ENVIRONMENTAL SCIENCE AND SUSTAINABLE DEVELOPMENT

UNIT-II

ENVIRONMENTAL POLLUTION AND ISSUES

ENVIRONMENTAL POLLUTION

INTRODUCTION:

According to **ODUM (1971)**, Pollution is **"an undesirable change in the characteristics of air, water and land that harmfully affect the life and also create health hazards for all living organisms on the globe"**.
According to **SOUTHWICK (1976),** Pollution can be defined as **"the unfavorable (or) alteration of environment caused by human activities and causing harm to human beings".**

TYPES OF POLLUTION:

Basically the Pollution is of two types viz.,

(1) Natural Pollution: This type of pollution is limited in its occurrence generally from natural hazards like volcanic eruptions, emissions of natural gas, soil erosion, ultraviolet rays, cosmic rays etc and
(2) Manmade Pollution: Most of the pollution is man made only. However, Pollution is usually categorized as Air Pollution; Water Pollution; Thermal Pollution; Noise Pollution; Land & soil Pollution; Radio Active Pollution and Marine Pollution

AIR POLLUTION

Air pollution may be described as "**the imbalance in quality of air so as to cause adverse effects on the living organisms existing on earth**". Pollution is due to the presence of undesirable substance of sufficient quantity which exists in environment.
The substance or energy which causes pollution is called pollutant.

Types of air pollutants:
Pollutants may be classified according to origin and state of matter.

a) According to Origin: Air pollutants are divided into two categories as primary & secondary.

1) Primary air pollutants are those which are emitted directly into the atmosphere.
   Eg: C; CO; CO_2; SOx ; N; S; H; NOx; CFC's etc .
2) Secondary air pollutants are those which are produced in the air by the interaction Among the primary air pollutants or by reaction with atmospheric constituents.
   Eg: **Ozone (O_3)**; **Smog; Para Acetyl Nitrate (PAN)**; **Acid Rain**; **Aerosols.**

b) According to State of Matter: Air pollutants include fine solids; liquids and gases. Dust, Smoke, Fumes etc are examples for solid particles whereas fog is an example for liquid particles.

PRIMARY POLLUTANTS

1. Carbon Monoxide: It is a colorless, odorless, poisonous gas that is produced by the incomplete burning of carbon based fuels (coal, petrol, diesel and wood) which comes from the automobile industries, exhaust devices, about 70% of CO emissions are from the transport sector.
When the air is polluted with CO, human blood is likely to be deprived of oxygen and leads to coma and death. In mild dosages, it leads to headache.

2. Oxides of Sulphur: SO_2 is a gas produced from burning of coal, mainly in thermal power plants. Some industries such as paper mills produce SO_2. It is injurious not only to men and plants, but it also attacks rapidly a few rocks such as limestone, marbles, electric contacts etc. It can even dissolve nylon.
Paper absorbs SO_2 causing the paper to become brittle and fragile. SO_2 polluted air leads to corrosion of metals such as Fe, Zn, Cu, steel etc… SO_2 is a major contributor to Smog and acid rain.
Sulphur trioxide is more irritant than SO_2 because it combines immediately with water to form sulphuric acid.

3. Oxides of Nitrogen: Combustion of coal, oil, natural gas and gasoline which produces upto 50 ppm of Nitrogen. NOx are also produced when fossil fuels are burned especially in power plants and motor vehicles. NO_2 poisoning results SILO FILTER disease. High levels of NO_2 exposure causes cough and make the human beings feel short of breath. People who are exposed to NO_2 for a long time have a higher chance of getting respiratory infections.
NOx compounds contribute for the formation of Ozone. Similarly, when nitrogen oxide when combine with SOx to form acid rain.

4. Chloro Fluoro Carbons: CFC's (also known as Freon) are non- toxic. They contain Carbon, Fluorine and Chlorine atoms. The five main CFCs are the following:
CFC – 11 (Trichloro Fluoro Methane $CFCl_3$)
CFC – 12 (Dichloro Fluoro Methane CF_2Cl_2)
The major uses of CFCs are as coolants in refrigerators and in air conditioners; as solvents in cleaners particularly for electronic circuit boards etc.. CFCs are the main cause of ozone depletion. CFCs have a lifetime in the atmosphere of about 20 to 100 years, and as a result one free chlorine atom from a CFC molecule can do a lot of damage.

SECONDARY POLLUTANTS:

1) Ozone (O_3) / Ozone layer Depletion: Ozone consists of oxygen molecules which contain three oxygen atoms. It is not emitted directly into the air but produced in the atmosphere when oxygen combines with oxygen radical (**O**·) in the presence of sunlight. Ozone protects us from ultra violet radiation and other harmful rays.
It is observed that over the last few years, many manmade processes release gases into atmosphere

causing drastic depletion of ozone layer. The chlorine atoms cause depletion of ozone slowly and holes are formed in the ozone layer.
Ozone reacts with tissues and cause for breathing and decrease the working ability of the lungs, chest pains and coughing. It lowers the human body resistance power and leads to cold; pneumonia also.

Antarctic Ozone depletion: According to NIMBUS-7 satellite picture which was taken on 5th October, 1987 the protective ozone layer showed a hole over 50% of the area of the Antarctica continent covering 7 million sq km.
On Jan 1st 1989, the country Montreal (Canada) proposed redesigning refrigeration, air conditioning technology replacing the use of CFCs by ozone friendly substitutes.

2) Smog: Smog is a combination of smoke and fog or various gases when react in the presence of sunlight. The effects of smog on human health cause for respiratory, irritation to the eyes, diseases related to nose, throat, bronchitis, pneumonia, headache, nerves, liver, and kidneys.
The first smog related deaths were recorded in London in 1873, when it killed 500 people. In 1892, December, London had worst experiences causing 1000 deaths. In 1940's severe smog began covering the cities of Los Angeles in USA.

3) Acid rain: Acid rain has become one of the most important global environmental problems and poses significant adverse impact on soils, rivers, lakes, forests and monuments. The phenomenon occurs when SOx and NOx from the burning of fossil fuels such as Petrol, Diesel, Coat etc combine with water vapour in atmosphere and fall as rain or snow or fog.
Natural sources like volcanoes, forest fires, etc also contribute SOx and NOx. Increased urban and industrial activities cause air pollution resulting in the rise of concentration of SO_2 and NOx. Sulphur dioxide and NO_2 combines with water vapour in the atmosphere produce sulphuric acid and Nitric acid respectively and results acid rain. Some of the examples are:
Europe and parts of W Asia have experienced rain with water pH range of 4.5 to 5.0 (acidic) in 1958.

