GE3451

ENVIRONMENTAL SCIENCES AND SUSTAINABILITY

UNIT I

Chapter - 1

Environment and Biodiversity

Syllabus

Definition, scope and importance of environment - need for public awareness. Eco-system and Energy flow - ecological succession. Types of biodiversity: genetic, species and ecosystem diversity - values of biodiversity, India as a mega-diversity nation - hot - spots of biodiversity - threats to biodiversity: habitat loss, poaching of wildlife, man - wildlife conflicts - endangered and endemic species of India - conservation of biodiversity : In-situ and ex-situ.

Contents

Definition, Scope and Importance of Environment

1. Definitions

Environment

• The environment is defined as, "the whole physical and biological system in which man and other organisms live". Environmental studies involves every issue that affects living organisms.

Environmental science

• Environmental science is a study that deals with the functioning of nature and interconnections between various things in the nature.

• Various interacting components of environment are biology, geology, chemistry, physics, engineering, sociology, health and economics. Positive and realistic planning is needed to balance them. Therefore, environmental science is essentially a multidisciplinary approach.

2. Scope

• Our natural landscape consists of forest, river, desert, rocks, minerals and soil. These landscapes are transformed into villages, town or cities by human beings. Even though we live in cities, the food grains are supplied from villages surrounding. It means that our daily life is linked with surrounding environment. We need water, air to survive and other day-to- day activities which are part of environment.

• Human beings are greatly depend on nature or environment. Therefore environmental resources like water, trees, minerals, food, energy, land must be preserved in their natural form.

• Now a days, because of technological advancements more foods can be grown by using fertilizers and pesticides, also construction of dams leads to environmental degradation.

• Most environmental resources like-water, minerals, petroleum products, wood etc. are being extracted continuously. Ecologists and environmental scientists have recognised that if these resources are consumed in this way it will degrade and deplete natural environment.

• A distinguishing characteristic of many environmental resources is that they are non- producible : If the natural resource is exhausted, it is not possible to reproduce them in original form. If we continue to extract them, they may not be available for future generations.

3. Importance

• Environmental studies involves multidisciplinary approach. Environmental resources play a multifunctional role as they command market prices. Any scarce natural resource (rarely available) will cost more as its supply is less e.g. wood, water.

• Huge amount of nature's clean water is being polluted and wasted. Waste by products of chemical process pollute water and gases are polluting air.

• Deforestation (cutting of trees) leads to increasing environment temperature, dry rivers, unavailability of fresh air. The accumulated effect of all above factors causes unhealthy atmosphere to human beings by giving variety of diseases.

• The misuse or waste of natural resources can be stopped by spreading awareness to preserve the nature or environment. All must contribute for safeguarding of environment and by preventing environmental damage.

1. People in Environment

• People have always cared about the environment through their perceptions of environmental issues and their attitudes.

• The environmental movement has become concerned with all aspects of the natural environment, land, water, minerals, living organisms, life processes, the atmosphere, climate, oceans and outer space.

• The environmental movement has expanded its examination of the nature with international economic co-operation, covering issues of commodity prices, structural adjustments subsidies on products prepared from natural resources.

• Many environmentalist have contributed their views in the interest of protecting nature, wildlife, ecosystem, agriculture and environment laws. Few of them are Charles Darwin, Salim-Ali, Indira Gandhi, S.P.Godrej, Madhav Gadgil, M.C. Mehta, Medha Patkar, Sundarlal Bahuguna.

• People can participate by forming pressure groups, watch dog (observer), advisory council, reforcing environmental laws.

2. Institutions in Environment / NGOs

• Scientific groups and Non-Government Organisation (NGOs) have played a major role in the environmental movement.

• Environmental groups have a wide range of interests. Small groups are organised to fight local problems other deal with a specific issue on a national scale.

• Over the past decades, more international environmental NGOs have emerged including powerful bodies such as Friends of Earth, Greenpeace and World Wide Fund for Nature (WWF). Through environmental groups individuals can influence national and international policies.

• The media have been used as powerful instrument in public awareness of many environmental issues, but the media is usually reactive rather than innovative.

3. Environmental Education

• Environmental study and education is important in order to preserve environment.

Scope of environmental studies

1. Environmental studies creates awareness and sensitivity to the total environment and problems associated with it.

2. To participate actively in environment protection and improvement.

3. Developing skills to identify and solve environmental problems.

4. To know the need of conserving natural resources.

Importance of environmental studies

1. It helps to understand the concept of "need of development without destruction of environment".

2. It helps to understand different environmental hazards.

3. It helps to understand and demand for laws for protecting environment and enforcement system.

4. It helps to relate the quality of life with environment.

Structure of Atmosphere

• The multilayered gaseous envelope that surrounds the earth is called air or atmosphere.

• The physio-chemical structure of atmosphere consists of five concentric layers.

These layers are :

1. Troposphere (10 km above earth)

2. Stratosphere (18 to 50 km)

3. Mesosphere (51 to 85 km)

4. Thermosphere / Ionosphere (upto 500 km)

5. Exosphere

1. Troposphere:

• Troposphere is the lowest layer of the atmosphere. It extends from 10 to 18 kms.

• It contains 75 % of the atmospheric mass. It also contains moisture.

• There is gradual reduction in temperature within troposphere from 15 to - 56 °C.

• The chemical constituents of troposphere are : O_2, CO_2, H_2O and N_2.

2. Stratosphere :

• Stratosphere extends from 18 to 50 kms above earth's surface.

• Stratosphere is characterized by temperature range of - 55 °C to 5 °C.

• Stratosphere is rich in ozone (O_3) gas and free from moisture and clouds.

• Stratosphere prevents earth from ultraviolet radiation of the sun.

3. Mesosphere :

• Mesosphere extends from 50 to 85 kms above earth's surface.

• The mesosphere possesses characteristics of low temperature - 92 °C and reduced atmospheric pressure.

• Mesosphere contains N_2 and less ozone gas.

4. Thermosphere

• The thermosphere extends upto 450 to 500 kms above earth surface.

• The thermosphere possesses characteristic of gradual increase in temperature upto 1200 °C.

• Thermosphere contains charged particles like O^+_2, O_+ and NO^+ .

5. Exosphere

• The exosphere extends from 1600 km to 3000 kms above earth's surface.

• The exosphere possesses characteristic of very high temperature because of direct solar radiation.

• The exosphere contains H-, and He only.

• Fig. 1.3.1 illustrates vertical structure of earth's atmosphere.

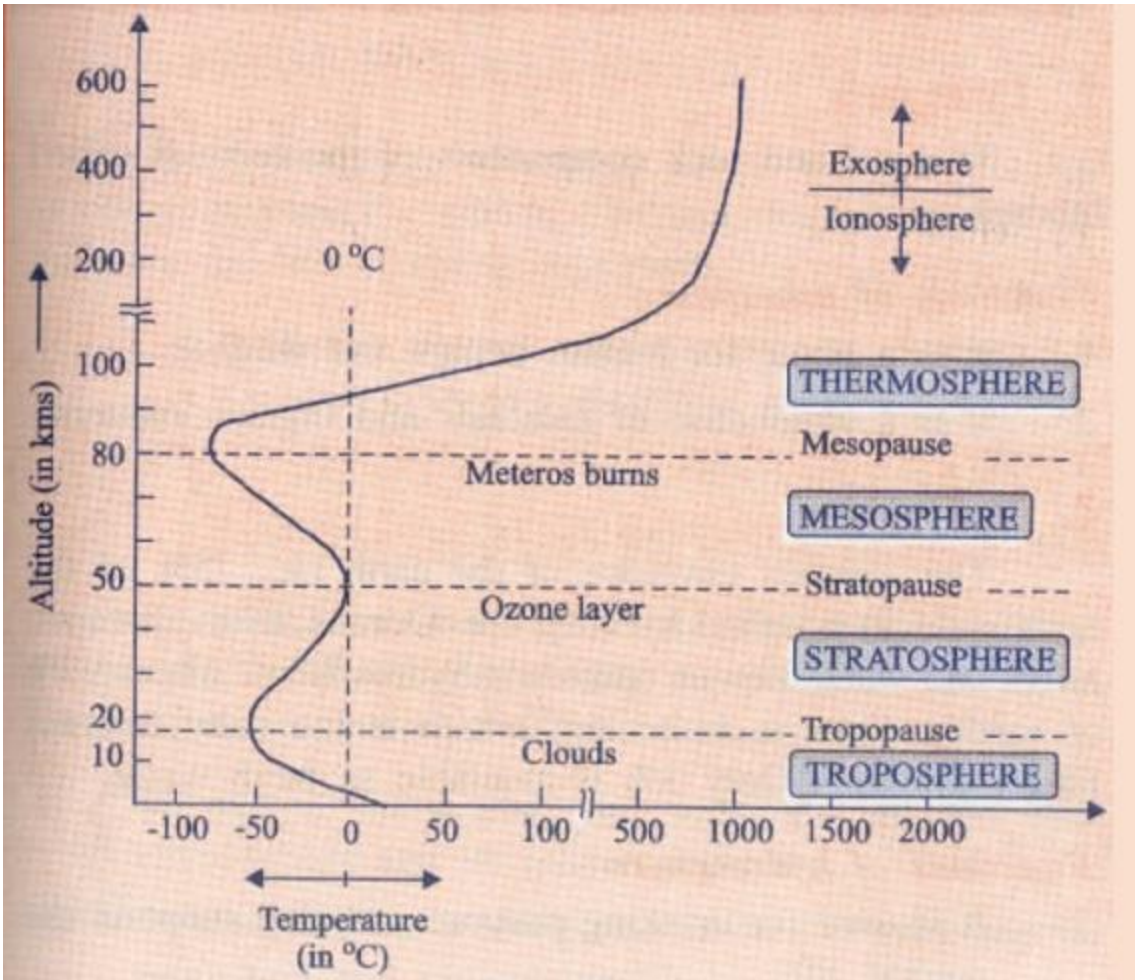

Fig. 1.3.1 Structure of atmosphere with temperature

1. Functions of Atmosphere

• Important functions of atmosphere are

1. Atmosphere absorbs Infra-red (IR) radiations thereby maintaining heat balance on earth.

2. Atmosphere contains several gaseous such as oxygen, carbon-dioxide and nitrogen, which are very important for sustaining life on earth.

Ecosystems (Structure and Function)

• Ecology is study of interactions among organisms with their environment.

• The environment consists of both biotic components (living organisms) and abiotic components (non-living organisms).

• The terms ecosystems is combination of two words, where 'eco' implies the environment and 'system' implies an interacting, inter-dependent complex.

Definitions of Ecosystem

1. An ecosystem is a group of plants and animals along with physical environment with which it interacts.

2. An ecosystem is a community of different species interacting with one another and with their environment exchanging energy and matter.

3. An ecosystem is a community of living organisms (plants, animals and microbes) in conjunction with the non-living components of their environment (things like air, water and mineral soil), interacting as a system.

4. An ecosystem is a biological community of interacting organisms and their physical environment.

Example : Grassland ecosystem, aquatic ecosystem, dessert ecosystem etc.

1. Scope and Importance of Ecosystem

Scope of Ecosystem

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• The misuse or waste of natural resources can be stopped by spreading awareness to preserve the nature or environment.

• All must contribute for safeguarding of environment and by preventing environmental damage.

2. Classification of Ecosystem

• On the basis of interference and noninterference by man, there exists two types of ecosystem.

I. Natural ecosystem. 2. Artificial ecosystem.

1. Natural ecosystem

• It operates under natural condition. There is no interference by man at all. It can be divided further on the basis of habitat.

i) Terrestrial ecosystem - Forest ecosystem, grassland ecosystem, dessert ecosystem.

ii) Aquatic ecosystem - It exists under water. It can be further divided into two types.

a) Fresh water ecosystem

- Running water (river), stream

- Standing water (lake, pond)

b) Marine ecosystem

- Salt water ecosystem.

2. Artificial / Man made ecosystem

• These ecosystems are maintained artificially by man where energy is added and manipulated through planning.

Examples : Cropland, gardens aquarium etc.

• Fig. 1.4.1 shows the ecosystem and its types.

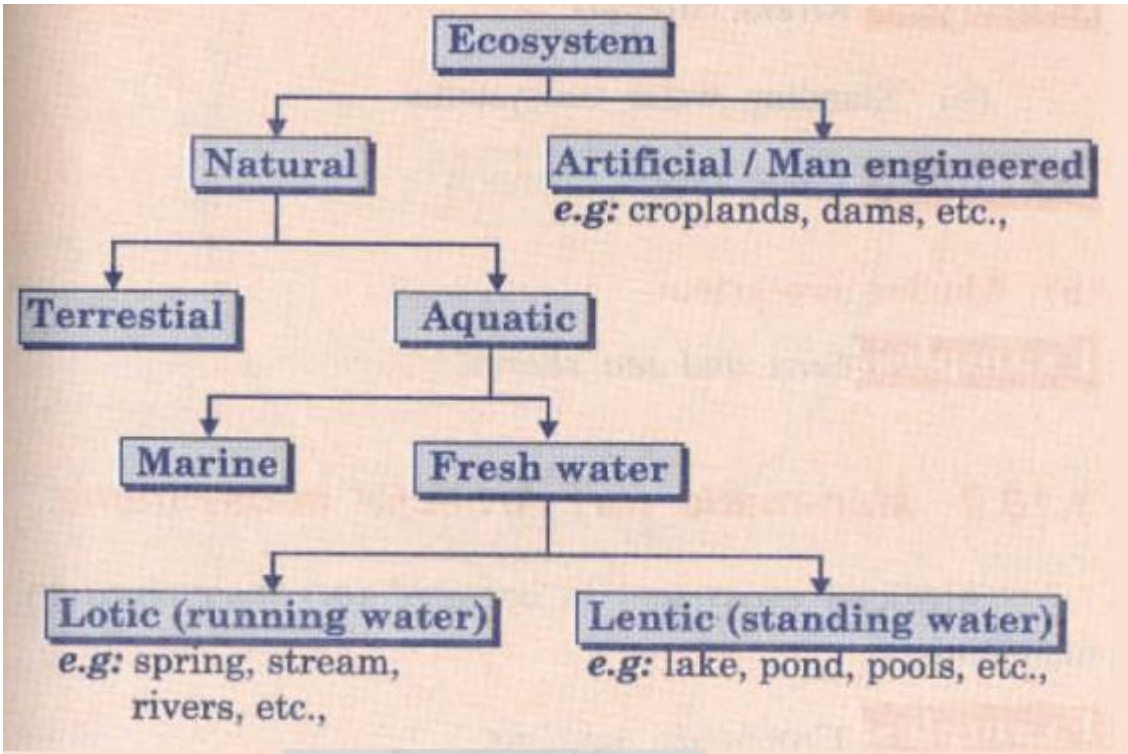


Fig. 1.4.1 : Types of ecosystem

3. Characteristics of Ecosystem

1. It is structural and functional unit of ecology.

2. Its structure is related to species diversity i.e. more complex ecosystem have high species diversity and simple ecosystem have low diversity.

3. Functions of ecosystem is related to energy flow and cycling of material involved and within ecosystem.

4. Ecosystem mature as we pass from less complex to more complex structure i.e. early stage has excess potential energy and relatively high energy flow per unit biomass than later stages. It reduces at energy stage.

5. Alterations in environment represent selective pressures upon populations to which it must adjust, those which are unable to adjust must disappear i.e. survival at fittest.

6. Environment and energy fixation in any ecosystem is limited and constant be exceeded without serious undesirable effects.

Review Question

1. Give the classification of ecosystem

Structure and Components of an Ecosystem

• The structure of an ecosystem indicates it's components (species diversity) and their interdependency for growth and survival.

• An ecosystem has two types of components.

1. Abiotic component (non-living).

2. Biotic component (living).

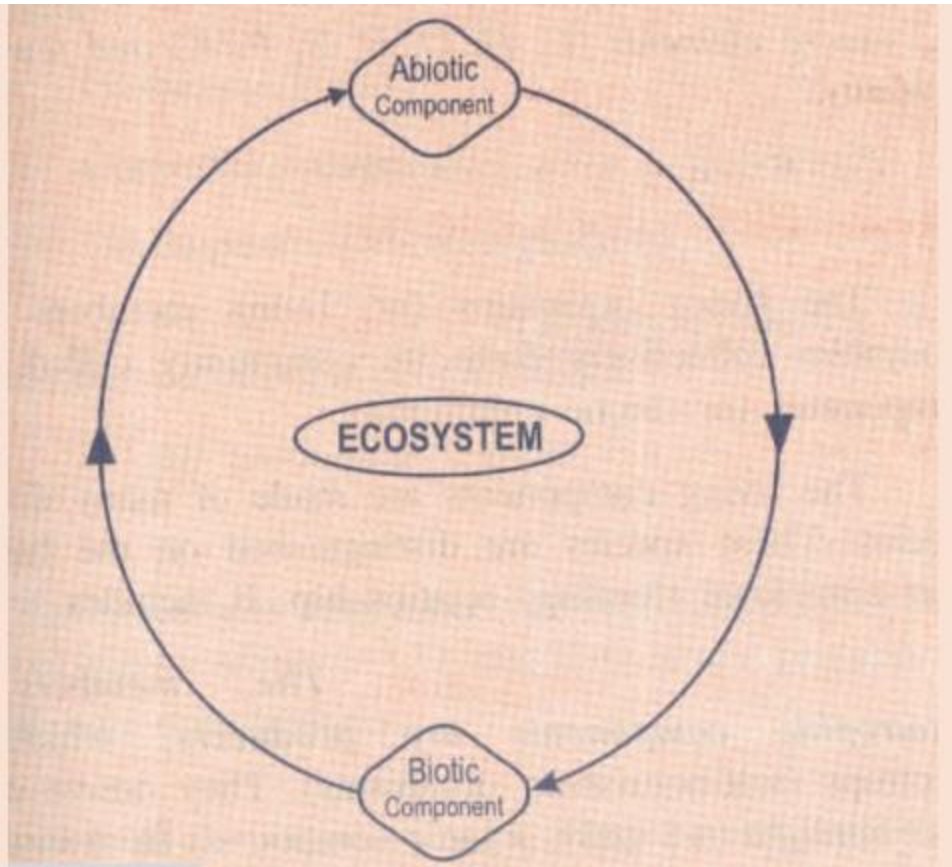


Fig. 1.5.1 Components of an ecosystems and their relationship

1. Abiotic (Non-Living) Components

• The abiotic components determine the type of organisms can live in specific area. Abiotic components can be physical components or chemical components.

1. Physical Components

• Physical components usually include sunlight, water, soil, temperature etc. These are necessary growth of species.

Examples

• Sunlight - Necessary for photosynthesis.

• Water - Essential for living things.

• Temperature - Necessary for survival.

• Soil - Provides base and nutrients.

2. Chemical Components

• Chemical components provide necessary nutrients to the organism.

Examples : Carbohydrates, proteins, liquids, nitrogen, phosphorous, potassium and oxygen.

2. Biotic Components

• Biotic components are living organisms of the ecosystem. Biotic component includes- plants, animals, fungi, bacteria and there living organisms.

• The biotic components of an ecosystems can be categorized into three categories, these are

1. Producers or autotrophs.

2. Consumers or heterotrophs.

3. Decomposers or detrivores.

a. Producers / Autotrophs

• The producers use energy from the sun and like nitrogen and phosphorus from the soil to produce high-energy chemical compounds by the process of photosynthesis.

• The energy from the sun is stored in the molecular structure of the these compounds. Producers are often referred to as being in the first rophic (growth) level and are called autotrophs.

Example : All green plants and algae.

b. Consumers / Heterotrophs

• Consumers use the energy (food) stored by the producers. Different categories of consumers are : Herbivores, carnivores and omnivores.

• Herbivores or primary consumers are those who eat producers directly.

Examples : Man, elephant, rabbit.

• Carnivores or secondary consumers eat primary consumers (animals).

Examples : Tiger, lion.

• Omnivores eat both producers and animals.

Examples : Fox, frog etc.

c. Decomposers

• Decomposers are- very important in ecosystem as they are responsible for recycling of nutrients.

• Decomposers attacks on dead producers, animals and animal wastes making them simple stable compound. These compounds can then be used as nutrients by the producers.

Examples : Bacteria and fungi.

Review Questions

1. Define the terms producers, consumers, decomposers and detrivores.

2. Explain the structure of an ecosystem

Energy Flow in Ecosystem

• The energy needed for the function of ecosystems comes from an external source, the sun. The solar energy is transformed into chemical energy by using

photo-synthesis. This chemical energy is nothing but carbohydrates and oxygen.

Photosynthesis equation

$$\underset{\text{carbon dioxide}}{CO_2} + \underset{\text{water}}{2H_2O} \xrightarrow{\text{sunlight}} \underset{\text{carbohydrate}}{CH_2O} + \underset{\text{oxygen}}{O_2} + \underset{\text{water}}{H_2O}$$

• A part of chemical energy is utilized by the producers (plants) for their growth and remaining energy is transferred to consumers.

• The decomposer utilizes the energy with consumer producing inorganic nutrient. This nutrient is again used by producer to produce food for consumer. Fig. 1.6.1 shows flow of energy and nutrients.

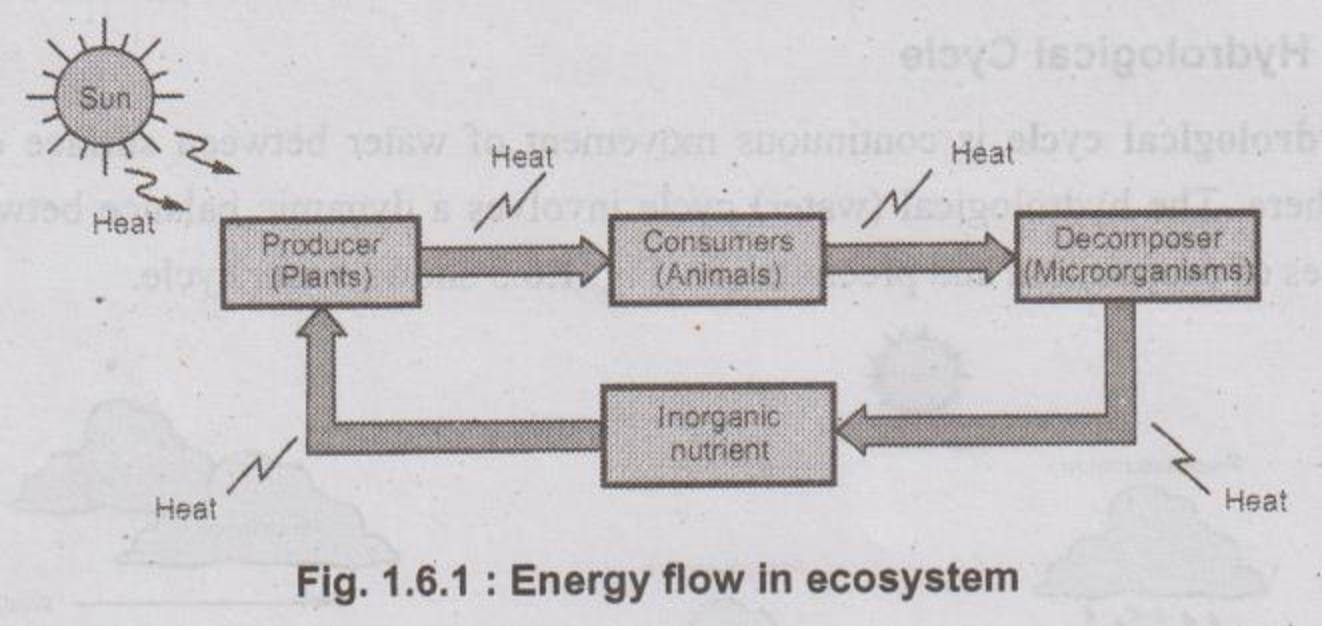


Fig. 1.6.1 : Energy flow in ecosystem

Nutrient cycle

• The producers use nutrients for preparing food and which is consumed by consumers and then decomposer recover the nutrients from consumer.

• Therefore, nutrients flow between biotic and abiotic components repeatedly, it is called as nutrient cycle or biogeochemical cycle.

1. Biogeochemical Cycle

• In an ecosystem the cycling of nutrient involves both biotic and abiotic components. The biogeochemical cycle involves

1. Hydrological cycle (Water cycle).

2. Oxygen cycle.

3. Nitrogen cycle.

4. Carbon cycle.

5. Phosphorous cycle.

2. Relationship between Structure and Function or Flow Model

• In an ecosystem the biotic components and abiotic components are linked together energy flow and nutrient cycling.

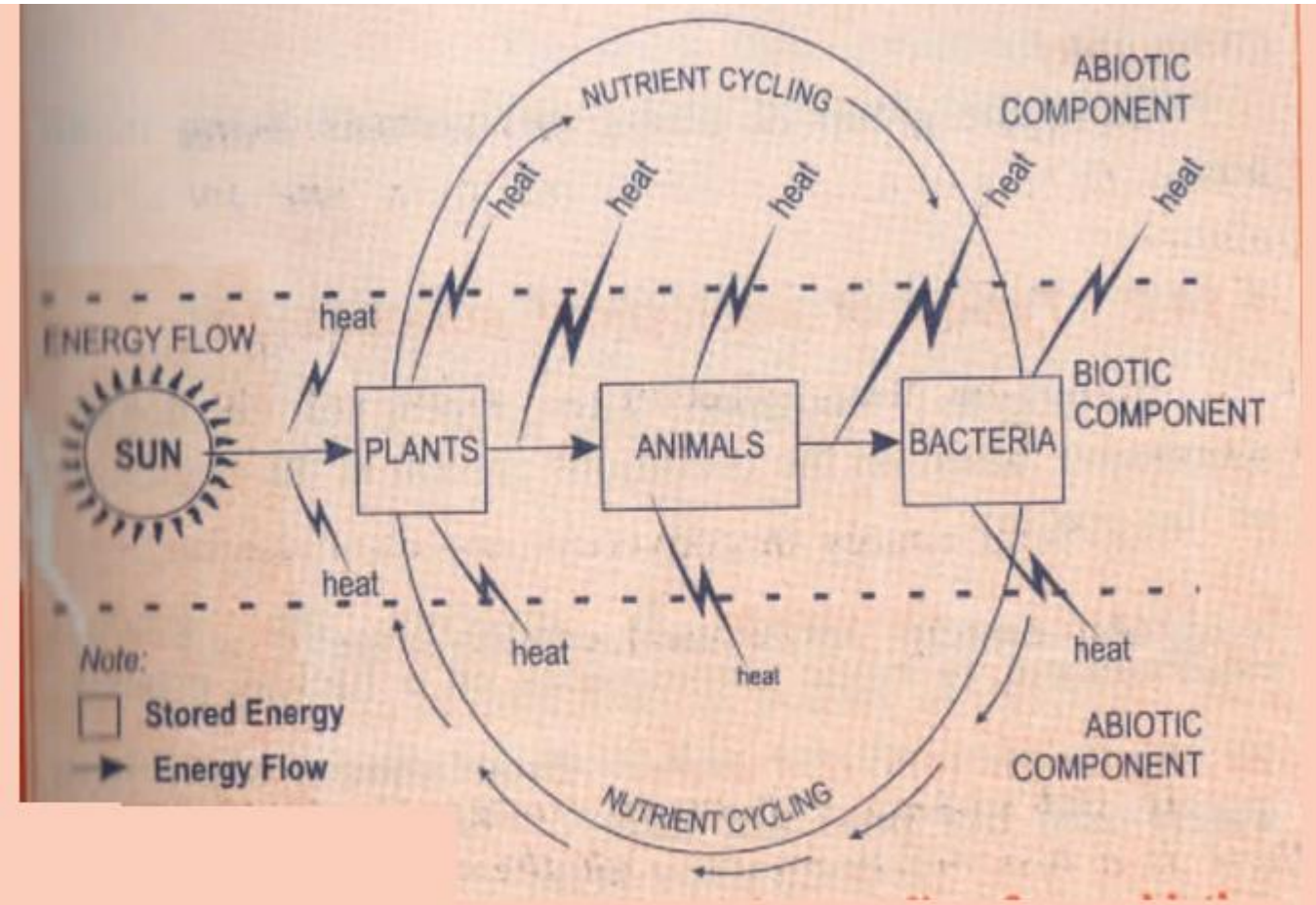


Fig. 1.6.2 : Energy flow and nutrient cycle

3. Hydrological Cycle

• The hydrological cycle is continuous movement of water between surface of earth and atmosphere. The hydrological (water) cycle involves a dynamic balance between the two processes of evaporation and precipitation. Fig. 1.6.3 shows water cycle.

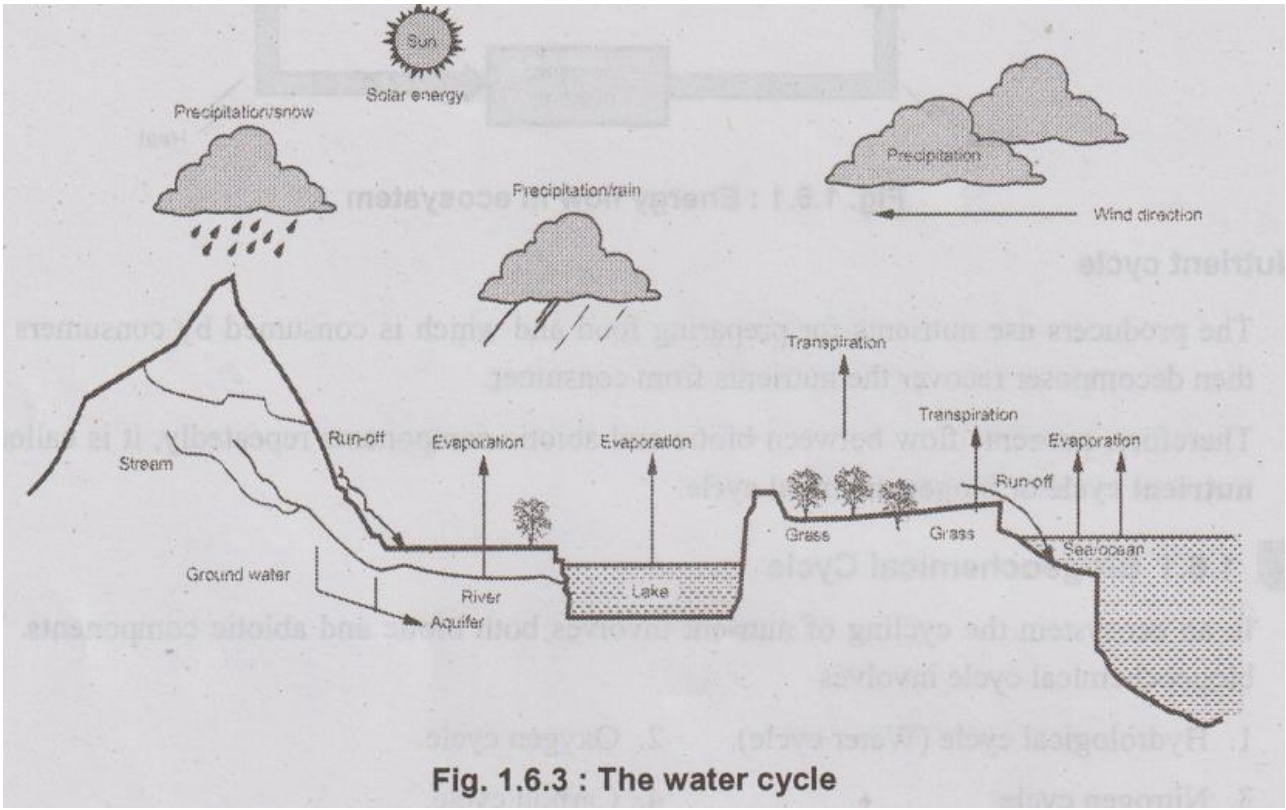


Fig. 1.6.3 : The water cycle

• Water is evaporated from the surfaces of both water bodies and land surfaces. It is also transpired from living plant cells.

• The water vapour produced is circulated throughout the atmosphere, where it is eventually precipitated as show and rain. Snow and rain are the ultimate sources of all drinkable water.

4. Carbon Cycle

• Carbon is an important element in all the bilogical or organic compounds. The carbon is found in all biotic components in different forms as food.

Examples : Proteins, carbohydrates, fats and amino acids. .

• In atmosphere, carbon dioxide (CO_2) is present as carbon element. The CO_2 is removed by photosynthesis process of green plants.

