

Pollution is any change in physical, chemical or biological characteristics of the environment that has the potentiality to harm human life, other species, natural resources

Contamination is presence of harmful organisms or their toxins that cause discomfort or disease

CAUSES OF POLLUTION

- i) The major cause of pollution are
 - Automobile exhaust
 - Increasing use of pesticides, insecticides and herbicides
 - Waste chemical production from factories
 - Rise in atmospheric CO₂
 - Radioactive substances
- ii) Natural pollution is pollution caused by natural sources. Example: Volcanic eruption, release of methane by paddy fields and cattle, release of carbon monoxide of plants and animals, emission of natural gas, ozone, nitrogen oxide, soil erosion, dust storms, ultra-violet rays etc. 99.95% of pollution is natural
- iii) Man made or anthropogenic pollution is pollution resulting from human activities like burning of fossil fuels, deforestation, mining, sewage, industrial effluents, pesticides, fertilizers etc. Amount of man-made pollution is hardly 0.05% of total but more dangerous than natural pollution
- iv) On the basis emission, pollution may be :
 - Point source pollution: It is from single point. Example municipal sewage and chimney
 - Line source pollution: It is passed along a narrow belt. Example Road due to automobile exhaust.
 - Area source pollution: It is over a large area. Example. Sprayed fertilizers or pesticides through run off

CLASSIFICATION OF POLLUTANTS

On the basis of their existence in nature pollutants are of two types:

- Quantitative pollutants: These normally occurs in nature but are also added in large quantities by man. Examples: CO, CO₂ and nitrogen oxide

- Qualitative pollutants: They do not occur in environment normally but are added by man. Example: D.D.T, insecticides
- On the basis of form, pollutants are of two types
 - i) Primary pollutants: These persists in the form in which they are added to environment. Example DDT, plastics, CO
 - ii) Secondary pollutants: These are formed by reacting amongst the primary pollutants. Example nitrogen oxide and hydrocarbons react in presence of sunlight to form two secondary pollutants such as PAN (peroxy acyl nitrate). Secondary pollutants are more toxic than the primary pollutants. The phenomenon of increase in toxicity by reaction among the pollutants is called synergism
- On the basis of their nature of disposal the pollutants are of two types:
 - i) Non-degradable pollutants: Pollutants which cannot be broken down by micro-organism. Example: DDT, phenolic compounds, ABS, hydrocarbons
 - ii) Biodegradable pollutants: Pollutants which can be broken down by micro-organism. Example Sewage

EFFECT OF POLLUTION

- Pollution has adverse effect like:
 - i) Crop production change
 - ii) Causes different diseases
 - iii) Soiling of building and textiles
 - iv) Loss of resources
 - v) Metal corrosion
 - vi) Money, funds, manpower involved for pollution control

AIR POLLUTION

According to WHO (World Health Organization) air pollution may be defined as “ the presence of materials in the air in such concentration which are harmful to man and his environment”

- Major sources of atmospheric pollution are
 - i) Combustion of fissile fuels in homes, factories, thermal plants, automobiles, railways, etc
 - ii) Mining and processing
 - iii) Chemical industries
 - iv) Cosmetic industries

- v) Welding, stone crushing.
- vi) Construction and demolition
- 52% of air pollution is caused by CO, 18% by SO₂, 12% by hydrocarbon, 10% by particulates, 6% by nitrogen oxides, 2% by remaining.

AIR POLLUTANTS AND THEIR EFFECTS

- Carbon dioxide (CO₂) – A major pollutant in atmosphere comes from burning of fossil fuels.
- Carbon monoxide (CO) – It is produced due to incomplete combustion, metallurgical operations and naturally by plants and animal. Normally CO has a brief residence in atmosphere and gets oxidized to CO₂. CO combines with haemoglobin, produces carboxyhaemoglobin which impairs oxygen transport resulting in headaches, decreased vision, cardiovascular disease, asphyxia.
- Particulate matter (PM) – It consists of soot, flyash, dust of various types, fur, hair, spores, pollen grain etc. Particulate matter is differentiated into settleable (larger than 10 µm,) remaining in air for less than one day, and suspended (lesser than 10 µm) remains in air for more than one day to several week. SPM (suspended particulate matter) is maximum in Kolkata. SPM is differentiated in aerosol (less than 1 µm), dust (more than 1 µm) and mist (liquid, more than 1 µm)
According to Central Pollution Control Board, particles most harmful to human health are of 2.5 µm diameter. Dust and smoke produce smog. Smoke is similar to dust but consists of visible suspension of carbon and other particle suspension of carbon and other particles given off by burning or smouldering organic matter. PM causes respiratory disease, tuberculosis, byssinosis (due to cotton dust), allergy.
- Nitrogen oxide (NO_x) – They are produced naturally through biological and non-biological activities from nitrates, nitrites etc. They cause fading and deterioration of textiles, produce lesions, necrosis, defoliation. They also cause eye irritation, respiratory troubles, lung edema, blood congestion, dilation of arteries and cancer.
- Sulphur dioxide (SO₂) – It is produced during combustion of fossil fuels, refining of petroleum and melting of sulphur containing ores. Sulphur dioxide produces smog. Maximum SO₂ pollution is formed in Kolkata. It causes membrane damage, destruction of chlorophylls. Lichens are most sensitive to SO₂ pollution. SO₂ corrodes metal, impairs sensitive equipments, damages building, marble, paper and textiles. It produces eye irritation, damages

respiratory tract, produces asthma, bronchitis. SO_2 produces acid rain which destroys vegetation and degrades articles.

