Environment - II

Unit – 1: Types of Environmental Pollution

Water Pollution

Introduction

Water is the essential element that makes life on earth possible. Without water there would be no life. We usually take water for granted. It flows from our taps when they are turned on. Most of us are able to bathe when we want to, swim when we choose and water our gardens. Like good health we ignore water when we have it. Although 71% of the earth's surface is covered by water only a tiny fraction of this water is available to us as fresh water. About 97% of the total water available on earth is found in oceans and is too salty for drinking or irrigation. The remaining 3% is fresh water. Of this 2.997% is locked in ice caps or glaciers. Thus only 0.003% of the earth' total volume of water is easily available to us as soil moisture, groundwater, water vapour and water in lakes, streams, rivers and wetlands. In short if the world's water supply were only 100 litres our usable supply of fresh water would be only about 0.003 litres (one-half teaspoon). This makes water a very precious resource. The future wars in our world may well be fought over water. By the middle of this century, almost twice as many people will be trying to share the same amount of fresh water the earth has today. As freshwater becomes more scarce access to water resources will be a major factor in determining the economic growth of several countries around the world.

Water Quality Standards

Water quality standards are assigns according to the goals for aquatic system by assigning its uses, managing to protect those uses, and creating requirements such as anti-degradation policies to protect them from pollutants. Set by each state, water quality standards regulate how clean a water body should be. States designate water bodies for specific uses based on their goals and expectations for their waters. Typical designated uses include:

- Protection and propagation of fish, shellfish and wildlife.
- Recreation.
- Public water supply.
- Agricultural, industrial, navigational and other purposes.

The important parameters that are normally associated with the measurement of water quality in monitoring situations are turbidity, salinity, biological oxygen demand (BOD), chemical oxygen demand (COD), microbial count, bioaccumulation, hardness of water, total dissolved solids (TDS) etc. Some of the important parameters for water quality standard are defined below (a) Hard and Soft water: The presence of multivalent cations, most notably calcium and

magnesium ions are referred to as water hardness. Soap does not produce lather with hard water instead it forms a sticky and gummy deposit called scum or soap curd. On the other hand, soft water has moderate to low levels of ions and is considered safe for drinking. Following table gives the relative amount of TDS in different types of water.

Classification	Amount of TDS (parts per million)
Very soft	0-70
Soft	70-140
Slightly Hard	140-210
Moderately Hard	210-320
Hard	320-530
Very Hard	>530

(b) BOD: Biochemical oxygen demand or BOD is known to be the standard amount of oxygen needed for biodegradation by microorganism.. Biochemical oxygen demand is said to be an indicator of the quantum of pollution load. If the load of pollution is high in amount, less will be the dissolved oxygen in water or greater amounts of dissolved oxygen shall be consumed. Similarly, a low value of BOD indicates relatively pure water. It is estimated that for drinking water the biochemical oxygen demand should be in the range 0.75-1.5 ppm. Contamination to water caused by any specific chemical cannot be measured by biochemical oxygen demand. It is basically measure of the contamination caused by totality of those compounds which can be oxidized in the presence of microorganisms. A large number of organic and inorganic compounds, however, are resistant to microbial oxidation. These, therefore, do not add to the BOD because they make water unfit for drinking.

(c) COD: At times, biochemical oxygen demand does not give an accurate assessment of pollution load. As has been stated, some compounds, like detergents, are resistant to microbial degradation and hence do not add on to the biochemical oxygen demand. Some other pollutants, like cellulose, are slow to get oxidized. Thus, during the five days period required for elucidation of biochemical oxygen demand, these may be only partially oxidized. It is also probable that water sample in question may contain toxic compounds, like biocides, which may poison the microorganisms even before they can act on pollutants, Moreover. The five days period required to assess the water quality by biochemical oxygen demand method is quite long. Although chemical oxygen demand is a fast and reliable method for assessing the water quality, it suffers from the drawback that aromatic hydrocarbon derivatives are not easily oxidized by most chemical oxidizing agents, including potassium dichromate. Hence, their presence cannot be judged by chemical oxygen demand determinations.

(d) DO: The organic pollution load in water encourages the growth of a myriad of microorganisms. These microorganisms decompose the complex organic compounds into simple inorganic constituents like carbonates, bicarbonates, nitrates, sulfates and phosphates. The removal of hazardous organic compounds from water by microorganisms is called self-purification. The microorganisms which bring about self-purification consume oxygen dissolved in water by way of respiration. If the amount of dissolved oxygen is high, the degree of self-purification of water would also be high. In such cases a milder water treatment operation shall be required. If, on the other hand, the amount of dissolved oxygen is less, some

of the impurities would not be eradicated by self-purification phenomena and hence advanced water treatment would be necessary in such cases. Thus, the level of dissolved oxygen is the most valuable analytical measure of the condition of polluted water. There are many factors affecting the concentration of dissolved oxygen in a stream. This includes: Temperature as oxygen is more easily dissolved in cold water. Flow as the concentration of oxygen vary with the volume and velocity of water flowing in a stream. Faster the rate of flow of water, more will be the concentration of oxygen entering the water from atmosphere.

(e)Bioaccumulation: The phenomenon of successive increase in concentration of a pollutant through a food web is called bio accumulation or bio concentration. For example DDT which is a non-biodegradable and carcinogenic chemical tends to undergo bioaccumulation. Therefore while formulating the water quality criteria due consideration is given for bio concentration and persistence.

Water Quality Criteria and Standards for Various Purposes

For proper functioning of any water body it should be highly pure because drinking water should be of highest purity. As water is very demanding, its management is very important for future security. In order to set the standard for the desire quality of a water body, it is essential to identify the uses of water in that water body.

Water Quality Standards are the basis of the water quality control program directed by the certain authorized agencies. A water quality standard is advanced to protect and maintain the quality of water necessary to meet its requirements such as swimming, recreation, public water supply,

Water quality standards consist of four basic elements:

1. Designated uses of the water body (e.g., public water supply, aquatic life, recreation)
2. Water quality criteria to protect designated uses by limiting chemical constituents that may be present in the water body. The criteria consist of numeric concentrations and/or narrative requirements.
3. An antidegradation policy to maintain and protect existing uses and high quality waters.
4. General policies addressing implementation issues (e.g., low flows, variances, mixing zones).

Water Quality Criteria for Classification of Water Bodies

In India, the Central Pollution Control Board (CPCB) has developed a concept of designated best use. According to this, out of the several uses of water of a particular body, the use which demands highest quality is termed its designated best use. Five designated best uses have been identified. This classification helps the water quality managers and planners to set water quality targets and design suitable restoration programs for various water bodies.

Designated Best Uses of Water (Source: CPCB)

Designated Best Use	Class	Criteria
Drinking Water Source without conventional treatment but after disinfection	A	1.Total Coliforms Organism MPN/ 100ml shall be 50 or less (MPN is most probable count) 2. pH between 6.5 and 8.5 3. Dissolved Oxygen 6mg/l or more 4. Biochemical Oxygen Demand 5 days 20 C, 2mg/l or less
Outdoor bathing (Organised)	B	1.Total Coliforms Organism MPN/ 100ml shall be 500 or less 2. pH between 6.5 and 8.5 3. Dissolved Oxygen 5mg/l or more 4. Biochemical Oxygen Demand 5 days 20 C, 3mg/l or less
Drinking water source after conventional treatment and disinfection	C	1. Total Coliforms Organism MPN/ 100ml shall be 5000 or less 2. pH between 6 and 9 3. Dissolved Oxygen 4mg/l or more 4. Biochemical Oxygen Demand 5 days 20 C, 3mg/l or less

Designated Best Use	Class	Criteria
Propagation of Wild life and Fisheries	D	1. pH between 6.5 and 8.5 2. Dissolved Oxygen 4mg/l or more 3. Free Ammonia (as N) 4. Biochemical Oxygen Demand 5 days 20 °C, 2mg/l or less
Irrigation, Industrial Cooling, Controlled Waste disposal	E	1. pH between 6.0 and 8.5 2. Electrical Conductivity at 25 °C micro mhos/cm, maximum 2250 3. Sodium absorption Ratio Max. 26* 4. Boron 2mg/l (Maximum)
	Below-E	Not meeting any of the A, B, C, D & E criteria

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Sodium adsorption ratio (SAR) is a measure of the suitability of water for use in agricultural irrigation, as determined by the concentrations of solids dissolved in the water. The formula for calculating sodium adsorption ratio is:

$$S.A.R. = \frac{Na^+}{\sqrt{\frac{1}{2}(Ca^{2+} + Mg^{2+})}}$$

Sources of Water Pollution:

In case of surface water pollution, pollutants enter a steam, river and a lake. A stage comes when water is either rendered unusable or risk prone from health point of view.

Types of Surface Water Pollution

Surface water pollution may be generally categorized as follows:

- **Point Source Pollution**
  Point source pollution is a well defined source that puts pollutants and effluents from domestic and industrial wastes through a distinct conveyance into different water bodies. This can be controlled effectively.
- **Non-Point Source Pollution**
  Non-point source (NPS) of water pollution is generally scattered sources (not originating from a single source) which cause diffused contamination. NPS pollution is often a cumulative effect of small amounts of contaminants gathered from a large area. Contaminated water from agriculture farms, construction sites, abandoned mines polluting rivers and lakes are some of the examples of this type of pollution. NPS pollution is extremely difficult to control.

Sources of Surface Water Pollution
Waters are generally polluted by natural and artificial (man-made) sources. The important sources of water pollution are as follows:

- **Natural Sources**

Natural sources of water pollution are as follows:

(i) **Siltation (Silt, sand and mineral particles):** It is common natural phenomenon occurring in most water bodies. As a result of this, not only the capacity of water bodies like river, lake, reservoir gets considerably reduced but causes pollution problem as well. Indiscriminate deforestation contributes to this phenomenon by loosening the upper soil layer and occurrence floods. These flood waters bring silts from the mountains and deposit into these water bodies. These water bodies need to be periodically desilted which is a time consuming and costly affair.

(ii) **Fluorides Content:** High concentration of fluoride ions (F) in natural waters particularly in groundwaters is a serious health risk. Fluoride concentration beyond 0.7 ppm can result in fluorosis disease in human beings. This disease affects bones, joints and teeth. Groundwaters in 12 states of the country namely Andhra Pradesh, Delhi, Gujarat, Karnataka, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, Maharashtra, Madhya Pradesh, Bihar and Orissa have high fluoride concentration leading to high percentage of dental and bone fluorosis.

(iii) **Arsenic Content:** Water with high arsenic content causes Arsenicosis (arsenic poisoning), a type of cancer in different parts of the body.

- **Artificial Sources**

From time immemorial, domestic (sewage and waste water), agriculture and industrial waste have been polluting open water bodies such as rivers, lakes, streams and oceans. Certain fraction of chemical fertilizers, pesticides/insecticides used for growing crops gets leached and flows with runoff water to the open water bodies contributing to water pollution. The following are the artificial sources of water pollution

(i) **Sewage Pollution (domestic and animal waste):** The sewage which contains garbage, soaps, detergents, waste food, human excreta and animal waste is one of the largest sources of water pollution. Disease causing micro-organism such as bacteria, fungi, protozoa and algae enter the water system through sewage. They result in a number of chemical processes in water and soil. A number of serious diseases like typhoid, cholera, gastroenteritis are directly caused by infected drinking water. Water polluted by sewage may also contain bacteria and viruses which affect human health adversely. Some of the pollutants like organic matter which are oxygen demanding substances cause deoxygenation of water bodies affecting aquatic life. The plant nutrients like phosphates and nitrates help in growth of algae by process called Eutrophication. Algae tend to out-compete plants under these conditions and many plant species begin to die. This dead organic matter becomes food for bacteria that decomposes it. With more food available, the bacteria increase in number which consume dissolved oxygen in the water. When the dissolved oxygen content decreases, many fish and aquatic insects cannot survive.

(ii) **Industrial Waste:** The industries located near open water bodies discharge their untreated effluents into them. They include highly toxic heavy metals such as chromium, arsenic, lead, mercury, etc. and harmful organic and inorganic wastes like acids alkalis, chlorides, cyanides, etc. Most ofthe rivers in India have become extremely polluted due to discharge of effluents and wastes from textile, sugar, paper, pulp, fertilizer, distillery, tannery and rubber and pesticide industries. Most of these chemically polluted water have detrimental effect on crop growth, fishery and aquatic species and are unsafe for drinking purposes. Plastic, caustic soda and some fungicides and pesticides release mercury along with other effluents in the water body. Mercury enters the food chain through bacteria, algae, fish and human

body. It results in depression, irritability, paralysis, blindness, birth defects and even death.

(iii) **Agricultural Waste:** Manures, fertilizers, pesticides, farm waste from animal and poultry farms and salts are drained from agriculture lands and join the water bodies. As a flow of large quantities of phosphatic, nitrogenous fertilizers and manures to the water bodies, the nutrient content becomes very high leading to depletion of dissolve oxygen. Consumption of nitrate rich water is very harmful for human health. Residues of toxic pesticides (DDT, Aldrin etc.) enter the human body through drinking water or food chain. These compounds are low water soluble but highly soluble in fats. The concentration of DDT in the river may be very low but if consumed by fish for a long period becomes unfit for human consumption. Similarly, some of the highly toxic chemical pesticides affect animal health while grazing through food chain. These chemicals even if consumed in very small amount, can cause hormonal imbalance and even cancer.