• The photosynthesis makes food for the plant. This food moves through food chain and finally the carbon present in dead matter is returned to atmosphere as CO_2.

Fig. 1.6.4 : Carbon cycle

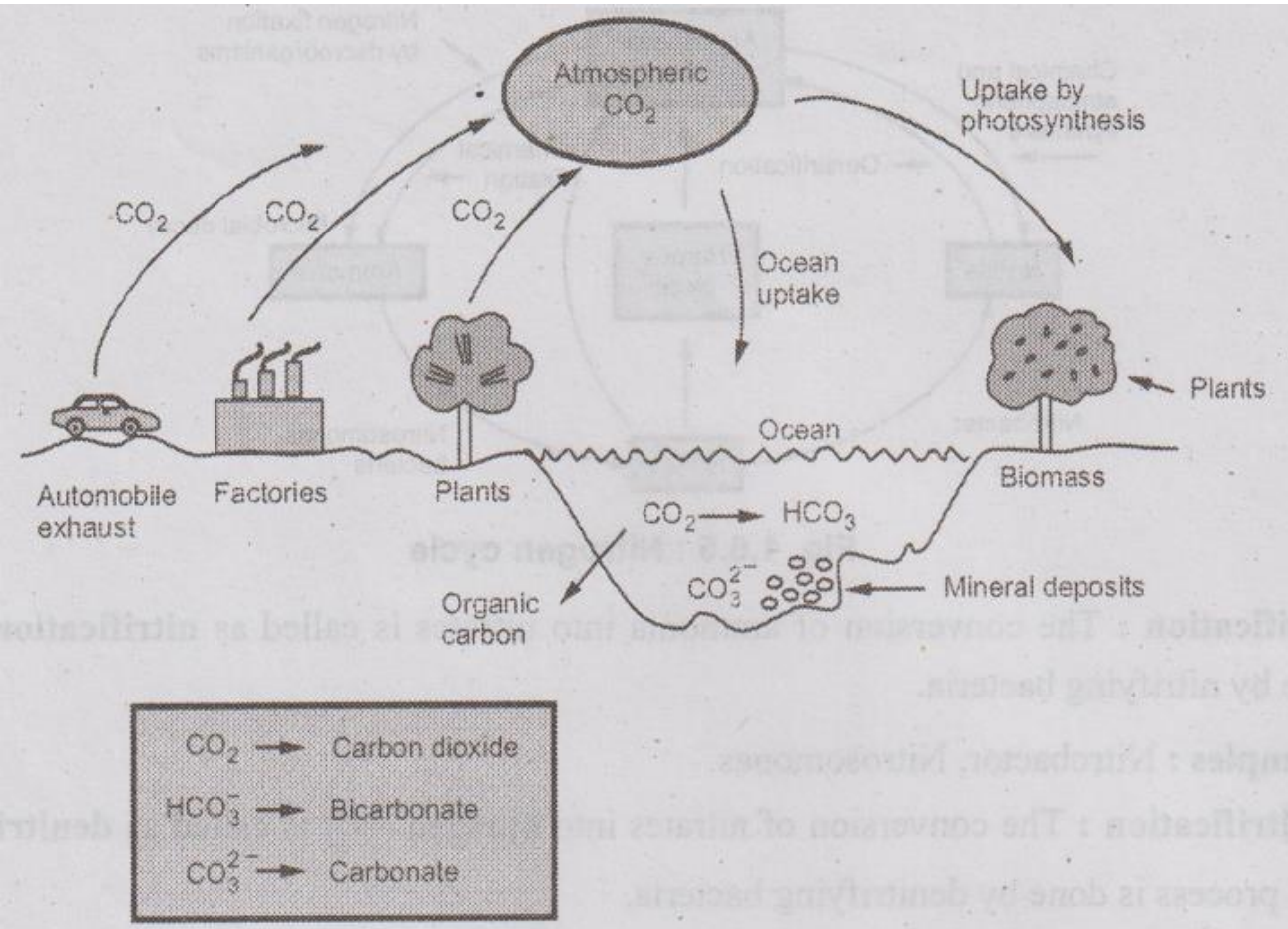


Fig. 1.6.4 : Carbon cycle

Sources of CO_2 in atmosphere

i) Respiration of plants, animals and humans librates CO_2, in atmosphere.

ii) Combustion of fuels releases CO_2

iii) Volcanic eruptions.

5. Nitrogen Cycle

• Nitrogen and its compounds are essential for its life process in the biosphere.

• Nitrogen gas (N_2) comprises about 78 % of the atmosphere, still plant growth is affected due to nitrogen, deficiency, agriculture quickly deplets soil nitrogen, therefore fertilizers fulfills this deficiency.

• The nitrogen is present in all biotic components in different forms as food.

Examples : Proteins, vitarriins, aminoacids etc.

• There is continuous exchange nitrogen between atmosphere and plants which is known as nitrogen cycle.

• Fig. 1.6.5 illustrates nitrogen cycle.

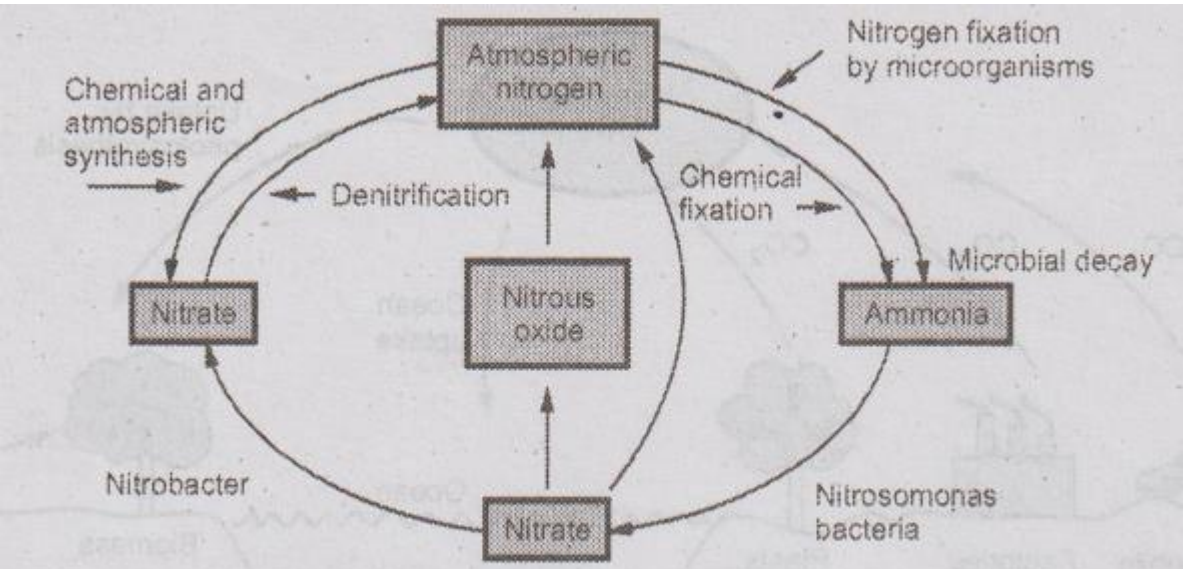


Fig. 1.6.5 : Nitrogen cycle

• **Nitrification :** The conversion of ammonia into nitrates is called as nitrification. This is done by nitrifying bacteria.

Examples : Nitrobactor, Nitrosomonas.

• **Denitrification :** The conversion of nitrates into nitragen (N2) is called as denitrification. This process is done by denitrifying bacteria.

Examples : Pseudomonas, fluorescence.

6. Phosphorous Cycle

• Phosphorus is found in rocks and fossils. It is present in all biotic components in different forms.

Examples : Bones, teeths, guano deposits.

• Phosphorus is excavated for fertilizer manufacturing. Farmers use excessive fertilizers for crops.

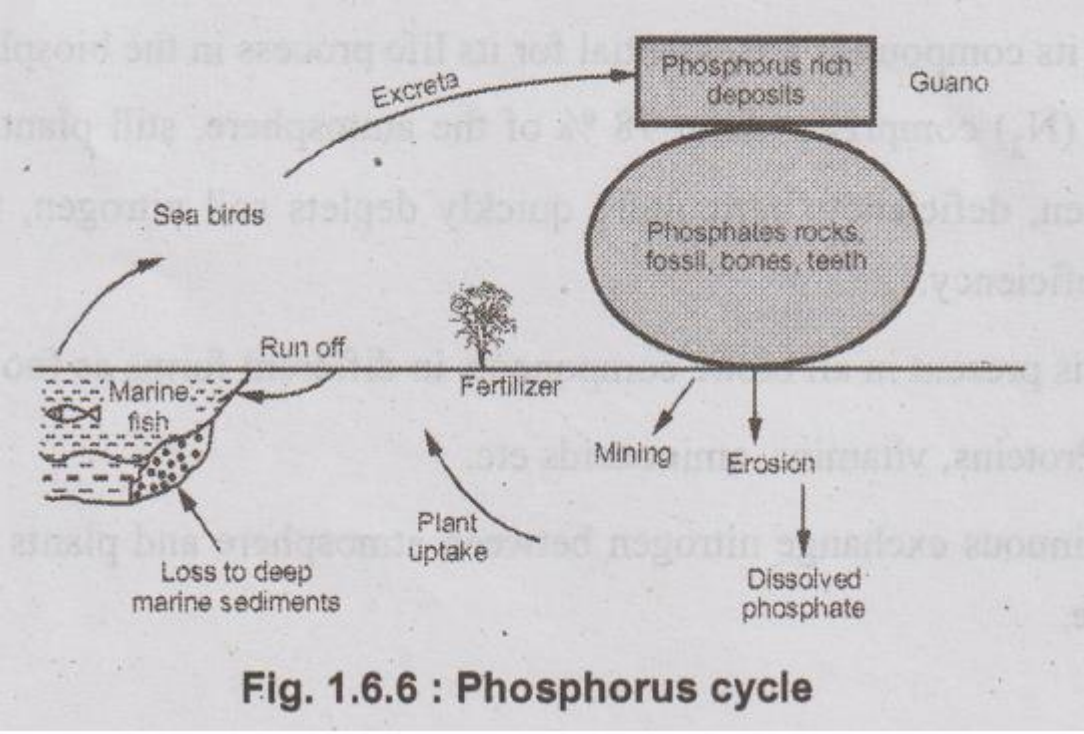


Fig. 1.6.6 : Phosphorus cycle

• This excess phosphate fertilizer move with surface runoffs to ocean and lost into sediments. Sea birds eat fishes, which are phosphorus rich and birds return phosphorus to land.

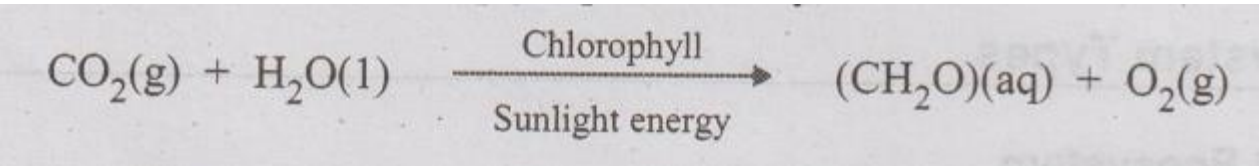
• The sea birds are playing an important role in phosphorus cycling. Animals and plants use phosphates during biosynthesis.

7. Photosynthesis

• Photosynthesis is a complex redox process by which plants, algae and certain bacteria, using the energy of sunlight, convert carbon dioxide and water into carbohydrates (sugar) and dioxygen.

• The catalysts used in plants are the chlorophyll pigments, carotenoids and the phycoblins. These pigments absorb light and help to convert it into chemical energy via the formation of new chemical bonds.

• The overall reaction can be simply represented by,



• Photosynthesis is the main way what foodstuffs are produced for the higher animals, atmospheric dioxygen is replenished and energy obtained from the sun is stored. Plants that can photosynthesis are therefore referred to as the primary producers in the food chain.

• All other organisms that feed on plants in order to use their organic compounds in respiration and as an energy source are called consumers.

Review Questions

1. With a neat sketch explain carbon cycle.

2. Explain energy flow models in ecosystem.

3. With a neat sketch, describe carbon cycle.

Functions of Ecosystem

• Three major functions of an ecosystem are

1. Primary function : Ecosystem produces starch by interaction of biotic and abiotic components.

2. Secondary function : Ecosystem is related to processes and events that change form of energy and materials within biotic and abiotic components.

3. Tertiary function : Ecosystem allows flow of energy and cycling of materials so that system remains stable and there is continuity in life.

1. Ecosystem Conservation

• Ecosystem and its conservation are now vital environmental issues of international concern.

• There are several strategies which are adapted for conservation of ecosytem. Some of these are -

1. Legislation : Formal policies and programmes for conservation and sustainable utilisation of ecosytem resources.

2. In -situ Conservation : Conserving the animals and plants in their natural habitats is known as in situ conservation.

3. Ex-situ Conservation : Ex-situ conservation of plants and animals preserve/ or protect them away from their natural habitat.

4. Community Participation in Biodiversity Conservation.

Ecosystem Types

1. Forest Ecosystem

• A forest ecosystem is one in which considerably tall and dense trees grow that support many animal species within it.

a. Types of Forest Ecosystem

• A forest ecosystem can be classified depending upon climatic conditions. Several forest ecosystems are :

1. Tropical rain forests 2. Tropical deciduous forests

3. Temperature deciduous forests 4. Tropical scrub forests

5. Temperature rain forests.

b. Structure and Function of Forest Ecosystem

• The forest ecosystem has two parts :

1. Abiotic (non-living) components.

2. Biotic (living) components.

1. Abiotic (non-living) components

• The abiotic components are inorganic and organic substances present in soil and atmosphere.

Examples : Climatic factors (temperature, rainfall light), minerals.

2. Biotic (living) components

• The biotic components includes both the large (macrophytes) and the microscopic plants and animals.

Examples

a. Producers - Trees, shrubs and ground vegetation.

b. Consumers - Ants, flies, insects, mice, deer, snakes, birds, tiger and lion.

c. Decomposers - Bacteria and fungi.

c. Characteristics of Forest Ecosystem

1. Forest have warm climate with adequate rainfall.

2. Forests have well defined seasons of about equal length.

3. Forest protects biodiversity.

4. Forests have tall and dense trees with many wild animals within ecosystem.

5. The soil of forest is rich in organic matter and nutrients.

6. Forests grow very slowly.

7. Forests provide various resources for human life.

2. Grassland Ecosystem

• A grassland has variety of grasses, herbs, insects depending on climatic conditions and temperature. The grass is major producers of biomass.

• The grassland may be either temperature or tropical. The grasslands are degraded because of overgrazing.

a. Types of Grassland Ecosystem

• Grassland ecosystem can be classified depending upon climatic conditions. Different grassland ecosystems are

1. Tropical grassland 2. Temperature grassland 3. Polar grassland.

b. Structure and Function of Grassland Ecosystem

• The grassland ecosystem has two parts :

1. Abiotic (Non-living) components

2. Biotic (Living) components.

1. Abiotic (Non-living) components '

• The abiotic components are sourced by CO_2, H_2O, nitrate, phosphates and sulphates.

Examples : Nutrients, C, H, O, N, P, S.

2. Biotic (Living) components

• Three biotic components are : producers, consumers and decomposers

I] Producers : Producers produce food.

Examples : Grasses, forbs and shrubs.

II] Primary consumers : They depend on grass for their food.

Examples : Cows, buffaloes, deer, sheep.

Secondary consumer : They feed on herbivores (primary consumers).

Examples : Snakes, lizards, birds etc.

Tertiary consumers : They feed on secondary consumers.

Examples : Hawks, eagles etc.

III] Decomposers - They decompose the dead organic matter.

Examples : Fungi and bacteria.

c. Characteristics of Grassland Ecosystem

1. Grassland ecosystem exists where rainfall is low and uneven.

2. The soil of grassland ecosystem is rich in nutrients and organic matters.

3. Grassland ecosystem provides largest biomass and is used for grazing animals.

4. The grassland ecosystem exists in moderate climates.

5. Grassland ecosystem is characterized by seasonal flowering plants and savannas (scattered trees).

3. Desert Ecosystem

• The ecological succession of grassland is deserts. Deserts are characterized by high temperature, less moisture, warm, dry, less vegetation, special habitats.

• Four major types of deserts are

1. Hot and dry desert. 2. Semiarid desert.

3. Coastal desert. 4. Cold desert.

a. Types of Desert Ecosystems

• Desert ecosystems can be categerized depending on climatic conditions:

1. Tropical desert

2. Temperature desert

3. Cold desert

b. Characteristics of Desert Ecosystem

1. Desert are subjected to strong winds.

2. There is low annual rainfall. .

3. The desert air is dry and climate is hot.

4. Temperature variation is large (days are hot and nights are cold).

5. Without or rare vegetation.

6. No soil is present.

c. Structure and Function of Desert Ecosystems

• Desert ecosystem consists of two components

1. Abiotic components 2. Biotic components

1. Abiotic components

Examples : Temperature, rainfall, sunlight, water etc.

2. Biotic components

a) Producers : Mostly found plant in deserts are succulent (cacti). They have water content inside which keeps them alive. The waxy outer layer protects them from sun.

Examples : Shrubs, bushes etc.

b) Consumers : Animals dig holes in ground to live in. They come out at night to find food. They can extract water from the seeds they eat.

Examples : Mice, rabbits, reptiles, squirrles etc.

c) Decomposers : Desert has poor vegetation with a very low amount of dead organic matter.

Examples : Fungi and bacteria.

4. Aquatic Ecosystem

• The ecosystems exists in the medium of water is called as aquatic ecosystem. In aquatic ecosystems, plants and animals live in water.

• The organisms found in aquatic environment are determined by quality of water such as clarity, salinity, oxygen content and rate of flow.

a. Types of Aquatic Ecosystem

• The aquatic ecosystems may be classified as -

1. Fresh water ecosystems :

Examples : Rivers, pond, lake, streams, wetland.

2. Marine ecosystems :

Examples : Marine or ocean, estuary.

b. Pond Ecosystem

• A pond is a freshwater aquatic ecosystem, where water remain in the same area for a longer period.

• As the pond fills in the monsoon season, a large number of food chains are formed. It contains several types of algae, aquatic plants, insects, fishes and birds.

Characteristic features of pond ecosystem

1. Most pond are temporary that has water only in monsoon season.

2. It is a stagnant (standing) water body.

3. The medium contains less nutrients.

4. Most pond become dry after the rains are over and are covered by terrestrial plants for the rest of year.

5. Pond get polluted easily due to limited amount of water.

Structure and functions of pond ecosystem

• The two components of pond ecosystems are :

1. Abiotic components 2. Biotic components.

1. Abiotic components

Examples : Light, temperature, chemical environment such as dissolved and particulate matter, oxygen, pH, phosphorous.

2. Biotic components

a. Producers : These are green photosynthetic organisms. They are of two types :

I] Phytoplankton : These are microscopic aquatic plants, which freely float on surface of water.

Examples : Algae, volvox, pandorina, cosmarium.

II] Microphytes : These are large floating plants and submerged plants.

Examples : Hydrilla, jussiaea, wolfia, demma.

b. Consumers :

I] Primary consumers (Zooplanktons) : Microscopic animals which can freely float on the surface of water.

Examples : Protozoa, very small fish, ciliates, flagellates.

II] Secondary consumers (Carnivores): They feed on zooplanktons.

Examples : Insects like water beetles and small fish.

III] Tertiary consumers : They feed on smaller fish.

Examples : Large fish like game fish.

c. Decomposers : They decompose-the dead plant and animal matter and their nutrients are released and reused by green plants.

Examples : Fungi, bacteria and flagellates.

c. Lake Ecosystem

• A lake is a giant permanent pond. A large amount of its plant material is the algae, which derives energy from the sun.

Types of lake

• Important types of lakes are

1. Oligotrophic lakes: Low nutrient concentrations.

2. Eutrophic lakes : Ovemourished nutrients.

3. Dystrophic lakes : Low pH, brown water, acidic.

4. Volcanic lakes : Receive water from magma after volcanic eruptions.

5. Meromictic lakes : Salt rich.

Characteristic features of lake ecosystem

1. Lake is a shallow fresh water body.

2. Lake is a permanent water body.

3. Food chains are inter linked with terrestrial food chains.

Structure and function of lake ecosystem

1. Abiotic components

Examples : Temperature, proteins and lipids, light, CO_2, O_2.

2. Biotic components

a. Producers : They can be green plants submerged, free floating and amphibious plants.

Examples : Phytoplanktons, algae and flagellates

b. Consumers : I] Primary consumers (Zooplanktons): Ciliates.

II] Secondary consumers : Insects, small fishes.

III] Tertiary consumers : Large fish.

c. Decomposers : They decompose the dead plant and animals.

Examples : Bacteria, fungi and actinomy cetes.

d. River or Stream Ecosystem

• The river or stream has running water. The river water contains more oxygen. There exists less species in rivers.

• The nutrient content in the water is largely determined by the terrian and vegetation surrounding the river.

• Overhanging vegetation adds a substantial amount of organic material from fallen leaves. The erosion of the streambed adds inorganic nutrients to the running water.

Characteristics of river/stream ecosystem

1. Rivers are fresh water system.

2. Dissolved oxygen content is more in streams.

3. Moving down stream, numerous tributaries join to form a river.

4. It carries sediments (from the erosion of soil) and nutrients.

Structure and function of river ecosystem

1. Abiotic components

Examples : Temperature, light, pH, nutrients, organic and inorganic compounds.

2. Biotic components

a. Producers : Phytoplankton, algae, water grasses, aquatic masses and amphibious plants.

b. Consumers :

i) Primary consumers : Water insects, snails, fishes.

ii) Secondary consumers : Birds, mammals.

c. Decomposers : Bacteria and fungi.

e. Ocean (Marine) Ecosystem

• The ocean or marine is a saltwater aquatic ecosystem. The ocean environment is characterized by its high concentration of salts and minearls.

• The marine or ocean ecosystem is largest of all ecosystems. It supplies huge variety of sea products, minerals, natural gas etc. ocean contains the richest diversity of species.

Characteristics of ocean ecosystem

1. It covers large surface area with saline water.

2. Marine or oceans are rich in biodiversity.

3. The evaporation of sea water provides rain water for the land.

4. Algae are abundant in ocean and provide much of the world's oxygen supply by absorbing huge amounts of atmospheric carbon dioxide.

Structure and function of marine ecosystem

1. Abiotic components

Examples : Temperature, light, Nacl, K, Ca and Mg salts, alkalinity.

2. Biotic components

a. Producers : Phytoplanktons (diatoms, unicellular algae), marine plants (seaweeds, chlorophyceal, phaeophyceae).

b. Consumer : These are heterotrophic macroconsumers. They depend on producers for their nutrition.

i) Primary consumers / herbivores : They feed on producers.

Examples : Crustaceans, moiluscs, fish.

ii) Secondary consumers/carnivores : They feed on herbivores.

Examples : Herring sahd, mackerel etc.

iii) Tertiary consumers : They are top consumers. They feed on small fishes.

Examples: Cod, haddock.

c. Decomposers : They decompose the dead organic matter.

Examples : Bacteria and some fungi.

Review Question

1. Explain pond ecosystem.

Biodiversity

• Varieties of life on the earth exists over thousands of years to fulfill the needs of mankind. For understanding the life cycle of plants and animals they must be classified and categorized properly.

Biodiversity (Biological diversity) is defined as variety and variability of living organisms in a given assemblage. Biodiversity covers whole life on earth.

• Biodiversity may be described in terms of genes, species and ecosystems, corresponding to three fundamental and hierarchically related levels of biological organization.

• All life depends on uninterrupted functioning of natural systems that ensure the supply of energy and nutrients, so ecological responsibility among all people is necessary for survival, security, equality and dignity of the world's communities.

1. Importance of Biodiversity

1. Increase ecosystem productivity; each species in an ecosystem has a specific role to play.

2. Support a larger number of plant species and, therefore, a greater variety of crops.

3. Protect freshwater resources.

4. Promote soils formation and protection.

5. Provide for nutrient storage and recycling.

6. Aid in breaking down pollutants.

7. Contribute to climate stability.

8. Speed recovery from natural disasters.

9. Provide more food resources.

10. Provide more medicinal resources and pharmaceutical drugs.

11. Offer environments for recreation and tourism.

2. Types of Biodiversity

• There are three basic types of biodiversity -

1. Genetic diversity

2. Species diversity

3. Ecosystem diversity or community diversity.

3. Genetic Diversity

• Genetic diversity is a measure of variety available for the same genes within individual species.

• Genetic diversity is based on variation between genes i.e. functional units of hereditary information. The genetic variability is essential for a healthy breeding population of a species.

Example : Each human being is different from all other, thousands of rice varieties are available.

4. Species Diversity

• Species diversity is the number of different species of living things within an area.

• Species are regarded as populations within which gene flow occurs under natural conditions. Members of one species, do not breed freely with members of other species.

Examples : Tiger, lion, teakwood, human being etc.

5. Ecosystem Diversity

• Ecosystem diversity relates to the variety of habitats, biotic communities and ecological processes in the biosphere as well as the diversity within ecosystems.

• Diversity can be described at a number of different levels and scales :

* Functional diversity is the relative abundance of functionally different kinds of organisms

* Community diversity is the number sizes and spatial distribution of communities, and is sometimes referred to as patchiness (uneven quality)

* Landscape diversity is the diversity of scales of patchiness.

• No simple relationship exists between the diversity of an ecosystem and ecological processes such as productivity, hydrology and soil generation.

• Neither does diversity correlate neatly with ecosystem stability, nor its resistance to disturbance and its speed of recovery.

• There is no simple relationship within any ecosystem between a change in its diversity and the resulting change in the system's processes.

• For example, the loss of a species from a particular area or region (local extinction or extripation) may have little or no effect on net primary productivity of competitors take its . place in the community.

• The converse may be true in other cases. For example, if herbivorous such as zebra and wild beasts are removed from the African savanna, net primary productivity of the ecosystem decreases.

Review Questions

1. Define the term biodiversity. What are its values ?

2. What is meant by genetic diversity ? Species diversity and ecosystem diversity.

Values of Biodiversity

• A rich biodiversity is the wealth of any nation. Biodiversity provides variety of environmental survives and ecosystem essential for human life. Each organism has its own significance in the biosphere.

• The value of biodiversity is classified into various categories depending on its use, such as

i) Consumptive use

iii) Social use

ii) Productive use

iv) Ethical use

v) Aesthetic

vi) Option value.

1. Consumptive Use

• Consumptive use is direct utilization of various species by the modem society. The major sources are - Food, medicinal plants, fuel etc. These products are directly supplied by biodiversity.

Examples

a) Food - Seasonal fruits, vegetable, food grains, sea food, chicken, duck.

b) Medicinal plants - Bamboo, eucaliptas, neep, honey comb, herbs.

c) Fuel - Fuel wood, timber, fodder, coal, petroleum, natural gas, biomass.

2. Productive Use

• Most commercial products are synthesized from natural products of biodiversity. The product may be derived from plants, animals and by products.

Examples : Silk, wool, leather, tusk - from animals and wood, cotton, oil seed, crop - from plants.

3. Social Values

• Social values of biodiversity counts for use of biodiversity for social aspect. The consumptive and productive values of biodiversity is closely related to the social concern.

• Many communities are finding that local bioversity can bring cash through ecotourism. Many people value biodiversity as a part of livelihood through cultural and religious sentiments.

Examples

Holy plants - Banyan, peepal, lotus etc.

Holy animals - Cow, peacock, snake etc.

4. Ethical Values

• Ethical value of biodiversity is related to conservation of life. Plants and animals have equal right to live and exist on our planet. No one has right to destroy other's life. The ethical value tells that any species may or may not be used but its presence is must in ecology.

• India's rich heritage and culture tells us to worship animals. Plants, rivers and mountains. Some communities have mission of preserving animals life.

5. Aesthetic Values

• Biodiversity is a beautiful and wonderful aspect of nature. Wild plants and animals are source of beauty wonder, joy and recreational pleasure for many people. Wild life tourism (ecotourism) is a good source of earning currency.

Examples

i) Neem and mango leaves are used during festivals and fair aesthetics.

ii) Ornamental plants, flowers are used for decoration.

iii) Elephants, horses and camels are used for ceremonial purposes.

6. Option Values

• The potential use of biodiversity is proseutly not known to us, this future possible use is termed as option value. Any specific species of biodiversity may be found very useful for any particular purpose ; if it is preserved and exists.

Example : Rarely found medicinal plant may be used for medicinal purpose for any chronic disease.

Review Questions

1. Define the term biodiversity. What are its values ?

2. What are the values of biodiversity ?

3. What are the values of biodiversity ? Describe.

Hot-spots of Biodiversity

• There is no uniform distribution of bio-diversity along the geographical regions of the world. Some habitats are found to be highly rich in abundant number in some specific regions.

• Hot-spots are the specific areas which contain the richest and the most threatened reservoirs of plant and animal species.

• The number of endemic species and degree of threats which are measured in terms of habitat loss, are certain criteria to determine a hot-spot. If these species lost, they can never be replaced.

1. Criteria to Qualify as Hot-spots

• To qualify as a hot-spot a region must satisfy following criteria.

1. The richness of endemic species.

2. Significant percentage of specified species should be present.

3. The site must have lost more than 70 % of its original habitat.

4. The site must be under threat.

2. Reason for Rich Biodiversity in Tropics

• The reasons for rich biodiversity in tropics are as following :

1. The tropics have more stable climate.

2. Tropical areas have warm temperature and high humidity, which provide favourable condition.

3. No single species can dominate hence there is an opportunity for many species to coexist.

4. The rate of outcrossing among plants is higher in tropics.

3. Area of Hot-spot

• Twenty five numbers of hot-spots are identified and selected for the conservation of biodiversity.

• The total area of the hot spots cover about 1.4 % of the total land surface on the earth.

Sr. No.	Hotspots	Plant species	Endemic plants
1.	Tropical Andes	45,000	20,000
2.	Mesoamerican forests	24,000	5,000
3.	Caribbean	12,000	7,000
4.	Brazil's Atlantic forest	20,000	8,000
5.	Panama Western Ecuador	9,000	2,250
6.	Brazil's Cerrado	10,000	4,400
7.	Central Chile	3,429	1,605
8.	California Floristic	4,426	2,125
9.	Madagascar	12,000	9,704
10.	Eastern Arc and Coastal forest of Kenya	4,000	1,500
11.	Western African forests	9,000	2,250
12.	Cape Floristic Province	8,200	5,682
13.	Succulent Karoo	4,849	1,940
14.	Mediterranean basin	25,000	13,000
15.	Caucasus	6,300	1,600
16.	Sundaland	25,000	15,000
17.	Wallacea	10,000	1,500
18.	Philippines	7,620	5,832
19.	Indo-Burma Eastern Himalayas	13,500	7,000
20.	South-Central China	12,000	3,500
21.	Western-Ghats Sri Lanka	4,780	2,180
22.	South-Western Australia	5,469	4,331
23.	New Caledonia	3,332	2,551
24.	New Zealand	2,300	1,865
25.	Polynesia / Micronesia	6,557	3,334
Total		–	**1,33,149**

4. Hot-spots of Biodiversity in India

• Out of 25 hot-spots in the world, two hot-spots are found in India.

1. Eastern Himalayas 2. Western Ghats.

• These areas are rich in floral wealth and also in reptiles, amphibians butterflies and some mammals.

a. Eastern Himalayas

• These area comprises Nepal, Bhutan and neighbouring states of northern India along with Yunnan province in southwest China.

• The eastern Himalayas form a distinct floral region. There are around 35000 plant species in Himalayas of which 30 % are endemic.

Features of Himalayan Regions

1. Eastern Himalayas shows an ultra varied topography, which has species diversity and endemism.

2. In Sikkim, in semi-isolated area of 7298 km of 4250 plant species, 2550 (60 %) are endemic.

3. In India's sector, there are 5800 plant species of which 2000 (36 %) are endemic.

4. In Nepal, there are 7000 plant species of which 500 (8 %) are endemic.

5. In Bhutan, there are 5000 plant species of which 750 (15 %) are endemic.

b. Western Ghats

• Western ghats extend along the western coastal region for about 1600 km in Tamilnadu, Maharashtra, Karnataka and Kerala.

