MC19101-ENVIROMENTAL SCIENCE AND ENGINEERING L T P C

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Common to I sem. B.E. – AERO, AUTO, BME, CIVIL, MECH & MCT and

B.Tech. – BIOTECH ,CHEMICAL& FOOD TECH.

And common to II sem. B.E. – CSE, ECE & EEE and B.Tech. – IT

OBJECTIVES:

- To understand the importance of natural resources, pollution control and waste management.
- To provide the students about the current social issues and environmental legislations.

UNIT I - NATURAL RESOURCES **9**

Environment -definition - scope and importance - forest resources -use and overexploitation - water resources -use and over utilization - dams - benefits and problems - water conservation - energy resources - growing energy needs - renewable and non renewableenergy sources - use of alternate energy sources -land resources -land degradation - role of an individual in conservation of natural resources.

UNIT II - ENVIRONMENTAL POLLUTION **9**

Definition - causes, effects and control measures of air pollution -chemical and photochemical reactions in the atmosphere - formation of smog, PAN, acid rain, and ozone depletion- noise pollution -mitigation procedures - control of particulate and gaseous emission(Control of SO_2, NO_X, CO and HC).

Water pollution - definition-causes-effects of water pollutants–marine pollution-thermal pollution-radioactive pollution-control of water pollution by physical, chemical and biological processes–waste water treatment-primary, secondary and tertiary treatment.

Soil pollution : definition-causes-effects and control of soil pollution.

UNIT III - SOLID WASTE MANAGEMENT **9**

Solid wastes - sources and classification of solid wastes -solid waste management options - sanitary landfill, recycling, composting, incineration, energy recovery options from wastes

Hazardous waste -definition -sources of hazardous waste-classification (biomedical waste, radioactive waste, chemical waste, household hazardous waste)-characteristics of hazardous waste ignitability (flammable) reactivity, corrosivity, toxicity -effects of hazardous waste -case study- bhopal gas tragedy - disposal of hazardous waste-recycling , neutralization, incineration, pyrolysis, secured landfill - E-waste management -definition-sources-effects -electronic waste recycling technology.

UNIT IV - SOCIAL ISSUES AND THE ENVIRONMENT **9**

Sustainable development -concept, components and strategies - social impact of growing human population and affluence, food security, hunger, poverty, malnutrition, famine - consumerism and waste products - environment and human health - role of information technology in environment and human health -disaster management– floods, earthquake, cyclone and landslide.

UNIT V - TOOLS FOR ENVIRONMENTAL MANAGEMENT **9**

Environmental impact assessment (EIA) structure -strategies for risk assessment–EIS-environmental audit-ISO 14000-precautionary principle and polluter pays principle-constitutional provisions- - pollution control boards and pollution control acts- environmental protection act1986- role of non-government organisations- international conventions and protocols.

TOTAL PERIODS 45

OUTCOMES:

On completion of the course students will be able to

- Be conversant to utilize resources in a sustainable manner.
- Find ways to protect the environment and play proactive roles.
- Apply the strategies to handle different wastes
- Develop and improve the standard of better living.
- Be conversant with tools of EIA and environmental legislation.

TEXTBOOKS

Benny Joseph, "Environmental Science and Engineering", 2nd edition, Tata McGraw-Hill, New Delhi,2008.

1. Gilbert M.Masters, "Introduction to Environmental Engineering and Science", 2nd edition, Pearson Education, 2004.

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1. Dharmendra S. Sengar, "Environmental law", Prentice hall of India Pvt Ltd, New Delhi,2007.
2. ErachBharucha, "Textbook of Environmental Studies", 3rd edition, Universities Press(I) Pvt Ltd, Hydrabad, 2015.,
3. G. Tyler Miller and Scott E. Spoolman, "Environmental Science", 15th edition, CengageLearning India PVT, LTD, Delhi, 2014.

4. Rajagopalan, R, “Environmental Studies-From Crisis to Cure”, 3rd edition,Oxford University Press,2015.
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Contents

UNIT I

NATURAL RESOURCES

1.1 INTRODUCTION

Natural resources are generally defined as all those things given by nature on, above and under the surface of the earth. In this broad sense natural resources include land, water, forests, fisheries and animals, mineral ores and sources of energy like coal, petroleum, gas and uranium, etc. The environmental discipline encompasses study in the basic principles of ecology and environmental sciences as well as the associated subjects such as policy, politics, law, economics, social aspects, planning, pollution control, natural resources, and the interactions of human beings and nature.

ENVIRONMENT DEFINITION: Environment is defined as the sum of total of all the living and non-living things around us influencing one another.

The disciplines included in environmental education are environmental sciences, environmental engineering and environmental management.

ENVIRONMENTAL SCIENCE: It deals with the scientific study of environmental system (air, water, soil and land), the inherent or induced changes on organisms and the environmental damages incurred as a result of human interaction with the environment.

ENVIRONMENTAL ENGINEERING: It deals with the study of technical processes involved in the protection of environment from the potentially deleterious effects of human activity and improving the environmental quality for the health and well beings of humans.

ENVIRONMENTAL MANAGEMENT: It promotes due regard for physical, social and economic environment of the enterprise or projects.

1.1.1 SCOPE AND IMPORTANCE OF ENVIRONMENTAL STUDIES

The scope of environmental studies are as follows:

1. To find and implement scientific, technological, economic and political solutions to environmental problems.
2. To study the interrelationship between living organism and environment.
3. To appreciate the importance of environment by assessing its impact on the human world, envision the surrounding environment, its functions and its value.
4. To study the dynamic processes and understand the features of the earth's interior and surface.

5. To study the integrated themes and biodiversity, natural resources, pollution control and waste management.

The importance of environmental studies are as follows:

1. To clarify modern environmental concept like how to conserve biodiversity.
2. To know the more sustainable way of living.
3. To use natural resources more efficiently.
4. The study creates awareness among the students to know about various renewable And non-renewable resources of energy.

1.2 FOREST RESOURCES

It is one of the most important renewable natural resources on this earth. About one-third of the world's land surface is covered with forest.

1.2.1 COMMERCIAL USES

(i) Man depends heavily on a larger number of plant and animal products from forests for his daily needs.

(ii) The chief product that forests supply is wood, which is used as fuel, raw material for various industries as pulp, paper, newsprint, board, timber for furniture items, other uses as in packing articles, matches, sports goods etc.

(iii) Indian forests also supply minor products like gums, resins, dyes, tannins, fibres, etc.

Many of the plants are utilized in preparing medicines and drugs; Total worth of which is estimated to be more than $300 billion per year.

(iv) Many forests lands are used for mining, agriculture, grazing, and recreation and for development of dams.

Depending upon the climate conditions, forest may be classified as:

1. ***Tropical Rain Forests:*** They are evergreen broadleaf forests found near the equator. They are characterized by high temperature, high humidity and high rainfall, all of which favor the growth of trees.

2. ***Tropical deciduous forests:*** They are found a little away from the equator and are characterized by a warm climate the year round. Rain occurs only during monsoon.

3. ***Tropical scrub forests:*** They are found in areas where the day season is even longer.

4. ***Temperate rain forests:*** They are found in temperate areas with adequate rainfall. These are dominated by trees like pines, firs, redwoods etc.

5. ***Temperate deciduous forests:*** They are found in areas with moderate temperatures.

6. ***Evergreen coniferous forests (Boreal Forests):*** They are found just south of arctic tundra. Here winters are long, cold and dry. Sunlight is available for a few hours only.

1.2.2 ECOLOGICAL USES

The ecological services provided by our forests may be summed up as follows:

(i) ***Production of Oxygen:*** The main greenhouse gas carbon dioxide is absorbed by the forests as a raw material for photo synthesis. Thus forest canopy acts as a sink for carbon dioxide thereby reducing the problem of global warming caused by greenhouse gas CO2

(ii) ***Wild life habitat:*** Forests are the homes of millions of wild animals and plants. About 7 million species are found in the tropical forests alone.

(iii) ***Regulation of hydrological Cycle:*** Forested watersheds act like giant sponges, absorbing the rainfall, slowing down the runoff. They control climate through transpiration of water and seed clouding.

1.2.3 BENEFITS OF FOREST RESOURCES

- Forest is an important natural resource. Forests are vital for the ecological balance and play an important role in temperature regulation in the atmosphere.
- Forests are natural and vast reservoir of food and shelter for animals. They provide natural habitats for numerous species of plants, animals and micro-organisms.
- Forests provide timber, bamboo, canes, leaves, grass, oil, resins, gums, shellac, tanning materials, dyes, hides, fur, fruits, nuts, roots, tubers and other useful things for human beings.
- Forests provide raw materials for forest-based industries.
- Forests are the natural home to medicinal herbs and plants.
- Forest directly or indirectly affects the climate (temperature, precipitation, moisture, underground water-table).
- Forests prevent floods and soil erosion, land degradation and improve the quality of air and water.

- Forests help in purifying air, water, and soil pollution.

1.2.4 USE AND OVER EXPLOITATION OF FOREST

A forest is a biotic community predominantly of trees, shrubs and other woody vegetation, usually with a closed canopy. This invaluable renewable natural resource is beneficial to man in many ways.

The direct benefits from forests are:

(a) ***Fuel Wood:*** Wood is used as a source of energy for cooking purpose and for keeping warm.

(b) ***Timber:*** Wood is used for making furniture, tool-handles, railway sleepers, matches, ploughs, bridges, boats etc.

(c) ***Bamboos:*** These are used for matting, flooring, baskets, ropes, rafts, cots etc.

(d) ***Food:*** Fruits, leaves, roots and tubers of plants and meat of forest animals form the food of forest tribes.

(e) ***Shelter:*** Mosses, ferns, insects, birds, reptiles, mammals and micro-organisms are provided shelter by forests.

(f) ***Paper:*** Wood and Bamboo pulp are used for manufacturing paper (News-print, stationery, packing paper, sanitary paper)

(g) ***Rayon*****:** Bamboo and wood are used in the manufacture of rayon (yarns, artificial silk-fibres)

(h) ***Forest Products:*** Tannins, gums, drugs, spices, insecticides, waxes, honey, horns, musk, ivory, hides etc. are all provided by the flora and fauna of forests.

The indirect benefits from forests are:

(a) Conservation of Soil:

Forests prevent soil erosion by binding the soil with the network of roots of the different plants and reduce the velocity of wind and rain, which are the chief agents causing erosion.

(b) Soil-improvement:

The fertility of the soil increases due to the humus which is formed by the decay of forest litter.

(c) Reduction of Atmospheric Pollution:

By using up carbon dioxide and giving off oxygen during the process of photosynthesis, forests reduce pollution and purify the environment.

(d) Control of Climate:

Transpiration of plants increases the atmospheric humidity which affects rainfall and cools the atmosphere.

(e) Control of Water flow:

In the forests, the thick layer of humus acts like a big sponge and soaks rain water preventing run-off, thereby preventing flash-floods. Humus prevents quick evaporation of water, thereby ensuring a perennial supply of water to streams, springs and wells.

1.3 DEFORESTATION

"It refers to drastic elimination of forest resources due to natural and manmade activities".

1.3.1 CAUSES OF DEFORESTATION

- ***Population explosion:*** Population explosion is the root cause of all the environmental problems, vast area of forests are cleared for human settlement
- ***Growing food demand:*** To meet the food demand of rapidly growing population more and more forests are cleared off for agricultural purpose**.**
- ***Fire wood:*** Increasing demand of wood for fuel increases pressure on forests.
- ***Raw material for wood based industry:*** Increasing demand of wood for making furniture, plywood, match box etc. results into tremendous pressure on forests.
- ***Infrastructure development*****:** Massive destruction of forest occurs for various infrastructure development like, big dams, highways projects etc.
- ***Forest fires:*** Forest fires may be natural or manmade cause a huge loss of forest
- ***Over grazing:*** Overgrazing of land by cattle result into soil erosion, desertification.
- ***Natural forces:*** Floods, storms, heavy winds, snow, lightening are some of the natural forces.
- ***Shifting Cultivation:*** It is a traditional agro forestry system widely practiced in north eastern region of country in which felling and burning of forests followed by cultivation of

crop for few years and abandon of cultivation allow forests for regrowth which cause extreme damage to forest.

1.3.2 CONSEQUENCES (EFFECTS) OF DEFORESTATION

Effect on climate	Increases Global warming due to increase in atm CO_2 Decrease in rainfall(Affects hydrological cycle) Climate becomes warmer due to lack of humidity in deforested areas, also pattern of rainfall changes.
Effect on biodiversity	Loss of flora and fauna result into loss of bio-diversity leading to disturbance in ecological balance worldwide.
Effect on resources	*Soil erosion:* The soil gets washed away with rain water on sloppy areas in the absence of trees leading to soil erosion. *Expansion of deserts*: Due to strong winds laden by rock dust, land mass gradually gets converted in atmosphere. *Loss of fertile land:* Less rainfall results into loss of fertile land owing to less natural vegetation growth. *Lowering of Water table:* Lack of recharging of underground reservoir, results into lowering of water table
Effect on economy	Increase in medicinal values Demand of industrial products. loss of industrial timber and non-timber products
Effect on food	Loss of fruit production Loss of root based foods. Loss of animals

1.3.3 METHODS OF CONSERVATION OF FORESTS

- *The conservation measure against the deforestation is afforestation. The development of forest by planting trees on waste land is called afforestation*
- *To regulate rainfall and maintain temperature*
- *To control atmospheric condition by keeping it clean*
- *To promote planned uses of wasteland*
- *To Protect forest ecosystem and to get benefits of forest products*

1.3.4 CASE STUDIES

(i) Desertification in hilly regions of the Himalayas

Desertification in Himalayas, involving clearance of natural forests and plantation of monocultures like Pinus roxburghi, Eucalyptus camadulensis etc., have upset the ecosystem by changing various soil and biological properties. The area is invaded by exotic weeds. These areas are not able to recover and are losing their fertility.

(ii) Disappearing Tea gardens in Chhota Nagpur

Following the destruction of forest rain fall declined in Chhota Nagpur to such an extent that tea gardens also disappeared from the region.

(iii) Waning rain fall in Udhagamandalam

The rainfall pattern was found to fluctuate with wooded land area in the hills. When the Nilgiri mountains had luxuriant forest cover annual rainfall used to be much higher.

1.4 WATER RESOURCES

1.4.1 USE AND OVER UTILIZATION

Water is an important component of all living beings. Nearly 80% of earth's surface is covered by water.

Ex: 1. A tree is made up of 60% by weight of water

2. Animals are made up of 50-65% of water

Forms of water: Water exists in three phases, solid, liquid and gas. It is circulated in accordance with the hydrological cycle.

Hydrological cycle

1. Evaporation

2. Precipitation

3. Transpiration

1. Evaporation: The transformation of water from liquid to gas phases as it moves from the ground or bodies of water into the overlying atmosphere. The source of energy for evaporation is primarily solar radiation. Evaporation often implicitly includes transpiration from plants, though together they are specifically referred to as evapotranspiration. Total annual evaporation amounts to approximately 505,000 km^3 (121,000 cu mi) of water, 434,000 km^3 (104,000 cu mi) of which evaporates from the oceans.

2. Precipitation: Condensed water vapour that falls to the Earth's surface. Most precipitation occurs as rain, but also includes snow, hail, fog drip, graupel, and sleet. Approximately 505,000 km^3 (121,000 cu mi) of water falls as precipitation each year, 398,000 km^3 (95,000 cu mi) of it over the oceans.

3. Condensation: The transformation of water vapour to liquid water droplets in the air, creating clouds and fog.

4. Transpiration: The release of water vapour from plants and soil into the air. Water vapour is a gas that cannot be seen.

5. Snowmelt: The runoff produced by melting snow.

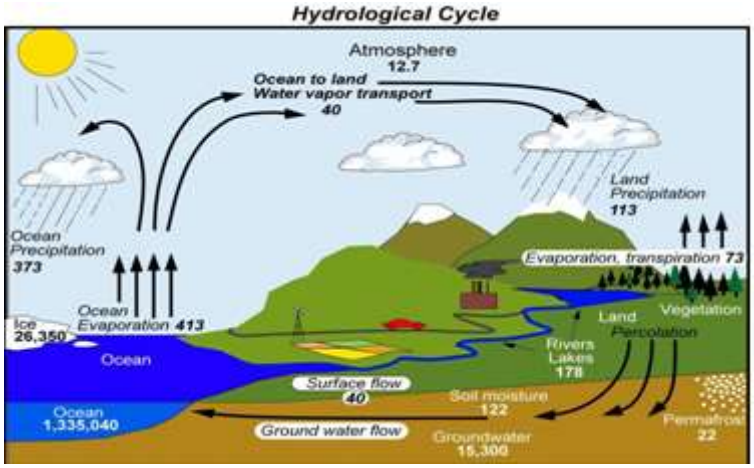


Fig.1.1

6. Runoff: The variety of ways by which water moves across the land. This includes both surface runoff and channel runoff. As it flows, the water may seep into the ground, evaporate into the air, become stored in lakes or reservoirs, or be extracted for agricultural or other human uses.

7. Infiltration: The flow of water from the ground surface into the ground. Once infiltrated, the water becomes soil moisture or groundwater.

8. Sub-surface Flow: The flow of water underground, in the vadose zone and aquifers. Subsurface water may return to the surface (e.g. as a spring or by being pumped) or eventually seep into the oceans. Water returns to the land surface at lower elevation than where it infiltrated, under the force of gravity or gravity induced pressures. Groundwater tends to move slowly, and is replenished slowly, so it can remain in aquifers for thousands of years.

8. Sublimation: The state change directly from solid water (snow or ice) to water vapour.

1.4.2 SOURCES OF WATER:

Naturally available water can be classified as:

(i) Surface water and (ii) Ground water

Surface Water:

(a) Rain Water:

It is the purest form of natural water because it is received by evaporation of surface water. But it is made impure by the polluted atmosphere from where it falls. Gases like SO_2, CO_2, NO and NO_2 from the industries and automobiles dissolve in the rain water forming the corresponding acids. Such polluted rain is acid rain.

Examples:

$$SO_2 + H_2O \rightarrow H_2SO_3$$

$$2SO_2 + O_2 \rightarrow H_2O \rightarrow 2H_2SO_4$$

$$4NO_2 + 2H_2O + 2O_2 \rightarrow 4HNO_3$$

(b) River water:

River receives water from rain and when this water travels over the land different minerals of the soil get dissolved in it.

(c) Lake water:

A lake, unlike a river does not flow through different lands, therefore it contains much lesser amounts of dissolved minerals and it has a constant chemicals composition. It can be used for drinking purposes.

(d) Sea water:

It is the most impure form of natural water because all the impurities thrown into rivers enter the sea. Continuous evaporation of sea water takes place. Out of the dissolved salts present in sea water, 2.6% is NaCl. Sea water also contains bicarbonates of Ca, K, Mg and bromides of K and Mg in small percentage.

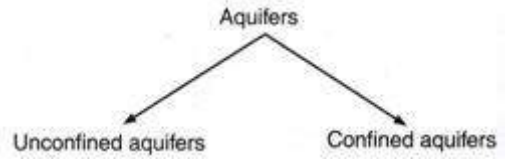
Ground Water:

Groundwater is about 35 – 50 times that of surface water supplies. Till some time back, groundwater was considered to be very pure. However of late, even groundwater aquifers have been found to be contaminated by leachates from sanitary landfills etc.

A layer of sediment or rock that is highly permeable and contains water is called an aquifer. Layers of sand and gravel are not call aquifers since they have low permeability.

Aquifers may be of two types:

Ground Water



1. Unconfined aquifers:

Unconfined aquifers are those which are overlaid by permeable earth materials and they are recharged by water seeping down from above in the form of rainfall and snow melt.

2. Confined aquifers:

Confined aquifers are those which are sandwiched between two impermeable layers of rock or sediments and are recharged only in those areas where the aquifers intersect the land j surface.

Sometimes the recharged area is hundreds of kilometres away from the location of the well. Ground water is not static, it moves, through at a very slow rate of about a meter or so in a year.

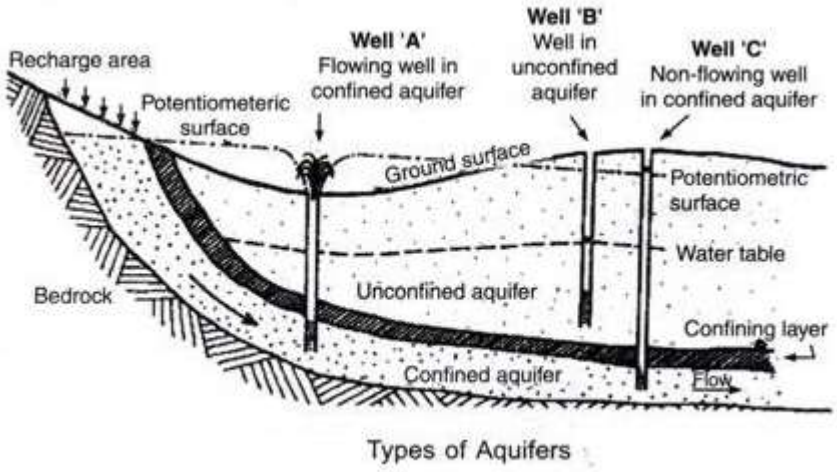


Fig. 1.2

1.4.3 OVER EXPLOITATION OF WATER RESOURCES:

With increasing human population and rapid development, the world water withdrawal demands have increased many folds and a large proportion of the water withdrawn is polluted due to anthropogenic activities. Out of the total water reserves of the world, about 97% is salty water and only 3% is fresh water. Even this small fraction of fresh water is not available to us as most of it is locked up in polar ice caps and just 0.003% is readily available to us in the form of ground water and surface water.

1.4.4 EFFECTS OF OVER EXPLOITATION OF WATER:

1. ***Decrease of Ground Water:*** **-** Due to increased usage of ground water, the ground water level decreases.

Reason: a) The erratic and inadequate rainfall.

b) The building construction activities are sealing the permeable soil zone, reduce the area for percolation of rain water and increase in surface runoff.

2. ***Ground subsidence:*** When the ground water withdrawal is more than its recharge rate, the sediments in the aquifer get compacted, which results in sinking of overlaying land surface

(Ground subsidence). Problems:

1. Structural damage in buildings
2. Fracture in Pipes
3. Reversing the flow of canals and tidal flooding.

3. *Lowering of water table:* Over utilization of ground water disturb the hydrological cycle.

1. Lowering of water table
2. Decreased pressure in the aquifers and change in the speed and direction of water flow.

4. *Intrusion of salt water:* In coastal area, over exploitation of ground water would lead to rapid intrusion of salt water from the sea.

Problems: Water cannot be used for drinking and agriculture

5. *Earthquake and landslides:* Over utilization of ground water leads to decrease in water level, which cause earthquake, landslides and famine.

6. *Decrease in ground water level:* As a result of over utilization of ground water, the level of ground water gets depleted.

7. *Pollution of water:* When ground water level near the agricultural land decrease. water containing the nitrogen as nitrate fertilizer, percolates rapidly into the ground and pollute the ground water. Problems: Water becomes unsuitable for potable use by infants, when nitrate concentration exceeds 45 mgs/ lit.

1.5 DAMS BENEFITS AND THEIR PROBLEMS:

Water is a precious resource that is becoming an increasingly scarce commodity worldwide. To reduce scarcity, there is a growing pressure to harness and uti-lize surface water sources like rivers by building dams over them. The potential use could be for irrigation, hydroelectricity, water transport etc.

1.5.1 BENEFITS OF DAMS:

(a) Hydroelectric generation.

(b) Transfer of water using canals from areas of excess to areas of deficit water.

(c) Irrigation during dry period.

(d) Flood control and soil protection.

(e) Ensuring year-round water supply.

(f) Multipurpose river valley projects also provide for inland water navigation.

(g) River valley projects with big dams play a key role in the development process due to their multiple uses.

- Provides employment for tribal people and raising the standard and quality of life.
- Helps in checking floods and generate electricity and reduce water and power shortage.
- provide irrigation water to lower areas and drinking water in remote areas
- Promote navigation and fishery.

1.5.2 PROBLEMS (IMPACTS OF DAMS)

Upstream problems (On forests)

- ✓ Reduces the forest area considerably
- ✓ Loss of flora and fauna
- ✓ Saltation and sedimentation of reservoirs
- ✓ Loss of non-forest land
- ✓ Stagnation and water logging near reservoir
- ✓ Breeding vectors and spread of vector –borne diseases
- ✓ Growth of aquatic weeds

Downstream problems include the following

- Water logging and salinity due to over irrigation
- Microclimatic changes
- Reduced water flow and slit deposition in river
- Flash foods
- Salt water intrusion at river mouth
- Loss of land fertility
- Outbreak of vector borne diseases.

Problems In tribal community

- ✓ Wide spread displacement of tribal people which affects their cultural heritage leads to physical and mental illness.
- ✓ They don't accommodate to modern food habits and lifestyle.
- ✓ Loss of income and economy since they depend on forest resources for earnings.
- ✓ Loss of information about medicinal plants.
- ✓ No proper resettlement and rehabilitation.

1.6 WATER CONSERVATION

"The process of storing water for future use is called water conservation".

1.6.1 NEED FOR WATER CONSERVATION

(i) Better life styles require more water.

(ii) With increase in population, the requirement for water also increases.

(iii) The annual rainfall decreases due to deforestation.

(iv) Over exploitation of ground water lead to drought.

(v) Agricultural and industrial activities require more fresh water.

1.6.2 MEASURES OF WATER CONSERVATION

The following measures can be followed to conserve water.

(i) Decreasing run-off losses:

This can be achieved by using contour cultivation or terrace farming

(ii) Reducing irrigation losses:

(a) Drip irrigation or sprinkling irrigation can conserve water up to 50%

(b) Use of lined or covered canals to reduce leakage.

(c) Irrigation in early morning or late evening reduces evaporation loss.

(d) Growing hybrid crop varieties which require less water and also conserve water.

(iii) Reuse of water:

(a) Treated water can be used for irrigation.

(b) The grey water from washing can be used for washing cars, watering gardens.

(iv) Preventing wastage of water:

This can be carried out in households, public places and commercial buildings in the following ways:

(a) Closing the taps when not in use.

(b) Repairing any leakage in pipes.

(c) Using small capacity flush in toilets.

(v) Discharge of sewage:

The discharge of sewage into natural water resource should be prevented as much as possible.

(vi) Reducing evaporation losses:

Evaporation of water in humid regions can be reduced by placing horizontal barriers of asphalt below the soil surface.

1.6.3 METHODS OF WATER CONSERVATION

The following two methods are important in water conservation

(i) Rain water harvesting

(ii) Watershed management

1.6.4 RAIN WATER HARVESTING

The process of collection of rain water directly

Discharging water into the ground is called rain water harvesting

Objective of rain water harvesting

(i) To reduce run off loss.

(ii) To stop the land subsidence

(iii) To avoid flooding roads

(iv) To minimize water conflicts.

(v) To reduce the ground water contaminations.

(vi) To avoid the intrusion of saline water at ground level

(vii) To raise the water table by recharging ground water.

(viii) To meet the increasing demands of water.

(ix) To reduce storm, water runoff and soil erosion.

Roof top rainwater harvesting method

It is the process of collecting rainwater from the roof of the building and storing in the underground for future use.

Method:

The rain water from the top of the roofs and other areas is diverted into the surface tank or recharge pits through a delivery system.

The surface tank or recharge pit is filled with t stones, graves and sand which serve as a sand filter.

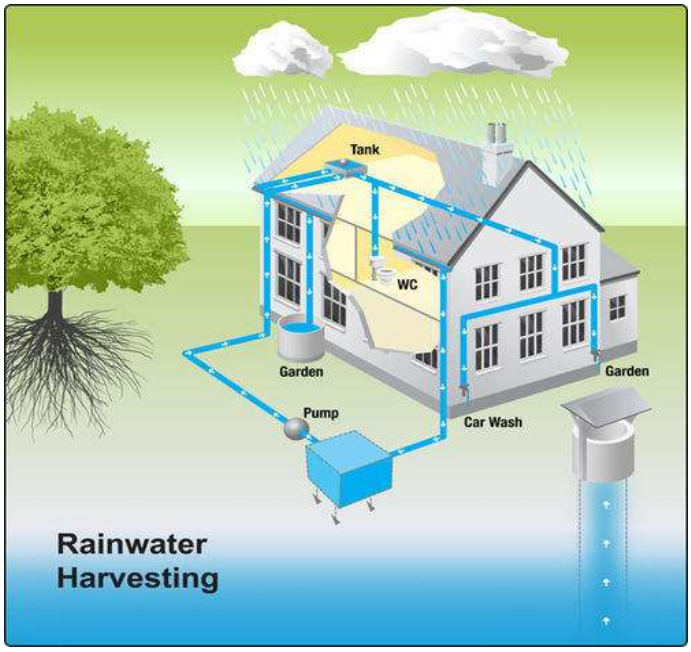


Fig.1.3

Advantages of rain water harvesting

(i) It raises the ground water levels.

(ii) It increases the availability of water from wells.

(iii) It reduces flood and soil erosion

(iv) It reduces the effect of droughts

(v) Water is assured for future generation.

(vi) It upgrades the social and environmental status.

Disadvantages

(i) The water supply is very limited

(ii) Uncertainty of rainfall

(iii) It is a seasonal method.

1.6.5 WATERSHED MANAGEMENT

Watershed is defined as the land area from which water drains under the influence of gravity into stream, lake, reservoir, estuary or other water body of surface water.

The management of rainfall and resultant runoff to is called watershed management.

It involves conservation, regeneration and proper use of water.

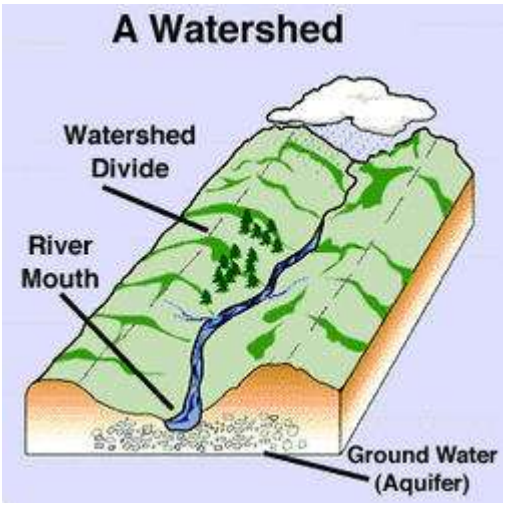


Fig.1.4

Factors affecting watershed

(i) Climate changes affect the watershed.

(ii) Overgrazing deforestation, mining, forest fire, soil erosion, construction activities, industrialisation, modern agricultural methods etc. affect and degrade various watersheds.

(iii) The watersheds are found to be degraded due to uncontrolled, unplanned and unscientific land use activities.

Objectives of watershed management

(i) To raise the ground water level.

(ii) To protect the forestry activities.

(iii) To protect the soil from erosion by runoff.

(iv) To improve the good productivity of the land.

(v) To minimize the risks of flood, droughts and landslides.

(vi) To develop rural areas and providing economy to them.

(vii) To provide domestic water supply, irrigation, hydropower generation.

Watershed management techniques

(i) Pits or Trenches:

Pits were dug at equal intervals to improve ground water level.

(ii) Earthen dam or stone embankment:

It is constructed in the catchment area to check the runoff water.

(iii) Farm pond:

It is built to improve water storage capacity of catchment areas

(iv) Underground barriers:

It is built long the voids to raise the water table.

Maintenance of watershed:

(i) Protect the vegetation along stream banks which prevents stream bank erosion.

(ii) Forestation are used to prevent soil erosion.

(iii) Minimize the livestock population in the watershed areas.

(iv) Use animal wastes on farms to pre prevent water contamination in water in watershed area.

(v) Terracing, bunding, contour cropping strip cropping etc. are to be used to minimize soil erosion and runoff on the slopes of watersheds.

1.7 ENERGY RESOURCES

Energy may be defined as, "any property, which can be converted into work."

1.7.1 DEVELOPMENT OF ENERGY:

1. The first form of energy is the fire.
2. The early man discovered fire and used it for cooking and heating purposes
3. Wood is the main source of energy, which is later replaced by coal.
4. Coal is now being replaced by the oil and gas.
5. Now due to insufficient availability and price hike, people started of thinking and using several alternative sources of energy.