- Fluorides – They are produced during refining of minerals. Fluorides cause fluorosis. It causes chlorosis, necrosis of leaf tips and margins. It causes abnormal calcification of bones and teeth, frequent diarrhea, neuromuscular disorders.
- Hydrocarbons – These are produced naturally as well as due to incomplete combustion. Hydrocarbons are carcinogenic, cause irritation of eyes and mucous membrane. There is increased mucus secretion and tearing of alveoli. Methane is naturally occurring hydrocarbon produced due to decomposition of organic matter, paddy fields and incomplete combustion in automobiles, industries.
- Chlorofluorocarbon / Freons (CFC) – This chemicals is used in refrigerator, propellents CFC reacts with ozone and depleted it.
- Other atmospheric pollutants – Mercury (burning of coal, smelting), methyl isocyanate (pesticide manufacture), phosgene (pesticide manufacture, dye industries) and lead (automobile exhausts) are pollutants added to atmosphere. Bhopal gas tragedy was due to release of phosgene and methyl isocyanate.
- Smog (Des Voeux, 1905) – Smog is opaque dark fog having condensed water vapours, dust, smoke and gases. Smog is of two types
 - i) Classical (London) smog – It occurs at low temperature, contains sulphur gases, smoke and dust particles. Classical smog has reducing environment. It is dark brown and opaque. The smog is formed by condensation of water vapour with H_2S and SO_2 over dust and smoke particles. Classical smog occurred in London during December 1952 when it affected 50% population and killed over 4000 persons.
 - ii) Photochemical (Los Angeles) smog – It was first reported over Los Angeles in 1940's. Photochemical smog is produced at high temperature over cities and town due to still air, emission of nitrogen oxides. Nitrogen dioxide splits into nitric oxide and nascent oxygen. Nascent oxygen combines with oxygen to form ozone. Ozone reacts with hydrocarbon to form aldehydes and ketone. Nitrogen oxides, oxygen, ketones combine to form peroxyacyl nitrates (PAN)
- Peroxyacyl nitrate(PAN) – It is produced due to reaction between NO_x and hydrocarbons under the effect of UV – radiation of sunlight. It causes eye irritation, respiratory tract disease in human. Several enzymes are deactivated by PAN

PREVENTION AND CONTROL OF AIR POLLUTION

Source Correction

This is the easiest solution to air pollution, where we control the emissions by changing the quality process. Example : Elimination of lead in gasoline to minimize level of lead in air

Treatment

According to size, range and types of air pollutant, suitable devices are effective.

These are

- Settling chamber: To remove large particulates
- Cyclone separators: The dirt air is blasted into a conical cylinder. This creates a violent swirl within the cone, the heavy materials migrate to wall and exits from the bottom of the cone. The clean air exits out from top.
- Bag filters: Fabric bags are used to collect dust like common vacuum cleaner
- Wet collector: It promotes contact between air and water. Water is introduced through a narrow throat section.
- Electrostatic precipitators: In power plants charged particulate matters are separated and collected through pipe.
- Gas scrubbers: It is used for dissolving gases
- Absorption: Activated carbon is used to capture pollutants
- Incineration: For removing gaseous pollutants CO₂, H₂O and inerts are used.
- Catalytic combustion: Use of catalyst to remove pollutants.

Dispersion: It is process of spreading out emission over large area and thus reducing concentration of the specific pollutants

Vegetation – A broad strip of vegetation along road and around industrial area reduces particulate pollution

Control of vehicular air pollution – The Supreme court directed the government to take appropriate measures for reducing pollution caused by automobiles through:

- i) Switch over of public transport from petrol/diesel to CNG
- ii) Phasing out of old vehicles
- iii) Compulsory use of unleaded petrol and reduced sulphur content of diesel
- iv) Compulsory regular check up of pollution emission of vehicles
- v) Fitting the vehicle with catalytic converters

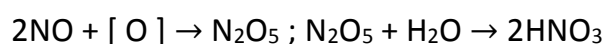
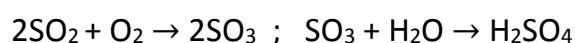
ACID RAIN

- The term was coined by Robert August
- Acid rain is rainfall and other forms of precipitation with pH less than 5. pH of normal rain is 5.6 – 6.5.
- Acid form atmosphere are deposited over earth in two forms

_ Wet deposition occurs through rain, snow and fog

_ Dry deposition is settling down of windblown acidic gases and particles over trees, articles and soil. About 50% of acidity is passed to earth as dry deposition

- Acid rain is caused by large scale emission of acidic gases into the atmosphere from thermal power plants, industries and automobiles. The common ones are sulphur dioxide, nitrogen oxide (NO_x), volatile organic carbon. NO_x are also produced in atmosphere through lightning. Sulphur dioxide and nitrogen oxides are changed in atmosphere into sulphuric acid and nitric acid by combining with oxygen and water.