• The Agasthimalai Hills and silent valley / New Amambalam Reserve basin are the two important places of biodiversity in western ghat region.

• Out of India's 49219 plant species, 1600 endemics (40 %) are found in this region. Only 6.8 % of the originial extent of vegetation existing today while the rest has been deforested or degraded.

Common plants : Temstroemia Japonica, Rhododendron and Hypericum.

Common animals : Blue bird, Lizard hawk.

Threats to Biodiversity

• There is loss or threat to biodiversity because of several reasons. These include primary changes in abiotic and biotic factors of an ecosystem which causes harmful effects on biodiversity.

• Major threats to the biodiversity are -

1. Habitat loss

2. Poaching of wild life

3. Man - wild life conflicts

4. Destruction of coastal areas

5. Filing up of wetlands

6. Commercial exploitation.

1. Habitat Loss

• The loss of wild habitats, due to rapid human population growth contributes to the rapid global destruction of biodiversity.

• Other important factors of loss of habitat are :

⊕ Deforestation

⊕ Destruction of wetlands

⊕ Over grazing

⊕ Urban development

⊕ Building of dams

⊕ Mining

⊕ Land slides

⊕ Poor agricultural practices

⊕ Industrial wastes.

2. Poaching of Wild Life

• Poaching of wildlife for sport, making profit and for human consumption. Wild species are hunted for their fur, tusks, meat, thorns. Various animals and their purpose of producing article / use are summarized here.

Sr. No	Species	Use
1.	Elephant	Ivory, ashtray
2.	Alligators	Boots for urban needs
3.	Blubber	Lubricating oils
4.	Baleen	Combs and other articles
5.	Tiger	Skin and bones
6.	Rhinos	Horns
7.	Deer	Musk, perfume

• Habitat loss also occur when man introduces species from one area into other, disturbing the balance of existing community. Species are lost due to destruction of natural ecosystem.

3. Man-Wild Conflicts

• Man is continuously interacting with different ecosystems for food, fuel, recreation, sports, urban development, waste disposal etc.

• Every activity is responsible directly or indirectly responsible for disturbing species.

• Natural forests are being deforested for timber and single species trees like teak, sal. This monoculture plantation creates imbalance ecosystem.

• Natural size of forests are reducing because of human encroachment, therefore animals often attacks on human society and creates violence.

Review Questions

1. What are the threats to biodiversity ?

2. Mention the threats to biodiversity.

Conservation of Biodiversity

• Biodiversity is an important tool for sustaining development in any country. Multiple utility of biodiversity in commercial, medical, genetic, aesthetic and ecological field makes it necessary to preserve biodiversity. There is need to educate people to adopt environment friendly practices.

1. Advantages of Conservation of Biodiversity

1. Biodiversity (ecotourism) is a good source of income.

2. Biodiversity provides various medicinal plants.

3. It provides life support system on earth.

4. Biodiversity maintain environmental balance on earth.

5. Various commercial aspects are related to biodiversity.

2. Factors affecting Biodiversity

1. Over-exploitation of natural resources.

2. Degradation of habitat.

3. Discharge of industrial waste.

4. Global warming.

5. Urbanization.

6. Use of insecticides.

7. Construction of dam.

8. Poaching and trade in wildlife species

9. Extension of agriculture and associated irrigation systems.

10. Filling up of wetlands

11. Population explosion

3. Approaches of Biodiversity Conservation

• The two basic approaches of biodiversity conservation are :

1. In-situ conservation (on site method)

2. Ex-situ conservation (off site method)

4. In-situ Conservation

• The in-situ conservation of biodiversity involves protection of species, where they naturally exists. It includes identifying and protecting reserved areas for biodiversity. These specific areas are national parks, sanctuaries, forests, lakes, botanical gardens, biosphere reserves where vast number of species of living organism, exist.

• The natural habitat maintained under in-situ conservation is called protected areas.

• Protecting the areas helps not only in conserving individual species but preserves ecosystem also. In these protected areas - tourism, explosive activities, poaching, shooting, grazing of domestic animals, cutting of trees are strictly prohibited.

• Inspite of these protections, these habitats are facing problem of encroachment, maintenance and monitoring land management. Also, various activities which are illegal but profitable for humans are earned out.

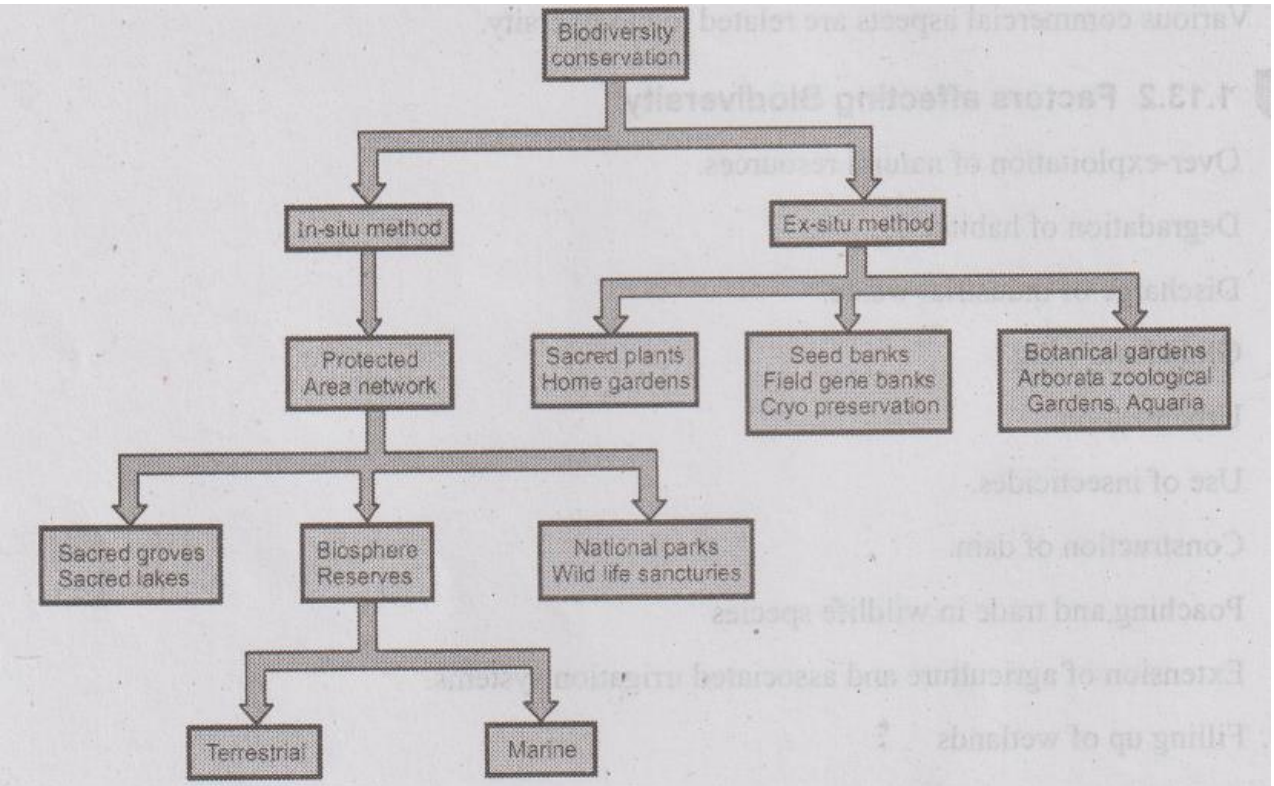


Fig. 1.13.1 : In-situ and ex-situ approaches of biodiversity conservation

Methods of In-situ Conservation

• Following methods are used for In-situ conservation are used.

Sr. No.	In-situ conservation	Available numbers
1.	Biosphere Reserves	7
2.	National Parks	80
3.	Wild-life Sancturies	420
4.	Botanical gardens	120

1. Biosphere reserves :

• The special category of protected areas in which human population constitutes an important component are called biosphere reserves.

• There are about 408 biosphere reserves in 94 countries by the end of 2000 year. In India following biosphere reserves are identified.

Sr. No.	Name of the site	Date of notification	Location and state
1.	Nilgiri	1.8.86	Part of Wynad, Nagarhole, Bandipur and Madumalai, Nilambur, Silent valley and Siruvani hills **(Tamil Nadu, Kerala and Karnataka)**.
2.	Nanda Devi	18.1.88	Part of Chamoli, Pithoragrah and Almora districts **(Uttar Pradesh)**.
3.	Nokerek	1.9.88	Part of Garo hills **(Meghalaya)**
4.	Manas	14.3.89	Part of Kokrajhar, Bongaigaon, Barpeta **(Assam)**.
5.	Sunderbans	29.3.89	Part of delta of Gangas and Brahmaputra river system **(West Bangal)**.
6.	Gulf of Mannar	18.2.89	Indian part of Gulf of Mannar between India and Srilanka **(Tamil Nadu)**.
7.	Great Nicobar	6.1.89	Southern most islands of **Andaman and Nicobar (A&N islands)**.
8.	Similipal	21.6.94	Part of Mayurbhanj district **(Orissa)**.
9.	Dibru-Saikh owa	28.7.97	Part of Dibrugarh and Tinsukia districts **(Assam)**.
10.	Dehang Debang	2.9.98	Part of Siang and Debang valley in **Arunachal Pradesh**.
11.	Pachmarhi	3.3.99	Part of Betul, Hoshangabad and Chindwara districts of **Madhya Pradesh**.
12.	Kanchanjunga	7.2.2000	Part of Kanchanjanga hills **(Sikkim)**.

Table 1.13.1 : Biosphere reserves in India

Role of Biosphere Reserves

1. Biosphere gives long-term survival of ecosystem.

2. Biosphere protects endangered species.

3. Biosphere protects maximum number of species and communities.

4. Biosphere serves as site of recreation and tourism.

5. Biospheres can be used for educational and research purpose.

Restriction

• Explosive activities are not permitted in biosphere..

2. National park :

• A national park is an area dedicated for conservation of wildlife along with its environment.

• Some important national park in India are listed below.

Name of National Park	State	Important Wildlife
Kaziranga	Assam	One horned Rhino
Gir National Park	Gujarat	Indian Lion
Bandipur	Karnataka	Elephant
Dachigam	J & K	Hangul
Corbett	U.P	Tiger
Kanha	M.P	Tiger
Periyar	Kerala	Tiger, Elephant
Dudwa	U.P	Tiger
Sariska	Rajasthan	Tiger
Ranthambore	Rajasthan	Tiger

3. Wild life sanctuaries :

• A wild life sanctuary is an area which is reserved for the conservation of animals only.

• Some important wild life sanctuaries in India are listed below.

Sr. No.	Name of sanctuary	State	Major wild life
1.	Hazaribagh sanctuary	Bihar	Tiger, Leopard
2.	Ghana bird sanctuary	Rajasthan	300 species of bird
3.	Sultanpur bird sanctuary	Haryanas	Migratory birds
4.	Abhor wild life sanctuary	Punjab	Black bug
5.	Mudumalai wildlife sanctuary	Tamilnadu	Tiger, Elephant, Leopard
6.	Vedanthangal bird sanctuary	Tamilnadu	Water birds
7.	Nal Sarovar bird sanctuary	Gujarat	Water birds
8.	Wild Ass sanctuary	Gujarat	Wild Ass, Wolf Chinkara
9.	Jaldapara wildlife sanctuary	West Bengal	Rhinoceros, Elephant, Tiger

5. Ex-situ Conservation

• The ex-situ conservations of biodiversity involves conservation of biodiversity under the control of human and outside the natural habitats.

• The endangered species of plants, and animals are collected in botanical gardens, zoos, aquariums and their maintenance and breeding is done under controlled conditions.

• The biodiversity management in captivity (human control) has certain advantages and disadvantages.

Advantages of Ex-situ conservation

1. The organisms will have longer life span because of assured food, water, shelter and security.

2. Because of special care the species endangered may survive longer.

3. Modem facilities can provide better process of breeding.

Disadvantages

1. Maintenance and cost of breeding plants and animals are expensive.

2. Species are habitual to favourable environmental conditions, they can not adapt to ever changing natural condition.

3. Freedom of wildlife is lost.

6. Steps of Conservation of Biodiversity

• Important steps for conservation of biodiversity are as follows -

1. Biodiversity inventories and assessments - population surveys and assessment.

2. Identifying and expanding protected areas.

3. Conserving biodiversity in seed banks and gene banks.

4. Controlling wild life trade.

5. Providing environmental education to the people.

6. Reviewing agricultural practices.

7. Controlling urbanization.

8. Geographical information system for planning and monitoring.

9. Restoration of biodiversity.

10. Population control.

11. Implementing Environmental Protection Act (EPA).

12. Involving more Non-govemment organizations (NGOs).

7. National Biodiversity Act

• India is party to the Convention on Biological Diversity (CBD) 1992 which recognizes the sovereign rights of states to use their own biological resources. In order to help in realizing the objectives of CBD, India has enacted an umbrella legislation called the biological Diversity Act 2002.

• The central government has established a body called the National Biodiversity Authority, on and from the 1st day of October, 2003.

• The Act aims at the conservation of biological resources and associated knowledge as well as facilitating access to them in a sustainable manner and through a just process for purposes of implementing the objects of the Act it establishes the National Biodiversity Authority in Chennai.

• The main functions of the authority are :

a) To lay down procedures and guidelines to govern the activities provided under section 3, 4, and 6. (Permission to foreigners/NRI's foreign companies)

i) For obtaining any biological resource (Section -3).

ii) For transferring the results of any research (Section -4).

iii) Certain collaborative research projects exempted (Section 5).

b) To advice the government of India. Specific areas mentioned as per the Act are the following:

i) Notifications of threatened species (Section - 38).

ii) Designate institutions as repositories for different categories of biological resources (Section - 39).

iii) Exempt certain biological resources, normally traded as commodities (Section - 40)

c) To encourage setting up state biodiversity boards

d) To build up database and documentation system

e) To create awareness through mass media

i) Training of personnel

ii) Necessary measures in the areas of intellectual propriety rights.

Review Questions

1. Explain biodiversity conservation measures.

2. Explain the measures of conservation of bio-diversity.

3. Explain in -situ measures of conversation of biodiversity.

Two Marks Questions with Answers

Q.1 Define ecology or environment.

Ans. : The environment is defined as, “the whole physical and biological system in which man and other organisms live". Environmental studies involve every issue that affects living organisms.

Q.2 Explain in brief biotic and abiotic components of ecosystem.

Ans. : .

• The structure of an ecosystem indicates it’s components (species diversity) and their interdependency for growth and survival.

• An ecosystem has two types of components.

1. Abiotic component (non-living).

2. Biotic component (living).

1. Abiotic (Non-Living) Components

• The abiotic components determine the type of organisms can live in specific area. Abiotic components can be physical components or chemical components.

• Physical components usually include sunlight, water, soil, temperature etc. These are necessary growth of species.

• Chemical components provide necessary nutrients to the organism. It includes Carbohydrates, proteins, liquids, nitrogen, phosphorous, potassium

2. Biotic Components

• Biotic components are living organisms of the ecosystem. Biotic component includes- plants, animals, fungi, bacteria and there living organisms.

• The biotic components of an ecosystems can be categorized into three categories, these are :

a) Producers or autotrophs.

b) Consumers or heterotrophs.

c) Decomposers or detrivores.

Q.3 Define ecosystem. State the characteristics of an ecosystem.

Ans. : Ecosystem : An ecosystem is a community of different species interacting with each other and with non-living environment, exchanging energy to form a stable self supporting system.

Characteristics of an ecosystem

1. It is structural and functional unit of ecology.

2. Its structure is related to species diversity i.e. more complex ecosystem have high species diversity and simple ecosystem have low diversity.

3. Functions of ecosystem are related to energy flow and cycling of material involved and within ecosystem.

4. Ecosystem mature as we pass from less complex to more complex structure i.e. early stage has excess potential energy and relatively high energy flow per unit biomass than later stages.

Q.4 Define natural resources and energy resources.

Ans.: Natural Resources -

• The natural resources are defined as the variety of things, processes obtained from environment to satisfy human needs and wants.

Energy Resources -

• Energy sources are available in different forms such as -wood, solar, wind, coal, petroleum, natural gas, nuclear fuels.

Q.5 Explain the types of natural energy resources.

Ans. : The natural resources can be classified into two major categories.

1. Renewable resources.

2. Non-renewable resources.

1. Natural resources : The renewable resources are the resources which regenerates through natural processes within a reasonable time period. They have the potential to regenerate as long as it is not used up faster than it is replaced. Examples : Forests, grass lands, wild life, soil, water, air.

2. Non-renewable resources : Non-renewable resources are not capable of regenerating. These resources have fixed quantity of stock in the earth's crust. These exhaustible resources include - coal, oil, natural gas, iron, copper.

Q.6 Mention the Ex-situ measures of conversion of biodiversity.

Ans.: Ex-situ measures for biodiversity -

• Ex-situ ('off site', 'out of place') conservation is a set of conservation techniques involving the transfer of a target species away from its native habitat to a place of safety, such as a zoological garden, botanical garden or seed bank.

• Various Ex-situ measures are :

1. Seed Banks; gene banks

2. Long term captive breeding

3. Animal translocations

4. Tissue culture banks

5. Cryopreservation of Gametes and Embryos

6. Botanical gardens

7. Zoological gardens

Q.7 What is food chain ?

Ans. : Transfer of energy from the source in plants through series of organisms with repeated stages of eating and being eaten is known as food chain.

Q.8 Define ecology and ecosystem.

Ans. : Ecology is study of earth's household including plants, animals micro-organisms and people which live together as interdependent.

Ecosystem is a community of different species interacting with each other, exchanging energy to form a stable self supporting system.

Q.9 Define biodiversity.

OR What is biodiversity ?

Ans. : Biodiversity is defined as variety and variability of living organisms in a given assemblage.

Q.10 What are endangered species ? Give example.

AU : Dec.-14

Ans. : When number of species of a particular type is reduced to a critical level, it is said to be endangered.

For example - Tiger, Elephant, Sandlewood trees.

Q.11 Write the classification of biodiversity.

Ans. : Classification of biodiversity :

1. Genetic diversity

2. Species diversity

3. Ecosystem diversity

Q.12 List out the types of land pollution.

Ans. : Types of land pollution :

1. Solid wast 2. Pesticides and fertilizers

3. Chemicals 4. Deforestation

Q.13 Define ecosystem diversity.

AU : Dec.-16

Ans.: Ecosystem diversity

• **Ecosystem diversity** is a term that incorporates both habitat and community diversity. A habitat is the environment in which an organism or species lives and includes the physical characteristics (e.g. climate or the availability of suitable food and shelter) that make it especially well suited to meet the life cycle needs of that species.

• A community consists of the assemblage of populations of plants and animals that occupy an area and their interactions with each other and their environment.

• An ecosystem is a unique combination of plant, animal and microorganism communities and their non-living physical characteristics interacting as a functional unit.

• Inherent in ecosystem diversity are thus both biotic (living) and abiotic (non-living) components, which makes it different from both genetic and species diversity.

Q.14 What do you understand by species biodiversities ? Give one example.

AU : May-17

Ans. : Species diversity is the number of different species of living things within an area. Species are regarded as populations within which gene flow occurs under natural conditions. Members of one species, do not breed freely with members of other species.

Example : Tiger, lion, teakwood, human being etc.

UNIT II

Chapter – 2

Environmental Pollution

Syllabus

Causes, Effects and Preventive measures of Water, Soil, Air and Noise Pollutions. Solid, Hazardous and E-Waste management. Case studies on Occupational Health and Safety Management system (OHASMS). Environmental protection, Environmental protection acts.

Contents

Environmental Pollution

• Pollution is defined as any substance introduced into the environment that adversely affects the usefulness of a resource.

• Pollution can be in the form of solid, liquid or gaseous substance. Pollution causes damage to human, plant and animal life. The nature and concentration of pollutant determine the severity of effect of pollution.

Pollution is defined as the excess discharge of any substance into the environment which affects adversely quality of environment and causing damage to humans, plants and animals.

• Terms used to describe pollution concentration are as under -

Examples : Industry pollution, automobile pollution, agriculture pollution, thermal pollution etc.

1. Definition of Pollution

• Ecologically, pollutants can be divided into three types :

1. Bio-degradable or non-persistent pollutants

2. Slowly degradable or persistent pollutants

3. Non-degradable pollutants.

1. Bio-degradable pollutants:

• The pollutants that can be rapidly decomposed by natural processes is called bio-degradable or non-persistent pollutants.

Examples : Domestic sewage, discarded vegetables etc.

2. Slowly degradable pollutants :

• Some pollutants remain in environment for longer time because they decompose very slowly by the natural processes.

Examples : Plastics, pesticides, etc.

3. Non-degradable pollutants :

• Some pollutants can not be decomposed by natural processes are called non-degradable pollutants.

Example : Lead, mercury, nuclear wastes etc.

2. Classification of Pollution

• The pollutants that pollute the environment is divided into following types.

1. Air pollution
2. Water pollution
3. Soil pollution
4. Marine pollution
5. Noise pollution
6. Thermal pollution
7. Nuclear hazards

Water Pollution

• Any physical, biological or chemical change in water quality that adversely affects living organisms or makes water unsuitable for certain uses is referred as water pollution.

• When the quality or composition of water changes by any means it becomes unsuitable for any purpose and is said to be polluted.

1. Types, Effects and Causes of Water Pollution

• Various types of water pollution their effects and causes are summarized here.

1. Infectious agents

• Micro-organisms are naturally found in water and can cause infections to human being.

Examples : Bacteria, virus, protozoa and parasitic worms.

Human sources I causes

• Human and animal wastes

Effects

• Infectious agents may cause amoebic dysentery, skin problems, maleria etc.

2. Oxygen demanding wastes / Dissolved oxygen

• This waste when discharged in water body are degraded by oxygen demanding micro-organisms. The amount of oxygen consumed by microbes is Biochemical Oxygen Demand (BOD).

• High levels of BOD can deplete the oxygen in water.

Examples : Organic waste such as animal manure and plant debris that can be decomposed by aerobic bacteria which requires oxygen.

Human sources / causes

• Sewage, animal feed lots, paper mills, food processing units.

Effects

• Depleted oxygen level in water may kill animals of aquatic life.

3. Inorganic chemicals

• Water soluble inorganic chemicals can pollute water.

Examples

• Acids, lead (pb), arsenic (As), selenium (Se), fluorides (F).

Human sources / causes

• Surface run-off, industrial effluents and household cleanser.

Effects

• Water cannot'be used for drinking and irrigation purpose.

• Causes skin cancers.

• Damage the nervous system, liver.

• Crop yield may reduce.

• Metals exposed to water may corrode.

4. Organic chemicals

• Water soluble organic chemicals pollute water.

Examples

• Oil, gasoline, plastic, pesticides, detergents, solvents.

Human sources / causes

• Industrial effluents, household cleansers, surface run-off from farms.

Effects

• Water cannot be used for drinking.

• Can cause several disease - cancer, damage of liver, nervous system.

• Can harm aquatic life.

5. Plant nutrients

• Water soluble compounds of plant nutrient or synthetic fertilizers pollute water.

Examples

• Nitrate, phosphate and ammonium.

Human sources I causes

• Sewage, manure, run-off of agricultural and urban.

Effects

• Causes excessive growth of algae killing aquatic life.

• Excessive nitrate can lower the oxygen carrying capacity of blood.

6. Sediment

• These are suspended solids or physical pollutants. They are always naturally present in the water.

Examples

• Soil, silt.

Human sources I causes

• Land erosion.

Effects

• It reduces photosynthesis.

• Aquatic food web is disrupted.

• Carry pesticides, bacteria and other harmful substances.

7. Radioactive materials

Examples

• Radioactive isotopes of uranium, thorium and cesium.

Human sources / causes

• Nuclear power plants.

• Nuclear weapons.

• Processing of uranium.

Effects

• Genetic mutations.

• Birth defects.

• Cancer.

8. Thermal pollution I Heat

• Thermal pollution is caused by increase in rise in temperature of water.

Examples

• Excessive heat, chemical reaction.

Human sources / causes

• Water cooling in industrial process.

Effects

• Aquatic organisms become more vulnerable to diseases.

9. Point and non-point sources water pollution

• Water pollutants are categorized as point source pollution and non-point source pollution.

I Point source of pollution

• Point source pollution is defined as any single identifiable source of pollution from which pollutants are discharged.

Examples

• Industrial discharge, factory smoke stack, municipal sewage etc.

• Point source pollution sources are discrete and identifiable and hence easy to monitor and regulate.

II Non-point source of pollution

• When a source of pollution cannot be readily, identified i.e. sources are scattered or diffuse they are called as non-point source of pollution.

Examples

• Run-off from farm lands, construction sites, parking lots, agriculture logging, animal waste.

• Table 2.2.1 lists some types of pollutants and their main sources.

Source of water pollution	Comment
Water and sewage company works.	Organic wastes and sometimes industrial wastes. Aluminium residues from water treatment.
Washing of equipment and plant in the food and drink industries.	Large, dilute volumes of effluent containing carbohydrates, proteins and fats may cause depletion in dissolved dioxygen in water.
Industrial wastes from paper, wool, leather industries.	Organic effluents containing proteins, fats, oils and putrescible solids. Also lime, potash and chromium salts. Sulphides from leather industry.
Electroplating and other metal industries Petrochemical, oil refining and pharmaceutical industries seepage from landfill sites.	Effluents containing metals and cyanides. A diverse chemical content and therefore difficult to treat. Industrial and domestic waste containing wide variety of chemicals may be difficult to treat.
Run-off from land, agricultural wastes and fertilisers.	Intensive farming causes concentration of waste in small areas - it causes effects and is treated similarly to domestic sewage. Excessive use of fertilisers can pollute rivers with nitrates via run-off.
Petroleum industry	Oil spills from ships, oil supertanker disasters and offshore drilling operations.
Acid rain	Formed by combination of SO_2 and NO_x with water in the atmosphere.
Radioactive materials	Present in wastes and (i) Uranium and thorium mining and refining, (ii) Nuclear power plants and (iii) Industrial, medical and scientific use.

Table 2.2.1 : Sources of water pollution

2. Effects of Water Pollution

On human beings

• On consuming polluted water following effects are observed on human beings :

1. Amoebic dysentery

2. Skin cancers

3. Cholera

4. Typhoid fever

5 . Damage of nervous system

6. Genetic mutations / Birth defects

7. Hepatitis

8. Malaria.

On plants and animals

1. Lower crop yields.

2. Harmful to aquatic life and wild life.

3. Excess growth of algae can kill aquatic life.

4. Reduce photosynthesis.

5. Disrupts food chain and food web.

3. Control Measures for Preventing Water Pollution

1. Setting up effluent treatment plants to treat waste.

2. Recycling of water must be encouraged.

3. Industrial wastes must be treated before discharge.

4. Educate public for preventing water pollution and the consequences of water pollution.

5. Strict enforcement of water pollution control act.

6. Continuous monitoring of water pollution at different places.

7. Developing economical method of water treatment.

8. River, streams, lakes and other water reservoirs must be well protected from being polluted.

4. Drinking Water Standards

• Drinking water is water intended for human consumption for drinking and cooking purposes from any source. It includes water (treated or untreated) supplied by any means for human consumption.

• Drinking water shall comply with the following requirements.

1. Organoleptic and Physical parameters

2. General parameters concerning substances undesirable in excessive amounts

3. Parameters concerning toxic substances

4. Parameters concerning radioactive substances

5. Bacteriological requirements

6. Virological requirements

7. Biological requirements

Bureau of Indian Standards for Drinking Water – Specification (BIS 10500 :1991)

Sr. No.	Substance or Characteristic	Requirement (Desirable Limit)	Permissible limit in the absence of alternate source
Essential characteristic			
1.	Colour (Hazen, units, max)	5	25
2.	Odour	Unobjectionable	Unobjectionable
3.	Taste	Agreeable	Agreeable
4.	Turbidity (NTU, Max)	5	10
5.	pH Value	6.5 to 8.5	No Relaxation
6.	Total Hardness (as $CaCO_3$) mg/lit. Max	300	600
7.	Iron (as Fe) mg/lit, Max	0.3	1.0
8.	Chlorides (as Cl) mg/lit, Max.	250	1000
9.	Residual, free, chlorine, mg/lit, Min.	0.2	--
Desirable characteristics			
10.	Dissolved solids mg/lit, Max	500	2000
11.	Calcium (as Ca) mg/lit, Max	75	200
12.	Copper (as Cu) mg/lit, Max	0.05	1.5
13.	Manganese ((as Mn) mg/lit, Max	0.10	0.3
14.	Sulfate (as SO_4) mg/lit, Max	200	400
15.	Nitrate (as NO_3) mg/lit, Max	45	100
16.	Fluoride (as F) mg, lit, Max	1.9	1.5
17.	Phenolic compounds (as C_6H_5OH) mg/lit, Max	0.001	0.002
18.	Mercury (as Hg) Mg/lit, Max	0.001	No relaxation
19.	Cadmium (as Cd) mg/lit, Max	0.01	No relaxation
20.	Selenium (as Se) mg/lit, Max	0.01	No relaxation
21.	Arsenic (as As) mg/lit, Max	0.05	No relaxation

Sr. No.	Substance or Characteristic	Requirement (Desirable Limit)	Permissible limit in the absence of alternate source
22.	Cyanide (as CN) mg/lit, Max	0.05	No relaxation
23.	Lead (as Pb) mg/lit, Max	0.05	No relaxation
24.	Zinc (as Zn) mg/lit, Max	5	15
25.	Anionic detergents (as MBAS) mg/lit, Max	0.2	1.0
26.	Chromium (as Cr^{6+}) mg/lit, Max	0.05	No relaxation
27.	Polynuclear aromatic hydro carbons (as PAH) g/lit, Max	--	--
28.	Mineral Oil mg/lit, Max	0.01	0.03
29.	Pesticides mg/*l*, Max	Absent	0.001
30.	Radio active Materials		
	i. Alpha emitters Bq/l,Max	--	0.1
	ii. Beta emitters pci/l, Max	--	1.0
31	Alkalinity mg/lit, Max	200	600
32	Aluminium (as Al) Mg/l, Max	0.03	0.2
33	Boron mg/lit, Max	1	5

Parameters and Risks or Effects

Parameters	Risks or Effects
Nitrate (NO_3)	Methemoglobinemia or blue baby disease in infants
Fluoride (F)	Brownish discoloration of teeth, bone damage
Arsenic (As)	Weight loss; Depression; Lack of energy; Skin and nervous system toxicity

5. Water Recycling

• Water recycling is reusing treated wastewater for beneficial purposes such as agricultural and landscape irrigation, industrial processes, toilet flushing and replenishing a ground water basin (referred to as ground water recharge).

• Water recycling offers resource and financial savings. Wastewater treatment can be tailored to meet the water quality requirements of a planned reuse.

• Recycled water can satisfy most water demands, as long as it is adequately treated to ensure water quality appropriate for the use.

• Recycled water is most commonly used for nonpotable (not for drinking) purposes, such as agriculture, landscape, public parks and golf course irrigation.

• Other non-potable applications include cooling water for power plants and oil refineries, industrial process water for such facilities as paper mills and carpet dyers, toilet flushing, dust control, construction activities, concrete mixing and artificial lakes.

• In addition to providing a dependable, locally-controlle.d water supply, water recycling provides tremendous environmental benefits. By providing an additional source of water, water recycling can help us find ways to decrease the diversion of water from sensitive ecosystems.

• Other benefits include decreasing wastewater discharges and reducing and preventing pollution. Recycled water can also be used to create or enhance wetlands and riparian habitats.

Suggested Water Recycling Treatment and Uses

Suggested Water Recycling Treatment and Uses			
Increasing Levels of Treatment Increasing Acceptable Levels of Human Exposure			
Primary Treatment : Sedimentation	**Secondary Treatment :** Biological Oxidation, Disinfection	**Tertiary / Advanced Treatment :** Chemical Coagulation, Filtration, Disinfection	
No uses Recommended at this level	Surface irrigation of orchards and vineyards Non-food crop irrigation Restricted landscape impoundments Groundwater recharge of non potable aquifer Wetlands, wildlife habitat, stream augmentation Industrial cooling processes	Landscape and golf course irrigation Toilet flushing Vehicle washing Food crop irrigation Unrestricted recreational impoundment	Indirect potable reuse: Groundwater recharge of potable aquifer and surface water reservoir augmentation

Review Questions

1. Mention the reasons for water pollution and explain the control measures.

2. What are the drinking water standards for nitrates and fluorides ? What are the health impacts of nitrates and fluorides.