Wood → coal → oil → alternate energy (solar, wind, tidal energy)

1.7.2 GROWING ENERGY NEEDS:

(i) Energy is essential to all human societies.

(ii) All industrial process like, mining, transport, living, heating and cooling in buildings, all require energy.

(iii) With the demands of growing population, the world is facing further energy deficit,

Our life style is also changing from al simple way of life to luxurious life style. At present 95% of the commercial energy is available only from the fossil fuels like coal, oil and natural gas, and are not going to last for many years. It would be really ironic if fuel becomes more expensive than food.

1.7.3 ENERGY DISTRIBUTION –WORLD SCENARIO

U.S.A and Canada 5% of the world's population- consume 25% of the available world's energy resources. It has been observed, that in U.S.A and Canada an average person consumes 300 GJ (Giga Joules; equal to 60 barrels of oil) per year. But in poor countries like Bhutan, Nepal and Ethiopia, an average person consumes less than 1 GJ per year. So a person in a developed country consumes almost as much energy in a single day as one person consumes in a whole year in a poor country. From the above scenario it is clear that our life style and standard of living are closely related to energy needs.

1.7.4 RENEWABLE ENERGY RESOURCES (OR) NON-CONVENTIONAL ENERGY RESOURCES

Natural resources can be regenerated continuously and are inexhaustible. They can be used again and again in an endless manner.

Example: Wood, solar energy, wind energy, hydropower energy, etc.

1. SOLAR ENERGY

- The energy that we get directly from the sun is called solar energy.
- Occurs due to nuclear fusion reactions in the sun

Methods of Harvesting Solar Energy

1. **Solar cells (or) photovoltaic cells (or) PV cells**

✓ It is a photovoltaic cell which converts light energy into electrical energy

✓ Solar cells consist of a p-type semiconductor and n-type semi-conductor

✓ They are in close contact with each other.

✓ When the solar rays fall on the top layer of p-type semi-conductor, the electrons from the valence band get promoted to the conduction band and cross the p-n junction into n-type semi-conductor.

✓ There by potential difference between two layers is created, which causes flow of electrons (i.e., an electric current)

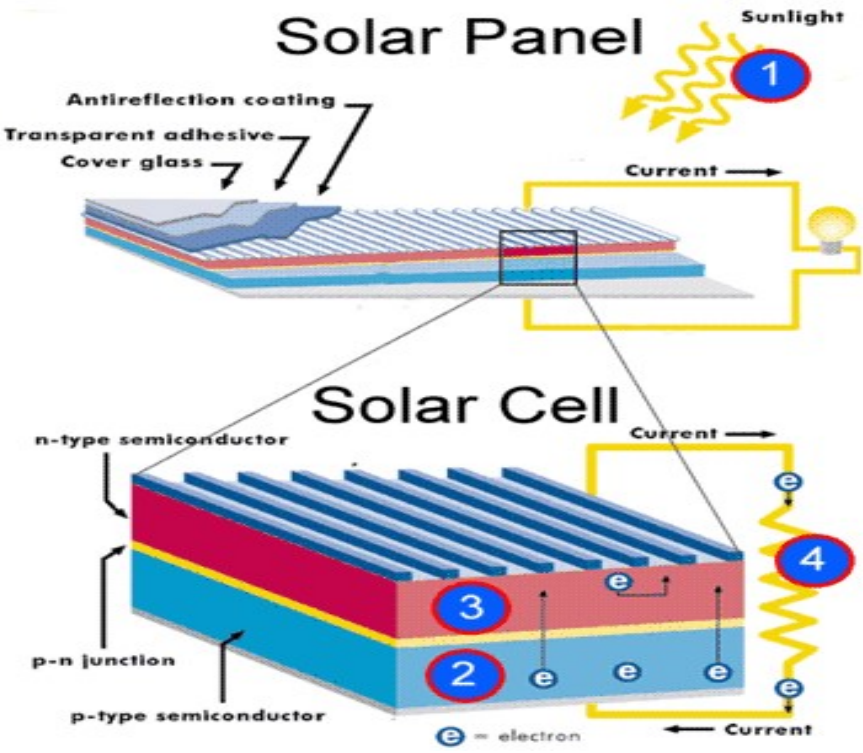


Fig.1.5

2. Solar Battery

When a large number of solar cells are connected in series it forms a solar battery.

Solar battery produce more electricity which is enough to run water pump, to run-street-light etc.

They are used in remote areas where conventional electricity supply is a problem.

3. Solar water heater

It consists of

- ❖ An insulated box inside of which is painted with black paint.
- ❖ Provided with a glass lid to receive and store solar heat.
- ❖ Inside the box it has black painted copper coil, through which cold water is allowed to flow in, which gets heated up and flows out into a storage tank.
- ❖ From the storage tank water is then supplied through pipes.

Merits:

- Pollution free energy

- Easy installation and maintenance
- The nutritional value is cooked food is not affected.
- Noiseless operation.
- No need of container to store fuel.

Demerits:

- Fails to work in nights and cloudy days.
- Requires backup systems.
- Cooking requires more time.
- Unfit for industrial systems.

2. WIND ENERGY

Definition

Moving air is called wind.

- ✓ Energy recovered from the force of the wind is called wind energy.
- ✓ The energy possessed by wind is because of its high speed.
- ✓ The wind energy is harnessed by making use of wind mills.

Harvesting of wind energy

Wind forms

- ✓ High speed wind have lot of energy can be converted into mechanical and electrical energy.
- ✓ This high speed wind rotates the blades of the wind mill continuously and turns the turbine which generate electricity
- ✓ The minimum speed required for satisfactory working of a wind generator is 15 km/hr.
- ✓ Wind forms are mostly located at coastal and hilly regions where winds are strong and steady.

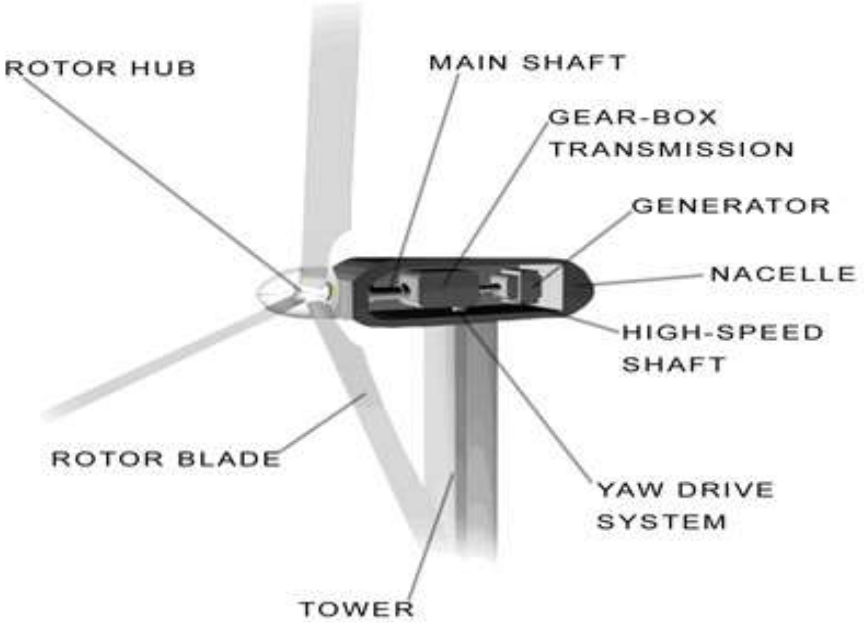


Fig.1.6

Advantages

- It does not cause any air pollution
- It is very cheap.
- Useful at remote places
- Land below wind mills con be used to grow crops.

Dis advantages

- uniform wind flow is not possible throughout the year
- less favorable in city locations
- affects migratory birds
- Backup systems are needed when winds are low

3. TIDAL ENERGY (OR) TIDAL POWER

Ocean tides, produced by gravitational forces of sun and moon, contain enormous amount of energy.

- ✓ The "high tide" and "low tide" refer to the rise and fall of water in the oceans.
- ✓ The tidal energy can be harnessed by constructing a tidal barrage.
- ✓ During high tide, the sea-water is allowed to flow into the reservoir of the barrage and rotates the turbine, which in turn produces electricity by rotating the generators.
- ✓ During low tide, when the sea level is low, the sea water stored in the barrage reservoir is allowed to flow into the sea and again rotates the turbine.

Fig.1.7

Advantages

- It does not cause pollution
- More efficient than wind because of the density of water.
- Predictable source of energy

Disadvantages

- Expensive to build and maintain
- Brings out major ecological changes in coastal region
- Interfere with fisheries
- affects habitat of water birds

4. BIOMASS ENERGY

Biomass is the organic matter, produced by plants or animals, used as sources of energy. Most of the biomass is burned directly for heating, cooling and industrial purposes.

E.g.: Wood, crop residues, seeds, cattle dung, sewage, agricultural wastes.

i. Biogas

- ✓ Mixture of methane, carbon dioxide, hydrogen sulphide, etc.
- ✓ It contains about 65% of methane gas as a major constituent
- ✓ Biogas is obtained by the anaerobic fermentation of animal dung or plant wastes in the presence of water.

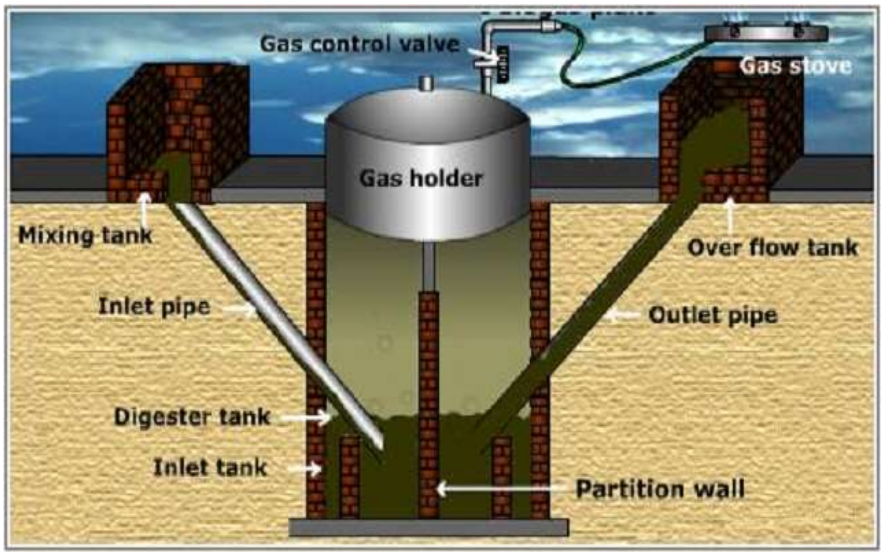


Fig.1.8

ii. Bio fuels

Biofuels are the fuels, obtained by the fermentation of biomass.

(a)Ethanol

Ethanol can be easily produced from the sugarcane. Its calorific value is less when compared to petrol, and produces much less heat than petrol.

(b)Methanol

Methanol can be easily obtained from ethanol or sugar-containing plants.

Its calorific value is also too low when compared to gasoline and diesel.

(c)Gasohol

Gasohol is a mixture of ethanol and gasoline.

- ✓ In India trial is being carried out to use Gasohol in cars and buses.
- ✓ Gasohol is a common fuel in Brazil and Zimbabwe for running cars and buses.
- ✓ Methanol is very useful since it burns at a lower temperature than gasoline or diesel. Due to its high calorific value, hydrogen can serve as an excellent fuel.
- ✓ Moreover, it is non-polluting and can be easily produced.
- ✓ Presently H_2 is used in the form of liquid hydrogen as a fuel in spaceships.

Merits:

- ✓ Pollution free energy
- ✓ Clean and low cost fuel
- ✓ Sludge left out is a rich fertilizer
- ✓ Nutrients are preserved.

Demerits:

- ✓ Suitable for rural areas

5. OCEAN THERMAL ENERGY CONVERSION (OTEC):

Ocean Thermal energy is also an industry method of utilizing solar energy. A large amount of solar energy is collected and stored in tropical oceans. The surface of water acts as the collector for solar heat, while upper layer of the sea acts as infinite heat storage reservoir. Thus heat contained in ocean could be converted into electricity.

The operation of OTEC plant is based on the heat source that is available at a higher temperature and a heat sink at lower temperature, it is possible in principle to utilize the temperature difference in a machine that can convert heat energy into mechanical energy and hence into electrical source.

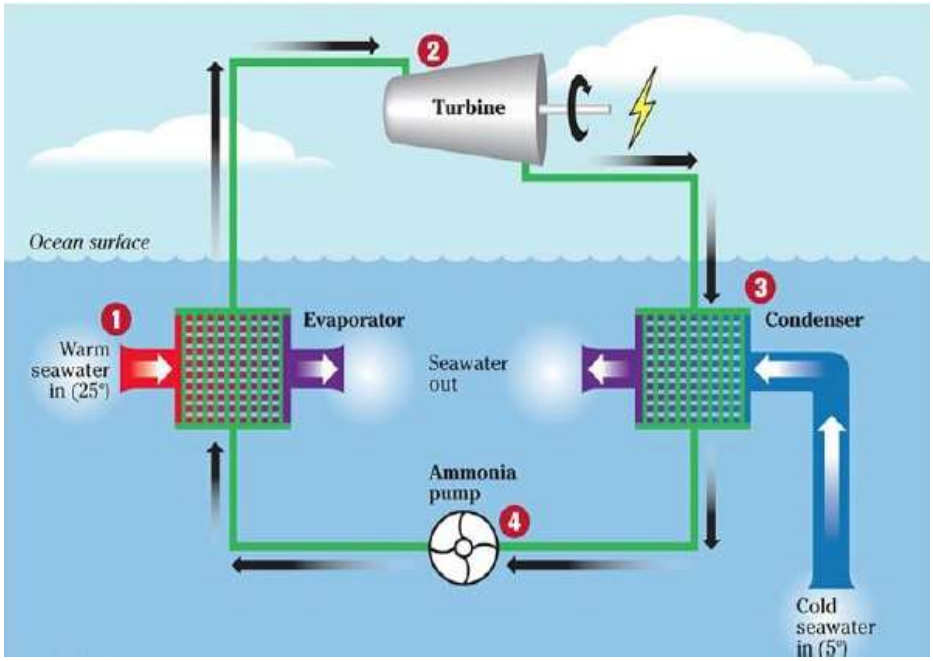


Fig.1.9

Advantages:

- No fuel is required in ocean thermal energy conversion plant.
- The amount of energy available for ocean thermal power energy generation is enormous and is replenished continuously.

Disadvantages:

- They have high cost.
- Prospects of OTEC are very low.

6. GEOTHERMAL ENERGY (GTE)

"***The energy stored from high temperature present inside the earth is called geothermal energy".***

When we move down the earth surface, the temperature increases at a rate of about 70°C per km. The core of the earth is very hot as it has molten materials.

This has enormous amount of geothermal energy.

The molten, hot materials of earth is in some regions are close enough to underground water and converts it into steam. By drilling wells, we can obtain steam and is used to produce electricity through generator.

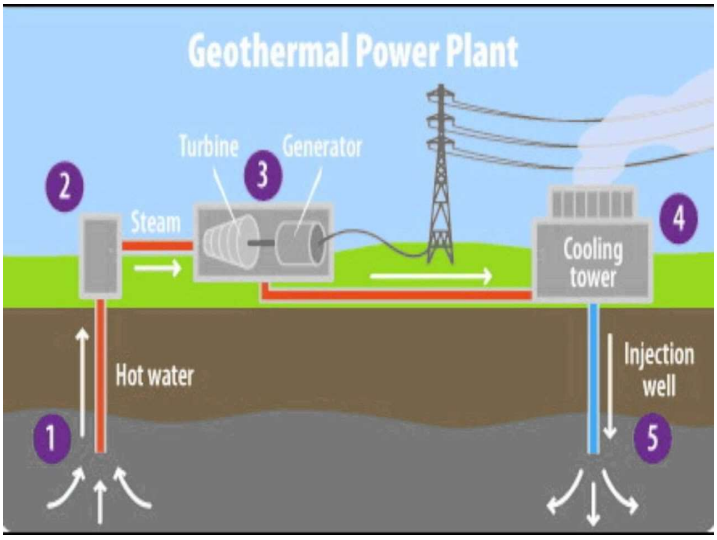


Fig.1.10

Advantages:

The power generation using GTE is more than solar and wind energies.

GTE can be directly used in hot water bath, resorts, aquaculture and greenhouse.

Disadvantages:

High installation costs.

Suited to particular region.

7. HYDROPOWER (HYDRO-ELECTRIC ENERGY):

Hydro-electric energy is produced from the kinetic energy of water falling from a height. Hilly and high land areas are suitable for this purpose, where there is continuous flow of water in large amounts falling from high slopes. Water falling from a height turns turbines at the bottom of dams to generate electricity. Approximately one fourth of the world's electricity is produced by hydropower.

Advantage:

It is cheaper than the electricity produced by thermal power plants.

Disadvantage:

Building a dam to hold the water leads to several environmental problems like destruction of animal habitats, submergence of vegetation and is displacement of people.

1.7.5 NON-RENEWABLE OR EXHAUSTIBLE ENERGY RESOURCES

Non-renewable resources which have accumulated in nature over a long span of time and cannot be quickly replenished when exhausted e.g., coal, petroleum, natural gas and nuclear fuel like uranium and thorium.

1. Coal:

Coal is a solid fossil fuel formed in several stages as buried remains of land plants that lived 300-400 million years ago were subjected to intense heat and pressure over millions of years. The ancient plants along the bank of rivers and swamps were buried after death into the soil and due to the heat and pressure gradually got converted into peat and coal over millions of years of time.

2. Petroleum:

Petroleum is oily, flammable, thick dark brown or greenish, liquid that occurs naturally in deposits, usually beneath the surface of the earth; it is also called as crude oil. Petroleum means rock oil, (Petra – rock, elaion – oil, Greek and oleum – oil, Latin), the name inherited for its discovery from the sedimentary rocks.

3. Natural Gas:

Natural gas has emerged as promising fuel due to its environment friendly nature, efficiency, and cost effectiveness. Natural gas is considered to be most eco-friendly fuel based on available information. Economically natural gas is more efficient since only 10 % of the produced gas wasted before consumption and it does not need to be generated from other fuels.

4. Nuclear Energy:

Nuclear energy is known for its high destructive power as evidenced from nuclear weapons. The nuclear energy can also be harnessed for providing commercial energy. The nuclear energy can also be harnessed for proving commercial energy.

Nuclear power produces around 11% of the world's energy needs, and produces huge amounts of energy from small amounts of fuel, without the pollution that we would get from burning fossil fuels.

Enormous amount of heat energy is liberated from a small amount of nuclear fuel when it undergoes a fission process. The chain reaction of nuclear fission process is shown in the fig.1.11 the energy liberated by this process from 1 kg of U^{235} is equal to the heat energy obtained by burning 4500 tonnes of high graded petroleum.

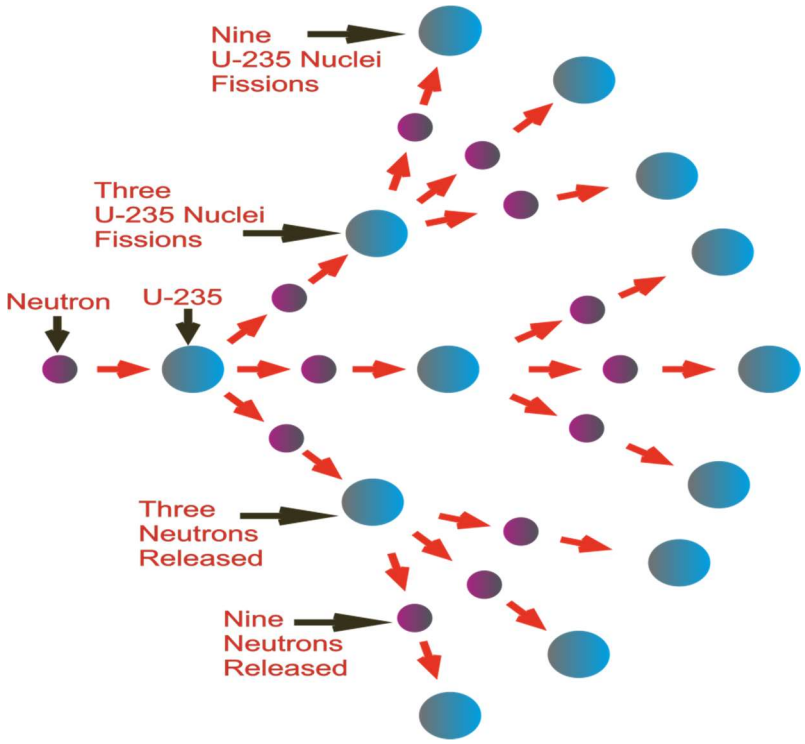


Fig.1.11

Advantages

- Nuclear power costs about the same as coal, so it is not expensive to make.
- Does not produce smoke or carbon dioxide, so it does not contribute to the greenhouse effect,
- Produces huge amounts of energy from small amount of fuel.
- Produces small amount s of waste
- Nuclear power is reliable.

1.8 USE OF ALTERNATE ENERGY SOURCES

The rapid increase in the demand of energy has caused worry about its supply. The main sources of energy are conventional sources. They are non-renewable and exhaustible sources.

These alternative sources include – Solar energy, Wind energy, Geo-thermal energy, Tidal energy, Biomass energy, Hydro power energy etc.

1. Fossil fuels are non-renewable energy sources. These are replaced by inexhaustible solar energy.

2. Useless waste materials like food waste, wood, crop residues, cattle dung and sewage waste can be converted into useful bio gas. This process reduces pollution and produces less polluted products.

3. Hydroelectric power projects do not upset the ecology.

4. It protects the environment from pollution-

   (a) Radioactive wastes are highly dangerous and require large land or aquatic area for disposal.

   (b) In thermal power plants, burning of coal, wood, oil etc. Produces smoke.

   (c) After burning, the disposal of fly ash requires large ash ponds.

   All these problems are solved by using alternate energy sources.

5. Alternate energy resources reduce the production cost.

6. Alternate energy resources are available continuously and the energy can be drawn at any time.

1.9 LAND RESOURCES:

It provides food, fibre, wood, medicine and other biological materials Soil is the mixture of inorganic materials (rocks and minerals) and organic materials (dead animals and plants).

Top soil is classified as renewable resources.

1.9.1 USES OF LAND RESOURCES:

1. Land provide, food, wood, minerals, etc., for us

2. Land nurtures the plants and animals that provide our food and shelter.

3. Land is used as watershed or reservoir

4. Land acts as a dust bin for most of the wastes, created by the modern society.

5. Land is used for construction of buildings, industries.

1.9.2 LAND DEGRADATION

"Any Process of degradation of soil or loss of fertility of the soil which affects productivity".

Causes:

- Landslides
- Soil erosion
- Desertification
- Water logging
- Salinity
- Shifting cultivation

Harmful effects of land degradation

- The soil texture and soil structure are deteriorated
- Loss of soil fertility, due to loss of invaluable nutrients
- Increase in water logging, salinity, and alkalinity and acidity problems.
- Loss of economic, social and biodiversity.

1.9.3. LAND SLIDES

"***Landslides are the downward and outward movement of a slope composed of earth materials such as rock, soil, artificial fills***". Other names of landslides are rockslide, debris slide, slump, earth flow and soil creep.

Causes of landslides

- ✓ Construction of dams, roads, canals & reservoirs
- ✓ mining activities
- ✓ Over exploitation of ground water also leads to landslides.
- ✓ Removal of vegetation

Harmful effect of landslides

- Landslide increases the turbidity of nearby streams, thereby reducing their productivity.
- Destruction of communication links.
- Loss of habitat and biodiversity.
- Loss of infrastructure and economic loss.
- Stability of hill slopes is endangered.
- Causes blockage and interruption in traffic

1.9.4 SOIL EROSION

Soil erosion is the process of removal of superficial layer of the soil from one place to another.

Causes of soil erosion

(i) Uneven distribution of rain fall

- ✓ Affects soil erosion in the form of rain, run-off, rapid flow, wave action.
- ✓ Gully erosion: When the rainfall is very heavy, deeper cavities or gullies are formed, which may be U or V shaped.
- ✓ Slip erosion: This occurs due to heavy rainfall on slopes of hills and mountains.

(ii) Wind

- ✓ Wind is the important climatic agent carry away the fine particles of soil and creates soil erosion.
- ✓ Saltation: occurs under the influence of direct pressure of stormy wind and the soil particles of 1-1.5 mm diameter move up in vertical direction

(iii) Biotic agents

- ✓ Overgrazing, mining and deforestation are the major biotic agents, cause soil erosion.
- ✓ Deforestation without reforestation, overgrazing by cattle, surface mining without land reclamation, irrigation techniques that lead to salt build- up, water logged soil, make the top soil vulnerable to erosion.

(iv) Landslides -Causes soil erosion.

(iv) Construction -Construction of dams, buildings, roads removes the protective vegetal cover and leads to soil erosion.

Effects of soil erosion

- ✓ Soil fertility is lost because of loss of top soil layer.
- ✓ Loss of its ability to hold water and sediment.
- ✓ Sediment runoff can pollute water and kill aquatic life

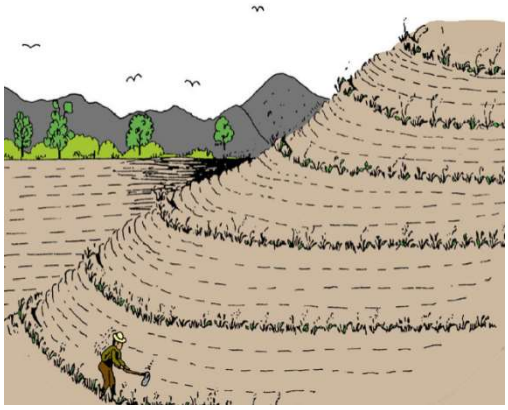
Control of soil erosion (or) soil conservation practices

1. Till farming

- In tradition method, the land is ploughed and soil is broken up and levelled to make a planting surface.
- This disturbs the soil and makes it susceptible to erosion

2. Contour farming

- It involves planting crops in rows across the contour of gently sloped land.
- Each row acts as a small dam to hold soil and to slow water runoff.



Contour farming

Terracing

Fig.1.12

3. Terracing

- It involves conversion of steep slopes into broad terraces, which run across the contour.
- This retains water for crops and reduces soil erosion by controlling runoff.

4. Alley cropping (or) Agro forestry

- ✓ It involves planting crops in strips or alleys between rows of trees of shrubs that can provide fruits and fuel wood.
- ✓ Even when the crop is harvested, the soil will not be eroded because trees and shrubs still remain on the soil and hold the soil particles.

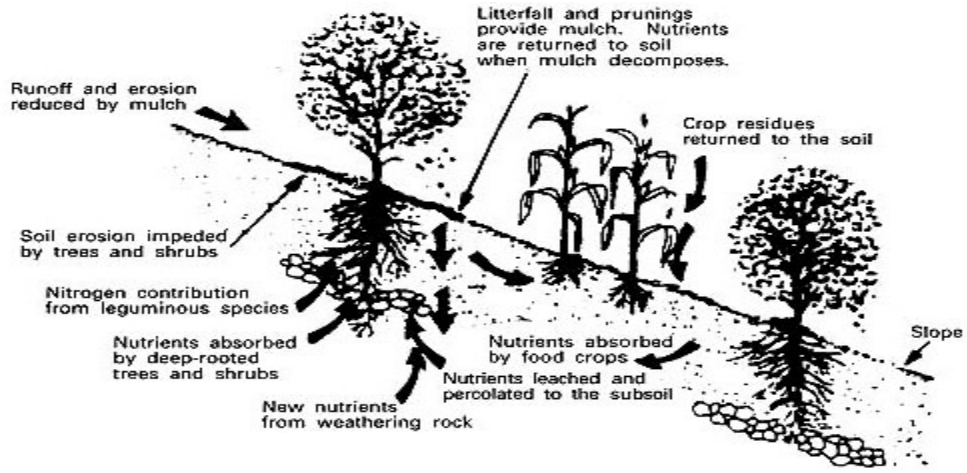


Fig. 1.13 Alley cropping

5. Wind breaks or shelter belts

- The trees are planted in long rows along the boundary of cultivated lands, which block the wind and reduce soil erosion.
- Wind breaks help in retaining soil moisture, supply of some wood for fuel and provide habitats for birds.

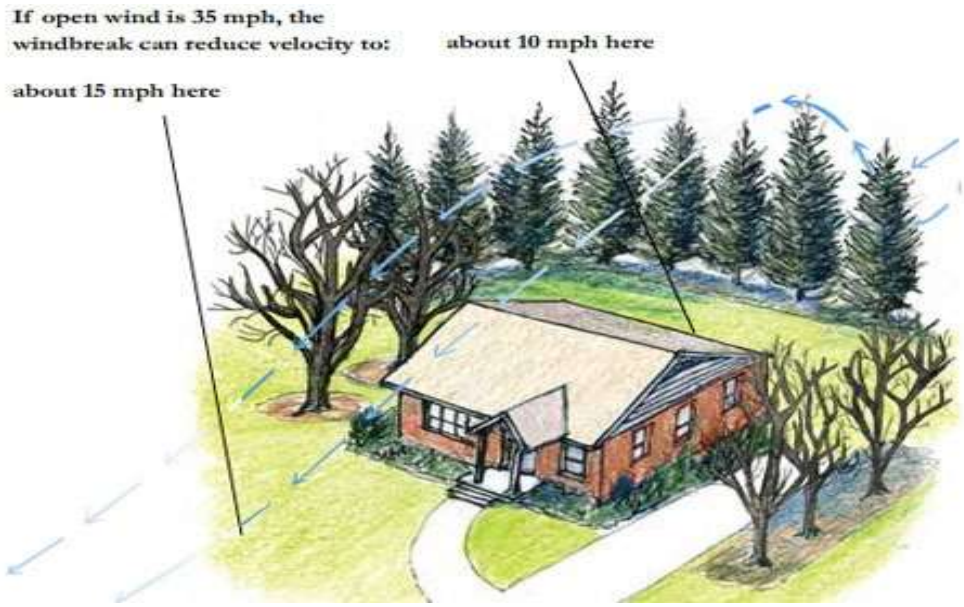


Fig.1.14 Wind break

1.9.5. DESERTIFICATION

- Progressive destruction or degradation of arid or semiarid lands to desert.
- Desertification leads to the conversion of range lands or irrigated croplands to desert.

- Desertification is characterized by de-vegetation, depletion of ground water, salination and soil erosion.

Causes of Desertification

(a)Deforestation

- The process of denuding and degrading a forest land initiates a desert.
- If there is no vegetation to hold back the rain water, soil cannot soak and groundwater level do not increases.
- This also increases, soil erosion, loss of fertility.

(b)Over grazing

- The increase in cattle population heavily grazes the grass land or forests and as a result denudes the land area.
- The denuded land becomes dry, loose and more prone to soil erosion and leads to desert.

(c)Water management

- ✓ Over utilization of ground water, particularly in the coastal regions, is resulting in saline water intrusion into aquifers which is unfit for irrigation.

(d)Mining and quarrying

- ✓ These activities are also responsible for loss of vegetal cover and denudation of extensive land area leading to desertification.

(e)Climate change

- ✓ Formation of deserts may also take place due to climate change, i.e., failure of monsoon, frequent droughts.

(f)Pollution

- ✓ Excessive use of fertilizers and pesticides and disposal of toxic water into the land also leads to desertification.

Harmful effect of desertification

- Changes in temperature
- Changes in rain fall and wind velocity
- Increased soil erosion

1.10 ROLE OF AN INDIVIDUAL IN CONSERVATION OF NATURAL RESOURCES

Different natural resources like forests, water, soil, food, mineral and energy resources play a vital role in the development of a nation. While conservation efforts are underway at National as well as International level, the individual efforts for conservation of natural resources can go a long way.