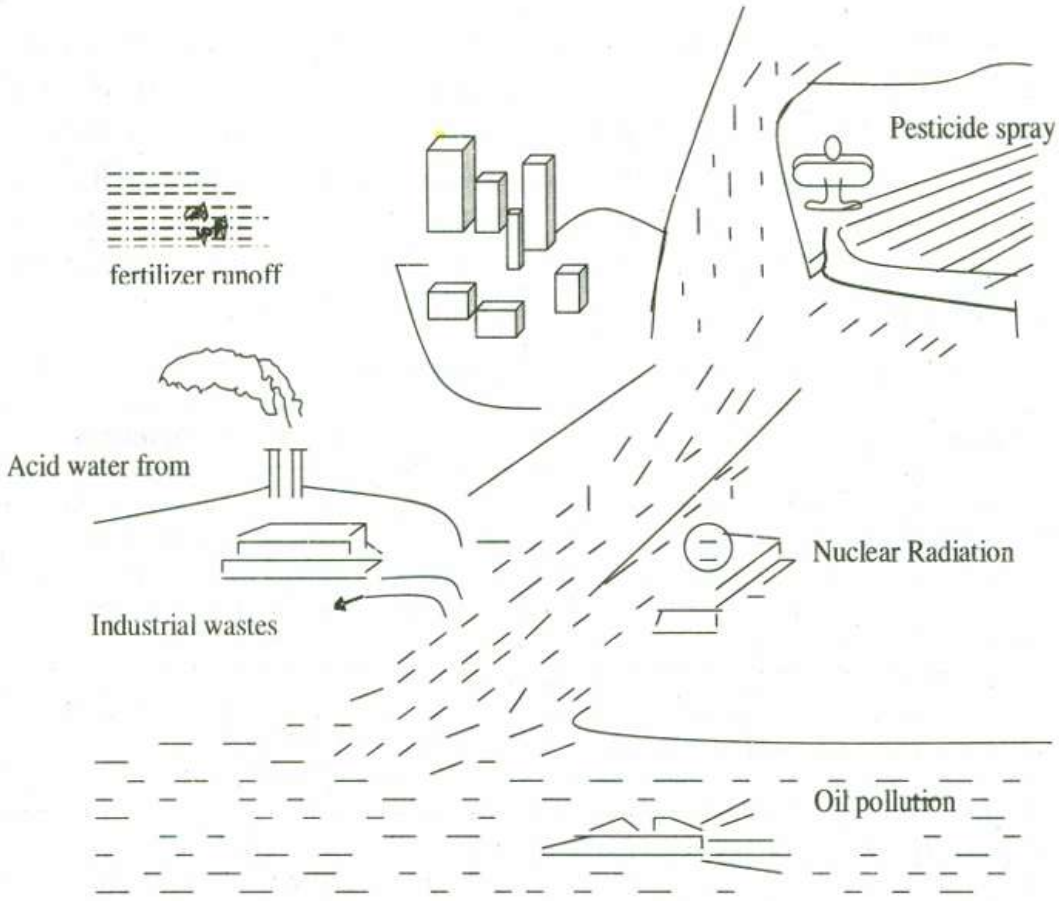

Fig. 5.2: Artificial sources of water pollution

(iv) **Physical Pollutants:** Physical pollutants such as radioactive wastes, thermal and oil have detrimental effects on human and animal health. Accidental leakage of waste material form nuclear power plants and industries, research laboratory and hospitals using radio isotopes can cause serious ailments like tumour and cancer. The nuclear and thermal power plants require water for cooling and the emerging hot water when discharged into rivers and lakes results in ecological imbalance of the water body. The dissolved oxygen level reduces considerably due to high temperature affecting fish and other aquatic species. Oil leakage from oil refineries and automobile service stations pollute water bodies threatening survival of fish and aquatic species.

Classification of water pollutants

The various types of water pollutants can be classified in to following major categories: (1) Organic pollutants, (2) Pathogens, (3) Nutrients and agriculture runoff, (4) Suspended solids and sediments (organic and inorganic), (5) Inorganic pollutants (salts and metals), (6) Thermal Pollution, and (7) Radioactive pollutants.

ORGANIC POLLUTANTS

Organic pollutants can be further divided into following categories:

a) Oxygen Demanding wastes: The wastewaters such as, domestic and municipal sewage, wastewater from food processing industries, canning industries, slaughter houses, paper and pulp mills, tanneries, breweries, distilleries, etc. have considerable concentration of biodegradable organic compounds either in suspended, colloidal or dissolved form. These wastes undergo degradation and decomposition by bacterial activity. The dissolved oxygen available in the water body will be consumed for aerobic oxidation of organic matter present in the wastewater. Hence, depletion of the DO will be a serious problem adversely affecting aquatic life, if the DO falls below 4.0 mg/L. This decrease of DO is an index of pollution.

b) Synthetic Organic Compounds: Synthetic organic compounds are also likely to enter the ecosystem through various manmade activities such as production of these compounds, spillage during transportation, and their uses in different applications. These include synthetic pesticides, synthetic detergents, food additives, pharmaceuticals, insecticides, paints, synthetic fibers, plastics, solvents and volatile organic compounds (VOCs). Most of these compounds are toxic and biorefractory organics i.e., they are resistant to microbial degradation. Even concentration of some of these in traces may make water unfit for different uses. The detergents can form foams and volatile substances may cause explosion in sewers. Polychlorinated biphenyls (PCBs) are used in the industries since 1930s which are complex mixtures of chlorobiphenyls. Being a fat soluble they move readily through the environment and within the tissues or cells. Once introduced into environment, these compounds are exceedingly persistent and their stability to chemical reagents is also high.

c) Oil: Oil is a natural product which results from the plant remains fossilized over millions of years, under marine conditions. It is a complex mixture of hydrocarbons and degradable under bacterial action, the biodegradation rate is different for different oils, tars being one of the slowest. Oil enters in to water through oil spills, leak from oil pipes, and wastewater from

production and refineries. Being lighter than water it spreads over the surface of water, separating the contact of water with air, hence resulting in reduction of DO. This pollutant is also responsible for endangering water birds and coastal plants due to coating of oils and adversely affecting the normal activities. It also results in reduction of light transmission through surface waters, thereby reducing the photosynthetic activity of the aquatic plants. Oil includes polycyclic aromatic hydrocarbons (PAH), some of which are known to be carcinogenic.

PATHOGENS

The pathogenic microorganisms enter in to water body through sewage discharge as a major source or through the wastewater from industries like slaughterhouses. Viruses and bacteria can cause water borne diseases, such as cholera, typhoid, dysentery, polio and infectious hepatitis in human.

NUTRIENTS

The agriculture run-off, wastewater from fertilizer industry and sewage contains substantial concentration of nutrients like nitrogen and phosphorous. These waters supply nutrients to the plants and may stimulate the growth of algae and other aquatic weeds in receiving waters. Thus, the value of the water body is degraded. In long run, water body reduces DO, leads to eutrophication and ends up as a dead pool of water. People swimming in eutrophic waters containing blue-green algae can have skin and eye irritation, gastroenteritis and vomiting. High nitrogen levels in the water supply, causes a potential risk, especially to infants under six months. This is when the methemoglobin results in a decrease in the oxygen carrying capacity of the blood (blue baby disease) as nitrate ions in the blood readily oxidize ferrous ions in the hemoglobin. In freshwater systems, eutrophication is a process whereby water bodies receive excess inorganic nutrients, especially N and P, which stimulate excessive growth of plants and algae. Eutrophication can happen naturally in the normal succession of some freshwater ecosystems. However, when the nutrient enrichment is due to the activities of humans, sometimes referred to as “cultural eutrophication”, the rate of this natural process is greatly intensified. Two major nutrients, nitrogen (N) and phosphorus (P), occur in streams in various forms as ions or dissolved in solution. Aquatic plants convert dissolved inorganic forms of nitrogen (nitrate, nitrite, and ammonium) and phosphorus (orthophosphate) into organic or particulate forms for use in higher trophic production.

The main effects caused by eutrophication can be summarized as follows:

1. Species diversity decreases and the dominant biota changes

2. Plant and animal biomass increase

3. Turbidity increases

4. Rate of sedimentation increases, shortening the lifespan of the lake, and

5. Anoxic conditions may develop.

SUSPENDED SOLIDS AND SEDIMENTS

These comprise of silt, sand and minerals eroded from land. These appear in the water through the surface runoff during rainy season and through municipal sewers. This can lead to the siltation, reduces storage capacities of reservoirs. Presence of suspended solids can block the sunlight penetration in the water, which is required for the photosynthesis by bottom vegetation. Deposition of the solids in the quiescent stretches of the stream or ocean bottom can impair the normal aquatic life and affect the diversity of the aquatic ecosystem. If the deposited solids are organic in nature, they will undergo decomposition leading to development of anaerobic conditions. Finer suspended solids such as silt and coal dust may injure the gills of fishes and cause asphyxiation.

INORGANIC POLLUTANTS

Apart from the organic matter discharged in the water body through sewage and industrial wastes, high concentration of heavy metals and other inorganic pollutants contaminate the water. These compounds are non-biodegradable and persist in the environment. These pollutants include mineral acids, inorganic salts, trace elements, metals, metals compounds, complexes of metals with organic compounds, cyanides, sulphates, etc.

- The accumulation of heavy metals may have adverse effect on aquatic flora and fauna and may constitute a public health problem where contaminated organisms are used for food.
- Algal growth due to nitrogen and phosphorous compounds can be observed.
- Metals in high concentration can be toxic to biota e.g. Hg, Cu, Cd, Pb, As, and Se. Copper greater than 0.1 mg/L is toxic to microbes.

THERMAL POLLUTION

Considerable thermal pollution results due to discharge of hot water from thermal power plants, nuclear power plants, and industries where water is used as coolant. As a result of hot water discharge, the temperature of water body increases. Rise in temperature reduces the DO content of the water, affecting adversely the aquatic life. This alters the spectrum of organisms, which can adopt to live at that temperature and DO level. When organic matter is also present, the bacterial action increases due to rise in temperature; hence, resulting in rapid decrease of DO. The discharge of hot water leads to the thermal stratification in the water body, where hot water will remain on the top.

RADIOACTIVE POLLUTANTS

Radioactive materials originate from the following:

- Mining and processing of ores,
- Use in research, agriculture, medical and industrial activities, such as I131, P32, Co60, Ca45, S35, C14, etc.
- Radioactive discharge from nuclear power plants and nuclear reactors, e.g., Sr90, Cesium Cs137, Plutonium Pu248, Uranium-238, Uranium-235,

- Uses and testing of nuclear weapons. These isotopes are toxic to the life forms; they accumulate in the bones, teeth and can cause serious disorders. The safe concentration for lifetime consumption is 1 x 10-7 microcuries per ml.

Effects of water pollutants

Sr. No.	Pollutants	Impact
1.	Organic pollutants *i)Oxygen Demanding wastes:* *ii)Synthetic organic pollutants* *iii) oil*	Depletion of the DO will be a serious problem adversely affecting aquatic life, if the DO falls below 4.0 mg/L. Most of these compounds are toxic and biorefractory organics. It also make water unfit for different uses. This pollutant is also responsible for endangering water birds and coastal plants due to coating of oils and adversely affecting the normal activities which cause reduction of light transmission and photosynthesis.
2.	Pathogens	Number of diseases transmitted by pathogens available in wastewater
3.	Nutrients	When these are disposed in aquatic environment, it can lead to growth of undesirable aquatic life. When it discharged on land it causes groundwater pollution.
4.	Thermal pollutants	When organic matter is also present, the bacterial action increases due to rise in temperature; hence, resulting in rapid decrease of DO. It also results in thermal stratification which alters spectrum of organisms.
5.	Radioactive pollutants	These isotopes are toxic to the life forms; they accumulate in the bones, teeth and can cause serious disorders
6.	Suspended solids and sediments	Presence of suspended solids can block the sunlight penetration in the water, which is required for the photosynthesis by bottom vegetation. Finer suspended solids such as silt and coal dust may injure the gills of fishes and cause asphyxiation.
7.	Inorganic pollutants	These pollutants include mineral acids, inorganic salts, trace elements, metals, metals compounds, complexes of metals with organic compounds, cyanides, sulphates, etc. They have adverse effect on aquatic flora and fauna and may constitute a public health problem.

Eutrophication

The term ‘eutrophication’ comes from the Greek word ‘eutrophos,’ which means well-fed or enriched. In context with the environment, eutrophication can be defined as the addition of artificial or non-artificial substances such as nitrates and phosphates, through fertilizers or sewage, to a freshwater system which leads to an increase in the primary productivity of phytoplankton. Eutrophication enhances the method of growth of plants in a water body by enriching them with nutrients. Eutrophication could be a serious environmental concern

leading to the deterioration of water quality and therefore the depletion of dissolved O2 in water bodies. Eutrophic waters will become dead zones that are unable to support life. Excessive content of nutrients in the eutrophic water can cause severe problems like low dissolved oxygen in the water. Severe algal growth decreases the light required for the growth of plants and in the process of plant decay, the level of oxygen in the water is depleted causing serious threats to the life of aquatic animals. Many times, lakes are naturally eutrophic by nature. There is progressive eutrophication in some instances as the lake gets old. There are different stages during the eutrophication process. They are nutrient-poor oligotrophic stage, nutrient-enriched mesotrophic stage and then nutrient saturated eutrophic stage. The term eutrophication is more widely known in relation to human activities where the artificial introduction of plant nutrients has led to community changes and a deterioration of water quality in many freshwater systems. This aspect has become increasingly important with increases in human population and more extensive development of agriculture and eutrophication now ranks with other major anthropogenic effects such as deforestation, global warming, depletion of the ozone layer and large scale environmental disturbance in relation to its potentially harmful effect on natural ecosystems.

