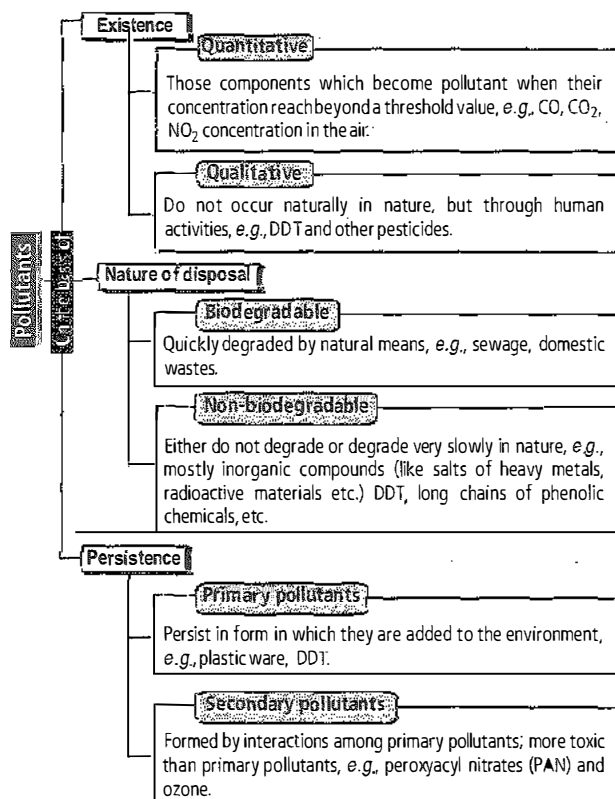## ENVIRONMENTAL ISSUES

- **Odum** defined **pollution** as, 'undesirable change in physical, chemical and biological properties of air, water and soil, which directly or indirectly affects human beings'.

- **The basic cause of pollution** is ever increasing rise in human population that is putting an equally increasing demand for more food, water supply, roads, transportation, dwelling units, schools, hospitals, electricity, more industrial products and a large number of other commodities. This is exerting pressure on natural resources which are, hence, undergoing depletion and degradation.

- A **pollutant** is any substance, chemical or other factor that changes the natural balance of environment.

CLASSIFICATION OF POLLUTANTS

- On the basis of their existence in nature, form (in which the pollutants persist after release), and nature of disposal, pollutants are of various types.

- The various classes of pollutants are shown in the given flow chart.

Existence

Quantitative
Those components which become pollutant when their concentration reach beyond a threshold value, e.g., CO, CO_2, NO_2 concentration in the air.

Qualitative
Do not occur naturally in nature, but through human activities, e.g., DDT and other pesticides.

Nature of disposal

Biodegradable
Quickly degraded by natural means, e.g., sewage, domestic wastes.

Non-biodegradable
Either do not degrade or degrade very slowly in nature, e.g., mostly inorganic compounds (like salts of heavy metals, radioactive materials etc.) DDT, long chains of phenolic chemicals, etc.

Persistence

Primary pollutants
Persist in form in which they are added to the environment, e.g., plastic ware, DDT.

Secondary pollutants
Formed by interactions among primary pollutants; more toxic than primary pollutants, e.g., peroxyacyl nitrates (PAN) and ozone.

Flow chart: Classification of pollutants.

AIR POLLUTION

- Air pollution is the occurrence or addition of foreign particles, gases or pollutants in the air which, have an adverse effect on human beings, animals, vegetation, etc.

- The **various causes of air pollution** are :
  - Combustion of natural gas, petroleum, coal and wood in industries, automobiles, aircrafts, railways, thermal plants, agricultural burning, kitchens, etc. (soot, flyash, CO_2, carbon, nitrogen oxides, sulphur oxides).
  - Metallurgical processing (mineral dust, fumes containing fluorides, sulphides and metallic pollutants like lead, chromium, nickel, beryllium, arsenic, vanadium, cadmium, zinc, mercury).
  - Chemical industries including pesticides, fertilizers, weedicides, fungicides.
  - Cosmetics.
  - Processing industries like cotton textiles, wheat flour mills, asbestos.
  - Welding, stone crushing, gem grinding.
  - The oxides of sulphur, carbon, nitrogen, hydrocarbons, photochemical oxidants and fluorides are the **common gaseous pollutants**.

- **Some important effects of air pollution are :**
  - Carbon monoxide(CO) is harmful to man as it competes with O_2 for haemoglobin and form carboxyhaemoglobin. CO poisoning can lead to **giddiness, laziness, exhaustion, asphyxiation, reduced vision, nervous** and **cardiovascular disorder** and even **death.**
  - Oxides of nitrogen **cause eye irritation, respiratory troubles, lung oedema, blood congestion and dilation of arteries.** Nitrogen monoxides like CO, lowers the oxygen carrying capacity of the blood.
  - SO_2 causes **chlorosis, necrosis of vegetation, metabolic inhibition** and **growth reduction.** Acid rain (**term coined by Robert Augustin 1872**) is the rainfall and other forms of precipitation with a pH of less than 5 (pH of normal rain is 5.6–6.5). **Acid rain is mainly due to pollution of sulphur dioxide** (combines with water to form sulphuric acid).
  - **Fluorides** cause fluorosis.
  - **Particulate matter** (PM) which consists of flyash, dust, spores, pollen grains, etc. causes respiratory disease tuberculosis, byssinosis, allergy and many more diseases in animals and plants.

