Chapter 62

Pollution & Global Environmental Changes

- An undesirable change (may be physical , chemical or biological) in air , water or soil due to excessive accumulation of pollutant is called as **pollution**.
- The pollution by volcanic eruption, UV radiation, soil erosion, dust storm, forest fire etc. are called as **natural pollution**.
- The pollution caused by human beings (industrial, water removal etc.) are called as **anthropogenic pollution**.
- A **pollutant** is any substance, chemical or other factor that changes the natural balance of environment.
- The increase in toxicity by reaction among the pollutant is known as **synergism**.
- Pollution is **different from contamination** which occurs in the presence of harmful organisms or their products causing disease or discomfort.
- **On the basis of emission of pollution**, it can be **point source** (from single point), **line source** (which passes along a belt), **area source** (in mining area) and **diffuse source** (over a large area).
- There are **5 types of pollution : air**, **water**, **land**, **noise** and **radioactive pollution**.

Pollutants

on the basis of

Existence

Quantitative those component which become pollutant when its concentration reaches beyond a threshold value, eg. CO, CO_2, NO_2 concentration in the air

Qualitative do not occur naturally in nature, but passed through human activities, eg. DDT and other pesticides

Natural disposal

Biodegradable quickly degraded by natural means, eg. sewage

Non-biodegradable either do not degrade or degrade very slowly in nature, eg. mostly inorganic compounds (like salts of heavy metals, radioactive materials etc.), DDT, long chain of phenolic chemical etc.

Persistence

Primary pollutants persists in form in which they are added to the environment, eg. plastic ware, DDT

Secondary pollutant formed by interaction among primary pollutant, more toxic than primary pollutant, eg. peroxyacyl nitrates (PAN) and ozone

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, C, 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 air pollutants have been classified into two categories as **primary air pollutants or primary emissions** and the **secondary air pollutants**.
- **Primary emissions or pollutants** include those substances which are **emitted directly from some identifiable sources**. These include – sulphur compounds; carbon compounds [includes oxides of carbon (CO, CO_2) and hydrocarbons]; nitrogen compounds (includes NO_2 and NH_3); halogen compounds [includes hydrogen fluoride (HF) and hydrochloric acid (HCl)]; particles of different size and different substances are found suspended in air.
- The oxides of sulphur, carbon, nitrogen, hydrocarbons, photochemical oxidants and fluorides are the **common gaseous pollutants**.
- **Carbon monoxide** (accounts for **50% of atmospheric pollution**) is the **most poisonous gas** and is released from motor vehicles and industries.
- Carbon monoxide is harmful to man as it **competes with O_2 for haemoglobin and form carboxyhaemoglobin**.
- When a man inhales air containing normal concentration of O_2 and also carbon monoxide, he suffers from suffocation because haemoglobin combines with CO instead of O_2 and the product formed cannot dissociate.
- CO poisoning can lead to giddiness, laziness, exhaustion, reduced vision, nervous and cardiovascular disorder and even death.
- The CO_2 increase in the air may cause rise in atmospheric temperature which may melt the polar ice, causing rise in ocean level and consequent flooding of towns.
- **Nitrogen oxide** form about **10% of pollutants**.
- Oxides of nitrogen **causes eye irritation, respiratory troubles, lung oedema, blood congestion and dilation of arteries**. Nitrogen monoxides like CO, lowers the oxygen carrying capacity of the blood.
- **Oxides of sulphur (sulphur dioxide** and **sulphur trioxide)** form about **18% of total air pollutants**.
- They may cause respiratory diseases (asthma, bronchitis, emphysema) and eczema in man. The exhausts from Mathura Refinery are a threat to the Taj at Agra.
- **Burning of fossil fuels** is the **main cause of sulphur dioxide pollution.**
- SO_2 and its transformation products in atmosphere on plant cell causes membrane damage, plasmolysis, chlorophyll destruction, metabolic inhibition, growth and yield reduction.
- SO_2 causes **chlorosis, necrosis of vegetation metabolic inhibition** and **growth reduction**.
- The compounds of SO_2 have **mutagenic effects**.
- **Acid rain** is **mainly due to pollution of sulphur dioxide** (combined with water forming sulphuric acid).
- Acid rain **(term coined by Robert August in 1872)** is rainfall and other forms of precipitation with a pH of less than 5. (pH of normal rain is 5.6–6.5).
- There are **two types of acid deposition** : wet deposition and dry deposition. **Wet deposition is acidic water** received through rain, fog and snow while **dry deposition is wind blown acidic gases** and **particles in the atmosphere**.