AIR POLLUTION EFFECTS, PREVENTION AND CONTROL MEASURES:

Human beings breathe 22000 times a day on the average, inhaling 16 kg of air. Atmosphere constitutes a protective cover of gases surrounding the earth which
sustains life and saves it from unfriendly environment.
The atmosphere consists of several layers viz. Troposphere, Stratosphere; Mesosphere; Thermosphere & Exosphere.
The lower atmosphere i.e., the troposphere contains 70% of gaseous components of major, minor and traces. Ultra violet radiation from the sun is absorbed by ozone in the stratosphere which is so called ozone layer located between 17 - 26 kms above sea level.

Effects of Air pollution: The effects of pollution may be direct and affect certain organisms. The effects of pollution may possess a hazard or nuisance. Long continued pollution even affects the evolution of a species and eliminates organisms that cannot tolerate certain pollutants and favor others who can eat.
Air pollution causes deaths, impair health, reduce visibility and brings vast economic losses. It can also cause intangible losses to historic monuments such as Taj Mahal.
Finally, Air pollution can affect the environment on a global scale.

Prevention and control of Air Pollution:

- Inputs that do not contain the pollutants.
- Operating process to minimize generation of the pollutants.
- Replacing the process with one does not generate the pollutant.
- Removing the pollutants from the process.
- Substitution of raw materials.

  Eg: The substitution of high sulphur coal with low sulphur coal in power plants.
  Eg: Changing a fossil fuel with nuclear energy can eliminate sulphur emission.
- By involving the Process Modification:
  Eg: Chemical and petroleum industries have changed by implementing Automated operations, computerized process control by reducing the Oxidation of SO_2 to SO_3 by reducing excess air.
- By involving the control technologies: Control equipment viz., Wet Collector (scrubber), Gravity Settling chamber; Cyclone Collectors, Dry Scrubbers, filters, electrostatic precipitators etc. are to be used to minimize the air pollution.

Air pollution can be reduced by

- Plant more trees and nurture the ones present.
- Minimize Pollution from Cars by using Electric Vehicles, Carpooling, Keeping Car well serviced
- Using environment friendly vehicles like bicycle to cover short distances.
- Using alternate sources of energy like solar energy rather than burning fossil fuels
- Using public transport whenever possible.
- Using Recylced Products and avoiding Plastics, Polythenes
- Keeping indoor plants
- Using Air Purifiers inside Home and Offices
- Grow Compost from Home Waste
- Print and photocopy on both sides of paper.
- Stop burning garbage, paper, dry leaves
- Quit Somking
- Buying Rechargeable batteries

Measures to improve air quality:

- Improving public transport
- Limiting the number of polluting vehicles on the road
- Introducing less polluting fuel
- Strict emission regulations
- Improved efficiency for thermal power plants and industries
- Moving from diesel generators to rooftop solar
- Increased use of clean renewable energy
- Electric vehicles

- Removing dust from roads
- Regulating construction activities
- Stopping biomass burning, etc.

Other air pollution control measures include:

1. By minimising and reducing the use of fire and fire products.
2. Since industrial emissions are one of the major causes of air pollution, the pollutants can be controlled or treated at the source itself to reduce its effects. For example, if the reactions of a certain raw material yield a pollutant, then the raw materials can be substituted with other less polluting materials.
3. Fuel substitution is another way of controlling air pollution. In many parts of India, petrol and diesel are being replaced by CNG – Compressed Natural Gas fueled vehicles. These are mostly adopted by vehicles that aren't fully operating with ideal emission engines.
4. Although there are many practices in India, which focus on repairing the quality of air, most of them are either forgotten or not being enforced properly. There are still a lot of vehicles on roads which haven't been tested for vehicle emissions.
5. Another way of controlling air pollution caused by industries is to modify and maintain existing pieces of equipment so that the emission of pollutants is minimised.
6. Sometimes controlling pollutants at the source is not possible. In that case, we can have process control equipment to control the pollution.
7. A very effective way of controlling air pollution is by diluting the air pollutants.
8. The last and the best way of reducing the ill effects of air pollution is tree plantation. Plants and trees reduce a large number of pollutants in the air. Ideally, planting trees in areas of high pollution levels will be extremely effective.

WATER POLLUTION

A large amount of water is discharged back after domestic and industrial usage. This is contaminated with domestic waste and industrial effluents. When this contamination reaches beyond certain allowed concentrations, it is called pollution and the contaminants are called the pollutants.

Water pollution may be defined as the contamination of streams, lakes, seas, underground water or oceans by substances, which are harmful for living beings. If the concentration of substances naturally present in water increases, then also the water is said to be polluted.

Water pollution may be defined as the contamination of streams, lakes, seas, underground water or oceans by substances, which are harmful for living beings. Industrialization and population explosion are two important factors for water pollution.

Water may be called polluted when the following parameters stated below reach beyond a specified concentration in water.

i) Physical parameters. Colour, odour, turbidity, taste, temperature and electrical conductivity constitute the physical parameters and are good indicators of contamination. For instance, colour

and turbidity are visible evidences of polluted water while an offensive odour or a bitter and difference than normal taste also makes water unfit for drinking.

ii) ii) Chemical parameters: These include the amount of carbonates, sulphates, chlorides, fluorides, nitrates, and metal ions. These chemicals form the total dissolved solids, present in water.

iii) iii) Biological parameters: The biological parameters include matter like algae, fungi, viruses, protozoa and bacteria. The life forms present in water are affected to a good extent by the presence of pollutants. The pollutants in water may cause a reduction in the population of both lower and higher plant and animal lives. Thus, the biological parameters give an indirect indication of the amount of pollution in water

Hydrosphere in the universe contains water in the form of oceans, rivers, lakes, tanks and many other water sources.

Water sources in the world are of two types.

They are (1) Marine water bodies and (2) Fresh Water bodies.

Water is a good solvent for many substances. Because of this property water cannot exist in its pure form at many parts of the world. Water pollution is mainly because of sewage, industrial disposals i.e., effluents.

PARAMETERS OF WATER POLLUTION:

Chemical examination of water (tests): pH; Biological Oxygen Demand (BOD), Dissolved Oxygen (DO), etc are some of the chemical tests to find the stage of pollution of water.

1. pH: The value of pH gives the degree of acidity or alkalinity of polluted water. Determination of pH is important in calculating the coagulant (thick or thin) dose.