- Some new devices are the most widely used for **control of air pollution.** These are :
  - **Settling chamber :** To remove large particulates.
  - **Cyclonic separators :** Dirty air is blasted into a conical cylinder. This creates a violent swirl within the cone. The heavy materials migrate to the wall and exit from the bottom of the cone. The clean air exits out from the top.

- Bag filters : Fabric bags are used to collect the dust-like common vacuum cleaner.

- Wet collector : It promotes the 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.

- Adsorption : It makes the use of activated carbon to capture pollutants.

- Incineration : For removing gaseous pollutants by burning them to CO_2, H_2O and inerts

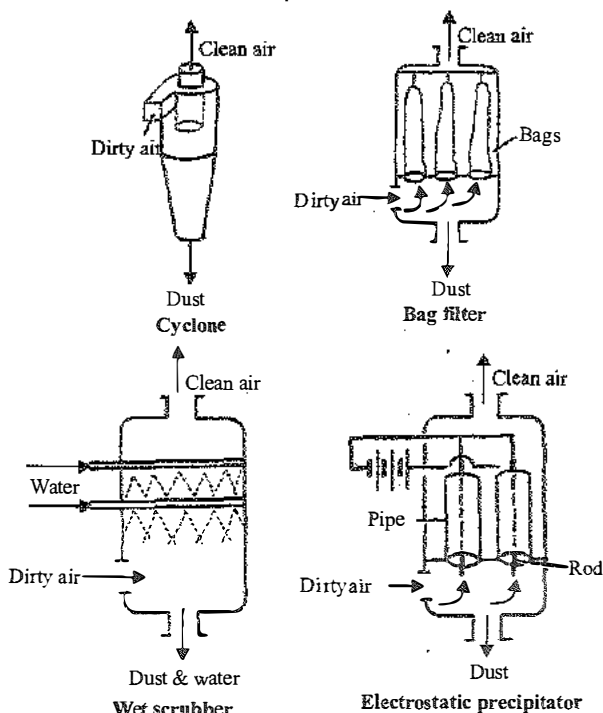- Catalytic combustion : Use of catalyst to remove pollutants.

Fig.: Wet collectors and electrostatic precipitators for control of particulates of air pollution.
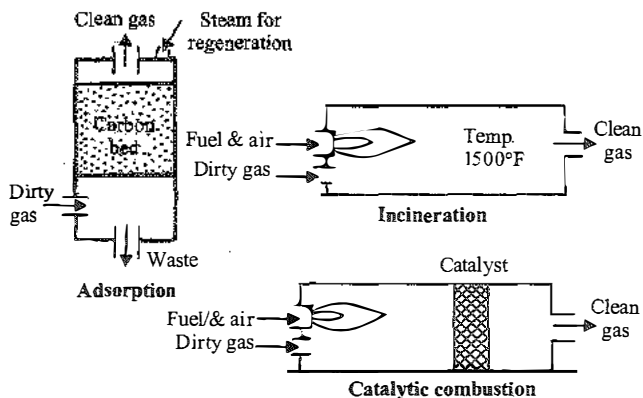

Fig.: An adsorption tower used for control of gaseous pollutants of air.

Controlling vehicular air pollution– A case study of Delhi

- There are more petrol driven vehicles in Delhi. Significant high levels of lead were found at many places. The safety level for the residential areas ranges from 100 ppm to 150 ppm. It is estimated that over 400 kg of lead is released into Delhi's air everyday. The Supreme Court directed the government to take appropriate measures for reducing pollution caused by automobiles through :

  - Switch over of public transport from diesel/petrol to CNG.
  - Phasing out of old vehicles.
  - Compulsory use of unleaded petrol and reduced sulphur content of diesel.
  - Compulsory regular check up of pollution emission of vehicles and enforcement of Euro II norms.
  - Fitting the vehicles with catalytic converters.

- Delhi became the first city of the world to use CNG for its public transport system and autorickshaws by the end of 2002. CNG (compressed natural gas) is a better fuel than petrol or diesel because it is cheaper, burns more efficiently, does not produce much pollution, cannot be siphoned off by thieves and cannot be adulterated like petrol and diesel.

Noise pollution

- In India, the Air (Prevention and Control of Pollution) Act came into force in 1981, but was amended in 1987 to include noise as an air pollutant.

- Unpleasant loud sound is called noise (also called slow killer) and disturbing level of noise is known as noise pollution.

- Annoying noise from industries, transport vehicles, agricultural machines, defence equipments, domestic gadgets, music systems, public address systems and demonstrations are various causes of noise pollution.

- Noise pollution is measured in decibels. Generally sound above 80 dB is termed as noise. A sound more than 115 db is harmful to the ears. Moderate conversation has a noise value of 60 dB; scooter, buses, trucks, etc. create noise of about 90 dB; jets of about 150 dB and rockets of 180 dB. A decibel value above tolerable limit of noise is about 140 dB.

- The first effect of noise pollution is anxiety and stress reactions. Deafness or hearing loss is the most serious pathological effect.

- A number of temporary physiological changes occur in the human body as a direct result of noise exposure. These are – rise in blood pressure, rise in intracranial pressure, increase in heart rate and breathing and increase in sweating.

- Green muffler scheme involves the growing green plants along roadsides to reduce noise pollution. Specific legislation and regulations should be proposed for designing and operation of machines, vibrations control, sound-proof cabins and sound-absorbing materials.

