment either by producing humus through death and decay-autogenic
  - Involves changes in abiotic environment
- **Mechanism of plant succession–Xerosere and Hydrosere**

  1. **Hydrosere**
     - In newly formed ponds, or any fresh water body
     - Starts with phytoplanktons
     - Different stages
       1. Phytoplankton stage
       2. Rooted submerged stage
       3. Rooted floating stage
       4. Reed-swamp stage
       5. Sedge-meadow stage
       6. Woodland stage

7. Forest stage

2. **Xerosere**
    - In xeric habitat, like rock, etc
    - On bare rock surface is called ithosere
    - Various stages of lithosere
        1. Crustose lichen stage
        2. Foliose lichen stage
        3. Moss stage
        4. Herbs stage
        5. Shrubs stage
        6. Forest stage

Module - II:

1. **Biodiversity and conservation**

Represents the totality, abundance, and interrelatedness of the genes, species and ecosystems of the region and their interaction with the interaction

- Components of biodiversity
    1. Genetic diversity
    2. Species diversity
    3. Community diversity and ecosystem diversity
    4. Landscape diversity
- Levels of biodiversity
    1. Alpha diversity
    2. Beta diversity
    3. Gamma diversity

- **Biodiversity - Global and Indian Scenario**
    - ✓ Biodiversity is rich in tropical countries, and poor in polar regions
    - ✓ 70%- invertibrates
    - ✓ 15%- plants
    - ✓ 15%- vertebrates
- **Megadiversity nations and hotspots**
    - ✓ The geographical regions with highly favorable ecological conditions, high species abundance and immense biodiversity
    - ✓ Eg: India

- ✓ Concept introduced by *Mittermier and Werner* 1990
- ✓ Countries include, Australia, Brazil, Cameroon, China, Colombia, Costa Rica, Ecuador, Ethiopia, India, Indonesia, Madagascar, Malaysia, Mexico, etc.

- **Hot spots**
  - ✓ The regions with extremely high species diversity
  - ✓ High concentrations of endemic species
  - ✓ Most seriously threatened flora and fauna
  - ✓ More than 1,500 endemic species and nearly 70% of its original habitat is lost
  - ✓ Two main hot spots
  - ✓ 1. Western Ghats
  - ✓ 2. Eastern Himalayas and indo-Burma
- **Threats to biodiversity**
  - ➢ Natural as well as anthropogenic factors
  - ➢ Natural threats- flood, drought, earth-quakes, volcanic eruptions, landslides, storms, typhoons, tsunamis, hurricanes etc
  - ➢ Anthropogenic – degradation, fragmentation, destruction of natural habitats, overexploitation of biotic resources, etc
  - ➢ Loss of biodiversity- tropical forest are disappearing at an alarming rate of 7.5 million hectares per year
  - ➢ Causes-
  - ➢ 1. Loss and fragmentation of habitats
  - ➢ 2. Introduction of exotic species
  - ➢ 3. Overexploitation of biotic resources
  - ➢ 4. Extensive urbanization and massive industrialization
  - ➢ 5. Environmental pollution
  - ➢ 6. Extension of intensive agriculture
  - ➢ 7. Large scale deforestation
  - ➢ 8. Indiscriminate massacre of wildlife

- **Endangered and endemic plant species –**

➢ Endangered Species : The endangered species are those living organisms which are almost on the critical level. Thousands of species of plants and animals are endangered and the number increases each year.

- The concept of Endemism was first given by CANDOLLE. When a species is found only in a particular geographical region because of its isolation, soil and climatic conditions, it is said to be endemic.
- Endemic species are geographically constrained to one particular place on the planet. They often live on islands, though humanity has pushed more than a handful of continent-based animals to an endemic state through hunting and habitat loss.
- Endemic species are more likely to form in biologically isolated areas such as islands and large bodies of water. Endemic species run a higher risk of extinction because of their geographic isolation
- Kiwi Endemic Species of New Zealand New Zealand
- Kangaroo Endemic Species of Australia Australia
- Giant Crab Endemic Species of Australia Australia
- Ant eater Endemic Species of Central America Central America
- Lemur Endemic Species of Madagascar Madagascar
- Giant Panda Endemic Species of China China
- Albatross Endemic Species of China China
- Horned grebe (Podiceps auritus) Endemic Species of China China
- Formosan Macaque Endemic Species of Taiwan Taiwan
- Honey creeper Endemic Species of Hawaii Hawaii
- Philippine Crocodile Endemic Species of Philippines Philippines
- Sub nosed Monkey Endemic Species of Vietnam Vietnam
- Indian Pangolin Endemic Species of India India
- Chin Kara Endemic Species of India India
- Grey Jungle Fowl Endemic Species of India India
- Single Horned Rhino Endemic Species of India
- Indian Elephant Endemic Species of India India
- Nilgiri Tahr Endemic Species of India India
- Andaman Serpent Eagle Endemic Species of India India
- Toad skinned Frog Endemic Species of India India
- Gloriosa superba Endemic Species of India India
- Andaman Cobra Endemic Species of India India
- Indian Flying Fox Endemic Species of India India
- Venated gliding frog Endemic Species of India India
-