Approx. half of the natural forest have been destroyed by acid rain in Europe and N-E United States.

- **Problems and impacts of acid rain** are –
  - Soil acidity – affect land flora and fauna.
  - Acidification of lakes and streams – affect aquatic life, crop productivity, human.
  - Corrodes buildings, monuments and statues made of lime stones, bridges, fences, railings etc.

In Greece and Italy, invaluable stone statues have been partially dissolved and the Tajmahal in India is affected by the acid rain.

- The **nitrogen oxides by producing peroxy acylnitrates, photochemical smog** affects human health and plant vegetation.
- **Flourides** causes **leaf chlorosis**, **necrosis of margins, tips** and **abscission of leaves, fruits** etc.

- Hydrogen flourides causes **flourosis**.
- **Phosgene** and **methyl isocyanate** were **responsible for the Bhopal gas tragedy** that took place in **1984 in India**.
- **Lead** is a pollutant from automobile exhausts which affects health adversely and causes mental illness.
- Lead is believed to be **responsible for the fall of the Roman Empire**.
- **Hydrocarbons** or **volatile organic compounds** are **formed naturally by incomplete combustion of fuel in automobiles**.
- **Marsh gas or methane** is produced during decomposition of organic matter, paddy fields and due to incomplete combustion in automobiles and industries.
- Many hydrocarbons are carcinogenic. They **also cause irritation of eyes and bronchial constriction**.
- **Garden pea** is **SO_2 pollution indicator**.
- **Lichens** are grown as **pollution indicator**.
- **Maize** indicates **flouride pollution**.
- **Particulate matter** (PM) are air borne matters which results not only from direct emission of particles but also from emissions of some gases that condense as particles directly or undergo transformation to form particles.
- PM consists of soot, flyash, dusts of various types, fur, hair, spores, pollen grains etc.
- Fine particles of ash present in fuel gas are called **fly ash**. It is expelled from thermal power plants.
- Fly ash **block the stomata and also reduces the absorption of light energy by plants**.
- Fly ash is **absent in automobile exhausts**.
- Particulate matter from processing industries, eg. cotton dust, iron mill dust, mine dust, flour mill dust, gem grinding **causes pneumoconiosis, byssinosis, emphysema, siderosis** and **other pulmonary problems** (iron deposition in tissues).
- Particulate matter can be **settleable** and **suspended**.
- **Suspended PM** can be **further differentiated** as **aerosol** (less than 1 mm), **dust** (solid, more than 1 mm) and **mist** (liquid, more than 1 mm).
- Smoke causes about **10 – 15%** of atmospheric pollution.
- Most of the components of smoke are similar to those present in automobile exhausts like sulphur dioxide, sulphites, **3-4-benzpyrene** (causing lung cancer) and oxides of nitrogen.
- Soot, lead particles from exhaust, asbestos, flyash, volcanic emission, pesticides, H_2SO_4, mist, metallic dust, cotton, cement dust etc. **when inhaled by man cause respiratory diseases** such as tuberculosis, cancer and byssinosis (due to cotton dust).
- Different bacterial cells, spores, fungal spores, pollen grains can create bronchial disorders, allergy and many other diseases in animals and plants.
- **Secondary air pollutants** are usually produced photochemically from primary pollutants and are called **photochemical oxidants**.
- Photochemical oxidants includes **peroxyacyl nitrate (PAN)**, **ozone** and **aldehydes**.These are formed by the reaction of nitrogen oxide with the hydrocarbons present in the air.
- Secondary pollutants are **photochemical smog** and **acid rain**.
- The fog deposited with smoke and chemical fumes forms a dark and thick covering, the **smog**.
- Smog is very common in almost all the industrial areas and the cities situated in the basin experience it more because there the smog is trapped for many days by the stagnant air.
- **Smog** is of **two types - classical (London) smog** and **photochemical (Los Angeles) smog**.
- **Classical smog**, occurs at low temperature, contains sulphur gases (hydrogen sulphide, sulphur dioxide), smoke & dust particles.
- It is formed by condensation of water vapours with H_2S & SO_2 over dust & smoke particles. In them **secondary pollutants are absent**.
- It occurred in London during December 1952 when it affected 50% of population & killed over 4000 persons.
- **Photochemical or Los angeles smog**, having oxidizing environment, **contains secondary pollutants**.
- It is formed at high temperature due to still air, emission of nitrogen oxides & carbohydrates from automobile exhausts & solar energy.
- The **principal photochemical products** are **olefins**, **aldehydes**, **ozone** (*described later*), **PAN** (peroxyacyl nitrate), **PBzN** and **photochemical smog**.
- **PAN** is **produced due to reaction between oxides of nitrogen and hydrocarbons under effect of ultra violet radiation of sunlight**, when O_3 is also formed.
- There are three techniques for control of gaseous **pollutants – combustion**, **absorption** and **adsorption method**.