I. Conserve Water

- Don't keep water taps running while brushing, shaving, washing or bathing.
- Check for water leaks in pipes and toilets and repair them promptly. A small pin-hole sized leak will lead to the wastage of 640 litres of water in a month.
- Use drip irrigation and sprinkling irrigation to improve irrigation efficiency and reduce evaporation.
- Install a small system to capture rain water and collect normally wasted used water from sinks, cloth-washers, bathtubs etc. which can be used for watering the plants

II. Conserve energy

- Turn off lights, fans and other appliances when not in use.
- Obtain as much heat as possible from natural sources. Dry the clothes in sun instead of drier if it is a sunny day.
- Use solar cooker for cooking your food on sunny days which will be more nutritious and will cut down on your LPG expenses.
- Grow deciduous trees and climbers at proper places outside your home to cut off intense heat of summers and get a cool breeze and shade. This will cut off your electricity charges on coolers and air-conditioners.
- Try riding bicycle or just walk down small distances instead of using your car or scooter.

III. Protect the soil

- While constructing your house, don't uproot the trees as far as possible. Plant the disturbed areas with a fast growing native ground cover.
- Make compost from your kitchen waste and use it for your kitchen-garden or flower-pots.

- Do not irrigate the plants using a strong flow of water, as it would wash off the soil.
- If you own agricultural fields, do not over-irrigate your fields without proper drainage to prevent water logging and salinization.
- Use mixed cropping so that some specific soil nutrients do not get depleted.

IV. Promote Sustainable Agriculture

- Do not waste food. Take as much as you can eat
- Reduce the use of pesticides.
- Fertilize your crop primarily with organic fertilizers.
- Eat local and seasonal vegetables. This saves lot of energy on transport, storage and preservation.
- Control pests by a combination of cultivation and biological control methods**.**

NATURAL RESOURCES – QUESTION BANK

Part – A

1. What are renewable resources? Give examples.

These resources are capable of being regenerated by ecological process within a reasonable time period. They have the potential to renew themselves.

Ex, Soil, water, air, wildlife, natural vegetation.

2. Mention same important causes of over exploitation.

Over exploitations of forest wealth in developing countries occurs in the following ways,

(a) Increasing agricultural production.

(b) Increasing industrial activities.

3. What are the preventive measures of deforestation?

1) Steps should be taken by the government to discourage the migration of people into the islands from mainland.

- To counter the depletion of forest areas, tree plantation programs have been started.
- Education and awareness programmes must be conducted.
- Strict implementation of law of Forest Conservation Act.

4. Define sustainable forestry.

Sustainable forestry is the optimum use of forest resources, which meets the needs of present without compromising the ability of future generations to meet their own needs.

5. What are the causes of deforestation?

1. Developmental projects.
2. Mining operations.
3. Raw-materials for industries.
4. Fuel requirements.
5. Shifting cultivation.

6. Forest fires.

6. What are the consequences of timber extraction?

1. Large scale timber extraction causes deforestation.

2. Timber extraction leads to soil erosion, loss of fertility, landslides and loss of biodiversity.

3. Timber extraction also leads to loss of tribal culture and extinction of tribal people.

4. Timber extraction reduces thickness of the forest.

7. State the problems caused by the construction of Dam.

(a) Displacement of tribal people.

(b) Loss of non-forest land.

(c) Loss of forests, flora and fauna.

(d) Landslips, sedimentation and siltation occur.

(e) Stagnation and water logging around reservoirs retards plant growth.

(f) Breeding of vectors and spread of vector-borne diseases.

(g) Reservoir induced seismicity (RIC) causes earthquakes.

(h) Navigation and aquaculture activities can be developed in the dam area.

8. What are the effects of dams on tribal?

1. Due to continuous removal of minerals, forest cover, the trenches are formed on the ground, leading to water logged area, which in turn contaminates the ground water.

2. During mining operations, the vibrations are developed, which leads to earthquake.

3. When materials are disturbed in significant quantities during mining process, large quantities of sediments are transported by water erosion.

9. Compare merits and problems of dams.

Merits of dams:

(i) Dams are built to control flood and store flood water.

(ii) Sometimes dams are used for diverting part or all of the water from river into a channel.

(iii) Dams are used mainly for drinking and agricultural purposes.

(iv) Dams are built for generating electricity.

Problems of dams:

(i) Displacement of tribal people.

(ii) Loss of non-forest land.

(iii) Loss of forests, flora

(iv) Reduced water flow and silt deposition in river

(v) Salt water intrusion at river mouth

10. What are renewable and non-renewable energy resources?

Renewable energy resources are natural resources which can be regenerated continuously and are inexhaustible. They can be used again and again in an endless manner.

Examples,

Renewable energy resources: wood, solar energy, wind energy.

Non-renewable energy resources: coal, petroleum.

11. What are the objectives of alternate energy sources?

(a) To provide more energy to meet the requirements of increasing population.

(b) To reduce environmental pollution and

(c) To reduce safety and security risks associated with the use of nuclear energy.

12. Differentiate renewable and non-renewable sources of energy.

Renewable energy	Non-renewable energy
1. It is regenerated continuously.	Cannot be regenerated.
2. In-exhaustible.	Exhaustible
3. It can be used again and again.	Cannot be used again.
4. It is pollution free	It pollutes the atmosphere.
5. Available limited amount in nature.	Available in unlimited amount in nature.
6. It is developed in a long period.	It is developed in a short period.

13. What are the conventional sources of energy for the mankind?

Non-renewable energy resources are natural resources, which cannot be regenerated once they are exhausted. They cannot be used again.

14. State the use of bio-energy as a non-conventional source of energy?

1. The cost of obtaining bio-energy through bio-gas plant is less than the cost of obtaining energy from fossil fuels.

2. Biomass consumes more CO_2 than is released during combustion of biomass.

3. It provides a stored form of energy and in many cases in a form suitable for vehicle propulsion.

15. What is geothermal energy?

The energy harnessed form the high temperature present inside the earth is called geothermal energy.

16. Mention the factors causing soil erosion.

1. Water

2. Wind

3. Biotic agents

4. Landslides

5. Construction

17. What is desertification? Give any two reasons for it.

It is a progressive destruction of arid or semi arid lands to desert.

Reason:

1. Deforestation.

2. Overgrazing.

3. Water management.

4. Mining and quarrying.

5. Pollution.

Question Bank Part – B

1. What is deforestation? What are the causes of deforestation? Explain their impact on the environment.

2. Discuss the benefits and problems of dams

3. Explain the Effects of over utilization of water.

4. What is renewable energy? Write a brief note on any two renewable energy sources.

5. What is land degradation? Explain the factors responsible for land degradation

6. Discuss the role of individual in the conservation of natural resources.

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UNIT II

ENVIRONMENTAL POLLUTION

2.1 INTRODUCTION

"Pollution is defined as the process of discharging unwanted matters into the environment which causes harmful effects on living beings and damage to materials".

The quality of the environment (air, water, soil) is affected due to the presence of pollutants. Pollutants is any substance present in the environment which can cause harmful effects to living organisms and materials.

2.2 AIR POLLUTION

"Any change in physical, chemical and biological characteristics of atmosphere due to the introduction of undesirable solid or gaseous particles which are harmful to human health and the environment is known as air pollution".

2.2.1 CLASSIFICATION

Air pollutants are generally grouped into the following two types

1. Gaseous pollutants
2. Particulate pollutants

(i) Gaseous pollutants

a) Carbon di oxide (CO_2)

Sources/Causes: Automobile exhaust, burning of fuels, Deforestation, Decay of Organic matter

Characteristics: Colourless, odourless and tasteless gas

Effects/Impacts:

- ✓ Global warming
- ✓ Breathing discomfort

b) Carbon monoxide (CO)

Sources/Causes: Incomplete combustion of fossil fuels, Cigarette smoking, Coal mines

Characteristics: Colourless, odourless and highly toxic gas

Effects/Impacts:

- ✓ Reduces the oxygen carrying capacity by forming carboxyhaemoglobin.
- ✓ Weakens(impairs) perception and thinking,

- ✓ Cause headache, drowsiness, dizziness and nausea.
- ✓ Chronic exposure can trigger and aggravate lung diseases (asthma and emphysema).

c) Oxides of Sulphur (SOx)

Sources/Causes: Burning of fossil fuels, roasting of sulphide ores, Sulphuric acid Plants Oil refineries

Characteristics: Colourless, pungent smelling gas

Effects/Impacts:

- ✓ Irritates respiratory tissues.
- ✓ Cause chlorosis (loss of chlorophyll)
- ✓ Corrosion of metals
- ✓ Results acid rain.
- ✓ Damages soil, plant and aquatic life.

d) Oxides of Nitrogen (NOx)

Sources/Causes: 1.Nitric acid plants 2.Thermal power plants 3.Explosive and fertilizer industries

Characteristics: Reddish brown irritating gas

Effects/Impacts:

- ✓ Lung irritation & damage
- ✓ Results acid rain.
- ✓ Leads to smog & reduces visibility
- ✓ Causes premature leaf fall.

e) Chloro fluoro carbons (CFC)

Sources/Causes: Refrigerators, Air conditioning systems

Characteristics: Reactive towards ozone

Effects/Impacts: Ozone depletion

f) Hydrocarbons

Sources/Causes: Petroleum and organic chemical industries

Characteristics: Foul smelling & reactive gas

Effects/Impacts:

- ✓ Cause mutations, reproductive problems or cancer.

- ✓ Photochemical smog (coughing, chest pain, breathlessness and irritation of the eye, nose and the throat).

(ii) Particulates

Sources/Causes: Dust from mines, Ceramic industries, Smoke due to incomplete combustion of fuels, Photochemical smog due to unburnt hydrocarbons Supersonic emissions

Effects/Impacts:

- ✓ Spoils exterior finish of materials
- ✓ Irritation to nose and lungs (asthma)
- ✓ Affects visibility of roads
- ✓ Damages plants

2.3 CONTROL MEASURES OF AIR POLLUTION

Removing particulate from stack exhaust gases by employing electrostatic precipitators, Bag-house filters, cyclone separators, scrubbers etc.

- ✓ Vehicular pollution can be checked by regular tune-up of engines; replacement of more polluting old vehicles; installing catalytic converters; by engine modification to have fuel efficient (lean) mixtures to reduce CO and hydrocarbon emissions; and slow and cooler burning of fuels to reduce NOx emission (Honda Technology).
- ✓ Using mass transport system, bicycles etc. Shifting to less polluting fuels (hydrogen gas). Using non-conventional sources of energy.
- ✓ Using biological filters and bio-scrubbers.
- ✓ Planting more trees,
- ✓ Industries should be located in places so as to minimize the effects of pollution after considering the topography and the wind directions.
- ✓ Providing a greater height to the stacks can help in facilitating the discharge of pollutants as far away from the ground as possible.
- ✓ Providing a greater height to the stacks can help in facilitating the discharge of pollutants as far away from the ground as possible.
- ✓ Substitution of raw material that causes more Green House Effect
- ✓ Chimneys of factories should be fitted with proper filters to prevent smokes from coming out and effect atmosphere.

2.3.1 TYPES OF DUST COLLECTOR

1. Cyclonic separator
2. Bag house filters
3. Electrostatic precipitators
4. Wet scrubbers

Cyclonic separator:

This is a method of removing particulates from an air, gas or water stream, without the use of filters, through vortex separation.

Rotational effects and gravity are used to separate mixtures of solids and fluids.

Cyclone: A high speed rotating (air) flow is established within a cylindrical or conical container. The inlet gas enters the chamber tangentially, swirls through the chamber in a corkscrew motion, and exits.

Due to the centrifugal force, the particle strikes the wall of the cylinder then fall in the hopper due to gravity. This is efficient for large particles.

Smaller particles which pose problems to human health are removed by this method. This can be employed before the use of other costly devices.

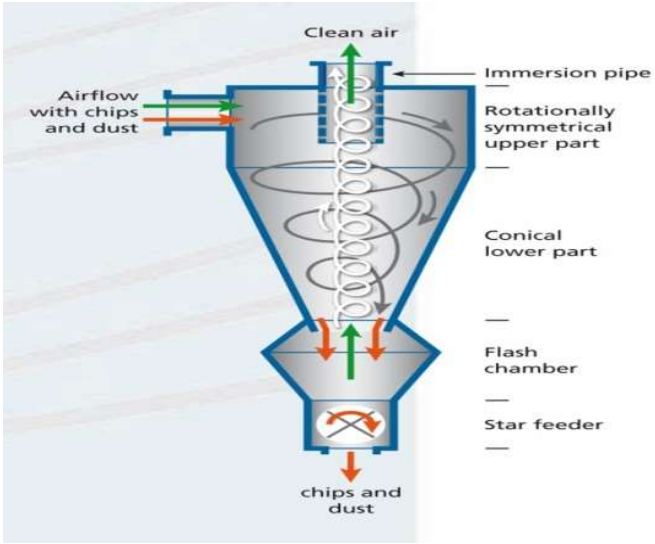

Fig.2.1 Cyclonic separator

Bag House filters:

Fabric dust collectors are commonly known as bag houses and for some applications are one of the most efficient and cost effective dust collector models.

In bag house collectors, the dust filled air stream passes through fabric bags that filter the dust particles.

Bags are made of different material such as woven or felted cotton, synthetic, or glass-fibre.

The device is efficient for removing small particles and preferred in various industries.

It is expensive and cannot be operated for moist gases. Corrosive gases can damages the materials of the bag.

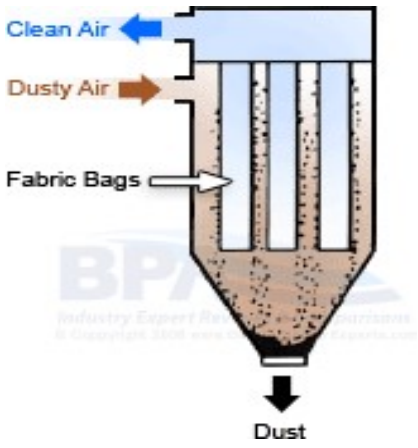

Fig.2.2 Bag house filter

Electrostatic precipitation

The removal of particulate matter from gas streams is an essential step for air pollution control. The best equipment is the *Electrostatic Precipitator*. Electrostatic precipitator is based on the principle that aerosol particles acquire charge when subjected to an electrostatic field.

The particles acquire a charge when a gas stream is led through a high voltage (30,000–100,000 volts) DC (direct current)—corona (electrical discharge under high voltage). The charged particles are attracted to a grounded surface from which they are recovered.

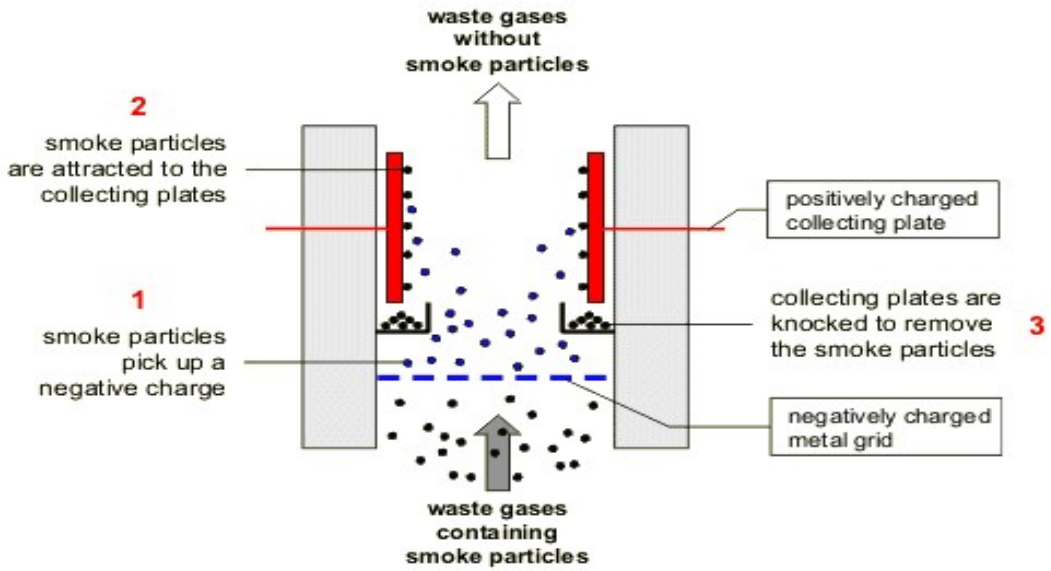

Fig.2.3 Electrostatic precipitator

Wet Scrubbers

Wet precipitation is the basic principle of wet scrubbers in which particles in the atmosphere are removed by nature.

The basic functions of these are to make contact between the particulates and the scrubbing liquid, usually water.

The major types of wet scrubbers are

(i) Spray towers

(ii) Centrifugal scrubbers

(iii) Venturi scrubbers and

(iv) Packed bed columns

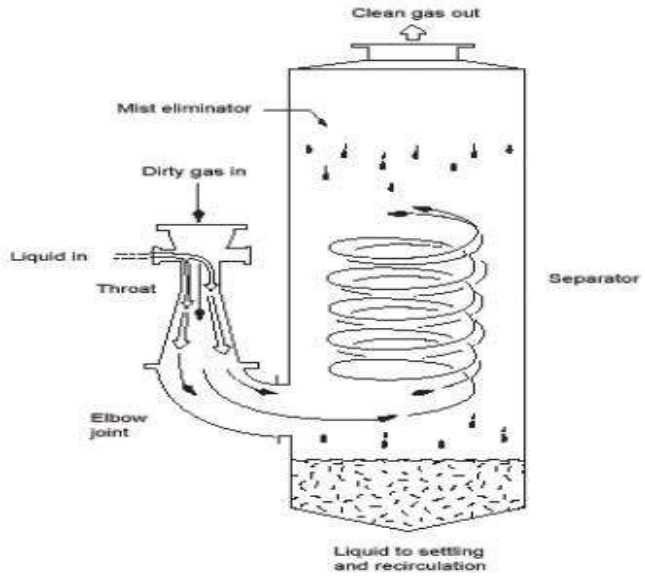

Fig.2.4 Wet Scrubber

2.4 CHEMICAL AND PHOTOCHEMICAL REACTIONS IN THE ATMOSPHERE

2.4.1 PHOTOCHEMICAL SMOG

Sources:

- ✓ Exhaust gases From Motor vehicles
- ✓ Unburnt Hydrocarbons
- ✓ Volatile Organic Compounds (VOC) (Paint thinners, solvents and petroleum constituents , Methane from termites, cows and cultivation)

It is a secondary pollutant which is obtained by the interaction of unburnt hydrocarbon and oxides of nitrogen in presence of sunlight.

$$\text{VOCs} + NO_x + \text{heat} + \text{sunlight} \rightarrow \begin{array}{l}\text{ground level ozone } (O_3)\\ + \text{other photochemical}\\ \text{oxidants}\\ + \text{aldehydes}\\ + \text{other secondary}\\ \text{pollutants}\end{array}$$

When exposed to ultraviolet radiation from the sun, some of the NO_2 reacts in complex ways with VOCs (volatile organic compounds) released by certain trees (such as some oak species, sweet gums, and poplars), motor vehicles, and businesses (such as bakeries and dry cleaners). The resulting mixture of pollutants, dominated by ground-level ozone.

Source	Necessary conditions	Reactions take place in atmosphere	Products
Primarily automobiles	volatile organic compounds (VOC) present	VOC + O* or O_3 → highly reactive organic radicals + NO_2 → Peroxyacetyl nitrates; Aldehydes	
Primarily automobiles	Nitrogen monoxide (NO) present	NO + organic radicals → NO_2	
From automobiles and formed from NO	Nitrogen dioxide (NO_2) present	O* + O_2 → O_3 (ozone); NO_2 → NO + O* (atomic oxygen); sunlight	Ozone
Sun	Sunlight		
Sun (summer temperatures)	Heat	Reactions take place more rapidly at higher temperatures.	

Table 2.1

Effects:-

- ✓ Asthma and chronic bronchitis
- ✓ Eye irritation and reduced resistance to cold and lung infections.
- ✓ Reduced visibility
- ✓ Causes chlorosis (loss of chlorophyll)
- ✓ Corrosion of metals
- ✓ Causes premature leaf fall.

Mitigation Measures for Photochemical Smog

- ✓ Catalytic converters-: Smog formation could be reduced by installing efficient catalytic converters in automobiles.
- ✓ Free radical traps-: The compound diethyl hydroxylamine, $(C_2H_5)_2NOH$ which readily combine with free radical initiators of photochemical smog (such as O., R., RO., H. etc.) will slow down the conversion of NO to NO_2
- ✓ Alternative energy sources-: Hybrid cars, hydrogen fuelled cars and cars run on different types of biodiesel may be viable methods of cutting down on vehicular exhaust emissions.

2.4.2 PAN –PEROXY ACETYL NITRATE

"Peroxyacetyl nitrate is a peroxyacyl nitrate. It is a secondary pollutant present in photochemical smog. It is thermally unstable and decomposes into peroxyethanoyl radicals and nitrogen dioxide gas. It is a lachrymatory substance".

It is also a Photochemical Smog. They are the secondary pollutants formed from per oxyacid radicals and NO_2.

The oxidation of aldehydes by hydroxyl radical proceeds by abstraction; for example, acetaldehyde reacts with hydroxyl radical and then oxygen addition to form the Peroxyacetyl radical ($CH_3CO\text{-}OO$)

$$CH_3CHO + OH^{\bullet} \rightarrow CH_3CO^{\bullet} + H_2O$$

$$CH_3CO^{\bullet} + O_2 \rightarrow CH_3C(O)OO^{\bullet} \text{ (acetylperoxy)}$$

The peroxyacetyl radical react with nitrogen dioxide to form a reasonably stable compound peroxyacetyl nitrate:

$$CH_3C(O)OO^{\bullet} + {}^{\bullet}NO_2 \rightarrow CH_3C(O)OONO_2$$

(PAN)

Sources

1. It comes from the degradation of isoprene, hydrocarbon, and acylation.
2. Blended gasoline with ethanol.

Environmental effects

1. Damages plant
2. React explosively
3. Plays a very large role in photochemical smog.

2.4.3 ACID RAIN

Sources/Causes: CO_2 –fossil fuels

NO_2--Thermal power plants, Explosive and fertilizer industries

SO_2 --Sulphuric acid Plants & Oil refineries

Formation of Acid Rain

When these gases (NOx and SOx) react with water vapour in the atmosphere, they form acids and descend on Earth as "acid rain" through rain water.

$$SO_2 + 1/2O_2 + H_2O \longrightarrow H_2SO_4$$

$$NO_2 + H_2O \longrightarrow HNO_3$$

Effects of Acid Rain

- ✓ Affects aquatic life
- ✓ Tree leaves and plantations are damaged
- ✓ Human nervous system, respiratory system and digestive system are affected.
- ✓ Causes irritation to mucus membrane and eyes.
- ✓ Corrosion of metals
- ✓ Damages monuments, statues, bridges and fences.
- ✓ Many forms of bacteria and earth warms were killed up.

2.4.4 OZONE DEPLETION

Ozone is earth's protective umbrella (filters harmful UV radiation from the Sun and protects life on Earth. It is 24 km thickness in the stratosphere

Its concentration in stratosphere is 10ppm.

Causes/Sources: *Chloro Fluoro Carbons* (**CFC**s) refrigerants and coolants

NO—supersonic emissions

Methyl bromide --Fumigant etc. destroy ozone in the stratosphere.

Halon- Fire extinguisher.

- ➢ These chemicals absorb UV radiation and break down to release a free chlorine atom.
- ➢ The free chlorine atom reacts with an ozone (O_3), forms chlorine monoxide (ClO) and a molecule of oxygen.
- ➢ The free chlorine molecule again reacts with ozone to form chlorine .
- ➢ The process continues, and this results in the depletion of the ozone layer.

$$Cl + O_3 \longrightarrow ClO + O_2$$

$$ClO + O \longrightarrow Cl + O_2$$

Hence, net effect:

$$O_3 + O \longrightarrow 2O_2$$

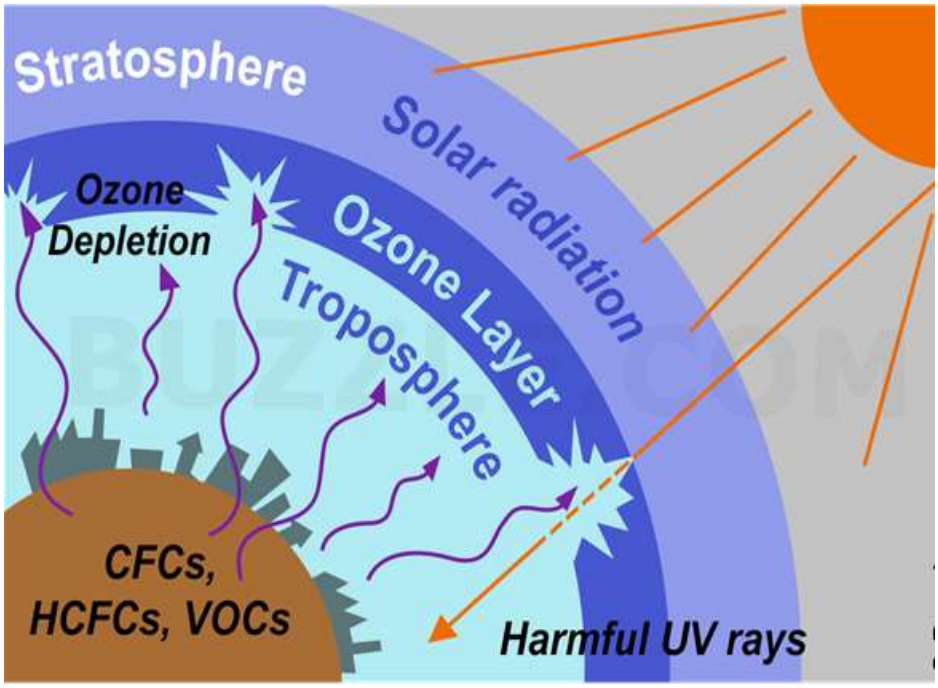

Fig. 2.5 OZONE LAYER DEPLETION

Effects of ozone layer depletion on human health

- ✓ Reddening of skin in sun shine (sun burn) cause skin cancer.
- ✓ Reduces the effectiveness of the immune system.
- ✓ Accelerates aging of skin due to high exposure.
- ✓ Eye disorders like cataracts and blindness.
- ✓ Ozone chemicals can cause difficulty in breathing, chest pain, throat irritation and hamper lung functioning.

Other living organisms

- ✓ It alters the shape and damage the plant growth.
- ✓ Changes flowering time.
- ✓ Some plants are more vulnerable to disease and produce toxic substances. There could even be losses of biodiversity and species.
- ✓ Hampers growth and development in larvae.
- ✓ Changes behaviour and habits.
- ✓ Causes deformities in some species.
- ✓ Retinal damage and blindness in some species.

Control of Ozone depletion

- ✓ Replace Halon-based fire extinguishers with others using foam.

- ✓ Avoid using ozone depleting agents.
- ✓ Dispose old refrigerators, air conditioners and freezers which used CFCs.
- ✓ Do not use cleaning solvents containing CFCs or ammonia.
- ✓ Avoid purchasing aerosol products containing CFCs.
- ✓ Buy wood products not treated with methyl bromide.

2.5 NOISE POLLUTION

"The unpleasant, unwanted and disagreeable sound that causes discomfort to all living beings is called noise pollution".

The unit of measurement of sound is called decibel. This is one tenth of the unit Bel.

- ✓ 1db is equal to the faintest sound, a human ear can hear.
- ✓ 20 dB is whisper, 40 dB is quiet office, and 60 dB is normal conversation.
- ✓ 80 dB is the level at which sound becomes physically painful. And can be termed as noise.
- ✓ 100 dB is train, 140 dB loud thunder, 150 dB airport &190 dB rocket engine

2.5.1 SOURCES OF NOISE POLLUTION

- ***Transportation activities*** - Automobiles, Air Crafts, Noise from railroads
- ***Construction Noise*** -construction of highways, city streets, and buildings which include pneumatic hammers, air compressors, bulldozers, loaders, dump trucks and pavement breakers.
- ***Domestic activities*** - household equipment's, such as vacuum cleaners, mixers and some kitchen appliances
- ***Industrial activities***- Pneumatic industries, textile, steel, saw mills etc.
- ***Loud Speakers / Public Address Systems*** - loud speakers / public address systems in functions, meetings, religious places in open areas is a source of serious nuisance.
- ***Firecrackers***- Use of firecrackers with high noise level may harm the human hearing system.

2.5.2 EFFECTS OF NOISE POLLUTION

- ➢ **Annoyance:** Noise above 80 dB may increase aggressive behaviour. It creates annoyance to the receptors due to sound level fluctuations, causes displeasure to hearing and causes annoyance.

- **Physiological effects:** The physiological features like breathing amplitude, blood pressure, heart-beat rate, pulse rate, blood cholesterol are effected. Sudden noise causes abortion in females.
- **Loss of hearing:** Exposure to sound levels
- ✓ less than 70 dB does not produce hearing damage
- ✓ more than 8 hours to sound levels in excess of 85 dB is potentially hazardous
- ✓ The threshold for pain is usually given as 140 dB (boom-cars, gunfire) and should never exceed 140 dB in adults and 120 dB in children.
- ✓ Levels greater than 165 dB, causes acute cochlear damage.
- Long exposure to high sound levels (80 to 100 dB) cause loss of hearing. This is mostly unnoticed, but has an adverse impact on hearing function.
- **Human performance:** The noise of traffic or the loud speakers of different types of horns divert the attention and affect performance of the people, for example in reading, attentiveness, problem solving etc. Lack in concentration can lead to accidents.
- **Nervous system:** Noise can trigger nervous system responses that affect the cardiovascular system and can lead to hypertension, stroke, heart failure, and immune problems. Also it causes pain, ringing in the ears, feeling of tiredness, thereby effecting the functioning of human system.
- **Sleeplessness:** It affects the sleeping there by inducing the people to become restless and lose concentration and presence of mind during their activities.
- **Damage to material:** The buildings and materials may get damaged by exposure to infrasonic / ultrasonic waves even get collapsed.

2.5.3 NOISE MITIGATION PROCEDURES

"Noise mitigation is a set of strategies to reduce noise pollution."

- Construction of sound proof rooms for noisy machines in industries.
- Use of horns with jarring sounds should be banned. No motor vehicle should be fitted with multi-functioned horn giving a succession of different note or with any other sound producing device giving an unduly harsh, shrill, loud or alarming noise on other similar vehicles of such sound signals.
- Every motor vehicle shall be fitted with a device (silencer).
- Noise producing industries, aerodromes, and railway stations should be shifted away from the inhabited areas.

- Proper law should be enforced to check the misuse of loudspeakers and public announcements systems. Loud speakers should be banned from 10pm to 6am.
- Growing green plants/trees along roadside to reduce noise pollution as they absorb sound.
- To avoid noise-induced hearing loss, pay attention to the noises around you and turn down the volume whenever possible.
- Avoid or limit time spent in noisy sports events.
- Wear adequate hearing protection, such as foam ear plugs or ear muffs, when you must be in a noisy environment or when using loud equipment.
- We must constantly check up on the appliances we use at home. Most of them have rubber insulations that act for soundproofing. But over time, this insulation may wear out, and that is when the noise pollution will begin. Keep track of which appliances need maintenance, and replace insulations if needed
- Noise is also made by the escape of exhaust gases from the engine, therefore every motor vehicle should be so constructed and maintained as not to cause undue noise when in motion.
- Industries and airports must be far away from the schools, colleges, hospitals and residential places.

2.6 CONTROL OF PARTICULATE AND GASEOUS EMISSION

(Control of SO_2, NOx, CO and HC)

2.6.1 CONTROL OF SOX

SOx includes six different gaseous compounds namely, SO- Sulphur monoxide, SO_2- Sulphur dioxide, SO_3- Sulphur trioxide, SO_4 – Sulphur Tetroxide, S_2O_5 – Sulphur Sesquioxide, S_2O_6 – Sulphur Heptoxide SOx Emissions are most significant.

There are six procedures for controlling of SOx emissions.

1. Natural dispersion of dilution
2. Using Alternate fuels.
3. Removal of Sulphur by desulphurization.
4. Control of SOx in the combustion process.
5. Treatment of flue gas by Dry methods and Wet Methods .

2.6.2 CONTROL OF NOX

1. Modify combustion to syppress NOx formation:
    - Low excess air operation.
    - Off-stoichiometric combustion.
    - Flue gas recirculation.

- Natural gas reburning

2. Reduce NOx to molecular nitrogen through controls (also known as flue gas treatment)
    - Selective Non-Catalytic Reduction (SNCR)
    - Selective Catalytic Reduction (SCR)
    - Dry Sorption NOx control Techniques .