- **Red data book –**
  - Red Data Book also known as IUCN RED LIST (International Union for Conservation of Nature), founded in 1964.
  - Red Data Book is a type of a public documents, which is created for the recordings of Endangered and rare species including Plants, Animals, Fungi, and as well as some local subspecies, which are present within the region of the State or Country.
  - Red Data Book help us in providing complete information for research, studies and also for monitoring the programs on rare and endangered species and their habitats.
  - The nine groups includes
  - Not Evaluated (NE), Data Deficient , Least Concern (LC), Near Threatened (NT), Vulnerable (VU), Endangered (EN), Critically Endangered (CR), Extinct in the Wild (EW), Extinct (EX)
- **Exotic and indigenous plant species –**
  - Exotic species are plants that have been introduced, by humans, to an area they are not native to, usually for decorative or ornamental purposes.
  - Sometimes exotic species can become invasive and disrupt native plant ecosystems.
- **Keystone species** –
  - The concept of the keystone species was introduced in 1969 by Robert T Paine
  - Commonly it's a predator.
  - It can be any organism.
  - Without keystone species, the ecosystem will be different
  - Helps to determine the types and numbers of various other species in the community.
  - Plays a critical role in maintaining the structure of an ecological community.
  - Keystone species is a species that has a disproportionately large effect on its natural environment relative to its abundance.

- **Flagship species**
- Flagship species are also known as charismatic species.

- These are iconic throughout the world due to their unique appeal. Panda, polar bears, turtles, tigers, rhinoceros, etc. are a few flagship species that have gained international recognition.
- Every country can have its own flagship species that are unique to its place. For eg., Iberian lynx is the flagship species in Spain.
- Flagship species are the species that are on the verge of extinction.
- They are therefore used as an ambassador to draw society's attention towards the need to conserve them.
- The Bengal Tiger, Asian Elephant, African Elephant, and Giant Panda are a few flagship species used by the World Wildlife Fund.
- The main objectives of flagship species are:
- The unique features of these animals help in attracting society's attention.
- Raising awareness about the protection and conservation of these species.

3. Conservation strategies ex situ and in situ methods.

- Conservation of biodiversity through establishment of protected areas like National Park, Wild life sanctuary, Biosphere Reserves, Marine Reserves etc.
- Since chemical pesticides are responsible for a large number of animal deaths occurring every year, minimizing the use of chemical pesticides is another technique for the survival of biodiversity.
- Preserving the habitat is the most important issue in the conservation of biodiversity.
- It is now recognized that ex situ techniques can be efficiently used to complement in situ methods, and they may represent the only option for conserving certain highly endangered and rare species (Ramsay et al., 2000).
- Both in situ and ex situ methods of biodiversity conservation are equally important.
- Protecting the loss of Biodiversity.
- **In situ protected areas**- WILD LIFE SANCTUARIES, TIGER RESERVES, NATIONAL PARKS, BIO SPHERE RESERVES
- **Ex-situ conservation** of plant genetic resources can be achieved through different methods such as DNA banks, Pollen banks and , In vitro storage methods, Field gene banks, Seed banks, Gene Sanctuaries