- In **combustion process**, oxidisable gaseous pollutants are completely burnt at a high temperature.
- In **absorption technique**, gaseous pollutants are absorbed in suitable absorbent materials.
- **Adsorption technique** is applied to control toxic gases, vapours and inflammable compounds that could not be efficiently removed or transferred by the aforesaid technique.
- According to sizes of air pollutants range and types of chemicals, different suitable devices are effective. Some **new devices** are **most widely used as settling chambers**, **cyclone collector**, **bag filters**, **wet collectors**, **electrostatic precipitators** (ESP, **most effective device**), **gas scrubbers**, **catalytic combustion**, **incineration** etc.

WATER POLLUTION

- **Water pollution** is the deterioration of the quality of water due to addition of foreign substances, factors (heat) and deprivation that makes it health hazard, 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** includes clay and slit from soil erosion, leaching of minerals, falling of organic matter from the banks.
- **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, from sewage or livestock operations
  - Food processing waste, including pathogens
  - Tree and bush debris from logging operations
  - VOCs (Volatile Organic Compounds, industrial solvents) from improper storage.
- **Some inorganic water pollutants include –**
  - Heavy metals including acid mine drainage
  - Acidity caused by industrial discharges (especially sulphur dioxide from power plants)
  - Chemical waste as industrial byproducts
  - Fertilizers, in runoff from agriculture including nitrates and phosphates
  - Silt in surface runoff from construction sites, logging, slash and burn practices or land clearing sites.
- **Organic matter in water provides nutrition for decomposers** such as bacteria and fungi. They breakdown the organic matter using oxygen and deficiency of oxygen kills fishes and other aquatic animals.
- **BOD** (biological oxygen demand) 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**.
- **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.
- Many pesticides such as **chlorinated hydrocarbons, organophosphates, organochlorine** compound etc are nonbiodegradable and their residues have long life. They enter the food chain and accumulates mostly in fatty acids.
- **Detergents** are regarded as **major pollutant in surface water.**
- **Phosphorous and nitrates of fertilizers** and **detergents** dissolve in water and **accelerate growth of algae which form mat on the water surface**.
- The **algal growth deoxygenate water** which are 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**.
- Industrial wastes such as cadmium, arsenic, mercury, lead, zinc etc. when released into water may reach the human body with contaminated food etc., which are very harmful for the health.
- The metals concentrate through the food chain to levels that result in heavy metal poisoning.
- Main sources of **mercury pollution** are combustion of impure coal, smelting of metallic ore, paper and paint industries.
- Concentration of toxic material increases at every trophic level. This is known as **biomagnification**.
- Radioactive waste from atomic power plants are stored in underground tanks. Radioactive materials reaches to crops, livestocks, and man through food chain.
- **Faecal pollution** is indicated by number of *Escherichia coli* in water.
- Warmer water has less oxygen (14 ppm at 0°C, 1 ppm at 20°C), so **thermal pollution** causes deoxygenation of water bodies which decreases the decomposition of organic wastes and kills the aquatic animals.
- **Phosphate pollution** is **caused by sewage and agricultural fertilizers**.
- Polluted water affect the health and economy of man as well as other living organisms. Pollutants make water unfit for domestic and industrial use.
- Taking fishes and other eatable aquatic animals poisoned with methyl mercury causes deformity called **minimata disease**.
- **Itai-itai disease (in Japan)** is **caused due to accumulation of cadmium**, characterized by pain in joints and bones .
- **In blue-baby syndrome excess nitrate** reacts with haemoglobin and forms nonfunctional methaemoglobin in infants. It **impairs oxygen transport**.
- Contamination of drinking water with **arsenic causes black foot disease**. It is characterized by diarrhoea.
- Excess use of fluoride tooth paste may lead to **skeletal fluorosis** or **knock knee disease** in which joints and bones become stiff and hard.
- Polluted water are treated in Effluent Treatment Plant before their release into water bodies. There are three steps in sewage treatment –
  - **Primary treatment** - Physical treatments such as sedimentation, floatation, fragmentation and filteration 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.