Noise Pollution

• No one can escape the unwanted sound that is called noise-a disturbance to our environment escalating so rapidly that it is becoming one of the major threats to the quality of human life.

• Noise pollution is defined as - unwanted, unpleasant sound that causes discomfort of human beings. Noise or sound is measured in decibal (dB).

• In homes, especially in developed countries, but also in big cities of developing countries more and more power gadgets constitute additional sources of noise. The effect of these multiple causes of noise can be cumulative.

• Noise exposure at work is added at home during leisure activities. Slowly, insensibly, man seems to accept noise-and the physiological and psychological deterioration that accompanies it-as an inevitable part of his life.

• Because noise does not pose as obvious and immediate a danger to health as polluted water or air, public wareness of noise and public commitment to noise reduction have been modest.

• Major differences between noise and other forms of pollution are as follows :

1. Noise is everywhere; it is not as easy to control as the sources of water and air pollution.

2. Although certain effects of noise, like those of many other pollutants, accumulate in the organism, if noise pollution were to cease there would be no noise residual in the environment, as there would be in the case of water and air pollutants.

3. Unlike air and water pollution, the effects of noise are felt only close to the source.

4. An essential awareness of noise and motivation to reduce the problem are not present ; people are more likely to complain and demand political action about air or water pollution than about noise.

5. Finally, noise is not likely to have genetic effects, while some form of air and water pollution, such as radioactive pollution, can cause genetic effects.

1. Sources / Causes of Noise Pollution

• All the noise sources can be categorized into three types

1. Industrial noise 2. Transport noise 3. Domestic noise

1. Industrial noise : Industrial noise sources are - steel industry, textile industry, power generation, oil refineries generate huge amount of noise.

2. Transport noise : Traffic is considered to generate most annoying kind of noise. Road traffic, rail traffic and air traffic, all contribute to transport noise.

3. Domestic noise : Domestic noise sources are - household gadgets such as mixer, washing machine, refrigerator, air conditioners, vacuum cleaners and recreational noise (TV, radio) etc.

2. Effects of Noise Pollution

• Noise pollution severely affects human health. Various health problems are being reported because of noise pollution, such as -

i) Neurological disorder

ii) Anxiety

iii) Mental distress

iv) Heartattacks

v) Pathological disorder

vi) Deafiness/Impairment of hearing

vii) Sleeplessness.

• Ultrasonic sound affects digestive, respiratory cardio vascular systems and semicircular canals of the internal ear. The heart-beat rate is also affected.

• Because of loud and sudden noise brain also get adversely affected. People are subject to psychiatric illness.

3. Control Measures of Noise Pollution

1. Source control

Source control involves source modification such as :

Acoustic treatment to machine surface.

Change in machine design.

Controlling vibration of machines.

Applying proper lubrication of machine.

2. Transmission path intervention

Keeping noise source in insulating enclosure.

Constructing sound proof rooms.

3. Receptor control

This includes protection of receiver by altering the work schedule.

Using earplugs where abnormal noise is produced.

Dissipation and deflection of noise.

4. Banning noise polluting vehicles.

5. Plantation of trees on road side and near building can absorb noise.

6. Enforcing noise pollution control act.

7. Educating people about noise pollution and its consequences.

4. Ambient Noise Level

• Ambient noise levels at different zones are listed here

Sr. No.	Zone	Day-time	Night-time
1.	Silent zone	50 dB	40 dB
2.	Residential zone	55 dB	45 dB
3.	Commercial zone	65 dB	55 dB
4.	Industrial zone	70 dB	70 dB

Soil Pollution

• Soil pollution is defined as the contamination of soil causing adverse effects on living organisms in it.

1. Causes of Soil Pollution

1. Soil erosion : Soil erosion can be defined as the movement of topsoil from one place to another. Soil erosion is a natural process due to wind, flood and due to human activities like - construction, overgrazing, farming and deforestation.

2. Industrial wastes : Various pollutants exists in environment from industrial wastes. Discharge from chemical industries, fertilizer company, pharmaceutical companies are highly polluting.

3. Urban wastes : Because of modem life style and eating habits the urban wastes are becoming very dangerous to the human beings. Urban wastes

include both domestic and commercial wastes. Plastic is used in almost all packed foods, which is a non-degradable material and harmful to the society in long run.

4. Agricultural practice : Use of strong fertilizer, pesticides and inorganic chemicals for increasing yields causes soil pollution. Their effects can be seen even after the crop.

5. Biological agents : Human and animal excreta wastes enter the soil pores and decompose pathogenic bacteria present in those wastes spread infection.

2. Effects of Soil Pollution

1. Toxic compounds affects plant growth and human life also.

2. Water logging and salinity makes soil infertile.

3. Hazardous chemicals enter into food chain from soil disturbing the biochemical process.

4. Nervous disorders, gastrointestinal disorder, joint pain, respiratory problems are the effects seen on human beings.

3. Control Measures for Preventing Soil Pollution

1. Soil erosion must be prevented or controlled by proper tree plantation.

2. All the wastes from industry, domestic, must be dumped with proper treatment.

3. Use of synthetic fertilizers must be avoided instead natural fertilizers must be preferred

4. Educate people regarding consequences of soil pollution and to prevent soil pollution.

5. Strict enforcement of environment protection law'.

6. Toxic and non-degradable materials must be totally banned.

7. Recycling and reuse of industrial and domestic wastes can minimize soil pollution considerably.

4. Impacts of Modern Agriculture

a. Fertilizers

1. Micronutrient imbalance

• The fertilizer contents are nitrogen, phosphorous and potassium, which are macronutrients. The excess use of fertilizer causes imbalance of micronutrients, which affects the productivity of soil.

2. Blue baby syndrome (Nitrate pollution)

• Nitrate is highly soluble, they leach deep into the soil and can elevate concentrations in groundwater. This results in unacceptable quality for drinking water and may cause serious health problem called Blue Baby Syndrome which leads even to death.

3. Eutrophication

• Phosphorous does not leach but more tightly bound to soil particles. Large amount of phosphorous used in fertilizers carried with soils by runoff water and reaches water bodies causing excessive growth of aquatic plants. This process is called Eutrophication.

• If this process continues, lakes and reserviors becomes choked with algal species. These algae have offensive oders and can kill fish.

• The life of algal species are less they die quickly and pollute the water, which affect the aquatic life.

b. Pesticides

• Pesticides are used to improve the crop yield. Pesticides kill the pets.

First Generation Pesticides

Examples : Sulpher, arsenic, lead and mercury.

Second Generation Pesticides

Example : Dichlorodiphenyl Trichloromethane (DDT).

• Pesticides protect crop from losses due to pests. Pesticides kill not only the pest of concern but also a wide range of other organisms including beneficial insects. They produce number of side effects.

1. Death of non-target organisms

• Pesticides kill several non-target species which are useful to us.

2. Producing new pests (Superpests)

• Some species survice even after applying pesticides. These species generate highly resistant generation which are immune to pesticides and are called superpests.

3. Bio-magnification

• Most pesticides are note bio-degradable and keep on concentrating in food chain. This process is called bio-magnification. Pesticides in bio-magnified form is harmful to human beings.

4. Risk of cancer

• Pesticides may cause cancer as it directly acts as carcinogens and indirectly suppresses immune system.

5. Contamination of ground water

• New pesticides are soluble in water. The surface runoff carries pesticides into streams, lakes and reserviors causing unacceptable level of nutrients and organic compounds (dissolved chemicals). This results in contamination of groundwater supplies.

c. Waterlogging and its Effects

• Waterlogging is the land where water stays for most of the period.

• Waterlogging occurs where clay soil is present excessively. During waterlogging the soil gets filled with water and soil-air gets depleted. Therefore, roots of plants don't get adequate air for respiration. The soil strength decreases and crop-yield falls.

• The soil is then no longer suitable for cultivation.

Causes of waterlogging

1. When soils are over irrigated.

2. Heavy rain.

3. Inadequate drain of water.

Remedy

• Following remedy is suggested to avoid waterlogging.

1. Avoid excessive irrigation.

2. Provide adequate drainage.

3. Bio-drainage trees to avoid waterlogging e.g. Eucalyptus.

Salinity

• The unabsorbed water undergo evaporation leaving behind thin layer of dissolved salts on the top soil. The process of accumulating salts on soil is called salinity.

• The saline soils are characterized by deposition of soluble salts such as sodium chloride, calcium chloride, magnesium chloride, sodium sulphate, sodium bicarbonates and sodium carbonates.

Effects of salinity

1. Because of salinity the soil becomes alkaline and crop yield decreases severely.

2. Salinization of land leads to stunt growth.

3. The land becomes impotent and no crop can be cultivated.

Remedy for salinity

1. The salt layer can be removed by flushing more fresh water.

2. Switch to salt tolerant crops like cotton, suger beet etc.

3. Recharge soil with fertile ones.

4. Providing underground drainage system.

Review Questions

1. What are the impacts of modern agriculture ?

2. Write the impact as of modern agriculture.

Air Pollution

Definition :

• Air pollution is defined as the undesirable contamination of gas. smoke, dust, fume, mist, odour or chemical particulates in the atmosphere which are injurious to human beings, plants and animals.

Causes of air pollution

1. Industrialization

2. Urbanization

3. Vehicles emission

4. Deforestation

5. Population

1. Classification of Air Pollutants

• Air pollutants can be broadly classified into two types -

1. Primary pollutants

2. Secondary pollutants

1. Primary pollutants

i) Pollutants that are emitted directly from either natural events or from human activities are called primary pollutants.

ii) The natural events are dust storms, volcano etc and human activities can be. emission from vehicles, industrial wastes.

iii) About 90 % of global air pollution is constituted by five primary pollutants.

Examples

i) Carbon oxides (CO and CO_2)

ii) Nitrogen oxides

iii) Sulphur oxides

iv) Hydrocarbons

v) Particulate matter.

2. Secondary pollutants

• Primary pollutants when reacting with each other or from basic components of air forms a new pollutant called secondary pollutant.

Examples : Sulphuric acid, nitric acid, carbonic acid. etc.

2. Difference between Primary and Secondary Air Pollutants

3. Common Air Pollutants

1. Carbon monoxide (CO)

• Carbon monoxide (CO) is a colourless odourless, flammable gas, which is a product of incomplete combustion. If carbon were completely oxidized during burning, complete combustion to carbon dioxide would occur and carbon monoxide would not be a problem.

• It is important not to confuse carbon monoxide with carbon dioxide. Carbon monoxide (CO) is an incomplete combustion product and can be toxic even at low concentrations, whereas carbon dioxide (CO2) is a complete oxidation product.

Sources of carbon monoxide

• Carbon monoxide is formed whenever a carbon containing material is burned.

• **For example :** Automobile exhausts, cigarettes etc. In addition to motor vehicles, sources of carbon monoxide include burning coal, natural gas or biomass.

• Biomass combustion can be a significant source of exposure in rural areas or in underdeveloped countries where it is burned for cooking, heating and even light.

• Atmospheric oxidation of methane gas and other hydrocarbons also produces carbon monoxide.

Effects of carbon monoxide

1. Health effects

• Many thousands suffer from carbon monoxide-related illness, which include headaches, dizziness and drowsiness. Reports shows that about 11 % heart failure caused by excess carbon monoxide.

• Carbon monoxide also has other adverse effects in the body. For example, it interferes with the oxygen-carrying proteins in muscles.

• If the victim continues to receive a high dosage of CO, then permanent brain damage and even death will result. Initial symptoms include dizziness, headache, nausea and faintness.

2. Environmental effects

• It increases globe temperature.

Measures to reduce carbon monoxide

• About half of the motor vehicle carbon monoxide emissions in this country are produced by only 10 % of the vehicles. Efforts are being made to find and remove these vehicles from the road.

• Car and truck owners need to maintain their vehicles so that they operate as cleanly as they were designed to operate.

• Other measures to control carbon monoxide emissions include facilities that bum fossil fuels or wood to maintain high burning efficiencies and prohibiting open burning of trash and garbage.

2. Sulphur dioxide (SO_2)

• Sulphur dioxide (SO_2) is a colourless gas with a sharp odour that accounts for about 18 % of all air pollution.

Sources of sulphur dioxide

1. Chemical industries

2. Metal smeltings

3. Pulp and paper mills

4. Oil refineries.

Effects of sulphur dioxide

i) Health effect

• Sulphur dioxide reacts with moisture in eyes, lungs and mucous membranes to form strong irritating acid. It can trigger allergic reaction and asthama.

ii) Environmental effect

• Reduced visibility; acid deposition of H_2SO_4 can damage trees, soils and aquatic life.

• The stratospheric ozone depletion, where by sulphate particles in the stratosphere provide surfaces on which ozone-destroying reactions occur. A third major effect is the antiwarming influence they exert in global climate change.

3. Nitrogen dioxide (NO_2)

• Nitrogen dioxide is a reddish brown irritating gas. They account for about 6 % of pollution.

Sources of nitrogen dioxide

1. Motor vehicle exhausts

2. Gasoline

3. Volcanoes

4. Lightning

Effects of nitrogen dioxide

i) Direct, exposure of NO_2 irritates eyes and causes infection, asthma.

ii) Poisonous to plant life. HNO_3 can canoed metals and eat away stones.

4. Lead (Pb)

• Lead a highly useful metal has been mined for thousands of years. And it has been known for thousands of years that lead is toxic to the nervous system. The level of lead in modem human skeletons and teeth is at least a hundred-fold greater than the level found in pre-industrial age skeletons.

Source of Lead

• The combustion of alkyl lead additives in motor fuels accounts for the major part of all lead emissions into the atmosphere. An estimated 80-90 percent of lead in ambient air derives from the combustion of leaded petrol.

. • Paint and storage batteries.

Effects of Lead

• Mental retardation, digestion problems, cancer.

• Harmful to wild life.

5. Particulate Matter

• Suspended particulate matter is defined as single particle or aggregates of particles with diameters greater than 2×10^{-10} m.

• Some particulate matter is natural i.e. rain. snow. fog. hail and mist, while others are often the result of human processes, e.g. smoke, soot and fumes.

• Some natural particulates are affected by human actions such as fog and wind-blown soils.

• Smoke and soot are the products of incomplete combustions of coal, petrol and diesel fuels in furnaces, domestic heating systems and vehicle engines.

Effects of SPM

• Aerosols are mixtures of minute solid or liquid particles suspended in air that form a haze or spoil visibility.

• The main problem to humans caused by atmospheric particulate matter is how far it is able to penetrate the respiratory system.

• Particles in the size range 30×10^{-6} to 100×10^{-6} m lodge in the nasal cavity, larynre and trachea. Some examples of particles of this size are pollen, fungal spores, cement dust and coal dust.

• Particles less than 15×10^{-6} m find their way into the bronchus and bronchioles e.g. tobacco, smoke and fumes.

• Particles of 4×10^{-6} m and less can enter the alveoli where gaseous exchange take place between tile bloodstream and air e.g. asbestos dust, glass fibre and viruses.

Sources of Suspended Particulate Matter (SPM)

• Particulate matter comes from two major sources. First, those emissions that come directly from sources such as coal combustion, wind-blown dust and quarrying. These are called primary particulates.

• Other particulates can be formed from chemical reactions between pollutant gases such as sulphur dioxide, the oxides of nitrogen and ammonia such reactions lead to the formation of solid sulphate and nitrates.

• Organic aerosols may also be formed by the oxidation of volatile organic compounds. These particulates are termed as secondary particulates.

Reducing Particulate Emissions

• Emissions of particles smaller than 10 pm in diameter (PM_{10}) are controlled to meet an 3 EPA standard of 150 micrograms per cubic meter ($\mu g/m^3$) of air.

• Although many cities barely meet this standard - studies have shown Associations between very fine particulates and increased respiratory

problems and premature death rates at lex els only one-third of the standard. In the near future, particulates of diameters 2.5 pm and less may be regulated.

6. Dioxins

• Dioxins are a class of chemical contaminants that are formed during combustion process such as waste in cineration. forest fires and paper pulp bleaching.

Air Pollutants, Major Source and their Human Health Effect

Pollutant	Major sources	Human health effects
Carbon monoxide (CO)	• Spark ignition combustion • Engine (motor vehicle exhausts) • Some industrial processes	• Displaces oxygen in the blood stream • Effects depend upon concentration and exposure time • Can include reduction in mental and physical abilities, and eventually death
Carbon dioxide (CO_2)	• All combustion/burning processes	• Possibly injurious to health only at very high concentrations • Can cause tiredness. • Asphyxiation can result • Atmospheric levels have risen from about 280 ppm a century ago to a value currently over 350 ppm.
Sulphur dioxide (SO_2)	• Heat and power generators that use the fossil fuels; coal is the single largest source • Smelting of non-ferrous ores • Manufacture of sulphuric acid	• Short-term exposure to low concentrations affects lung function • Higher concentrations cause chemical bronchitis and tracheitis (an inflammation of the trachea or windpipe), and can lead to increased mortality rates.
Nitrogen oxides or NO_x (mainly NO and NO_2)	• Motor vehicle exhaust • Heat and power generators • Nitric acid manufacture • Use of explosives • Welding processes • Fertiliser manufacturing plants.	• Impaired lung function at low concentrations • Increase in number of acute respiratory illnesses • Lung tissue damage
Lead (Pb)	• Motor vehicle exhaust • Metal production	• Children are particularly sensitive to lead poisoning • Lead has been shown to affect

4. Photochemical Smog

• Smog is a type of air pollution. The photochemical smog is a chemical reaction of sunlight, nitrogen oxides and volatile organic compounds in atmosphere which leaves airborne particles and ground-level ozone.

• The noxious mixture of air pollutants are highly reactive and oxidizing.

• Photochemical smog is considered to be a problem of modern industrialization.

5. Control Measures for Air Pollution

• For controlling air pollution in long term, control of contaminants at their source is more desirable and effective method.

1. Source control

i) By using unleaded petrol only

ii) Use of petroleum products having low sulphur

iii) Use of public transport system rather than private vehicle

iv) Plantation of trees helps to remove particulate and carbon monoxide also they absorb noise.

v) Industries and waste disposal should be outside of city and preferably downwind of city.

vi) Use catalytic converters to help control the emissions of carbon monoxide and hydrocarbons.

2. Control measures in industries

i) Emission rate should be restricted to permissible levels.

ii) Incorporating air pollution control equipment in design of plant layout must be made mandatory.

iii) Continuous monitoring of emission to check pollution.

Equipments used to control air pollution

i) Ensuring sufficient supply of oxygen to combustion chamber to complete the combustion

ii) Use of mechanical devices such as :

- Scrubbers

- Cyclones

- Bag houses

- Electrostatic precipitators

• In manufacturing process, electrical power and industrial plants above devices are used for removing particulates from exhaust gases.

• All these methods retain hazardous materials of the exhaust which can be disposed of safely.

• The set scrubber can be used to remove sulphur dioxide emissions.

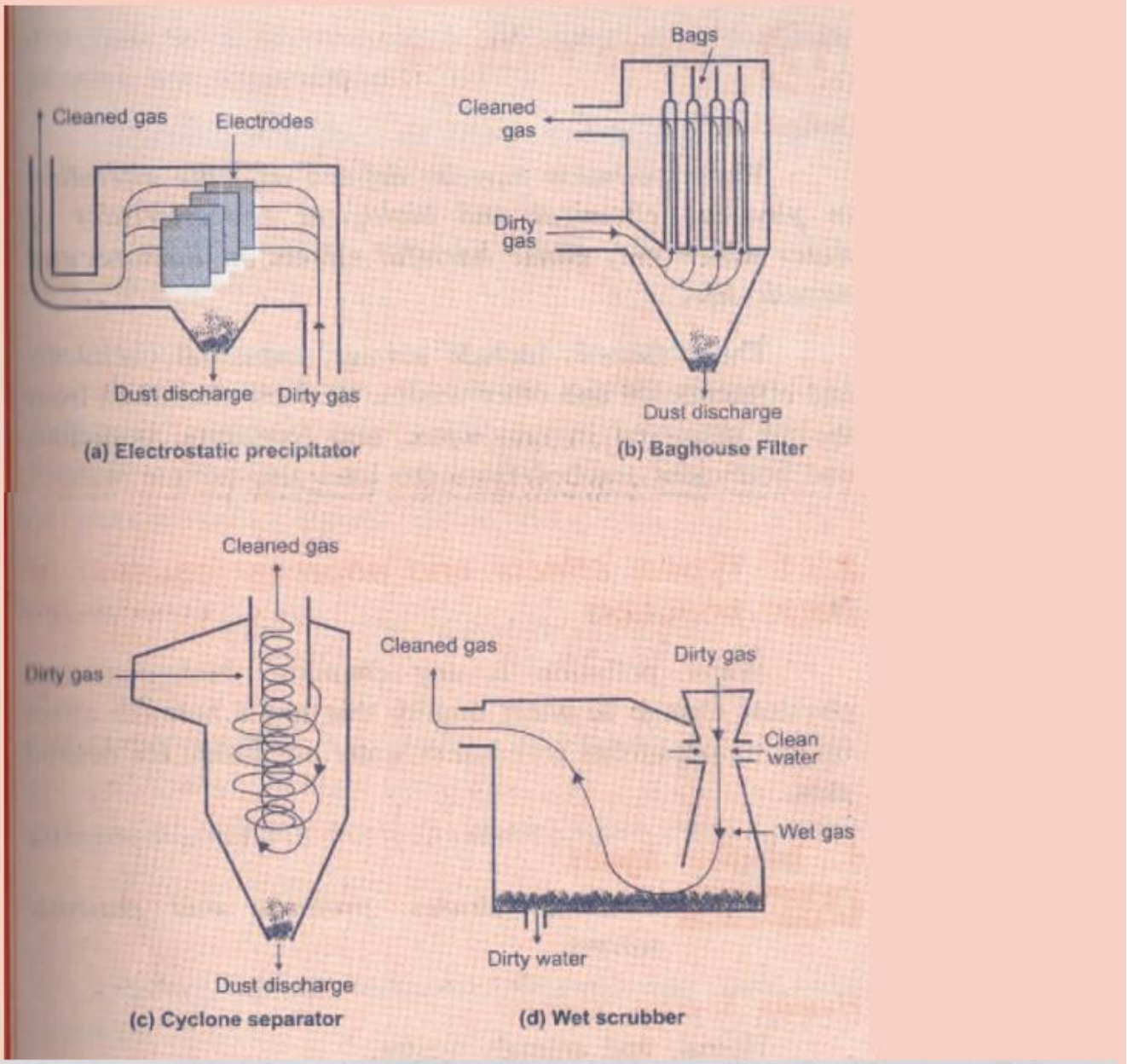


Fig. 2.5.1 : Control methods for removing particulates from exhaust gases

Review Questions

1. Define air pollution. What are the sources of air pollution ?

2. What are the global impacts of air pollution ?

Biomedical Waste : Management and Handling Rules

• Bio-medical Waste (Management and Handling) Rules. 1998 were notified by the Ministry of Environment and Forests (MoEF) under the Environment (Protection) Act, 1986. These rules apply to all persons who generate, collect, receive, store, transport, treat, dispose or handle bio-medical waste in any form.

• Thus bio medical waste should be segregated into containers/bags at the point of generation of waste. Thus colour coding and type of containers used for disposal of waste came into existence which is shown as follows :

Need For BMW Management

1. Nosocomial infections in patients from poor infection control practices and poor waste management.

2. Drugs which have been disposed of, being repacked and sold off to unsuspecting buyers.

3. Risk of air, water and soil pollution directly due to waste, or due to defective incineration emissions and ash.

4. Risk of infection outside hospital for waste handlers and scavengers, other peoples.

1. Types of Biomedical Wastes

Waste Category	Type of Waste
Category No.1	Human Anatomical Waste
Category No. 2	Animal Waste
Category No. 3	Microbiology and Biotechnology Waste
Category No. 4	Waste Sharps
Category No. 5	Discarded Medicine and Cytotoxic drugs
Category No. 6	Soiled Waste
Category No. 7	Solid Waste
Category No. 8	Liquid Waste
Category No. 9	Incineration Ash
Category No.10	Chemical Waste

2. Authority for Enforcement

• The authority for enforcement of the provisions of these rules in respect of all the health care facilities located in any State/Union Territory is the respective State Pollution Control Board (SPCB)/ Pollution Control Committee (PCC) and in case of health care establishments of the Armed Forces under the Ministry of Defence shall be the Director General, Armed Forces Medical Services (DGAFMS). This rule consists of six schedules and five forms.

3. Approach for Hospital Waste Management

• Based on Bio-medical Waste (Management and Handling) Rules 1998, notified under the Environment Protection Act by the Ministiy of Environment and Forest (Government of India) following are the ways for hospital waste management.

1. Segregation of waste

• Segregation, is the essence of waste management and should be done at the source of generation of Bio-medical waste e.g. all patient care activity areas, diagnostic services areas, operation theaters, labour rooms, treatment rooms etc. The responsibility of segregation should be with the generator of biomedical waste i.e. doctors, nurses, technicians etc. (medical and paramedical personnel). The biomedical waste should be segregated as per categories mentioned in the rules.

2. Collection of bio-medical waste

• Collection of bio-medical waste should be done as per Bio-medical waste (Management and Handling) Rules. At ordinary room temperature the collected waste should not be stored for more than 24 hours.

Type of container and colour code for collection of bio-medical waste

Category	Waste class	Type of container	Colour
1.	Human anatomical waste	Plastic bag	Yellow
2.	Animal waste	Plastic bag	Yellow
3.	Microbiology and biotechnology waste	Plastic bag	Yellow/Red
4.	Waste sharp	Plastic bag puncture proof	Blue/White
5.	Discarded medicines and Cytotoxic waste	Plastic bags	Black
6.	Solid (biomedical waste)	Plastic bag	Yellow
7.	Solid (plastic)	Plastic bag puncture proof	Blue/White
8.	Incineration waste	Plastic bag	Black
9.	Chemical waste (solid)	Plastic bag	Black

3. Transportation

• Within hospital, waste routes must be designated to avoid the passage of waste through patient care areas. Separate time should be earmarked for transportation of bio-medical waste to reduce chances of its mixing with general waste. Desiccated wheeled containers, trolleys or carts should be used to transport the waste/plastic bags to the site of storage/ treatment.

• Trolleys or carts should be thoroughly cleaned and disinfected in the event of any spillage. The wheeled containers should be so designed that the waste can be easily loaded, remains secured during transportation, do not have any sharp edges and is easy to clean and disinfect.

• Hazardous biomedical waste needing transport to a long distance should be kept in containers and should have proper labels. The transport is done through desiccated vehicles specially constructed for the purpose having fully enclosed body, lined internally with stainless steel or aluminium to provide smooth and impervious surface, which can be cleaned.

• The drivers compartment should be separated from the load compartment with a bulkhead. The load compartment should be provided with roof vents for ventilation.

4. Treatment of hospital waste

• Treatment of waste is required :

a) To disinfect the waste so that it is no longer the source of infection.

b) To reduce the volume of the waste.

c) Make waste unrecognizable for aesthetic reasons.

d) Make recycled items unusable.

5. Safety measures

• All the generators of bio-medical waste should adopt universal precautions and appropriate safety measures while doing therapeutic and diagnostic activities and also while handling the bio-medical waste.

• It should be ensured that:

a) Drivers, collectors and other handlers are aware of the nature and risk of the waste.

b) Written instructions, provided regarding the procedures to be adopted in the event of spillage/ accidents.

c) Protective gears provided and instructions regarding their use are given.

d) Workers are protected by vaccination against tetanus and hepatitis B.

6. Measures for waste minimization

• As far as possible, purchase of reusable items made of glass and metal should be encouraged. Select non-PVC plastic items. Adopt procedures and policies for proper management of waste generated, the mainstay of which is segregation to reduce the quantity of waste to be treated. Establish effective

and sound recycling policy for plastic recycling and get in touch with authorised manufactures.

4. Biomedical Hazardous Waste Management Rules

• Hazardous waste is defined as any waste which by reason of any of its physical, chemical, reactive, toxic, flammable, explosive or corrosive characteristics causes danger or is likely to cause danger to health or environment, whether alone or when in contact with other wastes or substances, and shall include wastes listed in Schedules I, II & III of the Rules.

• Every person who is engaged in generation, processing, treatment, package, storage, transportation, use, collection, destruction, conversion, offering for-sale, transfer or the like of the hazardous waste shall require to obtain an authorization from the State Pollution Control Board (SPCB).

• The hazardous waste shall be collected, treated, re-cycled, re-processed, stored or disposed of only in such facilities as may be authorized by the State Pollution Control Board for the purpose.

Type and Nature of HWs

1. Recyclable - Wastes having potential for recovery of useful /valuable material e.g. Metal bearing dross, ash, used oil etc.

2. Incinerable - Wastes having high calorific value, mainly organic wastes like solvents, tars, off-spec, organic products etc.

3. Land Disposable - Wastes that can neither be recycled or incinerated.

Solid Waste Management

• **Solid waste management** is a planned process of collection, storage, transportation, processing of disposable of solid wastes in safe and economic manner.

• On the basis of nature of solid wastes, it can be categorized into three types.

1. Urban or municipal wastes.

2. Industrial wastes

3. Hazardous wastes.

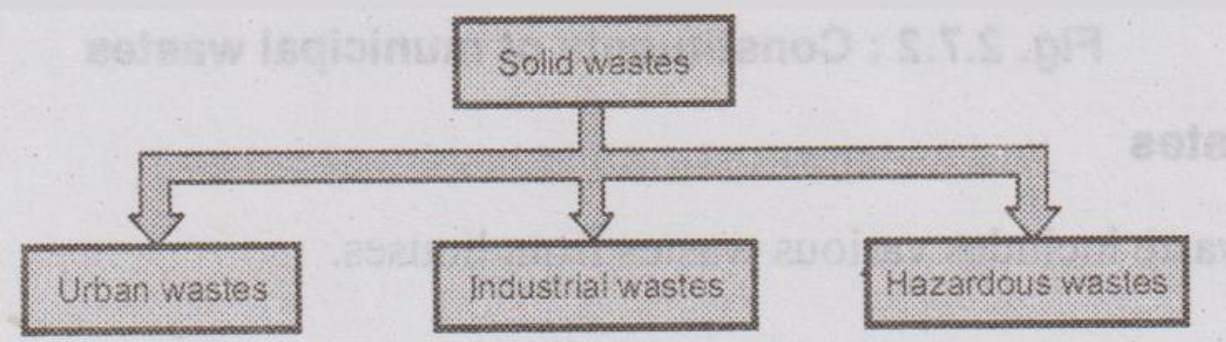


Fig. 2.7.1 : Types solid wastes

1. Objective of Solid Waste Management

1. The primary objective of solid waste management is reducing and eliminating adverse impacts of waste materials on human health and environment.

2. To control, collect, process, dispose of solid wastes in an economical way consistent with the public health protection.

3. To support economic development and superior quality of life.

4. Implementation of technologically simple farm composting plants (essentially in the agricultural holdings situated near the production areas in the partners' territories), with small and adequate scales. Possibility of giving an added value to the agricultural activity through the availability of an additional source of income for managing the treatment and selling resultant compost.

5. Identification of Waste and its Minimization at the Source

6. Collection, Segregation and Storage at the Site of Collection

7. Safe transportation of Solid Waste

8. Proper treatment of Solid Waste

9. Energy recovery and effective disposal of solid waste.

2. Sources of Municipal / Urban Wastes

• The municipal solid waste consists of following wastes.