2. Biological Oxygen Demand (BOD): It is defined as the quantity of oxygen utilized by micro organisms at a temperature of 20^{o}C, generally measured for 5 days. When water is polluted by unwanted materials, naturally the O_2 content gets reduced and that water become not fit for consumption either by human beings or animals or plants.
Living organisms require water with some quantity of sustainable oxygen in it. That oxygen is necessary for living organisms is generally called BOD. If there is reduction in oxygen content of water, it becomes unfit for biological consumption because there is change in BOD.

When pollutants enter a stream, river or lake these gives rise to surface water pollution. The surface water pollution has a number of sources.
These can categorized as: • Point and Non-point Sources • Natural and Anthropogenic Sources (i) Point and Non-point Sources .

The well-defined sources that emits pollutants or effluents directly into different water bodies of fresh water are called point sources. Domestic and industrial waste are examples of this type. The point sources of pollution can be effectively checked. On the other hand, the non-point sources of

water pollution are scattered or spread over large areas. This type of sources delivers pollutants indirectly through environmental changes and account for majority of the contaminants in streams and lakes. For example, the contaminated water that runs off from agriculture farms, construction sites, abandoned mines, enters streams and lakes. It is quite difficult to control non-point sources.

Sources of Water Pollution

The key causative of water pollution in India are:

- Urbanization.
- Deforestation.
- Industrial effluents.
- Social and Religious Practices.
- Use of Detergents and Fertilizers.
- Agricultural run-offs- Use of insecticides and pesticides.

. These can be broadly put under the following types. (i) Sewage Pollutants (Domestic and Municipal Waste) (ii) Industrial Pollutants (iii) Agricultural Pollutants (iv) Radioactive and Thermal Pollutants

(i) Domestic and Municipal Pollutants: The sewage contains garbage, soaps, detergents, waste food and human excreta and is the single largest sources of water pollution. Pathogenic (disease causing) microogranisms (bacteria, fungi, protozoa, algae) enter the water system through sewage making it infected. Typhoid, chloera, gastroenteritis and dysentery are commonly caused by drinking infected water. Water polluted by sewage may carry certain other bacteria and viruses cannot grow by themselves, but reproduce in the cells of host organisms. They cause a number of diseases, such as, polio, viral hepatitis and may be cancer which are resistant to like the organic matter are oxygen demanding substances.

(ii) Industrial Pollutants: Many industries are located near rivers or fresh water streams. These are responsible for discharging their untreated effluents into rivers like highly toxic heavy metals such as chromium, arsenic, lead, mercury, etc. along with hazardous organic and inorganic wastes (e.g., acids, alkalis, cyanides, chlorides, etc.). River Ganges receives wastes from textile, sugar, paper and pulp mills, tanneries, rubber and pesticide industries. Most of these pollutants are resistant to breakdown by microorganisms (called no biodegradable), therefore damage the growth of crops and the polluted water is unsafe for drinking purposes. Factories manufacturing plastic, caustic soda and some fungicides and pesticides release mercury (a heavy metal) along with other effluents in nearby water body. Mercury enters the food chain through bacteria, algae, fish and finally into the human body.

(iii) Agricultural Waste: Manure, fertilizers, pesticides, wastes form farms, slaughterhouse, poultry farms, salts and silt are drained as run-off from agricultural lands. The water body receiving large quantities of fertilizers (phosphates and nitrates or manures becomes rich in nutrients which leads to eutrophication and consequent depletion of dissolved oxygen. Consumption of water rich in nitrates is bad for human health especially for small children. Pesticides (DDT, dieldrin, aldrin, malathion, carbaryl etc.) are used to kill insect and rodent pests. Toxic pesticide residues enter the human body through drinking water or through food chain (biomagnification).

(iv) Physical Pollutants: Physical pollutants can be of different types. Some of them are discussed below: (a) Radioactive Wastes: Radionuclides found in water are radium and potassium-40. These isotopes originate from natural sources due to leaching from minerals. Water bodies are also polluted by accidental leakage of waste material from uranium and thorium mines, nuclear power plants and industries, research laboratories and hospitals which use radioisotopes. Radioactive materials enter human body through water and food, and may be accumulated in blood and certain vital organs. They cause tumors and cancer.

(v) Petroleum Products: Petroleum products are widely used for fuel, lubrication, plastics manufacturing, etc. and happen to be poisonous in nature. Crude oil and other related products generally get into water by accidental spillage from ships, tankers, pipelines etc. Besides these accidental spills, oil refineries, oil exploration sites and automobile service centres pollute different water bodies. Oil slick which floats on the water surface causes death of marine life and severely affects the ecosystem of the ocean. A list of various types of water pollutants, their sources and effects have b

COMMON TYPES OF WATER POLLUTANTS:

A) Based on sources **B) Based on natures**

A) Based on sources:

a) Disease causing agents: Bacteria, viruses, protozoan that enter water from domestic sewage and animal wastes.

b) Water soluble inorganic chemicals: Acids, salts and compounds of toxic metals such as Lead, Mercury can make water unfit to drink, harm fishes and other aquatic life. Also Nitrate, Phosphate compounds dissolve in water that can cause excessive growth of algae, which then die and decay, depleting dissolved O_2 in water and killing fish.

c) Water Soluble Organic chemicals: Oil, gasoline (a type of oil is obtained from petroleum), pesticides, detergents and many other water soluble chemicals that threaten human health and harm fish.

d) Heat: Large quantity of water is heated when it is used in the cooling towers of thermal power plants. When this hot water is discharged into the nearby water bodies, it causes an increase in its temperature.

e) Sewage: sewage is waste water from municipal area where there is human habitation. Sewage which comes from homes is called **domestic sewage**

B) Based on natures:

In nature water pollution is classified into three types by **Kimball** (1975). They are:

1. Domestic water pollution: Sewage is a part of domestic water pollution. Domestic sewage not only contains unwanted waste materials, but it is also infested with harmful bacteria, virus etc. These are responsible for causing diseases in animals and human beings, if they drink this polluted water and even plants may die if polluted water is provided. Domestic water pollution leads to Diarrhea, Cholera and Typhoid in human beings.

2. Agricultural Water Pollution: Water require for plants for its growth. Major irrigation, minor irrigation, sprinkler irrigation, drip irrigation, lift irrigation carry waste substances and causing water pollution in addition to the utilization of fertilizer and pesticides. Agricultural water pollution leads to Eutrophication & Water Bloom.