- Acid rain damages plants by direct effect on foliage and growing plants – chlorosis, necrosis, defoliation. It causes leaching of essential mineral soil. Due to acid rain many lakes in Germany and other European countries have a pH of less than 5, an acidity level considered lethal for many aquatic species. Acidity dissolves toxic metals like Hg, Pb, Zn, Al. Both acidity and toxic metals kill all type of aquatic life except some algae and fungi. Acid rain corrodes metals, marble, painted surface, slates, stone etc. The phenomenon is called stone leprosy.

WATER POLLUTION

- The water pollution may be defined as presence of foreign organic, biological, radiological or physical substance in water that tends to lower its quality and either constitutes a health hazard or decrease the utility of water.
- The various categories of water pollution are:
 - Biological pollutants: Pathogens such as viruses, bacteria, protozoans, algae.
 - Chemical pollutants: Organic chemicals like biocides, polychlorinated biphenyls, inorganic chemicals like cadmium, mercury, lead.

- Physical pollutants: Hot water from industries, oil spills from oil carriers etc. These pollutants are generated by different sources and activities:

SOURCES OF WATER POLLUTION

DOMESTIC SEWAGE

- Liquid waste from domestic activities such as kitchen, toilet and other household, wastewater.
- Domestic effluents carry organic wastes which are biodegradable.

INDUSTRIAL WASTEWATER

- The major sources of water pollution comes from wastes from industries such as paper mills, leather tanneries, textile and jute mills, chemical and petroleum industries.
- Most of the coastal water are threatened by pollution from the effluents of coastal prawn cultures farm and fish processing industries
- Power plants and nuclear power stations are main source of thermal pollution of water. In these plants, water is used for cooling and it becomes hot. Release of hot waste water, having 8 to 10°C higher temperature than intake water, causes thermal pollution in the water body.

AGRICULTURAL SOURCES

- MODERN agricultural techniques require the use of millions of tones of artificial fertilizers, pesticides, insecticide for obtaining better yield. These get mixed with groundwater, lakes etc and produce several health hazards.

OIL SPILLS

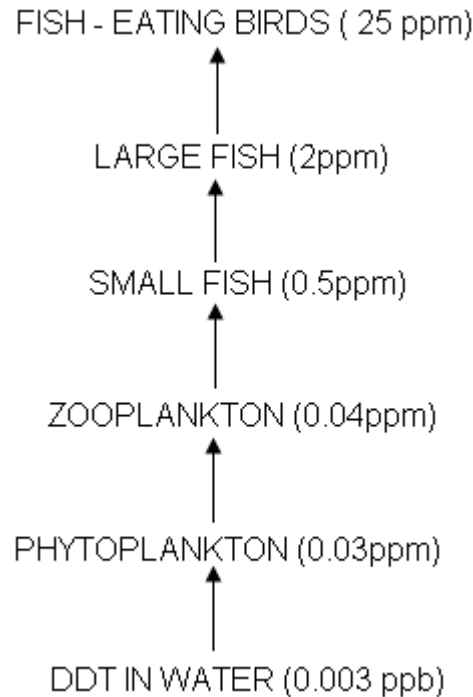
- Oil spills is the accidental discharge of petroleum in oceans or estuaries.
- Offshore oil mining, capsized oil tankers add to oil pollution of marine ecosystem.
- It forms thick layer called slick, which floats on the surface of sea and affect oceanic ecosystem as they are extremely harmful to coral reefs.

BIOLOGICAL MAGNIFICATION

- The phenomenon, through which certain pollutants gets accumulated in tissues in increasing concentrations along the food chains and produce fatal effect is called biomagnifications. The example of biological magnification is

that of DDT, which is an insecticide that is sprayed on water bodies to check the growth of mosquitoes.

- The concentration of DDT increases as it passes from water to plant body. Its concentration increases 800 times in the phytoplankton relative to the concentration in water. Zooplankton contained about 5 times greater DDT than phytoplankton.



BIOLOGICAL OXYGEN DEMANDS (BOD)

- Biological oxygen demand is the oxygen in milligrams required for five days in one litre of water at 20^o C for micro-organisms to metabolise organic wastes.
- BOD is a measure of oxygen required by aerobic material. Higher the BOD, lower would be dissolved oxygen (DO). Usually, a high BOD in water means high level of nutrients are present, along with a high number of microorganism feeding the nutrients.

EUTROPHICATION

- It is excessive growth of algae, plants and animals in water bodies due to nutrient enrichment particularly with nitrogen and phosphorus. Eutrophication is both natural and accelerated.
- Natural eutrophication occurs slowly at a rate which may not be detectable in human life time. Accelerated or cultural eutrophication occurs due to passage of sewage and run off from fertilized fields into ponds, lakes and other water bodies.

- Nutrients present in sewage and fertilizers cause dense growth of plants and planktonic algae. The algae use oxygen at night and may deoxygenate the water enough to kill fish and other animals. However, soon planktonic colouration to water depending upon the pigments present in them. The excess growth of planktonic algae that causes colouration of water is called algal bloom.
- In many cases bloom are formed by blue green algae. They are toxic to animals and humans. In some cases eutrophic water bodies support excessive growth of water hyacinth that chocks pond, lakes and rivers. Algal bloom and floating plants cut off light from submerged plants. They die and drastic decrease in oxygen causes organic loading of water and thus lakes turn into land.