Marine Pollution

Marine pollution can be defined as the intro duction of substances to the marine environment directly or indirectly by man resulting in adverse effects such as hazards to human health, obstruction of marine activities and lowering the quality of sea water. While the causes of marine pollution may be similar to that of general water pollution there are some very specific causes that pollute marine waters.

- The most obvious inputs of waste is through pipes directly discharging wastes into the sea. Very often municipal waste and sew age from residences and hotels in coastal towns are directly discharged into the sea.
- Pesticides and fertilizers from agriculture which are washed off the land by rain, en ter water courses and eventually reach the sea.
- Petroleum and oils washed off from the roads normally enter the sewage system but stormwater overflows carry these materials into rivers and eventually into the seas.
- Ships carry many toxic substances such as oil, liquefied natural gas, pesticides, indus trial chemicals, etc. in huge quantities some times to the capacity of 350,000 tonnes. Ship accidents and accidental spillages at sea therefore can be very damaging to the marine environment. Shipping channels in estuaries and at the entrances to ports of ten require frequent dredging to keep them open. This dredged material that may con tain heavy metals and other contaminants are often dumped out to sea.
- Offshore oil exploration and extraction also pollute the seawater to a large extent.

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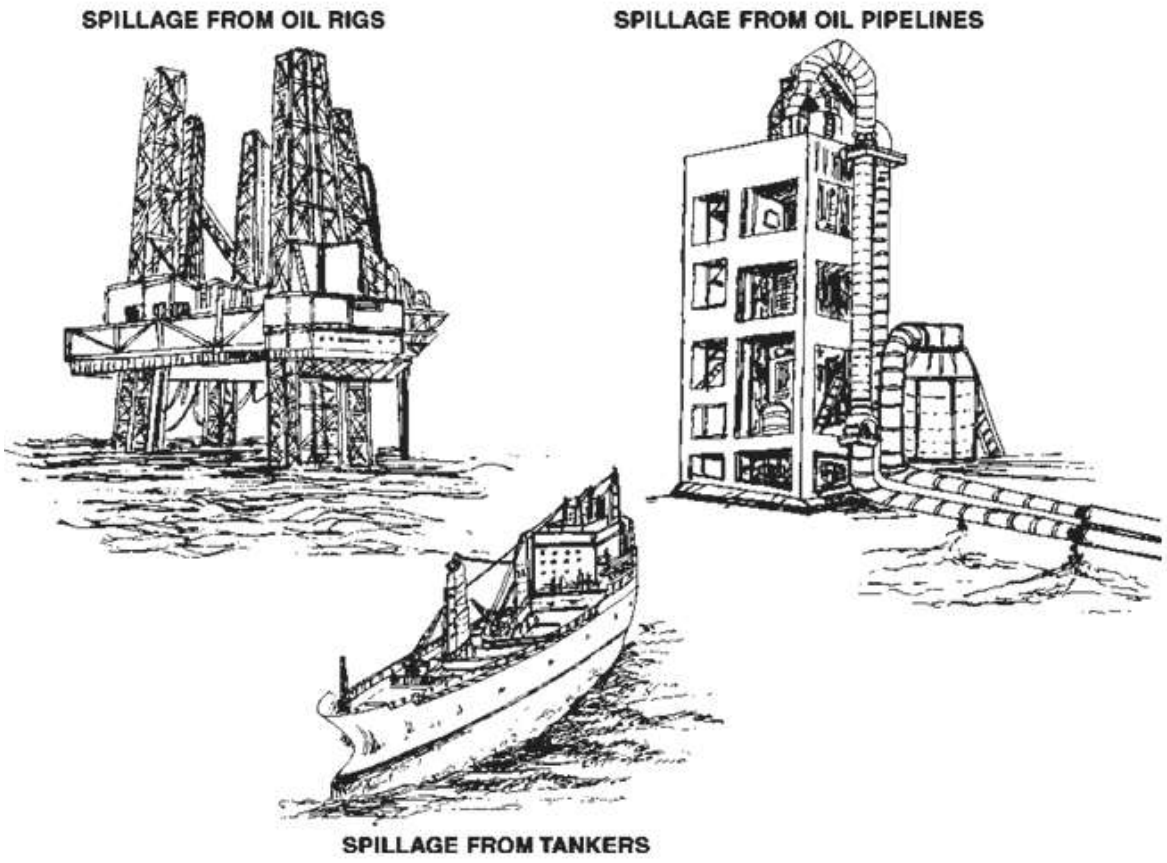


Pollution due to organic wastes:

The amount of oxygen dissolved in the water is vital for the plants and animals living in it. Wastes, which directly or indirectly affect the oxygen concentration, play an important role in determining the quality of the water. Normally the greatest volume of waste discharged to watercourses, estuaries and the sea is sewage, which is primarily organic in nature and is de graded by bacterial activity. Using the oxygen present in the water these wastes are broken down into stable inorganic compounds. How ever as a result of this bacterial activity the oxy gen concentration in the water is reduced. When the oxygen concentration falls below 1.5 mg/ lit, the rate of aerobic oxidation is reduced and their place is taken over by the anaerobic bacteria that can oxidize the organic molecules without the use of oxygen. This results in end products such as hydrogen sulphide, ammonia and methane, which are toxic to many organ isms. This process results in the formation of an anoxic zone which is low in its oxygen content from which most life disappears except for anaerobic bacteria, fungi, yeasts and some protozoa. This makes the water foul smelling.

Control measures:

One way of reducing the pollution load on marine waters is through the introduction of sewage treatment plants. This will reduce the biological oxygen demand (BOD) of the final product before it is discharged to the receiving waters. Various stages of treatment such as primary,

secondary or advanced can be used depending on the quality of the effluent that is required to be treated.

Primary treatment: These treatment plants use physical processes such as screening and sedimentation to remove pollutants that will settle, float or, that are too large to pass through simple screening devices. This includes, stones, sticks, rags, and all such material that can clog pipes. A screen consists of parallel bars spaced 2 to 7cms apart followed by a wire mesh with smaller openings. One way of avoiding the problem of disposal of materials collected on the screens is to use a device called a comminuter which grinds the coarse material into small pieces that can then be left in the waste water. After screening the wastewater passes into a grit chamber. The detention time is chosen to be long enough to allow lighter, organic material to settle. From the grit chamber the sewage passes into a primary settling tank (also called as sedimentation tank) where the flow speed is reduced sufficiently to allow most of the suspended solids to settle out by gravity. If the waste is to undergo only primary treatment it is then chlorinated to destroy bacteria and control odours after which the effluent is released. Primary treatment normally removes about 35 percent of the BOD and 60 percent of the suspended solids.

Secondary treatment: The main objective of secondary treatment is to remove most of the BOD. There are three commonly used approaches: trickling filters, activated sludge pro cess and oxidation ponds. Secondary treatment can remove at least 85 percent of the BOD. A trickling filter consists of a rotating distribution arm that sprays liquid wastewater over a circular bed of ‘fist size’ rocks or other coarse materials. The spaces between the rocks allow air to circulate easily so that aerobic conditions can be maintained. The individual rocks in the bed are covered with a layer of slime, which consists of bacteria, fungi, algae, etc. which degrade the waste trickling through the bed. This slime periodically slides off individual rocks and is collected at the bottom of the filter along with the treated wastewater and is then passed on to the secondary settling tank where it is re moved. In the activated sludge process the sewage is pumped into a large tank and mixed for several hours with bacteria rich sludge and air bubbles to facilitate degradation by micro-organisms. The water then goes into a sedimentation tank where most of the microorganisms settle out as sludge. This sludge is then broken down in an anaerobic digester where methane-forming bacteria slowly convert the organic matter into carbon dioxide, methane and other stable end products. The gas produced in the digester is 60 percent methane, which is a valuable fuel and can be put to many uses within the treatment plant itself. The digested sludge, which is still liquid, is normally pumped out onto sludge drying beds where evaporation and seepage remove the water. This dried sludge is potentially a good source of manure. Activated sludge tanks use less land area than trickling filters with equivalent performance. They are also less ex pensive to construct than trickling filters and have fewer problems with flies and odour and can also achieve higher rates of BOD removal. Thus although the operating costs are a little higher due to the expenses incurred on energy for running pumps and blowers they are preferred over trickling filters. Oxidation ponds are large shallow ponds ap proximately 1 to 2 metres deep where raw or partially treated sewage is decomposed by microorganisms. They are easy to build and manage and accommodate large fluctuations in flow and can provide treatment at a much lower cost. They however require a large amount of land and hence can be used where land is not a limitation.

Advanced sewage treatment: This involves a series of chemical and physical process that re moves specific pollutants left in the water after primary and secondary treatment. Sewage

treatment plant effluents contain nitrates and phosphates in large amounts. These contribute to eutrophication. Thus advanced treatment plants are designed to specifically remove these contaminants. Advanced treatment plants are very expensive to build and operate and hence are rarely used.

Pollution due to oil: Oil pollution of the sea normally attracts the greatest attention because of its visibility. There are several sources though which the oil can reach the sea.

Tanker operations

Half the world production of crude oil which is close to three billion tones a year is transported by sea. After a tanker has unloaded its cargo of oil it has to take on seawater as ballast for the return journey. This ballast water is stored in the cargo compartments that previously contained the oil. During the unloading of the cargo a certain amount of oil remains clinging to the walls of the container and this may amount to 800 tonnes in a 200,000 tonne tanker. The ballast water thus becomes contaminated with this oil. When a fresh cargo of oil is to be loaded, these compartments are cleaned with water, which discharges the dirty ballast along with the oil into the sea. Two techniques have substantially reduced this oil pollution. In the load-on-top system, the compartments are cleaned by high pressure jets of water. The oily water is retained in the compartment until the oil floats to the top. The water underneath that contains only a little oil is then discharged into the sea and the oil is transferred to a slop tank. At the loading terminal, fresh oil is loaded on top of the oil in the tank and hence the name of the technique. In the second method called ‘crude oil washing’, the clingage is removed by jets of crude oil while the cargo is being unloaded. Some mod ern tankers have segregated ballast where the ballast water does not come in contact with the oil. Thus with the introduction of these new methods of deballasting, the amount of oil entering the sea has been considerably reduced.

Dry docking

All ships need periodic dry docking for servicing, repairs, cleaning the hull, etc. During this period when the cargo compartments are to completely emptied, residual oil finds its way into the sea.

Bilge and fuel oils

As ballast tanks take up valuable space, additional ballast is sometimes carried in empty fuel tanks. While being pumped overboard it carries oil into the sea. Individually the quantity of oil released may be small but it becomes a considerable amount when all the shipping operations are taken into consideration.

Tanker accidents

A large number of oil tanker accidents happen every year. Sometimes this can result in major disasters such as that of the Exxon Valdez de scribed in the section on water pollution.

Offshore oil production

Oil that is extracted from the seabed contains some water. Even after it is passed through oil separators the water that is discharged contains some oil, which adds to marine pollution. Drill ing muds which are pumped down oil wells when it is being drilled normally contain 70 to 80

percent of oil. They are dumped on the sea bed beneath the platform thus heavily contami nating the water. Uncontrolled release of oil from the wells can be catastrophic events re sulting in oil pollution.

Control measures for oil pollution: Cleaning oil from surface waters and contaminated beaches is a time consuming labour intensive process. The natural process of emulsification of oil in the water can be accelerated through the use of chemical dispersants which can be sprayed on the oil. A variety of slick-lickers in which a continuous belt of absorbent material dips through the oil slick and is passed through rollers to extract the oil have been designed. Rocks, harbour walls can be cleaned with high pressure steam or dispersants after which the surface must be hosed down.

Effects of marine pollution: Apart from causing eutrophication a large amount of organic wastes can also result in the development of red tides. These are phytoplankton blooms of such intensity that the area is discolored. Many important commercially important marine species are also killed due to clogging of gills or other structures. When liquid oil is spilled on the sea it spreads over the surface of the water to form a thin film called an oil slick. The rate of spreading and the thickness of the film depends on the sea temperature and the nature of the oil. Oil slicks damage marine life to a large extent. Salt marshes, mangrove swamps are likely to trap oil and the plants, which form the basis for these ecosystems thus suffer. For salt marsh plants, oil slicks can affect the flowering, fruit ing and germination. If liquid oil contaminates a bird's plumage its water repellent properties are lost. Water thus penetrates the plumage and displaces the air trapped between the feathers and the skin. This air layer is necessary as it provides buoyancy and thermal insulation. With this loss the plumage becomes water logged and the birds may sink and drown. Even if this does not happen loss of thermal insulation results in exhaustion of food reserves in an attempt to maintain body temperature often followed by death. Birds often clean their plumage by preening and in the pro cess consume oil which depending on its toxicity can lead to intestinal, renal or liver failure. Drill cuttings dumped on the seabed create anoxic conditions and result in the production of toxic sulphides in the bottom sediment thus eliminating the benthic fauna. Fish and shellfish production facilities can also be affected by oil slicks. The most important commercial damage can however also come from tainting which imparts an unpleasant flavour to fish and seafood and is detectable at extremely low levels of contamination. This re duces the market value of seafood.