Ecological effects: The important troubling ecological impacts are:

1. Excessive nutrients in water bodies promote plant growth which leads to a drop in water quality;
2. Disruption of the natural ecosystem E.g. lack of oxygen for shelf marine life (causing a drop in their population).
3. Decrease in the recreational and aesthetic value of water bodies
4. Health problems when it occurs in drinking water reserves
5. Coral reef decline
6. Decreased biodiversity,
7. Changes in species composition and dominance, and
8. Toxicity effects.
9. Toxic phytoplankton species
10. Decreases in water transparency (increased turbidity)
11. Color, smell, and water treatment problems
12. Dissolved oxygen depletion
13. Increased incidences of fish kills
14. Loss of desirable fish species

3. Industrial water pollution: Many industries discharge waste materials containing harmful chemicals. Such Industrial wastes are called **effluents**. The river Godavari is polluted because of effluents released by the paper industry. It affects the entire water ecosystem causing enormous damage to fishes, prawns and fresh water animals.

Eg: Minamata disease & Fluorosis.

Minamata disease is a neurological syndrome caused by severe mercury poisoning. Symptoms include ataxia, numbness in the hands and feet, general muscle weakness, narrowing of the field of vision and damage to hearing and speech. In extreme cases, insanity, paralysis, coma, and death follow within weeks of the onset of symptoms.

Minamata disease was first discovered in Minamata city in Japan in 1956. It was caused by the release of methyl mercury from, the Chisso Corporation's chemical factory, which continued from 1932 to 1968. This highly toxic chemical bio- accumulated in shellfish and fish in Minamata Bay which when eaten by the local people resulted in mercury poisoning. While cat, dog, pig, and human deaths continued over more than 30 years, the government and company did little to prevent the pollution.

Fluorosis: People suffer from a disease called fluorosis after consuming water containing fluorine for sufficiently a long time. Quantity of fluoride in water is only 1 ppm. Diseases caused by fluorosis are:

Back pain and cannot easily bend.
Joints get stiffened as so movement of joints is impaired.
Teeth are the worst effected and a brown coating appears on the enamel of teeth giving bad appearance.
Persons with fluorosis cannot erect freely.

CONTROL MEASURES OF WATER POLLUTION:

1. Drinking water should be boiled, cooled and then used.
2. Disinfection of drinking water should be done by using chemicals like bleaching powder.
3. Pesticides and insecticides should be prevented from nearby use of water lakes,ponds and pools.
4. Drainage water should not be allowed to mix with drinking water.
5. Drainage system should be maintained properly.

6. Chlorination process is to be adopted for drinking water. For 1 litre of water 30 - 40 mg of chlorine is to be added to get perfect disinfection. It kills bacteria, fungi, fungal spores and other microbes also.

Water Pollution – Some Control Measures:

Waste water generated by household activity, industries or garbage landfills is called sewage which is classified as the municipal water pollution. Sewage contains solid matters in the form of suspended colloidal and dissolved organic matter, detergent, mineral matter, nutrients and gases.

The treatment of this waste water is carried out in the following three stages: (i) Primary treatment (ii) Secondary treatment, and (iii) Tertiary treatment.

Primary Treatment: When the waste water is to be dumped off into a river or flowing steam, the treatment is carried out by sedimentation, coagulation and filtration. This is known as primary treatment. If the water is required for drinking purposes, it has to undergo further treatment called secondary and tertiary treatments.

The following steps are performed to do primary treatment of water:

(i) Sedimentation: This step is carried out in large tanks specially built for this purpose in sewage treatment plant. The polluted water is allowed to settle so that silt, clay and other matter settle to be bottom and water is slowly allowed to move out. Fine particles do not settle and are thus required to be removed in the next step.

(ii) Coagulation: Fine particles and colloidal suspension are combined into large particles by a process called coagulation. This step is carried out by the addition of special chemicals called coagulants (flocculants) such as potash alum. The large particles either settle to the bottom or are moved in the next step.

(iii) Filtration: Suspended particles, flocculants, bacteria and other organisms are filtered by passing the water through a bed of sand or finely divided coal or through some fibrous materials. The total impurities collected in these steps are called sludge. It is used as a valuable fertilizer. On composting (i.e. the action of anaerobic bacteria), it releases sludge gas. It consists mainly of methane gas which is used for cooking purposes.

Secondary or Biological Treatment:

The water after primary treatment is not fit for drinking purposes and has to undergo further treatment. This is done through secondary or biological treatment. A commonly used method is to allow polluted water to spread over a large bed of stones and gravel so that the growth of different microorganisms needing nutrients and oxygen is encouraged. Over a period of time a fast moving food chain is set up. For example, bacteria consume organic matter from the polluted water; protozoa live on bacteria. Every form of life including algae and fungi help in the cleaning up process. This is called secondary treatment of water.

It involves the following processes

(i) Softening: By this treatment undesirable cations of calcium and magnesium are removed from hard waters. Either water is treated with lime and soda ash to precipitate Ca^{2+} ions as carbonates or it is passed through cation exchangers.

(ii) Aeration: In this process, soft water is exposed to air by forcing air through it to add oxygen to water. This encourages bacterial decomposition of organic matter into harmless products such as carbon dioxide and water. The addition of oxygen reduces carbon dioxide. sulphide etc. The water is as yet not fit for drinking purposes. The pathogenic and other microorganisms need to be killed. This is done in the next treatment.

(iii) Tertiary Treatment: The tertiary treatment is actually disinfecting water. Chlorine is the most commonly used disinfectant used for killing bacteria. However, chlorine also reacts with traces of organic matter present in water and forms undesirable chlorinated hydrocarbons (toxic and potentially carcinogenic).

It is therefore desirable to reduce the organic matter in water before passing chlorine gas. Other methods of disinfection such as ultraviolet radiation, ozone gas treatment or reverse osmosis are preferred over chlorine treatment. But these methods are more expensive. Fig.34.3 gives a clear picture of the process of sewage treatment in total.

sustainable wastewater treatment

Sustainable treatment is one which does not create secondary wastewater pollution (there is no need to add chemicals to wastewater during treatment) and there is no need to supply external energy for the process. The world depends on wastewater treatment facilities to sustain the environment and prevent the spread of disease. However, maintaining a clean water supply can have a large carbon footprint, contributing to climate change. The future of wastewater plants must include plans to incorporate sustainable methods.

Methods of Wastewater Treatment

Some water treatment methods have been around for decades. Modern techniques may result in cleaner water, but they also use more energy.

Physical Processes

Physical processes like filtration and sedimentation use water pressure or gravity to remove large impurities from the water stream. These techniques are energy-efficient to a point. However, more intensive filtration processes like reverse osmosis require additional energy to force water through membranes.

Chemical Processes

Water treatment plants use chemicals to adjust the pH of effluent. Compounds like hydrogen peroxide and sodium hypochlorite can disinfect water for a safe return to the water cycle.