EFFECTS OF WATER POLLUTION ON HUMAN BEINGS

- Domestic sewage contains pathogens like viruses, bacteria, protozoans and worms. Contaminated water causes diseases like cholera, typhoid, amoebiasis, jaundice etc. Such contamination makes water unsuitable for drinking, bathing etc.
- Heavy metal contamination causes serious health problems. Mercury poisoning (minamata disease) happens when mercury is converted into extremely toxic methyl mercury, which can cause numbness of limbs, lips and tongue, deafness, blurring of vision and mental retardation.
- Excess of nitrate in drinking water is unsafe for human health and fatal for infants. It reacts with haemoglobin and forms non-functional methaemoglobin that impairs oxygen transport. This is called methaemoglobin or blue baby syndrome
- Overexploitation of ground water perhaps initiates leaching of arsenic from soil and rock sources and contaminates ground water chronic exposure of arsenic causes black foot disease. Arsenic causes diarrhea, neuritis, lungs and skin cancer.
- Excess fluoride in drinking water causes teeth deformity, hardened bones and stiff painful joints or knock knee disease.
- Copper causes hypertension, uremia, fever.
- Lead interferes with oxygen and glucose metabolism. Harmful effects include anemia, vomiting, loss of appetite, damage to liver, kidneys and brain.
- Zinc causes vomiting, cramps, renal damage.

- Harmful effect of cobalt includes diarrhea, hypertension, damage to liver and kidney, diarrhea and skeletal deformities call itai-itai.

CONTROL OF WATER POLLUTION

- Improved methods for handling and disposal of sewage garbage should be introduced.
- To control the epidemic and other diseases proper methods of sterilization of water drawn from shallow wells, should be developed.
- The effluents from industries should be neutralized and treated before discharges into streams. Suspended matter should be removed by settling or filtration and specific poisons should be removed by chemical methods
- The industrial and municipal wastewaters are treated in effluent treatment plant (ETP) prior to disposal in water bodies. Sewage treatment system often involves three stages:
 - Primary treatment: This is a physical process that involves the separation of large debris followed by sedimentation in tanks.
 - Secondary treatment: This is a biological process and is carried out by microorganism. In this treatment wastewater is pumped in shallow stabilization, where the microbes oxidize the organic matter. The process results in release of CO₂ and formation of sludge. The sludge is continually aerated for further oxidation. Algae grown in the upper lighted zone of the wastewater supply aeration by generating O₂.
 - Tertiary treatment: This is physico-chemical process that removes turbidity in wastewater caused by the presence of nutrients (nitrogen phosphorus, etc) dissolved organic matter, metals and pathogens. This stage involves chemical oxidation of wastewater by strong oxidizing agents, such as chlorine gas, perchlorate salts, UV-radiation and ozone gas.
 - It contains a lot of salts and other solids. Alum, ferric chloride and lime are used for their precipitation. They precipitate 90% of suspended solids and 90% of phosphates. It should be neutralized and treated further with activated carbon for removal of dissolved organics and colouring agents. Water is now treated for removal of salts and nitrate. Ideally such a water should be recycled to irrigation.

SOIL POLLUTION

- It is alteration in soil caused by removal or addition of substance and factors which decreases its productivity, quality of plants and groundwater. Negative

soil pollution is reduction in soil productivity due to erosion and over-use. Positive soil pollution is reduction in soil productivity due to addition of undesirable products (industrial wastes, air pollution wash down by rain). Landscape pollution is converting fertile land into barren one by dumping wastes (ash, sludge, garbage, industrial wastes).

SOURCES OF SOIL POLLUTION

1. Pesticides: They include insecticides, fungicides, algacides, weedicides and rodenticides.
 - (i) Organochlorine – These include DDT, BHC etc. They are persistent, fat soluble and show biomagnifications.
 - (ii) Organo-pesticides- Deradable but toxic to workers eg, malathion, parathion, carbamates.
 - (iii) Inorganic pesticides – They contain arsenic and sulphur and is persistent.
 - (iv) Weedicides – Often persistent and harmful.
2. Fertilizers: Excessive use causes natural microflora. Leaching down causes pollution of underground water salts entering crop plants in excess may prove harmful. For example, nitrate rich leaves, fruits and water produce nitrate in alimentary canal that enters blood, combines with haemoglobin which forms methaemoglobin and reducing oxygen transport. It may prove fatal for infants.
3. Industrial effluents/ wastes: They include scrap, effluents, sludge, flyash and radioactive wastes. Industrial solid wastes and sludge add a lot of toxic chemicals into soil. Flyash is fall-out from industrial emissions especially thermal plants. Radioactive wastes from testing laboratories and other sources also pollute the soil.
4. Municipal wastes: they include domestic wastes market wastes, sweepings, wastes from commercial complex, plastic can etc.
5. E-wastes: Electronic wastes are irreparable computers, mobile and other electronic goods

CONTROL OF SOLID WASTES

1. Recovering and recycling
It is carried out with the help of rag pickers. The articles which can recovered and recycled are tins, cans, other metal wastes, glass, plastic, polyethylene, rags, paper and cardboard. Metal waste can be melted and purified.
2. Source reduction

Garbage and other organic wastes are taken out of urban area and used for formation of compost, biogas and manure.

Three R's Reduce, Reuse and Recycle of wastes

3. Burning

Burning is combustion of solid wastes having organic materials in open space. It produces offensive odour and air pollution. Better methods are incineration and pyrolysis.