Air Pollution

Composition of air

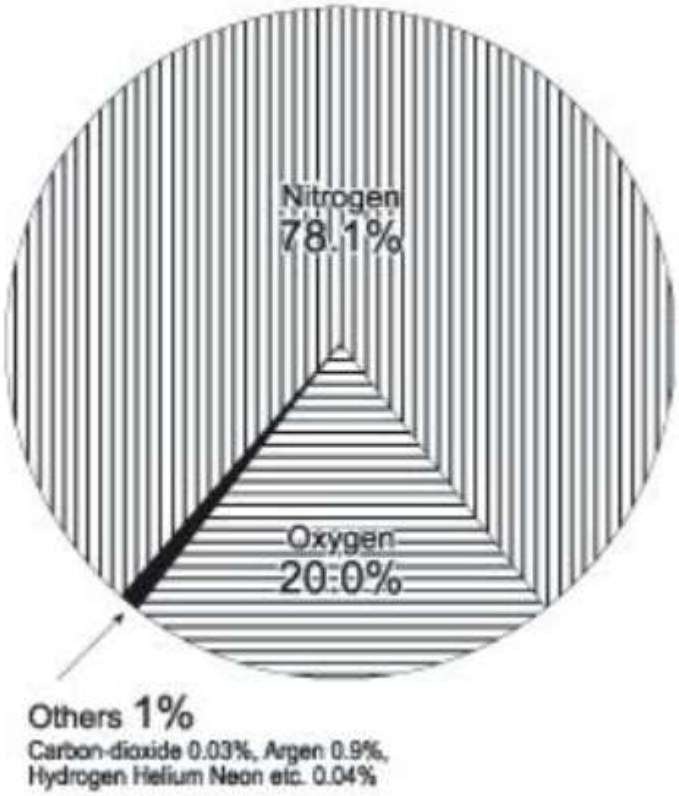
The atmosphere is made up of different types of gases, water vapour and dust particles. The composition of the atmosphere is not static. It changes according to the time and place.

(A) Gases of the atmosphere: The atmosphere is the mixture of different types of gases, including water vapour and dust particles. Nitrogen and Oxygen are the two main gases of the atmosphere. 99 percent part of it is made up of these two gases. Other gases like organ, carbon dioxide, hydrogen, nion, helium etc. form the remaining part of atmosphere.

Table: Amount of gases in the dry and air of the atmosphere.

Serial No.	*Gas*	*Amount (in percentage)*
A.	**Main**	
1.	Nitrogen	78.1 } 99%
2.	Oxygen	20.9 }
B.	**Secondary**	
1.	Organ	0.9 } 0.99%
2.	Carbon Dioxide	0.03
3.	Hydrogen	0.01
4.	Nion	0.0018
5.	Helium	0.0005
6.	Ozone	0.00006
7.	Others	

The amount of ozone gas in the atmosphere is very little. It is limited to the ozone layer but it is very important. It protects the living beings by absorbing the ultra-violet rays of the sun. If there was no ozone gas in the atmosphere, there would not have been existence of living beings and plants on the earth surface.



(B) Water vapour

Gaseous form of water present in the atmosphere is called water vapour. Water vapour present in the atmosphere has made life possible on the earth Water vapour is the source of all kinds of precipitation. Its maximum amount in the atmosphere could be upto 4 percent. Maximum amount of water vapour is found in hot-wet regions and its least amount is found in the dry regions. Generally, the amount of water vapour goes on decreasing from low latitudes to high latitudes. In the same way, its amount goes on decreasing with increasing altitude. Water vapour reaches in the atmosphere through evaporation and transpiration. Evaporation takes place in the oceans, seas, rivers, ponds and lakes while transpiration takes place from the plants, trees and living beings.

(C) Dust Particles

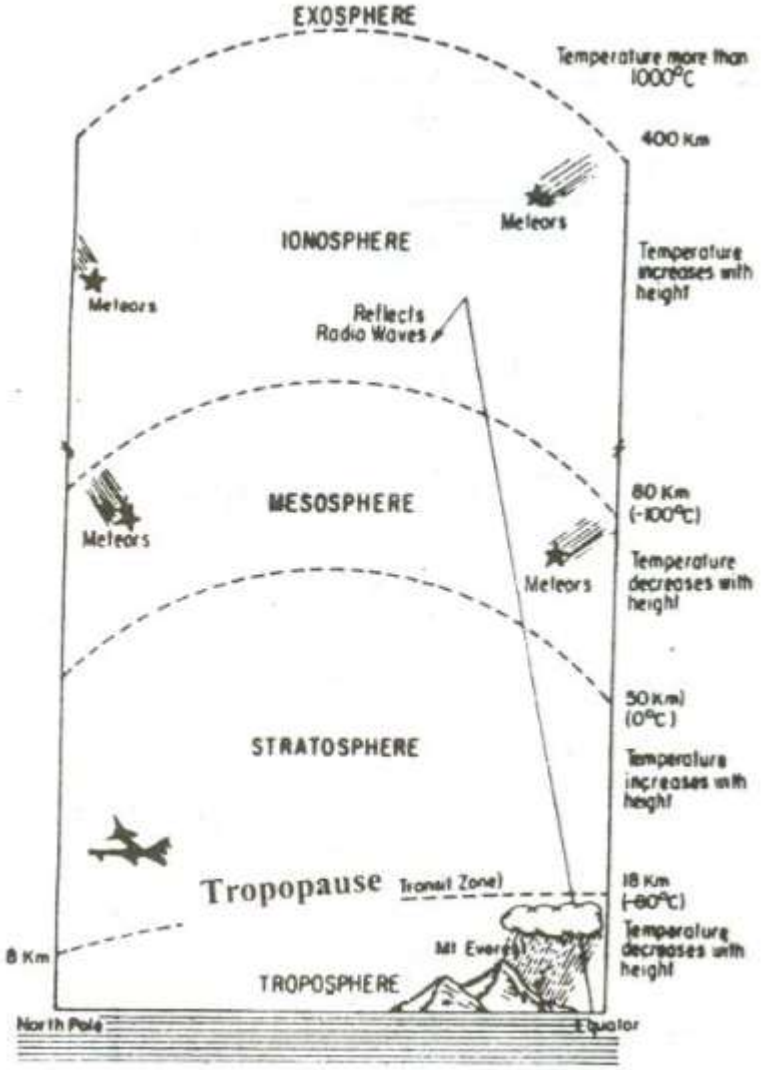
Dust particles are generally found in the lower layers of the atmosphere. These particles are found in the form of sand, smoke and oceanic salt. Sand particle have important place in the atmosphere. These dust particles help in the condensation of water vapour. During condensation water vapour gets condensed in the form of droplets around these dust particles. Due to this process the clouds are formed and precipitation is made possible.

Structure of Atmosphere

The atmosphere is an integral part of the earth. It surrounds the earth from all sides. Generally it extends upto about 1600 kilometres from the earths surface. 97percent of the total amount of weight of the atmosphere is limited upto the height of about 30

kilometres. The atmosphere can be divided into five layers according to the diversity of temperature and density.

(a) Troposphere (b) Stratosphere (c) Mesosphere (d) Ionosphere (e) Exosphere



(A) TROPOSPHERE:-

i. This is the lowest layer of the atmosphere.

ii. The height of this layer is about 18 kms on the equator and 8 kms on the poles. The main reason of higher height at the equator is due to presence of hot convection currents that push the gases upward.

iii. This is the most important layer of the atmosphere because all kinds of weather changes take place only in this layer. Due to these changes development of living world take place on the earth. The air never remains static in this layer. Therefore this layer is called changing sphere or troposphere.

iv. The environmental temperature decreases with increasing height of atmosphere. It decreases at the rate of 10C at the height of 165 metre. This is called Normal lapse rate.

v. The upper limit of the troposphere is called tropopause. This is a transitional zone. In this zone characteristics of both the troposphere and ionosphere are found.(b)

(B) STRATOSPHERE:-

i. This layer is above the troposphere.
ii. This layer is spread upto the height of 50 kms from the Earth's surface. Its average extent 40 kms.
iii. The temperature remains almost the same in the lower part of this layer up to the height of 20 kms. After this the temperature increases slowly with the increase in the height. The temperature increases due to the presence of ozone gas in the upper part of this layer.
iv. Weather related incidents do not take place in this layer. The air blowshorizontally here. Therefore this layer is considered ideal for flying of aircrafts.

(C) MESOSPHERE:-

(i) It is the third layer of the atmosphere spreading over stratosphere.

(ii) It spreads upto the height of 80 kms. from the surface of the earth. It's extentis 30 kms.

(iii) Temperature goes on decreasing and drops upto – 1000C.(iv) 'Meteors' or falling stars occur in this layer.

(D) IONOSPHERE:-

(i) This is the fourth layer of the atmosphere. It is located above the mesosphere.

(ii) This layer spreads upto the height of 400 kms. from the surface of the earth.The width of this layer is about 300 kms.

(iii) The temperature starts increasing again with increasing height in this layer.

(iv) Electrically charged currents flows in the air in this sphere. Radio waves arereflected back on the earth from this sphere and due to this radio broadcastinghas become possible.

(E) EXOSPHERE:-

(i) This is the last layer of the atmosphere located above ionosphere and extendsto beyond 400 km above the earth.

(ii) Gases are very sparse in this sphere due to the lack of gravitational force.Therefore, the density of air is very less here.

Ambient air quality standards in India developed by the Central Pollution Control Board

Area Category	SPM µg/m3	SO2 µg/m3	Co µg/m3	NOx µg/m3
Industrial and mixed use	500	120	5000	120
Residential and rural	200	80	2000	80
Sensitive	100	3	1000	30

Classification of air pollutants

The pollutants of air can be classified as follows: (The first method)

(1) Natural impurities: e.g. mist, fog, pollen of flower, corn, bacteria and products from the explosion of volcano.

(2) Aerosole: e.g. dust, smoke, mist and fumes.

(3) Other impurities: e.g. gases, vapour and compounds.

The second method of classification of pollutants can be taken as follows:

(1) According to origin

(2) According to chemical composition.

(3) According to state of matter.

These classes can again be divided into sub-divisions which are as follows:

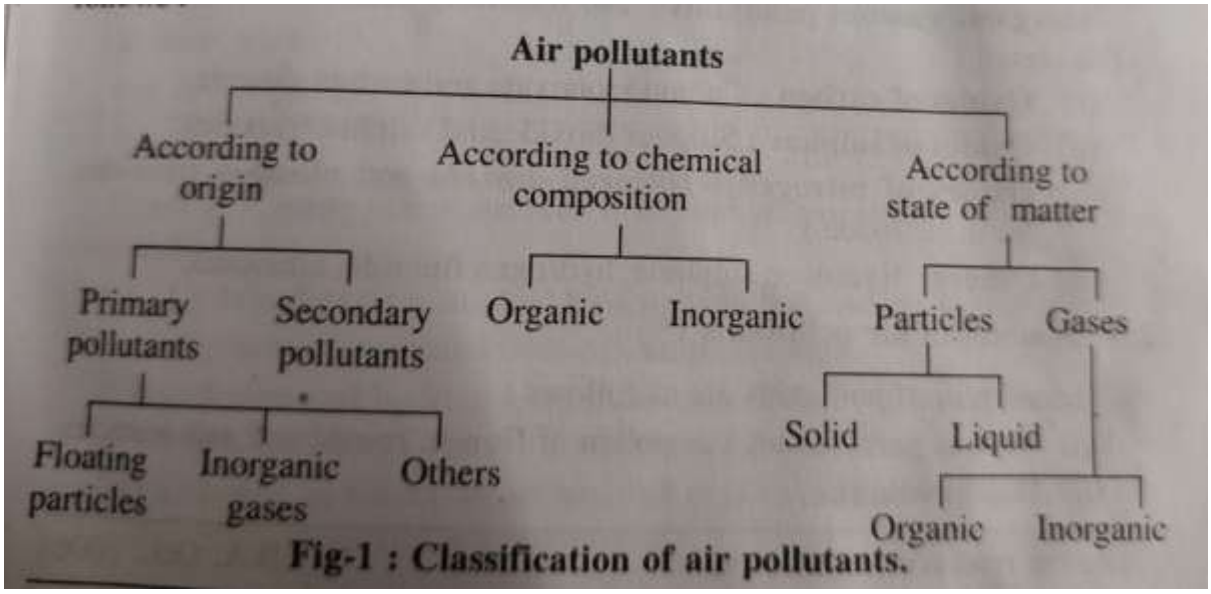


Fig-1 : Classification of air pollutants.

(A) Primary pollutants: These pollutants enter directly in atmosphere. There are three sub-divisions of this class.

i. **Floating particles:** e.g. ash, smoke, fog, fumes, mist , spray.
ii. **Inorganic gases:** Sulphur dioxide (SO2) , hydrogen sulphide (H2S) Nitric oxide (NO), Carbon monoxide (CO), Carbon dioxide (CO2), hydrogen fluoride (HF) and hydrocarbon (HC).
iii. **Others:** Radioactive elements.

(B) Secondary pollutants: The pollutants that are produced in the atmosphere when certain chemical reactions take place among the primary pollutants are called secondary pollutants. e.g. Sulphur trioxides (SO3) Nitrogen dioxide (NO2) Peroxy acetyl nitrate (PAN), Ozone (O3), aldehyde, ketones and salts (sulphate and nitrate).

Organic pollutants: In this type, the constituent elements are carbon hydrogen, nitrogen, phosphorus and sulphur.