WATER POLLUTION

- **Water pollution** is the deterioration of quality of water due to addition of foreign substances, factors (heat) and deprivation that makes it health hazard and unfit for human use and aquatic organisms.

- **Water pollutants** may be of three types – **biological** (viruses, bacteria, protozoa etc); **chemical** (organic wastes, organic biocides, inorganic chemicals); and **physical** (hot water, oil spills etc).

- Water pollution has two major sources – **natural** and **anthropogenic**.

- **Natural sources of water pollution** include clay and silt from soil erosion, leaching of minerals etc.

- **Anthropogenic or man-made sources of water pollution** are domestic waste, sewage, soaps and detergents, run-off from agricultural fields having fertilizers and pesticides, industrial wastes, heat, waste from animal sheds and slaughter houses, oil pollution, etc.

- **Sources of water pollution are :**
  - Industrial discharge of chemical wastes and byproducts.
  - Discharge of poorly-treated or untreated sewage.
  - Surface runoff containing pesticides.
  - Slash and burn farming practice, which is often an element within shifting cultivation agricultural systems.
  - Surface runoff containing spilled petroleum products.
  - Surface runoff from construction sites, farms, or paved and other impervious surfaces, *e.g.*, silt.
  - Discharge of contaminated and/or heated water used for industrial processes.
  - Acid rain caused by industrial discharge of sulphur dioxide (by burning high-sulphur fossil fuels).
  - Excess nutrients added by runoff containing detergents or fertilizers.
  - Underground storage tank leakage leading to soil contamination, hence aquifer contamination.

- Water pollutants may be **organic or inorganic type**.

- **Some organic water pollutants** are insecticides and herbicides, a huge range of organohalide and other chemicals, bacteria, food processing waste including pathogens, tree and bush debris, VOCs (volatile organic compounds) and industrial solvents.

- Some inorganic water pollutants include heavy metals, sulphur dioxide, chemical waste, fertilizers including nitrates and phosphates and silt.

Consequences of water pollution

- Water pollution affects the normal functioning of water bodies, aquatic organisms and deteriorates the quality of water.

- The consequences of water pollution are given in the following flow chart :
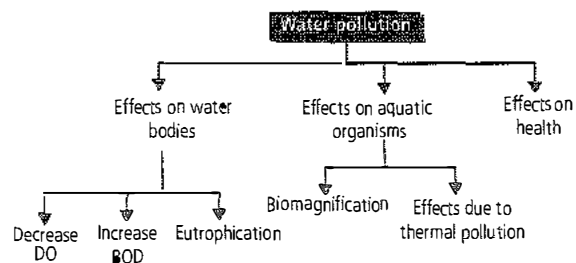
Dissolved oxygen (DO)

- Most aquatic organisms respire with oxygen dissolved in water.

- The amount of oxygen gas dissolved in a given quantity of water at a particular temperature and atmospheric pressure is referred to as **dissolved oxygen (DO)** and generally is expressed in **parts per million (ppm)**.

- Discharge of sewage in large quantities results in a drop in DO because decomposers utilize a lot of dissolved oxygen in decomposing organic matter.

- The water containing DO below 8 ppm is considered polluted. The gravely polluted water has DO below 4 ppm to nil.

Biological oxygen demand (BOD)

- The phenomenon, through which certain pollutants get accumulated in tissues in increasing concentration along the food chains, and produce fatal effects is called **biomagnification or biological magnification**. DDT is non-biodegradable pollutant and its biological magnification occurs, *i.e.*, its concentration goes on increasing with each trophic level. Further it causes air, water and soil pollution.

- **Biological oxygen demand is the oxygen in milligrams required for five days in one litre of water at 20°C for the microorganisms to metabolise organic wastes.** In simple words, BOD is the amount of dissolved oxygen required by bacteria in decomposing the organic wastes of water. Higher the BOD, lower would be the dissolved oxygen. When large amount of sewage is dumped into water, the BOD will increase. Pure drinking water should have BOD of less than 1 ppm. If BOD is less than 1500 mg/litre, it indicates weak sewage or less pollution. If BOD is 1500–4000 mg/litre, it indicates medium sewage or medium pollution. If BOD is more than 4000 mg/litre, it indicates strong sewage or high pollution.

- **Chemical oxygen demand (COD)** test is aimed to determine the amount of oxygen needed to oxidise all pollution materials. The value of COD is much higher than BOD.

Eutrophication

- Phosphorous and nitrates of fertilizers and detergents dissolve in water and accelerate the growth of algae which form mat on the water surface. The algal growth deoxygenate water which is responsible for death of fishes and other aquatic animals. The increased productivity of lake and pond etc. due to nutrient enrichment is called **eutrophication**. Eutrophication causes reduction in dissolved oxygen.

- **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 the fish and other animals. However, soon planktonic algae increase in number and impart a characteristic 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**. Water hyacinth (*Eichhornia crassipes*) is one such plant that sometimes chokes ponds, lakes and rivers. Algal blooms and floating plants cut-off light from submerged plants. The latter die. There is drastic decrease in oxygen replenishment inside water. It causes organic loading of water.