1. Domestic wastes 2. Commercial wastes

3. Construction wastes 4. Biomedical wastes

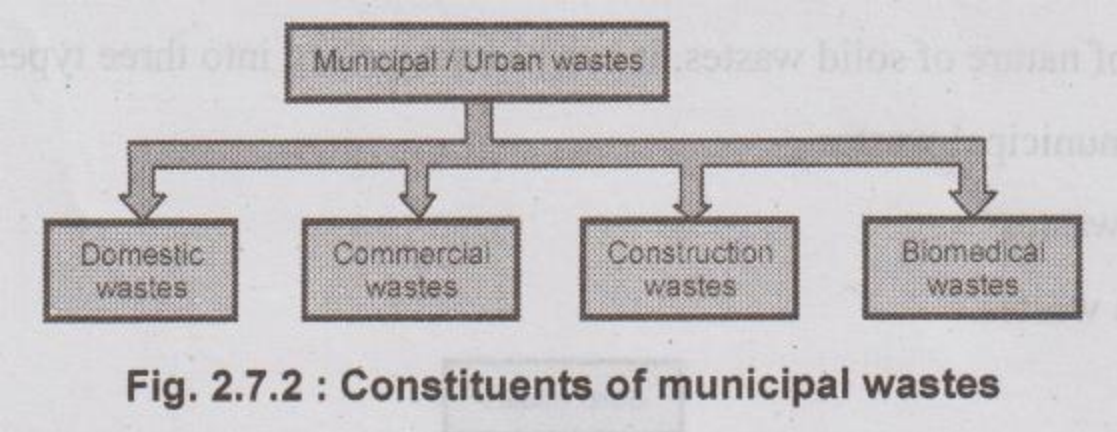


Fig. 2.7.2 : Constituents of municipal wastes

1. Domestic wastes

• Domestic waste includes various wastes from houses.

Examples

• Food waste, cloth, waste paper, glass, polythene, metals dust etc.

2. Commercial wastes

• Commercial wastes include waste coming out from shops, market, offices, institutions and hotels.

Examples

• Packaging material, waste papers, cans, bottles, rubber, plastic etc.

3. Construction wastes

• The construction wastes include the wastes of construction materials.

Examples

• Wood, concrete, debris, lime, cement, tin, Plaster of Paris (PoP) etc.

4. Biomedical wastes

• Biomedical waste includes the organic materials.

Examples

• Anatomical wastes, infectious wastes.

Types and characteristics of municipal wastes

• The municipal wastes can be categorized into two categories.

1. Bio-degradable wastes

2. Non-bio-degradable wastes

1. Bio-degradable wastes

• The urban solid waste materials, which can be degraded by micro-organisms are called bio-degradable wastes.

Examples

• Food, vegetables, tea leaves, egg shells, fruits etc.

2. Non-bio-degradable

• The part of urban solid waste materials, which can not be degraded by micro-organisms are called non-bio-degradable wastes.

Examples

• Polythene bags, Plaster of Paris (PoP), scrap materials, etc.

3. Sources of Industrial Wastes

• The main sources of industrial wastes are chemical industries, processing industries etc.

• The constituents of industrial waste are :

1. Nuclear power plants 2. Thermal power plants

3. Chemical industries 4. Other industries

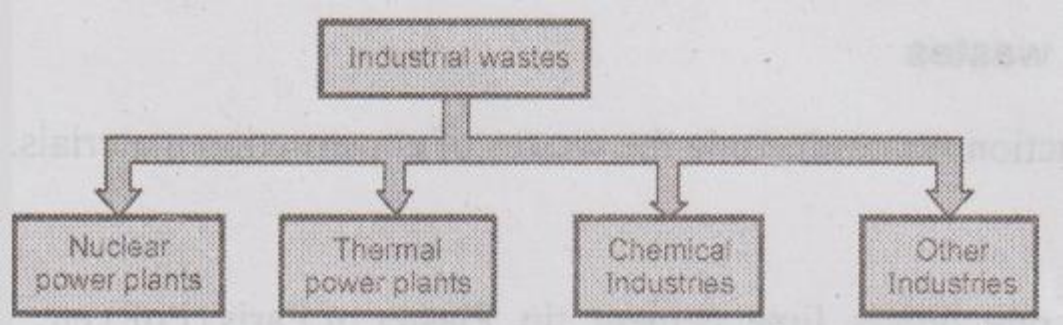


Fig. 2.7.3 : Constituents of industrial wastes

1. Nuclear power plants

• It generates radio-active wastes

2. Thermal power plants

• Thermal power plant produces flyash, hot water, unburnt fuel.

3. Chemical Industries

• It produces large quantities of toxic-chemicals, oxides, acids.

4. Other industries

• It includes packing material, wood, scrap material, oil, paint, dyes, lime, cement, rubber, organic wastes, acids, alkalis.

4. Hazardous Wastes

• The hazardous wastes are those wastes which cause substantial danger to all living things including human, plant or animal life.

Sources of hazardous wastes

• Chemical manufacturing industries

• Petroleum refineries

• Paper mills

• Smelters

• Radio-active substances

Types arid characteristics of hazardous wastes

1. Toxic wastes

• They are poisonous even in very small amounts.

a) Acute toxicity - These wastes have immediate effect on humans or animals and causes death.

b) Chronic toxicity - It causes long term effect and slowly results in irrepairable harm.

2. Reactive wastes

• These wastes react with air. water, heat and generate toxic gases.

Examples : Gun powder, nitroglycerine.

3. Corrosive wastes

• These wastes destroy materials and living tissues by chemical reaction.

Examples : Acids, bases.

4. Infectious wastes

• It spreads infections to exposed persons.

Examples : Used bandages, human tissue from surgery, hypodermic needles.

5. Process in Solid Waste Management

• An integrated approach to the waste management is to be adopted. The waste management hierarchy includes following components.

1. Reduce 2. Reuse 3. Recycle 4. Recover 5. Dispose

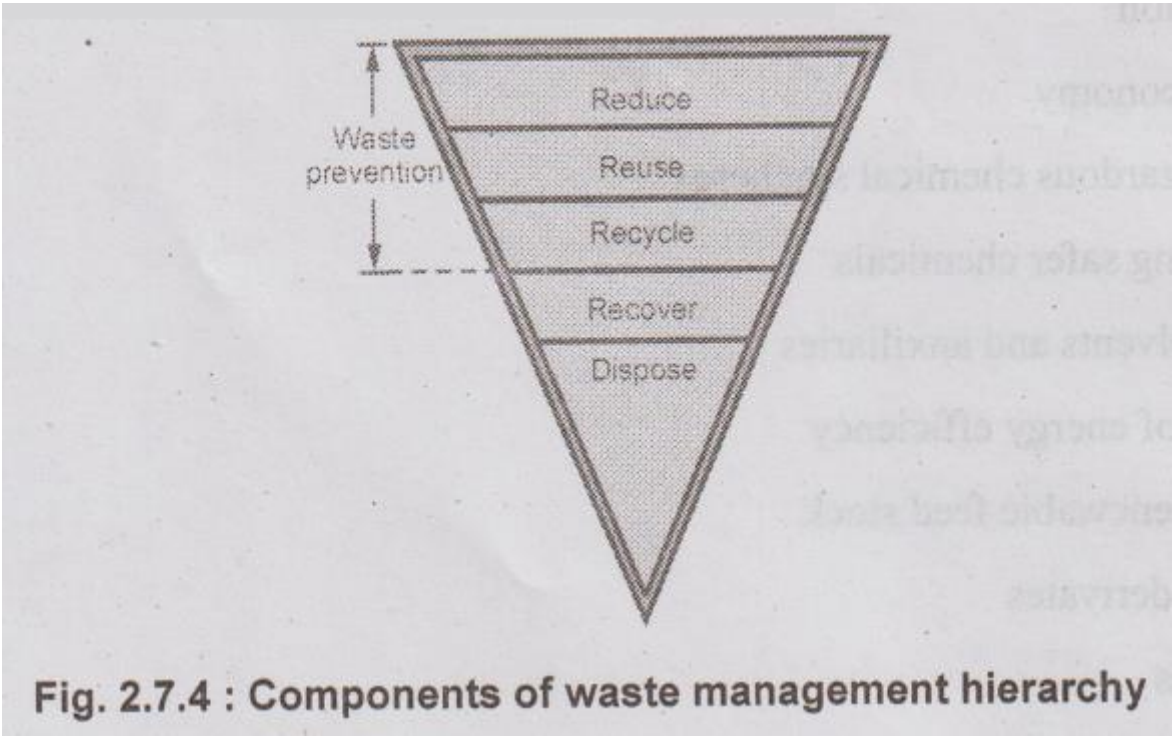


Fig. 2.7.4 : Components of waste management hierarchy

• All above activities are arranged in a hierarchical manner. The first priority is waste avoidance, means not producing the waste. If the waste is produced then quantity should be minimized.

• The second priority is reuse i.e. maximizing recovery by reuse and recycling of suitable waste materials.

• The three components i.e. reduce, reuse and recycle together is called waste prevention.

• Once the possibilities of waste prevention are exhausted, the next priority is reduce to the volume of residual wastes being passed on for final disposal i.e. extracting resources in the form of products or energy in the process. Fig. 4.6.4 shows waste management hierarchy.

Methods of disposal of solid waste

• Disposing of municipal solid wastes can be done by any of the following methods :

1. Land fill - Spreading waste on land after few years it becomes compact which is then covered by soil.

2. Incineration - Waste is reduced by burning and then disposed.

3. Composting - Organic waste is fertilized or decomposed making it useful for growing plants and trees.

6. Green Chemistry

• Green chemistry is a philosophy of chemical research and engineering that encourages the design of products and process that minimizes the use and generation of hazardous substances. It is also called as sustainable chemistry.

• Twelve principles of Green chemistry

1. Prevention

2. Atom economy

3. Less hazardous chemical syntheses

4. Designing safer chemicals

5. Safer solvents and auxiliaries

6. Design of energy efficiency

7. Use of renewable feed stock

8. Reduce derivates

9. Catalysis

10. Design for degradation

11. Real time analysis for pollution prevention

12. Inherently safer chemistry for accident prevention.

7. E-Waste

• Electronic waste describes and includes old, end-of-life electronic appliances such as computers, lap tops, TVs, DVD players, mobile phones, mp3 players , tape drives networking products, servers, etc., which have been disposed of by their original users (corporates, business establishments, government agencies and households) in most cases.

• It comprises of relatively expensive and essentially durable products used for data processing, telecommunications or entertainment by the said users.

• E-waste is growing exponentially simply because the markets in which these products are produced are also growing rapidly as many parts of the world cross over to the other side of the Digital Divide'.

• The changing lifestyle of people and urbanization has lead to increasing rates of consumption of electronic products. This has made electronic waste management an issue of environment and health concern.

• E-wastes are considered dangerous, as certain components of some electronic products contain materials that are hazardous, depending on their condition and density.

• The hazardous content of these materials pose a threat to human health and environment.

• E-waste contains different hazardous constituents such as - lead, cadmium, mercury and plastic.

• Discarded computers, televisions, VCRs, stereos, copiers, fax machines, electric lamps, cell phones, audio equipment and batteries if improperly disposed can leach lead and other substances into soil and groundwater.

• Many of these products can be reused, refurbished, or recycled in an environmentally sound manner so that they are less harmful to the ecosystem.

a. Disposal of E-waste

• The toxic substance of E-waste affects environment and human severly. Hence proper disposal and recycling is must for E-wastes. Different methods of E-waste disposal are -

1. Landfill

2. Incineration

3. Reuse

4. Recycle

1. Landfill

• Landfill method is suitable for quantitatively small e-waste i.e. domestic and small users. E-waste is piled up and covered with other domestic waste and soil.

2. Incineration

• E-waste is burnt in controlled environment. The toxic gases or smoke is released into atmosphere.

3. Reuse

• The spares and components are removed from the device and with some modification, they are used for other applications.

4. Recycle

• The important ingredients of E-waste is collected and sent to manufacturing companies producing similar components.

Occupational Health and Safety (OH&S)

• An Occupational Health and Safety Management System (OHSMS) is a fundamental part of an organisation's risk management strategy.

• The Occupational Health and Safety Management System (OHSMS) implemented to manage Occupational Health and Safety (OHS).

• Occupational Health and safety management is an important aspect of working for any organization be it manufacturing or Service.

• Definition of OHSMS according to ILO-OSH (2001) is -

“A set of interrelated or interacting elements to establish OSH policy and objectives and to achieve those objectives”.

• Occupational Health and Safety Assessment Series (OHSAS) 18001 (2007) define OHSMS as,

“Part of an organization’s management system used to develop and implement its OH&S policy and manage its OH&S risks.”

Benefits of implementing Occupational Health and Safety (OH&S)

1) Helps in implementing Occupational Health and Safety (OHS) Management System.

2) Helps in identifying OHS performance parameters.

3) Helps in identifying significant hazards and risk involved. Helps to protect the employees and working environment.

4) Protect its workforce and others under its control

5) Comply with legal requirements

6) Facilitate continual improvement

Environmental Protection Act

• Environment Protection Act (EPA) is introduced to make provisions for controlling the pollution. In 1980 the Government of India established an independent department.

• The prime function of this department is to generate environmental awareness amongs the public so as to reduce the environmental pollution.

• Number of laws are implemented to control pollution and protect environment. Under the Ministry of Environement and Forest, various pollution control boards at central and state levels are setup.

• The regulatory structure and hierarchy of implementing EPA is shown in Fig. 2.9.1.

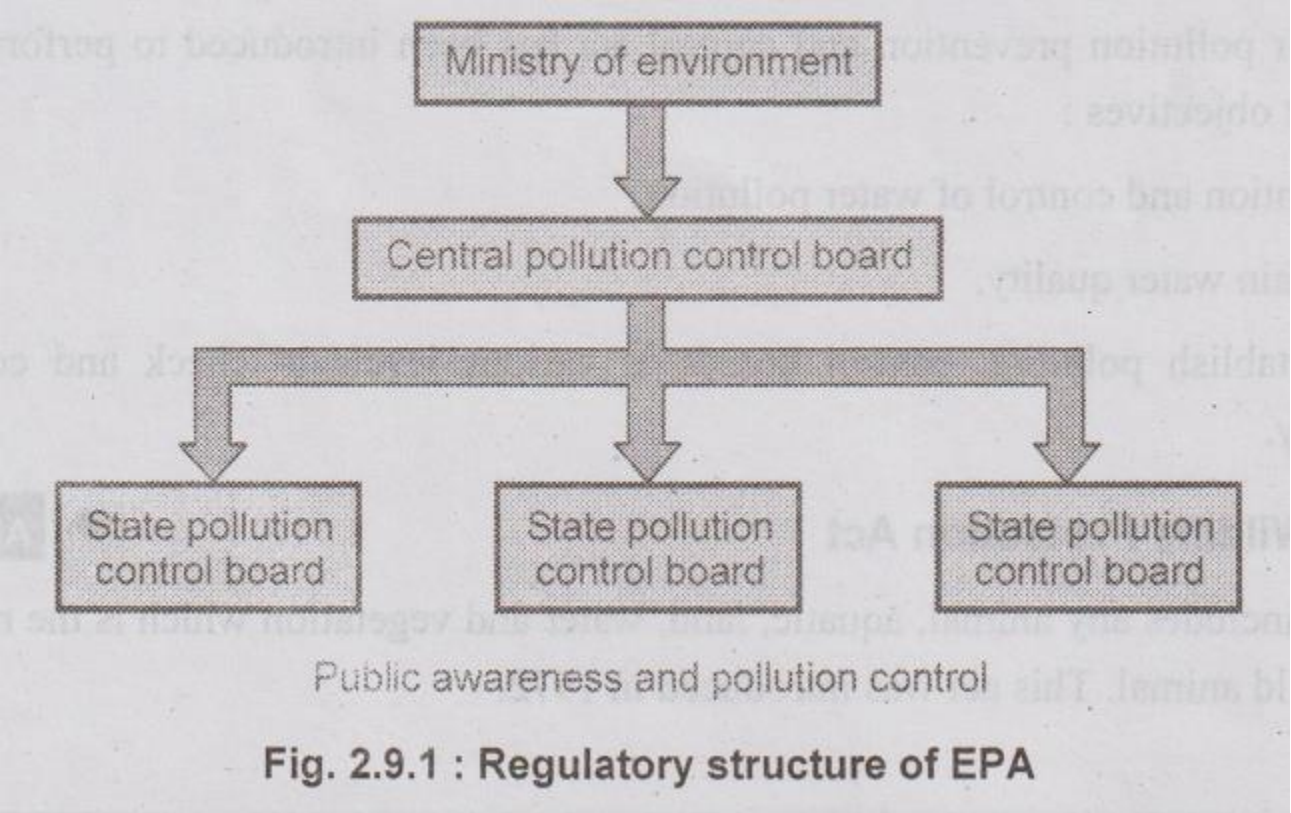


Fig. 2.9.1 : Regulatory structure of EPA

• Some important regulations under EPA and the year of implementations are given below :

1. The Air (Prevention and control of pollution) Act 1981.

2. The Water (Prevention and control of pollution) Act 1974.

3. Wild life protection Act 1972.

4. Forest conservation Act 1980.

1. Air (Prevention and Control of Pollution) Act

• Air pollution means presence of any air pollutant in the atmosphere. The air pollutant can be solid, liquid or gaseous substances.

• The concentration of such substance when exceeds, it becomes injurious to human beings or other living creatures. This act was introduced in 1981.

Objectives of Air Act

• The air pollution prevention and control act has been introduced to perform following important objectives :

1. Prevention and control of air pollution.

2. Maintain air quality.

3. To establish pollution control boards at various levels to check and control air quality.

2. Water (Prevention and Control of Pollution) Act

• Water pollution is defined as any changes in physical, chemical, biological properties of water or discharge of waste water which is injurious to

* Ecological system

* Public health/safety

* Domestic or agricultural use.

• This act was introduced in 1974.

Objectives of Water Act

• The water pollution prevention and control act has been introduced to perform following important objectives :

1. Prevention and control of water pollution.

2. Maintain water quality.

3. To establish pollution control boards at various levels to check and control water quality.

3. Wildlife Protection Act

• Wildlife includes any animal, aquatic, land, water and vegetation which is the natural home of any wild animal. This act was introduced in 1972.

Objectives of Wildlife Protection Act

• The objectives of wildlife protection act as follows.

1. To.maintain essential ecological processes and life supporting systems.

2. To pressure the biodiversity.

3. To protect wildlife.

4. Forest Conservation Act

• Forest is a biotic community composed of trees, shrubs and woody climbers. Timber, charcoal, oil, resin, lac, gum. Seeds are forest produce.

• Silk, sandle-wood, rocks and other plants used for Pharmaceutical purpose are important forest produce. Forest conservation act was introduced in 1972.

Objectives of Forest Conservation Act

• The prime objectives of forest conservation act are as follows.

1. Protection and conservation of forest.

2.To ensure proper use of forest produce.

5. Environmental Laws

• Various environmental laws for controlling hazardous substances are listed in Table 2.9.1.

Legislation	Description
Atomic Energy Act (Nuclear Regulatory Commission)	Regulates nuclear energy production and nuclear waste disposal.
Clean Air Act (EPA)	Regulates the emission of hazardous air pollutants.
Clean Water Act (EPA)	Regulates the discharge of hazardous pollutants into the nations surface water.
Comprehensive Environmental Response, Compensation and Liability Act (Superfund) (EPA)	Provides for the clean-up of inactive and abandoned hazardous waste sites.
Federal Insecticide, Fungicide and Rodenticide Act (EPA)	Regulates the manufacture, distribution and use of pesticides and the conduct of research into their health and environmental effects.
Hazardous Materials Transportation Act	Regulates the transportation of hazardous material.
Marine Protection, Research and Sanctuaries act (EPA)	Regulates waste disposal at sea.
Occupational Safety and Health Act	Regulates hazards in the workplace, including worker exposure to hazardous substances.
Resource Conservation and Recovery Act (EPA)	Regulates hazardous waste generation, storage, transportation, treatment and disposal.
Safe Drinking Water Act (EPA)	Regulates contaminant levels in drinking water and the disposal of wastes into injection wells.
Surface Mining Control and Reclamation Act	Regulates the environmental aspects of mining (particularly coal) and reclamation.
Toxic Substance Control Act (EPA)	Regulates the manufacture, use and disposal of chemical substances.

Table 2.9.1 : Environmental laws controlling hazardous substance

6. Environmental Impact Assessment (EIA)

• Environmental Assessment (EA), sometimes referred to as Environmental Impact Assessment (EIA) is a procedure for ensuring that the potential environmental effects of any new development or project are considered before it is allowed to proceed.

• Environmental assessment is a vital component in the concept of environmental management with environmental management system representing a useful tool for developers in conducting environmental assessments of their projects.

• Environmental Assessment (EA) is an appraisal technique for ensuring that the potential environmental effect of every new development are identified and considered before any approval is given.

• Environmental Assessment (EA) or Environmental Impact Assessment (EIA) as it is sometimes termed, is essentially the concept and process by which detailed information addressing the likely environmental effects of a development or project is gathered and evaluated by the developer or client organisation before being considered by the planning authority in deciding of planning permission should be formally granted. The collection of information documenting the projects potential-environmental effects is the environmental statement.

a. Environmental Statement (ES)

• The Environmental Statement (ES) is a publicly available document submitted to the planning authority and it accompanies the developer's planning application.

• Generation of the environmental statement is the responsibility of the developer as it is gathering all the information and facts needed for its development. In practice, it is likely that the developer will employ a consultant to conduct the detailed investigation and produce the statement.

• The environmental statement may, depending upon circumstances, be brief and simple or lengthy and complex but it must provide a clear description of the projects likely environmental effects on a range of conventional environmental factors.

b. Benefits of EIA

• The benefits of the environmental impact assessment directive to organisations are that

1. It provides the basis for better decision making in the procurement of their projects.

2. It ensures that the potential environmental effects of their proposals are fully considered.

3. It allows the formulation of projects within a framework of greater safeguard and acceptability.

4. It promotes greater interaction between the developer and planning and approval authorities..

5. It provides the judgemental processes to be administered more systematically timely and effectively.

• Environmental assessment is a management function aimed at providing as much information as possible to allow the most appropriate and best decision to be reached in the interests of working within the environment.

• Environmental assessment in practice represents a two tier system of environmental consideration. Environmental assessment is therefore, in practical terms, a review and audit of the development process.

c. Participants to ES

• The following list represents the principal participants to the environmental assessment process.

1. The developer - Responsible for initiating and undertaking an environmental assessment of proposed development or projects.

2. Specialist consultants - Appointed by the developer to conduct the environmental assessment and produce the environmental statement to support the planning application. Specialist consultants may include; landscape architect, environmental scientist, design architect, engineer planner, other construction or life science related specialist.

a) The planning authority - The public body with responsibility for considering the environmental effects of a planning application.

b) The secretary of state - Involved in the environmental assessment decision making process in specific situations.

c) The public - May become involved in environmental assessment in publically sensitive projects where for example they may raise issues and objections with the planning authority or to the secretary of state.

d) Statutory and other consultees - Statutory and non statutory bodies may be asked to provide advice and information in the decision-making process. These involve such specialist organisations as the Countryside Commission, The Nature Conservancy Council, The Historic Building and Monuments Commission etc.

d. Role of Environmental Consultant

• The principal role of the environmental consultant within the environmental assessment process is to undertake the following.

1. Liaise with the developer on all aspects of environmental assessment.

2. Appraise the developer on matters of environmental legislation and regulations.

3. Liaise with other specialist consultants where required.

4. Liaise with the planning authority upon matters concerning the environmental assessment.

5. Liaise with statutory, non-statutory and other consultees who become involved in environmental assessment.

6. Undertake an Environmental Site Survey (ESS) to collect, collate and analyse the information necessary for the environmental assessment of the proposal.

7. Provide the environmental statement submitted with the developer's planning application to the planning authority.

• The environmental consultant may be asked by the developer to,

a) Act in the capacity of environmental consultant during the briefing, design and procurement phases.

b) Act as environmental consultant during the construction phase on-site.

e. Stages of EIA

• There are seven principal elements in the process of environmental assessment. These are supported by one further element, essential to the realisation of success but which is frequently understood. These elements are,

1. Project description

2. Screening

3. Scoping

4. Baseline studies

5. Impact prediction / Identifying and evaluating alternatives

6. Mitigation assessment

7. Environmental statement

8. Environmental monitoring.

1. Project description

• This is a sufficient and clear description of the project together with details of its location.

• Although detailed information is not required at this initial stage, the developer must provide the planning authority with sufficient information to judge whether an environmental assessment is necessary.

2. Screening

• Screening is the process of determining for a particular project, the need for an environmental assessment.

3. Scoping

• Scoping is connected with directing the environmental assessment towards aspects of specific importance.

• Scoping is a vital step in the environmental assessment process as it must clearly identify those aspects which require detailed study and analysis and forms the basis for impact prediction of environmental effects.

• The result of scoping is the development of an environmental assessment programme or schedule which relates particular attributes of the development process to environmental aspect.

4. Baseline studies

• Baseline studies are concerned with the identification of the significant environmental impacts that must be assessed.

• Baseline studies follow on naturally from or even form an inherent part of scoping. The environmental assessment programme or schedule developed during scoping will direct the baseline study. This will provide information on -

a) The detailed description of the project.

b) The project's environs.

c) The social dimension.

5. Impact prediction

• This is concerned with assessing the potential for environmental effect of those aspects identified during scoping and baseline studies.

• The focus of this aspects is, by definition, on determining the likely effect of specific project aspects upon the environment. Naturally it is difficult frequently impossible, to predict potential environmental effects with any degree of accuracy.

• Usually environmental impact prediction is a subjective description of what will happen, known from experience or what might happen based upon reasoning or expectation. Strictly, analysis should lead to accurate prediction based on verifiable information. It should be determined and not based on judgement or guesswork.

• In practice, environmental assessment should involve detailed investigation by experienced consultants and the resulting information presented in clear and unambiguous form, based on sound common sense reasoning of accurate data.

6. Mitigation assessment

• This focuses upon consideration of the measures to be taken to alleviate or minimise environmental effects.

• The accent of this section is towards summarising recommendations developed during the analytical and predictive processor, aimed at mitigating the environmental effects of the project.

7. Environmental statement

• The statement is the mechanism by which the developer places the findings of the environmental assessment before the planning authority. The extent and detail of an environmental statement will be determined by the characteristics and situation of the particular project.

8. Environmental monitoring

• Environmental monitoring is concerned with monitoring the environmental effects of the project, if and when the project is given approval to proceed.

• Environmental monitoring is essential as a concept, as it provides the sound base upon which wider principles and practices will undoubtedly advance in the future.

• It is rapidly becoming a prerequisite to the wider issues of environmental regulation and auditing schemes and looks set to play an even more significant role in the future.

7. Salient Features of the EPA

The Environment (Protection) Act has been brought into force from November, 1986. Its salient features are :

(a) Conferring powers on the Central Government to :

(i) Take all necessary measures for protecting quality of environment,

(ii) Co-ordinate actions of States, officers and other authorities under this Act,

(iii) Plan and execute a nationwide programme for prevention, control and abatement of environmental pollution,

(iv) Lay down standards for discharge of environmental pollutants,

(v) Empower any person to enter, inspect, take samples and test,

(vi) Establish or recognise environmental laboratories,

(vii) Appoint or recognise government analysts,

(viii) lay down standards for quality of environment,

(ix) Restrict areas in which any industries, operations or processes may not be carried out subject to certain safeguards,

(x) Lay down safeguards for prevention of accidents and take remedial measures in case of such accidents,

(xi) Lay down procedures and safeguards for handling hazardous substances,

(xii) Constitute an authority for exercising powers,

(xiii) Issue directions to any person, officer or authority including the power to direct closure, prohibition or regulation of any industry, operation or process,

(xiv) Require any person, officer or authority to furnish any prescribed information and

(xv) Delegate powers to any officer of a state or authority;

(b) It confers powers on persons to complain to courts regarding any violation of the provisions of the Act, after a notice of 60 days to the prescribed authorities;

(c) The Act makes it obligatory for the person in charge of a place to inform the prescribed authorities regarding any accidental discharge of any pollutant in excess of prescribed standards.

• The concerned authorities, on receipt of such information, shall take remedial measures to prevent or mitigate pollution caused by such accidents and expenses incurred by the authorities in respect of remedial measures are recoverable with interest from the polluter;

(d) It prescribes stringent penalties for violation of the provisions of the Act; and

(e) Jurisdiction of civil courts is barred under the Act.

• A comprehensive Environment (Protection) Act came into being in 1986 to remedy the lacunae noticed in the earlier laws and to serve as a single legislation on the subject.

Review Questions

1. What are the salient features of the following acts ?

i) The environment (Protection) Act 1986.

ii) Water (Prevention and control of pollution) act 1974.

2. Briefly discuss to salient features of wildlife protection act.

AU : Dec.-14, Marks 8

3. Explain in brief about the present regulatory trends in air, waste water and recycling.

AU : May-14, Marks 12

4. Name the laws that have been framed for environmental protection and mention the objectives for each act.

5. Name the laws that have been framed for environmental protection and mention the objectives for each act.

6. Explain salient features of water act.

7. Explain a note on EIA

Environment and Sustainability: Unit II: Environmental Pollution : Two Marks Questions with Answers

Two Marks Questions with Answers

Q.1 Define air pollution. What are various sources of air pollution ?

Ans.: Air Pollution :

• Air pollution is defined as the undesirable contamination of gas, smoke, dust, fume, mist, odour or chemical particulates in the atmosphere which are injurious to human beings, plants and animals.

Sources of air pollution

1. Industrialization

2. Urbanization

3. Vehicles emission

4. Population growth

• Industry, in its broadest sense is a major contributor to air pollution. The exhaust from industry may contains various poisonous gases, hazardous effluents and noise also.

• Urbanization is another major cause of air pollution. Waste of construction material also contributes to it. Various electrical and electronic gadgets used for human comfort are also making air pollution.

• Number of vehicles increasing day by day which emits various dangerous gases such as CO, CO_2, Pb, SO_2, and unburnt hydrocarbons.

• Population growth also causes air pollution as the garbage is generated by each human being. Food consumption also increases with population.

Q.2 Define ozone layer depletion. State impact of Ozone layer depletion.

Ans.: Ozone Layer Depletion :

• Ozone (O_3) is a gas found in atmosphere. Ozone is highly concentrated in stratosphere which lies about 15-50 km above the earth's surface. This is known as ozone layer.

• The ozone in stratosphere protects living organisms from the ultraviolet radiation of the sun. In particular, it absorbs ultraviolet (UV) radiations and screens out harmful UV radiations.

Impact of ozone layer depletion

1. Effects on human health

• UV rays damage genetic material in skin causing skin cancer.

• Prolonged exposure to UV rays may cause blindness.

• Human resistivity is reduced resulting in allergies and infections.

2. Effects on aquatic system

• Kills lower fauna and flora

• Affects photosynthesis process cause mutation.

3. Effect on materials

• Degradation of point quality and plastics.

4. Effects on climate

• Climate change.

• Global warming.

Q.3 What is mean by chemical Hazards ?

Ans.: Chemical hazards :

• Chemical hazards can be both natural and human-made chemicals in the environment.

• Human-made chemical hazards include many of the synthetic chemicals we produce, like disinfectants, pesticides and plastics.

• Some chemical hazards occur naturally in the environment, like the heavy metals lead and mercury. Some organisms even produce natural chemicals that are an environmental hazard, such as the compounds in peanuts and dairy that cause allergic reactions in humans.

Q.4 Name any four air pollutants, their sources and effects.

Ans.: Air pollutant, their sources and effects :

Air pollutant	Sources	Effects
CO	• Engine combustion • Industrial processes	• Displaces oxygen in blood system
SO_2	• Fossile fuels • Sulphuric acid	• Long function • Bronchitis
NO_2	• Vehicle exhaust • Explosives	• Respiratory • Lung tissue damage
Lead	• Vehicle exhaust • Thermal power plant	• Poisoning • Mental retardation

Q.5 What is the role of individual in pollution prevention ?

Ans.: Pollution prevention :

• Pollution prevention is not a job of any specific person but all individuals must contribute in preventing pollution.

• Every individual should think about reducing pollution and act accordingly.

1. Importance of plantation of trees.

2. Reduce use of wood, paper etc. that comes from forests.

3. Reuse various useful materials.

4. Avoid use of non-degradable items e.g. plastic bags.

5. Conserve water. Implement rain water harvesting.

Q.6 Define acid rain. List any four impacts of acid rain.

Ans.: Acid rain :

• The term "acid rain" means acidification of the ecosystem by natural boiler which evaporates water from the sea, lakes and rivers and sends it down in the form of rain.

• Normally rain water is always slightly acidic because of the fact that CO_2, present in the atmosphere gets dissolved on it. Because of the presence the of SO_2 and NO_2, gases as pollutants in the atmosphere, the pH of the rain water is further lowered. This type precipitation of water called acid rain or acid deposition.

Impacts of acid rain :

1. Both dry and wet deposition of sulphur dioxide significantly increases the rate of corrosion of lime stone, sand and marble.