- Incineration: It is controlled aerobic combustion of wastes inside chambers of temperature 900 -1300°C. Incinerators are fitted with scrubbers and electrostatic precipitators to prevent release of smoke and toxic chemicals.
- Pyrolysis: It is combustion inside chambers in the absence of oxygen at temperature of 1650°C. It does not yield pollutants but industrial gas and other substances are produced.

4. Construction material

Flyash is being converted into bricks for construction work. Flyash, industrial effluents containing toxic chemicals and hazardous metals can be used as bedding material or road construction

5. Dumping

Dumping is piling of waste on selected low lying land. It is of two types, open and sanitary.

- Open dumping: It is accumulating of waste on uncovered low lying area. The waste is piled up as high as the equipment can easily do. The waste is periodically burnt or compressed at intervals to reduce its bulk.
- Sanitary dumping: The waste is compacted and covered over by a layer of earth.

NOISE POLLUTION

- Noise can be defined as unwanted sound.
- Noise is measured in decibel (dB). The decibel measures the loudness of noise to the ear. The range of hearing in human beings is upto 120dB. We can hear ordinary 50dB but any sound above 120dB is harmful. Prolonged noise at 95dB will produce deafness, nervous tension and rise in blood pressure.

SOURCES OF NOISE POLLUTION

- Main sources of noise pollution are:
 - Various industries such as textile mills, printing press, engineering establishment.

- Agricultural machines like tractors, harvesters
- Defense equipment such as tanks, artillery, rocket launching, explosions
- Entertaining equipment like radio, record players and television sets.
- Domestic gadgets such as fans, vacuum cleaners, pressure cookers.
- Public address system like loud speakers.
- Transport vehicles like buses, trains, cars, scooters, jet planes.
- Dynamite blasting.
- Crackers used at occasions like marriage and festivals.
- Bull dozing, stone crushing, construction work.

EFFECTS OF NOISE POLLUTION

- Noise brings about
 - Damage to ear drum and impairment of hearing.
 - Interference in conversation and hearing.
 - Emotional disturbance, development of anxiety and stress.
 - Damage to eye sight, color perception, night vision etc.
 - Hypertension, changes in peripheral circulation and breathing problems, decreased heart output and gastric problems.
 - Startle reaction.
 - Headache, sleeplessness, annoyance and irritability.
 - Reduced productive performance.

CONTROL OF NOISE POLLUTION

- Delimiting of acoustic zoning. A silent zone for 100m around hospitals and educational institutes will provide comfort for ailing patients and help students to concentrate on their studies.
- Use of cotton plugs or ear muffs in occupational exposure.
- Development of quieter machines.
- Sound proof insulating jackets or filters for reducing noises from machines
- Restricted use of loudspeakers.
- Acoustic furnishing and low voice radio / TV.
- Regulation of noise on road.
- Green muffler.

RADIOACTIVE POLLUTION

- It is degradation of environment due to release of radioactivity. Radio activity is measured in units called roentgens or 'r'.

1. Background radiation

It is radiation level found naturally in biosphere due to cosmic rays reaching earth and radio-nuclides found in earth's crust. The naturally occurring radioactive elements are Uranium-232, Uranium-235, Thorium-232, Radium-224, Radon-222, Potassium-40 and Carbon-14.

2. Man-made radiation

They are due to mining and refining of radioactive elements like plutonium, uranium and Thorium, nuclear power plants and fuels, preparation of radioactive isotopes, production and explosion of nuclear weapons.

- Nuclear weapons: They use Uranium-235, Plutonium-239 for fission and hydrogen or lithium as fusion material.

A nuclear explosion produces:

- Uncontrolled chain reaction
 - Tremendous heat.
 - Neutron flux that changes other element to radioactive state.
 - Unused explosive and activation products.
 - A lot of radioactive and other gases forming mushroom type cloud.
 - Iodine-131 forms thyroxine and damages spleen, lymph nodes, leucocytes, bone marrow, produces lung tumour, skin cancer as well as sterility.
 - Strontium-90 causes bone cancer, blood cancer and tissue regeneration.
 - Cesium-137 brings about nervous, muscular and genetic changes.
- Atomic reactors: They employ controlled radioactive fission, fusion for liberation of energy.
 - The coolant water causes thermal pollutions.
 - Small amount of radioactivity enters coolant water which undergoes magnification to some 75,000 times in birds.
 - They release halogen and inert gases.
 - A mishap can be dangerous as an atomic explosion.
 - Radioactive waste is highly pollutant and its dumping requires several precautions – first cooling in small ponds for 50 -100 years and then packing in special containers, which are buried some 500 metres deep in rocks or at the bottom of ocean.
 - Harmful effects
They were first recorded in 1909 in uranium miners as skin burns and cancer. Young and recently divided cells become easily damaged. Short range effects are loss of nails and hair, bleeding, changed proportion of blood cells, changed

metabolism. Long range effects are tumours, cancer, mutations, genetic deformities.

THERMAL POLLUTION

- Rise in temperature of air and water due to waste heat from various sources such as thermal power plants, nuclear power plants, industries and automobiles causing undesirable changes in the natural environment is called thermal pollution.

EFFECTS OF THERMAL POLLUTION

- Heat causes deoxygenation in water.
- Rise in temperature of water speeds up metabolic activities of aquatic organisms. As a result, they require more oxygen.
- Increase in microbial activity in hot water also contributes to death of fishes.
- Migration of aquatic animals is affected due to formation of different thermal zones in water.