SOIL POLLUTION

- Soil pollution, also **called land pollution** is addition or removal of nutrients which reduces the productivity of soil.
- The substances which are responsible for the reduction of soil productivity is called as **soil pollutants**.
- Soil pollutant alters the basic composition of the soil that may kill important soil organisms.
- **Pesticides, fertilizers, chemicals** and **radioactive wastes** etc. are the **main sources of soil pollution**.
- Various metals such as lead, tin, copper, cadmium etc., insecticides such as BHC, DDT, aldrin, melathion, fungicides, weedicides and many fertilizers are responsible for soil pollution.

- Quality of land also deteriorate due to **deforestation**, **desertification**, **water logging**, **flooding**.
- There are **two types** of soil pollution : **positive** and **negative soil pollution**.
- When there is **addition of undesirable substance** in the soil then it is called as **positive pollution**.
- When there is **reduction of soil fertility** due to loss of its top layer, it is called as **negative pollution**.
- Negative pollution is also, sometimes, called **third pollution or landscape pollution** in which fertile land is converted into barren areas by addition of solid wastes like leather good, spoiled food items etc.
- 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**.
- There are **two types of wasteland** : **unculturable** and **culturable**. Rocky area, snow-covered area, steep slopes are unculturable area. Water-logged land, marshy area, forest land etc. are the example of culturable land area.