2. Forest tree population is affected by acid rain.

3. Acid rain in combination with ozone may damage the coating on leaves and needles. This may weaken or damage them and provide opportunities for disease to enter the tree.

4. Acid rain may change the characteristics of soil and eventually pollute the streams and lakes.

Q.7 Define water pollution and give the sources of water pollution.

Ans. : Water Pollution :

• Water pollution can- be defined as alteration in physical, chemical or biological characteristics of water making it unsuitable for designated use in its natural state.

• There are two sources of water pollution. They are :

1. Point sources - Specific sites near water which directly discharge effluents into them.

2. Non-point sources - Sources are scattered and individually collect pollute water.

Q.8 What do you mean by DO and BOD?

Ans. : Dissolved Oxygen : Dissolved Oxygen (DO) is the amount of O_2 dissolved in a given quantity of water at a particular temperature and atmospheric pressure.

Biological Oxygen Demand (BOD) : Biological Oxygen Demand (BOD) is defined as the amount of DO required to aerobically decompose biodegradable organic matter over a period of 5 days at 20 °C.

Q.9 Name some of the acts enacted by the Indian Government to protect the environment.

Ans.:

1. The Water (Prevention and Control of Pollution) Act 1974
2. The Water (Prevention and Control of Pollution) Cases Act 1977
3. The Air (Prevention and Control of Pollution) Act 1981
4. The Environment (Protection) Act 1986
5. The Public Liability Insurance Act 1991

Q.10 What are the common objectives of Environmental Legislation?

Ans.: Objectives of Environmental Legislation

1. To control further damage to the environment and ecosystem
2. To conserve the environment.

3. To restore the environment in areas damaged including such measures as reclamation of degraded land.

4. To create authorities to administer the policy and contents of the legislation.

5. To provide penalties and prosecution for violation of laws.

Q.11 What are the objectives of water act ?

Ans.: Objectives of water act:

1. Prevention and control of water pollution.

2. Maintain water quality.

3. Establishing pollution control boards.

Q.12 List out the advantages of rain water harvesting.

Ans.: Advantages of RWH

1. Rain water harvesting increases ground water table.

2. Recharging of ground water table improves water quality.

3. It increases water availability to individual.

4. Minimizes local flooding and droughts.

5. Rain water harvesting helps eliminating desertification.

Q.13 Define noise pollution.

Ans.: Noise pollution

• Noise pollution is defined as - unwanted, unpleasant sound that causes discomfort of human beings. Noise or sound is measured in decibal (dB).

• Sound becomes unwanted when it either interferes with normal activities such as sleeping, conversation or disrupts or diminishes one's quality of life. Not all noise can be called noise pollution. If it does not happen regularly, it may be termed as 'Nuisance'

• Noise is a physical form of pollution and is not directly harmful to the life supporting systems namely air, soil and water. Its effects are more directly on the receiver i.e. man.

• Noise pollution is the result of modern industrialized urban life and congestion due to over population.

Q.14 Define pollution.

Ans. : The excess discharge of any substance into the environment which affects adversely environment quality.

Q.15 Define acid rain.

Ans. : Formation of sulphuric acid due to atmospheric pollutants with oxygen, water or moisture is called as acid rain.

Q.16 What is disaster management ?

Ans. : The management of natural calamities (earthquake, cyclones, land slides, flood) in efficient way to save lives and materials is called disaster management.

Q.17 Explain the term composting.

Ans. : Composting is a process of converting the organic waste material into fertilizer by anaerobic bacterial activity.

Q.18 What is zero discharge ? Why is zero discharge not practical in most instances ?

AU : May-14

Ans. : Zero discharge :

• When there is no measurable emissions from the defined source it is called as zero discharge.

• Zero discharge is a hypothetical condition.

Q.19 What are the major causes of earth quake ?

Ans.: Causes of earth-quake :

1. Volcanic erruptions causes disequilibrium.

2. Tectonic activity associated with plate marging.

3. Seismic wares

4. Suddun movement of rock strata.

Q.20 What do you mean by noise pollution ?

Or Define noise pollution.

Ans. : Any unwanted, unpleasent sound that causes discomfort of human being is called as noise pollution.

Q.21 What is the role of individual in pollution prevention.

Ans.

• Pollution prevention is not a job of any specific person but all individuals must contribute in preventing pollution.

• Every individual should think about reducing pollution and act accordingly.

1. Importance of plantation of trees.

2. Reduce use of wood, paper etc. that comes from forests.

3. Reuse various useful materials.

4. Avoid use of non-degradable items e.g. plastic bags.

5. Conserve water. Implement rain water harvesting.

Q.22 Give two examples of physical hazard.

Ans. : A physical hazard is defined as "A factor within the environment that can harm the body without necessarily touching it. Vibration and noise are examples of physical hazards".

Examples of Physical hazards include but aren't limited to electricity, radiation, pressure. noise, heights and vibration amongst many others.

Q.23 What is PAN ? Give detrimental effects.

Ans. : The common components of photochemical smog are ozone, nitric oxide, acrolein, formaldehyde and peroxyacetyl nitrate (PAN).

• Photochemical smog causes serious health problems. Both .ozone and PAN act as powerful eye irritants. Ozone and nitric oxide irritate the nose and throat and their high concentration causes headache, chest pain, dryness of the throat, cough and difficulty in breathing.

• Photochemical smog leads to cracking of rubber and extensive damage to plant life. It also causes corrosion of metals, stones, building materials, rubber and painted surfaces.

Q.24 Write any two chemical hazards present in the environment.

Ans.: Chemical hazards can be both natural and human-made chemicals in the environment.

• Human-made chemical hazards include many of the synthetic chemicals we produce, like disinfectants, pesticides and plastics.

• Some chemical hazards occur naturally in the environment, like the heavy metals lead and mercury. Some organisms even produce natural chemicals that are an environmental hazard, such as the compounds in peanuts and dairy that cause allergic reactions in humans.

Q.25 Write any four principles of green chemistry.

Ans.: Principles of green chemistry :

1. Prevention

2. Atom economy

3. Less hazardous chemical syntheses

4. Designing safer chemicals

5. Safer solvents and anxiliaries

6. Design of energy efficiency

Q.26 What are the characteristics of PAN ?

Ans.:

1. Peroxyacetyl nitrate is a peroxyacyl nitrate (PAN). It is a secondary pollutant present in photochemical smog.

2. PAN is thermally unstable and decomposes into peroxyethanoyl radicals and nitrogen dioxide gas. It is a lachrymatory substance.

3. Peroxyacetyl nitrate (PAN) is an oxidant that is more stable than ozone.

Q.27 Mention the effects of nuclear wastes in humans.

Ans. : Nuclear waste : is generally a variety of solids, liquids, and gases which are produced during the generation of nuclear energy during fission, mining of uranium, do nuclear research and weapons production. They are normally classified as low-level, medium-level or high- level wastes, according to the amount and types of radioactivity in them.

1. The losing of hair quickly and in clumps occurs with radiation exposure at 200 rems or higher.

2. Brain : Since brain cells do not reproduce, they won't be damaged directly unless the exposure is 5,000 rems or greater. Like the heart, radiation kills nerve cells and small blood vessels, and can cause seizures and immediate death.

3. Blood System : When a person is exposed to around 100 rems, the blood's lymphocyte cell count will be reduced, leaving the victim more susceptible to infection. Early symptoms of radiation sickness mimic those of flu and may go unnoticed unless a blood count is done.

4. Heart : Intense exposure to radioactive material at 1,000 to#5,000 rems would do immediate damage to small , blood vessels and probably cause heart failure and death directly.

5. Gastrointestinal Tract : Radiation damage to the intestinal tract lining will cause nausea, bloody vomiting and diarrhoea.

Q.28 How cyclone is formed ?

Ans. : Tropical cyclones form only over warm ocean waters near the equator.

• To form a cyclone, warm, moist air over the ocean rises upward from near the surface. As this air moves up and away from the ocean surface, it leaves is less air near the surface. So basically as the warm air rises, it causes an area of lower air pressure below.

• Air from surrounding areas with higher air pressure pushes in to the low pressure area. Then this new cool air becomes warm and moist and rises, too. And the cycle continues.

• As the warmed, moist air rises and cools the water in the air forms clouds. The whole system of clouds and wind spins and grows, fed by the ocean's heat and water evaporating from the ocean surface.

• As the storm system rotates faster and faster, an eye forms in the centre. It is very calm and clear in the eye, with very low air pressure. Higher pressure air from above flows down into the eye.

Q.29 What is particulate matter ?

Ans.: Particulate matter

• Particulate matter (PM) is the sum of all solid and liquid particles suspended in air many of which are hazardous. This complex mixture includes both organic and inorganic particles, such as dust, pollen, soot, smoke, and liquid droplets. These particles vary greatly in size, composition, and origin.

• Particle pollution is made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust particles.

• Particles in air are either directly emitted, for instance when fuel is burnt and when dust is carried by wind, or indirectly formed, when gaseous pollutants previously emitted to air turn into particulate matter.

Q.30 List the types of Nuclear reactors.

Ans.: Types of Nuclear reactors

• There are six main reactor types in use around the world. The various designs use different concentrations of uranium for fuel, different moderators to slow down the fission process, and different coolants to transfer heat.

• The most common reactor type is the pressurized water reactor (PWR).

Reactor Type	Fuel	Moderator	Coolant
Pressurized Water Reactor (PWR)	Enriched UO_2	Water	Water
Boiling Water Reactor (BWR)	Enriched UO_2	Water	Water
Pressurized heavy water reactor "CANDU"(PHWR)	Natural UO_2	Heavy water	Heavy water
Gas-Cooled Reactor (GCR)	Natural U (metal), enriched UO_2	Graphite	Carbon dioxide
Light Water Graphite Reactor (LWGR)	Enriched UO_2	Graphite	Water
Fast Breeder Reactor (FBR)	P_uO_2 and UO_2	None	Liquid sodium

Q.31 List some ways to protect soil.

Ans. : Ways to protect soil -

1. Soil erosion must be prevented or controlled by proper tree plantation.

2. All the wastes from industry, domestic, must be dumped with proper trea

3. Use of synthetic fertilizers must be avoided instead natural fertilizers mu;

4. Educate people regarding consequences of soil pollution and to prevent s

Q.32 List any four water quality parameters and their importance.

Ans.: Water quality parameters :

S.N.	Parameters	Health/Sanitary Significance
1.	Dissolved Oxygen	The amount of oxygen dissolved in water. Most aquatic organisms need oxygen to survive and grow.
2.	Temperature	Temperature is a measure of the average energy (kinetic) of water molecules
3.	Electrical Conductivity	Solids can be found in nature in a dissolved form. Salts that dissolve in water break into positively and negatively charged ions.
4.	Salinity pH	pH is a measure of how acidic or basic (alkaline) the water is (the term pH comes from the French: "puissance “Hydrogène” which means strength of the hydrogen). It is defined as the negative log of the hydrogen ion concentration.
5.	Turbidity	Turbidity is a measure of the amount of suspended particles in the water. Algae, suspended sediment, and organic matter particles can cloud the water making it more turbid.

UNIT III

Chapter - 3

Renewable Sources of Energy

Syllabus

Energy management and conservation, New Energy Sources : Need of new sources. Different types new energy sources. Applications of - Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy.

Contents

Energy Management

• Energy management is a process by which a sector or an organisation can effectively manage how much energy they produce and how to control, monitor and conserve as much energy as they can while also generating enough energy to meet their demand of energy.

• Energy management is the process of tracking and optimizing energy consumption to conserve usage in a building.

• Energy management is a process that not only manages the energy production from different energy harvesting resources (solar, nuclear, fossil fuel) but also concerns optimal utilization at the consumer devices.

• Energy management is the means to controlling and reducing a building's energy consumption, which enables owners and operators to :

a) Reduce costs - Energy represents 25 % of all operating costs in an office building.

b) Reduce carbon emissions in order to meet internal sustainability goals and regulatory requirements.

c) Reduce risk - The more energy you consume, the greater the risk that energy price increases or supply shortages could seriously affect your profitability. With energy management solutions, you can reduce this risk by reducing your demand for energy and by controlling it so as to make it more predictable.

• There are few steps for the process of energy management:

1. Collecting and analysing continuous data.

2. Identify optimizations in equipment schedules, set points and flow rates to improve energy efficiency.

3. Calculate return on investment. Units of energy saved can be metered and calculated just like units of energy delivered.

4. Execute energy optimization solutions.

5. Repeat step two to continue optimizing energy efficiency.

1. Energy Conservation

• Energy conservation means reducing the consumption of energy by producing or using less of it.

• Energy conservation is “the prevention of the wasteful use of energy, especially in order to ensure its continuing availability”.

• Energy conservation is achieved when growth of energy consumption is reduced, measured in physical terms.

• Energy conservation can be the result of several processes or developments, such as productivity increase or technological progress.

• Energy conservation and Energy Efficiency are separate, but related concepts.

• Energy Conservation is the deliberate practice or an attempt to save electricity, fuel oil or gas or any other combustible material, to be able to put to additional use for additional productivity without spending any additional resources or money.

Energy Management

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New Energy Sources

• Conventional or traditional energy sources are available in limited quantity on the one hand and on the other hand, their use creates one type of pollution or the other.

• Hence the need of energy should be fulfilled by alternate sources. These are also called renewable or non-polluting energy sources.

• As compared to polluting sources, the alternate energy sources are abundantly available in nature and they do not produce large amounts of pollution if used for various applications.

• Awareness drives monetary benefits in terms of subsidies, tax rebates or exemptions, more funding and encouragement for harnessing as well as improving the efficiency of non¬polluting sources of energy is needed to be done on war footing.

• With more and more population, there will be more and more need of industries, urbanization (transportation, cooking and household uses) will need more energy on a continuous basis.

• Faster and safer transportation will require more energy. The requirements can be met with use of solar energy, wind energy and biomass energy to a large extent.

• At suitable places, other sources like tides, waves, geothermal energy can be used in the 21st century.

Hydrogen Energy

• Hydrogen fuel cells produce electricity by combining hydrogen and oxygen atoms. The hydrogen reacts with oxygen across an electrochemical cell similar to that of a battery to produce electricity, water and small amounts of heat.

• Hydrogen is an energy carrier that can be used to store, move and deliver energy produced from other sources.

• Hydrogen is a clean fuel that, when consumed in a fuel cell, produces only water.

• Hydrogen can be produced from a variety of domestic resources, such as natural gas, nuclear power, biomass and renewable power like solar and wind.

• These qualities make it an attractive fuel option for transportation and electricity generation applications. It can be used in cars, in houses, for portable power and in many more applications.

1. Advantages of Hydrogen Energy

1. Hydrogen is renewable

• Hydrogen is a renewable energy source which means we cannot run out of it, at least not on a human timescale. It's a rich source of energy which is all around us.

2. Hydrogen is a clean energy source

• When we burn hydrogen no harmful by-products are released into the atmosphere. In fact, once hydrogen has been used as an energy source, it can be converted to drinking water for astronauts.

3. Hydrogen energy is not toxic

• Hydrogen does not cause damage to human health unlike nuclear energy or natural gas.

4. Hydrogen energy is highly efficient

• Hydrogen is incredibly dense in energy and is able to provide a lot of power. It is 3 times more powerful than most fossil based fuel sources so less hydrogen is required to perform the same tasks. This is why hydrogen is used in space exploration to fuel spaceships, aeroplanes, boats, cars and fuel cells.

2. Disadvantages of Hydrogen Energy

1. Hydrogen is volatile

• Because of its high energy content, hydrogen gas is a highly flammable and volatile substance which makes it a risky fuel to work with.

2. Hydrogen energy is expensive to produce

• Both steam-methane reforming and electrolysis are expensive processes which prevents a lot of countries from committing to mass production. Research and trials are in process to try and discover a cheap and sustainable way to produce enough hydrogen without contributing more carbon into the atmosphere.

3. Hydrogen energy is difficult to store

• Hydrogen is a much lighter gas than gasoline which makes it difficult to store and transport. To be able to store it we need to compress it into a liquid and store it at a low temperature. The high amounts of pressure needed to store hydrogen makes it a difficult fuel to transport in large quantities.

4. Hydrogen can be dangerous

• Hydrogen is incredibly flammable which makes it a dangerous fuel if not handled correctly. There is also no smell to hydrogen so sensors are required to detect leaks.

Solar Energy

• Solar radiation arriving at earth's surface, called as 'insolation' is in the form of electromagnetic waves, without any mass associated with it. Hence it is the direct and pure form of energy.

• The solar radiations are intercepted by suitable 'collector system' (flat plate or parabolic collectors) and heat energy available can be used for heating air, water or liquids as required.

• Density of insolation varies from place to place depending on altitude and metrological conditions.

• A solar thermal device consists of collector, distribution (circulation) system, storage and insulation.

• Solar energy is trapped by collector and by simple heat transfer techniques, heat energy is transferred through water, air or other suitable fluid.

• For more temperature and efficiency, number of collectors and parabolic collectors are designed.

Harvesting / Harnessing Solar Energy

• The techniques for collecting, converting and using solar energy is called as harvesting or harnessing. Some important solar harvesting devices are :

1. Solar cells / photovoltaic cells / PV cells

2. Solar heat collectors

3. Solar water heaters

4. Solar cooker

5. Solar water pumps

Solar cells or PV cells

• Solar cells are actually p-n junction diode working on photovoltaic technology i.e. there is direct conversion of solar radiation into Direct Current (DC) electricity.

• Semiconducting materials are most effective in this process of conversion.

• The light energy is converted into equivalent DC energy by solar cells (PV cells). This energy is then stored in some device (battery); so that it can be used whenever needed.

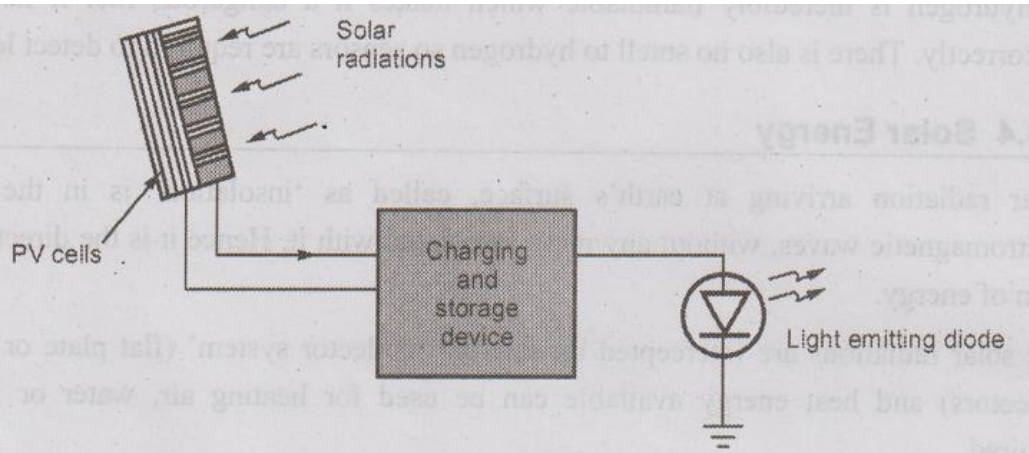

Fig. 3.4.1 : Solar cells

Uses

1. PV cells are commonly used in calculators and watches.

2. PV cells provide power to satellites.

3. Small electric appliances like - solar lamp, radio, street lighting.

4. Industrial applications - water pumping, wheather stations.

Solar heat collectors

• A solar heat collector is used for heating modern houses in eastern countries. A solar home or building is designed to collect the Sun's heat through South facing glass windows.

• In solar-heated buildings, sunspaces are built as large heat absorbers. The floors are made of tiles or bricks that absorb heat throughout the day, they release the heat at night when weather is cold.

Uses

1. Solar heat collector used in cold countries for making domestic or commercial places hot.

1. Use of Solar Energy

• Solar energy can be used for following purposes :

1) Air or water heating for industrial processes, use of solar pumps for water pumping.

2) Distillation and desalination of water (solar still).

3) Hot water for cooking, cleaning and similar uses, (solar water heater).

4) Electricity generation by using photovoltaic cells.

5) Solar drying for food and vegetable products for cottage and small scale industries.

6) Other uses like solar cookers, lamps, lanterns, battery charger, etc. for household purpose.

7) Solar cars/vehicles have been designed.

2. Advantages of Solar Energy

1. Solar energy is freely available.

2. It does not produce ash, fumes and noise pollution hence it is clean, noiseless and environment friendly.

3. It saves money in long run.

4. It is renewable form of energy

5. Non polluting. No wastes created by its use.

6. Has lot of domestic applications. Hence advantageous for huge Indian population.

3. Disadvantages of Solar Energy

1. Initial cost is very large.

2. Energy should be stored in batteries.

3. Large space is needed for installation.

4. Energy generated is dependent on solar intensity

5. High temperatures cannot be achieved (> 40 °C). Efficiency of collector goes down with increase in temperature.

6. Clouds affect the amount and quality (efficiency). Hence may not be available when required.

Ocean Thermal Energy Conversion (OTEC)

• Ocean thermal energy conversion (OTEC) is a source of renewable energy.

• Ocean Thermal Energy Conversion (OTEC) makes use of the naturally occurring thermal gradient of the oceans.

• The warm water acts as a heat source whilst the cold water at about 1000 m acts as a heat sink. This creates a thermal power cycle which can be used to generate electricity.

• The minimum difference required between the heat source and the heat sink is 20 °C.

• The efficiency of OTEC is very low (< 4 %) but the enormous magnitude of this potential energy resource merits its investigation.

• In addition, OTEC could provide a continuous energy supply, unlike many other renewable technologies.

1. Advantages of OTEC System

1. Power from OTEC is continuous, renewable and pollution free.

2. Unlike other forms of solar energy, output of OTEC shows very little daily or seasonal variation.

3. Drawing of warm and cold sea water and returning of the sea water, close to the thermocline, could be accomplished with minimum environment impact.

4. Electric power generated by OTEC could be used to produce hydrogen.

5. Tropical and sub-tropical island sites could be made free from pollution caused by conventional fuels for electricity generation.

6. OTEC system might help in enrichment of fishing grounds due to the nutrients from the unproductive deep waters to the warmer surface waters.

7. A floating OTEC plant can generate power even at mid sea and can be used to provide power for off shore mining and processing of manganese nodules.

2. Limitations of OTEC System

1. Capital investment is very high.

2. Due to small temperature difference in between the surface water and deep water, conversion efficiency is very low about 3-4 %.

3. Low efficiency of these plants coupled with high capital cost and maintenance cost makes them uneconomical for small plants.

Tidal Energy

• Tides are caused by. the interaction of the gravitational effects of the sun and moon and the Earth's rotation. The relative motions of these bodies produce a range of different tide cycles.

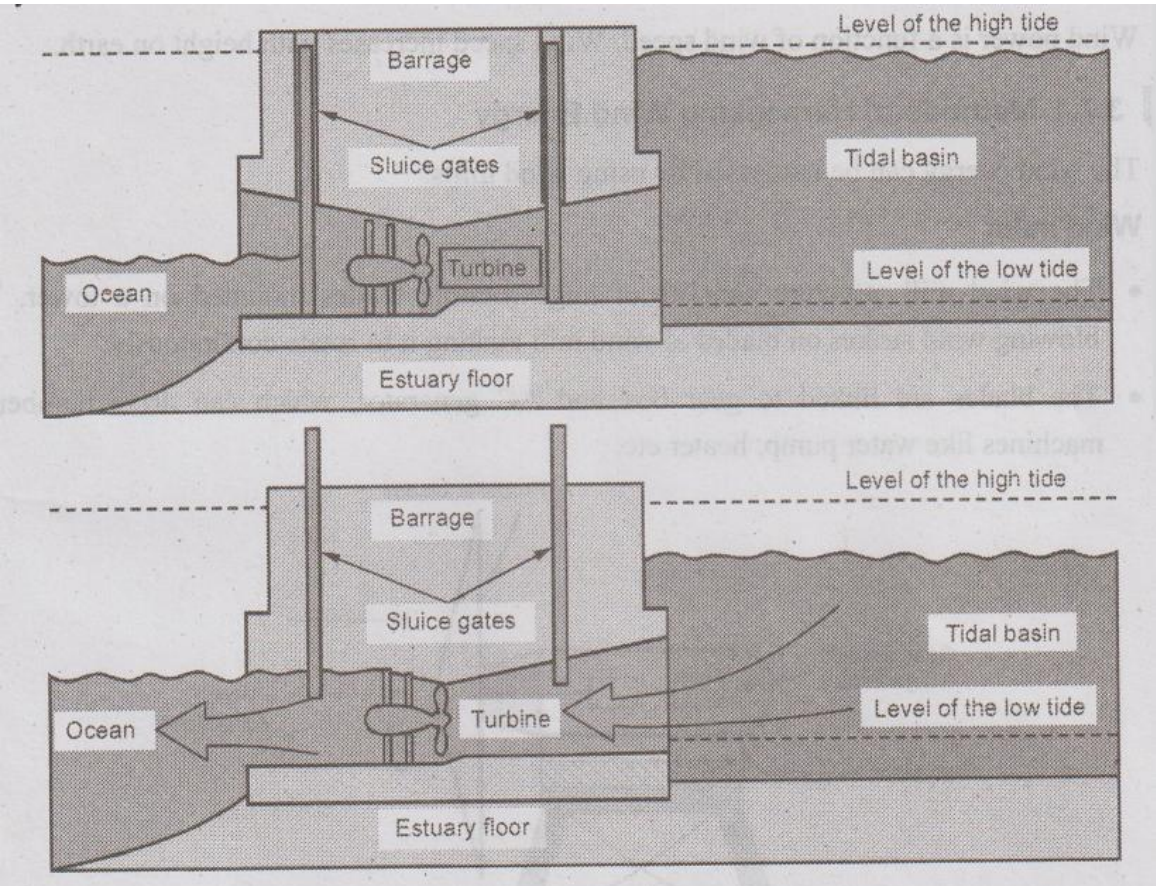

Fig. 3.6.1

• However, in common with all tidal projects, very large capital investment is required. The environmental effects of such projects are considerable and must be individually assessed. They include negative effects on ports, navigation, wildlife and recreation.

Advantages of tidal energy :

1. It is a renewal form of energy.

2. It does not required fuel.

3. It does not produce ash and fume hence clean.

Disadvantages of tidal energy :

1. It requires huge investment for construction.

2. Possibility of damaging equipments frequently.

Wind Energy

• Wind energy is kinetic energy of moving air. The uneven absorption of solar radiation by earth's surface causes differences of temperature, density and pressure which produce air movements.

• Wind power is a function of wind, speed. Wind speed increases with height on earth.

1. Methods of Harnessing Wind Energy

• The wind energy can be harnessed by using wind mills.

1. Wind mills

• The wind mill structure consists of huge rotating blades mounted on a tower. The blowing wind strikes on blades of wind mill making it to rotate continuously.

• The blades are linked to gear box and AC generator, which can drive number of machines like water pump, heater etc.

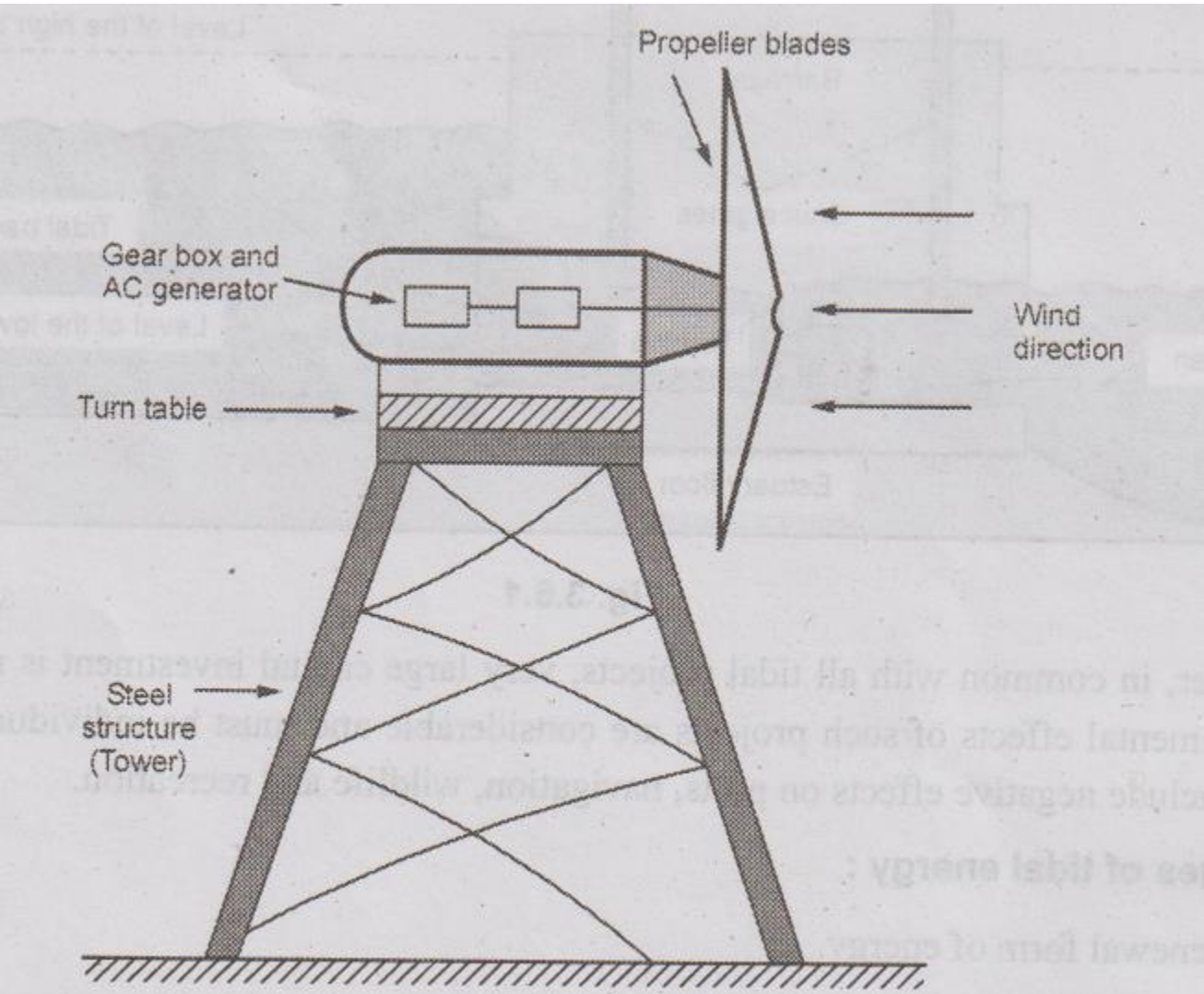

Fig. 3.7.1 : Wind mill

2. Advantages of Wind Energy

1. The entire process of wind power is non-polluting.

2. Wind energy is one of the sustainable source of energy.

3. Wind energy is renewable.

4. Wind energy is available at free of cost.

5. Suitable for remote locations.

3. Disadvantages of Wind Energy

1. Wind is an intermittent source, and the intermittence depends on geographic distribution of wind. Therefore, it can not be used as sole resource of electricity and requires backup or storage system.

2. Storage technology is not fully developed.

3. Damage of local environment by deforestation and hence loss of biodiversity.

4. Birds may get killed.

5. Noise pollution in local area may affect TV reception.

4. Comparison of Solar and Wind Energy

Sr. No.	Solar energy	Wind energy
1.	Can be extensively used anywhere.	Can not be used extensively (depending on the geographical and meterological factor) anywhere.
2.	Energy requirements can be met with satisfactorily with small variations.	As wind speed and direction changes, energy production cannot meet the requirements.
3.	Energy from sun (radiation) can be used for uses like solar heating, solar drying, solar electric generation solar distillation, solar desalination.	Energy from wind cannot be used for such variety of uses.
4.	Hence there are large number of applications from houses to industries.	Applications are limited.
5.	Only depends on clouds (season) and time of day i.e. no solar radiations are available at night,	Does not depend much on the clouds, season, time of day etc. if wind continues to flow.
6.	Installations does not require large open space (top of roof is sufficient).	Huge open space is required for installing wind mills.

Review Question

1. Discuss the advantages and disadvantages of wind energy.

Two Marks Questions with Answers

Q.1 What is renewable energy ?

Ans. : Renewable energy :

• Renewable energy, often referred to as clean energy, comes from natural sources or processes that are constantly replenished.