- *Daphnia* and trout are sensitive to water pollution.
- *E.coli* is an indicator of faecal pollution. **MPN (most probable number)** of *E.coli* is indicator of water pollution.
- *Pseudomonas* is a bacteria which is a decomposer and degrade organic matter.
- Garden pea is **SO₂ pollution indicator**.
- Lichens are also grown as SO₂ pollution indicator.
- Maize indicates **flouride pollution**.

Effects on aquatic organisms

- Generally plants and animals have the ability to wash out many poisons out of their system but certain chemicals such as pesticides, insecticides, methyl mercury tend to accumulate in the body. For example, DDT, and a few other toxic chemicals do not dissolve in water but dissolve in fats, therefore, they accumulate in organisms for long period. This is called **bioaccumulation**. The accumulated substance does not get metabolised or excreted and is passed on to the next higher trophic level.

- DDT is non biodegradable pollutant and its biological magnification occurs, *i.e.*, its concentration goes on increasing with each trophic level. Further, it causes air, water and soil pollution.
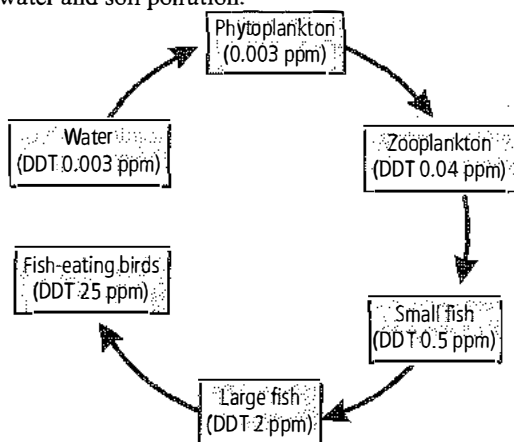
Flow chart: Biomagnification of DDT in an aquatic food chain.

Effects due to thermal pollution

- Large quantities of hot water released from power plants cause ecological imbalance due to death of some fish species and other aquatic organisms. An increase in temperature of water **increases the metabolism** and hence the organisms require more oxygen. Since the DO of water decreases with increase of temperature, this causes **suffocation.**

- Increase in temperature due to thermal pollution at stretches of water body obstructs the migration of fish species and thus interferes with their life cycle.

Effects on human health

- Water pollution deteriorates the quality of water used for drinking, bathing, swimming, recreation and irrigation. Water contaminated with sewage has foul smell and creates unhygienic conditions in the surroundings and affects our health. Drinking water polluted with sewage is a source of viruses, bacteria, protozoa and worms. Water-borne infectious diseases like **cholera, dysentery, typhoid, jaundice** and worm infection are the major public health problems in developing countries.

- Excess quantities of heavy metals such as mercury, lead, cadmium, nitrate, fluoride and chlorine are harmful to health in the following ways :

Mercury
- Mercury is converted into **methyl mercury** by bacterial action in aquatic environment.
- It resulted in **Minamata disease** in Japan in 1952 due to eating of fishes taken from mercury polluted Minamata Bay.

Cadmium
- Consumption of rice grown on water polluted with cadmium caused disease in Japan called Itai-Itai.
- **Itai-Itai** is a painful disease of bone and also results in the cancer of liver and lungs.
- Cadmium gets accumulated in liver, kidneys and pancreas and interferes with some enzymes.

Nitrate
- Excess of nitrate in drinking water causes **methaemoglobinemia.**
- Nitrate converts haemoglobin to methaemoglobin, which is non functional form of haemoglobin.
- Nitrate can be fatal to human, especially infants under three months. Such infants are called **"blue babies".**

Fluoride
- Fluoride toothpastes are used to prevent dental decay but excess causes mottled teeth, stiffening of joints and hardened bones called **skeletal fluorosis** or **knock-knee disease.**
- The deformity of knees may lead to total inability to move. Excess of fluoride in water has been noticed in Tamil Nadu, Kerala, Gujarat, Rajasthan, Punjab, Haryana and Bihar

Chlorine
- Chlorination of water produces chlorinated organic compounds. Many of these are known **carcinogens** and **teratogens.**

Heavy metal poisoning

Control of water pollution

- Various legislative measures should be employed to control water pollution. Improved methods for handling and disposal of sewage garbage should be introduced. Polluted water is treated in **effluent treatment plants** before its release into water bodies.
- There are three steps in sewage treatment :
  - **Primary treatment :** Physical treatments such as sedimentation, floatation, fragmentation and filtration are involved in primary treatment.
  - **Secondary treatment :** There are two ways in secondary treatment : anoxic (it is through the action of anoxic micro-organisms and macromolecules) and aerobic (it is by two ways : trickling filter method and activated sludge method).
  - **Tertiary treatment :** Removal of nitrates and phosphates takes place in this step.
- Sewage water treatment is very expensive that is why only first two steps are followed in many countries.
- Treatment of industrial effluents involves neutralization of acids and bases, precipitation of metallic compounds, chemical oxidation, etc.

NEERI (National environmental engineering research institute) has devised a very cheap and unconventional process of sewage treatment in specially constructed large shallow ponds. These ponds are known as **oxidation or stabilization ponds.** Domestic or industrial wastes with organic nutrients are stored in these pits in dilute condition for a few days. In the presence of sunlight and organic nutrients, the medium flourishes with green algae and colonies of bacteria. The bacteria digest the organic waste and water is purified. This water is rich in nitrogen, phosphorus and potassium and can be used as irrigation water.