Inorganic pollutants: Carbon monoxide, carbon dioxide, carbonates, Oxide of sulphur (SOx) Oxides of nitrogen (NOx) Ozone, hydrogen fluoride hydrogen chloride.

Pollutants in the form of solid particles: Dust, smokes, fumes, floating, ash

Pollutants of the form of liquid particles: Mist and spray.

Organic gaseous pollutants: The following substances are included in this class:

(i) Hydro carbons: Hexane, benzene, ethelene, methane, butane and butadine.

(ii) Aldehydes and ketones: Formaldehyde, acetone

(iii) Others: Chlorinated hydrocarbons and alcohol.

Inorganic gaseous pollutants: The following substances are included in this class:

(i) Oxides of carbon: Carbon monoxide and carbon dioxide.

(ii) Oxides of sulphur: Sulphur dioxide and sulphur trioxides.

(iii) Oxides of nitrogen: Nitrogen dioxide and nitrogen trioxides. (or nitric oxide.)

(iv) Others: Hydrogen sulphide, hydrogen fluoride, ammonia.

Sources of common air pollutants like PM, SO2, Nox, Natural & Anthropogenic Sources

- ***Particulate Matter***

Term	Meaning	Examples
Aerosol	General term for particles suspended in air	Sprays from pressurized cans
Mist	Aerosol consisting of liquid droplets	Sulfuric acid mist
Dust	Aerosol consisting of solid particles that are blown into the air or are produced from larger particles by grinding them down	Dust storm
Smoke	Aerosol consisting of solid particles or a mixture of solid and liquid particles produced by chemical reaction such as fires	Cigarette smoke, smoke from burning garbage
Fume	Generally means the same as smoke but often applies specifically to aerosols produced by condensation of hot vapors of metals.	Zinc/lead fumes

- ***SO2***

The common sulfur compounds exist in the atmosphere is SO2, SO3, H2S and H2SO4. Combustion of fossil fuels and roasting of metal sulfide ores are the anthropogenic sources. Out of these sulfur trioxide (SO3) is directly emitted in ore smelting and fossil fuel combustion and also by the oxidation of SO2and readily soluble in water to produce H2SO4 which is known as acid rain. The reactions of formation are as follows.

S + O2 = SO2

It is estimated that100-130 million tonnes of SO2 per year enter the atmosphere through anthropogenic activities and 50-70 million tonnes are released from natural sources like volcanoes, sea spray and microbial activities.

- ***Nitrogen Compounds***

  The most abundant gas in the atmosphere is nitrogen with 78.09% abundance. The major gaseous forms of nitrogen in the atmosphere are molecular nitrogen(N2), nitrous oxide (N2O), nitrogen dioxide (NO2), nitric oxide (NO) and ammonia (NH3). The details of these gases and their role in pollution are explained here.

  Nitrous Oxide

  It is a natural constituent of the air in the atmosphere with concentration of 0.30 ppm. It acts as a strong oxidizing agent. It is also called laughing gas because of its euphoric effects. It is produced in the soil by anaerobic bacteria. It generates NO in the stratosphere by photolytic dissociation.

  Nitric Oxide

  Nitric oxide is generated naturally by anaerobic processes in soil and water, by combustion processes and by photochemical destruction of nitrogen compounds in the stratosphere.

The major man made sources are automobile exhaust, combustion of fossil fuel-fired electric generating stations, industrial boilers, incinerators and home heaters.

Nitrogen Dioxide

Nitrogen dioxide is light yellowish orange at low concentrations and brown at high concentrations. It is produced by the direct oxidation of NO in the atmosphere as per the following reaction.

Natural and Anthropogenic Pollutants

The pollutants which are released by the natural sources such as eruption of volcanoes, sea sprays, lightning and microbial processes are called natural pollutants. Where as pollutants released by human activities such as industrial and vehicular emissions are known as anthropogenic pollutants.

The sources for natural pollutants are listed below:

1. Biogenicsources - soil microorganism, hydrosphere organism, vegetation and animals.
2. Geophysical sources - soil dust and sea salt
3. Geochemical sources - volcanism, burning of biomass and lightening

The anthropogenic sources are:

1. Biogenic sources - Agriculture
2. Chemical sources - chemical processes, high temperature processes and combustion
3. Physical processes - dust resuspension and volatilization

Effects of common air pollutants

(1) If in the air, the proportion of pollutants is more than the fives proportion then the air pollutants affect humans, animals, birds and vegetations adversely.

(2) Air pollutants are also harmful to the movable and immovable properties of man.

(3) Air-pollutants also create an adverse effect on human health:

(i) Presence of sulphur dioxide in particles, leads to asthma or respiratory problems.

(ii) Presence of lead in the particles then the enzyme processing is stopped in children.

(iii) Presence of cadmium in the particles leads to an adverse effect on the circulatory system.

(iv) Presence of zinc and copper in the particles leads to an adverse effect on the digestive system and may also harm kidney.

(v) Presence of nickel in the particles creates the possibility of lung cancer.

(vi) Presence of mercury in the particles results into diseases of sensory nerves and kidney.

(vii) Presence of carbon monoxide results into uneasiness, giddiness and unconsciousness or speech is tammered.

(viii) Presence of nitrogen dioxide may result into diseases of respiratory system and pulmonary adema. It also creates a burning sensation in the eyes (This is because of the secondary pollutant created by the chemical eqations of NO2 + HC).

(ix) Foul odour is released by the presence of hydrogen sulphide in the air.

(4) Effects of air pollutants on vegetations

(i) If the leaves of the vegetations are covered by the layers of the pollutants then it diminishes the photosynthesis process. If animals eat these leaves then it creates an adverse effect on them.

(ii) Sulphur dioxide, ruins the chlorophyll content in the leaves.

(iii) Due to nitrogen dioxide the production of citrus plants, tomates is decreased. Also, the quality of cotton and pulses gets diminished.

(iv) Peroxy acetyl nitrate (PAN) ruins the peaks of the leaves and creates adverse effects on grapes.

(5) Effects of air pollutants on materials:

(i) Due to the presence of sulphur dioxide, metals like steel rust. It also affects dyes, leather and clothes.

(ii) The particles of sulphuric acid in air make the marble and lime stones rusty. Due to these reasons the Taj Mahal is adversely affected.

(iii) Due to the presence of ozone in air, cracks develop in artificial rubber. It also creates adverse effects on the fibres of cotton, nylon and polyester.

(iv) Due to nitrogen oxide the fibres of acetate rayon and cotton loose their colour within two three months.

(iv) If there is the presence of humidity and nitrate then nickel and brass are found to rust in excess.

Land Pollution

Uses of Land

Land use is characterized by the arrangements, activities and inputs people undertake in a certain land cover type to produce, change or maintain it.

The purpose for which an area of land is used by humans: e.g. cropland, urban settlements, forests. Wildor natural land, by contrast, is that not used by humans.

The five most common uses are recreational, transport, agricultural, residential and commercial.

1. Recreational

When a property's land use is defined as recreational, it means it is meant to be used for the enjoyment of the people who use it. This could be anything from parks and open spaces to athletic fields, playgrounds and swimming pools. Cities add recreational land into their blueprints to ensure the area has places for people to go and enjoy. These aren't essential for the development of a community, but help to attract both permanent residents and visitors.

2. Transport

Transport land is designed for the structures that help people get from one destination to the other. Transport land includes things like roads, airports, train stations and subway stations.

3. Agricultural

Agricultural land is used for the growing and harvesting of crops and livestock. These are things like ranches, farms and pastures.

4. Residential

The purpose of residential land is to build homes. This could mean mobile homes, single family homes or even apartment complexes. Depending on the local area, the status of the market and the type of residences you plan on building, you'll need to consider other things such as the accessibility to the property, the proximity to local amenities, the local schools, crime rate, etc. There are some restrictions associated with this type of land use, such as the types of animals permitted on the property(dogs and cats are usually ok, pigs and horses not-so-much) Other restrictions may include the size of the building, the minimum lot size how close buildings on your lot can be to each other.

5. Commercial

This type of land is designated for businesses, warehouses, shops and any other infrastructures related to commerce. This type of land is commonly used for office buildings, restaurants, shops and other businesses. And while commercial land usually doesn't take up much space, it's critical to the economy of a community.

Land degradation

Land degradation refers to an appreciable loss of productivity of land. The process of lowering of the current and/or potential capability of land to produce goods or ecological services is known as land degradation. The lowering of land capability may be both quantitative and/or qualitative in nature. The rate of this process may be 1) slow and continuous, or 2) short-lived between various states of ecological equilibrium. Although the terms land degradation and soil degradation is synonymous, the difference between them is mostly of academic interest. Soil is an integral part of land, hence, any deterioration quantitatively or qualitatively (in its quality, mass or volume, either singly or in combination), is also a deterioration of land. Soil degradation refers to removal/erosion of the top most layer of the land. This top soil contains organic matter and beneficial organisms which contribute to soil health. The term soil degradation is more specific and is directly related to agro productivity and is preferably used among researchers from agriculture discipline as compared to the more comprehensive term land degradation.

Causes

The land pollution is created by the following factors:

(i) Pollution growth (ii) Urbanization (iii) Industrialisation (iv) More than necessary use of insecticides (v) More than necessary use of chemical fertilizers (vi) Wastes and filth. (vii) More than necessary use of irrigation projects.

(1) Due to the population growth, the excretion and dead bodies of humans and animals, as well as the broken pots, vessels and other articles when thrown on the land or dug in the ground create the land polluted.

(2) Due to more than necessary irrigation projects the salt efficiency of the land increases and the nitrogen installation efficiency decreases. This results in the pollution of the land and it decreases the production of the crop-yield.

(3) Further, for urbanization and industrialisation, new factories and buildings are required to be constructed and the scraps formed during the construction work and the wastes and rubbish etc. when disposed off create land pollution.

(4) Further, when agricultural lands are used for construction purpose, the fertility of the land as well as the nutrients (such as some minerals and gases) are also destroyed.

5) Further the construction structure creates obstruction in the flow of water which results in the accumulation of surface water and the chemicals used in the factories, as well as the fertilizers used in quantity which is more than necessary to decrease the fertility of land.

Effects

(1) The industrial pollutants render land toxic. About 5 lakhs of people die each year due to these effluents.

(2) Several heavy metals present destroy useful microorganisms present in the soil.

(3) The soluble salt given out as pollutant damages the cultivated farms.

(4) Soil pollution due to sewage has the same effect as brought about by sewage polluted water.

(5) Several diseases are inflicted on human beings due to pathogenic forms present in the soil.

(6) Agricultural land becomes non useful.

(7) Use of more than necessary chemical fertilizers accumulate in the land the particles of which can mix up with the yield - such as crop, vegetables and fruits. These yields become useless for the human consumptions.

Control

The steps of controlling land pollution are as follows:

(1) The immediate disposal of wastes and rubbish should be made, using systematic natural or scientific artificial techniques.

(2) Using Suez project the drainage water can first be converted into natural fertilizer and the remaining water can be diverted into farms or gardens, so that micro-organisms can be controlled.

(3) The industrial wastes can also be decomposed using scientific methods and the harmless water can then be flown.

(4) Any type of wastes, scraps, hardmorum, cement concrete wastes or polluted water cannot be thrown onto agricultural land.

(5) Precautionary measures should be taken to see that there are no pollutants in air as well as in the water.

Soil Erosion

Soil erosion can be defined as the movement of surface litter and topsoil from one place to another. While erosion is a natural process often caused by wind and flowing water it is greatly accelerated by human activities such as farm ing, construction, overgrazing by livestock, burning of grass cover and deforestation. Loss of the topsoil makes a soil less fertile and

reduces its water holding capacity. The topsoil, which is washed away, also contributes to water pollution clogging lakes, increasing turbidity of the water and also leads to loss of aquatic life. For one inch of topsoil to be formed it normally requires 200-1000 years depending upon the climate and soil type. Thus if the topsoil erodes faster than it is formed the soil becomes a non-renewable resource. Thus it is essential that proper soil conservation measures are used to minimize the loss of top soil. There are several techniques that can protect soil from erosion. Today both water and soil are conserved through integrated treatment methods. Some of the most commonly employed methods include the two types of treatment that are generally used.

• Area treatment which involves treating the land

• Drainage line treatment which involves treating the natural water courses (nalas)

Noise Pollution

Introduction

Various eminent persons of the field of environmental studies have defined noise differently in their own ways. e.g.

(1) Odum states the definition of noise as: "Unnecessary sound which has no effect on the environment, still then it is called noise."

2) Harnel states that, "Noise is unwanted, unpleasant or disagreeable sound that cause discomfort and under industrial situation noise invites deafness.

3) Blum states that, "Noise is a disturbance maker in our concentration and it is an interference maker in our efficiency."

(4) Veetal states that, "Noise means an unpleasant voice."

(5) Teefin states that "Noise is a sound which disturbs even the normal work and creates dimness to the brilliance of an individual."

A more appropriate definition of noise is as follows:

"Noise is wrong sound, in the wrong place at wrong time."

e.g. (1) When we are reading some important lessons, and if we hear some unpleasant voice or sound and if we do not keep concentration in reading. then that sound or voice is a noise, even if it may be an excellent music.

(2) If we are to go for a sleep and if one can start some filmy - song which may be either sung vocally or may be played on tape, radio or TV and if we are disturbed in sleeping, then this sound or tune of this filmy song becomes a noise for us. The unwanted, unpleasant voice or sound can be considered as a noise. More noise is the pollution of the environment.