- **Organizations** –

1. **IUCN**
    - The International Union For Conservation Of Nature And Natural Resources (IUCN) 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, lobbying and education.
    - Best known for compiling and publishing Red list : accesses the conservation status of species worldwide.
    - IUCN's mission is to "influence, encourage and assist societies throughout the world to conserve nature and to ensure that any use of natural resources is equitable and ecologically sustainable".
    - The IUCN Red list is set upon precise criteria to evaluate the extinction risk of thousands of species and subspecies.
    - A series of regional red lists are produced by countries or organizations, which assess the risk of extinction
    - The IUCN is the world's main authority on the conservation status of species.
    - IUCN Red list was founded in 1964, is the world's most comprehensive inventory of the global conservation status of biological species.
    - The IUCN Red list of threatened species is also known as the IUCN Red list or Red data list.
2. **UNEP & WWF**
    - WWF is one of the world's largest conservation organizations.
    - The World Wide Fund for Nature (WWF) is an international non-governmental organization founded on April 29, 1961, working in the field of the biodiversity conservation, and the reduction of humanity's footprint on the environment.
    - The United Nations Environment Programme (UNEP) is an agency of the United Nation that coordinates its environmental activities, assisting developing countries in implementing environmentally sound policies and practices.

- United Nations Environment Programme Abbreviation : UNEP Formation : 1972 June 5 Type :Programme Legal status :Active Headquarters : Nairobi, Kenya Head :Achim Steiner Parent organization

3. National Bureau of Plant Genetic resources (NBPGR)
    - Plant Exploration and Germplasm Collection Division has the objective to plan, coordinate and conduct explorations for collecting germplasm.
    - There are facilities for DNA fingerprinting of released varieties and genetic stocks of crop plants of India.
    - The center has worked with the objectives of standardization of molecular marker systems for DNA profiling and their application in variety identification. It has developed diagnostics for detection of transgenes in crop plants

Module-III

Chapter 1.

- **Pollution**: When Harmful Substances Contaminate the Environment it is Called Pollution. Pollution refers to the very bad condition of environment in terms of quantity and quality .
- **Sources and types of pollution**
    1. Air
        - Causes of Air Pollution Major sources of Air Pollution - Industries - Automobiles and Domestic fuels -High Proportion of undesirable gases, such as sulphur dioxide and carbon monoxide
        - Effects of Air Pollution - Air Pollution affects Human health , Animals, Plants, The atmosphere as a whole
        - How to Avoid Air Pollution - Use natural Gases, like lpg autos, Do not Burst Crackers, Use less Amount of Fuel for Vehicles, Avoid using and use electric stoves (bio gas)
    2. Water
        - Water Pollution- The Contamination of water with undesirable substances which make it unfit for usage is termed water Pollution.
        - Causes of Water Pollution - About 40% of Deaths worldwide are caused by Water Pollution. Water Pollution is Caused by organsic and inorganic industrial wastes and affluents discharged into rivers.

- Effects of Water Pollution - Diseases like Cholera ,Malaria, Typhoid (spread during the rainy season), Aquatic life gets destroyed
- How to Avoid Water Pollution - Rivers should not be used for washing clothes or bathing animals, Harvesting of Rainwater to meet water requirements, Dams &embankments must be created, The rivers must not be contaminated, In sacred river like Ganga the dead bodies shouldn't thrown.

3. Soil
    - One fourth of area is covered by land
    - Land is a earth which is occupied by people for shelter,occuption etc..,
    - Causes of Land Pollution- Industrial Waste, Household Garbage, Sewage waste, Mining and quarrying
    - Effects of Land Pollution- House hold Garbage like putting Plastics, Ground water will gets Affected, Man cannot be farming, The Land Cannot be construct house
    - Prevention of Land Pollution - More and more land should be brought under farming, Trees should be planted everywhere, Waste matter should be disposed immediately, Avoid drilling the Land for more underground water, Avoid using more fertilizers and Pesticides.
4. Thermal
    - Thermal Pollution is the harmful increase in water temperature in streams, rivers, lakes, or occasionally, coastal ocean waters.
    - It is the degradation of water quality by any process that changes ambient water temperature.
    - A temperature increase as small as 1 or 2 Celsius degrees (about 2 to 4 Fahrenheit degrees) can kill native fish, shellfish, and plants, or drive them out in favor of other species, often with undesirable effects.
    - 2. The major sources of thermal pollution are discharge of heated water or hot waste material into water bodies from, Coal fired power plants, Hydro-electric power, Domestic sewage, Industrial effluents, Nuclear power plant
    - Other causes are Soil erosion, Deforestation ,Thermal shock
5. Noise
    - Noise pollution not only results in irritation and anger.