2.6.3 CONTROL OF CO

Capture Technologies:

1. Post-Combustion Scrubbing : This is considered as the first step towards large-scale capture, CO_2 is removed from exhaust gas after combustion. This technology can be retrofitted to existing equipment.
2. Pre-Combusiton Decarbonization (Hydrogen) Natural Gas is converted to hydrogen and CO_2 in a reformer. The CO_2 is compressed for storage and the hydrogen is mixed with air for combustion, emitting only nitrogen and water.
3. Oxyfuel Oxygen is separated from air and then burned with hydrocarbons to produce an exhaust with a high concentration of CO_2 for storage.

Solvent Absorption:

CO_2 is soluble in some solvents, notably entanolamines.

e.g., monoethanolamine (MEA).

Absorption proceeds at low temperatures, whereas desorption occurs at elevated temperatures.

Membrane Separation:

Gas separation by membranes relies on the different permeation rates of gases through the membrane pores. Typical membrane examples: polysulfone/silicon, cellulose acetate, polyphenylneoxide, polyalkene, polyimide, polydimethylsiloxane, and polytherimide. In the membrane separation method CO_2 is captured from a mixture of CO_2 and H_2, which is the product of coal gasification and the water shift reaction.

2.6.4 CONTROL OF HYDROCARBON (HC)

Control of hydrocarbons can be generally accomplished by adsorption,

Incineration, condensation and gas absorption.

The methodology is usually chosen depending upon the temperature, composition and volumetric flow rate of emission stream, space constraints and allowable installation and operational costs.

Adsorption: This method can be done by either physical adsorption or chemical adsorption. The physical adsorption involves weak vanderwaals force, giving the advantage of reversibility and regeneration due to the weaker bonding of the gas and adsorbent material.

Incineration : Complete combustion or oxidation of pure hydrocarbons produces carbon dioxide and water.

Condensation: It employs a drop in temperature and /or increase in pressure to cause the VOCs and HCs in the emission stream to condense. The cleaned air stream is separated from the condensate containing a target pollutants.

Gas Absorption: It involves the adsorption of gas into a liquid. Water can be used for recovery of water – soluble compounds such as acetone and low molecular weight alcohols, which can later be separated from water using distillation.

Catalytic converters should be used to help control emissions of carbon monoxide and hydrocarbons.

Membrane separation as described in CO control measure could be used to control hydrocarbon.

2.7 WATER POLLUTION

"Any change in physical ,chemical and biological characteristics of water which causes harmful effects on humans or other living systems is known as Water pollution."

2.7.1 SOURCES OF WATER POLLUTION

1. Point sources 2. Non-point sources

1. Point sources: These are pollutants whose specific locations can be known.

(i.e.) These sources are located at specific places, they are fairly easy to identify, monitor, and regulate.

Examples Industries, Power plants,Off shore oil wells, sewage treatment plants, underground mines, and oil tankers.

2. Non-point sources: These are pollutants whose specific locations cannot be known. These sources are scattered, which individually or collectively pollute water

Examples Surface runoff from agricultural field, Over flowing small drains,

Rain water sweeps road and fields

2.7.2 TYPES, SOURCES AND EFFECTS OF WATER POLLUTION

Type/Examples	**Major sources**	**Effects**
Infectious agents (pathogens) Bacteria, viruses, , protozoa, parasites	Sewage, human and animal wastes, natural and urban runoff from land, industrial waste	Cause diseases like typhoid, cholera, diarrhea,Jaundice Depletion of dissolved oxygen in water (foul odour) health effects (outbreaks of water borne diseases)
Oxygen-demanding wastes Biodegradable animal wastes and plant debris	Sewage, animal feedlots, food processing facilities, pulp mills	Deplete dissolved oxygen needed by aquatic species
Plant nutrients Nitrates (NO_3^-) and phosphates (PO_4^{3-})	Agricultural discharges(fertilizers)	excessive growth of algae (eutrophication) & affects aquatic life(low DO) nitrates cause methemoglobenemia
Organic chemicals Oil, gasoline, plastics, pesticides, cleaning solvents	Industry, farms, households	Damages CNS(central nervous system),Causes birth defects and genetic disorder, harmful to aquatic life
Inorganic chemicals Acids, bases, salts, metal compounds	Industry, households, surface runoff	Makes water unfit for drinking Reduces crop yield Causes cancers damages CNS, liver ,Kidney
Sediments Soil, silt	Natural erosion, runoff from agricultural land and construction sites	Disrupt photosynthesis, food webs, other processes Affects water quality, reduces fish population
Heavy metals Lead, mercury, arsenic	Unlined landfills, household chemicals mining refuse, industrial discharges	Cause cancer, disrupt immune and endocrine systems damages CNS, liver ,Kidney
Thermal Heat	Electric power and industrial plants nuclear and thermal plants	Make some species vulnerable to disease Decreases solubility of oxygen in water, disrupts aquatic ecosystems

Radioactive Materials	Natural sources, uranium mining and processing, hospitals and research laboratories using radioisotopes	✓ These generally cause 'Gene' mutation, ionization of body fluids, chromosomnal mutations and cancers. ✓ Destroy body cell tissue, adversely effects reproductive system. ✓ Radioactive metals like heavy metals are nephrotoxic and damage kidneys.
Acids and alkalies	Mine drainage, industrial wastes, natural and urban runoff	Kill fresh water organisms, unfit for drinking, irrigation and industrial use.

Table 2.2

2.8 MARINE POLLUTION:

Marine pollution is defined as "the introduction of substances to the marine environment directly or indirectly by man resulting in adverse effects such as, hazardous effects to human health, obstruction of marine activities and lowering the quality of sea water".

2.8.1 SOURCES OF MARINE POLLUTION:

- Direct discharge of Municipal waste and sewage from residences and hotels in coastal towns into sea.
- Agricultural runoff contains pesticides and fertilizers get collected finally into sea.
- Petroleum and oil washed off from roads normally enter sewage system and finally into seas.
- Ship accidents and accidental spillage at sea can therefore be very damaging to the marine environment.
- Off shore oil exploration also pollute the sea water to a large extent,
- Dry docking: All ships periodic dry docking servicing; cleaning the hulls etc. during this period when cargo compartments are emptied, residual oil goes into sea.
- Pollution due to oil: The contamination of sea water is mainly due to the leakage in oil tankers during transportation, oil production, oil tankers disaster and ship accident.
- Volcanic eruptions in the sea.

2.8.2 EFFECTS OF MARINE POLLUTION:

- Marine pollution directly affects marine organisms and tehen to humans through food chain.
- It causes ecological imbalance in the marine environment.
- Contamination of marine water due to thermal power plants, petroleum refineries and nuclear reactors causes thermal pollution. This alters the quality of water.
- The coastal lands are polluted by agricultural wastes. Polluted coastal water mixes into the ground water and degrade the ground water quality.
- Oil film over the sea water decreases the DO content.
- The continuous oil film inihibits photosynthesis and inhibits the growth of plankton.
- Hydocarbons and benzpyrene accumulate in fish. Consumption of these fishes by man may cause cancer.
- Detergents used to clean up the oil spill are also harmful to marine life.
- Presence of heavy metals in marine water affects the birds through thinning of egg shells and tissue damage egg.

2.8.3 CONTROL MEASURES OF MARINE POLLUTION:

- The coastal waters should be analysed periodically to determine pollution levels.
- Oil present in the marine water should be removed by dispersion or emulsification methods or using chemicals.
- Toxic pollutants from industries and sewage should not be discharged to coastal water.
- Development activities on coastal area should be minimized.
- Local communities must be involved in curbing marine pollution.
- Recreational beaches should be maintained in a neat and tidy manner using latest cleaning techniques and ma power.

Case Study- The Miniamatta Epidemic

Miniamatta is a small coastal village in Japan. The Chisso Chemical Company, which produces vinyl polymer plastics used organomercurial compound. The industry released its effluent into Miniamatta sea. The effluent containing mercury ions is converted into methyl mercury, which is highly toxic.

The marine organisms like phytoplankton and zoo-planktons easily absorb the toxic methyl mercury compound. These organisms are consumed by small fishes and these are inturn consumed

by large fishes. Finally the large fishes are consumed by human beings. Thus the poisonous chemical (methyl mercury) enter into the body of human beings through food chain.

Effect:

It damages the central nervous system, which causes various disorders such as

(a) Loss of vision and hearing.

(b) Loss of muscular co-ordination and severe headache.

(c) Nervous disorders.

2.9 THERMAL POLLUTION

2.9.1 THERMAL POLLUTION - DEFINITION

"Thermal pollution is defined as the addition of excess of undesirable heat to water thereby making it harmful to man, animal or aquatic life."

2.9.2 SOURCES OF THERMAL POLLUTION:

The following sources contribute to thermal pollution.

1. Nuclear power plants 2.Thermal power plants 3.Industrial effluents 4.Domestic sewage 5.Hydro-electric power

1. ***Nuclear power plants:*** Heated effluents from power plants are discharged at 10 C higher than the receiving waters that affects the aquatic flora and fauna.
2. ***Thermal power plants:*** Coal fired power plants the condenser coils are cooled with water from nearby lakes or rivers. The resulting heated water is discharged into streams
3. ***Industrial effluents:*** Industries like textile, paper, pulp and sugar manufacturing release huge amounts of cooling water along with effluents into nearby natural water bodies.
4. ***Domestic Sewage:*** Domestic sewage is discharged into rivers, lakes, canals or streams with minimal treatment or without any treatment. These wastes have a higher organic temperature and organic load.
5. ***Hydro-electric power:*** Generation of hydroelectric power sometimes leads to negative thermal loading in water systems.

2.9.3 EFFECTS OF THERMAL POLLUTION

1. ***Reduction in dissolved oxygen:*** The addition of heat decreases the dissolved content of water resulting in death of fish and other aquatic organisms.
2. ***Increase in toxicity:*** The rising temperature increases the toxicity of the chemicals present in water causes massive mortality to fish.

Eg: A 10°C increase in temperature of water doubles the toxicity effect of potassium cyanide,

3. ***Interference in biological activity:*** Temperature is considered to be of vital significance to physiology, metabolism and biochemical processes that control respiratory rates, digestion, excretion, and overall development of aquatic organisms. Temperature changes cause total disruption to the entire ecosystem.
4. ***Interference in reproduction:*** In fishes, several activities like nest building, spawning, hatching, migration and reproduction depend on optimum temperature.
5. ***Direct mortality:*** Thermal pollution is directly responsible for mortality of aquatic organisms. Increase in temperature of water leads to exhaustion of microorganisms thereby shortening the life span of fish. Above a certain temperature, fish die due to failure of respiratory system and nervous system failure.
6. ***Food storage for fish:*** Abrupt changes in temperature alters the seasonal variation in the type and abundance of lower organisms leading to shortage of right food for fish at the right time.

2.9.4 CONTROL MEASURES FOR THERMAL POLLUTION:

The following methods can be adapted to control high temperature caused by thermal discharges:

1. **Cooling towers**: Temperature of the water can be reduced by taking the water to wet or dry cooling towers
    (i) **Wet cooling tower:** Hot water coming out from the condenser (reactor) is allowed to spray over baffles. Cool air, with high velocity, is passed from sides, which takes away the heat and cools the water.
    (ii) **Dry cooling tower:** Here, hot water is allowed to flow in long spiral pipes. Cool air with the help of a fan is passed over these hot pipes, which cools down hot water. This cool water can be recycled.

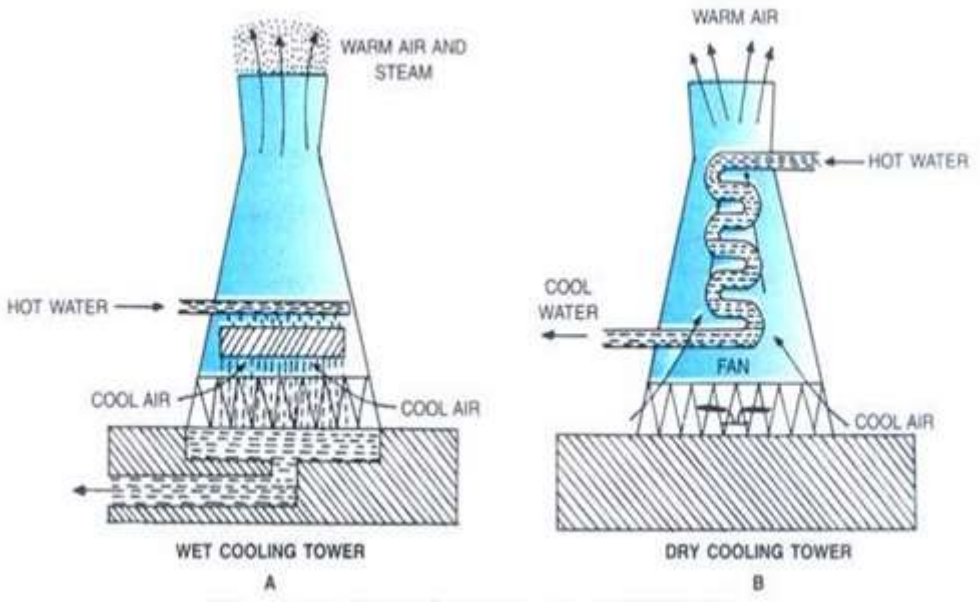

Fig. 2.6 Wet and Dry cooling towers

2. **Cooling ponds:** Discharging the heated water into Cooling ponds ,where the temperature is reduced and the water can reused as cooling water.
3. **Spray ponds**: The water coming out from condensers is allowed to pass into the ponds through sprayers. Here water is sprayed through nozzles as fine droplets. Heat from the fine droplets gets dissipated to the atmosphere.

Fig. 2.7 Spray ponds

4. **Artificial lakes:** Artificial lakes are man made water bodies that offer once-through cooling. The heated effluents can be discharged into the lake at one end and water for cooling purposes may be withdrawn from the other end. The heat is eventually dissipated through evaporation.

Fig 2.8 Artificial lake

2.10 RADIO ACTIVE POLLUTION

2.10.1 RADIOACTIVITY

Radioactivity is the phenomenon of emission of energy from radioactive isotopes (i.e., unstable isotopes), such as Carbon-14, Uranium-235,Radium-226, etc. The emission of energy from radioactive substances in the environment is often called as 'Radioactive Pollution'.

2.10.1 Sources/causes of nuclear hazards

Natural sources (81%) include radon (55%), external (cosmic, terrestrial), and internal (K-40, C-14, etc.)

Man-made sources (19%) include medical (diagnostic x-rays- 11%, nuclear medicine- 4%), consumer products, and other Nuclear power plants , Nuclear accidents , Disposal of Nuclear wastes, use of nuclear weapons. (fallout, power plants, air travel, occupational, etc.)

2.10.2 EFFECTS OF NUCLEAR HAZARDS

All organisms are affected from radiation pollution, and the effects are extremely dangerous. The effects may be somatic (individual exposed is affected) or genetic (future generations) damage. The effects are cancer, shortening of life span and genetic effects or mutations. Some of the possible effects are listed as under:

1) Radiations may break chemical bonds, such as DNA in cells. This affects the genetic make-up and control mechanisms. The effects can be instantaneous, prolonged or delayed types. Even it could be carried to future generations.

2) Exposure at low doses of radiations (100-250 rads), men do not die but begin to suffer from

fatigue, nausea, vomiting and loss of hair. But recovery is possible.
3) Exposure at higher doses (400-500 rads), the bone marrow is affected, blood cells are reduced, natural resistance and fighting capacity against germs is reduced, blood fails to clot, and the irradiated person soon dies of infection and bleeding.
4) Higher irradiation doses (10,000 rads) kill the organisms by damaging the tissues of heart, brain, etc.
5) Workers handling radioactive wastes get slow but continuous irradiation and in course of time develop cancer of different types.
6) Through food chain also, radioactivity effects are experienced by man.
But the most significant effect of radioactivity is that it causes long range effects, affecting the future of man and hence the future of our civilization.

2.10.3 CONTROL OF NUCLEAR HAZARDS (RADIO-ACTIVE POLLUTION)

On one hand, the peaceful uses of radioactive materials are so wide and effective that modern civilization cannot go without them on the other hand, there is no cure for radiation damage. Thus the only option against nuclear hazards is to check and prevent radioactive pollution. For this:
1) Leakages from nuclear reactors, careless handling, transport and use of radioactive fuels, fission products and radioactive isotopes have to be totally stopped.
2) Safety measures should be enforced strictly.
3) Waste disposal must be careful, efficient and effective.
4) There should be regular monitoring and quantitative analysis through frequent sampling in the risk areas.
5) Preventive measures should be followed so that background radiation levels do not exceed the permissible limits.
6) Appropriate steps should be taken against occupational exposure.
7) Safety measures should be strengthened against nuclear accidents.

2.11 CONTROL OF WATER POLLUTION

Process	Applications	Advantages	Disadvantages
Air Flotation	Emulsified Oil, Fats, Grease, Finely Suspended Solids	Breaks mechanical emulsions. Inexpensive. Relatively safe	Volatile emissions. Does not remove dissolved constituents. Does not break chemical emulsions. Requires chemical additives. Froth disposal. Difficult maintenance. High energy cost.
Oil Coalescing	Free and Emulsified Oil	Low maintenance. No mechanical elements. Breaks mechanical emulsions. Enhanced oil removal. No chemical additives. Relatively safe. Easy to operate. Low energy costs.	Does not remove dissolved constituents. Waste oil disposal. Does not break chemical emulsions
Filtration	Free and Emulsified Oil, Suspended Solids	Removes some dissolved contaminants. Relatively safe. Easy to operate. Low energy costs.	Susceptible to fouling. Odors, bacterial growth. High maintenance Backwashing required
Adsorption	Organic compounds, some inorganic compounds	Removes some dissolved contaminants, relatively safe, easy to	Susceptible to fouling odours, bacterial growth, High maintenance

		operate, Low energy costs	Regeneration or disposal required.
Chemical precipitation	Inorganics, Metals	Removal of dissolved constituents. Low maintenance. Metals recovery. Somewhat safe. Low energy costs. Easy to operate.	Volatile emissions. Proper handling and storage of reactants is required. Waste sludge disposal. Selective removal. Requires chemical additives.
Electrolytic Recovery	High-Concentration-Organics, Inorganics, Metals.	Removal of dissolved constituents. Metals recovery. Relatively safe. Easy to operate. No waste sludge	High capital and operating costs. Selective removal. Difficult maintenance. High energy cost. Susceptible to fouling.
Ion Exchange	Low-Concentration Organics, Inorganics, Metals	Removal of dissolved constituents. Metals recovery. Relatively safe. Easy to operate. Water can be reused.	High capital and operating costs. Selective removal. Difficult maintenance. High energy cost Susceptible to fouling.
Reverse Osmosis	Low-Concentration Organics, Inorganics. Metals	Removal of dissolved constituents. Metals recovery. Relatively safe. Easy to operate. Water can be reused.	High capital and operating costs. Selective removal. Difficult maintenance. High energy cost. Susceptible to fouling.
Chemical Oxidation/ Reduction	High-Concentration Organics, Some Inorganics	Removes dissolved contaminants. High degree of treatment. No waste streams.	High capital and operating costs. Selective removal. Difficult maintenance. Difficult to operate.

Biological process:

Aerobic Processes: Aerobic treatment processes take place in the presence of air and utilize those microorganisms (also called aerobes), which use molecular/free oxygen to assimilate organic impurities i.e. convert them in to carbon dioxide, water and biomass.

Anaerobic Processes: The anaerobic treatment processes take place in the absence of air (molecular/free oxygen) by those microorganisms (also called anaerobes) which do not require air (molecular/free oxygen) to assimilate organic impurities. The final products of organic assimilation in anaerobic treatment are methane and carbon dioxide

Some methods for controlling the water pollution

1. Farmers can reduce the running of fertilizers from their agricultural lands to the nearby water bodies and leaching into aquifers.
2. Over fertilization and improper application of pesticides can be avoided.
3. Soil erosion can be minimized by reforesting critical and important water sheds.
4. Proper treatment must be given to all the effluents from the industries.
5. By preventing ground water contamination.

2.12 WASTE WATER TREATEMENT

The main objective of waste water treatment are

(i) To convert harmful compounds into harmless compounds.

(ii) To eliminate the offensive smell.

(iii) To remove the solid content of the sewage

(iv) To destroy the disease producing microorganisms.

Treatment process

The waste water treatment process involves the following steps.

I. Preliminary Treatment

In this treatment, coarse solids and suspended impurities are removed by passing the waste water through bar and mesh screens.

II. Primary treatment (or) Settling process

In this treatment, greater proportion of the suspended inorganic and organic solids are removed from the liquid sewage by settling. In order to facilitate quick settling coagulants like alum, ferrous sulphate are added. These produce large gelatinous precipitates, which entrap finely divided organic matter and settle rapidly.

$$Al_2(SO_4)_3 + 6\ H_2O \rightarrow 2Al(OH)_3 \downarrow + 3H_2SO_4$$

III. Secondary (or) Biological treatment

In this treatment, biodegradable organic impurities are removed by aerobic bacteria. It removes upto 90% of the oxygen demanding wastes. This is done by trickling filter or activated sludge process.

1.Trickling filter process

Trickling filter is a circular tank and is filled with either coarse or crushed rock. Sewage is sprayed over this bed by means of slowly rotating arms.

When sewage starts percolating downwards, microorganisms present in the sewag grow on the surface of filtering media using organic material of the sewage as food. Afte completion of aerobic oxidation the treated sewage is taken to the settling tank and the sludge is removed. This process removes about 80-85% of BOD.

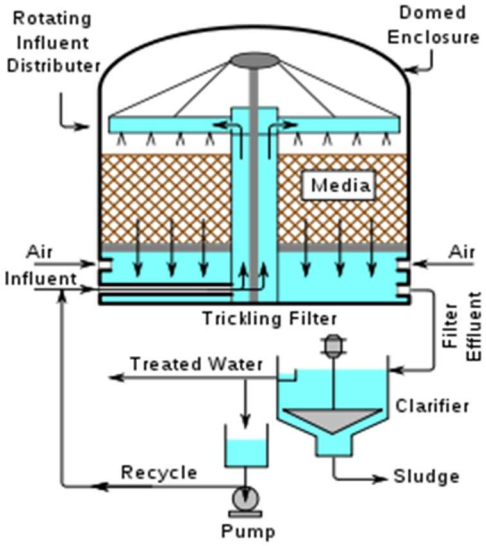

Fig. 2.9 Trickling filter

2. Activated sludge process

Activated sludge is biologically active sewage and it has a large number of aerobic bacterias, which can easily oxidise the organic impurities.

The sewage effluent from primary treatment is mixed with the required amount of activated sludge. Then the mixture is aerated in the aeration fig.2.10. Under these condition, the organic impurities of the sewage get oxidised rapidly by the micro-organisms.

After aeration, the sewage is taken to the sedimentation tank. Sludges settle down in this tank, called activated sludge, a portion of which is used for seeding fresh batch of the sewage. This process removes about 90-95% of BOD.

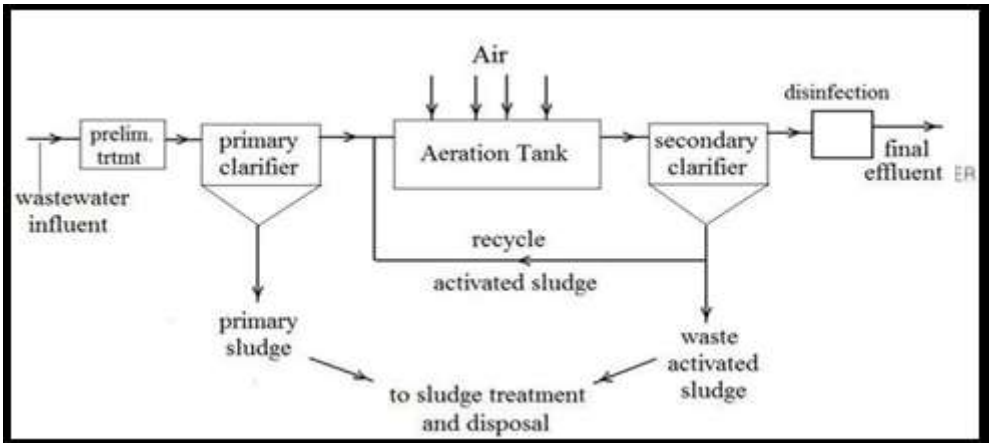

Fig. 2.10.Activated Sludge wastewater treatment flow diagram

Tertiary treatment

After the secondary treatment, the sewage effluent has to lower BOD (25 ppm), which can be removed by the tertiary treatment process.

In the tertiary treatment, the effluent is introduced into a flocculation tank, where lime is added to remove phosphates. From the flocculation tank the effluent is led to ammoia stripping tower, where pH is maintained to 11 and the NH_4^+ is converted to gaseous NH_3. Then the effluent is allowed to pass through activated charcoal column, where minute organic wastes are adsorbed by charcoal. Finally the effluent water is treated with disinfectant (chlorine).

Disposal of sludge

This is the last stage in the sewage treatment. Sludge formed from different steps can be disposed by

(i) Dumping into low-lying areas.

(ii) Burning of sludge (incineration)

(iii) Dumping into the sea

(iv) Using it as low grade fertilizers.

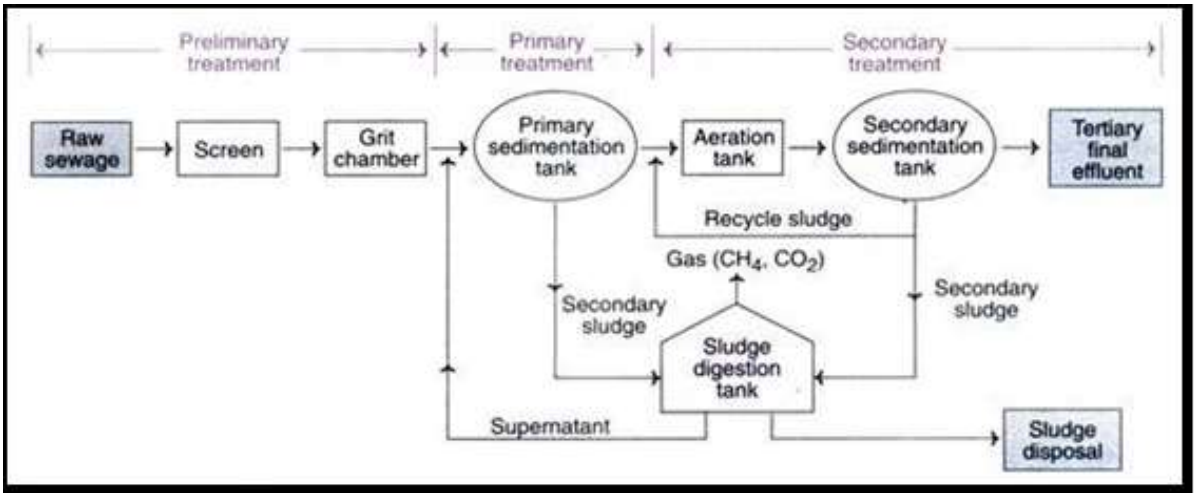

Fig.2.11Flow sheet diagram of waste water treatment

2.13 SOIL POLLUTION

Soil pollution is defined as, ***"contamination of soil by human and natural activities which may cause harmful effect on living organisms".***

2.13.1 Sources & Effects

Soil pollution mainly occurs due to the following:

1.Industrial wastes 2.Urban wastes 3.Agricultural practices 4.Radioactive pollutants 5.Biological agents.

1.Industrial wastes – Disposal of Industrial wastes are the major source of soil pollution

Sources: Industrial pollutants are mainly discharged from various sources such as pulp and paper mills, chemical fertilizers, oil refineries, sugar factories, tanneries, textiles, steel, distilleries, fertilizers, pesticides, coal and mineral mining industries, drugs, glass, cement, petroleum and engineering industries etc.

Effect:

- ✓ These pollutants may alter the chemical and biological properties of soil, results in loss of fertility.
- ✓ Contamination of pesticides may lead to bio magnification which will disturb the biochemical process and finally lead to serious effects on living organisms.
- ✓ **Urban wastes** – Urban wastes comprise of both commercial and domestic wastes consisting of dried sludge and sewage. All the urban solid wastes are commonly referred to as refuse.

Constituents of urban refuse:

This refuse consists of garbage and rubbish materials like plastics, glasses, metallic cans, fibres, paper, rubbers, street sweepings, fuel residues, leaves, containers, abandoned vehicles and other discarded manufactured products.

Urban domestic wastes though disposed off separately from industrial wastes, can still be dangerous. This happens because they are not easily degraded.

3. Agricultural practices

Modern agricultural practices pollute the soil to a large extent. With the advancing agro-technology, huge quantities of fertilizers, pesticides, herbicides and weedicides are added to increase the crop yield.

At the same time the excessive use of it may cause soil contamination and enter into food chain.

4. Radioactive pollutants

Radioactive substances resulting from explosions of nuclear testing laboratories and industries giving rise to nuclear dust radioactive wastes, penetrate the soil and accumulate giving rise to land/soil pollution.

Ex: Radio nuclides such as Strontium 90, Iodine-129 and 131, Cesium-137 and , Barium-140, Cesium-144 and Lanthanum-140 deposited on the soil emit gamma radiations. Strontium get deposited in bones and tissues instead of calcium.

5.Biological agents

Soil gets a large amount of human, animal and bird excreta which constitute a major source of land pollution by biological agents. Which is the breeding source for microorganisms resulting decease breakout.

2.13.2 Control of Soil Pollution

- Preserving the top soil(fertile soil) by planting more trees which avoids soil erosion.
- Understanding the relationship between soil,water and plants and protect the mineral cycles of fixation.
- Effluents should be properly treated before discharging them on the soil.
- Solid wastes should be properly collected and disposed off by appropriate method.
- Use of optimal dose of fertilizers and pesticides.
- Reduce the use of pesticides and fertilizers in agricultural activities
- More plough can improve aeration, porosity and permeability of the soil.

- Biodegradable organic waste should be used for generation of biogas.
- Microbial degradation of biodegradable substances is also one of the scientific approaches for reducing soil pollution
- Make the people aware about the concept of reduce, recycle and reuse
- Avoid buying package items as they will lead to garbage and end up in landfill sites
- Ensure that you do not litter on the ground and do proper disposal of garbage
- Buy biodegradable products
- Do organic gardening and eat organic food that will be grown without the use of pesticides
- Create dumping ground away from the residential area

ENVIRONMENTAL POLLUTION QUESTION BANK

Part A

1.Define pollution

Any undesirable change in the physical, chemical or biological characteristics of the environment (air, water, soil) by the introduction of foreign substance which can cause harmful effects on various forms of life or property

2.Define Air pollution.

Any change in physical ,chemical and biological characteristics of **atmosphere** due to the **introduction of undesirable solid or gaseous particles** which are harmful to human health and the environment is known as air pollution.

3.Classify the sources of Air pollution.

Natural sources: Volcanic activity, vegetation decay, forest fires

Man-made sources: Thermal power plants, Automobiles, Industrial emissions and supersonic emissions.

4. What are primary and secondary pollutants? Give examples.

Primary pollutants :They are ***emitted directly*** from ***identifiable sources*** by natural events and human activities.

Eg:- *CO and CO_2, NO_2, SO_2,volatile organic compounds and suspended particulate matter.*

Secondary pollutants :They are formed by the interaction of primary pollutants with some natural constituents of atmosphere.

Eg:- sulfuric acid, nitric acid, Ozone(O_3), Peroxy acetyl nitrate (PAN) and Smog etc.

5. What are the general causes of air pollution?

Combustion of fossil fuels, Coal burning power plants, Decay of plants

6.Give any four secondary air pollutants.

Acid rain, Ozone(O_3), Peroxy acetyl nitrate (PAN) and Smog

7. What is photochemical smog and how it affects health and environment?

It is a secondary pollutant which is obtained by the interaction of unburnt hydrocarbon and oxides of nitrogen in presence of sunlight

Effects:- Asthma and chronic bronchitis , Eye irritation and reduced resistance to cold and lung infections,Reduced visibility ,Causes chlorosis (loss of chlorophyll),Corrosion of metals

8. What are point and non-point sources of water pollution?

Point sources: These are pollutants whose specific locations can be known.