Biological Processes

Bacteria and other organisms naturally break down organic material in wastewater. Activated sludge is a common aerobic process that removes impurities over time. Many wastewater plants are implementing anaerobic techniques that allow for the harvesting of methane as a biofuel.

Environmental Impacts of Wastewater Management

Incomplete wastewater management can have heavy environmental consequences. Plants send effluent into local water resources like waterways, ponds, and lakes. If the treatment does not remove chemicals like nitrogen and phosphorus, algae blooms may develop, creating dead zones for aquatic life.

However, the most significant environmental impact comes from electricity usage. All wastewater plants require energy, especially when employing energy-hungry pumps to move water. Depending on the volume and techniques used, sewage treatment plants can contribute to a municipality's carbon footprint.

Developing Sustainable Methods for Wastewater Management

Developing sustainable wastewater treatment facilities requires examining how they obtain energy and the efficiency with which they use it. Harnessing the byproducts of wastewater treatment is another way to lessen the overall impact.

Green Energy and Sustainable Water Treatment

Using gravity for all treatment methods is unfeasible to achieve the level of cleanliness necessary for producing safe effluent. Recognizing that plants and their pumps will need power, designers are looking for ways to reduce energy demand by employing green energy.

Sustainability means building solar farms on or around the wastewater plant in some locations. Municipalities often place their wastewater facilities on open land. Dedicating some of the land to energy production can make the plant self-sufficient.

In other cases, the plant uses treatment byproducts like methane and hydrogen to fuel its processes. While burning methane contributes to greenhouse gases, it is a cleaner energy source than coal.

Harvesting Nutrients

Using treatment byproducts is another way to lower the total energy costs of water treatment. When left in effluent, the nitrogen and phosphorus that cause algae blooms can serve as nutrients for the agricultural industry. Revenue from byproduct sales will also lower wastewater operating costs.

Water Recycling

Sustainability for water systems will involve recycling water in locations with a low supply. The plant must include more effective treatment measures if effluent flows to the public water supply.

Chemical Treatment

Researchers are learning how the timing of chemical processes can affect the efficiency of wastewater treatment. Pre-treating water to adjust its quality can make biological methods faster and more effective, increasing a plant's capacity without expansion.

zero waste concept:

Zero Waste means designing and managing products and processes to systematically avoid and eliminate the volume and toxicity of waste and materials, conserve and recover all resources, and not burn or bury them.

Implementing Zero Waste will eliminate all discharges to land, water or air that are a threat to planetary, human, animal or plant health.

- Extended Producer Responsibility and Product Redesign
- Reduce Waste, Toxicity, Consumption, and Packaging
- Repair, Reuse and Donate
- Recycle
- Compost
- Down Cycle and Beneficial Reuse
- Waste-Based Energy as disposal
- Landfill Waste as disposal

3R (Reduce, Reuse, Recycle)
Reduce means to make smaller/less in amount.

Reuse means to use something again, either for its original purpose or repurposed for a different task.

Recycle means to convert waste into material that can be used to remake the item, or to make something else.

Firstly, we should try to reduce how much waste we produce and therefore the amount of unnecessary items we purchase. If something still needs to be purchased, then we should next try to reuse it for something else at the end of its life. If we cannot reuse it, then we must recycle it as a last resort. Even though recycling should be considered last, it is an important part of the process. In addition to conserving the world's natural resources, it is estimated that over 700 million tonnes of carbon dioxide emissions is avoided every year from recycling!

Any waste that cannot be recycled is either taken to the incinerator where it gets burnt in an enclosed chamber or, if it cannot go to the incinerator, the waste is taken to landfill sites where it is then left to rot. This produces a lot of methane which is one of the more potent greenhouse gases. Also, as there is so much waste being produced, there is simply not enough space at these landfill sites, which then leads to illegally burning the waste or dumping it in the oceans, with little to no control.

Global environmental issues

Environmental Issues

Environmental issues are the harmful effects of human activities on the environment. These include pollution, overpopulation, waste disposal, climate change, global warming, the greenhouse effect, etc.

Various environment protection programs are being practised at the individual, organizational and government levels with the aim of establishing a balance between man and the environment.

Some of the current environmental issues that require urgent attention are:

Climate Change

Climate change is a great concern in today's scenario. This problem has surfaced in the last few decades. Greenhouse gases are the major cause of climate change. Environmental changes have several destructive impacts such as the melting of glaciers, change in seasons, epidemics, etc.

Global Warming

The burning of fossil fuels, emissions from automobiles and chlorofluorocarbons add to the greenhouse gases in the atmosphere. This has led to an increase in the earth's temperature causing environmental changes. This increase in temperature across the globe is known as global warming.

Ozone Layer Depletion

The ozone layer is a layer of concentrated ozone gas. It protects us from the sun's harmful ultraviolet rays. This very important layer is being destroyed by CFCs (chlorofluorocarbons), which are used in industries and everyday life (e.g. aerosol cans).

The chlorine in these compounds destroys the ozone layer. The hole in the ozone layer leaves humans and wildlife exposed to harmful UV rays resulting in several skin diseases including cancer.

Water Pollution

The introduction of harmful substances into rivers, oceans, lakes and ponds, which changes the physical, chemical or biological condition of the water is called water pollution. The polluted water lacks oxygen and therefore the organisms die.

Water is the main source of life and therefore it is our prime duty to prevent it from any kind of pollution.

Air Pollution

Air pollution is the result of emissions from industries, automobiles, and the increasing use of fossil fuels. The gaseous emissions have added to an increase in the temperature of the earth. Not only this, but it had also increased the risk of diseases among individuals.

Solid Waste Management

Solid-waste management is defined as the discipline associated with the generation, storage, collection, transfer and transport, processing, and disposal of solid waste in a manner that it does not have a harmful effect on the environment.

Deforestation

Deforestation is the depletion of trees and forests at an alarming rate. The trees provide us with oxygen, and several raw materials and also maintain the temperature of the earth. Due to the depletion of trees for commercial purposes, there has been a drastic change in the earth's climate.

Forests are an abode to a large number of wild animals and plants. Destruction of forests has led to the elimination of a large number of plants and animal species affecting biodiversity.

Overpopulation

The earth's population is increasing drastically. It is estimated to be more than seven billion. The increasing population has led to a shortage of resources. If this continues, it will be very difficult to sustain such a huge population. The other environmental issues including pollution, waste management, deforestation, climate change and global warming are all associated with overpopulation.