- The sound is pleasant or not depends upon its loudness, duration, rhythm and the mood of the person.
- Noise can be simply defined as unwanted sound.
- Causes of Noise Pollution - Traffic Noise, Air craft Noise, Noise from construction and civil engineering works, Noise from the Industries, Noise from other sources.
- Effects of Noise Pollution -Hearing Loss, High Blood Pressure, Stress, Sleep Disturbance, Color Blindness
- How to Avoid Noise Pollution - The Government should ensure the new machines that Should be noise proof, Airports must be away from residential area, The Sound horn symbol is to be in School Roads.
- Biodegradable and non-biodegradable pollutants

- **Biodegradable pollutants**: can be broken down into simpler, harmless, substances in nature in due course of time (by the action of micro-organisms like certain bacteria)

  Domestic wastes (garbage), urine, faecal matter, sewage, agriculture residues, paper, wood, cloth, cattle dung, animal bones, leather, wool, vegetable stuff or plants are biodegradable pollutants.
- **Non-biodegradable pollutants**: cannot be broken down into simpler, harmless substances in nature,

  DDT, plastics, polythene, bags, insecticides, pesticides, mercury, lead, arsenic, metal articles like aluminum cans, synthetic fibres, glass objects, iron products and silver foils are non-biodegradable pollutants.
- **Biomagnification**- also known as bioamplification or biological magnification, is any concentration of a toxin, such as pesticides, in the tissues of tolerant organisms at successively higher levels in a food chain.
- **BOD**- Biochemical oxygen demand (BOD) represents the amount of oxygen consumed by bacteria and other microorganisms while they decompose organic matter under aerobic (oxygen is present) conditions at a specified temperature.

Chapter : 2

- **Global environmental changes – climatic changes – global warming**
- **Global warming**- The gradual increase in the overall temperature of Earth's atmosphere due to the greenhouse effect. This effect is caused by increased

levels of carbon dioxide, chlorofluorocarbons and other gases in the air, many of them released by human activity.

- **Greenhouse gases-** The warming of Earth's atmosphere due to the buildup of heat-trapping gases, such as carbon dioxide and methane. Scientists refer to these pollutants as greenhouse gases.
- **Greenhouse gases** include water vapour, carbon dioxide, methane, nitrous oxide, ozone and some artificial chemicals such as chlorofluorocarbons (CFCs).
- **Acid rains-** Acid rain, or acid deposition, is a broad term that includes any form of precipitation with acidic components, such as sulfuric or nitric acid that fall to the ground from the atmosphere in wet or dry forms. This can include rain, snow, fog, hail or even dust that is acidic
- **El-nino-** is a climate pattern that describes the unusual warming of surface waters in the eastern tropical Pacific Ocean. El Nino is the "warm phase" of a larger phenomenon called the El Nino-Southern Oscillation (ENSO).

Chapter : 3

- **Management of environmental pollution - conventional and phytotechnological approaches**

➢ Phytotechnology has been introduced and developed for the treatment of urban runoff, domestic and industrial wastewater, and remediation of polluted soil since the last three decades. Constructed wetlands and phytoremediation are examples of the most commonly applied technologies for removal of pollutants in water and soil.

➢ Phytotechnology is not only known as cost effective means for water quality improvement and stormwater control, but also provides aesthetics and wild life habitat (USEPA, 1993).

- **Solid wastes management including e-wastes-**

➢ The collecting, treating, and disposing of solid material that is discarded because it has served its purpose or is no longer useful.

➢ Improper disposal of municipal solid waste can create unsanitary conditions, and these conditions in turn can lead to pollution of the environment and to outbreaks of vector-borne disease.

- The tasks of solid-waste management present complex technical challenges. They also pose a wide variety of administrative, economic, and social problems that must be managed and solved.
- **Electronic waste or e-waste** is generated when electronic and electrical equipment become unfit for their originally intended use or have crossed the expiry date.
- Computers, servers, mainframes, monitors, compact discs (CDs), printers, scanners, copiers, calculators, fax machines, battery cells, cellular phones, transceivers, TVs, iPods, medical apparatus, washing machines, refrigerators, and air conditioners are examples of e-waste (when unfit for use).
- This has led to an exponential increase in e-waste generation.
- E-waste is a rich source of metals such as gold, silver, and copper, which can be recovered and brought back into the production cycle.
- There is significant economic potential in the efficient recovery of valuable materials in e-waste and can provide income-generating opportunities for both individuals and enterprises.
- The E-Waste Management Rules, 2016 were amended by the government in March 2018 to facilitate and effectively implement the environmentally sound management of e-waste in India.