Examples Industries, Power plants, Off shore oil wells, sewage treatment plants, underground mines, and oil tankers.

Nonpoint sources: These are pollutants whose specific locations cannot be known. These sources are scattered, which individually or collectively pollute water

Examples: Runoff from agricultural field, Over flowing small drains, Rain water sweeps road and fields

9. Write any four sources water pollutants.

Industrial wastes, Agricultural wastes(Nutrients), Thermal power plants,Pathogens, and Oxygen depleting chemicals

10. Write any two causes of soil pollution.

1.Industrial wastes 2.Urban wastes 3.Agricultural practices 4.Radioactive pollutants 5.Biological agents

11.Define soil pollution (or)What do you understand by soil pollution?

Soil pollution is defined as, "contamination of soil by human and natural activities which may cause harmful effect on living organisms".

12. Mention the effects of ozone on plants.

Destroys chlorophyll, damage certain crops like rice,corn,wheat

13. Define PAN.

"Peroxyacetyl nitrate is a peroxyacyl nitrate. It is a secondary pollutant present in photochemical smog. It is thermally unstable and decomposes into peroxyethanoyl radicals and nitrogen dioxide gas. It is a lachrymatory substance".

It is formed by the photochemical reaction of Hydrocarbons with nitrogen oxides.

14. Mention some control measures of air pollution.

- ✓ Using mass transport system, bicycles etc.
- ✓ Shifting to less polluting fuels (hydrogen gas).
- ✓ Using non-conventional sources of energy.
- ✓ Planting more trees.
- ✓ Industries should be located far from the residential areas

15. What is acid rain?

When these gases (NOx and SOx) react with water vapour in the atmosphere, they form acids and descend on Earth as "acid rain" through rain water.

$$SO_2 + 1/2O_2 + H_2O \longrightarrow H_2SO_4$$

$$NO_2 + H_2O \longrightarrow HNO_3$$

16. Mention the causes for acid rain

CO_2 –fossil fuels ,NO_2 - Thermal power plants, Explosive and fertilizer industries

SO_2 - Sulphuric acid Plants &Oil refineries

Formation of Acid Rain

When these gases (NOx and SOx) react with water vapour in the atmosphere, they form acids and descend on Earth as "acid rain" through rain water.

17. What is the mechanism of ozone layer depletion?

The CFCs themselves do not destroy ozone molecules but they decay ozone molecules at low temperatures. A small amount of chlorine atom and chlorine mono-oxide function as catalyst in the process of destruction of ozone. The reactions involved are:

$$Cl + O_3 \longrightarrow ClO + O_2$$

$$ClO + O \longrightarrow Cl + O_2$$

Hence, net effect:

$$O_3 + O \longrightarrow 2O_2$$

18. What do you meant by noise pollution?

Noise pollution is defined as any unwanted, unpleasant or disagreeable sound that causes discomfort to all living beings".

Eg:- Industrial Noise Transport Noise and Neighbourhood noise

19. What are the sources of thermal pollution?

1. Nuclear power plants
2. Coal fired plants
3. Industrial effluents
4. Domestic sewage
5. Hydro-electric power

20.What is Thermal pollution.

Thermal pollution is defined as the addition of excess of undesirable heat to water thereby making it harmful to man, animal or aquatic life.

21. What is marine pollution?

"Any direct or indirect introduction of foreign substances or energy into the marine environment which leads to imbalance in marine ecology is known as marine pollution

22. List the sources of Marine Pollution.

1. Agricultural runoff contains Pesticides and fertilizers 2. Petroleum and oil washed off from roads 3. Ship accidents and accidental spillage at sea 4 Off shore oil exploration

23.Mention the physical and chemical parameters of quality of water.

Physical parameters:- colour, taste , odour and turbidity

Chemical parameters:- acidity, alkalinity,P^H ,fluoride chloride and nitrates

Part B

1. Explain the causes, effects and control measures of air pollution
2. Give an account on the various methods of controlling air pollution
3. Mention the causes, effects and control measures of water pollution
4. Write about one of the waste water treatment techniques, with a neat schematic diagram.
5. Explain the causes, effects and control of soil pollution.
6. Explain the causes, effects and control measures of thermal pollution
7. What is noise? How is noise pollution controlled? Suggest suitable steps.
8. What is marine pollution? Explain the ill effects of marine pollution.
9. Write briefly about the hazards caused by the nuclear wastes.

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UNIT III

SOLID WASTE MANAGEMENT

3.1 SOLID WASTES

Solid waste means any garbage, refuse, sludge from a waste water treatment plant, water supply treatment plant, or air pollution control facility and other discarded materials including solid, liquid, semi-solid, or contained gaseous material, resulting from industrial, commercial, mining and agricultural operations, and from community activities, but does not include solid or dissolved materials in domestic sewage, or solid or dissolved materials in irrigation return flows.

In Simple Words – "Solid wastes are any discarded or abandoned materials. Solid wastes can be solid, liquid, and semi-solid or containerized gaseous material".

3.1.1 SOURCES OF SOLID WASTE

Source	Waste
Residential	Garbage from food wastes, plastics, paper, glass, leather, cardboard, metals, yard wastes, ashes and special wastes like bulky household items like electronics, tires, batteries, old mattresses and used oil.
Industrial	Waste from light and heavy manufacturing industries, construction sites, fabrication plants, canning plants, power and chemical plants.
Commercial	Plastics, food wastes, metals, paper, glass, wood, cardboard materials
Institutional	Glass, rubber waste, plastics, food wastes, wood, paper, metals, cardboard materials, electronics
Construction and Demolition Areas	Steel materials, concrete, wood, plastics, rubber, copper wires debris dirt and glass.
Municipal services	Waste from street cleaning, wastes from parks and beaches, wastewater treatment plants, landscaping and wastes from recreational areas including sludge.
Treatment Plants and Sites	Waste from refineries, power plants, processing plants, mineral extraction plants and chemicals plants.
Agriculture	spoiled food, pesticide containers
Biomedical	Syringes, bandages, used gloves, drugs, paper, plastics, food wastes and chemicals

Table 3.1 Sources of Solid Waste

3.1.2 CLASSIFICATION OF SOLID WASTE

- **Municipal Solid wastes:** Solid wastes that include household garbage, rubbish, construction & demolition debris, sanitation residues, packaging materials, trade refuges etc. are managed by any municipality.
- **Bio-medical wastes:** Solid or liquid wastes including containers, intermediate or end products generated during diagnosis, treatment & research activities of medical sciences.
- **Industrial wastes:** Liquid and solid wastes that are generated by manufacturing & processing units of various industries like chemical, petroleum, coal, metal gas, sanitary & paper etc.
- **Agricultural wastes:** Waste generated from farming activities. These substances are mostly biodegradable.
- **Radioactive wastes:** Waste containing radioactive materials. Usually these are byproducts of nuclear processes. Sometimes industries that are not directly involved in nuclear activities may also produce some radioactive wastes e.g. radio-isotopes, chemical sludge etc.
- **E-wastes:** Electronic wastes generated from any modern establishments which may be described as discarded electrical or electronic devices. Some electronic scrap components like CRT may contain contaminants such as Pb, Cd, Be or brominated flame retardants.

3.2 SOLID WASTE MANAGEMENT

Different steps in solid waste management are

a) Collection b) Transportation c) Storage d) Segregation e) Disposal

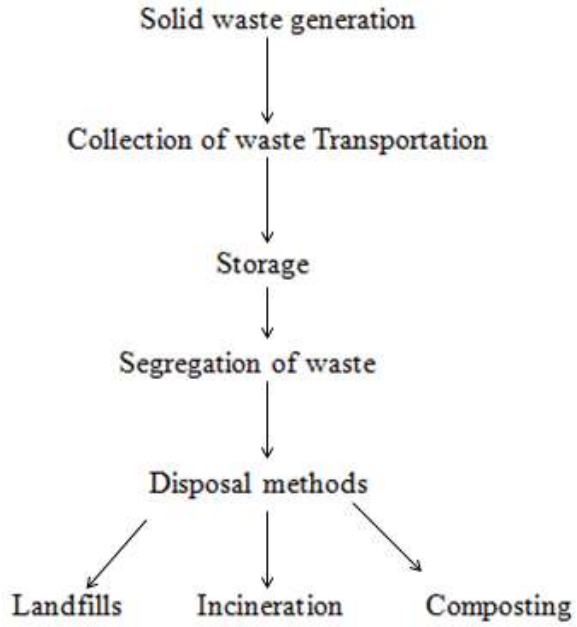
a) **Collection:** Waste from various places is collected by local waste collector or and sanitation worker through regular waste collection, or by special collections for recycling.

b) **Transportation:** Vehicles used for transportation of wastes shall be covered, should not be exposed to open environment to prevent their scattering and to ensure hygiene.

c) **Storage:** Collected waste materials are stored in such a manner as they do not create unhygienic and insanitary conditions around it. Wastes stored are not exposed to open atmosphere. Bins for storage of bio-degradable wastes shall be painted green, those for

storage of recyclable wastes shall be printed white and those for storage of other wastes shall be printed black.

d) **Segregation:** This includes organizing awareness programmes for segregation of wastes and shall promote recycling or reuse of segregated materials. Recycling is the reprocessing of discarded materials into useful products. Recycling occurs in three phases, first the waste is sorted, recyclables are collected and the recyclables are used to create raw materials. These raw materials are then used in the production of new products. The process of reducing, reusing and recycling saves money, energy, raw materials, land space and also reduces pollution.



e) Disposal of solid wastes

Incineration: incineration is the most common thermal treatment process of the combustion of waste in the presence of oxygen in which the wastes are converted to carbon dioxide, water vapour and ash. The process reduces volume of the waste, rendering it harmless and reducing transportation cost. During incineration high levels of toxic dioxins, furans, lead and cadmium may be emitted with the fly ash of incinerator.

Energy from incineration

i) Incineration: To incinerate something is to burn it. In waste management terms, however, **incineration** means burning in a controlled and managed process – usually at high temperature. Different types of incinerator are used for burning waste. They differ by the temperature at which

they operate the cost of construction, the method of operation and the maintenance requirement. Incinerators can be used for disposal of wastes in health institutions and government and private institutions/offices/industries. Incineration can reduce the volume of refuse by up to 90% and the only remaining residual waste is ash. It significantly reduces the volume of material for final disposal. Incineration is only classed as 'recovery' in waste management if the energy (heat) that is produced is used in some way.

ii) Composting: Composting is the controlled aerobic decomposition of organic matter by the action of microorganisms and small invertebrates. The process is controlled by making the environmental conditions optimum for the waste decomposers to increase. The rate of compost formation is controlled by the composition and constituents of the materials i.e. their Carbon/Nitrogen (C/N) ratio, temperature, moisture content and the amount of air. Correct C/N ratio, optimum temperature of 50-60°C, moderate moisture levels and sufficient oxygen or air is required for composting. Most widely used composting is vermicomposting-using earthworms.

iii) *Sanitary landfill:*

Sanitary Landfills are designed to greatly reduce or eliminate the risks that waste disposal may pose to the public health and environmental quality. In a sanitary landfill, garbage is spread out in thin layers, compacted and covered with clay or plastic foam. In the modern landfills the bottom is covered with an impermeable liner, usually several layers of clay, thick plastic and sand. The liner protects the ground water from being contaminated due to percolation of leachate. Leachate from bottom is pumped and sent for treatment. When landfill is full it is covered with clay, sand, gravel and top soil to prevent seepage of water. Several wells are drilled near the landfill site to monitor if any leakage is contaminating ground water. Methane produced by anaerobic decomposition is collected and burnt to produce electricity or heat.

iv) Solid waste recycling

Recycling is the recovery and reuse of materials from wastes. Solid waste recycling refers to the reuse of manufactured goods from which resources such as steel, copper or plastics can be recovered and reused. Recycling and recovery is only one phase of an integrated approach to solid waste management that also includes reducing the amount of waste produced, composting, incinerating, and landfilling.

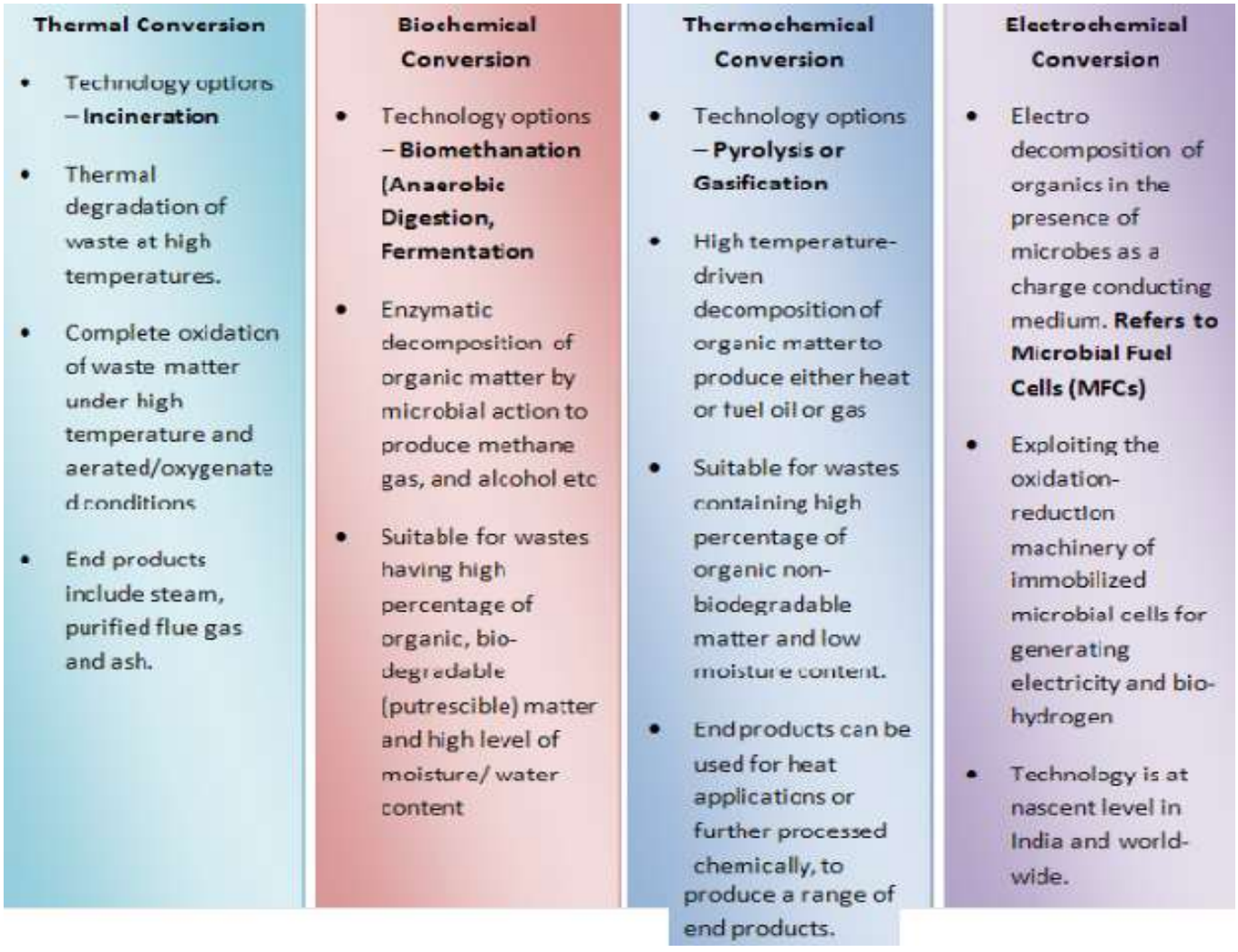
Recycling is a significant way to keep large amounts of solid waste out of landfills, conserve resources, and save energy.

The options for recycling depend on the type of waste. For example, waste paper can be broken down to its fibres in a process called pulping. The pulp is cleaned and then formed into new paper to be used for printing or packaging. Waste metals and glass can also be recycled by melting them

down into new raw materials. Sheet metals can be beaten and reformed into new products. Plastic bottles can be ground down and used to make plastic rope or plastic coating for electric wires. For some wastes, recycling involves complex technical processes and requires specialised machinery, but others can be recycled more simply and on a small scale. All types of organic waste can be recycled by composting, which can be carried out at home or on a larger scale.

3.3 ENERGY RECOVERY FROM WASTES

Energy can be recovered from the organic fraction of waste (biodegradable as well as non-biodegradable) through thermal, thermo-chemical, biochemical and electrochemical conversion methods..



A brief description of the commonly applied technologies for energy generation from waste is as follows

Anaerobic Digestion / Biomethanation

- In this process, the organic fraction of the waste is segregated and fed into a closed container (biogas digester).
- In the digester, the segregated waste undergoes biodegradation in presence of methanogenic bacteria and under anaerobic conditions, producing methane-rich biogas and effluent.
- The biogas can be used either for cooking/heating applications, or for generating motive power or electricity through dual-fuel or gas engines, low-pressure gas turbines, or steam turbines.
- The sludge from anaerobic digestion, after stabilization, can be used as a soil conditioner. It can even be sold as manure depending upon its composition, which is determined mainly by the composition of the input waste.

Combustion / Incineration

- In this process, wastes are directly burnt in presence of excess air (oxygen) at high temperatures (about 800°C), liberating heat energy, inert gases, and ash.
- Combustion results in transfer of 65%–80% of heat content of the organic matter to hot air, steam, and hot water.
- The steam generated, in turn, can be used in steam turbines to generate power.

Pyrolysis/Gasification

- Pyrolysis is a process of chemical decomposition of organic matter brought about by heat. In this process, the organic material is heated in absence of air until the molecules thermally break down to become a gas comprising smaller molecules (known collectively as syngas).
- Gasification can also take place as a result of partial combustion of organic matter in presence of a restricted quantity of oxygen or air.
- The gas so produced is known as producer gas. The gases produced by pyrolysis mainly comprise carbon monoxide (25%), hydrogen and hydrocarbons (15%), and carbon dioxide and nitrogen (60%).
- The next step is to 'clean' the syngas or producer gas. Thereafter, the gas is burnt in internal combustion (IC) engine generator sets or turbines to produce electricity.

Landfill Gas recovery

- The waste dumped in a landfill becomes subjected, over a period of time, to anaerobic conditions. As a result, its organic fraction slowly volatilizes and decomposes, leading to production of 'landfill gas', which contains a high percentage of methane (about 50%).
- It can be used as a source of energy either for direct heating/cooling applications or to generate power through IC engines or turbines.

3.4 HAZARDOUS WASTE

"Hazardous waste is the waste that has substantial or potential threats to public health or the environment".

These wastes pose present or potential risks to human health or living organisms, due to the fact that they: are non-degradable or persistent in nature, can be biologically magnified, they are highly toxic and even lethal at very low concentrations.

The criteria used to determine the nature of hazard include toxicity, phytotoxicity, genetic activity and bioconcentration. The threat to public health and the environment of a given hazardous waste is dependent on the quantity and characteristics of the waste involved.

3.4.1 SOURCES OF HAZARDOUS WASTES

- Flammable examples solvents - from chemical manufacturers, laundries & dry cleaners, metal plating, tanneries, print shops etc.
- Corrosive examples acids and alkalis - from cleaning & maintenance, equipment repair, vehicle body shops etc.
- Reactive examples bleaches and oxidizers - from chemical manufacturers, laboratories etc.
- Toxic and eco-toxic examples heavy metals, pesticides, cyanides from metals manufacturing, photographic processing, pesticide end users etc.

3.4.2 CLASSIFICATION OF HAZARDOUS WASTES

i. Radioactive wastes

Substances that emit ionising radiation are radioactive. Such substances are hazardous because prolonged exposure to radiation often results in damage to living organisms. Radioactive substances are of special concern because they persist for a long period. The period in which radiation occurs is commonly measured and expressed as half-life, i.e., the time required for the radioactivity of a given amount of the substance to decay to half its initial value. For example, uranium compounds have half-lives that range from 72 years for U^{232} to 23,420,000 years for U^{236}.

ii. Chemical wastes

Most hazardous chemical wastes can be classified into four groups: synthetic organics, inorganic metals, salts, acids and bases, and flammables and explosives. Some of the chemicals are hazardous because they are highly toxic to most life forms. When such hazardous compounds are present in a waste stream at levels equal to, or greater than, their threshold levels, the entire waste stream is identified as hazardous.

iii. Biomedical wastes

The principal sources of hazardous biological wastes are hospitals and biological research facilities. The ability to infect other living organisms and the ability to produce toxins are the most significant characteristics of hazardous biological wastes. This group mainly includes malignant tissues discarded during surgical procedures and contaminated materials, such as hypodermic needles, bandages and outdated drugs. This waste can also be generated as a by-product of industrial biological conversion processes.

vi. Household hazardous wastes

Household wastes such as cleaning chemicals, batteries, nail polish etc. in Municipal Solid waste (MSW) constitute hazardous waste. Especially batteries contain mercury which are alkaline which is dangerous enough to kill people. Generic household hazardous material include non-chlorinated organic, chlorinated organic, pesticides, latex paint, oil based paints, waste oil, automobile battery and household battery.

3.4.3 CHARACTERISTICS OF HAZARDOUS WASTES

Hazardous wastes are materials that are known or tested to exhibit one or more of the following hazardous traits:

- Ignitability
- Reactivity
- Corrosivity
- Toxicity

Ignitability	A waste is an ignitable hazardous waste, if it has a flash point of less than 60°C; readily catches fire and burns so vigorously as to create a hazard; or is an ignitable compressed gas or an oxidiser. Naphtha, lacquer thinner, epoxy resins, adhesives and oil based paints are all examples of ignitable hazardous wastes.
Reactivity	A material is considered a reactive hazardous waste, if it is unstable, reacts violently with water, generates toxic gases when exposed to water or corrosive materials Eg.Waste gunpowder, sodium metal or wastes containing cyanides or sulphides.
Corrosivity	A liquid waste which has a pH of less than or equal to 2 or greater than or equal to 12.5 is considered to be a corrosive hazardous waste. When these caustic or acid solutions are disposed of, the waste is a corrosive hazardous waste.
Toxicity	The toxic characteristic identifies wastes that are likely to leach dangerous concentrations of toxic chemicals into ground water

Table 3.2 Characteristics of Hazardous Waste

3.4.4 EFFECTS OF HAZARDOUS WASTE

1. Short-Term Effects on the Environment

The main risk in the short term is water pollution. The chemicals that pour into our waterways make streams, rivers, lakes and aquifers unsafe to use for drinking or agricultural purposes. This creates health hazard to the biotic components in the ecosystem. However, it is the long-term results that truly terrify.

2. Long-Term Effects on the Environment

Long-term effects include signs of mutation in animals, cancer and other diseases in humans, trash in our waterways and green spaces, and the destruction of many natural resources. Populations of insects such as bees, which are crucial in preserving the fertility of plant life, are dying off faster than they can repopulate due to human pollution.

Hazardous Waste and Global Warming

Emissions pour into the air every single day from both primary businesses and the secondary waste treatment plants that help to mitigate pollution. These chemicals destroy the ozone, which then warms the Earth and causes hazardous wastes to impact the Earth in new ways, wrecking now more-fragile ecosystems.

Hazardous Waste Affect Human and Animal Health

Bodily fluids are another kind of hazardous waste that often gets disposed of improperly. We now have to worry about the spread of human disease as well. Other forms of chemical

contamination, such as mercury and lead, pose major human health risks – especially to developing children. They accumulate in tissue, build up over time, and can lead to following diseases.

- Behaviour abnormalities
- Cancer
- Physiological malfunctions (e.g. kidney failure, reproductive impairment)
- Genetic mutations
- Physical deformations
- Birth defects

3.4.5 CASE STUDY – BHOPAL GAS TRAGEDY

Bhopal disaster also referred to as the Bhopal gas tragedy, was a a gas leak incident on the night of 2-3 December 1984 at the Union Carbide India Limited (UCIL) pesticide plant in Bhopal, Madhya Pradesh.It was considered to be the world's worst industrial Disaster over 500,000 people were exposed to methyl isocyanate MIC gas and other chemicals.

In the early morning hours of December 3rd 1984 a poisonous methyl isocyanate gas cloud (forty tons of toxic gases) from UCIL pesticide plant spread throughout the city because the reactor got exploded. This is because water carrying catalytic material had entered MIC storage tank and caused a failure in the cooling system.

Methyl isocyanate is a toxic gas, lower concentration of which affects lungs and eyes and causes irritation in the skin. Higher concentration of MIC, remove oxygen from the lungs and can cause death.

The disaster indicated a need for enforceable international standards for environmental safety, preventative strategies to avoid similar accidents and industrial disaster.

Health effects of the Bhopal methyl isocyanate gas leak exposure

	Early effects (0–6 months)
Ocular	Chemosis, redness, watering, ulcers, photophobia
Respiratory	Distress, pulmonary edema, pneumonitis, pneumothorax.
Gastrointestinal	Persistent diarrhea, anorexia, persistent abdominal pain.
Genetic	Increased chromosomal abnormalities.
Psychological	Neuroses, anxiety states, adjustment reactions
Neurobehavioral	Impaired audio and visual memory, impaired vigilance attention and response time, Impaired reasoning and spatial ability, impaired psychomotor coordination.
	Late effects (6 months onwards)
Ocular	Persistent watering, corneal opacities, chronic conjunctivitis
Respiratory	Obstructive and restrictive airway disease, decreased lung function.
Reproductive	Increased pregnancy loss, increased infant mortality, decreased placental/fetal weight
Genetic	Increased chromosomal abnormalities
Neurobehavioral	Impaired associate learning, motor speed, precision

Fig 3.2 Health Effects of Bhopal Methyl Isocyanate Gas Leak Exposure

3.4.6 DISPOSAL OF HAZARDOUS WASTE

Hazardous waste management involves the steps such as generation, storage, transport, processing and disposal. Processing is mainly done to recover useful products and to prepare waste for disposal. But prior to disposal, hazardous wastes need appropriate treatment, depending on the type of waste. The various options for hazardous waste treatment can be categorized under physical, chemical, thermal and biological treatments.

Waste Recycling

Used or residual waste materials are called secondary materials and are divided into the following five groups namely spent materials, by-products, sludge, commercial chemical products and scrap metals.

- A hazardous secondary material is recycled if it is used or reused
  Eg. Energy recovery

- A material is reclaimed if it is processed to recover a usable product or if it is regenerated.
  Eg. Regeneration of spent solvents.

- ❖ A material is used or reused if it is either employed as an ingredient in an industrial process to make a product.
  Eg. distillation bottoms from one process used as feedstock in another process or if it is employed as an effective substitute for a commercial product
  Eg. spent pickle liquor used as a sludge conditioner in wastewater treatment.

- ❖ "Use constituting disposal" is recycling that involves the direct placement of wastes or products containing wastes.
  Eg. Asphalt with petroleum-refining wastes as an ingredient on the land.

  "Burning for energy recovery" is recycling that involves burning a hazardous waste for its fuel value (either directly or when it is used to produce a fuel).

Benefits of Recycling Hazardous Waste

Hazardous waste reuse, recycling, and reclamation can avoid environmental hazards, protect scarce natural resources, reduce the nation's reliance on raw materials and energy and provide economic benefits.

Environmental Benefits

There are several, interrelated environmental benefits of recycling hazardous waste including:

- reducing the consumption of raw materials,
- reducing pollution.
- reducing energy use and
- Reducing the volume of waste that must be treated and disposed off.

ECONOMIC BENEFITS

Hazardous waste recycling is not only good for the environment, but can benefit an organization's bottom line. Recycling hazardous waste can increase production efficiency and reduce costs associated with purchasing raw materials and waste management.

A. Chemical treatment – Neutralization

Hazardous wastes are categorised as corrosive when their solution pH is less than 2 or more than 12.5. Such wastes can be chemically neutralised . Generally acidic wastes are neutralised with slaked lime [$Ca(OH)_2$] in a continuoulsy stirred chemical reactor. The rate of addition of lime is controlled by feed back control system which monitors pH during addition. Lime is least expensive and is widely used for treating acidic wastes. Since the solubility of lime in water is limited, solution of excess lime do not reach extremely high pH values. Alkaline wastes may be neutralised by adding sulphuric acid. It is a relatively inexpensive acid. For some applications acetic acid is preferable since it is non toxic and biodegradable. Alkaline wastes can also be neutralised by bubbling gaseous carbondioxide forming carbonic acid. The advantage of CO_2 is that it is often readily available in the exhaust gas from any combustion process at the treatment site. Many waste

treatment processes like oxidation/reduction, adsorption, wet air oxidation, ion-exchange, stripping and biochemical treatment require prior pH

Following is a list of commonly generated waste streams that can be neutralized and disposed of into the sanitary sewers:

- Copper sulfate/Nitric acid
- Copper nitrate, copper sulfate, copper acetate, and copper chloride/acid
- Hydrochloric acid/Thiamine/Pyroxidine
- Nitric acid/Copper nitrate/Potassium nitrate/Sodium nitrate
- Sodium bicarbonate
- Ammonium hydroxide/nitric Acid mix

B. Thermal treatment

The two main thermal treatments used with regard to hazardous wastes are:

(i) Incineration: Incineration can be regarded as either a pre-treatment of hazardous waste, prior to final disposal or as a means of valorizing waste by recovering energy. It includes both the burning of mixed solid waste or burning of selected parts of the waste stream as a fuel. The concept of treating hazardous waste is similar to that of municipal solid waste.

(ii) Pyrolysis: This is defined as the chemical decomposition or change brought about by heating in the absence of oxygen. This is a thermal process for transformation of solid and liquid carbonaceous materials into gaseous components and the solid residue containing fixed carbon and ash.

The application of pyrolysis to hazardous waste treatment leads to a two-step process for disposal. In the first step, wastes are heated separating the volatile contents (e.g., combustible gases, water vapour, etc.) from non-volatile char and ash.

In the second step volatile components are burned under proper conditions to assure incineration of all hazardous components

The first step of pyrolysis treatment is endothermic and generally done at 425°C to 760°C. The heating chamber is called the pyrolyser. Hazardous organic compounds can be volatilised at this low temperature, leaving a clean residue.

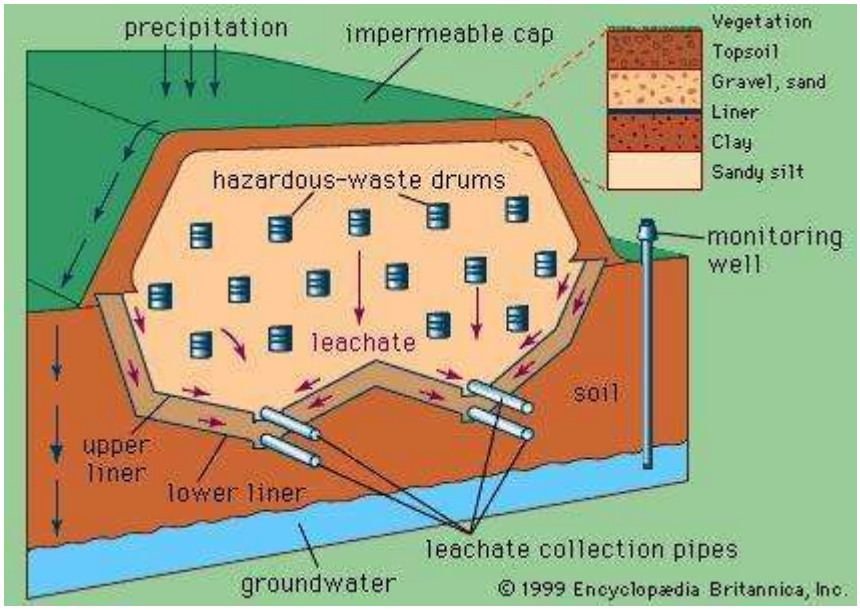
In the second step, the volatiles are burned in a fume incinerator to achieve destruction efficiency of more than 99%. The pyrolysis process can be applied to solids, sludges and liquid wastes.

C. SECURED LANDFILLS

Landfilling of hazardous solid or containerized waste is regulated more stringently than landfilling of municipal solid waste. Hazardous wastes must be deposited in so-called secure landfills, which provide at least 3 metres (10 feet) of separation between the bottom of the landfill and the underlying bedrock or groundwater table.