Hence, any voice (or sound or music), which can disturb under certain situations, then it can be considered as noise. The unit of measurement of voice or sound is a decible (db). Hence, the intensity of sound is a decible. When we blow air in the ear and the sound so created has intensity 0 db. If we listen the voice which can seem to break the ear and the ear is damaged and starts aching of the ear then the intensity of this sound 140 db. When two men talk to one another then the sound generated is of intensity 50 to 60 db. The intensity of the sound generated at the time of jet plane is to be launched in air from the earth is approximately 140 db. The intensity of sound created by the loud motor horn is about 120 db.

Sound and Noise

Sound is main means of communication in many animals, including humans. A low sound is pleasant and harmless. A loud, unpleasant or unwanted sound is called as noise. A given sound can appear music to some and noise to others. It depends upon loudness, duration and mood of a person. Noise (La. nausea=seasickness) is physical form of pollution. It is not harmful to air, soil and water but affects the animals including humans. Noise is unwanted

sound, that is unpleasant, loud and disruptive. Humans have a hearing range called as audible range. Audible range depends upon frequency and loudness of sound. For a person with normal hearing, frequency ranges from 20 to 20,000 Hz and loudness ranges from 0 to 120 dB. Sound is measured in decibels (dB). A decibel value above 80 is considered to be noise pollution.

Noise measurements

- A decibel(dB) is the main unit to measure the intensity of loudness of sound.
- Normal human ear can detect sound between 0 dB to 140 dB
- But, anything between 120 to 150 dB cause pain and problem.

Source	Decibels(dB)
Turbo jet airplane	150
Truck without muffler	90
Noisy class, alarm clock, police whistle	80
Average residence	40
Quiet room	20
Lowest audible sound	0

Causes

Sources of noise pollution can be divided into two types:

(1) Outdoor noise pollution, and (2) Indoor noise pollution.

(1) Outdoor noise pollution: Noise emanating from factories, vehicles and playing of loudspeakers during various festivals can contribute to outdoor noise pollution.

(2) Indoor noise pollution: Noise emanating from locally loudly played radio, T.V., music-system and other electronic gadgets can contribute to indoor noise pollution.

(i) Noise from vehicles: The voice created by the machine, emitting smoke in the environment, the voice of horn, the voice created by the doors of the vehicles, while opening and closing, the voice of the horn of trains, buses.

ii) Noise from machines: t\The noise of the machines used in industries is too much. e.g. In Surat, in certain localities each and every house possesses the weaving power looms. These machines are of huge sizes and hence they fertilizer factory, power plants, where also machineries are of tremendous sizes create too much noise. Similarly other factories such as: Cement factory are used, they create also tremendous noises. Further at present each house facilitated with houshold flour mill and washing machine and they also create a noise with much more intensity

(iii) Noise at the building/ construction work: The voice created by the labourers and mixer - machineries at the construction of bridges, roads buildings etc. or their renovations are having intensities with tremendously, These are the unbearable noises and hence create noise pollution. e.g. At the construction of buildings or big industries and complexes the continuous noises.

Effects

(1) Effects of noise pollution on mental health: Noise can also cause emotional or psychological effects such as irritability, anxiety and stress. Lack of concentration and mental fatigue are significant health effects of noise.

(2) Effect on ear: The most direct harmful effect of excessive noise is physical damage to the ear and the temporary or permanent hearing loss often called a "temporary threshold shift" (TTS). People suffering from TTS are unable to detect weak sounds. Temporary effects are noticed at sound levels between 80 and 130 db. The permanent loss, usually called "noise-induced at work will develop NIPTS. A sound level of 150 db or more can physically permanent threshold shift" (NIPTS). People exposed to 95 db sound levels repture the human ear-drum.

(3) Other effects: In addition to hearing losses, excessive sound levels can cause harmful effects on the circulatory system by raising blood pressure and altering pulse rates.

(4) Noise pollution changes life of men. Those who are working in high level of intensity they have possibly to face the problems such as: cardiac disturbance, neuro-sensory impairment, quarreling nature.

(5) Due to noise pollution, there is a possibility of mental retardation and madness.

(6) The patient becomes more sick due to the noise pollution.

lose their efficiency gradually, and they commit erros in more proportion.

(8) Due to noise, man cannot sleep soundly.

(9) Due to noise pollution the decision ability of man is gradually decreased.

(10) Due to noise the quality level of man is gradually decreasing

(11) In western countries, the children are experiencing deafness by the pop-music with more intensity.

Thermal Pollution

Causes

The discharge of warm water into a river is usually called a thermal pollution. It occurs when an industry removes water from a source, uses the water for cooling purposes and then returns the heated water to its source. Power plants heat water to convert it into steam, to drive the turbines that generate electricity. For efficient functioning of the steam turbines, the steam is condensed into water after it leaves the turbines. This condensation is done by taking water from a water body to absorb the heat. This heated water, which is at least 15oC higher than the normal is discharged back into the water body.

Effects

The warmer temperature decreases the solubility of oxygen and increases the metabolism of fish. This changes the ecological balance of the river. Within certain limits thermal additions can promote the growth of certain fish and the fish catch may be high in the vicinity of a power plant. However sudden changes in temperature caused by periodic plant shutdowns both planned and unintentional can change result in death of these fish that are acclimatized to living in warmer waters. Tropical marine animals are generally unable to withstand a temperature increase of 2 to 3 degree C and most sponges, mollusks and crustaceans are eliminated at temperatures above 370C. This results in a change in the diversity of fauna as only those species that can live in warmer water survive.

Role of individual in the prevention of pollution

There are a host of environmental problems caused by human actions on the environment. If we are to respond to these problems we have to recognize that each of us is individually re sponsible for the quality of the environment we live in. Our personal actions can either worsen or improve our environmental quality. Several people may feel that environmental problems can be solved with quick technological fixes. While a majority of individuals would want a cleaner environment, not many of them want to make major changes in their lifestyle that could contribute to a cleaner environment. Decisions and actions taken by individuals to a very large extent determine the quality of life for everyone. This necessitates that individuals should not only be aware of various environ mental issues and the consequences of their actions on the environment but should also make a firm resolve to develop environmentally ethical lifestyles. With the help of solar energy, natural processes developed over billions of years can indefinitely renew the topsoil, water, air, forests, grasslands and wildlife on which all forms of life depend, but only as long as we do not use these potentially renewable resources faster than they are replenished. Some of our wastes can be diluted, decomposed and recycled by natural processes indefinitely as long as these processes are not overloaded. Natural processes also provide ser vices of flood prevention, erosion control at no costs at all. We must therefore learn

to value these resources and use them sustainably. Concepts that help individuals contribute to wards a better quality of our environment and human life.

- Develop respect or reverence for all forms of life.
- Each individual must try to answer four basic questions:
  Where do the things that I consume come from?
  What do I know about the place where I live?
  How am I connected to the earth and other living things?
  What is my purpose and responsibility as a human being?
- Try to plant trees wherever you can and more importantly take care of them. They reduce air pollution.
- Reduce the use of wood and paper products wherever possible. Manufacturing pa per leads to pollution and loss of forests which releases oxygen and takes up carbon dioxide. Try to recycle paper products and use recycled paper wherever possible.
- From the mail you receive reuse as many envelopes that you can.
- Do not buy furniture, doors, window frames made from tropical hardwoods such as teak and mahogany. These are forest based.
- Help in restoring a degraded area near your home or join in an afforestation program.
- Use pesticides in your home only when absolutely necessary and use them in as small amounts as necessary. Some insect species help to keep a check on the populations of pest species.
- Advocate organic farming by asking your grocery store to stock vegetables and fruits grown by an organic method. This will automatically help to reduce the use of pesticides.
- Reduce the use of fossil fuels by either walking up a short distance using a car pool, sharing a bike or using public transport. This reduces air pollution.
- Shut off the lights and fans when not needed.
- Don’t use aerosol spray products and commercial room air fresheners. They damage the ozone layer.
- Do not pour pesticides, paints, solvents, oil or other products containing harmful chemicals down the drain or on the ground.
- Buy consumer goods that last, keep them as long as possible and have them repaired as far as possible instead of disposing them off. Such products end up in landfills that could pollute ground water.
- Buy consumer goods ages in refillable glass containers instead of cans or throwaway bottles.
- Use rechargeable batteries.
- Try to avoid asking for plastic carry bags when you buy groceries or vegetables or any other items. Use your own cloth bag instead.
- Use sponges and washable cloth napkins, dish towels and handkerchiefs instead of paper ones.
- Don’t use throwaway paper and plastic plates and cups when reusable versions are available.
- Recycle all newspaper, glass, aluminum and other items accepted for recycling in your area. You might have to take a little trouble to locate such dealers.
- Set up a compost bin in your garden or ter race and use it to produce manure for your plants to reduce use of fertilizers.

- Try to lobby and push for setting up garbage separation and recycling programs in your localities.
- Choose items that have the least packaging or no packaging.
- Start individual or community composting or vermicomposting plants in your neighbor hood and motivate people to join in.
- Do not litter the roads and surroundings just because the sweeper from the Municipal Corporation will clean it up. Take care to put trash into dustbins or bring it back home with you where it can be appropriately disposed.
- You must realize that you cannot do everything and have solutions for every problem in the world. You can however concentrate on issues that you feel strongly about and can do something about. Focusing your energy on a particular issue will help you get better results.
- You could join any of the several NGOs that exist in our country or become volunteers. Organize small local community meetings to discuss positive approaches of pollution prevention.
- Learn about the biodiversity of your own area. Understand the natural and cultural assets. This would help you to develop a sense of pride in your city/town/village and will also help you understand the problems facing their survival.
- You cannot improve your world by not voting. You have the option to make a choice rather than complain later on.
- It is important that you do not get discouraged at the first sign of trouble. Do not dwell on the negative aspects. But take positive actions wherever you can to make the world a better place to live in.
- When talking to elected officials always be courteous and reasonable. You may dis agree with a particular position but be respectful in doing so as you will gain little by being hostile and brash.
- Take care to put into practice what you preach. Remember environment protection begins with YOU

Compiled and Prepared by: Ms. Vishva Mehta

Unit – 2: Energy Resources and Global Environmental Issues

Energy Resources

Global and Indian energy demand scenario, Future Projections

Energy resources are natural sources used to generate power and energy for households, industries, transport, agriculture and services. Energy plays a crucial role in economic development and improvement of living standards.

1. Global Energy Demand Scenario

Global energy demand has been continuously increasing due to population growth, industrialisation, urbanisation and rising income levels. Fossil fuels such as coal, oil and natural gas continue to dominate the global energy mix, although renewable energy sources are growing rapidly.

Developed countries consume large amounts of energy, while developing countries are witnessing rapid growth in energy demand due to economic expansion.

2. Global Energy Demand: Future Projections

Global energy demand is expected to rise steadily up to 2050. Electricity demand will grow faster than overall energy demand due to digitalisation, electric vehicles and increased use of electrical appliances. Renewable energy will be the fastest-growing energy source, while fossil fuels will decline gradually but remain important in the near future.

3. Indian Energy Demand Scenario

India is one of the fastest-growing energy-consuming countries in the world. Energy demand in India is increasing due to rapid economic growth, industrial expansion, urbanisation, population growth and improved access to electricity.

Coal is the dominant source of energy in India, followed by oil, natural gas and renewable energy sources such as solar and wind.

4. India's Energy Demand: Future Projections

India is expected to contribute a significant share to global energy demand growth in the coming decades. Electricity consumption is projected to increase rapidly. Renewable energy capacity is expected to expand, while coal will continue to play an important role in the medium term.

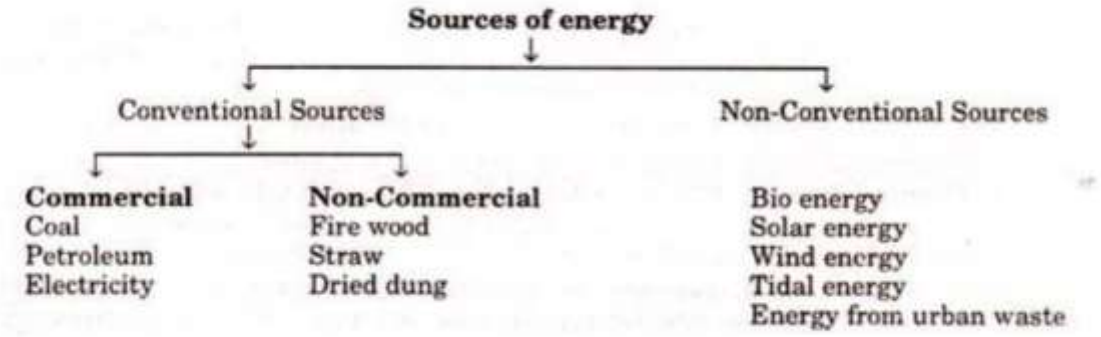
5. Comparison: Global and Indian Energy Demand

Globally, energy demand growth is moderate, whereas India's energy demand growth is very high. While the world is gradually shifting towards renewable energy, India is balancing coal usage with increasing renewable energy development to support economic growth and sustainability.

6. Conclusion

Energy demand is rising both globally and in India. Renewable energy will play a key role in the future, but fossil fuels will remain relevant in the short and medium term. Effective energy planning is essential for sustainable economic development and environmental protection.