- **Environmental legislations in India (Prevention and Control of Pollution act, 1981)**

- An Act to provide for the prevention, control and abatement of air pollution

Module-IV

1. Major ecosystems of the Biosphere;
    - **I. Sea, Estuarine ecosystem**

      Characteristics of marine ecosystem
        1. Continuity
        2. Stability
        3. Temeperature
        4. Current
        5. Tides and waves
        6. Pressure
        7. Light
        8. Salinity and alkalinity

9. Dissolved oxygen and carbon dioxide
10. Dissolved nutrients

- **Marine biota** consists of **producers, consumers, decomposers**
- **Biotic division** of the sea divides **pelagic realm** and **benthic realm**
- **Pelagic realm- neritic province** and **oceanic province**
- **Oceanic province- epipelagic, mesopelagic, bathypelagic and abyssopelagic**
- **Benthic realm- littoral zone, deep sea zone,**
- **Benthic organisms-** biota of sandy beaches, biota of rocky shores, biota of muddy shores, biota of deep sea

II. Lentic ecosystem: lake, Pond;

1. **Pond ecosystem-** Small, shallow, stagnant and isolated water body
2. **Types of ponds-**
   i. Ponds derived from large lakes
   ii. Small ponds having no connection with lakes at any time
   iii. Artificial ponds
3. Components of pond ecosystem
   i. Abiotic components
   ii. Biotic components
4. **Lake ecosystem**
5. Classification of lake ecosystem-
   i. Tectonic lakes
   ii. Glacial lakes
   iii. Kettle lakes
   iv. Ox bow lakes
   v. Volcanic lakes
   vi. Solution lakes
   vii. Lakes formed by wind action
   viii. Man -made lakes

- Classification of lakes based on thermal stratification
  I. Amictic lakes
  II. Oligomictic lake
  III. Meromictic lakes
  IV. Holomictic lakes

- Functional classification of lake biota
    - Producers
    - Consumers
    - Decomposers and transformers

III. Lotic ecosystem: river;

Main features

1. **Current**
2. **Land water interchange**
3. **Oxygen tension**
4. **Thermal stratification**

IV. Desert; - vast stretch of arid land with harsh and hostle environmental conditions

Desert vegetation

a. **Ephemerals**
b. **Annuals**
c. **Perennials**
d. **Geophytes**
e. **Shrubs and microflora**

Adaptations of desert plants

1. Morphological adaptations
2. Anatomical adaptations

Adaptations of desert animals

1. **Adaptations for getting water**
2. **Adaptations for conservation of water**
3. **Protective and defensive adaptations**

V. Forest;

Kinds of forest

a. **Tropical rainforest**
b. **Tropical deciduous forests**
c. **Temperate forests**
d. **Northern coniferous forests**

VI. Grass land.

Types

- **Temperate grass lands**
    a. **Prairies**
    b. **Pampas**
    c. **Velds**
    d. **Steppes**
- **Tropical grass lands**

2. **Techniques in plant community studies – Quadrat and transect methods –**
    1. Quadrat method of sampling- studying for terrestrial communities
    2. Types of quadrats-
        a. List quadrats
        b. Count quadrates
        c. Cover quadrats
        d. Chart quadrats
        e. Permanent quadrats
3. Methods
    1. Nested pots methods
    2. Species area curve methods
4. **Transect method of sampling**
    - Types
        1. Belt transect
        2. Line transect
5. **Species area curve – density,**
    - Numerical strength of species in a community in relation to a definite unit area
    - Two types- crude density and ecological density

      Density=total number of individuals of a species in all the sample pots/total number of sample pot studied
6. **Frequency-**
    - degree of dispersion in term of percentage occurrence
    - frequency=total number of sampling units in which the species occur/total number of sampling units studied*100
7. **abundance,**
    - estimated number of individuals of a species per unit area

- abundance= total number of individuals of the species in all the sampling units/in which species has occcured

8. **importance value index –**
    - overall picture of the ecological importance of a species in relation to the community structure can be obtained by adding the values of relative density, relative dominance, and relative frequency
9. **construction of phytographs.**
    - The position of a species in the community structure can be shown with the help of a phytograph
    - First a circle is made and then the circle is divided into four equal quarters by two diagonal lines lying at right angles to each other