A secure hazardous-waste landfill must have two impermeable liners and leachate collection systems. The double leachate collection system consists of a network of perforated pipes placed above each liner. The upper system prevents the accumulation of leachate trapped in the fill, and the lower serves as a backup.

Collected leachate is pumped to a treatment plant. In order to reduce the amount of leachate in the fill and minimize the potential for environmental damage, an impermeable cap or cover is placed over a finished landfill.



3.5 ELECTRONIC WASTE OR E-WASTE

"Electronic waste (e-waste) refers to the broken or obsolete electronic components and materials".

E-waste materials may be valuable and recyclable, such as random access memory and reusable laptops.

Common discarded electronic products include computers, televisions, stereos, copiers and fax machines, cathode ray tube monitors.

Informal processing of e-waste in developing countries can lead to adverse human health effects and environmental pollution. Electronic scrap components, such as CPUs, contain potentially harmful materials such as lead, cadmium, beryllium, or brominated flame retardants.

3.5.1 SOURCES & EFFECTS

E-waste sources	Constituents	Health effects
Solder in printed circuit boards, glass panels, and gaskets in computer monitors	Lead	Damage to central and peripheral nervous systems, blood systems, and kidney damage. Adverse effects on brain development of children, causes damage to the circulatory system and kidney.
Chip resistors and semi-conductors	Cadmium	Toxic irreversible effects on human health, Accumulates in kidney and liver causes neural damage
Relays and switches, and printed circuit boards	Mercury	Chronic damage to the brain, respiratory and skin disorders due to bioaccumulation in fishes
Galvanized steel plates and decorator or hardener for steel housing	Chromium	Causes bronchitis
Cabling and computer housing	Plastics and PVC	Burning produces dioxin that causes reproductive and developmental problems
Electronic equipment and circuit boards	Brominated flame-retardants	Disrupt endocrine system functions
Front panels of CRTs	Barium, phosphorus, and heavy metals	Cause muscle weakness and damage to heart, liver, and spleen
Copper wires, Printed circuit board tracks.	Copper	Stomach cramps, nausea, liver damage, or Wilson's disease
Nickel–cadmium rechargeable batteries	Nickel	Allergy of the skin to nickel results in dermatitis while allergy of the lung to nickel results in asthma
Lithium-ion battery	Lithium	Lithium can pass into breast milk and may harm a nursing baby. Inhalation of the substance may cause lung edema.
Motherboard	Beryllium	Carcinogenic (lung cancer). Inhalation of fumes and dust causes chronic beryllium disease or beryllicosis.

3.5.2 RECYCLING TECHNIQUES

Electronics recycling: It is a challenging because discarded electronics devices are sophisticated devices manufactured from varying proportions of glass, metals, and plastics. The process of recycling can vary, depending upon materials being recycled and the technologies employed, but here is a general overview.

Collection and Transportation: Collection and transportation are two of the initial stages of the recycling process, including for e-waste. Recyclers place collection bins or electronics take-back booths in specific locations and transport the collected e-waste from these sites to recycling plants and facilities.

Shredding, Sorting, and Separation: After collection and transportation to recycling facilities, materials in the e-waste stream must be processed and separated into clean commodities that can be used to make new products. Efficient separation of materials is the foundation of electronics recycling. Initial shredding of e-waste stream facilitates sorting and separation of plastics from metals and internal circuitry. So, e-waste items are shredded into pieces as small as 100mm to prepare for further sorting.

Various Recylcing techniques involved are:

1. Hydrometallurgical method

This process is mainly used for profitable recycling of metallic fraction. In this method, metal contents are dissolved into leaching solutions such as strong acids and alkalis. This is followed by electro refining of desired metals. This technique is considered to be more flexible and energy saving, hence cost effective. Widely used leachate is aqua regia, nitric acid, sulfuric acid and cyanide solutions. In case of non-metallic substrates, metals leach out in the resulting solution, from the substrate.

2. Electrochemical processing

Electrochemical processing can be done to recover metals, in case of metallic substrates. Thus, a pure metal recovered is sold without any further processing while the remaining non-metallic substrates still need to be treated thermally prior reusing or dumping in landfills. The major disadvantage of this method is the corrosive and poisonous nature of the liquid being used. This process also leaves high totally dissolved solids.

3. Mechanical recycling

It is a physical recycling method. In this method, the disassembled samples are first cut

into specific sizes depending upon the milling needs. Then the pieces are put through a milling process resulting into fine pulverized PCB powder. This powder is subjected to eddy current separators that separates the metal by their eddy current characteristics. Finally the pulverized samples are subjected to density separation process depending upon the density and particle size; stratification can be seen in the liquid column.

3. Electrostatic separation method

In electrostatic separation technologies, electric force acting on charged or polarized bodies is used for the separation of granular materials. These technologies have been applied for recycling of metals and plastics from industrial wastes. Electrostatic separation technologies can be used to recycle Cu, Al, Pb, Sn and iron, certain amount of noble metals and plastic from scrapped printed circuit board (PCB).

4. Magnetic separation method

Magnetic separators with low intensity drum separators are widely used for the recovery of ferromagnetic metals from non-ferrous metals and other non-magnetic wastes . The disadvantage of magnetic separation is agglomeration of the particles. This agglomeration causes the magnet to also pull the non-metal materials which agglomerate with the ferrous material. Hence efficiency of separation lacks.

Recycling of non-metallic fractions by gasification process The main application of the gasification process is in the generation of synthesis gas (CO, H_2). Gasification is roughly performed at a temperature of 1600^{o}C and about 150 bar pressure. The hydrogen rich synthesized gas is the most significant product of gasification. It is a valuable feedstock for methanol synthesis. After proper processing, certain fractions of this gas could be used for generation of heat and electricity.

Electronics Recycling Associations:

ISRI (the Institute of Recycling Industries): ISRI is the largest recycling industry association with 1600 member companies, of which 350 companies are e-waste recyclers.

CAER (Coalition for American Electronics Recycling): CAER is another leading e-waste recycling industry association in the U.S. with over 130 member companies operating around 300 e-waste recycling facilities altogether throughout the country.

EERA (European Electronics Recyclers Association): EERA is the leading e-waste recycling industry association in Europe.

EPRA (Electronic Products Recycling Association): EPRA is the leading e-waste recycling industry association in Canada.

SOLID WASTE MANAGEMENT – QUESTION BANK

Part A

1. Define Solid wastes.

Solid wastes are any discarded or abandoned materials. Solid wastes can be solid, liquid, and semi-solid or containerized gaseous material".

2. Give their types of Solid Waste.

Municipal Solid wastes, Bio-medical wastes, Industrial wastes, Agricultural wastes, Radioactive wastes and E-wastes

3. Define E-wastes.

Electronic waste (e-waste) refers to the broken or obsolete electronic components and materials. E-waste materials may be valuable and recyclable, such as random access memory and reusable laptops.

4. List out the basic Techniques of Energy Recovery from Waste.

Thermal, thermo-chemical, biochemical methods and electrochemical methods.

5. Define Hazardous waste .

Hazardous wastes refer to wastes that may, or tend to, cause adverse health effects on the ecosystem and human beings. These wastes pose present or potential risks to human health or living organisms, due to the fact that they: are non-degradable or persistent in nature; can be biologically magnified; are highly toxic and even lethal at very low concentrations.

6. List out the types of Hazardous wastes:

Radioactive substance, Chemicals, Biomedical wastes, Flammable wastes, Explosives and Household hazardous wastes.

7. List out the important source for e-waste.

Solder in printed circuit boards, glass panels, and gaskets in computer monitors, Chip resistors and semi-conductors, Electronic equipment and circuit boards

8. List the functional elements of solid waste management. Which of these are relevant

to rural settings? Explain why these are relevant but the others are not.

The functional elements of waste management are: onsite handling, storage and processing; collection; transfer and transport; resource recovery and processing; and disposal. In rural areas, waste is not normally collected or transported, so the second and third elements are not relevant. Most waste in rural areas is organic and there is plenty of space. Onsite handling, resource recovery in the form of recycling or composting and final disposal is found in rural areas.

9. Define Pyrolysis method.

Pyrolysis is a chemical recycling technique, extensively used for recycling synthetic polymers including polymers that are mixed with glass fibers. Pyrolysis of such polymers gives gases, oils and chars. These products can further be used as chemical feedstock or fuels the printed circuit boards are heated to a temperature, high enough to melt down the solder, used to bind the electrical components to the circuit board, in the presence of oxygen. After pyrolysis blackish metal substance is left behind.

10. What are the advantages of incineration process?

During incineration high levels of toxic dioxins, furans, lead and cadmium may be emitted with the fly ash of incinerator.

11. Write short note on anaerobic Digestion.

In this process, the organic fraction of the waste is segregated and fed into a closed container (biogas digester).

In the digester, the segregated waste undergoes biodegradation in presence of methanogenic bacteria and under anaerobic conditions, producing methane-rich biogas and effluent.

The biogas can be used either for cooking/heating applications, or for generating motive power or electricity through dual-fuel or gas engines, low-pressure gas turbines, or steam turbines.

The sludge from anaerobic digestion, after stabilization, can be used as a soil conditioner. It can even be sold as manure depending upon its composition, which is determined mainly by the composition of the input waste.

12. Write short note on Landfill Gas recovery.

The waste dumped in a landfill becomes subjected, over a period of time, to anaerobic conditions. As a result, its organic fraction slowly volatilizes and decomposes, leading to production of 'landfill gas', which contains a high percentage of methane (about 50%).

It can be used as a source of energy either for direct heating/cooling applications or to generate power through IC engines or turbines.

13. List out the important effects of Hazardous waste to Human health.

- Behaviour abnormalities
- Cancer
- Physiological malfunctions (e.g., kidney failure, reproductive impairment)
- Genetic mutations
- Physical deformations
- Birth defects

14. List out the important effects of e - waste to Human health.

Damage to central and peripheral nervous systems, blood systems, and kidney damage, chronic damage to the brain, Respiratory and skin disorders due to bioaccumulation in fishes.

PART B

1. Explain solid waste management technique.
2. Explain Hazardous waste management technique.
3. Explain recycling of e – waste with suitable technique.
4. Discuss about Bhopal tragedy.
5. Discuss about source ,types and impact of solid waste.
5. Discuss about source ,types and impact of hazardous waste.

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UNIT IV

SOCIAL ISSUES AND THE ENVIRONMENT

4.1 Introduction – Sustainable Development

In the year 1987, the World Commission on Environment and Development (WCED) is introduced the term sustainable development in its report our common future (the Brundtland Commission). According to WCED, sustainable development may be defined as a process of changes in which the exploitation of resources, direction of investments, the orientation of technological development and the institutional changes are in harmony and enhance both current and future potential to meet human need as aspiration.

In other words, it is defined as **"sustainable development is the development that meets the needs of the present without compromising on the ability of the future generations to meet their own needs"**. Sustainable development considers the impact of environmental changes and tries to minimise the impact.

The symptoms of unsustainability

It is in experiencing the present quality of our lifestyle that we become aware and conscious of the need for better standards and conditions that sustainable development alone can ensure. The overwhelming symptoms of unsustainability surround us:

- Population explosion
- Poverty and disease
- Scarcity of clean air, water and housing
- Accumulation of garbage and hazardous wastes
- Global warming, rising sea levels and unpredictable climate patterns
- Excessive consumption of fossil fuels and natural resources
- Mass extinction of species

4.1.0 THE MAIN FEATURES OF SUSTAINABLE DEVELOPMENT

- **Sustained Rise in Real per Capita Income**: Real per capita income and economic welfare should continue to for a long time.
- **Rational Use of Natural Resources**: Sustainable Development simply considered that the natural resources.
- **Preserving natural resources for future generations**: Sustainable development aims to make use of natural resources and environment to raise existing living standards in such a way that upcoming generations will not be able to get their own needs.

4.1.1 THE RIO EARTH SUMMIT AND AGENDA 21

In June, 1992, in Rio de Janeiro, representatives from 179 countries came together for the United Nations Conference on Environment and Development, popularly known as the Rio Earth Summit. One of the major agreements signed during this meeting was a programme of action called Agenda 21, the 900-page document describes first steps towards initiating Sustainable Development across local, national and international levels as the world moved into the 21st century.

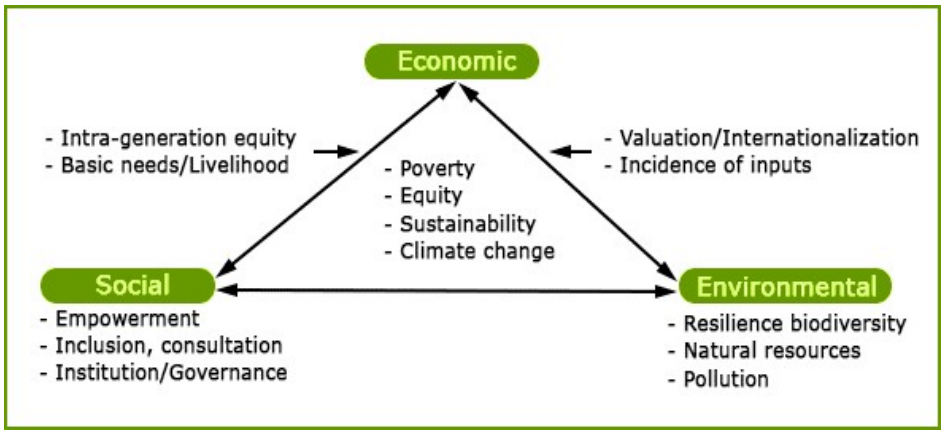
4.1.2 THE THREE ELEMENTS OF SUSTAINABLE DEVELOPMENT

1. Social, Economic and Environmental Dimension, such as combating poverty and promoting sustainable urban planning.

2. Conservation and Management of Resources, such as safeguarding the oceans' fisheries and combating deforestation.

3. Strengthening the Role of Major Groups, such as women, local governments and NGO's and Means of Implementation, such as transfer of environmentally-sound technology.

Dimensions of sustainable development:



4.1.3 THE CONCEPT OF SUSTAINABLE DEVELOPMENT

1. **Social progress which recognizes the needs of everyone:** Everyone should share in the benefits of increased prosperity and a clean and safe environment. Needs must not be met by treating others, including future generations and people elsewhere unfairly.
2. **Effective protection of the environment**: We must limit global environmental threats, such as climate change to protect human health and safety from hazards such as poor air quality and toxic chemicals and to protect things that people need or value, such as wildlife and landscape.
3. **Prudent use of natural resources:** We need to ensure that non-renewable resources are used efficiently and that alternatives are developed to replace them. Renewable resources, such as water, should be used in ways that do not endanger the resource or cause serious damage or

pollution and follow the principle of Reduce, Reuse, Recycle (3R) approach for the optimum use of natural resources.

4. **Maintenance of high and stable levels of economic growth and employment:** so that everyone can share in high living standards and greater job opportunities.
5. **Population Stability:** By maintaining the population stability we can create chance to achieve the sustainable development.

4.1.4 EXAMPLES OF SUSTAINABLE DEVELOPMENT

1. **Solar Energy:** The greatest advantages of solar energy are that it is completely free and is available in limitless supply. Both of these factors provide a huge benefit to consumers and help reduce pollution. Replacing non-renewable energy with this type of energy is both environmentally and financially effective.

2. **Wind Energy:** Wind energy is another readily available energy source. Harnessing the power of wind energy necessitates the use of windmills however, due to construction cost and finding a suitable location, this kind of energy is meant to service more than just the individual. Wind energy can supplement or even replace the cost of grid power and therefore may be a good investment and remains a great example of sustainable development.

3. **Crop Rotation:** Crop rotation is defined as "the successive planting of different crops on the same land to improve soil fertility and help control insects and diseases." This farming practice is beneficial in several ways, most notably because it is chemical-free. Crop rotation has been proven to maximize the growth potential of land, while also preventing disease and insects in the soil. Not only can this form of development benefit commercial farmers, but it can also aid those who garden at home.

4. **Efficient Water Fixtures:** Replacing current construction practices and supporting the installation of efficient shower heads, toilets and other water appliances can conserve one of Earth's most precious resources of water.

Examples: dual-flush and composting toilets. It is important that sustainable water use is employed at the individual and societal level.

5. **Green Space:** Green spaces include parks and other areas where plants and wildlife are encouraged to thrive. These spaces also offer the public great opportunities to enjoy outdoor recreation, especially in dense, urban areas. According to the UW-Madison Department of Urban and Regional Planning, advantages of green spaces include, "helping regulate air quality and climate, reducing energy consumption by countering the warming effects of paved surfaces, recharging groundwater supplies and protecting lakes and streams from polluted runoff."

Researcher found that moving to a greener area could lead to significant and lasting improvements to an individual's mental health.

Think sustainable

The transition to sustainable living or development can be catalyzed by a change in thinking and shift in values. Values such as a concern for human rights, responsibility for the earth and the welfare of future generations are needed for the success of sustainable development. We have been entrusted with the responsibility of creating a safe and supportive environment for tomorrow and what emerges will depend on the decision we take today: decisions founded on moral and ethical values.

The agents for the change for sustainable development,

1. **Sustainable living in practice**

   The state of the earth is every individual's responsibility and it is our detachment from the environment and its problems that deters individual action.

2. **Conserve fossil fuels**
   - Switch off fans and lights when are needed
   - Let the breeze in by switching off the air-conditioning
   - Avoid the use of electrical appliances wherever possible

3. **Conserve water**
   - Consciously use only as much as you need
   - Repair leaking taps and pipes
   - Do not pollute water sources
   - Harvest Rainfall.
4. **Save the trees**
   - Reduce use of paper and paper products
   - Recycle used paper
   - Plant and care for trees

5. **Keep the air clean**
   - Stop smoking

- Do not burn paper or other wastes
- Drive vehicle(s) with a catalytic converter
- Keep your vehicles well maintained
- Implement pollution control and treatment facilities in your factory

6. **Reduce garbage**
    - Buy goods with less / recyclable packaging
    - Reuse / recycle paper, metal, glass, plastic items
    - Carry your own shopping bag and say no to plastic bags
    - Compost kitchen and garden waste

7. **Protect wildlife**
    - Do not use animal skins / parts / products
    - Do not collect rare specimens of plants / animals
    - Support conservation efforts

8. **Buy local products**
    - Energy spent in transportation and handling is saved
    - Material used in packing is saved
    - Local economy improves
    - More money is made available for environmental conservation

9. **Harvest water**
    - Water scarcity reduces ass water table improves
    - Siltation of water bodies is controlled
    - The nutrients in the soil are preserved
    - Green cover and agricultural yield increase
    - Dependence on chemical fertilizers reduces
    - Pollution of water bodies decreases
    - Rainfall increases

10. **Think green**

- Say no to non-recyclable, use and throw articles
- Replace paper cups, plates and napkins with metal, glass and cloth
- Use natural products for cleaning, fertilizing and getting rid of bugs and insects

11. Spread awareness

- Show your family and friends how to eco-friendly
- Gather support for an environmental cause
- Write to your local government representative demanding action for environmental issues
- Set an example by following an eco-friendly lifestyle.

4.2 Social Impact of Growing Human Population

$$\mathbf{I = P \times A \times T}$$

I = PAT is the mathematical notation of a formula put forward to describe the impact of human activity on the environment.

The expression equates human impact on the environment (I) to the product of three factors: population(P), affluence (A) and technology (T). It is similar in form to the Kaya identity which applies specifically to emissions of the greenhouse gas carbon dioxide.

The equation was developed in 1970 by Paul R. Ehrlich and John Holdren.

Ehrlich and Holdren states that all three factors were important but emphasized the role of human population growth, focusing on a broader scale, being less specific in space and time.

The equation can aid in understanding some of the factors affecting human impacts on the environment.

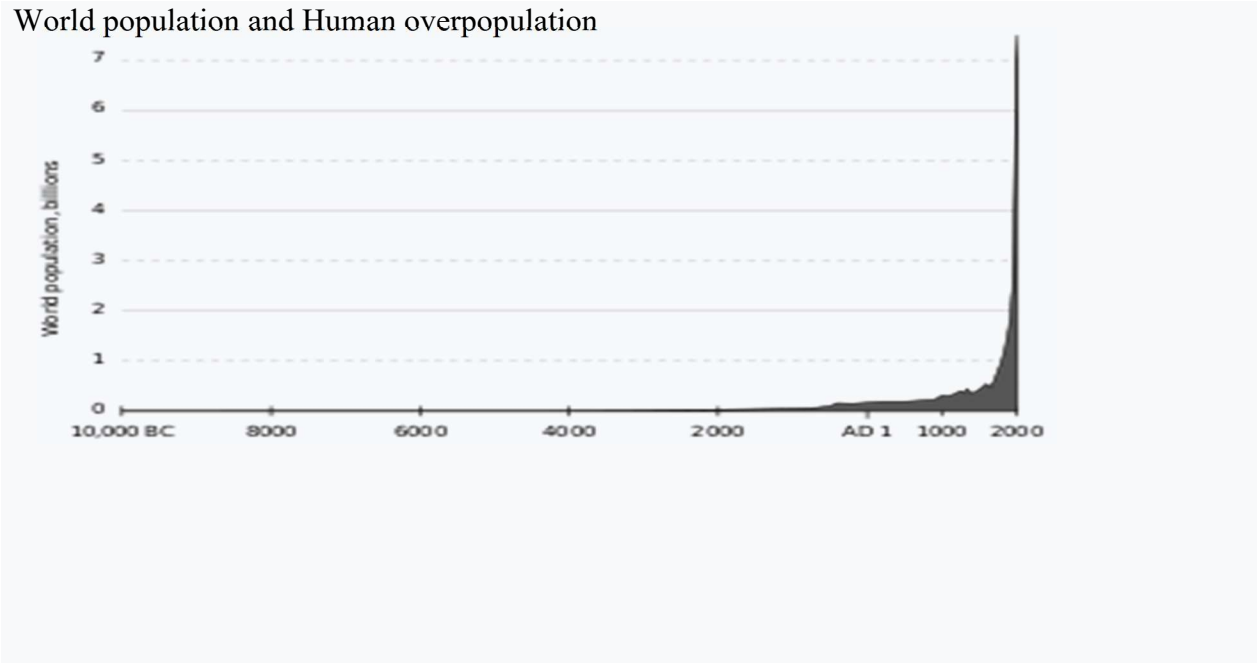
4.2.1 THE DEPENDENT VARIABLE

The variable "I" in the "I=PAT" equation represents environmental impact. The environment may be viewed as a self-regenerating system that can sustain a certain level of impact sustainably. The maximum sustainable impact is called the carrying capacity. As long as "I" is less than this amount the associated population, affluence, and technology that make up "I" are sustainable. If "I" exceeds the carrying capacity, then the system is said to be in overshoot, which can only be a temporary state. Overshoot may degrade the ability of the environment to sustain impact, therefore reducing the carrying capacity. Impact may be measured using ecological footprint analysis in units of global hectares (gha). Ecological footprint per capita is a measure of the quantity of Earth's biologically productive surface that is needed to regenerate the resources consumed per capita.

Impact is modelled as the product of three terms, giving gha as a result. Population is expressed in human numbers; therefore affluence is measured in units of gha per capita. Technology is a unit less efficiency factor.

4.2.2 THE THREE FACTORS

4.2.2.1 Population



Population (est.) 10,000 BC – 2000 AD

In the I=PAT equation, the variable **P** represents the population of an area, such as the world. Since the rise of industrial societies, human population has been increasing exponentially. This has caused Thomas Malthus, Paul Ehrlich and many other so postulates that this growth would continue until checked by widespread hunger and famine The United Nations project that world population will increase from 7.7 billion today (2019) to 9.8 billion in 2050 and about 11.2 billion in 2100.

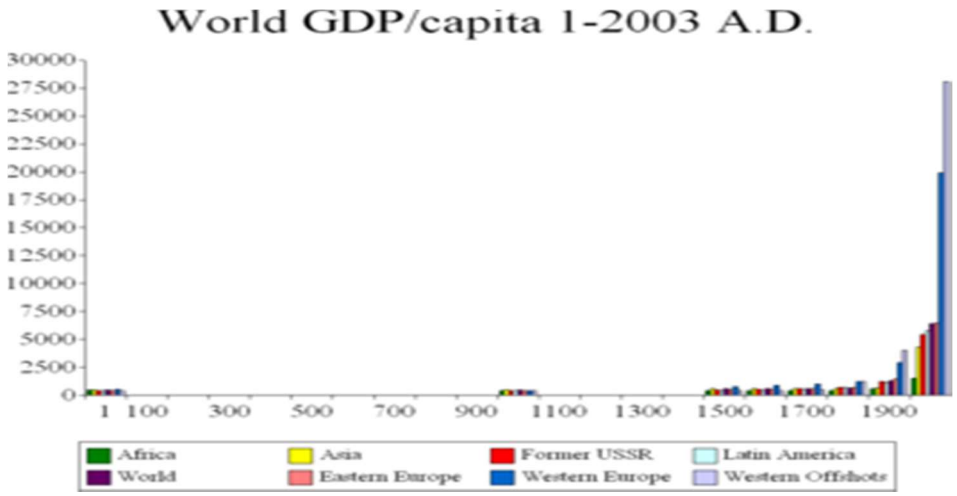
These projections take into consideration that population growth has slowed in recent years as women are having fewer children. This phenomenon is the result of demographic transition all over the world. Although the UN projects that human population may stabilize at around 11.2 billion in 2100, the I=PAT equation will continue to be relevant for the increasing human impact on the environment in the short to mid-term future.

4.2.2.2 Environmental Impacts of Population

Increased population increases humans' environmental impact in many ways, which include but are not limited to:

- Increased land use - Results in habitat loss for other species
- Increased resource use - Results in changes in land cover
- Increased pollution - Can cause sickness and damages ecosystems
- Increased climate change
- Increased biodiversity loss

4.2.2.3 Affluence



World GDP per capita (in 1990 Geary-Khamis dollars)

The variable **A** in the I=PAT equation stands for affluence. It represents the average consumption of each person in the population. As the consumption of each person increases, the total environmental impact increases as well.

A common proxy for measuring consumption is through GDP per capita. While GDP per capita measures production, it is often assumed that consumption increases when production increases. GDP per capita has been rising steadily over the last few centuries and is driving up human impact in the I=PAT equation.

4.2.2.4 Environmental Impacts of Affluence

Increased consumption significantly increases human environmental impact. This is because each product consumed has wide-ranging effects on the environment. For example, the construction of a car has the following environmental impacts:

- 605,664 gallons of water for parts and tires
- 682 lbs. of pollution at a mine for the lead battery

- 2178 lbs. of discharge into water supply for the 22 lbs. of copper contained in the car

The more cars per capita, the greater the impact. Ecological impacts of each product are far-reaching; increases in consumption quickly result in large impacts on the environment through direct and indirect sources.

4.2.2.5 Technology

The **T** variable in the I=PAT equation represents how resource intensive the production of affluence is; how much environmental impact is involved in creating, transporting and disposing of the goods, services and amenities used. Improvements in efficiency can reduce resource intensiveness, reducing the T multiplier.

Since technology can affect environmental impact in many different ways, the unit for **T** is often tailored for the situation to which I=PAT is being applied. For example, for a situation where the human impact on climate change is being measured, an appropriate unit for **T** might be greenhouse gas emissions per unit of GDP.

4.2.2.6 Environmental Impacts of Technology

Increases in efficiency can reduce overall environmental impact. However, since **P** has increased exponentially, and **A** has also increased drastically, the overall environmental impact, **I**, has still increased.

4.3 Food Security

An Introduction to the Basic Concepts of Food Security is exists when all people, at all times, have physical and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life.

4.3.1 THE FOUR DIMENSIONS OF FOOD SECURITY

In1996 World Food Summit From this definition, four main dimensions of food security can be identified.

Physical Availability of Food

Food availability addresses the "supply side" of food security and is determined by the level of food production, stock levels and net trade. Economic and physical access to food an adequate supply of food at the national or international level does not in itself guarantee household level food security.

Concerns about insufficient food access have resulted in a greater policy focus on incomes, expenditure, markets and prices in achieving food security objectives. Food utilization is

commonly understood as the way the body makes the most of various nutrients in the food. Sufficient energy and nutrient intake by individuals is the result of good care and feeding practices, food preparation, and diversity of the diet and intra-household distribution of food. Combined with good biological utilization of food consumed, this determines the nutritional status of individuals. Stability of the other three dimensions over time even if your food intake is adequate today, you are still considered to be food insecure if you have inadequate access to food on a periodic basis, risking a deterioration of your nutritional status. Adverse weather conditions, political instability, or economic factors (unemployment, rising food prices) may have an impact on your food security status. For food security objectives to be realized, all four dimensions must be fulfilled simultaneously.

4.3.2 THE DURATION OF FOOD INSECURITY

Food security analysts have defined two general types of food insecurity:

1. Chronic food insecurity transitory food insecurity is... long-term or persistent.
2. Short-term and temporary occurs when... people are unable to meet their minimum food requirements over a sustained period of time.

There is a sudden drop in the ability to produce or access enough food to maintain a good nutritional status. Results from the extended periods of poverty, lack of assets and inadequate access to productive or financial resources.

4.3.3 THE SEVERITY OF FOOD INSECURITY

When analyzing food insecurity, it is not enough to know the duration of the problem that people are experiencing, but also how intense or severe the impact of the identified problem is on the overall food security and nutrition status. This knowledge will influence the nature, extent and urgency of the assistance needed by affected population groups. Different ‘scales’ or ‘phases’ to ‘grade’ or ‘classify’ food security have been developed by food security analysts using different indicators and cut-off points or ‘benchmarks’.

Examples include: Measuring the Severity of Undernourishment the measure for hunger compiled by FAO, defined as undernourishment, refers to the proportion of the population whose dietary energy consumption is less than a pre-determined threshold. This threshold is country specific and is measured in terms of the number of kilocalories required to conduct sedentary or light activities.

4.3.4 VULNERABILITY

The dynamic nature of food security is implicit when we talk about people who are vulnerable to experiencing food insecurity in the future.

Vulnerability is defined in terms of the following three critical dimensions:

1. Vulnerability to an outcome
2. from a variety of risk factors
3. because of an inability to manage those risks.

Indeed, a person can be vulnerable to hunger even if he or she is not actually hungry at a given point in time.

Vulnerability analysis suggests two main intervention options:

1. Reduce the degree of exposure to the hazard
2. Increase the ability to cope.

By accounting for vulnerability, food security policies and programs broaden their efforts from addressing current constraints to food consumption, to include actions that also address future threats to food security.

4.3.5 HUNGER, MALNUTRITION AND POVERTY

It is important to understand how these three concepts are related to food insecurity.

4.3.6 HUNGER

Hunger is usually understood as an uncomfortable or painful sensation caused by insufficient food energy consumption. Scientifically, hunger is referred to as food deprivation. Simply put, all hungry people are food insecure, but not all food insecure people are hungry, as there are other causes of food insecurity, including those due to poor intake of micro-nutrients. Malnutrition results from deficiencies, excesses or imbalances in the consumption of macro- and/or micronutrients.

4.3.7 MALNUTRITION

Malnutrition may be an outcome of food insecurity, or it may relate to non-food factors, such as:
- inadequate care practices for children, insufficient health services and an unhealthy environment.

While poverty is undoubtedly a cause of hunger, lack of adequate and proper nutrition itself is an underlying cause of poverty.

4.3.8 POVERTY

A current and widely used definition of **poverty** is “Poverty encompasses different dimensions of deprivation that relate to human capabilities including consumption and food security, health, education, rights, voice, security, dignity and decent work.” Organisation for Economic Co-operation and Development (OECD) it is argued that a strategy for attacking poverty in

conjunction with policies to ensure food security offers the best hope of swiftly reducing mass poverty and hunger.

However, recent studies show that economic growth alone will not take care of the problem of food security. What is needed is a combination of income growth, supported by direct nutrition interventions and investment in health, water and education also. Food insecurity, hunger and malnutrition are results poor physical, cognitive development and low productivity.

4.4 Famine

4.4.1 INTRODUCTION

Famine nowadays is a serious threat to the existence of humans in many parts of the world. As most of us have seen on many TV news stations these populations decrease and many people in these regions die as a result of famine, hunger, and diseases accompanied by famine. In this study we examined the causes of famine, the illness effects it has on sufferers and solutions due to over population.

What is famine?