River action plans

- The municipal waste water is discharged directly into rivers resulting in their pollution and high incidence of water borne diseases.
- In order to protect the major rivers of India from sewage pollution, the Ministry of Environment and Forests, has initiated development of sewage treatment plants under the **National River Conservation Authority,** *e.g.,* Ganga Action Plan (GAP), Yamuna Action Plan, Sutlej Action Plan, Gomti Action Plan.
- Under these plans, it is proposed to build a large number of sewage treatment plants so that only treated sewage may be discharged in the rivers.

SOLID WASTE MANAGEMENT

- **Solid** wastes are discarded or left-over solid materials. The terms rubbish and trash are often used interchangeably for solid waste materials. The various sources of solid wastes are municipal wastes, industrial wastes, mining wastes, hazardous wastes, defunct ships and electronic wastes.
- **Municipal** wastes are solid wastes from homes, shops, offices, schools, street and road sweepings which are collected and disposed off by municipalities. The major

components are waste paper, textiles, leather, metals, glass, plastic and polythene, food wastes, etc.

- **Industrial** wastes include scrap, effluents, sludge and flyash. Flyash is fall out from industrial emissions especially thermal plants which is often mixed with smoke. It consists of oxides of silica, aluminium and iron alongwith small quantities of heavy metals.
- **Mining** wastes include mine dust, rock tailings, slack and slag. Toxic metals and chemicals present in the mining wastes destroy vegetation and produce many deformities in animals and human beings.
- **Hospital** wastes are full of hazardous materials like infected organic wastes, pathogens, pathogen carriers, harmful chemicals, needles, syringes, vials, etc. alongwith some disinfectants.
- **Electronic** wastes (e-wastes) include irreparable computers, mobiles and other electronic goods. Electronic wastes are generally sent to developing countries like India, China and Pakistan for extraction of metals through recycling.

Control of solid wastes

- It involves collection and categorisation of wastes, transport to disposal site and disposal of waste. Disposal of waste consists of **recovery and recycling, source reduction, burning and dumping.**
- The articles which can be recovered and recycled are tins, cans and other metal wastes, glass, plastic, rags, paper and cardboard.

Case study of remedy for plastic wastes

- A plastic sack manufacturer in Bangalore has managed to find the ideal solution to ever-increasing problem of accumulating plastic waste. Ahmed Khan, aged 57 years old, has been producing plastic sacks for 20 years. About 8 years ago, he realised that plastic waste was a real problem.
- Polyblend, a fine powder of recycled modified plastic, was then developed by his company. This mixture is mixed with the bitumen that is used to lay roads.
- In collaboration with R. V. College of Engineering and the Bangalore City Corporation, Ahmed Khan proved that blends of Polyblend and bitumen, when used to lay roads, enhanced the bitumen's water repellent properties, and helped to increase road life by a factor of three.
- The raw material for creating Polyblend is any plastic film waste. So, against the price of ₹ 0.40 per kg that rag pickers had been getting for plastic waste, Khan now offers ₹ 6.
- Using Khan's technique, by the year 2002, more than 40 kms of road in Bangalore has already been laid. At this rate Khan will soon be running short of plastic waste in Bangalore, to produce Polyblend. Thanks to innovations like Polyblend.

- In source reduction, garbage and other organic wastes are taken out of urban areas and used for formation of **compost, biogas** and **manure. In composting,** the sludge obtained after primary treatment of sewage alongwith other wastes are allowed to decompose in an open space. In 4 – 6

months compost is ready for use as a manure. Cowdung and other organic wastes of farm houses can now be profitably placed in **gobar gas plants** which not only enrich manure but also provide biogas for domestic use.
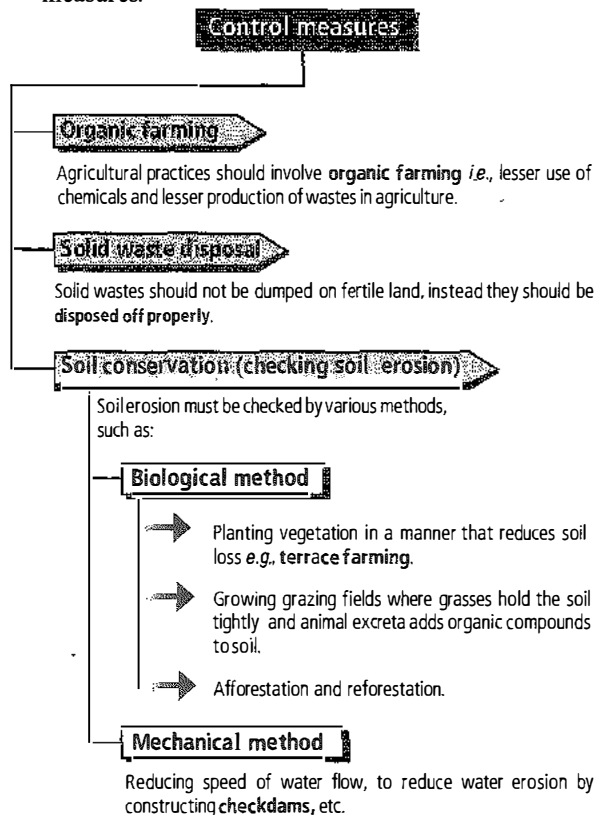
- **Burning** is combustion of solid waste containing organic compounds in open places. It, however, produces offensive odour and air pollutants. Better methods are incineration and pyrolysis. **Incineration** is controlled aerobic combustion of wastes inside chambers at temperature of 900 - 1300°C. **Pyrolysis** is combustion inside chambers in the absence of oxygen at a temperature of 1650°C. It does not yield pollutants.
- **Dumping** is piling of waste on selected low lying land. It is of two types, open and sanitary.