Conventional and Non-Conventional sources of energy



Conventional Sources of Energy:

These sources of energy are also called non-renewable sources. These sources of energy are in limited quantity except hydro-electric power. These are further classified as commercial energy and non-commercial energy:

Commercial Energy Sources: These are coal, petroleum and electricity. These are called commercial energy because they have a price and consumer has to pay the price to purchase them.

(a) Coal and Lignite: Coal is the major source of energy. Coal deposits in India are 148790 million tonnes. According to an estimate, coal reserves in India would last about 130 years. India is now the fourth largest coal producing country in the world. Coal deposits are mainly found in Orissa , Bihar, Bengal and Madhya Pradesh.

Advantages:

• Abundant availability in India.

• Reliable source of energy for thermal power plants.

• Supports industrial growth (iron, steel, cement).

Limitations:

• Non-renewable and finite resource.

• Low calorific value in Indian coal.

• Causes air pollution.

Utilisation:

• Electricity generation.

• Industrial fuel.

• Domestic fuel in some regions.

Exploitation & Environmental Problems:

• Mining causes deforestation and land degradation.

• Emission of carbon dioxide leads to global warming.

• Health hazards to miners.

(b) Oil and Natural Gas: In these days, oil is considered as the most important source of energy in India and the world. It is widely used in automobiles, trains, planes and ships etc. In India, it is found in upper Assam, Mumbai High and in Gujarat. The resources of oil are small in India. Despite tremendous increase in oil production. India still imports 70% of has oil requirements from abroad. As per current rate of consumption, oil reserves in India may last about 20 to 25 years. Natural gas has been the most important source of energy since last two decades. It can be produced in two ways:(i) With petroleum products as associated gas. (ii) Free gas obtained from gas fields in Assam, Gujarat and Andhra Pradesh.

Advantages:

• High energy efficiency.
• Easy transportation and storage.
• Widely used in transport and industries.

Limitations:

• Limited reserves in India.
• High import dependence.
• Price fluctuations in global market.

Utilisation:

• Fuel for automobiles, aviation, railways.
• Petrochemical industry.
• Cooking gas (LPG, PNG).

Exploitation & Environmental Problems:

• Oil spills damage marine ecosystems.
• Air pollution from combustion.
• Contribution to greenhouse effect.

(c) Electricity: Electricity is the common and popular source of energy. It is used in commercial and domestic purposes. It is used for lighting, cooking, air conditioning and working of electrical appliances like T.V., fridge and washing machine.

There are three main sources of power generation:

1. Thermal Power: It is generated in India at various power stations with the help of coal and oil. It has been a major source of electric power.

Advantages:

• Large-scale power generation.

• Established technology.

Limitations:

• Uses fossil fuels.

• Causes air pollution.

Environmental Problems:

• Emission of smoke and ash.

• Global warming.

2. Hydro-electric power: It is produced by constructing dams over overflowing rivers. For example Bhakra Nangal Project, Damodar Valley Project and Hirakud Project etc.

Advantages:

• Renewable source.

• No air pollution.

Limitations:

• High initial cost.

• Displacement of people.

Environmental Problems:

• Submergence of forests.

• Disturbance to aquatic life.

3. Nuclear Power: Nuclear Power plants use radioactive substances such as uranium as fuel. This fuel is cheaper than coal. India has nuclear power plants at Tarapur, Kota (Rajasthan)Kalapakam (Chennai) Naroura (UP).

Advantages:
• High energy output.
• Low fuel requirement.

Limitations:
• Risk of radiation.
• Disposal of nuclear waste.

Environmental Problems:
• Radioactive pollution.
• Long-term ecological risks.

Non-Commercial energy Sources:
These sources include fuel wood, straw and dried dung. These are commonly used in rural India. Agricultural wastes like straw are used as fuel for cooking purposes. Animal dung when dried is also used for cooking purposes. The straw and dung can be used as valuable organic manure for increasing fertility of soil and in turn productivity.

Advantages:
• Easily available in rural areas.
• Low cost.

Limitations:
• Low efficiency.
• Health hazards due to smoke.

Utilisation:
• Cooking and heating.

Environmental Problems:
• Indoor air pollution.
• Deforestation.

Non-Conventional Sources of Energy:
As the fossil fuels are one of the biggest pollutants on the planet, demand for the non-conventional sources is developing. These sources not only instigate greenhouse effects but also reduce the dependence on oil and gas. Therefore, in order to meet the energy demand of

the increasing population, the scientists are developing methods for us to tap into various non-conventional sources of energy, which are not only renewable but also non-polluting. Examples are Natural sources like Bio energy, solar energy, wind energy and tidal energy. These are also pollution free hence can be used to produce clean form of energy by avoiding any wastage. The various sources are given below:

1. Solar Energy:
This is the most important non-conventional source of energy. Energy produced by harnessing the sunlight is called solar energy. For this process, solar photovoltaic cells are exposed to sunlight to produce electricity. Photovoltaic cells are those which convert sun light energy into electricity. Solar energy is used in solar cooker for cooking, in solar heater, in solar cells etc.

Advantages:
• Renewable and pollution free.
• Abundant availability.

Limitations:
• High installation cost.
• Weather dependent.

Utilisation:
• Solar cookers, heaters, electricity.

2. Wind Energy: This type of energy can be produced by harnessing wind power. It is used for operating water pumps for irrigation purposes.

Advantages:
• Clean energy.
• Renewable.

Limitations:
• Location specific.
• Irregular supply.

Utilisation:
• Electricity generation.
• Water pumping.

3. Tidal Energy: Energy produced by exploiting the tidal waves of the sea is called tidal energy.

Advantages:
• Predictable and renewable.

Limitations:
• High cost.

• Limited locations.

Utilisation:
• Power generation.

4. Bio Energy: This type of energy is obtained from organic matter. It is of two kinds:
(i) Bio Gas: Bio Gas is obtained from Gobar Gas Plant by putting cow dung into the plant. Besides producing gas this plant converts gobar into manure. It can be used for cooking, lighting and generation of electricity.
(ii) Bio Mass: Biomass is the organic matter that originates from plants, animals, wood, sewage. These substances burn to produce heat energy which then generates electricity. The chemical composition of biomass varies in different species but generally, biomass consists of 25% of lignin,75% of carbohydrates or sugar. Biomass energy is also applicable for cooking, lighting, and generation of electricity. The residue left after the removal of biogas is a good source of manure.

Advantages:
• Waste utilization.
• Produces manure.

Limitations:
• Requires continuous raw material.

Utilisation:
• Cooking, lighting, electricity.

5. Geothermal energy: Geothermal energy is the heat energy that we get from hot rocks present in the earth's crust. So Geothermal wells release greenhouse gases trapped within the earth but these emissions are much lower per energy unit than the fossil fuels. This energy generally involves low running costs since it saves 80% on fossil fuels. Due to this, there is an increase in the use of geothermal energy. It helps in reducing global warming and does not create pollution.

Advantages:

• Low running cost.

• Environment friendly.

Limitations:

• Limited availability.

• High initial cost.

Utilisation:

• Electricity and heating.

Advantages

Advantages of Conventional Sources of Energy

1. Conventional sources of energy such as coal, petroleum and natural gas are easily available.
2. They are capable of producing large amounts of energy required for industries.
3. The technology used for conventional energy is well developed and reliable.
4. These sources provide continuous and stable power supply.
5. They support rapid industrial and economic development.
6. Transportation and storage of fossil fuels are convenient.
7. They are suitable for large-scale power generation.

Advantages of Non-Conventional Sources of Energy

1. Non-conventional sources of energy are renewable and inexhaustible.
2. They are environment friendly and cause very little pollution.
3. They reduce dependence on fossil fuels.
4. They help in conserving natural resources.
5. Operating cost is low after installation.
6. They promote sustainable development.
7. They are suitable for rural and remote areas.

Limitations

Limitations of Conventional Sources of Energy

1. Conventional sources of energy are non-renewable and limited.
2. Their excessive use leads to depletion of resources.
3. They cause air, water and land pollution.
4. They contribute to global warming and climate change.
5. Mining and drilling damage the environment.
6. They pose health hazards to human beings.
7. Import dependence increases economic burden.

Limitations of Non-Conventional Sources of Energy

1. Initial installation cost is very high.
2. Energy generation depends on natural conditions.
3. Power supply is irregular in nature.
4. Advanced technology and skilled labour are required.
5. Large land area is required for some projects.
6. Energy storage is difficult.
7. Availability is location specific.

Utilization

Utilisation of Conventional Sources of Energy

1. Coal is used in thermal power plants for electricity generation.
2. Petroleum is used as fuel in transport sector.
3. Natural gas is used for cooking and fertilizer production.
4. Conventional energy is used in industries and factories.
5. It is used for domestic and commercial purposes.
6. It supports railways, aviation and shipping.
7. It is used in defense and heavy machinery.

Utilisation of Non-Conventional Sources of Energy

1. Solar energy is used in solar cookers and electricity generation.
2. Wind energy is used for power generation and irrigation.
3. Biogas is used for cooking and lighting.
4. Biomass is used as fuel and electricity generation.
5. Tidal energy is used for power generation in coastal areas.
6. Geothermal energy is used for heating and electricity.
7. These sources are useful in off-grid areas.

Exploitation and related Environmental problems

1. Excessive exploitation of coal through mining leads to large-scale deforestation.
2. Open-cast mining causes land degradation and loss of fertile soil.
3. Burning of coal and petroleum releases carbon dioxide, contributing to global warming.
4. Thermal power plants emit smoke, ash and harmful gases, causing air pollution.
5. Mining activities pollute nearby rivers and groundwater sources.
6. Oil drilling and transportation increase the risk of oil spills, damaging marine ecosystems.
7. Natural gas extraction may cause land subsidence and leakage of methane gas.
8. Construction of large dams for hydroelectric power leads to displacement of local communities.
9. Submergence of forests due to dams results in loss of biodiversity.
10. Nuclear power generation creates radioactive waste which is difficult to dispose safely.
11. Improper disposal of nuclear waste poses long-term health and environmental risks.
12. Over-exploitation of energy resources disturbs ecological balance and affects sustainable development

Environmental implications of Non-conventional Energy Sources

1. Non-conventional energy sources help in reducing air pollution as they do not burn fossil fuels.
2. Use of solar and wind energy significantly lowers carbon dioxide emissions.

3. These sources play an important role in controlling global warming and climate change.
4. Non-conventional energy helps in conserving exhaustible natural resources.
5. Solar energy does not produce smoke, ash or harmful gases.
6. Wind energy generation does not create water or soil pollution.
7. Biogas plants help in proper disposal of animal waste and reduce environmental contamination.
8. Use of biomass energy reduces agricultural waste and open burning of crop residues.
9. Tidal and geothermal energy cause very low environmental damage compared to conventional sources.
10. Non-conventional energy supports sustainable and eco-friendly development.
11. These energy sources reduce dependence on coal and petroleum, thereby decreasing environmental degradation.
12. Overall, non-conventional energy contributes to a cleaner and healthier environment

Global Environmental Issues

Climate change

Climate is the average weather of an area. It is the general weather conditions, seasonal variations and extremes of weather in region. Such conditions which average over a long period at least 30 years is called climate. The Intergovernmental Panel on Climate Change (IPCC) in 1990 and 1992published best available evidence about past climate change, the green house effect and recent changes in global temperature. It is observed that earth's temperature has changed considerably during the geological times. It has experienced several glacial and interglacial periods. However, during the past10000 years of the current interglacial period, the mean average temperature has fluctuated by 0.51˚cover 100 to 200 year period. We have relatively stable climate for thousands of years due to which we have practiced agriculture and increased population. Even small changes in climatic conditions may disturb agriculture that would lead to migration of animals including humans. Anthropogenic activities are upsetting the delicate balance that has been established between various components of the environment. Green house gases are increasing in atmosphere resulting in increase in the average global temperature. This may upset the hydrological cycle; result in floods and droughts in different regions of the world, cause sea level rise, changes in agricultural productivity, famines and death of humans as well as livestock

Global Warming

Definitions of Global Warming:

(1) An increase in the average temperature of the earth's atmosphere (especially a sustained increase that causes climatic changes)

(2) An overall increase in world temperatures which may be caused by additional heat being trapped by green house gases.

(3) The progressive gradual rise of the earth's surface temperature thought to be caused by the green house effect and responsible for changes in global climate patterns. An increase in the near surface temperature of the earth Global warming has occurred in the distant past as the result of natural influences, but the term is most often currently used to refer to the warming predicted to occur as a result of increased emissions of green house gases.

(4) Terms "like climate change" and "global warming" are often used to mean the same thing. Global warming emphasizes the rise in average temperatures of the earth.

(5) Global warming relates to an increase in the average temperature of the earth's surface that has been observed in recent years, and it is projected to continue. It is debated as to whether this is a natural occurrence or whether human activity has impacted or accelerated it. However evidence is over whelming that human activity since the industrial revolution is responsible.

Causes of Global Warming:

(1) Global Warming is increasing the earth's average temperature. The green house gases are the main culprits of global warming. The green house gases like carbon dioxide, methane, and nitrous oxide are playing hazards in the present times. These green house gases trap heat in earth's atmosphere and thus result in increasing the temperature of earth. The excessive emission of these gases is the major cause of global warming.