• For example, sunlight or wind keep shining and blowing, even if their availability depends on time and weather.

• While renewable energy is often thought of as a new technology, harnessing nature's power has long been used for heating, transportation, lighting and more.

Q.2 Why water is a unique natural resource ?

Ans. : Water is unique natural resource :

• Water is an important component of all the living beings. Water is used for drinking, cleaning, agriculture, power generation, industrial purpose.

• Only 1 % of water is readily available for human kind hence it is a unique natural resource.

Q.3 What are fossil fuels and why they are non-renewable ?

Ans. : Fossil Fuels :

• Fossil fuels are hydrocarbon-containing materials of biological origin occurring within Earth's crust that can be used as a source of energy.

• Coal, oil and natural gas are called as fossil fuels.

• The energy can be obtained by burning or lightening them. Once they burnt they can not be regenerated hence they are called as non-renewable.

Q.4 What are the environmental benefits of solar energy?

Ans.: Environmental Benefits of Solar energy :

• Solar power, like other renewable energy resources, has many environmental and health benefits.

• Solar reduces greenhouse gas emissions, which contribute to climate change and also results in fewer air pollutants like sulphur dioxide and particulate matter, which can cause health problems.

Q.5 How do solar photovoltaic (PV) panels work?

Ans.: PV Panel:

• Solar panels absorb the sun's energy throughout the day and convert it into Direct Current (DC) electricity.

• Most homes and businesses run on Alternating Current (AC) electricity, so the DC electricity is then passed through an inverter to convert it to usable AC electricity. At that point, you either use the electricity in your house or send it back to the electric grid.

Q.6 Differentiate between renewable and non-renewable natural resources.

AU : May-08, 19

Ans. :

Renewable

These are the sources which regenerates the natural processes with a reasonable time period.

Non-renewable

These sources are not capable to regenerate.

Q.7 What are the conventional sources of energy for the man kind ?

AU : Dec.-05

Ans. : Non-renewable energy sources are the conventional sources of energy. These resources can not be generated after they exhausted.

Example : Oil, gas, coal etc.

Q.8 Define sustainable forestry.

Ans. : It is the highest rate at which the forest resources can be used without reducing its supply to future generation.

Q.9 State the environment effects of extracting and using mineral resources.

AU : May-08

OR Mention any two environmental effects of mining for mineral resources.

AU : May-16

Ans. :

1. Surface and ground water pollution
2. Soil erosion
3. Air pollution
4. Adverse effect on biomass, ecosystem
5. Devegetation of land

Q.10 Define water logging.

Ans. : Water logging is the state of land with excess of water.

Q.11 Define soil erosion.

Ans.: Soil erosion is a process of degradation of topsoil of land.

Q.12 What are renewable resources ?

Ans. : The resources that regenerates through natural processes with reasonable time period is called renewable resources.

Q.13 What do you mean natural resources ? Give examples.

AU : May-14

Ans. : Natural resources : The variety of things processes obtained from environment to satisfy human needs and wants are called as natural resources.

Example : air, water forest minerals etc.

Q.14 What are the energy needs procured for India ?

AU : May-14

Ans.: Energy procurement from different sectors in India :

i) Thermal power - 30 % approx ii) Hydro power - 20 % approx

iii) Nuclear power - 1 % approx

Q.15 Write the problems due to construction.

AU : May-14

Ans.: Problems due to construction :

1. Environmental degradation

2. Deforestation (Loss of agriculture land)

3. Increase in green house effect.

4. Reduction in ground water level.

Q.16 Define non-renewable resources.

Ans. : Non-renewable resources : Non-renewable energy resources are those natural resources which are finite and exhaustible.

Example : Coal, pertroleum, natural gas etc.

Q.17 What is desertification ? AU : May-15

Ans. : Desertification is a form of land degradation. Occuring is semi-arid areas due to anthropogenic activities.

Q.18 What do you mean by land degradation ? AU : Dec-15

Ans. : Land Degradation : Any change in land that reduces its quality and productivity is referred as land degradation. The land degradation results in deterioration of soil or loss of fertility of the soil.

Q.19 What are the causes of land degradation ?

AU : May-16

Ans.:

1. Population

2. Urbanization

3. Fertilizers and pesticides

4. Damage to top soil

5. Waterlogging

Q.20 What is Biogas ? Mention its uses.

AU : Dec.-16

Ans. : Biogas is a mixture consisting of 65 % methane (CH_4) and of 35 % CO_2. It is renewable energy resulting from biomass.

Uses of Biogas : 1. Cooking fuel 2. Heating fuel 3. Production of electricity a

Q.21 Write any two problems caused by high saline soils.

Ans.:

1. Because of salinity the soil becomes alkaline and crop yield decreases severely.

2. Salinization of land leads to stunt growth.

3. The land becomes impotent and no crop can be cultivated.

Q.22 Define producers

Ans. : The producers use energy from the sun and nutrients like nitrogen and phosphorous from the soil to produce high energy compounds.

For example - Green plants, trees.

Q.23 Name the four ecosystems.

Ans.:

1. Forest ecosystem.

2. Grassland ecosystem.

3. Desert ecosystem.

4. Aquatic ecosystem.

Q.24 Define Ecosystem.

Ans.: Ecosystem

• An ecosystem includes all of the living things (plants, animals and organisms) in a given area, interacting with each other, and also with their non-living environments (weather, earth, sun, soil, climate, atmosphere).

• Ecosystems are the foundations of the Biosphere and they determine the health of the entire earth system.

• The living things are biotic features, and the non-living things are abiotic features.

• There are very many types of ecosystems out there, but the three major classes of ecosystems, (sometimes referred to as biomes), are the following :

1. Freshwater Ecosystems 2. Terrestrial Ecosystems 3. Ocean Ecosystems

• All ecosystems have three basic components:

1. Autotrophs (producers of energy) 2. Heterotrophs (consumers of energy)

3. Non-living matter

UNIT IV

Chapter - 4

Sustainability and Management

Syllabus

Development, GDP, Sustainability - concept, needs and challenges - economic, social and aspects of sustainability - from unsustainability to sustainability - millennium development goals and protocols - Sustainable Development Goals-targets, indicators and intervention areas Climate change - Global, Regional and local environmental issues and possible solutions - case studies. Concept of Carbon Credit, Carbon Footprint. Environmental management in industry - A case study.

Contents

Sustainable Development Goals (SDGs)

• The Sustainable Development Goals (SDGs) aim to transform our world. They are a call to action to end poverty and inequality, protect the planet and ensure that all people enjoy health, justice and prosperity. It is critical that no one is left behind.

• Sustainable Development Goals (SDGs) are the layout to achieve a better and more sustainable world for all by 2030.

• The sustainable development goals (SDGs) are a universal plan for all countries to end poverty, protect the planet and ensure prosperity for all.

• Sustainable Development goals are a call for action to address a series of global challenges, such as: poverty, inequality, climate, environmental degradation and justice.

• A growing number of corporations use SDGs to orient, prioritize and report on their CSR activities.

• The SDGs are an integral part of the 2030 Agenda for Sustainable Development, which aims at fostering a more sustainable future.

• Adopted by 193 countries in 2015, the SDGs emerged from the most inclusive and comprehensive negotiations in UN history and have inspired people from across sectors, geographies and cultures.

Sustainable Development

• Sustainable development is defined as development that meets the needs of the present without compromising the ability of the future generations to meet their own needs.

• Development means improving people's lives. Sustainable development means extending progress without exhausting resources, beyond the future requirements.

True sustainable development

• The true, sustainable development aims at optimum use of natural resources with high degree of reusability, minimum wastage, least generation of toxic and maximum productivity.

1. Five Principles of Sustainable Development

• The principles of sustainable development involve safeguarding and using existing resources in a sustainable way to enhance the long-term management of and investment in, human, social and environmental resources, which is more important than ever due to the evidence of diminishing natural resources and the impacts of unsustainable development.

• Following are five important principles of sustainable development.

1. Living within environmental limits

2. Achieving a sustainable economy

3. Promoting good governance

4. Using sound science responsibly

5. Ensuring a strong, healthy and just society

• The principles form the basis of national sustainable development strategies and action plans. These principles helped formulate the national sustainable development strategy and these principles are used to assess all policies and actions.

• In addition to the five agreed principles a sixth principle is now added : To promote opportunity and innovation.

2. Sustainable Development Aspects

• Three aspects of sustainable development are recognised as :

1. Economic : An economically sustainable system must be able to produce goods and services on a continuing basis, to maintain manageable levels of government and external debt and to avoid extreme sectoral imbalances which damage agricultural or industrial production.

2. Environmental : An environmentally sustainable system must maintain a stable resource base, avoiding over-exploitation of renewable resource systems or environmental sink functions and depleting non-renewable resources only to the extent that investment is made in adequate substitutes. This includes maintenance of biodiversity, atmospheric stability and other ecosystem functions not ordinarily classed as economic resources.

3. Social : A socially sustainable system must achieve distributional equity, adequate provision of social services including health and education, gender equity and political accountability and participation.

Sustainable Development Multidimensional Concept

• Sustainable development is a multidimensional concept, which involves continuous decision making of interlinked issues such as environment, social community and economy. Fig. 4.2.1 shows important aspects of sustainable development.

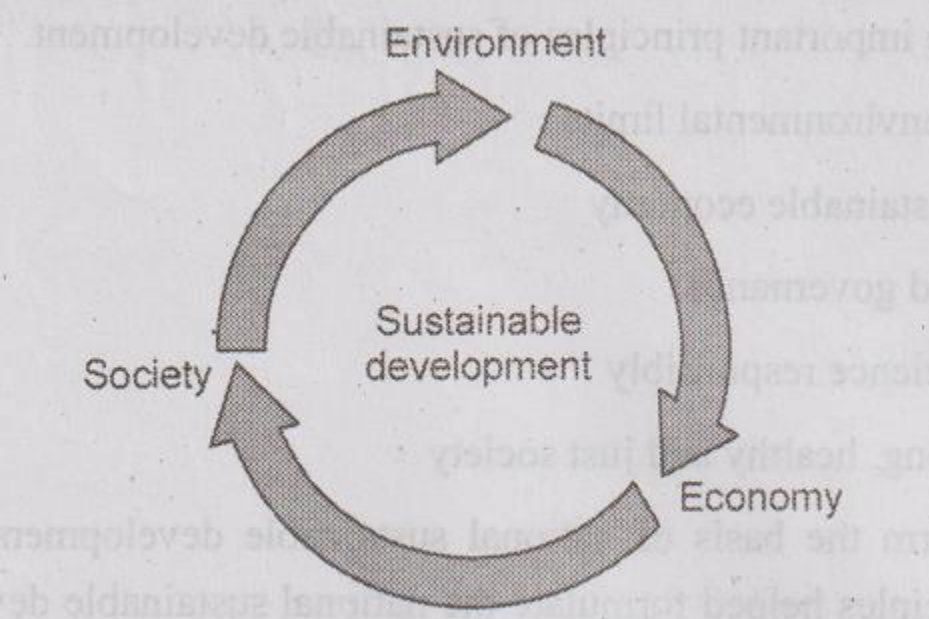

Fig. 4.2.1 : Sustainable development aspects

• All the aspects are integrated and balanced without compromising the ability of present and future generations to meet their needs.

• Each of the three areas is commonly referred to as a system : Economic systems, environmental systems and social systems each have their own logic. It. is an impossible task to analyze all these systems at once.

• Different indicators can be used to measure different dimensions of sustaihability. Indicators imply measurement; measurement implies the theoretical definition of concepts to measure.

3. Agenda for Sustainable Development

• In 1992, Earth Summit was held at Rio de Janeiro of Brazil. A declaration of the summit is - "a new and equitable global partnership through the creation of new levels of co-operation among states."

• **Agenda 21** of the summit proposes - "sustainable development starts from environmental policy. Social and economic equity are the other requirements of sustainable development."

• The important points of this agenda 21 are -

1. Carrying capacity based developmental planning process.

2. A preventive environmental policy.

3. Structural economic change.

4. The enlarged role of environmental management tools like -

* Environmental Impact and Risk Assessment (EIRA),

* Environmental Audit (EA),

* Life Cycle Assessment (LCA),

* Natural Resource Accounting (NRA).

4. Objectives of Sustainable Development

1. To promote equity and fairness.

2. To improve quality of human life.

3. Sustaining of natural resources.

4. Protecting ecosystem.

5. To fulfill international obligations.

6. Considering economic and environmental in decisions.

7. To consider system as a whole.

8. Long term planning and implementation.

5. Factors Affecting Sustainable Development

1. Renewable and non-renewable resources.

2. Population growth and population density.

3. Gross Domestic Product (GDP) per capita.

4. Consumption of energy and environmental resources.

5. Pollution.

6. Conservation / Use of land.

7. Poverty gap index.

8. Environmental awareness, education, literacy.

6. Threats to Sustainability

• Various threats to sustainability are

1. Resource depletion

3. Loss of resilience

2. Waste accumulation

4. Loss of regionality

5. Threats to biological diversity

6. Threats to food chain

7. Emerging diseases for animals

Review Question

1. Discuss the recent approaches to achieve sustainable development.

AU : May-16, Marks 12

Sustainable Agriculture

• Sustainable agriculture is a type of agriculture of producing food grains, fibers, plants, animal products or live stocks using farming techniques that protect the environment, public health, human communities and animal welfare.

• The sustainable agriculture enables us to produce healthful food without compromising future generations' ability to do the same.

• Sustainable agriculture integrates three main goals - environmental health, economic profitability and social and economic equity.

• The goal of sustainable agriculture is the responsibility of all participants in the system, including farmers, labourers, policymakers, researchers, retailers and consumers. Each group has its own part to play, its own unique contribution to make to strengthen the sustainable agriculture community.

• Several other goals of sustainable agriculture are conserving water, reducing the use of fertilizers and pesticides and promoting biodiversity in crops grown and the ecosystem.

• Sustainable agriculture also focuses on maintaining economic stability of farms and helping farmers improve their techniques and quality of life.

1. Benefits of Sustainable Agriculture

• There are many benefits of sustainable agriculture and broadly they can be divided into human health benefits and environmental benefits.

1. Human health benefits

• In terms of human health, crops grown through sustainable agriculture are better for people. Due to the lack of chemical pesticides and fertilizers, people are not being exposed to or consuming synthetic materials. This limits the risk of people becoming ill from exposure to these chemicals.

• In addition, the crops produced through sustainable agriculture can also be more nutritious because the overall crops are healthier and more natural.

2. Environmental benefits

• Sustainable agriculture has also had positive impacts of the environment. One major benefit to the environment is that sustainable agriculture uses 30 % less energy per unit of crop yield in comparison to industrialized agriculture. This reduced reliance on fossil fuels results in the release of less chemicals and pollution into the environment.

• Sustainable agriculture also benefits the environment by maintaining soil quality, reducing soil degradation and erosion and saving water.

• In addition to these benefits, sustainable agriculture also increases biodiversity of the area by providing a variety of organisms with healthy and natural environments to live in.

Organic Farming

• Organic farming works in harmony with nature rather than against it. The organic farming involves using techniques to achieve good crop yields without harming the natural environment or the people who live and work in it.

• Organic farming is a holistic system designed to optimize the productivity and fitness of diverse communities within the agro-ecosystem, including soil organisms, plants, livestock and people.

• Organic agriculture is a holistic production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles and soil biological activity.

• Organic farming emphasises the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions

require locally adapted systems. This is accomplished by using, where possible, agronomic, biological and mechanical methods, as opposed to using synthetic materials, to fulfill any specific function within the system.

• The principal goal of organic production is to develop enterprises that are sustainable and harmonious with the environment.

1. Principles of Organic Farming

• The general principle of organic production includes the following :

1. Protect the environment, minimize soil degradation and erosion, decrease pollution, optimize biological productivity and promote a sound state of health.

2. Maintain long-term soil fertility by optimizing conditions for biological activity within the soil.

3. Maintain biological diversity within the system.

4. Recycle materials and resources to the greatest extent possible within the enterprise.

5. Provide attentive care that promotes the health and meets the behavioural needs of livestock.

6. Prepare organic products, emphasizing careful processing and handling methods in order to maintain the organic integrity and vital qualities of the products at all stages of production.

7. Rely on renewable resources in locally organized agricultural system.

2. Advantages of Organic Farming

1. Saving : The production cost is reduced because no need to buy expensive chemicals and fertilizers.

2. Easy switch : Farmers can easily switch from conventional farming to organic farming.

3. Healthier farm workers.

4. Production boost : When the farmer starts using the organic method of farming then he observes a production boost. The reason of this boost is the usage of crop rotation, compost pits and manure.

5. In the long term, organic farms save energy and protect the environment.

6. Revenue generation : The demand of organic food is more than that of its supply and this factor boosts up the price of organic food. Therefore, when the farmers sell the organic foods in the market then they earn more income. High income is an important advantage of organic farming due to which many farmers turn toward this method.

7. Organic farming helps in reducing global warming.

8. Organic farming causes fewer residues in food.

9. Biodiversity promotion : More animals and plants can live in the same place in a natural way. This is called biodiversity.

10. Organic farming helps preventing ground water pollution.

3. Disadvantages of Organic Farming

1. Organic food is more expensive because farmers do not get as much out of their land as conventional farmers do. Organic products may cost up to 40 % more.

2. Time consuming : Organic farming method is time consuming and it is one of the biggest disadvantages of organic farming. The farmer has to maintain the greater interaction for getting good results. It is a labor intensive job and for a single farmer it is somewhat unsuitable.

3. Production costs are higher because farmers need more workers.

4. Marketing and distribution is not efficient because organic food is produced in smaller amounts.

5. Food illnesses may happen more often.

6. Organic farming cannot produce enough food that the world's population needs to survive. This could lead to starvation in countries that produce enough food today.

Bio-Fuel

• Bio-fuels are non-fossil fuels. Biofuels are energy sources made from living things or the waste that living things produce.

• Bio-fuels are energy carriers that store the energy derived from organic materials (biomass), including plant materials and animal waste.

• Bio-fuels are fuels produced directly or indirectly from organic material - biomass - including plant materials and animal waste.

1. Generations of Bio-Fuels

• Bio-fuels can come from a wide variety of sources and can be roughly divided into four categories or "generations

1. First generation bio-fuels :

• These are made from sugars, starches, oil and animal fats that are converted into fuel using already-known processes or technologies. These fuels include

biodiesel, bio alcohols, ethanol and bio-gasses, like methane captured from landfill decomposition.

2. Second generation bio-fuels :

• These are made from non-food crops or agricultural waste, especially ligno-cellulosic biomass like switch-grass, willow or wood chips.

3. Third generation bio-fuels :

• These are made from algae or other quickly growing biomass sources.

4. Fourth generation bio-fuels :

• These are made from specially engineered plants or biomass that may have higher energy yields or lower barriers to cellulosic breakdown or are able to be grown on non- agricultural land or bodies of water.

2. Biodiesel

• Biodiesel is a liquid fuel, technically known as a mono alkyl ester or long chain Fatty Acid Methyl Esters (FAME).

• Biodiesel is a renewable fuel that can be produced in any climate using already developed agricultural practices.

• Biodiesel is made from renewable resources such vegetable oils (canola, sunflower, soybean, etc.), reclaimed vegetable or animal fats, algae and alcohols or other types of biomass.

• B100 is 100 % biodiesel. Biodiesel is widely available in both its neat form (Bl00) and in blends with petroleum diesel (for example: B2, B5, B20).

• It provides substantial reductions in carbon monoxide, unbumed hydrocarbons and particulate emissions from diesel engines. Some emissions tests have shown slight oxides of nitrogen (NOx) increase with biodiesel. New research on real-time vehicles has shown a decrease in NOx emissions.

• Biodiesel fuels are appealing because of -

1. renewable, nontoxic and biodegradable nature.

2. significance to the efforts to reduce dependence on imported petroleum.

3. potential to reduce DPM emissions.

• **Ethanol** is an alcohol made from feed stocks (such as corn), sugar cane or cellulosic material. Ethanol is generally blended with gasoline for use in internal combustion engines.

Climate Change

• The average weather of a particular place is called as climate.

• The earth's climate is changing dramatically because of human intervantion. The climate is influenced directly by temperature and other metrological conditions such as wind, precipitation and glaciation.

• Long term variation in temperature is major cause of climatic change in environment.

1. Causes of Climatic Changes

1. Presence of green house gases in atmosphere.

2. Depletion of ozone layer.

Ozone Layer Depletion

• Ozone (O_3) is a gas found in atmosphere. Ozone is highly concentrated in stratosphere which lies about 15 - 50 km above the earth's surface. This is known as ozone layer.

• The ozone in stratosphere protects living organisms from the ultraviolet radiation of the sun. In particular, it absorbs ultraviolet (UV) radiations and screens out harmful UV radiations.

1. Hole in Ozone Layer

• The amount of ozone present in atmosphere is delicate balance between the maning and destruction of ozone that depends upon the existence of naturally occuring trace compound.

• If some unnatural compounds are added to this balance that can provide extra catalytic species, then the destruction of ozone will be enhanced. This situation is known as hole in the ozone layer or depletion of ozone layer.

2. Ozone Depleting Substances

• Ozone layer is very much destroyed by the catalytic reactions having free radicals such as clorine (Cl), bromin (Br), hydrogen (H) and nitric oxide (NO).

• Following gases causes depletion of ozone in atmosphere

Sr. No.	Gases	Principal sources
1.	Chloro Fluoro Carbon (CFC)	Refrigerents in refrigerators propellent in aerosol spray cans.
2.	Hydro Chloro Fluoro Carbon (HCFC)	Refrigerents, blowing agents air conditioners.
3.	Bromo Fluoro Carbons (BFC)	Fire extinguishers.
4.	Nitric Oxide (NO)	Detonation of nuclear weapons, nitrogenous fertilizers.

3. Impact of Ozone Layer Depletion

• Effect / impact or consequences of ozone layer depletion are :

1. Effects on human health

UV rays damage genetic material in skin causing skin cancer.

Prolonged exposure to UV rays may cause blindness.

Human resistivity is reduced resulting in allergies and infections.

2. Effects on aquatic system

Kills lower fauna and flora

Affects photosynthesis process cause mutation.

3. Effect on materials

Degradation of point quality and plastics.

4. Effects on climate

Climate change.

Global warming.

4. Measurement of Ozone / Dobson Unit

• The amount of atmospheric ozone is measured by "Dobson spectrometer" and is expressed in Dobson Units (DU).

• One Dobson Unit (1 DU) is equivalent to 0.01 mm thickness of pure ozone at the density is poses it is brought to ground level (1 atm) pressure.

• In temperature latidue concentration of ozone is 350 DU and in tropics it is 250 DU.

5. Control Measures for Depletion of Ozone Layer

1. Reducing CFCs and other ozone depleting chemicals.

2. To make serious efforts to produce and propagate the use of alternative chemicals which do not deplet ozone in stratosphere.

Carbon Credit

• Carbon trading is currently the central pillar of the Kyoto Protocol and other international agreements aimed at slowing climate change. Carbon trading is a market-based approach to controlling pollution.

• Carbon trading is a emission trading specifically for carbon dioxide (CO_2) calculated in tonnes of carbon dioxide equivalent or tCO_2^e.

• Carbon trading is about the rights of greenhouse gas emissions. The idea is a response to the Kyoto Protocol. Under Carbon trading, a country having more emissions of carbon is able to purchase the right to emit more and the country having less emission trades the right to emit carbon to other countries.

• Both countries and companies can reduce their emissions below designated levels and sell this amount to a business or country with greenhouse gas emissions that are too high.

• The financial instrument used for this trade is called offset carbon/carbon credit which is equivalent to one metric ton of equivalent CO_2 equivalent.

• Carbon credits are measured in tonnes of carbon dioxide: 1 Credit = 1 Tonne of CO_2

• Difference between carbon footprints and carbon credits is: carbon offsets is total emissions where as carbon credits is total reduction in emission. Carbon credits are bought to compensate carbon footprints.

Carbon Footprint

• A carbon footprint is a measure of the amount of carbon dioxide emitted through the combustion of fossil fuels.

• The carbon footprint is total amount of greenhouse gases produced to directly and indirectly support human activities, usually expressed in equivalent tons of carbon dioxide (CO_2).

Definition

• "The carbon footprint is a measure of the exclusive total amount of carbon dioxide emissions that is directly and indirectly caused by an activity or is accumulated over the life stages of a product."

For a Product or Process

• A carbon footprint is the total amount of CO_{2q} and other greenhouse gases, emitted over the full life cycle of a process or product. It is expressed as grams of CO_2 equivalent per kilowatt hour of generation (gCO_2eq/kWh), which accounts for the different global warming effects of other greenhouse gases.

For a Business Organisation

• In the case of a business organization, it is the amount of CO, emitted either directly or indirectly as a result of its everyday operations. It also might reflect the fossil energy represented in a product or commodity reaching market.

• When you drive a car, the engine burns fuel which creates a certain amount of CO_2 depending on its fuel consumption and the driving distance.

• When you heat your house with oil, gas or coal, then you also generate CO_2. Even if you heat your house with electricity, the generation of the electrical power may also have emitted a certain amount of CO_2.

• When you buy food and goods, the production of the food and goods also emitted some quantities of CO_2.

• Your carbon footprint is the sum of all emissions of CO_2, which were induced by your activities in a given time frame.

• Usually a carbon footprint is calculated for the time period of a year.

• The best way is to calculate the carbon dioxide emissions based on the fuel consumption. In the next step you can add the CO_2 emission to your carbon footprint. Below is a table for the most common used fuels :

Fuel Type	Unit	CO_2 emitted per unit
Petrol	1 liter	2.3 kg
Gasoline	1 liter	2.3 kg
Diesel	1 liter	2.7 kg
Oil (heating)	1 liter	3 kg

• **Example :** If your car consumes 7.5 liter diesel per 100 km, then a drive of 300 km distance consumes 3 × 7.5 = 22.5 liter diesel, which adds 22.5 × 2.7 kg = 60.75 kg CO_2 to your personal carbon footprint.

1. Reducing Carbon Footprint

• Carbon footprint can be reduced by several ways :

1. Alternatives to driving - When possible walk or ride your bike in order to avoid carbon emissions completely. Carpooling and public transportation drastically reduce CO_2 emissions by spreading them out over many riders.

2. Drive a low carbon vehicle - High mileage doesn't always mean low CO_2 emissions. All vehicles have an estimated miles-per-gallon rating. Electric cars emit no CO_2 if they're charged with clean electricity.

3. Driving style - Speeding and unnecessary acceleration reduce mileage by up to 33 %, waste gas and money and increase your carbon footprint.

4. Tyre inflation and other tuning - Properly inflated tires improve your gas mileage by up to 3 %. It also helps to use the correct grade of motor oil and to

keep your engine tuned, because some maintenance fixes, like fixing faulty oxygen sensors, can increase fuel efficiency by up to 40 %.

5. Avoid traffic - Being stuck in traffic wastes fuel and unnecessarily creates CO_2. Use traffic websites and apps and go a different way or wait.

6. Excess weight - Remove excess weight from your car. Use cruise control.

7. Reduce your carbon footprint from air travel - Until petroleum-based aviation fuel is replaced, you should avoid flying when possible, fly less frequently, fly shorter distances and fly economy class.

Avoid air travel, instead increase your use of video-conferencing tools like Skype.

Economy class is best, for the same reasons as carpooling and public transportation. Each flyer's share of a flight's carbon emissions is relatively less because it's spread out over more people.

8. Don't fly on private jets - Fly first or business class if you must, because at least those seats always fill up anyway and avoid private jets.

9. Insulate and seal your home - Reduce drafts and air leaks with caulk, insulation and weather stripping.

10. Appliances - Make energy efficiency a primary consideration when choosing a new furnace, air conditioning unit, dishwasher or refrigerator. Products bearing the ENERGY STAR label are recognized for having superior efficiency.

11. Lighting - Turn off lights you're not using and when you leave the room. Replace incandescent light bulbs with compact fluorescent or LED ones.

12. Thermostat - Don't set it too high or low. Install a programmable model to turn off the heat/air conditioning when you're not home.

13. Solar - Add solar panels to the roof of your home. This costs a little more than the above options, but many providers offer financing options which minimize upfront costs.

14. Reduce your food carbon footprint from food - Eat locally-produced and organic food. Buy local food that is naturally growing in season. Do you really need to eat strawberries flown in from the other side of the planet ? You want to eat fresh food, so what better that stuff growing locally.

It has been estimated that 30 % of greenhouse gas emissions result from the production and transport of food. Transporting food requires petroleum-based fuels and many fertilizers are also fossil fuel-based.

15. Deforestation - Deforestation is a top contributor to carbon emissions and thus climate change.

16. Avoid partying - This is for both food sustainability and economic inequality.

17. Water usage - Lower the amount of energy used to pump, treat and heat water by washing your car less often, using climate-appropriate plants in your garden, installing drip irrigation so that plants receive only what they need and making water-efficient choices when purchasing shower heads, faucet heads, toilets, dishwashers and washing machines.

Stop daydreaming in the shower and hurry up as lots of hot water is being wasted.

18. Avoid buying bottled water - Apart from being ridiculously expensive (it's just water!) it may have travelled half way round the planet to get to you. Surely tap water in your own reusable container will do.

19. Reuse and recycle - It has been estimated that 40 % of greenhouse gas emissions result from the "provision of goods," which means the extraction of resources, manufacturing, transport and final disposal of "goods" which include consumer products and packaging, building components and passenger vehicles, but excluding food. By buying used products and reselling or recycling items you no longer use, you dramatically reduce your carbon footprint from the "provision of goods."

20. Support clean energy sources - Whenever you can, advocate for clean alternatives to fossil fuels, such as wind, solar, geothermal and appropriately designed hydroelectric and biomass energy projects.

21. Use fountain pen rather disposable plastic pens.

22. Do not put your supermarket vegetables into separate little plastic bags - it's just a waste of bags. Use your own reusable bag to cart the entire goodies home.

23. Print on both sides of the paper and use recycled inks.

24. Use cleaning products that are not derived from oil - so look for vegetable based ones.

25. Wash your clothes at low temperatures, the detergents still work and the clothes don't mind.

Environmental Sciences and Sustainability: Unit IV: Sustainability and Management : Two Marks Questions with Answers

Two Marks Questions with Answers

Q.1 What is EIA?

Ans. :

• Environmental Impact Assessment (EIA) is the process of -assessing the likely environmental impacts of a proposal and identifying options to minimise environmental damage.

• The main purpose of EIA is to inform decision makers of the likely impacts of a proposal before a decision is made.

• EIA provides an opportunity to identify key issues and stakeholders early in the life of a proposal so that potentially adverse impacts can be addressed before final approval decisions are made.

• EIAs are essential for projects resulting in a major change in land use or located in environmentally sensitive areas.

• The clarity of environmental impacts identified, evaluated and mitigated is a measure of the adequacy and worth of an EIA.

Q.2 Write the various uses of sustainable development indicators.

Ans.:

Indicator domain	Stock Indicators	Flow Indicators
Foundation well-being	Health-adjusted life expectancy.	Index of changes in age-specific mortality and morbidity (place holder).
	Percentage of population with post-secondary education.	Enrolment in post -secondary education.
	Temperature deviations from normals.	Greenhouse gas emissions.
	Ground-level ozone and fine particulate concentrations.	Smog-forming pollutant emissions.
	Quality-adjusted water availability.	Nutrient loadings to water bodies.
	Fragmentation of natural habitats.	Conversion of natural habitats to other uses.
Economic well-being	Real per capita net foreign financial asset holdings.	Real per capita investment in foreign financial assets.
	Real per capita produced capital.	Real per capita net investment in produced capital.
	Real per capita human capital.	Real per capita net investment in human capital.
	Real per capita natural capital.	Real per capita net depletion of natural capital.
	Reserves of energy resources.	Depletion of energy resources.
	Reserves of mineral resources.	Depletion of mineral resources.
	Timber resource stocks.	Depletion of timber resources.
	Marine resources stocks.	Depletion of marine resources.

Q.3 What do you know about watershed ?

Ans.: Watershed

• A watershed describes an area of land that contains a common set of streams and rivers that all drain into a single larger body of water, such as a larger river, a lake or an ocean.

• A watershed can cover a small or large land area.

• It combines with other watersheds to form a network of rivers and streams that progressively drain into larger water areas.

• Topography determines where and how water flows. Ridge tops surrounding a body of water determine the boundary of a watershed. Imagine turning an open umbrella upside down in the rain.