SOIL POLLUTION (AGROCHEMICALS AND THEIR EFFECTS)

- **Pesticides, fertilizers, chemicals and radioactive wastes are the main sources of soil pollution.** Pesticides include insecticides, fungicides, algicides, rodenticides and weedicides. Alongwith target organism they harm non-target organisms as well. This destroys the ecosystem of the soil.

Control of soil pollution

- Soil pollution can be checked by improving the disposal wastes, appropriate use of chemical fertilizers and use of biological pest control.
- The most important measure to check land degradation is restoration of forest, crop rotation, improved drainage, etc.
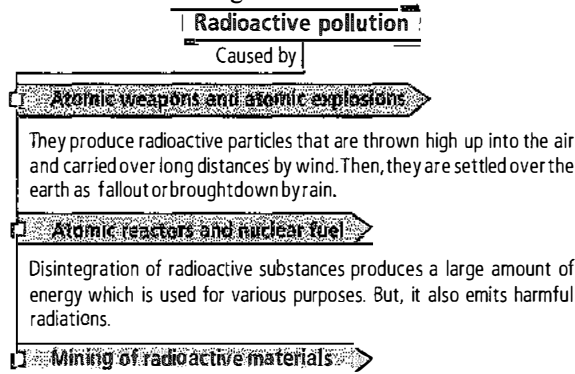- Soil pollution can be controlled by applying following measures:

Control measures

Organic farming

Agricultural practices should involve **organic farming** *i.e.,* lesser use of chemicals and lesser production of wastes in agriculture.

Solid waste disposal

Solid wastes should not be dumped on fertile land, instead they should be **disposed off properly.**

Soil conservation (checking soil erosion)

Soil erosion must be checked by various methods, such as:

Biological method
- Planting vegetation in a manner that reduces soil loss *e.g.,* **terrace farming.**
- Growing grazing fields where grasses hold the soil tightly and animal excreta adds organic compounds to soil.
- Afforestation and reforestation.

Mechanical method

Reducing speed of water flow, to reduce water erosion by constructing **checkdams,** etc.

Case study of organic farming
- Integrated organic farming is a cyclical, zero-waste procedure, where waste products from one process are cycled in as nutrients for other processes. This allows the maximum utilisation of resource and increases the efficiency of production.
- Ramesh Chandra Dagar, a farmer in Sonipat, Haryana, includes bee-keeping, dairy management, water harvesting, composting and agriculture in a chain of processes, which support each other and allow an extremely economical and sustainable venture.
- There is no need to use chemical fertilizers for crops, as cattle excreta (dung) are used as manure. Crop waste is used to create compost, which can be used as a natural fertilizer or can be used to generate natural gas for satisfying the energy needs of the farm.
- He has created the Haryana Kisan Welfare Club regarding this.

RADIOACTIVE POLLUTION

- Radioactive pollution is the physical pollution of air, water and soil with radioactive materials *e.g.,* radium, thorium, uranium, etc.
- Radioactive pollution chiefly caused by man-made radiations, can occur due to various human activities which are discussed in the given flow chart.

Radioactive pollution

Caused by

Atomic weapons and atomic explosions

They produce radioactive particles that are thrown high up into the air and carried over long distances by wind. Then, they are settled over the earth as fallout or brought down by rain.

Atomic reactors and nuclear fuel

Disintegration of radioactive substances produces a large amount of energy which is used for various purposes. But, it also emits harmful radiations.

Mining of radioactive materials

For nuclear reactors and other uses, radioactive materials are dug out from soil. It increases risk of health hazards in mine labourers and people in vicinity.

- Radioactive pollution affects all the organisms including humans. It causes cancer, mutations and even death in humans and animals.
- Radioactive wastes should be **changed into harmless form** or stored in safe place where they may gradually decay in a harmless manner. Radioactive wastes having only very low radiation can be discharged into sewers.
- Atomic explosions and use of atomic weapons should be given up.
- As there is no cure for radiation damage, radioactive pollution must be checked.

GREENHOUSE EFFECT AND GLOBAL WARMING

- The atmospheric greenhouse gases form a blanket-like covering around the earth. They control the escape of heat from the earth's surface to outer space and keeps it warm and hostile. This phenomenon is known as **greenhouse effect.**

- The capacity of atmosphere to keep the earth warm depends on the amount of greenhouse gases – the gases which are transparent to solar radiation but retain and partially reflect back long wave heat radiations. Greenhouse gases radiate a part of this solar energy back to the earth. The phenomenon is called greenhouse flux. Because of greenhouse flux, the mean annual temperature of earth is 15°C. In its absence it will fall to –18°C.
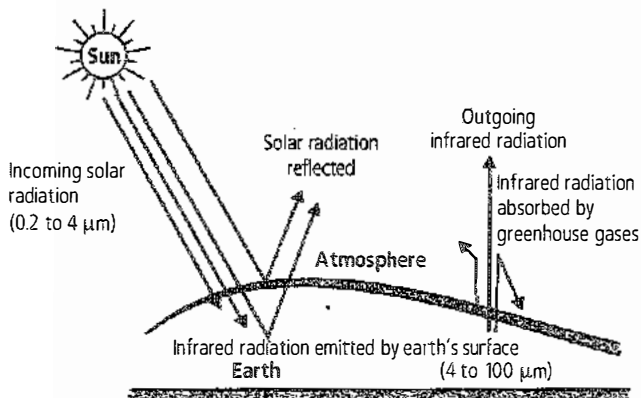

Fig.: Greenhouse effect in keeping the earth warm.