The literal meaning of **famine** is "extreme inadequacy and the scarcity of food." Famine is the phenomenon which occurs in a vast terrestrial area due to various environmental and biological reasons. Some of the prime reasons are population imbalance, scarcity of water or lack of rainfall, population imbalance, crop failure, government policies.

4.4.2 FAMINES IN INDIA

Famine in Indian sub-continent is a chronicle feature. Agriculture in India is heavily dependent on a suitable climate. A summer monsoon is a must for the irrigation of crops. Lack of rainfall and droughts had lead to several famines in India between 11th and 17th centuries severely.

Notable Famines in India

- Bengal Famine of 1943
- Chalisa Famine of 1783
- Great Bengal Famine of 1770
- Skull Famine of 1791
- Orissa Famine of 1866
- Deccan Famine of 1630
- Bihar Famine of 1873
- Agra Famine of 1837

These famines caused widespread scarcity of food and were responsible for numerous deaths across the country. The most significant famines in this list are the great Bengal famine of 1770 caused around 10 million deaths; skull famine or Doji bara famine caused 11 million deaths and Chalisa famine which also caused 11 million deaths approximately.

4.4.3 CAUSES OF FAMINE

1. *Natural Causes*

- Floods, cyclone, storms
- Droughts
- Earthquake

Draughts cause extreme scarcity of water and thus results in crop failure. On the other hand, floods and earthquakes can destroy the crops or food storage places. These all result in food scarcity and eventually famines.

2. *Man-made Reasons*

- Lack of food (due to no crop failure or no storage of food)
- No proper food distribution in certain regions
- Consumption of contaminated water and air. Crop irrigation impossible in such situations.
- Political issues, Government policies, and Civil Wars

Case Studies

Specific governments around the world have put policies that unintentionally caused famine to spread in their regions, and civil wars has led many countries, like Sudan, to experience hunger. Bad government policies have once led China to one of the greatest famine in history, when Mao Zedong has planned to improve China's industry and agriculture.

In order for this to happen, China was reformed into communes. Chinese citizens have worked for the commune and everything they had was owned by their commune. Workers were assigned to do work they were not capable of doing. A year later, machinery broke down, workers were injured, and buildings fell down because the steal produced and used in the buildings was week. Soon enough hunger was spread all over china, around 9 million died from starvation in 1960, and other millions of Chinese workers suffered illness for the lack of food. This plan which led china to famine was called the Great Leap Forward.

Similarly, unwise government policies have led North Korea to experience famine in the mid-1990s, and Zimbabwe in the early-2000s. In the early 1970s and 1980s, both Ethiopia and Sudan has suffered from famine due to their dictatorship governments, as food was shipped from Wollo

in Ethiopia to its capital city in order to be sold with higher prices, which led famine to occur in Wollo.

Then again, In the 1950s, china's resources depended greatly on government actions, as it was the government's responsibility to distribute food among provinces equally. As well as it is their responsibility to provide education and proper health care during the famine, with more educated people there are, the healthier their choices might be, as that might have decreased the resultant death rates in the Chinese famine. Due to unequal distribution of food, as governments usually prefer supplying urban residents over rural residents, the food accessibility was more devastating in the rural areas, which also led the severity of famine to vary from a region to another, as what happened to china in the 1950s.

4.4.4 EFFECTS OF FAMINES

Starvation is nothing but biological consequences of continuous scarcity of food. During the famine, starvation occurs on a mass scale.

Various **diseases** occur in the human body during the famine like Cholera. It is caused by bacteria, *Vibrio* cholerae, which leads an increased amount of water to be increased from cells that line the intestines. Symptoms include watery diarrhea, abdominal cramps, dry, mucous membranes, mouth, and skin, excessive thirst and lethargy.

Dropsy, which is now referred as **edema** is caused due to excessive fluid under the skin, the body swells. The affected area often retains a dimple after being pressed for few seconds.

Dysentery is another condition which affects the human body, where a bacterial infection is spread by water, stool, and food. Poor sanitation, contaminated food and water and crowded living conditions lead to dysentery. Symptoms include blood in stool, abdominal pain, diarrhea, and fever.

Another notable condition is **anemia**. There can be a lot more diseases that are caused due to famines. Apart from diseases, famines also cause *lower fertility rates, poor living conditions, fewer income options, various socio-political issues, etc.*

4.4.5 HOW TO PREVENT FAMINE

Famine can be avoided by following simple procedures, however political and governmental policies are the main aspects that would determine having famine or not, as unwise decision might repeat the incidence of the Great leap Forward and korea in the mid 1900's.

The main skills inhabitants of the land should know are how to hunt for food if they're living in regions where they depend mainly on animals. Growing, trapping, and storing food are also basic skills residents should consider knowing in order for them to survive and prevent famine from spreading. If living in the wild or an undeveloped region, residents should own guns, bows, baits

and traps; Farmers should be trained to cultivate their lands on a scientific basis and having developed machinery.

4.4.6 REDUCING FAMINE

Many actions should be taken in order for famine to reduce to reach its lowest dangerous state. The steps are simple, yet people still have problems reducing famine's effects.

Procedures to beat famine involves the use of modern technologies since 70% of 3rd world famine countries rely on agriculture, the use of fertilizers, irrigation, financially supporting farmers, developing institutions, democracy, those procedures allowed India and developed countries to beat famine, as Agricultural experts from Denmark and India gathering in Copenhagen at the Royal Veterinary and Agricultural University considered long term solutions.

Using modern science, genetic engineering in order to stop pest attacks and kill insects and destroy animal diseases, and fix low yields were also some solutions recommended by Prof Pinstrup-Andersen, he also adds that developing countries should invest in infrastructure, education, improvements of health care and domestic markets, and these things can easily be done with the help of developed countries and cooperation between each other in science in order to help the poor countries.

According to Mitra: "India adopted the first generation of Green Revolution technologies in the late 1960s, directly after its last famine (of 1965-66) which killed half a million people. This is best contrasted with China, whose policies induced the largest man-made famine in history during the same time period, killing tens of millions of people. Other countries, including the famine-ravaged states in Africa, would do well to follow India's example".

4.5 Consumerism and waste product

- Consumerism refers the consumption of natural resources by the people
- It is an organized movement of citizens and government
- The special concentration is given to improve the rights and power of Byers in relation to the seller
- It is related to population growth and demand
- Needs of resources increased

4.5.1 TRADITIONALLY FAVORABLE RIGHTS OF SELLER

1. The right to introduce any product
2. The right to charge any price
3. The right to spend any amount to promote their product
4. The right to use incentives to promote their product

4.5.2 TRADITIONAL BUYERS' RIGHT

1. The right to buy or not to buy
2. The right to expect a product to be safe
3. .The right to expect a product to perform as claimed

4.5.3 IMPORTANT INFORMATION TO BE KNOWN BY BUYERS

1. Ingredients of a product
2. Manufacturing date and expiry date
3. Whether the product has been manufactured against an established law of nature or involved in rights violation

4.5.4 OBJECTIVES OF CONSUMERISM

- It improves the power and rights of buyer
- It involves making the manufacturer liable for the entire life cycle of a product
- It force the manufacturer to reuse and recycle the product after usage
- Items which are very hard to decompose can be returned to the manufacturer for reclaiming useful parts and disposing the rest
- The reusable packing material like bottles can be returned to the manufacturer. It makes the product cheaper and avoids pollutions
- Active consumerism increases the human health and happiness and saves resources.

Suggestions for efficient consumerism

1. Standards should be verified before buying or accepting a product from market.
2. In every possible way waste must be minimized.
3. Waste minerals have to be recycled.
4. Strict laws must be implemented

4.5.5 SOURCES OF WASTES

Agricultural, mining, industrial and municipal wastes

Example for the waste products

- Glass, papers, garbage, plastics, soft drinks canes, metals, food waste, auto mobile wastes, dead animals, construction and factory wastes

4.5.6 ELECTRICAL & ELECTRONIC WASTES

- Computer, mobile phones, printers, Xerox machine, calculators.
- After using these instruments, they are thrown as waste.

4.5.7 EFFECTS OF WASTES

1. Wastes released from the chemical industries and from explosives are dangerous to human life.

2. The dumped wastes degrade soil and maker unfit for irrigation

3. E- waste contains more than 1000 chemicals which are toxic and causes environmental pollution

4. In computers lead present in monitor, cadmium in chips and cathode ray tube, PVC in cables all these cause cancer and other respiratory problems

5. Plastics are difficult to recycle and their combustion produces toxic gases.

4.5.8 FACTORS AFFECTING CONSUMERISM AND GENERATION OF WASTES

1. people-over population

It causes degradation of resources, poverty and premature death. This situation occurs in less developed countries.

Consumption – over population

It occurs when there are less people than the available resources, therefore over exploitation takes place.

The major environmental problems around us are

1. Air and water pollution by industries
2. Forestry
3. Land resources
4. Urbanization
5. Waste management

4.6 Environment and Human Health

Environment related issues that affect our health have been one of the most important triggers that have led to creating an increasing awareness of the need for better environmental management. Changes in our environment induced by human activities in nearly every sphere of life have had an influence on the pattern of our health. The assumption that human progress is through economic growth is not necessarily true.

We expect urbanization and industrialization to bring in prosperity, but on the down side, it leads to diseases related to overcrowding and an inadequate equality of drinking water, resulting in an increase in waterborne diseases such as infective diarrhoea and air borne bacterial diseases such as tuberculosis. High-density city traffic leads to an increase in respiratory diseases like asthma. Agricultural pesticides that enhanced food supplies during the green revolution have affected both the farm worker and all of us who consume the produce.

Modern medicine promised to solve many health problems, especially associated with infectious diseases through antibiotics, but bacteria found ways to develop resistant strains,

frequently even changing their behaviour in the process, making it necessary to keep on creating newer antibiotics. Many drugs have been found to have serious side effects.

4.6.1 INFECTIOUS DISEASES

Many infectious diseases have re-emerged with a vengeance. Loss of effective control over diseases such as malaria and tuberculosis, have led to a return of these diseases decades after being kept under stringent control. Other diseases were not known to science earlier and seem to have suddenly hit our health and our lives during the last few decades. AIDS, due to the Human Immunodeficiency Virus (HIV) caused through sexual transmission and Severe Acute Respiratory Syndrome (SARS) are two such examples. While these cannot be directly related to environmental change, they affect the environment in which we live by forcing a change in lifestyles and behaviour patterns.

While better health care has led to longer life spans, coupled with a lowered infant mortality, it has also led to an unprecedented growth in our population which has negative implications on environmental quality. A better health status of society will bring about a better way of life only if it is coupled with stabilising population.

Environmental health, as defined by WHO, comprises those aspects of human health, including quality of life, that are determined by physical, chemical, biological, social, and psychosocial factors in the environmentDefinition of Health Impact Assessment (HIA) by WHO, Health impact assessment is combination of procedures, methods and tools by which a policy, program or project may be judged as to its potential effects on the health of a population, and the distribution of those effects within the population.

4.6.2 IMPORTANT STRATEGIC CONCERNS

• The world must address people's health care needs and sustainable use of natural resources, which are closely linked to each other

• Strategies to provide clean potable water and nutrition to all people is an important part of a healthy living environment

• Providing clean energy sources that do not affect health is a key to reducing respiratory diseases.

• Reducing environmental consequences of industrial and other pollutants such as transport emissions can improve the status of health.

• Changing patterns of agriculture away from harmful pesticides, herbicides and insecticides which are injurious to the health off farmers and consumers by using alternatives such as Integrated Pest Management and non-toxic bio pesticides can improve health of agricultural communities, as well as food consumers.

• Changing industrial systems into those that do not use or release toxic chemicals that affect the health of workers and people living in the vicinity of industries can improve health and environment.

• There is a need to change from using conventional energy from thermal power that pollutes air and nuclear power that can cause serious nuclear disasters to cleaner and safer sources such as solar, wind and ocean power that do not affect human health. Providing clean energy is an important factor that can lead to better health.

• The key factors are to control human population and consume less environmental goods and services which could lead to'health for all'. Unsustainable use of resources by an ever growing population leads to unhealthy lives.

4.7 Role of Information Technology in Environment

Information technology plays a vital role in the field of environmental education

Information technology means collection, processing storage and dissemination of information.

A number of software have been developed so study about the environment.

The internet facilities, information through satellites, World Wide Web, and Geographical Information systems, provide us up-to-date information on various aspects of environment, weather.

4.7. 1. REMOTE SENSING

Remote sensing refers to any method, which can be used to gather information about an object without actually coming in contact with it.

Any force field like acoustic, gravity, magnetic, electromagnetic, etc., could be used for remote sensing, covering various disciplines extending from laboratory testing to astronomy.

At present the term 'remote sensing' is used more commonly to denote identification of earth feature by detecting the characteristics electromagnetic radiation that is reflected/emitted by the earth.

4.7.2 COMPONENT OF A REMOTE SENSING SYSTEM

A remote sensing system consists of a sensor to collect radiation and other important parts includes

1. Platform.
2. An Aircraft.

3. A balloon.

4. Rocket and

5. Satellite

The information received by the sensor is suitably manipulated and transported back to the earth. The data are reformed and processed on the ground to produce Photographs computer compatible magnetic tapes (CCT) or other digital storage medium .The Photographs data are interpreted visually/digitally to produce thematic maps and other resource information. Detection of the energy by the sensor, converting it into Photographic image or electrical output Transmission of the sensor output. Preprocessing of the data and generation of the data products Collection of ground truth and other information Data analysis and interpretation Integration of interpreted images with other data towards deriving magnet strategies for various themes or other applications.

4.7.3 REMOTE SENSING SYSTEM FOR RESOURCE MANAGEMENT

1. Remote sensing data (image) have been used to derive thematic information on various natural resources and environment. The type and level of information extracted depends on the expertise of the analyst and what he is looking in the data.
The remote sensing image of land can be used to derive information of vegetative cover, water bodies, land use pattern, geological features, soil etc.,

2. In forestry Sustainable forest information on the type, wood volume and biomass, losses, encroachment etc. are informed early.

3. In land Cover Spatial information on land use is required at different depending upon use.
Remote Sensing data is converted to the spatial resolution plays a role on the scale of mapping.
Remote sensing data has been used in many applications related to water resources such as surface water body mapping, ground water targeting, wetland, inventory, flood monitoring,
management requires reliable density and extent of forest Cover, forest fire, pest and disease induced Remote sensing provides all such scales map,

4. Water resources, reservoir sedimentation, water quality monitoring, run-off modeling, Snow cover monitoring, irrigation water management and many more.
One of the simplest applications is inventorying surface water bodies.

4.7.4 DATABASE

Database is the collection of inter-related data on various subjects. It is usually in computerized form and can be retrieved whenever required. There are several Distribution Information Centres (DICs) in our country that are linked with each other and with the central information network having access to international database.

The Ministry of Environment and Forests, Government of India has taken up the task of compiling a database on issues like wildlife, forest cover, wastelands etc.

4.7.5 ENVIRONMENTAL INFORMATION SYSTEM (ENVIS)

ENVIS established in 1982 aims on providing environmental information to decision makers, policy planners, engineers and scientists all over the country. ENVIS centres work for generating a network of database in areas like pollution control, clean technologies, biodiversity, renewable energy, wildlife, environmental management and remote sensing.

Objectives of ENVIS

a. To build up a repository and dissemination centre in Environmental Science and Engineering.

b. To gear up modern technologies of acquiring, processing, storage, retrieval and dissemination of information of environmental nature.

c. To promote research, development and innovation in environmental information technology.

d. To provide national environmental information service relevant to meet the future needs.

ENVIS Network

ENVIS has a network of several participating institutions forming a number of nodes, known as ENVIS centers, which work with a Focal Point in the Ministry of Environment and Forests. Due to its compact network, ENVIS has been designed as the National Focal Point (NFP) for INFOTERRA, a global environmental information network of United Nations Environment Programme (UNEP).

a. ENVIS India is in process of establishing 85 ENVIS nodes of which 81 have already been established which include government departments, institutions and NGO's.

b. ENVIS nodes are supposed to create websites on specific environment related areas, establishes linkages with all information sources, create database on selected parameters and publish bulletins. They serve as interface for the users on the assigned subject.

4.7.6. NATIONAL MANAGEMENT INFORMATION SYSTEM (NMIS)

NMIS of the Department of Science and Technology has compiled a database on Research and Development projects along with information about research scientists and personnel involved.

4.7.7 GEOGRAPHICAL INFORMATION SYSTEM (GIS)

GIS has proved to be a very effective tool in environmental management. GIS is a technique of superimposing various thematic maps using digital data on a large number of inter-related or inter-dependent aspects.

Applications of GIS

1. Different thematic maps containing digital information on a number of aspects like water resources, forest land, soil type, crop land, industrial growth, human settlement etc. are superimposed in a layered form in computer using soft-wares.
2. Interpretations of polluted zones, degraded lands can be made based on *GIS.*
3. GIS can be used to check unplanned growth and related environmental problems.

4.7.8 SATELLITE DATA

1. Satellite data helps in providing correct and reliable information about forest-cover.
2. It also provides information of atmospheric phenomena like monsoon, ozone layer depletion, smog, etc.,
3. From the satellite data many new reserves of oil, minerals, can be discovered.

4.7.9 WORLD WIDE WEB

A vast quantum of current data is available on World Wide Web. One of the most important online learning centres with power web is www.mhhe com, which provides current information on environmental science.

Important on-line learning Centre

1. Www.mhhe. com / environmental science.
2. Multimedia Digital Content Manager (DCM) in the form of CD-ROM.

Applications

1. This on-line learning centre provides the current and relevant information on, principles, problems, queries, application of environmental science.
2. It has digital files of phto5, power point lecture presentations animations web exercises and quiz. These are useful to both Students and teachers of environmental Studies.

4.8 Role of Information Technology in Human Health

4.8.1 INTRODUCTION

Information Technology plays a key role in human health.

It has changed the human life style completely. Many health organizations are turning to package solution of IT for streamlining service oriented work in an effective manner. The health service technology mainly involves three systems. They are

1. Finance and accounting.
2. Pathology.
3. Patient Administration: Clinical System

The IT packages purchased from U.S Company was found successful in the finance and accounting and pathology systems. But there were difficulties in implementing patient administrative system (PAS) or clinical system which involves the registration, admission and transfer of patients as well as medical records,

- sundry handling,
- clinical order entry,
- results operating and
- The clinic scheduling systems.

The implementation of IT packages of the PAS went off successfully with rural hospitals as well as medium-sized hospitals without much complication, whereas the PAS system was met with constant difficulties in implementation in larger hospitals and with networks.

4.8.2 INSTITUTE OF OCCUPATIONAL HEALTH NATIONAL

The National Institute of Occupational Health, developed by the Indian government, provides computerized information on occupational health i.e., the health aspects of people working in various hazardous and non-hazardous industries, safety measures, etc.

4.8.3 ONLINE INFORMATION ON HEALTH:

It provides vast quantum of information on different subjects including human health and environment. The patient can seek help of a super-specialist doctor placed at far off distance. Recently, an American Company M-square started Home Medican Transcription System (Hometrans) under which a medical online service can be started from home. The person

interested in it needs to have a computer, telephone, helpline, voice script software and an internet for operating medical transcription.

4.9 Disaster Management

Introduction

Disaster, as defined by the United Nations, is a serious disruption of the functioning of a community or society, which involves widespread human, material, economic or environmental impacts that exceed the ability of the affected community or society to cope using its own resources.

Disaster management is how we deal with the human, material, economic or environmental impacts of said disaster, it is the process of how we "prepare for, respond to and learn from the effects of major failures". Though often caused by nature, disasters can have human origins. According to the International Federation of Red Cross & Red Crescent Societies a disaster occurs when a hazard impacts on vulnerable people. The combination of hazards, vulnerability and inability to reduce the potential negative consequences of risk results in disaster

(VULNERABILITY+ HAZARD) / CAPACITY = DISASTER

Natural disasters and armed conflict have marked human existence throughout history and have always caused peaks in mortality and morbidity. This article examines the advances in the humanitarian response to public health over the past fifty years and the challenges currently faced in managing natural disasters and armed conflict.

According to the International Federation of Red Cross & Red Crescent Societies Natural Disasters are naturally occurring physical phenomena caused either by rapid or slow onset events that have immediate impacts on human health and secondary impacts causing further death and suffering.

Types of Disasters

Natural Disasters

- Geophysical (e.g. Earthquakes, Landslides, Tsunamis and Volcanic Activity)
- Hydrological (e.g. Avalanches and Floods)
- Climatological (e.g. Extreme Temperatures, Drought and Wildfires)
- Meteorological (e.g. Cyclones and Storms/Wave Surges)
- Biological (e.g. Disease Epidemics and Insect/Animal Plagues)

The United Nations Office for Disaster Risk Reduction characterise Natural Disasters in relation to their magnitude or intensity, speed of onset, duration, and area of extent e.g.

Earthquakes have short durations and usually affect a relatively small region, whereas Droughts are slow to develop and fade away and often affect large regions.

Man-made Disasters

Man-Made Disasters as viewed by the International Federation of Red Cross & Red Crescent Societies are events that are caused by humans which occur in or close to human settlements often caused as a results of Environmental or Technological Emergencies. This can include,

- Environmental Degradation
- Pollution
- Accidents (e.g. Industrial, Technological and Transport usually involving the production, use or transport of hazardous materials)

Some disasters can result from multiple hazards, or, more often, to a complex combination of both Natural and Man-made causes which involve a break-down of authority, looting and attacks on strategic installations, including conflict situations and war.

Complex Emergency

- Food Insecurity
- Epidemics
- Armed Conflicts
- Displaced Populations

According to ICRC these Complex Emergencies are typically characterized by

- Extensive Violence
- Displacements of Populations
- Loss of Life
- Widespread Damage to both Societies and Economies
- Need for Large-scale, Humanitarian Assistance across Multiple Agencies
- Political and Military Constraints which impact or prevent Humanitarian Assistance
- Increased Security Risks for Humanitarian Relief Workers.

Pandemic Emergencies

Pandemic (from Greek pan "all" and demos "people") is an epidemic of infectious disease that has spread across a large region, which can occur to the human population or animal population and may affect health, disrupts services leading to economic and social costs. It may be an unusual or unexpected increase in the number of cases of an infectious disease which already exists in a certain region or population or can also refer to the appearance of a significant number of cases of an infectious disease in a region or population that is usually

free from that disease. Pandemic Emergencies may occur as a consequence of Natural or Man-Made Disasters. These have included the following Epidemics.

- Ebola
- Zika
- Avian Flu
- Cholera
- Dengue Fever
- Malaria
- Yellow Fever

Comprehensive Disaster Management (CDM)

A Comprehensive Disaster Management (CDM) programme that illustrates the cyclic process by which we plan for and reduce the impact of disasters, and take steps to recover after a disaster has occurred. Appropriate actions at all points in the CDM cycle will lead to greater preparedness, better warnings, reduced vulnerability or the prevention of disasters during the next repetition of the cycle.

Phases of the CDM Cycle

There are four phases in the CDM cycle

1. **Mitigation**

During the mitigation phase structural and non-structural measures are undertaken to limit the adverse impact of natural hazards, environmental degradation and technological hazards. According the United Nations International Strategy for Disaster Reduction (UNISDR), the adverse impacts of hazards often cannot be prevented fully, but their scale or severity can be substantially lessened by various strategies and actions.

Management activities in the mitigation phase encompass engineering techniques and hazard-resistant construction as well as improved environmental policies and public awareness, as well as hazard vulnerability and risk assessment.

Measures taken during the mitigation phase also address preventing natural or man-caused events from giving rise to disasters or any emergency situations, e.g. not allowing your child to have access to matches, gasoline, or kerosene oil.

2. **Preparedness**

During the preparedness phase of the CDM cycle measures are taken to reduce the minimum level possible, of loss in human life and other damage, through the organization of prompt and efficient actions of response and rehabilitation such as practicing earthquake and fire drills.

Preparedness activities are geared towards minimizing disaster damage, enhancing disaster response operations and preparing organizations and individuals to respond. They also involve planning, organizing, training, interaction with other organizations and related agencies, resource inventory, allocation and placement, and plan testing.

3. **Response**

Actions carried out in a disaster situation with the objective to save life, alleviate suffering and reduce economic losses. The main tool in response is the implementation of plans which were prepared prior to the event.

Response activities are post activities geared towards:

- Providing emergency assistance
- Reducing probability of additional injuries or damage
- Speeding recovery operations
- Returning systems to normal level.

4. **Recovery**

   In the recovery phase, also referred to as the recovery and rehabilitation phase, activities are geared towards the restoration of basic services and the beginning of the repair of physical, social and economic damage e.g. lifelines, health and communication facilities, as well as utility systems.

The recovery phase also includes efforts to reduce disaster risk factors.

4.9.1 FLOODS

Definition

When water flow exceeds, water carrying capacity of water bodies decreases. Then excess of water overflow on the surrounding and living area is called flood.

Causes of flood

- Heavy rainfall, rainfall during cyclone
- Sudden snow melt
- Lowering the water carrying capacity of channels
- Excess release of water from dams
- Construction work on earth reduces infiltration capacity of soil, speed up water flow Clearing of forest.

Effects of flood

- Heavy suffering to the people living in the low lying area
- Their houses and properties were destroyed
- Destroy the crops and live stock
- Economic loss and health diseases

Flood management

- Encroachment of flood way
- Building walls prevent from flood
- Divert the flood direction into dry water bodies
- Encroachment of plain should be banned
- Construction of garden, parks and zoo in the plain
- River net working
- Pre and after flood information should be broadcasted
- Afforestation

4.9.2 CYCLONE

- Low depression formed on ocean and sea moves towards the land and destroys the living and non living things in land area.
- Their speed varies between 180-500 km/hr

Different names of cyclone

- Hurricane
- Typhoons
- Cyclones
- Willy Willies

Effect

- Damage to human life, crops, roads, transport, communication, tanks, livestock.
- Slowdown the developmental activities

Cyclone management

- Forecasting the weather condition and intensity of cyclone
- Cyclone warning by radar system

- Every half an hour location of cyclone should be announced
- We should not stop the cyclone but minimize the damage
- Afforestation

4.9.3 Land slides

- The movement of earth materials like rock, stones, soil, and debris from higher region to lower region is called landslides.

Causes of land slides

- Rain, forces on top materials, over weight on top material, too steep slope and lubricating the layers
- Transportation on the slope
- Earth quake, shocks, cyclone, and vibrations
- Water run off in rainy season and erosion in hill station
- Underground mining activities
- Road or house building on slope

Effects

- Block the road and divert the passage
- Soil erosion
- Damage the livestock, crops, and houses

Landslides management

- Unloading the upper parts of the slope
- Improving the cultivation in the sloppy area
- Steepness of slope reduced by forming benches
- Concrete setup at the base of slope
- Soil stabilization using chemicals should be effective
- Drainage formation on the sloppy area

4.9.4 EARTH QUAKES

Definition

- It is a sudden vibration on earth surface due to sudden release of enormous amount of energy stored in the rocks under the earth crust.

Causes

- Volcanic eruptions, hydrostatic power.
- Underground nuclear testing.
- Decrease of underground water level.

Effect

- Landslides.
- Damage the settlement and transport system.
- Collapses houses and other structures.
- Peoples die in thousands.
- Deformation of ground surface.
- Tsunami, loss of life and property.

Earthquake management

- Constructing earth resistant buildings, wooden houses.
- Seismologist must analyze the possibility of earthquake in land areas.

SOCIAL ISSUES AND THE ENVIRONMENT – QUESTION BANK

Part-A

1. **Define the term of sustainable development.**

It is defined as "Sustainable development is development that meets the needs of the present, without compromising the ability of future generations to meet their own needs."

2. **Draw the dimensions of sustainable development**

Sustainable development requires balanced integration of economic, social and environmental dimensions.

What Is IPAT?

I = PAT or I = P x A x T

- This is an equation that expresses the idea that environmental impact (I) is the product of three factors such as population (P), affluence (A) and technology (T).
- This equation was first proposed by two scientists named Ehrlich and Holdren in the early 1970s as a way to calculate the impact of humans on the environment.

3. **What is Affluences?**

In the I=PAT Equation, A is the Affluence, it is means that the average consumption rate of individuals within the population.

4. **What is famine?**

A **famine** is a widespread scarcity of food, caused by several factors including war, inflation, crop failure, population imbalance, (or) government policies. This phenomenon is usually accompanied (or) followed by regional malnutrition, starvation, epidemic, and increased mortality.

5. **What is malnutrition?**

Malnutrition refers to deficiencies, excesses or imbalances in a person's intake of energy and nutrients. The term malnutrition covers two broad groups of conditions. One is 'under nutrition'-which includes stunting (low height for age), wasting (low weight for height), underweight (low weight for age) and micronutrient deficiencies or insufficiencies (a lack of important vitamins and minerals).

6. Define consumerism

It refers to the consumption of resources by the people. It is an organized movement of citizens and government.

7. Write the objectives of consumerism

1. It improves the rights and power of the buyers.
2. It involves making the manufacturer liable for the entire life cycle of a product.
3. It forests the manufacturer to reuse and recycle the product after usage.
4. Active consumerism improves human health and happiness and also it save resources.

8. Define Health Impacts Assessment (HIA)

Health impact assessment (**HIA**) is defined as "a combination of procedures, methods, and tools by which a policy, program, or project may be judged as to its potential effects on the health of a population, and the distribution of those effects within the population."

9. Brief the principle of remote sensing method

Remote sensing is the acquisition of information about an object or phenomenon without making physical contact with the object and thus in contrast to on-site observation, especially the Earth. Remote sensing is used in numerous fields, including geography, land surveying and most Earth Science disciplines (for example, hydrology, ecology, meteorology, oceanography, glaciology, geology).it also has military, intelligence, commercial, economic, planning, and humanitarian applications.

In current usage, the term "remote sensing" generally refers to the use of satellite- or aircraft - based sensor technologies to detect and classify objects on Earth, including on the surface and in the atmosphere and oceans, based on propagate signals (e.g. electromagnetic radiation).

It may be split into "active" remote sensing (such as when a signal is emitted by a satellite or aircraft and its reflection by the object is detected by the sensor) and "passive" remote sensing (such as when the reflection of sunlight is detected by the sensor).

10. Expand ENVIS

It is Environmental Information system which has been developed by the Ministry of Environment and forest, by the government of India. ENVIS works for generating a network

of database in areas like pollution control, clean technologies, remote sensing, coastal ecology and biodiversity etc.....

11. Write the applications of GIS

1. Different thematic maps containing digital information on various aspects like water resources, soil type, and forestland cropland are superimposed on a layered form in computer using software's.
2. Interpretation of polluted zones, degraded lands can be made based on GIS.
3. GIS can be used to check unplanned growth and related environmental problems.

12. What is flood?

Whenever the magnitude of water flow exceeds the carrying capacity of the channel within its banks, the excess of water over flows on the surrounding cause's floods.

13. Write steps for cyclone management

1. Satellite images are used by meteorological departments for forecasting the weather conditions, which reveal the strength and intensity of the storm.
2. Radar systems are used to detect the cyclone and are being used for cyclone warning.
3. For observing the exact location of cyclone, every half an hour satellite picture are analysed.
4. It is difficult to stop the information of cyclones, but the effect of which is minimized by planting more trees on the coastal belt, construction of dams, dykes, embankments and wind breaks.

14. Write the causes of landslides.

1. Downhill movement of earth is mainly caused by rain, forces either increasing the top material weight, lubricating the various layers or making the slope too steep.
2. Movement of heavy vehicles on the unstable sloppy regions create landslides.
3. Earthquake, shocks, vibrations and cyclone create landslides.
4. Underground caves and underground mining activities may also leads to landslides.

PART-B

1. What are the social impacts of growing population?
2. Discuss the role of information technology in the environmental protection and human health.
3. Write short note on Earthquake and cyclone.
4. Define Sustainable development and write the various methods to build a better sustainable development.
5. Explain the Essential of Food security.
6. What are the causes, effects and control measures of famine India?
7. Explain the process of consumerism and waste products.
8. Discuss the various natural disasters management.

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UNIT-V

TOOLS FOR ENVIRONMENTAL MANAGEMENT

5.1 Environmental Impact Assessment (EIA)

Environmental Impact Assessment (EIA) is a process of evaluating the likely environmental impacts of a proposed project or development, taking into account inter-related socio-economic, cultural and human-health impacts, both beneficial and adverse.