RADIOACTIVE POLLUTION

- Pollution of air, water and soil with radioactive materials is called as **radioactive pollution**.
- Radioactive pollution may be **natural or man-made**.
- Cosmic rays which reaches the earth, radiation from radioactive material present in rocks, soil etc. are **natural radiation**.
- Atomic explosion, atomic reactors and nuclear fuel, mining and refining of plutonium and thorium etc. are **man-made radiation**.
- Radioactive pollution affects all the organisms including humans. It causes **cancer, mutations and even death** in humans and animals.
- Radioactive wastes from various atomic reactors should be changed into harmless form before disposing off.
- Leakage of radioactive material from nuclear reactors should be prevented. Atomic explosion and use of atomic weapons should be banned.
- Radioactive pollution is **not curable**, hence it must be checked.
- Radioactive substances that are carried to distant places by wind and fall on the ground alongwith rain water is called **nuclear fall out**.
- Wastes from atomic power plants come in the form of spent fuels of uranium and plutonium.
- In India, there are **4 atomic power plants** : **Narora, Tarapur, Kalpakkam,** and **Rawat Bhata**.
- Many radioactive isotopes like C^{14}, I^{125}, P^{32}, O^{18} and their compounds are used in **scientific researches**.
- On the basis of their action on cells, **radiations** are **divided into two categories – non-ionising radiations & ionising radiations**.
- **Non-ionising radiations** include ultra-violet rays (100–300 nm) which are **known to cause sunburn**, **snow blindness**, **inactivation of organic bio-molecules formation of thymine-dimer in DNA**, and **skin cancer**.
- **Ionising radiations** include X-rays, cosmic rays and atomic radiations which **damage the living cells by ionisation (shifting the electrons from one to other bio-molecule)**.
- High altitude plants have **polyploidy** as a protective mechanism against radiations.
- **Actively growing and dividing cells** like those of stratum germinativum, intestinal lining, bone marrow, gonads and embryo (with all cells rapidly growing and dividing) are **more susceptible to ionising radiations**.
- **Less active and non-dividing cells** like osteocytes of bones, muscles fibres and neurons are **not so easily damaged** by radiations.
- **Strontium-90** accumulates in the bones to cause bone cancer and tissue degeneration in a number of organs.
- **Iodine-131** damages WBCs, bone marrow, spleen, lymph nodes, skin cancer, sterility and defective eye sight.
- **Radioactive iodine** may also cause cancer of thyroid glands.
- **Cesium-137** brings about nervous, muscular and genetic changes.
- **Uranium** causes skin cancers and tumors in the miners.

NOISE POLLUTION

- **Unpleasent loud sound** is called as **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**.
- 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**.
- **Noise pollution can cause** damage to heart, increase blood cholesterol and even raise blood pressure and is also responsible for stomach disorders (ulcers), reduced hormonal secretions and change in the renal functions.
- Noise also causes anxiety and stress, increased rate of heart beat, headache by dilating blood vessels etc.
- A **constant exposure** to noise of **130 dB** (explosions) may **lead to partial or complete deafening of the ears**.
- A **regular exposure** to sound of **80 dB reduces hearing by 15 dB in 10 years**.
- Noise **become uncomfortable above 100 dB**.
- Noise stimulates the **secretion of adrenaline** which increases irritability, nervousness, neuromuscular tension and feeling of fatigue, so decreasing the working efficiency.
- Noise causes **vasoconstriction** which decreases the blood flow.
- Average street noise level in the metropolitan cities like Mumbai, New Delhi and Calcutta is **above 95 dB**.
- Mumbai considered to be the **third noisest city** in the world. Some areas in Mumbai have recorded as high as 105 dB of noise.
- **Reduction of noise level from the source**, **check of noise transmission, and protection of human beings from noise** are the **three main measures to control noise pollution**.
- **Green muffler scheme** involves the growing green plants along roadsides to reduce noise pollution.

GLOBAL ENVIRONMENTAL CHANGES

- The atmospheric green house gases forms a blanket like covering around the earth. It controls the escape of heat from the earth's surface to outer space and keep it warm and hostile. This phenomenon is known as **green house effect**.
- The capacity of atmosphere to keep the earth warm depends on the amount of green house gases.
- The greenhouse effect is a phenomenon whereby increased carbon dioxide emissions create a condition in the upper atmosphere, causing a trapping of excess heat and leading to increased surface temperatures.
- The **major natural greenhouse gases** are – **carbon dioxide** (60%), **methane** (20%), **nitrous oxide** (6%) and **chlorofluorocarbons** (14%). Also of minor significance are **water vapour** and **ozone**.
- The **major atmospheric constituents (N_2 and O_2) are not greenhouse gases**, because homonuclear diatomic molecules (e.g. N_2, O_2, H_2) neither absorbs nor emit infrared radiation as there is no net change in the dipole moment of these molecules.
- When concentration of green house gases increase in the atmosphere, it retains more and more infrared radiation, resulting in enhanced green house effect.
- Due to enhanced green house effect, there is increase in **global mean temperature or global warming**.
- Carbon dioxide, methane, chlorofluorocarbon and nitrous oxide are radioactive gases which **absorbs long wave infrared radiations**.
- Global warming has many fold effects as –

Table : Important legislations for the protection of environment.