CONTROL OF THERMAL POLLUTION

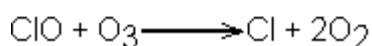
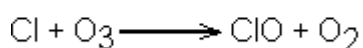
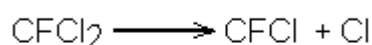
- Cooling ponds: In this method, water from the condensers is stored in ponds where natural evaporation causes its cooling. This water is discharged in nearby water body.
- Spray towers: In this method, water from the condensers is received in spray ponds. There after it is sprayed through nozzles in the form of fine jets. Water drops dissipate the heat to the atmosphere.
- Cooling towers: In this method, hot water is sprayed over baffles. The cool air entering from sides takes away the heat and results in cooling of water.

GLOBAL ENVIRONMENTAL CHANGES

OZONE LAYER DEPLETION

- Ozone layer or shield is present in the stratosphere. It is also called ozonosphere. Thickness of ozone is measured in Dobson unit (DU).
- Ozonosphere functions as shield against strong UV radiations.
- Depletion in the concentration of ozone over a restricted area as over Antartica is called ozone hole.
- Ozone depleting substances (ODS) are substances which react with ozone present in the stratosphere and destroy the same. The major ODS are

chlorofluorocarbons (14% of total depletion), sulphur dioxide, halogen, carbon tetrachloride, methyl chloroform etc. A single chlorine atom converts 1 lakh molecules of ozone into oxygen



- UV-B are harmful as well as capable of deep penetration. Thinning of ozone layer increases the amount of UV-B radiations reaching the earth.
- The various effects of ozone depletion are:
 - Cornea absorbs UV-B radiations and become inflamed. The disorder is called "snow blindness" cataract. It leads to diminishing of eye sight, photoburning and later permanent damage to cornea that results in actual cataract.
 - UV-B radiation damage skin cells causes ageing of skin and skin cancer.
 - Damage of nuclei acids increase resulting in higher number of mutations.
 - UV radiations inhibit photosynthesis by affecting photosynthetic machinery.
 - Decreased photosynthetic activity will increase CO₂ concentration of the atmosphere resulting in global warming.

GREEN HOUSE EFFECT

- It is warming effect found in green house by allowing solar radiations to pass in but preventing loss wave heat radiations to pass out due to glass panels, water vapours and carbon dioxide. Because of its green houses are used for growing tropical plants in temperate areas.
- The whole sunlight does not reach the earth. About one fourth of incoming solar radiations are reflected back by clouds and gases another one fourth of radiation are absorbed by atmospheric gases. The gases which are transparent to solar radiation but retain and partially reflect back long wave heat radiation are called green house gases.
- Green house gases are essential for keeping the earth warm and hospitable. They prevent a substantial part of long wave radiation emitted by earth to escape into space. Rather green house gases radiate a part of it back to earth. This phenomenon is called green house flux. Because of green house flux, the mean annual temperature is 15°C.

- The various green house gases are CO₂ (60%), CH₄(20%), chlorofluorocarbon (14%) and nitrous oxide (6%), other of minor significance are water vapour and ozone.
- Global warming – It is believed that increase in concentration of green house gas has resulted in rise of atmospheric temperature. Rise in temperature will be slight in tropics, moderate in middle latitudes and maximum in polar regions.

The effects of global warming

- Warming of atmosphere will significantly increase its moisture carrying capacity while troposphere warms up, the stratosphere will cool down hence increasing the size of ozone hole. This would also cause extensive changes in precipitations due to changed pattern of air mass movements.
- The global warming may contribute a sea level rise due to the thermal expansion of ocean as it warms and melts the glaciers and Greenland ice sheets. A rise of even half a meter in sea level would profoundly affect human population, one third of which lives within 60km of coastline. Numerous low lying islands may be submerge.
- Each plant or animals species occur within a specific range of temperature. The global warming is likely to shift the temperature ranges and as a result, would affect altitudinal and latitudinal distribution pattern of organism with increasing global warming. Many species are expected to shift pole wards or towards high elevation in mountain areas. Since trees are sensitive to temperature stress, a rapid rise of temperature may cause extensive death of trees and their vegetation by scrub vegetation. Many species may not able to migrate fast enough to track temperature changes and may disappear.
- Small temperature increase may slightly improve crop productivity in temperate region, but larger temperature changes will reduce crop productivity. This will have disturbing consequences on world food supply.

ENVIRONMENTAL LAWS FOR CONTROLLING POLLUTION

1. Environment (Protection) act, 1986
 - It is the most comprehensive law meant for prevention, control of environmental pollution by laying down emission norms and setting up of central and state pollution control boards
 - The boards check the emissions and effluents by various institutes and industries, their treatment and disposal. The act encompasses air, water,

soil and noise. Rules have been framed under this law from time to time such as

- i) Hazardous wastes (management and handling) Rule 1989.
 - ii) Noise Pollution (Regulation of control) Rules 2000.
 - iii) Biomedical waste (management and handling) Rules, 1998.
 - iv) Recycled plastic manufacture and usage Rule 1999.
 - v) Ozone depleting substances (Regulation and control) Rule 2000.
 - vi) Municipal Solid Wastes (Management and handling) Rule 2000.
2. Insecticide Act 1968
 - It regulates manufacture, import, sale, transport, distribution and use of insecticides laying down various rules to reduce risk to human health and health of other organisms.
 3. Water (prevention and control of pollution) Act 1974.
 - It specifies quality of water for various purposes, way and means to control water pollution and prevention of detrimental pollution and prevention of detrimental effects on human health and health of other biological entities.
 4. Air (Prevention and control of pollution) Act 1981
 - This act is meant for preserving quality of air, controlling air pollution and preventing detrimental effects of air pollutants and human health and health of other biological entities. By an amendment in 1987, noise was also recognized as air pollutants.