(2) The major source of carbon dioxide is the power plants. These power plants emit large amounts of carbon dioxide produced from burning of fossil fuels for the purpose of electricity generation. Coal is the major fuel that is burnt is these power plants. Coal produces around 1.7 times as much carbon dioxide per unit of energy when flamed as does natural gas and 1.25 times as much as oil. The coal gives out eighty percent more carbon per unit of energy it produces as compared to natural gas. Another major source of carbon dioxide in the atmosphere is the emission from the cars and other vehicles. About twenty percent of carbon dioxide emitted in the atmosphere comes from burning of gasoline in the engines of the vehicles. This is true for most of the developed countries. Moreover, if sports bike and vehicles that aft essentially designed for rough terrain, emit more carbon dioxide when used for general purpose on roads. It is always better to use vehicles designed for city driving on the city roads.

(3) Buildings, both commercial and residential represent a larger source of global warming pollution than cars and trucks. Building of these structures require a lot of fuel to be burnt which emits a large amount of carbon dioxide in the atmosphere.

(4) The second major green house gas after carbon dioxide, which causes global warming, is Methane. Methane is more than 20 times as effectual as CO_2 at entrapping heat in the atmosphere. Methane is obtained from resources such as rice paddies, bovine flatulence, bacteria in bogs and fossil fuel manufacture. Almost in all parts of the world, rice is grown on flooded fields. When fields are flooded, anaerobic situation build up and organic matter in the soil decays, releasing methane to the atmosphere. Nitrous oxide. which is a colourless gas with a sweet odour, is another green house gas. The main sources of nitrous oxide include nylon and nitric acid production, cars with catalytic converters, the use of fertilizers in agriculture and the burning of organic matter. Greater emissions of nitrous oxides in the recent decades is leading global warming.

(5) Another major cause of global warming is deforestation. Deforestation is to be blamed for 25% of all carbon dioxide release entering the atmosphere, by the cutting and burning of about 34 million acres of trees each year. Trees collect the CO_2 that we breathe out and give away from various other sources, and they give back oxygen that we breathe in. Thus, cutting of trees is leading to greater concentration of carbon dioxide in the atmosphere. Greater urbanization, requirement of land for factories and buildings, requirement of timber are all reasons that are leading to deforestation, which in turn is leading to global warming.

Effects of Global Warming:

Green house gases stay can stay in the atmosphere for an amount of years ranging from decades to hundreds and thousands of years. No matter what we do, global warming is going to have some effect on Earth. Here are the 5 deadliest effects of global warming.

1. Polar ice caps melting: The ice caps melting is a four-pronged danger.

First, it will raise sea levels. There are 5,773,000 cubic miles of water in ice caps, glaciers, and permanent snow. According to the National Snow and Ice Data Center, if all glaciers melted today the seas would rise about 230 feet.

Second, melting ice caps will throw the global ecosystem out of balance. The ice caps are fresh water, and when they melt they will desalinate the ocean, or in plain English - make it less salty. The desalinization of the gulf current will disrupt ocean currents, which regulate temperatures. The stream shutdown or irregularity would cool the area around north-east America and Western Europe. Luckily, that will slow some of the other effects of global warming in that area.

Third, temperature rises and changing landscapes in the Arctic circle will endanger several species of animals. Only the most adaptable will survive.

Fourth, global warming could snowball with the ice caps gone. Ice caps are white and reflect sunlight, much of which is relected back into space, further cooling Earth. If the ice caps melt, the only reflector is the ocean. Darker colors absorb sunlight, further warming the Earth.

Green House Effect

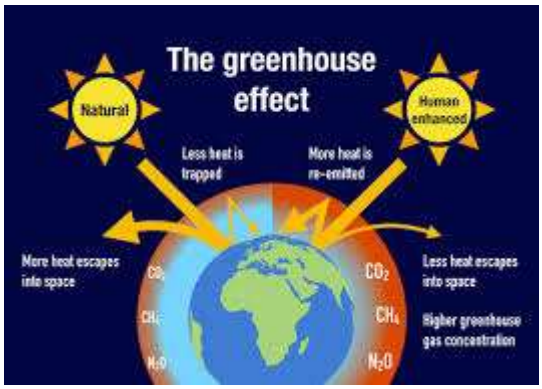
In the atmosphere the proportion of carbon dioxide (CO_2) is about 0.03%. The addition of CO_2 to the atmosphere is mainly due to the burning of fossil fuel, such as coal, oil etc. The cover of carbon dioxide becomes comparable to the glass windows of a green house. The sun raditions may come to the earth but they do not return back due to the covering of CO_2. As a result of this, the global temperature is becoming high. This phenomenon is referred as the "green house effect".

Further due to the burning of fossil fuels in the industries and vehicle, the proportion of CO_2 in atmosphere is increasing continuously. Between 1870 to 1970, the proportion of CO_2 increased from 290 PPM to 320 PPM. At present, it is 350 to 360 PPM. If such an increase is maintained continuously then by the year 2040 it will become 450 PPM. Over and above CO_2 other gases chloro fluoro carbon, methane and oxides of nitrogen will greatly disturb the temperature of the earth surface. Hence all such gases together are described as green house gases. If the proportion of $CO_2$and other green house gases go on increasing continuously then in the next fifty years, the temperature of earth will rise by 2º to 5º C.

This term of "Green House Effect" was first used by J. Faurier in 1827. It is also known as "Atmospheric Effect", "The earth heating effect" or "The Problem of CO_2. In the cold regions, the construction of green house is made by the transparent walls and ceilling for providing heat and maintaining the required temperature necessary for plants and land.

During the daytime the sun rays enter the transparent walls and ceiling of the green houses and provide light and heat to the land and vegetations. But at night, this heat does not exit by radiation through the transparent walls and ceiling. It remains there in the green house and keeps the atmosphere warm.

Similarly, the process of keeping the earth's atmosphere warm is called the green house effect.



Radiations from the sun continuously approach the earth. Some of them having short wave - lengths (e.g. Ultra violet rays) are reflected in the sky due to ozone layers. The remaining rays approach the earth with the help of the atmosphere. 25% of the rays are absorbed in the clouds. Only 5% heat of the Sun reaches the earth and gets reflected. This heat spreads in the atmosphere due to the green house gases, but it does not exit from the atmosphere. Among the green house gases carbon dioxide (CO_2) plays the major role, which stores the reflected heat. But if the proportion of CO, increases, then that heat is reflected back to the earth and finally it results in an increase of the temperature of the earth.

In the atmosphere, there are mainly four green house gases:

(i) Carbon dioxide (CO_2): This gas has a share of 57% in the green house effect.

(ii) Methane (CH4): This gas has a share of 12% in the green house effect.

(iii) Nitrouse Oxide (NO_2): This gas has a share of 6% in the green house effect.

(iv) Chlorinated fluro carbon or Chloro fluro carbon (CIFC): This gas has a share of 25% in the green house effect.

Impact of green house effect:

The continuous increase in the atmospheric temperature will increase the temperature of the earth, by 1.5°C to 4.5°C by the year 2030.

(1) Due to this the ice in the polar zones will melt and due to this melting of ice the coastal regions or cities will sink or drown in the additional water. Not only that but the land near the banks will become more salty and this will invariably result in land pollution.

(2) This will also create an adverse effect on wild life and hence this will result in the change of the forest region.

(3) Due to increase in heat, the moisture of the earth will decrease and hence it will decrease the production of some corn yields.

(4) There is a possibility of three types of changes due to the green house effect such as:

(i) Increase in temperature

(ii) Imbalance of water-cycle and

(iii) Increase in insects and worms.

(5) Due to the changes in temperature and water cycle, some vegetations and the living organisms will be adversely affected and some other will be seen diseased by the adverse effect.

(6) There is also a possibility of unexpected changes in the atmosphere. changes in the season schedule and changes in the whirl-wind.

Acid Rain

The carbon dioxide (CO2) in the atmosphere naturally converts into carbonic acid (H_2CO_3) by chemical reaction with water. When the solubility of this carbonic acid in rain water becomes less than 5.6 PH then the rain is called acid rain.

e.g. The effect of this acid rain was noted variously in different countries in different years

(i) In 1958, the rain water in Europe was found to be of less than 5.0 PH.

(ii) In 1962, the rain water in Netherland was found to be of less than 4.5 PH.

(iii) In 1962 to 1966, the rain water in Sweeden was found to be less than 4.5 PH, due to which an adverse effect on the ecosystem of living organisms was created and hence it came to know the dangerous impact of acid rain on the biodiversity or living organisms.

(iv) In 1979, the vegetations and the micro-organisms of about 20,000 lakes in Sweden were found destructed due to the effect of this acid rains.

(v) India also experienced this acid rain in Chembur and Trombay of Bombay province. After that this acid rain was also noted in big industrial cities like: Delhi, Kanpur, Pune and Kolak.

Robert Angus used this world of "acid rain" very first in 1872. According to his view, this word of "acid rain" means more acids in the rain water In this acid rain there is the possibility of the other acids also such as sulphuric acid (H_2SO_4). Nitric acid (HNO_2) and Hydrochloric acid (HCI). They are usually found in the proportions as shown below:

H2SO4 - 60-70%

HNO3 - 30-40%, while HCI is having a very small percentage.

Effects of acid rain:

The effects of acid rain are as follows:

(1) Acid rain dissolves and washes away nutrients in the soil, which are needed by plants. It can also dissolve naturally occuring toxic or poison plants. substances like aluminium and mercury, freeing them to pollute water.

(2) Acid rain indirectly affects plants by removing nutrients from the soil in which they grow. It affects trees more directly by creating holes in the waxy coating of leaves, causing brown dead spots which affect the plants photosynthesis. Such trees are also more vulnerable to insect infestations drought and cold. Spruce and fir forests at higher elevations seem to be most at risk. Farm crops are less affected by acid rain than forests.

(3) Acidic rain that falls or flows as ground water to reach rivers, lakes and wet lands, causes the water in them to become acidic. This affects plants and animals in aquatic ecosystem.

(4) Acid rain also affects wild-life. By an adverse effect on one species, the entire food chain is disrupted, ultimately endangering the entire ecosystem.

(5) Acid rain and dry acid deposition damages buildings, automobiles and other structures made of stone or metal. The acid corrodes the materials causing extensive damage and ruins historic buildings.

(6) Although surface water polluted by acid rain does not directly harm people, the toxic substances reached from soil can pollute the water supply.

(7) Acid with other chemicals in the air, produces urban smog, which causes respiratory problems.

(8) Fish caught from the water polluted by the acid rain may be harmful for human consumptions.

Precautionary measures to avoid acid rain:

(1) The best way to stop the formation of acid rain is to reduce the emissions of sulphur dioxide and nitrogen oxides into the atmosphere For that fossil fuels should not be used for power plants, vehicle and industries.

(2) Switching to cleaner burning fuels is also a way out. i.e. use of natural gas should be encouraged.

(3) Spray of a mixture of water and limestone into the pollutant gases is also a remedy.

(4) Catalytic converters are used in factories which can reduce the harmful chemicals into less harmful ones.

(5) If the acid rain has affected soil then powdered limestone can be added to the spoil by a liming process to neutralize the acidity of the soil.

Depletion of Ozone layer

The stratosphere of the atmosphere lies around the earth within the layer belt of 13 to 25 km. height and it contains mainly ozone. This ozone is formed by the action of sunlight on oxygen. Ozone is a highly poisonous gas with a stringent odour. It is a form of oxygen that has three atoms in each molecule, It is considered as a pollutant at the ground level and constitutes a health hazard by causing respiratory ailments like asthma and bronchitis. It also causes harm to vegetations and leads to a deterioration of certain materials like plastic and rubber.

Ozone in the upper atmosphere, however, is vital to all forms of life as it protects the earth from the sun's harmful ultra violate radiation, preventing it from approaching the earth's surface. Nobody has taken the specific note of the existence of this ozone. But in 1985, it was announced that there had been a depletion in the ozone layer surrounding the south pole. After this announcement it has been taken on hand the research about this ozone matter. It was noted that the ozone proportion which was 50% in the atmosphere in 1987 has now come down to 40% after the continuous decrease.

This reduction is mainly due to the chlorofluoro carbons (CIFCs) which are used as refrigerants and aerosol spray propellants. These CIFCs destruct ozone by photolitic process. This ozone layer helps in protecting biotic lives by stopping the ultraviolet rays coming from the sun, due to which temperature of the earth is kept in control. If there have been no some such that the living organisms including man would not have survived hurdle of ozone the temperature of the earth would have become so much high that the living organisms including man would have not survived.

Effects of ozone layer depletion:

(1) Effects on humans and animals: The destruction of ozone layer causes increased incidence of skin cancer and cataracts.

(2) Effects on plants and vegetations: It also causes damage to certain crops. It creates adverse effects on the leaves which can reduce the growth and development of plants and hence it results into less production of the crops, Side by side, it also reduces the productions of chlorophyll. the planktons are damaged or destructed. This will also destruct the biotic

(3) Effects on aquatic organisms: Due to the increase of temperature organisms which are maintained on them. Further the aquatic situation can also change at the global level too.

Steps to be taken for prevention of ozone depletion:

(1) For finding the causes of this ozone depletion, the research work is to be handled at global level.

(2) As stated earlier the root cause of this ozone depletion is CIFCs which should be banned.

(3) In Montreal Treaty it was agreed upon unanimously to ban using CIFC by almost all the countries of the world. Hence, at present it is rarely used in some fields.

(4) Other chemicals and industrial compounds such as bromine. halocarbon and nitrous oxides from fertilizers continue to attack the ozone layer. So their use may also be minimized.

(5) Better alternatives should be found out to ban completely CIFC and other hazardous chemicals.