• Rain that hits anywhere within the umbrella's surface area would go to the bottom at the center of the umbrella. Any rain that didn't hit the umbrella would fall to the ground. The umbrella is like a watershed; it collects everything that falls into it.

Q.4 What is holocaust ?

Ans.: Holocaust

• The act of large-scale killing of living beings is called holocaust. The holocaust may be either caused by natural disaster such as earthquake, flood, fire, volcanoes or by man-made activities such as war.

UNIT V

Chapter – 5

Sustainability Practices

Syllabus

Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment, Environmental Impact Assessment. Sustainable habitat : Green buildings, Green materials, Energy efficiency, Sustainable transports. Sustainable energy : Non - conventional Sources, Energy Cycles carbon cycle, emission and sequestration, Green Engineering : Sustainable urbanization - Socioeconomical and technological change.

Contents

5.12 Low Carbon Life Cycle

5.13 Two Marks Questions with Answers

Zero Waste

• Zero Waste is a philosophy and a design principle for the 21st Century. It includes 'recycling' but goes beyond recycling by taking a 'whole system' approach to the vast flow of resources and waste through human society.

• To make recycling work for everyone, we need to buy products made from the materials we recycle. This reduces the need to utilize non-renewable resources by reusing materials that have already been consumed.

• Zero Waste means designing and managing products and processes to reduce the volume and toxicity of waste and materials, conserve and recover all resources and not bum or bury them.

• Producing recycled materials uses less energy and saves more trees than producing "virgin" materials.

• Implementing Zero Waste will help reduce discharges to land, water or air that may be a threat to planetary, human, animal or plant health and imitate sustainable natural cycles, where all discarded materials are resources for others to use.

• The zero waste approach seeks to maximize recycling, minimize waste, reduce consumption and ensures that products are made to be reused, repaired or recycled back into nature or the marketplace.

• Zero Waste systems reduce greenhouse gases by :

1. Saving energy - especially by reducing energy consumption associated with extracting, processing and transporting raw materials and waste.

2. Reducing and eventually eliminating the need for landfills and incinerators

Goal of Zero Waste

• The goal of Zero Waste is to :

1. Maximize recycling

2. Minimize waste

3. Reduce consumption

4. Ensure products are made to be reused, repaired or recycled

5. Purchase sustainable products

Concept of 5R (Refuse, Reduce, Reuse, Repurpose, Recycle)

• According to the 5 R's, four actions should be taken, if possible, prior to 'recycling': refuse, reduce, reuse, repurpose and then recycle.

• Incorporating this methodology into your business' waste reduction and recycling efforts will minimize landfill waste and help take your recycling program to the next level.

1. Refuse : Do not buy anything which we do not really need.

2. Reduce : Reduce the amount of garbage generated. Alter our lifestyle so that minimum garbage is generated.

3. Reuse : Reuse everything to its maximum after properly cleaning it. Make secondary use of different articles.

4. Repurpose : For every item that can't be refused, reduced or reused, try repurposing it. Many people in the green community refer to this method as upcycling. You may be surprised to learn how many common office products serve more than one purpose.

5. Recycle : Keep things which can be recycled to be given to rag pickers or waste pickers (Kabadiwallahs). Convert the recyclable garbage into manures or other useful products.

Circular Economy

• The circular economy is a systems solution framework that tackles global challenges like climate change, biodiversity loss, waste and pollution.

• In circular economy, products are designed for durability, reuse and recyclability and materials for new products come from old products.

• Circular economy is a new production and consumption model that ensures sustainable growth over time. With the circular economy, we can drive the optimization of resources, reduce the consumption of raw materials and recover waste by recycling or giving it a second life as a new product.

• The circular economy is important as it promotes sustainable development. It advocates using waste as an input for producing new finished goods.

• The circular economy supports creating reserves of raw materials and adopting innovative methods to eliminate any steps that reduce the cost and time to make new finished goods.

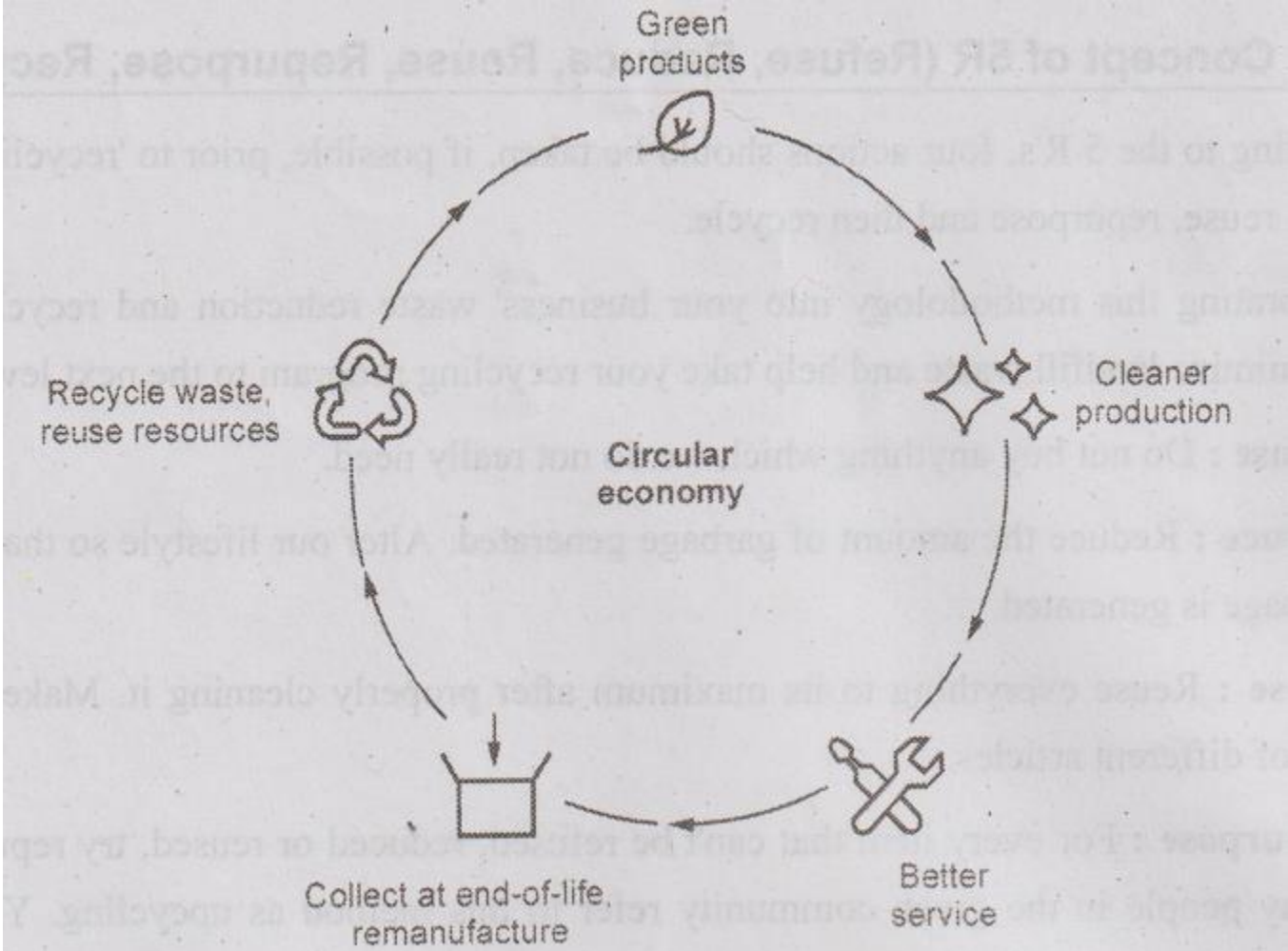

Fig. 5.3.1 : Circular economics

1. Linear Economy Versus Linear Economy

• In a linear economy, materials flow in a straight line from resource extraction, to manufacturing and then to landfill.

• Value is created by producing and selling as many products as possible. This model is characterized by wasted resources and excessive pollution, causing ecosystem degradation, wealth concentrations and social inequities.

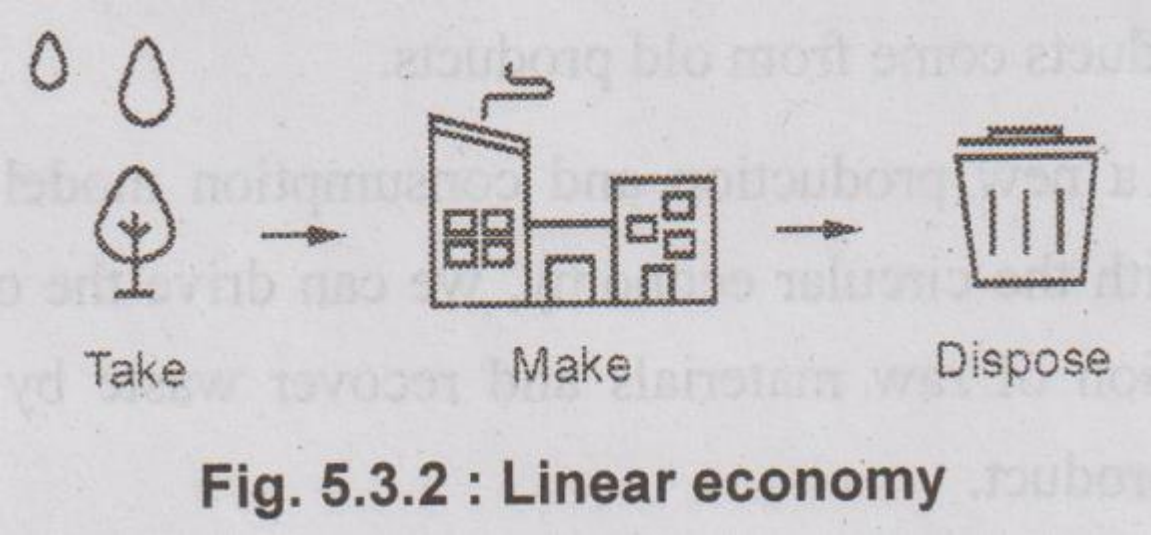

Fig. 5.3.2 : Linear economy

• A circular economy model, on the other hand, aims to redefine growth to benefit people and the planet. It entails gradually decoupling economic activity from the consumption of finite resources and designing waste out of the system.

• Underpinned by a transition to renewable energy sources, the circular business model builds economic, natural and social capital.

2. Principles of Circular Economy

• The circular economy is based on three principles, driven by design :

1. Eliminate waste and pollution

2. Circulate products and materials (at their highest value)

3. Regenerate nature

3. Benefits of Circular Economy

1. It reduces waste as it promotes the recycling of finished goods.

2. It offsets any potential price rise of the commodity.

3. Its adoption helps achieve efficiency and effectiveness as resources are recycled to get new products.

4. It promotes the rental business by advocating to reuse of an economic entity rather than purchasing a new entity.

Quality System Standard ISO 14001: 2004

• The purpose of ISO is to promote the development of standardization and related world activities in order to facilitate the international exchange of goods and services and to develop co-operation in intellectual, scientific technological and economic activities.

• The ISO 14000 family addresses various aspects of environmental management. The very first two standards, ISO 14001:2004 and IS014004:2004 deal with environmental management systems (EMS).

• ISO 14001:2004 provides the requirements for an EMS and ISO 14004:2004 gives general EMS guidelines.

1. ISO 14000 Series Standards

1. ISO 14001 Environmental management systems-Requirements with guidance for use.

2. ISO 14004 Environmental management systems-General guidelines on principles, systems and support techniques.

3. ISO 14015 Environmental assessment of sites and organizations.

4. ISO 14020 series (14020 to 14025) Environmental labels and declarations.

5. ISO 14030 discusses post production environmental assessment.

6. ISO 14031 Environmental performance evaluation-Guidelines.

7. ISO 14040 series (14040 to 14049), Life Cycle Assessment, LCA, discusses pre- production planning and environment goal setting.

8. ISO 14050 terms and definitions.

9. ISO 14062 discusses making improvements to environmental impact goals.

10. ISO 14063 Environmental Communication-Guidelines and examples.

11. ISO 14064 Measuring, quantifying and reducing Greenhouse Gas emissions.

2. Uses of ISO 14004:2004

• ISO 14004:2004 provides guidance on the establishment, implementation, maintenance and improvement of an environmental management system and its coordination with other management systems.

• An EMS (Environmental Management Systems) meeting the requirements of ISO 14001:2004 is a management tool enabling any organization to :

1. Identify and control the environmental impact of its activities, products or services.

2. Improve its environmental performance continually.

3. Implement a systematic approach to setting environmental objectives and targets, to achieving these and to demonstrating that they have been achieved.

Sustainable Habitat

• Sustainable Habitat is defined as an approach towards a balanced and sustainable development of the ecosystem of habitat which offers adequate shelter with basic services, infrastructure, livelihood opportunities along with environmental and socio-economic safety including equality, inclusiveness and disaster-resilience.

1. Green Building

• A Green building focuses on increasing the efficiency of resource use - energy, water and materials - while reducing building impact on human health and the environment during the building's lifecycle, through better sitting, design, construction, operation, maintenance and removal.

• Green Buildings should be designed and operated to reduce the overall impact of the built environment on its surroundings.

• Green buildings are designed to reduce the overall impact of the built environment on human health and the natural environment by :

1. Efficient use of energy, water and other resources.

2. Protecting occupant health and improving employee productivity.

3. Reducing waste, pollution and environmental degradation.

• Effective green buildings are more than just a random collection of environmental friendly technologies, however.

• They require careful, systemic attention to the full life cycle impacts of the resources embodied in the building and to the resource consumption and pollution emissions over the buildings complete life cycle.

2. Planning for Sustainable Building

1. Green building materials

• Renewable plant materials like bamboo and straw, lumber from forests certified to be sustain ably managed, dimension stone, recycled stone, recycled metal and other products that are non-toxic, reusable, renewable and/or recyclable (e.g. sheep wool, panels made from paper flakes,

compressed earth block, adobe, baked earth, rammed earth, clay, vermiculite, flax linen, sisal, seagrass, cork, expanded clay grains, coconut, wood fibre plates, calcium sand stone etc.)

• The EPA (Environmental Protection Agency) also suggests using recycled industrial goods, such as coal -combustion products, foundry sand and demolition debris in construction projects.

2. Reduced energy use

• Designers orient windows and walls ahd place awnings, porches and tress to shade windows and roofs during the summer while maximizing solar gain in the winter.

3. Reduced waste

• During the construction phase, one goal should be to reduce the amount of material going to landfills.

4. Rain water harvesting

• Rain water harvesting is done by collecting the water from terrace or roof and storing in underground tanks for using it in the summer months.

5. Reduction of wastes and pollution

• By collecting human waste at the source and running it to a semi-centralized biogas plant with other biological waste, liquid fertilizer can be produced.

3. Advantages of Green Building

1. Green buildings harmonise with the local climate, traditions, culture and the surrounding environment.

2. Green buildings are designed to save energy and resources, recycle materials and minimise the emission of toxic substances throughout its life cycle.

3. Green buildings make efficient use of resources; have significant operational savings and increases workplace productivity.

4. Green buildings are able to sustain and improve the quality of human life whilst maintaining the capacity of the ecosystem at local and global levels.

5. Building green sends the right message about a company or organisation - that it is well run, responsible and committed to the future.

Energy Efficiency

• Energy efficiency is the use of less energy to perform the same task or produce the same result.

• Energy efficiency is defined as the use of energy in an optimum manner to achieve the same service that could have been achieved using a common less efficient manner.

• Energy efficiency is the practice of reducing the energy requirements while achieving the required energy output.

• Energy-efficient homes and buildings use less energy to heat, cool and run appliances and electronics and energy-efficient manufacturing facilities use less energy to produce goods.

• Energy efficiency is one of the easiest and most cost-effective ways to combat climate change, reduce energy costs for consumers.

• Energy efficiency is also a vital component in achieving net-zero emissions of carbon dioxide through decarbonization.

• Efficient use of energy can be understood in terms of using energy in such a way as to obtain the maximum benefit.

Sustainable Transport

• The sustainable transport definition can be best described as any type of transport that does not rely on the world's natural resources to power it.

• Sustainable Transportation refers to any means of transportation that is green and has low impact on the environment.

• Sustainable transportation is also about balancing our current and future needs. Examples of sustainable transportation include walking, cycling, transit, carpooling, car sharing and green vehicles.

• Sustainable Transport is sometimes known as Green Transport and it is any form of transport that does not use or rely on dwindling natural resources. Instead it relies on renewable or regenerated energy rather than fossil fuels that have a finite life expectancy. For this reason it is said to have a low or a negative effect on the environment since it makes use of energy sources that are sustainable.

• Walking, cycling and sailing are excellent examples of sustainable transport.

• The sustainable transport definition can be best described as any type of transport that does not rely on the world's natural resources to power it.

• Sustainable transportation options run on clean fuel, batteries or both. Alternative fuels can be used in flexible-fuel and dual-fuel vehicles as well as vehicles with advanced technology, such as hybrid power systems and fuel cells.

• Alternative fuels help conserve fuel and reduce emissions. They include :

a) Biodiesel

b) Electricity

c) Ethanol

d) Hydrogen

e) Natural Gas

f) Propane

1. Benefits of Sustainable Transport

• Sustainable modes of transportation have several benefits. These include :

1) Reduced traffic congestion

2) Cost savings on fuel and vehicles

3) Reduced greenhouse gas emissions

4) Reduced dependence on non-renewable energy sources

5) Reduced transportation costs

6) Increased physical activity

7) Increased social interaction

8) Support for local businesses and a vibrant economy

9) Healthier lifestyles and a better quality of life

10) Improved accessibility to reliable, affordable transportation options for all.

Sustainable Energy : Non-conventional Sources

• The conventional sources of energy are generally non-renewable sources of energy, which are being used since a long time. These sources of energy are being used extensively in such a way that their known reserves have been depleted to a great extent.

• The sources of energy which are being produced continuously in nature and are in exhaustible are called non-conventional energy.

• Non-conventional sources are also known as renewable sources of energy.

• Various forms of renewable energy -

1. Solar energy

2. Wind energy

3. Bio energy

4. Hydro energy

5. Geothermal energy

6. Wave and tidal energy

Carbon Sequestration

• Carbon dioxide is the most commonly produced greenhouse gas. Around 45 % of the CO_2 emitted by humans remains in the atmosphere, which is a significant factor behind global warming.

• Carbon sequestration is the process of capturing, securing and storing carbon dioxide from the atmosphere.

• Carbon dioxide (CO_2) Capture and Storage (CCS) is the idea to capture the CO_2 from industrial processes like coal plants and then store it in deep geological formations.

• Carbon sequestration is one method of reducing the amount of carbon dioxide in the atmosphere with the goal of reducing global climate change.

• The idea is to stabilize carbon in solid and dissolved forms so that it doesn't cause the atmosphere to warm. The process shows tremendous promise for reducing the human carbon footprint.

• Carbon sequestration is key method for removing carbon from the earth's atmosphere.

• There are two main types of carbon sequestration :

1. Biological carbon sequestration and

2. Geological carbon sequestration

1. Biological Sequestration

• Biological carbon sequestration happens when carbon is stored in the natural environment. This includes what are known as carbon sinks, such as forests, grasslands, soil, oceans and other bodies of water. This is also known as an indirect or passive form of sequestration.

1. Forests

• Forests and woodlands are considered one of the best forms of natural carbon sequestration. CO_2 binds to plants during photosynthesis, exchanging it for oxygen as a purifying emission.

• On average, forests store twice as much carbon as they emit, while an estimated 25 % of global carbon emissions are sequestered alongside forests in other vegetative forms, such as grasslands or rangelands (fields, prairies, shrub lands etc.).

• Protecting such natural environments is therefore crucial to ensuring carbon sinks capture CO_2 effectively. Deforestation poses the biggest threat to this natural process, as does construction or intensive agriculture.

2. Soil

• Through bogs, peat and swamps, carbon can be captured and stored as carbonates. These carbonates build up over thousands of years as CO_2 mixes with other mineral elements, such as calcium or magnesium.

• Eventually, carbon is released from the earth, but not for a very long time - after more than 70,000 years in some cases.

3. Oceans

• Aquatic environments and large bodies of water are also great absorbers of CO_2They absorb another estimated 25 % of emitted $CO_2$from the earth's atmosphere. This carbon is mostly held in the upper layers of the oceans.

• Too much carbon can acidify the water, posing a threat to the biodiversity that exists below - yet another reason to decarbonise our atmosphere.

2. Geological Carbon Sequestration

• Geological carbon sequestration happens when carbon is stored in places such as underground geological formations or rocks. This process is largely artificial or direct, representing an effective way of neutralising emissions put into human practices, such as manufacturing or construction.

• It's also largely technological as a result, with recent innovations showing carbon being sequestered more effectively on larger scales. They include :

1. Graphene production : The production of graphene requires CO_2 as a raw material. Although limited to certain industries, it's used heavily in the production of the tech devices we use on a day-to-day basis, such smartphones or computer processors.

2. Engineered molecules : A fairly new science, scientists can change the shape of molecules to form new compounds by capturing carbon from the air. In practice, this could present an efficient way of creating raw materials while reducing atmospheric carbon.

3. Carbon Capture and Storage (CCS) : CCS involves capturing carbon dioxide that's been produced by power generation or industrial activity, such as cement or steel-making. This CO-, is then compressed and transported to deep underground facilities, where it's injected into rock formations for permanent storage.

Green Engineering

• Green engineering is the design, commercialization and use of processes and products in a way that reduces pollution, promotes sustainability and minimizes risk to human health and the environment without sacrificing economic viability and efficiency.

• Green Engineering can be defined as environmentally conscious attitudes, values and principles, combined with science, technology and engineering practice, all directed toward improving local and global environmental quality.

• Green engineering utilizes engineering processes and methods that minimize pollution, improve a business' sustainability and decrease the potential for health issues caused by unsafe manufacturing and design methods.

• Green engineering embraces the concept that decisions to protect human health and the environment can have the greatest impact and cost-effectiveness when applied early, in the design and development phase of a process or product.

• Green Engineering is necessarily interdisciplinary and therefore, is best considered as a set of concepts which can be applied across engineering disciplines.

1. Processes in Green Engineering

• Engineers may use many processes when green engineering, including :

1. Waste reduction :

• Many commercial processes, such as manufacturing and shipping products, may waste energy through inefficient manufacturing and delivery methods.

• Green engineering seeks ways to minimize this waste, including finding new fuel methods and minimizing unnecessary production steps that needlessly use energy.

2. Materials management:

• Materials management entails finding better and safer materials for diverse engineering purposes, particularly in product design and manufacturing.

• Engineers may identify new and safer materials or invent options to integrate into their plans and find better and more efficient production methods.

3. Pollution prevention :

• Pollution prevention focuses on identifying a company's pollution sources and minimizing their waste.

• Engineers may identify why pollution occurs, find processing methods that decrease its spread, integrate newer and cleaner techniques and enhance manufacturing and delivery cleanliness.

4. Product enhancement:

• Green engineers seek to improve the products or services they're engineering while making them safer for the environment.

• This process may include finding alternate energy sources that work better than traditional options or identifying greener and more efficient manufacturing materials and methods.

2. Principles of Green Engineering

1. Inherent Rather Than Circumstantial : Designers need to strive to ensure that all materials and energy inputs and outputs are as inherently non-hazardous as possible.

2. Prevention Instead of Treatment : It is better to prevent waste than to treat or clean up waste after it is formed.

3. Design for Separation : Separation and purification operations should be designed to minimize energy consumption and materials use.

4. Maximize Efficiency : Products, processes and systems should be designed to maximize mass, energy, space and time efficiency.

5. Output-Pulled Versus Input-Pushed : Products, processes and systems should be “output pulled” rather than “input pushed” through the use of energy and materials.

6. Conserve Complexity : Embedded entropy and complexity must be viewed as an investment when making design choices on recycle, reuse or beneficial disposition.

7. Durability Rather Than Immortality : Targeted durability, not immortality, should be a design goal.

8. Meet Need, Minimize Excess : Design for unnecessary capacity or capability (e.g., "one size fits all") solutions should be considered a design flaw.

9. Minimize Material Diversity : Material diversity in multicomponent products should be minimized to promote disassembly and value retention.

10. Integrate Material and Energy Flows : Design of products, processes and systems must include integration and interconnectivity with available energy and materials flows.

11. Design for Commercial Afterlife : Products, processes and systems should be designed for performance in a commercial afterlife.

12. Renewable Rather Than Depleting : Material and energy inputs should be renewable rather than depleting.

3. Cradle to Cradle Concept

• Cradle-to-cradle (C2C) is a way of designing products or processes that work more like natural systems.

• Cradle-to-cradle is a term used in life-cycle analysis to describe a material or product that is recycled into a new product at the end of its life, so that ultimately there is no waste. Zero waste, Zero trash, Zero litter, Zero garbage, Nothing to throw away.

• Cradle to Cradle design refers to a production process where products are developed for closed-loop systems in which every output ingredient is safe and

beneficial - either to biodegrade naturally and restore the soil (called a biological nutrient) or to be fully recycled into high-quality materials for subsequent product generations (called a technical nutrient).

• C2C design method is intended to replace a make-take-dispose approach which begins with new raw materials mined from the earth and ends with piles of garbage.

• C2C is used to minimise the environmental impact of products by employing sustainable production, operation and disposal practices and aims to incorporate social responsibility into product development.

Urbanization

• Urbanization is a process of moving population from rural areas to urban areas for improving life standards and life style through scientific and technological developments.

• The energy related problems due to urbanization include -

1. Pollution from coal: The use of coal pollutes the environment.

2. Acid rain : Various industries are releasing harmful gases like sulphur oxides, nitrogen oxides which reacts with water or moisture in the environment produces sulphuric acid.

3. Pollution from vehicle : The exhausts from two-wheeler, four wheeler and other transport vehicles produces huge level of air pollution.

4. Deforestation : Human needs space to live hence this requirement is fulfilled by deforestation and building houses. Even after this human needs wood for house furniture and timber as fuel.

5. Global warming : Combustion of fossil fuels (oil, petrol, diesel, gas) produces harmful gases, which acts as green house i.e. short wave and natural light can pass but traps heat radiation hence overall environment temperature rises.

6. Use of electricity : Large amount of electricity is utilized for human comforts like - A/C, washing machine, refrigerator, water heater etc. Hence, electricity requirement is increasing day by day.

1. Solution for Urban Energy Problem

1. Use of public transport instead of using private vehicles.

2. Reducing energy consumption in all respect.

3. Using energy efficient devices.

4. Encourging use of solar and wind energy.

5. Imposing strict laws, penalties and energy audits.

Low Carbon Life Cycle

• Low carbon refers to a minimal output of greenhouse gas emissions into the biosphere, specifically refers to the greenhouse gas carbon dioxide. So, low carbon life means a kind of lifestyle in which people do their best to reduce energy consumption and carbon greenhouse gas emissions. Low carbon economy is an economy model based on low energy consumption, low pollution and low emission.

• Low carbon lifestyles create less carbon dioxide emissions. Activities that create carbon dioxide are driving cars, heating homes, generating electricity, flying planes, making goods in factories and transporting things a long way.

Two Marks Questions with Answers

Q.1 What is e-waste ?

Ans. : E-Waste :

• The term "e-waste" is an abbreviation of electronic waste.

• E-Waste is a term used to cover items of all types of electrical and electronic equipment (EEE) and its parts that have been discarded by the owner as waste without the intention of re-use.

• E-waste is a general term, it can be considered to denote items such as TV appliances, computers, laptops, tablets, mobile phones, white goods - for example, fridges, washing machines, dryers - home entertainment and stereo systems, toys, toasters and kettles.

Q.2 Write the concept of Green building.

Ans.:

• A Green building focuses on increasing the efficiency of resource use - energy, water and materials - while reducing building impact on human health and the environment during the building's lifecycle, through better sitting, design, construction, operation, maintenance and removal.

• Green buildings should be designed and operated to reduce the overall impact of the built environment on its surroundings.

• Green buildings are designed to reduce the overall impact of the built environment on human health and the natural environment by :

1. Efficiently using energy, water and other resources.

2. Protecting occupant health and improving employee productivity.

3. Reducing waste, pollution and environmental degradation.

Q.3 What is ozone depletion ?

Ans. : Ozone depletion : Breakdown of the ozone shield (a thin layer of ozone gas molecules in the atmosphere) that can absorb damaging ultraviolet

radiation and have major implications for global weather ; CFCs and halons greatly speed the process.

Q.4 List out any four environmental protection acts.

Ans. : 1. Air (Prevention and control of pollution) Act.

2. Water (Prevention and control of pollution) Act.

3. Forest censervation Act.

4. Environmental lows.

Q.5 What are the major effect of global warming ?

Ans.: Effects of global warming :

1. Changes in climate.

2. Effect on agriculture productivity.

3. Effect on water resources.

Q.6 List out the objective of EIA.

Ans.: Objectives of EIA :

1. To identify the reasons of problem.

2. To identify the problems and issues of the parties.

3. To identify the affected parties.

Q.7 Mention the effects of ozone on plants.

Ans. : Effects of ozone on plants

1. Ozone enters through openings into the leaf and damage the cells that produce the food for the plant.

2. Once the ozone is absorbed into the leaf, plants may suffer from toxic effect and growth loss exists.

Q.8 Define EIA and its benefits.

Ans. : Environmental Impact Assessment (EIA) is the process of assessing the likely environmental impacts of a proposal and identifying options to minimise environmental damage.

Benefits of EIA :

1 EIA gives basis for better decision making.

2. EIA provides potential environmental effects.

3. Helps in formulation of projects.

Solved Model Question Paper

[As Per New Syllabus]

Environmental Sciences and Sustainability

Semester - IV (Common to All Branches)

Time : Three Hours] [Maximum Marks : 100

Answers ALL Questions

PART-A (10x2 = 20 Marks)

Q.l Explain in brief biotic and abiotic components of ecosystem.

(Refer Two Marks Q.2 of Chapter -1)

Q.2 Define ecosystem diversity.

(Refer Two Marks Q.13 of Chapter -1)

Q.3 How cyclone is formed ?

(Refer Two Marks Q.28 of Chapter - 2)

Q.4 List any four water quality parameters and their importance.

(Refer Two Marks Q.32 of Chapter - 2)

Q.5 What renewable energy ?

(Refer Two Marks Q.l of Chapter - 3)

Q.6 Define ecosystem.

(Refer Two Marks Q.24 of Chapter - 3)

Q.7 Write the various uses of sustainable development indicators.

(Refer Two Marks Q.2 of Chapter - 4)

Q.8 What do you know about watershed ?

(Refer Two Marks Q.3 of Chapter - 4)

Q.9 What is e-waste ?

(Refer Two Marks Q.l of Chapter - 5)

Q.10 Define EIA and its benefits.

(Refer Two Marks Q.8 of Chapter - 5)

PART - B (5× 13 = 65 Marks)

Q.ll a) Explain the structure of an ecosystem.

(Refer section 1.5) [13]

OR

b) Explain energy flow models in ecosystem.

(Refer section 1.6) [13]

Q.12 a) What are the impacts of modern agriculture ?

(Refer section 2.4) [13]

OR

b) i) Define air pollution. What are the sources of air pollution ?

(Refer section 2.5) [7]

ii) What are the salient features of the following acts ?

i) The environment (Protection) Act 1986.

ii) Water (Prevention and control of pollution) Act 1974.

(Refer section 2.9) [6]

Q.13 a) Discuss the advantages and disadvantages of wind energy'.

(Refer section 3.7) [13]

OR

b) What is OTEC ? State it's advantages and limitations.

(Refer section 3.5) [13]

Q.14 a) Discuss the recent approaches to achieve sustainable development.

(Refer section 4.2) [13]

OR

b) i) What is carbon footprint ? How to reduce footprints ?

(Refer section 4.9) [7]

ii) Explain ozone layer depletion.

(Refer section 4.7) [6]

Q.15 a) Explain Quality System Standard ISO 14001: 2004.

(Refer section 5.4) [13]

OR

b) What is green building ? State planning for sustainable building and advantages of green building.

(Refer section 5.5) [13]

PART-0 (1 × 15= 15 Marks)

Q.16 a) Explain the concept of urbanization.

(Refer section 5.11) [15]

OR

b) Explain concept of 5R.

(Refer section 5.2) [15]