	Name of Act	Function
1.	**The Environment Protection Act, 1986**	Law meant for the protection of air, water, soil and noise.
2.	**The Insecticide Act, 1968**	Power of government to regulate the import, manufacture, sale, distribution and use of insecticides.
3.	**The Water** (prevention and control of pollution) **Act, 1974**	Deals with preservation and quality control of water pollution.
4.	**The Air** (prevention and control of pollution) **Act, 1981**	Deals with preservation and control of air pollution.

- **Effect on weather and climate** - There is increase in average temperature by 1.4-5.8 degree centigrade by the year 2100. Warming of atmosphere increases its moisture containing capacity. All these are responsible for change in precipitation pattern. This climatic change is harmful for human health.
- **Sea level change** - The global warming is responsible for increase in sea level and melting of glaciers and green land ice sheets.
- **Effects on range of species distribution** -

Due to increase in global warming, many species are expected to shift poleward or towards high elevation in mountain regions.
  - **Food production** - Increase in temperature causes extensive growth of weeds which ultimately decrease crop production.
- 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 green house gas emission.
- Stratosphere have a thick layer of **ozone** which **protects life on earth from harmful effects of UV radiations**.
- **Ozone** in the 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.
- Ozone absorbs most of the ultraviolet radiation, so it **shields earth against biologically harmful solar radiations.**
- **Ozone depletion** refers to the phenomenon of reduction in the amount of ozone in the stratosphere. The depletion of O_3 layer by human activities may have serious implications and this has become a subject of much concern over the last few years.
- Ozone layer depletion **has various negative effects on atmosphere**. UV radiation increases more on earth. In humans it causes skin cancer, cataract, reducing the functioning of immune system. UV radiation inhibits photosynthesis in phytoplanktons.
- **Chloroflourocarbons 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 fertilisers) and **hydrocarbons** are **responsible for O_3 depletion**.
- CFC produces active chlorine in the presence of UV radiation. These destroy ozone, converting it into oxygen.
- Nitrogen dioxide is a pungent gas; it produces a brownish haze, causes nose and eye irritations and pulmonary discomfort.
- Major aerosol pollutant present in jet plane emissions is **fluorocarbon**.
- The **ozone** layer is **destroyed by aerosols**.
- Aerosols are certain chemicals released into the air with force in the form of mist or vapour.
- The thickness of ozone shield is declining gradually. This is called as **ozone hole** (First discovered in 1985 over Antarctica).
- **Dobson** is an **unit of ozone hole amount**.
- UV radiation is non-ionizing type and it is lethal due to inactivation of proteins, pigments and nucleic acids.
- Carotenoid pigments prevent the damage of plant cells from ultraviolet rays.
- The molecular action of ultraviolet rays is mainly reflected through destruction of hydrogen bonds between DNA strands.

- **Montreal Protocol :** A landmark international agreement to protect the stratospheric ozone by agreeing to limit the production and use of ozone depleting substances phasing out ozone depleting substances & helping the developing countries to implement use of alternatives to CFCs.
- **Helsinki Declaration** (May, 1989) : Montreal Protocol was ratified by 82 nations at Helsinki. They pledged to phase out CFCs by 2000.
- In June 1990, 93 nations amended Montreal Protocol and Helsinki Declaration. They agreed to phase out CFCs and other ODS by the end of 20th century.
- **Intergovernmental Panel on Climate Changes** (IPCC, 1988) : Prepared a world climatic programme (WCP).
- **Convention on Climate Change** (CCC) Under UN framework in 1991.
- **Earth Summit** (United Nations Conference on Environment and Development, 1992). It was held in Rio-de-Janeiro (Brazil) and adopted the recommendations of CCC for reducing greenhouse gases. The recommendations were signed by 154 nations. They pledged to maintain emission of green house gases at 1990 level.
- **Kyoto Protocol :** International conference held in Kyoto, Japan (during December 1997) obtained commitments from different countries for reducing overall greenhouse gas emissions at a level 5% below 1990 level by 2008-2012.

End of the Chapter