- Recently the concentration of greenhouse gases has started rising resulting in enhanced greenhouse effect that is resulting in increased mean global temperature. It is called global warming.
- During the past century, the temperature of earth has increased by 0.6 °C, most of it during the last three decades.
- Scientists believe that this rise in temperature is leading to deleterious changes in the environment and resulting in odd climatic changes (*e.g.*, El Nino effect), thus leading to increased melting of polar ice caps as well as of other places like the Himalayan snow caps. Over many years, this will result in a rise in sea level that can submerge many coastal areas.
- The various greenhouse gases are CO_2 (warming effect 60%), CH_4 (effect 20%), chlorofluorocarbons or CFCs (14%) and nitrous oxide (N_2O, 6%). Others of minor significance are water vapours and ozone.
- Some strategies should be followed to deal with global warming :
  - Vegetation cover should be increased for photosynthetic utilization of carbon dioxide.
  - Chlorofluorocarbon should be replaced with some other substitute having little effect on global warming.
  - Reducing the use of nitrogen fertilizers to reduce nitrous oxide emission.
  - Minimizing the use of fossil fuel to reduce the greenhouse gas emission.

OZONE LAYER DEPLETION

- Stratosphere has a thick layer of ozone (good ozone) called ozonosphere which protects life on earth from harmful effects of UV radiations. Thickness of ozone is measured in Dobson units.

- Ozone in earth's atmosphere is generally created by ultraviolet light striking oxygen molecules, which consist of two oxygen atoms (O_2), creating two single oxygen atoms, known as atomic oxygen. The atomic oxygen then combines with a molecule of O_2 to create ozone, O_3. In stratosphere, ozone is formed and photodissociated. It dissipates the energy of UV radiations.
- Ozone absorbs most of the ultraviolet radiation, so it shields earth against biologically harmful solar radiations.
- Ozone depleting substances (ODS) are substances which react with ozone present in the stratosphere and destroy the same. The ozone layer is destroyed by aerosols which are certain chemicals released into the air with force in the form of mist or vapour. Major aerosol pollutant present in jet plane emissions is fluorocarbon. Besides chlorofluorocarbons or CFCs (CCl_2F_2 and CCl_3F; used as coolants in air conditioners and refrigerators, cleaning solvents, aerosol propellants and foam insulation), nitrogen oxides (coming from fertilizers) and hydrocarbons are also responsible for O_3 depletion.

Effects of ozone depletion

- Ultraviolet radiations are of three types - UV-C (100 - 280 nm), UV-B (280 - 320nm) and UV-A (320 - 390nm). The intermediate or UV-B are harmful as well as capable of deep penetration. Thinning of ozone layer (commonly called as ozone hole) increases the amount of UV-B radiations reaching the earth.
- Researches show that surface UV-B radiation inhibits photosynthesis in Antarctic phytoplanktons. This, in turn, can affect the whole food chain of organisms that depend on phytoplankton. Elevated levels of UV-B radiation affect photosynthesis, as well as damage nucleic acid in living organisms.
- UV radiations of wavelengths shorter than UV-B, are almost completely absorbed by Earth's atmosphere, given that the ozone layer is intact. But, UV-B damages DNA and mutation may occur. It causes aging of skin, damage to skin cells and various types of skin cancers. In human eye, cornea absorbs UV-B radiation and a high dose of UV-B causes inflammation of cornea, called snow-blindness, cataract, etc. Such exposure may permanently damage the cornea.

International initiatives for mitigating ozone depletion

- Montreal Protocol – The Montreal Protocol was a convention signed in 1987 by 27 industrialised countries. It is a landmark international agreement to protect the stratospheric ozone and to limit the production and use of ozone-depleting substances. To date, more than 175 countries have signed the Montreal protocol.
- Earth Summit (United Nations Conference on Environment and Development, 1992) – It was held in Rio-de-Janerio (Brazil) and adopted the recommendations of CCC (Convention on Climate Change) for reducing greenhouse gases. The recommendations were signed by 154 nations. They pledged to freeze the emission of greenhouse gases at 1990 level.

- **Kyoto Protocol (Dec. 1997)** – International conference held in **Kyoto, Japan** obtained commitments from different countries for reducing overall greenhouse gas emissions at a level 5% below 1990 level by 2008-2012.
- **Beijing Protocol (1999)** – The protocol lays down steps to reduce emission of CFCs and other ozone depleting substances. It separates the efforts to be made by developing and developed countries.