Objectives of EIA

1. **To identify the main issues and problem of the parties.**
2. **To identify who is the party.**
3. **To identify what are the problems of the parties.**
4. **To identify why the problems are arise.**

Benefits of EIA

1. **Cost and time of the project is reduced.**
2. **Performance of the project is improved.**
3. **Waste treatment and cleaning expenses are minimized**
4. **Usages of resource are decreased.**
5. **Biodiversity is maintained.**
6. **Human health is improved.**

5.1.1 PROCESS OF EIA (OR) KEY ELEMENTS OF EIA

The key elements used in the process of EIA are:

a) Scoping to identify which potential impacts are relevant to assess (based on legislative requirements, international conventions, expert knowledge and public involvement), to identify alternative solutions that avoid, mitigate or compensate adverse impacts on biodiversity (including the option of not proceeding with the development, finding alternative designs or sites which avoid the impacts, incorporating safeguards in the design of the project, or providing compensation for adverse impacts), and finally to derive terms of reference for the impact assessment.

b) Screening to determine which projects or developments require a full or partial impact assessment study.

c) Assessment and evaluation of impacts and development of alternatives to predict and identify the likely environmental impacts of a proposed project or development, including the detailed elaboration of alternatives.

d) Reporting the Environmental Impact Statement (EIS) or EIA report, including an environmental management plan (EMP), and a non-technical summary for the general audience.

Review of the Environmental Impact Statement (EIS), based on the terms of reference (scoping) and public (including authority) participation.

Decision-making on whether to approve the project or not, and under what conditions; and

e) Monitoring, compliance, enforcement and environmental auditing. Monitor whether the predicted impacts and proposed mitigation measures occur as defined in the EMP. Verify the compliance of proponent with the EMP, to ensure that unpredicted impacts or failed mitigation measures are identified and addressed in a timely fashion.

5.2 Risk Assessment

Risk assessment is defined as the overall process of risk identification, qualification, evaluation, acceptance, aversion and management. Risk management is the managerial response based on the resolution of various policy issues such as acceptable risk. Risk management decisions are made by considering risk assessments within the context of political, social and economic realities.

5.2.1 PROCESS OF RISK MANAGEMENT CONSISTS OF THE FOLLOWING

1. **Risk Identification**
2. **Risk quantification (or) Estimation**
3. **Risk evaluation**
4. **Risk acceptance**
5. **Risk aversion and control**

1. Risk Identification It is the process of observation and recognition of new risk parameters (or) new relationships among existing risk parameters or perception of a change in the existing risk parameters.

2. Risk estimation consequently, is an estimation process, starting from the occurrence probability and ending at the consequence values.

3. Risk evaluation is a complex process of the developing acceptable levels of risk to individuals, groups (or) the society as a whole.

4. Risk acceptance implies that a risk taker is willing to accept some risk is to obtain a gain (or) benefit, if the risk cannot possibly be avoided (or) controlled.

5. Risk aversion is the control action, taken to avoid or eliminate the risk, regulate or modify the activities to reduce the magnitude or frequency of adverse affects, reduce the vulnerability of exposed persons, property or in this case urban systems, develop and implement and recovery procedures and institute loss-reimbursement and loss-distribution.

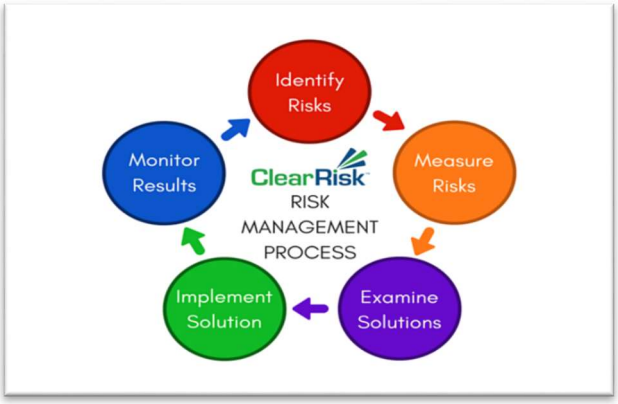

Fig 5:1 Scheme of Risk Management Process

5.3. Strategic Environmental Assessment (SEA)

Sadler and Verheem (1996) define Strategic Environmental Assessment (SEA) as the formalized, systematic and comprehensive process of identifying and evaluating the environmental consequences of proposed policies, plans or programmes to ensure that they are fully included and appropriately addressed at the earliest possible stage of decision-making on a par with economic and social considerations. Since this early definition the field of SEA has rapidly developed and expanded, and the number of definitions of SEA has multiplied accordingly.

SEA, by its nature, covers a wider range of activities or a wider area and often over a longer time span than the environmental impact assessment of projects.

SEA does not replace or reduce the need for project-level EIA (although in some cases it can), but it can help to streamline and focus the incorporation of environmental concerns (including biodiversity) into the decision-making process, often making project-level EIA a more effective process.

SEA is commonly described as being proactive and 'sustainability driven', whilst EIA is often described as being largely reactive.

5.4. The Environmental Impact Statement (EIS)

The Environmental Impact Statement (EIS) is a government document that outlines the impact of a proposed project on its surrounding environment. In the United States, these statements are mandated by federal law for certain projects. Environmental Impact Statements are meant to inform the work and decisions of policymakers and community leaders.

Here, teaching legal document will explore the EIS—what is it, who writes them and why, what parts and information are typically included, and why they are significant resources for teaching about the environment and environmental policy in the classroom.

5.4.1 STANDARD CONTENTS

The content of a federal EIS is regulated by the Council on Environmental Quality (CEQ), an office in the executive branch of the federal government tasked with enforcing the rules established by NEPA. A typical federal EIS includes the following four sections.

- Section 1-Introduces the proposed action and its purpose and need.
- Section 2-describes the affected environment, provides a baseline for understanding the current environmental situation in relation to the Proposed Action.
- Section 3-Presents a range of alternatives to the Proposed Action—this is considered the "heart" of the EIS.
- There is always no action alternative presented. Understanding how the environment would respond if no action were taken helps to evaluate the Proposed Action and Alternatives.
- Section 4-analyzes the environmental impact of each of the Proposed Actions and Range of Alternatives. The analysis include:
    - Impacts to threatened or endangered species
    - Air and water quality impacts
    - Impacts to historical and cultural sites, particularly sites of significance for indigenous peoples
    - Social and economical impacts to local communities, including housing stock, businesses, property values, and considerations of aesthetics and noise expected
    - Cost and schedule analysis for all of the actions and alternatives presented.

The EIS may include additional topics not required for every project, including financial plans, environmental mitigation plans, and plans for complying with any additional required federal, state, or local permits.

With so much to address, the typical EIS is a lengthy document, often more than 100 pages. The table of contents, however, makes quick work identifying specific sections that might be most useful for a classroom discussion or civic action.

5.5. ENVIRONMENTAL AUDIT

Environmental audit is a general term that can reflect various types of evaluations intended to identify environmental compliance and management system implementation gaps, along with related corrective actions. In this way they perform an analogous (similar) function to financial audits.

5.5.1 TYPES OF AUDITS

There are generally two different types of environmental audits: compliance audits and management systems audits.

a) **Compliance Audits**

As the name implies, these audits are intended to review the site's/company's legal compliance status in an operational context.

Compliance audits generally begin with determining the applicable compliance requirements against which the operations will be assessed. This tends to include federal regulations, state regulations, permits and local ordinances/codes. In some cases, it may also include requirements within legal settlements.

Compliance audits may be multimedia or programmatic.

Multimedia audits involve identifying and auditing all environmental media (air, water, waste, etc.) that apply to the operation/company.

Programmatic audits (which may also be called (thematic or media-specific) are limited in scope to pre-identified regulatory areas, such as air.

b) **Management System audit** An audit conducted on a management system. It can be described as a documented activity performed to verify, by examination and evaluation of objective evidence, that applicable elements of the system are appropriate and effective and have been developed, documented, and implemented in accordance and in conjunction with specified requirements.

5.5.2 ENVIRONMENTAL AUDITING PROCESS

To ensure that your environmental management system (EMS) is properly set up and effectively maintained, you need to **plan and carry out environmental audits**. Each audit should consist of a planning stage, the audit itself and post-audit activities.

Systematic approach to environmental audits

1. Plan the audit – a) decide which area, process or procedure you are going to audit according to the plan. b) Speak to the manager responsible to ensure that resources will be available and that there is no conflict with operational requirements.

2. Prepare checklists –a) read through the procedures applicable to that area and then prepare an internal audit form. b) Obtain and review any necessary background documents. c) Review your EMS documents.

3. Conduct and document the audit –a) Ask questions and observe. Record the replies and your observations on your audit form immediately. b) Try to carry out your audit when people are carrying out the process or working in the areas being audited. c) Identify and summarize all non-conformances and observations.

4. Request corrective actions –a) write down your suggestions and get agreement from the person responsible for the area being audited. b) Complete any administrative tasks. c) State the date for the next audit.

5.6. ISO 14000

ISO 14000 is a series of environmental management standards developed and published by the International Organization for Standardization (ISO) for organizations. The ISO 14000 standards provide a guideline or framework for organizations that need to systematize and improve their environmental management efforts. The ISO 14000 standards are not designed to aid the enforcement of environmental laws and do not regulate the environmental activities of organizations.

5.6.1 OBJECTIVES OF ISO 14000

The primary objective of the ISO 14000 series of standards is to promote effective environmental management systems in organizations.

The standards seek to provide cost-effective tools that make use of best practices for organizing and applying information about environmental management.

The ISO 14000 family was developed in response to a recognized industry need for standardization. With different organizational approaches to environmental management, comparisons of systems and collaboration had proved difficult.

Compliance to an ISO 14000 EMS (Environmental Management Systems)

- Assures customers of your commitment to demonstrable environmental management
- Maintains excellent public relations
- Satisfies investor criteria and improves access to capital
- Obtains insurance at reasonable cost
- Enhances your image and market share
- Meets your clients' registration requirements
- Improves cost control by identifying and eliminating waste and inefficiency
- Lessens incidents that result in liability
- Reduces your consumption of materials and energy
- Facilitates the attainment of permits and authorizations
- Decreases the cost of complying with environmental regulations
- Improves industry-government relations

ISO 14000 registration

The registration of ISO 14000 is the formal recognition of an organization's ability to conform to the requirements of an EMS. Organizations may simply declare that their EMS meets the requirements of ISO 14001 ("self-declaration"). However, many organizations choose to have their EMS registered, usually to provide greater assurance to clients and the public, or because regulators and clients require it.

What are the principles behind the ISO 14000 series?

The ISO 14000 standards and documents are being developed with the following key principles in mind:

- To result in better environmental management
- To encompass environmental management systems and the environmental aspects of products
- To be applicable in all countries
- To promote the broader interests of the public as well as users of these standards
- To be cost-effective, non-prescriptive and flexible so they are able to meet the differing needs of organizations of any type or size, worldwide
- As part of their flexibility, to be suitable for internal and/or external verification

- To be scientifically based
- Above all, to be practical, useful and usable.

5.6.2 ISO 14000 FACTS

- ISO 140ISO 14004:2016 - Environmental Management Systems - General Guidelines On Implementation
- ISO 14006:2011 - Environmental Management Systems - Guidelines For Incorporating Eco design
- ISO 14015:2001 – Environmental Management – Environmental Assessment of Sites And Organizations (EASO)
- ISO 14020:2000 – Environmental Labels And Declarations – General Principles

5.7. Precautionary Principle and Polluter pays principle

Precautionary Principle

INTRODUCTION Precautionary principle is a new principle for guiding human activities, to prevent harm to the environment and to human health and has been emerging during the past few decades. The precautionary principle was first introduced in 1984 at the first international conference on protection of the North Sea. Soon after, the principle integrated with many other legally binding international treaties such as the Rio Declaration and Kyoto Protocol.

5.7.1 FORMULATIONS OF PRECAUTIONARY PRINCIPLE

Many definitions of the precautionary principle exist: Precaution may be defined as "caution in advance", "caution practiced in the context of uncertainty", or informed prudence.

Two ideas lie at the core of the principle

1. An expression of a need by decision-makers to anticipate harm before it occurs. Within this element lies an implicit reversal of the onus of proof: under the precautionary principle it is the responsibility of an activity-proponent to establish that the proposed activity will not (or is very unlikely to) result in significant harm.
2. The concept of proportionality of the risk and the cost and feasibility of a proposed action.

5.7.2 APPLICATIONS

The application of the precautionary principle is hampered by both lack of political as well as the wide range of interpretations placed on it.

1. Scientific uncertainty should not automatically preclude regulation of activities that pose a potential risk of significant harm (Non-Preclusion PP).

2. Regulatory controls should incorporate a margin of safety; activities should be limited below the level at which no adverse effect has been observed or predicted (Margin of Safety PP).
3. Activities that present an uncertain potential for significant harm should be subject to best technology available requirements to minimize the risk of harm unless the proponent of the activity shows that they present no appreciable risk of harm (BAT PP).
4. Activities that present an uncertain potential for significant harm should be prohibited unless the proponent of the activity shows that it presents no appreciable risk of harm (Prohibitory PP).

5.7.3 POLLUTER PAYS PRINCIPLE

The principle is simple; those who pollute the environment must pay for the damages they have caused. The idea originated in the 1970's when members of OECD (organization for Economic Co-operation and Development) countries introduced a payment method, where pollution control cost is to be financed by the polluters and not the public in general. Hence the method of environmental financing got its name the polluter-Pays principle. Even though this principle is accepted widely in practice, it is often been ignored.

Example: Farmers causing the death of fish through slurry pollution have not been fined the full costs of restoration of the river. As the polluter –pays principle is only a payment method designed to finance pollution control activities, it cannot guarantee efficiency or cost effectiveness in environment protection.

5.7.4 SCOPE OF THE POLLUTER-PAYS PRINCIPLE

The primary goal of the polluter-pays principle is to achieve and maintain a cleaner environment. The polluter pays principle of particularly valid for and an appropriate remedy to victims of damage from environmentally harmful activities. However other questions arise concerning the following,

1. The extent of environmental damages
2. The need for a reasonable and better compensation for such damages
3. The adoption of promotional measures or preventive approaches for better management of environmental resources.

Problems Associated with the implementation of the Polluter-Pays principle

1. Environmental conservation is often regarded as a luxury.
2. The product cost for environmentally goods.
3. Due to budget limitations.

5.8. Constitutional Provisions

India is the first country which has made provisions for the protection and improvement of environment in its constitution. In the 42nd amendment to the constitution in 1976, provisions to this effect were incorporated in the constitution of India with effect from 3rd Jan, 1977.In the directive Principles of state policy in Chapter-IV of the constitution, Article 48-A was inserted which enjoins the state to make endeavor for protection and improvement and safeguarding the forest and wildlife of the country.

5.8.1 THE PROVISIONS ACT FOR POLLUTION

1. Indian penal code
2. The criminal procedure code
3. The factories act
4. The Indian forest act
5. The merchant shipping Act

5.8.2 POLLUTION CONTROL BOARDS AND POLLUTION CONTROL ACTS

a) Central Pollution control board (CPCB)

According to section 16 – A, in India the following are the functions of CPCB.

Functions

1) It advises the central govt –regarding the pollution prevention.
2) It plans for the prevention and control of pollution
3) It lays down standards for the well water and air.
4) It identifies areas or industries causing air pollution
5) It encourage industries to adopt 3R for wastes.
6) It advises the industries to treat effluents with modern technology.
7) It establishes laboratories for the analysis of air and water samples.
8) It provides technical assistance and guidance to state boards.
9) It sponsors research regarding water and air pollution
10) It embassies' clean technology by the industries to reduce pollution.

b) State pollution control board(SPCB)

Functions

Under section 7 – B in India the following are the function of the SPCB

1. Planning a comprehensive program for prevention, control and abatement of pollution.
2. Advise the state government regarding the pollution control and location of industries.

3. Conducting and encouraging investigations and research related to different aspects of pollution.
4. Inspecting effluent and water treatment plant.
5. Prescribing effluent standards
6. Establishing laboratories for analysis of sample
7. Performing any function assigned by the CPCB or SPCB
8. Evolving economical and reliable methods of disposal, treatment and reuse of waste / water
9. Organizing educational programs in collaboration with CPCB.

5.8.3 POLLUTION CONTROL ACTS IN INDIA

Some of the Environmental legislation and laws that India has formulated,

1. The water (prevention and control of pollution) Act, 1974, as amended up to 1988
2. The water (prevention and control of pollution) Rules 1975
3. The water (prevention and control of pollution) Rules 1975(procedure for transaction of business)
4. The water (prevention and control of pollution) Cess Act,
5. The Air (prevention and control of pollution) Act, 1981 as amended by amendment Act, 1987.

5.8.4 ISSUES INVOLVED IN ENFORCEMENT OF ENVIRONMENTAL LEGISLATION

- Drawbacks of wildlife protection Act
- Drawbacks of Forest Act 1980 and
- Drawbacks of Environment Act 1972.

5.9. Environment (protection) Act, 1986

This is a general legislation law in order to rectify the gaps and laps in the above facts. This act empowers the Central government to fix the standards for quality of air, water, soil and noise and to formulate procedures and safe guards for handling of hazard substance.

Objectives of Environment Act

1. To protect and improvement of the environment.
2. To prevent hazards to all living creatures and property.
3. To maintain harmonious relationship between humans and their environment.

5.9.1 IMPORTANT FEATURES OF ENVIRONMENT ACT

1. Persons carrying on industry, operation, etc., not to allow emission or discharge of environmental pollutants in excess of the standards
2. Persons handling hazardous substances to comply with procedural safe-guards
3. Furnishing of information to authorities and agencies in certain cases
4. Powers of entry and inspection
5. Power to take sample and procedure to be followed in connection with Environmental laboratories
6. Government Analysts
7. Reports of Government Analysts
8. Penalty for contravention of the provisions of the act and the rules, orders and directions
9. Offences by companies
10. Offences by Government Departments

5.10. Role of Non –Government Organisation (NGO)

Non government organisations (NGO) are the legally constituted organisations created by voluntary organisation or people. They play an important role in all stages of project development (planning, execution). Their significant contribution is to impart environmental education. This organisation includes experts as well as the common layman. Mainly it requires the participation and commitment of the public.

5.10.1 IMPORTANT ROLES OF NGO'S

1. To protect environment resources and their economical use.
2. To organise course like lectures, seminars
3. To create informational materials like newsletter brouchers, booklets, articles and videos.
4. To analyse and monitor the resource independently
5. To protect the rights of the citizens to a healthy environment and consumer's rights to clean environment.
6. To keep vigil in the surrounding area, well, river, lake, land air against pollution and reporting to state board/ central board.
7. To conduct sampling and analysis of well/ river water to establish its quality.
8. To publish the notified restricted areas where to establish its quality.
9. To provide information on fish killing to the environment not noticed by the state board.

5.10.2 SOME IMPORTANT NGO'S IN INDIA

1. Centre for Science and Environment (CSE), New Delhi.
2. Centre of Environmental Education (CEE), Ahamadabad.
3. Environmental Society of India, Chandigarh
4. Madras Environmental Society, Chennai
5. Indian society of nature volunteer, sonepat.
6. Centre of Himalayan environment and development, chamoli,
7. Orissa Environment Society (OES), Bhuvaneswar.
8. Society for conservation of forest and wild life Pune.
9. Rajasthan environment preservation society, Jaipur.
10. Environmental society of Tirupathi, Tirupathi.

5.11. International conventions and protocols

Introduction

In order to deal with regional and global environmental changes, it is necessary to develop new scientific and political mechanisms that could operate at the international level. An international convention is intended to build an international consensus that a particular ecological, wildlife or pollution problem exists. The convention is worded in general terms to allow all the countries to "sign on" recognizing that the problem exists and that there is some need for concern and multinational action.

The convention usually does not include specific control action requirements. This allows the greatest number of countries to agree that there is problem without raising the concern for economic and social consequences of pollution control measures. The convention commits countries to conducting further research and monitoring on the issue and commits countries to various reporting requirements, asking for submission of regular reports to the conferences on what they have done to enforce the convention.

5.11.1 IMPLEMENTATION OF CONVENTIONS

Implementation of the convention involves a three-step process for most countries,

1. First, when a country signs the convention, often at the ministerial level, agreeing to the contents in principle. This signature does not impose a legal obligation on the signing country to ratify at a later stage.
2. The national Government then ratifies that countries commitment to participating in the convention activities. The idea of ratification developed because it was thought reasonable

that, after a convention had been signed, countries should have a further opportunity to consider the often complex and important issues involved before finally being legally bound by them.

3. The convention activities enter in to force when a specified number of countries sign and ratify their involvement. The number of countries needed to trigger entry in to force is established during the negotiation process and convention to convention.

5.11.2 MAJOR INTERNATIONAL ENVIRONMENTAL CONVENTIONS

1. Ramsar Convention (Convention on wetlands of international Importance especially as waterfowl habitat)

In 1971 in Ramsar, Iran. The International Conference on preservation of marshes and waterfowl was held, the objectives of which were to recognise the importance of marshes for animals and plants and the ecological system as a whole and to promote the conservation of marshes.

2. CITES (Convention on international trade in endangered species of wild fauna and flora)

CITES aims to protect wild fauna and flora in danger of extinction by corporation in restricting international trade between export and import states. CITES were first formed in the 1960's international discussion of the regulation of wildlife trade for conservation purposes was something relatively new. With hind sight, the need for CITES is clear.

Annually, international wide life trade is estimated to be worth billions of dollars and to include of millions of plant and animal specimens. The trade is diverse, range from live animals and plants to a vast array of wildlife product derived from them. Many wildlife species in trade are not endangered, but the existence of an agreement to ensure the sustainability of the trade is important in order to safeguard these resources for the future.

CITES was drafted as a result of a resolution adopted in 1963 at a members of IUCN. The text of the convention was finally agreed at a meeting of representatives of 80countries in Washington DC.

CITES works by subjecting international trade in specimens of selected species to certain controls. These require that all import, export, re-export and introduction from the sea of species covered by the convention have to be authorised through a licensing system.

3. Vienna Convention for the Protection of the Ozone Layer

The Ozone layer around the globe absorbs most of the ultra violet rays (UV-B) that harm creatures, but CFCs and some other substances destroy the ozone layer. If the ozone layer is deleted, the amount of UV-rays which reaches the ground will increase and in effect human body or ecological balance will be damaged. People became keenly aware of life mechanism and vienna conventions for the protection of the ozone layer in 1985, and montreal protocol on substances that deplete the ozone layer in 1987 were adopted.

4. **Basel Convention (Basel Convention on the control of Transboundary movement of Hazardous wastes and their disposal)**

In 1980s, some African stated suffered from environmental pollution caused by wastes moved from developed European states. To deal with these problems, the Basel convention on the control of Transboundary movement of wastes was adopted in Basel, Switzerland in march 1989.

5. **Earth Summit – Conventions on Climate Change and Biological Diversity**

In 1992, more than 100 heads of state met in Rio de Janeiro, Brazil for the first international Earth summit convened to address urgent problems of environmental protection and socio economic development. The assembled leaders signed the convention on climate change and the convention on Biological diversity, endorsed the Rie de declaration and the forest principles, and adopted agenda 21 for achieving sustainable development in the 21st century.

Environment and development agenda compasses the following issues,

- Combating poverty
- Changing consumption patterns.
- Demographic dynamics and sustainability
- Protection and promotion of Human health.
- Promoting sustainable human settlement development
- Science for sustainable development.
- Promoting education, public awareness and training.
- National mechanisms and international cooperation for capacity – building.

During this convention a commission on sustainable development (CSD) was created to monitor and report on implementation of the earth summit agreements.

The following are the major principles agreed upon in the Rio declaration.

1. Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature.
2. State should cooperate to promote a supportive and open international economic system that would lead to economic growth and sustainable development in all countries, to better address the problems of environmental degradation.

3. States should effectively cooperate to discourage or prevent the relocation and transfer to other states of any activities and substances that cause serve environmental degradation or are found to be harmful to human health
4. Peace, development and environmental protection are interdependent and indivisible.
5. State shall resolve all their environmental disputes peacefully and by appropriate means in accordance with the character of the United Nations.
6. **UNFCC (United National Framework convention on Climate Change)**

When the percentage of green houses gases like CO_2 has increases in the air brings about global warming, and it has caused grave concern in recent years. The United Nations Framework convention on climate change (UNFCC) was adopted in may 1992 in the earth summit in Rio de Janerio. The objectives of this convention were to stabilize the density of green house gases, and to reduce or limit the emissions of these gases.

7. **CBD (Convention on Biological Diversity)**

Convention on biological diversity adopted in 1992 in the earth summit in Rio De Janerio, aims for the conversion of biological diversity, the sustainable use of its components and the fair and equitable sharing of benefits arising out of the utilization of genetic resourced.

8. **UNCCD (United Nations to Combat Desertification in Those countries Experiencing serious Drought and / or Desertification, Particularly in Africa)**

The convention to combat desertification provides that developing country parties affected by desertification undertake to prepare and implement national and regional action program as appropriate and that developed country parties undertake to support such efforts.

9. **International Plant Protection Convention (IPPC)**

The international Plant Protection Convention is a treaty deposited with the director –General of FAO of the UN. It has basically been designed to control pests, with the more specific purpose of securing common and effective action to prevent the spread and introduction of pests of plant and plant products and promoting measures for their control.

10. **Stockholm convention on POPs (Persistent Organic Pollutants)**

The Stockholm Convention aims to reduce and eliminate 12 POPs that can possibly affect the next generation, such as Dioxin, Furan, and DDT. POPs are chemical that remain intact in the environment for long periods, become widely distributed geographically accumulate in the environment for long periods and also become widely distributed geographically accumulate in the fatty tissue of living organism and they are toxic to humans and wildlife. POP circulates globally and can cause damage wherever they travel.

5.11.3 MAJOR INTERNATIONAL ENVIRONMENTAL PROTOCOLS

1. The Montreal Protocol on Substances that Deplete the Ozone Layer

The Vienna convention for the protection of the Ozone Layer (1985), which outlines a country's responsibilities for protecting human health and the environment against the adverse effects of ozone depletion and established the frame work under which the Montreal protocol was negotiated. The Montreal protocol on substance that Deplete the ozone layer is a landmark international agreement designed to protect the stratospheric ozone layer. The treaty was originally signed in 1987 and substantially amended in1990's and 1992.

In India an ozone Cell in ministry of Environment and forests came in to existence with effect from 1 April, 1993. It deals with all works relating to the Vienna Convention for the protection of Ozone Layer and the Montreal protocol for phasing out Ozone Depleting Substances (ODS) the use of ODS is to be phased out by the year 2010 as per the schedule prescribed in the protocol.

2. Kyoto protocol

The **Kyoto Protocol** is an international treaty which extends the 1992 United Nations Framework Convention on Climate Change (UNFCCC) that commits state parties to reduce greenhouse gas emissions, based on the scientific consensus that (part one) global warming is occurring and (part two) it is extremely likely that human-made CO_2 emissions have predominantly caused it.

The Kyoto Protocol was adopted in Kyoto, Japan, on 11 December 1997 and entered into force on 16 February 2005. There are currently 192 parties (Canada withdrew from the protocol, effective December 2012) to the Protocol.

The Kyoto Protocol implemented the objective of the UNFCCC to reduce the onset of global warming by reducing greenhouse gas concentrations in the atmosphere to "a level that would prevent dangerous anthropogenic interference with the climate system" (Article 2). The Kyoto Protocol applies to the six greenhouse gases listed in Annex A: Carbon dioxide (CO_2), Methane (CH_4), Nitrous oxide (N_2O), Hydro fluorocarbons (HFCs), Per fluorocarbons (PFCs), and Sulphur hexafluoride (SF_6).

The Protocol is based on the principle of common but differentiated responsibilities, it acknowledges that individual countries have different capabilities in combating climate change, owing to economic development, and therefore puts the obligation to reduce current emissions on developed countries on the basis that they are historically responsible for the current levels of greenhouse gases in the atmosphere.

UNIT-V

TOOLS FOR ENVIRONMENTAL MANAGEMENT

Question Bank

PART-A

1. **What is the definition of environmental impact assessment?**

   Environmental Impact Assessment (EIA) is a process of evaluating the likely environmental impacts of a proposed project or development, taking into account inter-related socio-economic, cultural and human-health impacts, both beneficial and adverse.

2. **What are the stages of environmental impact assessment?**

   Key stages in the Environmental Assessment process include: screening, alternatives, preliminary assessment, scoping, mitigation and environmental statements.

3. **What do you mean by risk management?**

   Risk management is the process of identifying, assessing and controlling threats to an organization's capital and earnings. These threats, or risks, could stem from a wide variety of sources, including financial uncertainty, legal liabilities, strategic management errors, accidents and natural disasters.

4. **What are the five steps in risk management process?**

   Together these 5 risk management process steps combine to deliver a simple and effective risk management process.

   Step 1: Identify the Risk. ...

   Step 2: Analyze the risk. ...

   Step 3: Evaluate or Rank the Risk. ...

   Step 4: Treat the Risk. ...

   Step 5: Monitor and Review the risk.

5. **What is the purpose of environmental audit?**

   The purpose of environmental auditing is to assess periodically the compliance of completed or on-going activities with the requirements of legislation, measures proposed in environmental policies, environmental management systems and environmental schemes or the provisions of standards and contracts.

6. What is meant by ISO 14000?

ISO 14000 is a series of environmental management standards developed and published by the International Organization for Standardization (ISO) for organizations. The **ISO 14000** standards provide a guideline or framework for organizations that need to systematize and improve their environmental management efforts.

7. What is the precautionary principle and why is it important?

The **Precautionary Principle** is a strategy to cope with possible risks where scientific understanding is yet incomplete, such as the risks of nano technology, genetically modified organisms and systemic insecticides. Imposed without adequate consideration of the human rights of those affected.

8. What does the polluter pays principle mean?

The '**polluter pays**' **principle** is the commonly accepted practice that those who produce pollution should bear the costs of managing it to prevent damage to human health or the environment.

9. Who is polluter?

A person or organization that puts harmful substances or waste into the water, air, etc., causing damage to the environment: The region's third-largest industrial polluter reduced its emissions by about a third.

10. What are the constitutional provisions?

Constitutional provision is a law that is written in the Constitution itself and does not come from a rule or statute. It establishes the basic rights, duties and structure of the polity. These provisions cannot be easily altered except by the way of amendment procedure given in the Constitution itself.

11. What are the core provisions of Indian Constitution?

The values expressed in the Preamble are expressed as objectives of the Constitution. These are: sovereignty, socialism, secularism, democracy, republican character of Indian State, justice, liberty, equality, fraternity, human dignity and the unity and integrity of the Nation.

12. What is the role of state pollution control board?

(a) To promote cleanliness of streams and wells in different areas of the state.

(b) To advise the Central Govt, on matters concerning the prevention and control of water pollution.

(c) To co-ordinate the actions of the State Board and resolve disputes among them.

13. What are the powers and functions of Central Pollution Control Board?

Functions of the Central Board at the National Level. Advise the Central Government on any matter concerning prevention and control of water and air pollution and improvement of the quality of air. Perform such other function as may be prescribed by the Government of India**.**

14. What is the full form of SPCB?

State Pollution Control Board (**SPCB**) - India Environment Portal. News, reports, documents, blogs, data, analysis on environment & development. India, South Asia.

15. What are international protocols?

In international politics, protocol is the etiquette of diplomacy and affairs of state. It may also refer to an international agreement that supplements or amends a treaty. A protocol is a rule which describes how an activity should be performed, especially in the field of diplomacy.

16. What are the international agreements to control global warming?

The Kyoto Protocol is an international treaty which extends the 1992 United Nations Framework Convention on Climate Change (UNFCCC) that commits state parties to reduce greenhouse gas emissions, based on the scientific consensus that (part one) global warming is occurring.

PART-B

1. Explain in detail about the process of EIA.
2. Write the different steps of Risk management.
3. Explain the Environmental Impact Statement (EIS).
4. Write the all the features of ISO 14000.
5. Give the details of Environmental Audits
6. Explain the precautionary Principle.
7. Describe about the polluter pays principle.
8. Elaborate the role of state and central pollution control boards.

9. Mention all the features of environmental (protection) Act,1986
10. Note on the role of NGO's in India.
11. Write about the major international Environmental conventions.
12. Explain some major environmental Protocols and their functions.

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