INTERNATIONAL INITIATIVE FOR MITIGATING GLOBAL CHANGE

1. Montreal Protocol (16 September 1987): 27 industrialized countries agreed to limit production of chlorofluorocarbons to half the level of 1986.
2. Helsinki Declaration (May 1989): Montreal Protection was ratified by 82 nations at Helsinki. They pledge to phase out CFC by year 2000.
3. In June 1990, 93 nations amended Montreal Protocol and Helsinki Declaration. They agreed to phase out CFC's till date 175 nations have signed it.
4. Intergovernmental Panel on climatic change (IPCC, 1988)
Prepared world climatic programme (wcp)
5. Convention on climate change (CCC) : Under UN framework in 1991.
6. Earth Summit (United Nation Conference on Environment and Development, 1992).

It was held in Rio-de-Janeiro (Brazil) and adopted the recommendations of CC for reducing greenhouse gases. The recommendations were signed by 154

nations. They pledged to maintain emission of green house gases at 1990 level.

7. Kyoto Protocol (Dec 1997)

International conference held in Kyoto, Japan obtained commitments from different countries for reducing overall greenhouse gas emissions at a level of 5% below 1990 level by 2008 – 2012.

8. World Summit for sustainable development (2002)

The Summit was held in Johannesburg, South Africa, for discussing ways and means to sustain development without depletion of biodiversity.

9. U.N. Convention on climatic change (CCC, 2004)

The meeting was held in Buenos Aires, Argentina, for preparing strategy to reduce global warming.

10. Bali conference (2007) : It has concentrated on ways and means to check global warming.

11. Copenhagen conference (2009): Participating countries have agreed to voluntarily reduce CO₂ emissions.

12. UN climate change conference (CCC, 2011): It was held in Durban, South Africa.

DEGRADATION BY IMPROPER RESOURCE UTILISTION AND MAINTENANCE.

- Degradation of natural resources not only occurs due over-exploitation and action of pollutants but also due o improper utilization practices.

(i) Soil erosion

It is removal of top soil occurs when the plant cover is removed. The agencies that cause soil erosion are water and wind. Plants cover is removed due to deforestation, over grazing, leaving tilled loose soil for a few days unirrigated and unseeded. Since only top soil is fertile soil erosion reduces productivity of land. The water eroded soil passes into rivers and reservoirs.

It raises river bed causing flood and storage capacity of reservoirs also reduces. Water becomes muddy killing all types of aquatic life.

(ii) Desertification

It occurs in plain where excessive grazing and trees felling leaves the land barren. In dry season, such exposed is eroded by wind. As fine soil particles are taken away by wind, heavy sand particles are left. They also show creepy. The area becomes arid and sandy.

(iii) Water logging

It is the presence of water more than field capacity of the soil. Water logging occurs due to

- (a) Seepage from irrigation channels.
- (b) Excessive irrigation.
- (c) Absence of underground drainage. Water logging drives out soil air. Anaerobic conditions produce toxins, prevent root growth and kill the plants.
- (iv) Soil salinity
Poorly drained soil in semi-arid areas and soil irrigated by brackish water turn saline. Evaporation of water from the surface draws more and more water from below. As soil water contains salts. Salts are left over the surface while the water evaporates.

DEFORESTATION

It is removal, decrease or deterioration of forest cover of an area.

CAUSES OF DEFORESTATION

1. Jhuming
In India about 5 lakh hectares of land is cleared every year through lopping, burning the remainder, mixing the ash with soil and sowing the cleared land with crop seeds. The land is used for 2-3 years without manuring. This results in nutrient depletion, reduced moisture retention and increased soil erosion
2. Hydroelectric projects
Dams, reservoirs and hydroelectric projects submerge forest killing all plants and animals.
3. Forest fires
Huge forest fires engulfing areas of 40,000 km² have occurred in Indonesia in 1983 and 1997.
4. Human establishment
5. Mountain and forest Road
Construction of roads and railways in hilly forested areas bring about a lot of deforestation, landslides and soil erosion large sections are dynamited. This weakens the already fragile mountain system. The fragments pass into valleys. They increase soil erosion.
6. Overgrazing
India with 2.4% geographical area has some 500 million livestock population. Grazing area is only 13 million hectars where one hectare of land supports only 6 livestock heads. The remaining livestock naturally grazes in forests

trampling seedlings and compaction of soil. Compaction of soil reduces water storing capacity.

7. Requirement of wood

It is rising, some 300 million m³ for fuel and 40 million m³ for industry, mostly timber and paper industry.

8. Quarrying and mining.

EFFECTS OF DEFORESTATION

1. Shrinking fuel wood

In India, availability of fuel –wood in 58 million m³ / year against requirement of 300 million m³/year.