DEFORESTATION

- Deforestation is removal, decrease or deterioration of forest cover of an area.
- The **causes** of deforestation and denudation are well known. The principal causes have been the **population explosion** in man and livestock leading to enchanced requirement of timber and fuelwood, and grazing respectively Increase in shifting (jhum) cultivation in the north-eastern states of India has also laid large forest tracts bare. A major cause of deforestation has been the **construction of hill roads** (about 30,000 km long) most of which are in strategic and the most fragile belt of Himalayas.
- **Fire** is the worst enemy of the forests. It destroys the full-grown trees, young trees of future forests, seeds and even humus. Animal life is also lost and there is a danger to human life too in a forest fire.
- Many kinds of insects are **forest pests.** They destroy trees by eating up leaves, boring into shoots and spreading diseases. It is difficult to spray on extensive forest, but biological control is possible.
- **Grazing** and **gnawing mammals** first eat or trample the young plants, then destroy the leaves on the lower branches of tall trees, and finally damage their trunks and roots.
- **Storm** and **snow** damage the forests. These natural forces are beyond the human power to control.
- Barriers (dams) constructed across the streams to form water reservoirs for generating power or preventing floods submerge and kill large tracts of forests.
- **The effects of deforestation are :**
  - Land erosions and landslides
  - Change in climate
  - Global warming
  - Reduced timber availability
  - Siltation
  - Occurring of flash floods

- **Afforestation** is growing forest over an area where no forest existed earlier.
- **Reforestation** is restoring of forest cover over an area where one existed earlier but was removed at some point of time in the past. A tree plantation movement or Van Mahotsava is being carried out in India since 1950. Under this movement, both government and private agencies perform tree plantation during July and February every year.

Case study of people's participation in conservation of forests

- In 1731, the King of Jodhpur (Rajasthan) asked his miniters to arrange wood for construction of a new palace. The ministers and workers went to forest near a village inhabited by Bishnois, for cutting down the trees. A Bishnoi woman Amrita Devi hugged a tree and asked king's men to first cut her before cutting the tree. The kings men cut down the tree along with Amrita Devi. Her three daughters and hundreds of other Bishnois lost their lives in saving trees. Such a commitment for saving environment is found nowhere else.
- The Government of India has recently instituted Amrita Devi Bishnoi Wildlife Protection Award for individuals and rural communities who show extraordinary courage and dedication in protecting wildlife.
- Chipko movement is movement initially meant for protecting trees but now meant for preservation of environment including habitat and wildlife.
- 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 and in 1974 near village Reni (led by Gaura Devi). The movement had two leaders, Chandi Prasad Bhatt of Gopeshwar and Sunder Lal Bahuguna of Silyara in Tehri region.
- A similar movement was undertaken by Pandurang Hegde in the south. It is known as appiko movement. It aims at uliso (conservation), belesu (growth plantation) and balasu (rational use).
- Silent valley of Kerala was also saved through public agitation against setting up of hydroelectric project in natural forest area.

CONCEPT MAP

Environmental Issues

Pollution
- It is 'undesirable change in physical, chemical and biological properties of air, water and soil, which directly or indirectly affects human beings'.

Air pollution
- Primarily results from burning of fossil fuels in industries and automobiles.
- Effects include reduction in growth and yield of crops and their premature death. Affects respiratory system of humans and of animals.
- Devices such as settling chamber, cyclonic separators, bag filters, electrostatic precipitators, etc. are used to control air pollution.
- Noise is also considered an air pollutant.

Water pollution
- It is deterioration of water quality that makes it unfit for consumption.
- Causes are domestic sewage, industrial discharge, surface run off containing pesticides, detergents, fertilizers, silt, etc., oil spills.
- Consequences of water pollution are:
  - decreased DO
  - increased BOD
  - eutrophication
  - biomagnification
  - thermal pollution
  - health hazards
- Water pollution can be controlled by sewage treatment.

Solid waste management
- Solid waste refers to everything that goes out in trash.
- Sources of solid wastes are municipal wastes, industrial wastes, mining wastes, hazardous wastes, defunct ships and electronic wastes.
- Disposal of wastes consists of recovery and recycling, source reduction, burning and dumping (landfills).

Agrochemicals & their effects (Soil pollution)
- Pesticides, fertilizers, chemicals and radioactive wastes are the main sources.
- Control measures include:

  → Organic farming

  → Solid waste disposal

  → Soil conservation by terrace farming, growing grazing fields, afforestation, reforestation.

Radioactive pollution
- Pollution of air, water and soil with radioactive materials.
- It is caused by atomic weapons and atomic explosions, atomic reactors and nuclear fuel, mining of radioactive materials.
- These wastes should be changed into harmless form and stored in safe place where they may gradually decay in a harmless manner.

Greenhouse effect and global warming
- Greenhouse effect is a naturally occurring phenomenon that is responsible for heating of Earth's surface and atmosphere.
- Increased level of greenhouse gases (N_2O, CFCs, methane, CO_2) has led to considerable heating of earth causing global warming. This is resulting in odd climatic changes, melting of ice caps, etc.
- Control measures include cutting down use of fossil fuels, improving efficiency of energy usage, reducing deforestation, planting trees and slowing down the growth of human population.

Ozone layer depletion
- Ozone layer (layer which protects life on earth from harmful effects of UV radiations) is being depleted by ozone depleting substances (ODS), such as chlorofluorocarbons, nitrogen oxides, hydrocarbons, etc.
- Ozone depletion or thinned ozone layer (ozone hole) is particularly marked over Antarctic region.
- It causes aging of skin, damage to skin cells and various types of cancer, snow blindness, cataract, etc.

Deforestation
- It is the conversion of forested areas to non-forested ones.
- It results in enhanced CO_2 concentration, loss of biodiversity, disturbed hydrological cycle, soil erosion, and desertification.