Solutions to Environmental Issues

Following are some of the most common solutions to the environmental issue:

1. Replace disposal items with reusable items.
2. The use of paper should be avoided.
3. Conserve water and electricity.
4. Support environmental friendly practices.
5. Recycle waste to conserve natural resources.

Environmental issues are a warning of the upcoming disaster. If these issues are not controlled, there will soon be no life on earth.

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 greenhouse 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˚ c over 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.

Greenhouse 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

Global warming is a gradual, long-term increase in the average temperature of Earth's atmosphere due to the greenhouse effect where gasses from various human activities, including the burning of fossil fuels, trap heat from solar radiation.

Some greenhouse gases occur naturally in the atmosphere, while others result from human activities. Naturally occurring greenhouse gases include water vapor, carbon dioxide, methane, nitrous oxide, and ozone (refer Figure 9.4). Certain human activities, however, add to the levels of most of these naturally occurring gases.

Carbon dioxide is released to the atmosphere when solid waste, fossil fuels (oil, natural gas, and coal), and wood and wood products are burned.

Methane is emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from the decomposition of organic wastes in municipal solid waste landfills, and the raising of livestock. Nitrous oxide is emitted during agricultural and industrial activities, as well as during combustion of solid waste and fossil fuels.

Very powerful greenhouse gases that are not naturally occurring include hydro fluorocarbons (HFCs), per fluorocarbons (PFCs), and sulfur hexafluoride (SF_6), which are generated in a variety of industrial processes.

Global warming comes from the over-accumulation of **greenhouse gasses** (GHGs) such as carbon dioxide (CO2), nitrous oxide (N2O), and methane (CH4) in the Earth's atmosphere.

The excess **greenhouse gasses can come from a variety of sources**, though most involve burning fossil fuels in some way:

- **Electricity generation:** Burning coal, natural gas or other fossil fuels to generate electricity accounts for about a quarter of greenhouse gas emissions in the US, the EPA estimates.
- **Transportation:** Burning fuel to move people and goods is one of the largest sources of GHGs in the US.

- **Buildings:** Fossil fuels burned to heat buildings and refrigerants that leak out of cooling systems are major sources of GHGs in buildings.
- **Deforestation:** Deforestation removes the trees that act as a natural GHG filter, absorbing carbon dioxide and releasing oxygen into our atmosphere.
- **Agricultural Practices:** Modern farming accounts for more than **10% of all human-produced greenhouse gas emissions**, largely due to livestock and rice cultivation.
- **Consumer goods:** The energy used in the manufacturing and transportation of consumer goods leads to increased greenhouse gas emissions.
- **Mining:** Operations that rely on fossil fuels emit significant levels of GHGs.
- **Waste disposal:** When plastics and other non-biodegradable waste decompose, it releases toxic gasses into the environment and the potent GHG methane.

Global Warming (Climate Change) Implications

Rise in global temperature

Rise in sea level

In general, the faster the climate change, the greater will be the risk of damage. The mean sea level is expected to rise 9 - 88 cm by the year 2100, causing flooding of low lying areas and other damages.

Food shortages and hunger

Water resources will be affected as precipitation and evaporation patterns change around the world. This will affect agricultural output. Food security is likely to be threatened and some regions are likely to experience food shortages and hunger.

ACID RAIN

Acid rain is a form of precipitation characterized by high concentrations of acidic compounds, usually in the form of dissolved ions or molecules. Acid rain contains Sulphur dioxide (SO_2) and nitrogen oxides (NO_x) which are emitted from fossil fuel combustion. Acidic pollutants can also be discharged from the smokestacks of ships and coal-fired power plants.

Oxides of sulfur and nitrogen originating from industrial operations and fossil fuel combustion are the major sources of acid forming gases. Acid forming gases are oxidized over several days by which time they travel several thousand kilometers. In the atmosphere these gases are ultimately converted into sulfuric and nitric acids.

In absence of rain, dry deposition of acid may occur. Acid forming gases like oxides of Sulphur and nitrogen and acid aerosols get deposited on the surface of water bodies, vegetation, soil and other materials. On moist surfaces or in liquids these acid forming gases can dissolve a form acids similar to that formed in acid rain.

Effects of acid rain:

Acid rain causes a number of harmful effects below pH 5.1. The effects are visible in the aquatic even at pH less than 5.5.

1. It causes deterioration of buildings especially made of marble e.g. monuments like Taj Mahal. Crystals of calcium and magnesium sulphate are formed as a result of corrosion caused by acid rain.
2. It damages stone statues. Priceless stone statues in Greece and Italy have been partially dissolved by acid rain.
3. It damages metals and car finishes.
4. Aquatic life especially fish are badly affected by lake acidification
5. Aquatic animals suffer from toxicity of metals such as aluminium, mercury, manganese, zinc and lead which leak from the surrounding rocks due to acid rain.
6. It results in reproductive failure, and killing of fish.
7. Many lakes of Sweden, Norway, and Canada have become fishless due to acid rain.
8. It damages foliage and weakens trees
9. It makes trees more susceptible to stresses like cold temperature, drought, etc . Many insects and fungi are more tolerant to acidic conditions and hence they can attack the susceptible trees and cause diseases.

Control measures:

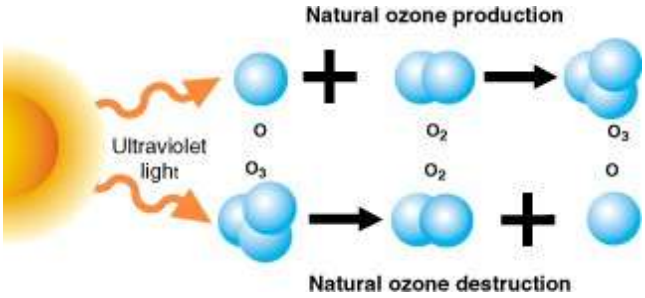
1. Emission of SO_2 and NO_2 from industries and power plants should be reduced by using pollution control equipments.
2. Liming of lakes and soils should be done to correct the adverse effects of acid rain.
3. A coating of protective layer of inert polymer should be given in the interior of water pipes for drinking water

OZONE LAYER DEPLETION

One of the most important characteristics of this environmental degradation is that it affects all mankind on a global scale without regard to any particular country, region, or race. The whole world is a stakeholder and this raises issues on who should do what to combat environmental degradation.

Earth's atmosphere is divided into three regions, namely troposphere, stratosphere and mesosphere. The stratosphere extends from 10 to 50 kms from the Earth's surface. This region is concentrated with slightly pungent smelling, light bluish ozone gas. The ozone gas is made up of molecules each containing three atoms of oxygen; its chemical formula is O_3.