2. Reduced timber

3. Change in climate

Deforestation results in reduced rainfall, increased drought, hotter summers and cold winters.

4. Soil erosion

Soil is exposed in insolation, dries up and get eroded by wind and water

5. Flash floods

They occur during rainy season due to non-retention of water in soil, increased runoff water flowing into streams and rivers during rains.

6. Siltation

Rainy season rivulets bring eroded soil and brings the deposits on bed of reservoirs reducing storage capacity.

7. Drought loss of biodiversity, rainfall

8. Global warming

Deforestation increases atmospheric CO₂ content by releasing carbon stored in organic matter and reduced primary productivity.

CONSERVATION AND MANAGEMENT OF FORESTS.

1. Sustained yield block cutting : Cutting is allowed only in non-vulnerable forest at a rate which is equal to their regeneration capacity.

2. Control of weeds, pesticides and controlled grazing.

3. Chipko movement: It is movement initially meant for protecting trees but now meant for preservation of environment including habitat and wild life. Chipko movement was born in March 1973 in Gopeshwar in Chamoli district, when trees were not allowed to be cut by village folk by hugging them first near village Mandal, then Rampur Phata in 1974 near village Reni (led by Gaura Devi). The movement has two leaders, Chandi Prasad Bhatt of Gopeshwar and

Sunder Lal Bahuguna of silyara in Jehri region. A similar moment was undertaken by Paudurang Hegde in south. It is known as appiko movement.

4. Other forms of forestry:

- (i) Social forestry – Raising quick growing multipurpose plants in common village lands for meeting requirement of fodder, firewood and small timber.
- (ii) Urban forestry – It is plantation of fruit, flower and shade bearing plants in urban areas to reduce pollution and ultimate yield of wood
- (iii) Agroforestry – It is plantation of multipurpose trees, shrubs along with crops for stabilizing soil, meeting the needs of fodder, fruit and timber.
- (iv) Production plantation – It is growing of industry required trees on specific, free grazing lands. Production plantation decrease pressure from real forests.

5. Reserve forest – These forests are grown over ecologically fragile area where our water regimes are also located.

6. Joint Forest management (JFM): Despite best efforts by the forest department, the degraded sal forest of Arabari in Midnapore district could not be regenerated. The forest officer A.K.Banerjee was allowed to seek participation of villagers in regeneration on employment cum share basis. Within few years, by 1983, Arabari forest has been revived. Buoyed by this success, the government of India introduced the concept of Joint Forest Management of forest for which the communities get benefits from forests like fruits, gum, rubber, medicine etc.

7. Bishnois: Forest conservation is an old practice in India. In 15century, Guru Jambheshwar Maharaja enunciated 29 principles for protecting the environment, on account of this principles, his followers are known as Bishnoi. Bishnoi do not allow falling of trees and killing of animals. In 1731, a king of Jodhpur asked one of his minister to arrange wood for his new palace. The minister along with personnel of royal force came to forest near village Khejrli. A Bisnoi woman Amrita Devi hugged the tree and challenged King's men to cut her down before cutting the trees. She sacrificed her life. Her three daughters and 360 other Bishnois lost their lives saving trees. This perhaps a singular example where humans laid down their lives in order to save trees. Government of India has instituted Amrita Devi Bishnoi wild life protection Award for rural individuals and communities who show exemplary courage and dedication for protecting wildlife.

FOREST AND WILDLIFE LAWS

1. FOREST ACTS, 1927

- (i) Establishment and management of three types of forests – village forest, reserved forest and protected forests
- (ii) Protection of non-governmental forests and forest land against over-exploitation
- (iii) Control of movement of forest products
- (iv) Control of grazing.

2. Forest (conservation) Act, 1980, Amended 1988.

No forest land can be de-reserved and diverted to non-forest purposes without the approval of central government. A diversion when permitted would be accompanied by compensatory a forestation, in some cases twice the forest area lost. Six regional offices have been set up to monitor enforcement of Act – Bangalore, Bhopal, Bhubhaneshwar, Lucknow, Shillong and Chandigarh.

3. Wildlife (Protection) Act, 1972, Amended 1991

- i) The act restricts and prohibits hunting of animal
- ii) Protection of certain plants from excessive exploitation
- iii) Setting up and managing national parks and sanctuaries
- iv) Creation of zoo authority for controlling of zoos and captive breeding.
- v) Control trade in wildlife, wildlife products
- vi) Encouraging and assisting formation of wildlife societies.

4. National Forest policy (1988)

It aims at increasing cover of forest in plains and hills so that optimum of 33% forest cover is achieved in plains and 67% in hills. Other aims are:

- i) Maintenance of environmental stability through preservation and restoration of ecological balance.
- ii) Check on soil erosion and denudation of catchment areas
- iii) Checking on spread of sand dunes.
- iv) Increase in forest tree cover through massive afforestation and social forestry programmes.
- v) Steps to create massive people's movement of afforestation, management and protection of forests. Already about 17.33 million hectares of degraded and protected by 84632 Joint Forest Management Committees

IMPORTANT DATES

1. World Environment Day : 5th June
2. National Pollution Prevention day : 2nd December
3. Hiroshima Day : 6th August
4. Nagasaki Day: 9th August
5. Ozone day: 16th September
6. Earth day: 22nd April