The ozone layer, in the stratosphere acts as an efficient filter for harmful solar Ultraviolet B (UV-B) rays Ozone is produced and destroyed naturally in the atmosphere and until recently, this resulted in a well-balanced equilibrium .



Ozone is formed when oxygen molecules absorb ultraviolet radiation with wavelengths less than 240 nanometres and is destroyed when it absorbs ultraviolet radiation with wavelengths greater than 290 nanometres. In recent years, scientists have measured a seasonal thinning of the ozone layer primarily at the South Pole. This phenomenon is being called the ozone hole.

Ozone Depletion Process

Ozone is highly reactive and easily broken down by man-made chlorine and bromine compounds. These compounds are found to be most responsible for most of ozone layer depletion.

The ozone depletion process begins when CFCs (used in refrigerator and air conditioners) and other ozone-depleting substances (ODS) are emitted into the atmosphere. Winds efficiently mix and evenly distribute the ODS in the troposphere. These ODS compounds do not dissolve in rain, are extremely stable, and have a long life span. After several years, they reach the stratosphere by diffusion.

Strong UV light breaks apart the ODS molecules. CFCs, HCFCs, carbon tetrachloride, methyl chloroform release chlorine atoms, and halons and methyl bromide release bromine atoms. It is the chlorine and bromine atom that actually destroys ozone, not the intact ODS molecule. It is estimated that one chlorine atom can destroy from 10,000 to 100,000 ozone molecules before it is finally removed from the stratosphere.

Chemistry of Ozone Depletion

When ultraviolet light waves (UV) strike CFC* ($CFCl_3$) molecules in the upper atmosphere, a carbon-chlorine bond breaks, producing a chlorine (Cl) atom. The chlorine atom then reacts with an ozone (O_3) molecule breaking it apart and so destroying the ozone. This forms an ordinary oxygen molecule (O_2) and a chlorine monoxide (ClO) molecule. Then a free oxygen** atom breaks up the chlorine monoxide. The chlorine is free to repeat the process of destroying more ozone molecules. A single CFC molecule can destroy 100,000 ozone molecules.
* CFC - chlorofluorocarbon: it contains chlorine, fluorine and carbon atoms. ** UV radiation breaks oxygen molecules (O_2) into single oxygen atoms.

Effects of Ozone Layer Depletion

1) Effects on Human and Animal Health: Increased penetration of solar UV-B radiation is likely to have high impact on human health with potential risks of eye diseases, skin cancer and infectious diseases.

2) Effects on Terrestrial Plants: In forests and grasslands, increased radiation is likely to change species composition thus altering the bio-diversity in different ecosystems. It could also may affect the plant community.

3) Effects on Aquatic Ecosystems: High levels of radiation exposure in tropics and subtropics may affect the distribution of Phytoplankton's, which form the foundation of aquatic food webs. It can also cause damage to early development stages of fish, shrimp, crab, amphibians and other animals, the most severe effects being decreased reproductive capacity and impaired larval development.

4)Effects on Bio-geo-chemical Cycles: Increased solar UV radiation could affect terrestrial and aquatic bio-geo-chemical cycles thus altering both sources and sinks of greenhouse and important trace gases, e.g. carbon dioxide (CO_2), carbon monoxide (CO), carbonyl sulfide (COS), etc. These changes would contribute to biosphere-atmosphere feedbacks responsible for the atmosphere build-up of these greenhouse gases.

5) Effects on Air Quality: Reduction of stratospheric ozone and increased penetration of UV-B radiation result in higher photo dissociation rates of key trace gases that control the chemical reactivity of the troposphere. This can increase both production and destruction of ozone and related oxidants such as hydrogen peroxide, which are known to have adverse effects on human health, terrestrial plants and outdoor materials.

The ozone layer, therefore, is highly beneficial to plant and animal life on earth filtering out the dangerous part of sun's radiation and allowing only the beneficial part to reach earth. Any disturbance or depletion of this layer would result in an increase of harmful radiation reaching the earth's surface leading to dangerous consequences.

CARBON FOOTPRINT INTRODUCTION:

'Carbon footprint' measures the total greenhouse gas emissions caused directly and indirectly by a person, organization, event or product.

The footprint considers all six of the Kyoto Protocol greenhouse gases: Carbon dioxide (CO2), Methane (CH4), Nitrous oxide (N2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulphur hexafluoride (SF6).

A carbon footprint is measured in tons of carbon dioxide equivalent (tCO2e). The carbon dioxide equivalent (CO2e) allows the different greenhouse gases to be compared on a like-for- like basis relative to one unit of CO2. CO2e is calculated by multiplying the emissions of each of the six greenhouse gases by its 100-year global warming potential (GWP).

The main types of carbon footprint for organizations are:

A) <u>ORGANISATIONAL CARBON FOOTPRINT</u>

Emissions from all the activities across the organization, including buildings' energy use,

industrial processes and company vehicles.

An organizational or business carbon footprint measures the direct and indirect greenhouse gas emissions arising from all of an organization's activities. A good place to get an estimation of your business carbon footprint is our carbon footprint indicator. Read more about organizational carbon footprints below.

- Types of emissions
- Why calculate
- How to calculate - organizational carbon footprints
- How we can help

The Greenhouse Gas Protocol* standard is commonly used to categorize an organization's emissions into 3 groups or 'scopes':

- **Scope 1 - Direct emissions**
  Direct emissions resulting from activities within the organization's control. Includes on-site fuel combustion, manufacturing and process emissions, refrigerant losses and company vehicles.
- **Scope 2 - Indirect emissions: electricity and heat**
  Indirect emissions from electricity, heat or steam purchased and used by the organization.
- **Scope 3 - Indirect emissions: other**
  Any other indirect emissions from sources not directly controlled by the organization. Examples include: employee business travel, outsourced transportation, waste disposal, water usage and employee commuting.

Under the Greenhouse Gas Protocol, an organization must include scope 1 and 2 emissions within its carbon footprint. There is broad discretion about which scope 3 emissions should be included in a business carbon footprint - for example; organizations often include waste disposed to landfill and employee business travel from scope 3.

If you have your energy usage details, use our carbon footprint calculator to calculate your organizational carbon footprint.

* The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard, revised edition. World Business Council for Sustainable Development and World Resources Institute.

The 2 main reasons for calculating an organizational carbon footprint are that it will help you to:

- **Manage and reduce emissions**
  Reducing your business carbon footprint often results in cost savings. Analyzing your organization's carbon footprint will help you to identify and prioritize areas for potential reduction.
- **Reporting**
  More and more organizations want to be able to demonstrate their carbon footprint for reasons of:
    - **Mandatory reporting requirements**
      Climate change legislation such as the Carbon Reduction Commitment Energy Efficiency Scheme (CRC) or EU Emissions Trading Scheme require such

reporting, for example.

- **Corporate social responsibility (CSR)**
  Showing that you are behaving in a responsible and ethical way is becoming ever more important
- **Responding to requests**
  Partners, customers and investors are increasingly interested in carbon emissions data. There are also carbon reporting initiatives such as the Carbon Disclosure Project.

Steps:

The basic 6 steps required to calculate a carbon footprint for an organization are as follows:

1. Establishment of the assessment boundaries:
   - Organizational
   - Operational
   - Greenhouse gases
2. Collection of data.
3. Calculation of emissions using appropriate emissions factors
4. Convert usage into CO2 equivalent
5. Verifying the results (optional)
6. Reporting the carbon footprint

1. Method definition
You need to have a consistent method to get accurate results – especially if you are going to rely on lots of different people to collect and interpret data.
Good sources of standards include:

- Greenhouse Gas Protocol
  Free set of commonly used standards
- International Organization for Standardization, ISO 14064
  Builds on many of the concepts introduced by the GHG Protocol

2. Establishment of the assessment boundaries:
You will need to define:

- Organizational boundaries
  What parts of the organization are included? This can be complex for large organizations with many subsidiaries, joint ventures or leased assets.
- Operational boundaries
  All **scope 1** and **scope 2** emissions should be included, but the organization can choose which **scope 3** emissions to include.

When choosing a boundary try to take account of how your organization works, other reporting periods, legislative requirements, and the practicalities of data collection.

3. Collate data
It is important to collect data as thoroughly and accurately as possible. The main sources of data are usually:

- **Gas and electricity** – meter readings or bills (kWh)
- **Other fuels** – usage in liters, kWh, MJ, liters
- **Transport** – usage by fuel type (if this is not possible estimate it based on the mileage of the vehicles and fuel economy assumptions)

4. Convert usage into CO_2 equivalent

The carbon footprint is measured in tones CO_2 equivalent (tCO_2e). This is calculated by converting the data you have collected. You should always use conversions from credible sources, see our conversion factor tables. It is important that you identify any data gaps and list the assumptions you have made in calculating the footprint.

5. Verifying the results (optional)

To add credibility, it makes sense for a third party to verify your carbon footprint. The Carbon Trust Standard is one such company that can do this – as well as helping you to measure, reduce, and communicate your carbon footprint.

6. Reporting the carbon footprint

Make sure you carbon footprint is presented clearly and honestly. This means providing complete information about each of the steps above, including methods, footprint boundaries, data quality and assumptions. Also - try to keep a consistent approach over different years, explaining any changes in reporting or business structure that might impact the footprint.

B) PRODUCT CARBON FOOTPRINT

Emissions over the whole life of a product or service, from the extraction of raw materials and manufacturing right through to its use and final reuse, recycling or disposal.

A product carbon footprint measures the greenhouse gas emissions at each stage of the product's life.

A product carbon footprint measures the greenhouse gas emissions at each stage of the product's life. This includes:

- Extraction, production and transportation of raw materials
- Manufacture or service provision
- Distribution
- End-use
- Disposal/recycling

At each stage greenhouse gas emissions can result from such sources as: energy use, transportation fuel refrigerant losses from air conditioning units and waste. In the case of a "service product" the life-cycle stages are defined across the duration of the service.

Measuring a product's carbon footprint offers a number of benefits, including:

- **Attracting customers**
  Customers are becoming increasingly aware of the environmental impact of the goods and services they use. Working with the Company or demonstrating a lower footprint

than competitor products can deliver competitive advantage.

- **Brand identity**
  Reporting product carbon footprints shows that an organization takes its social responsibility seriously.
- **Leadership**
  Reporting your products' carbon footprints will support your corporate responsibility programme and enhance your reputation.
- **Cost savings**
  Identifying areas where greenhouse gas emissions can be reduced often results in cost savings - in terms of transport energy, waste and packaging for example.
- **Emissions savings**
  Looking at the whole supply chain could help you identify savings.

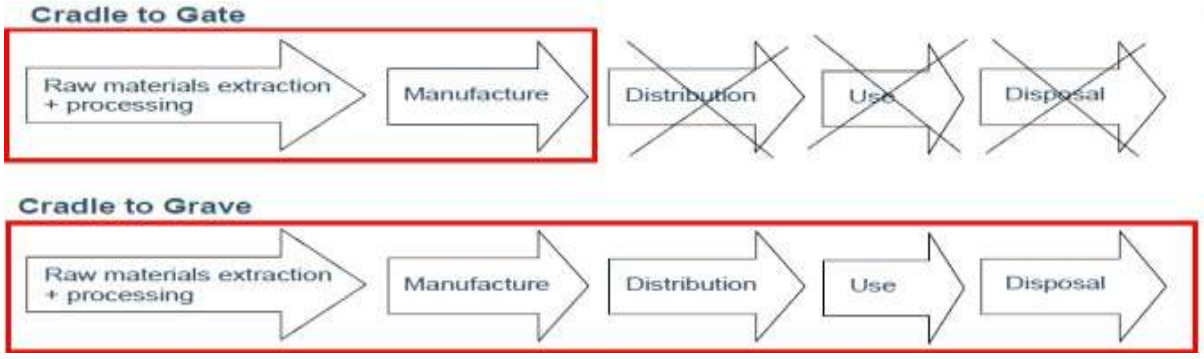
The basic steps required to calculate a carbon footprint for a product are as follows:

1. Analyze the materials and supply chain processes.
2. Build a supply chain map for the product.
3. Define the assessment boundaries (including the selection of greenhouse gases and the emissions sources which will be included).
4. Data collection
5. Calculation of emissions using appropriate emissions factors.

1. The **primary footprint** is a measure of our direct emissions of CO2 from the burning of fossil fuels including domestic energy consumption and transportation (e.g. car and plane). We have direct control of these.

2. The **secondary footprint** is a measure of the indirect CO2 emissions from the whole lifecycle of products we use - those associated with their manufacture and eventual breakdown. To put it very simply – the more we buy the more emissions will be caused on our behalf.

Product Carbon Footprints are commonly expressed either as 'cradle to gate' footprints, or 'cradle to grave' depending on the life-cycle stages included.



CARBON CREDIT INTRODUCTION

Carbon credits are a tradable permit scheme. It is a simple, non-compulsory way to counteract the

greenhouse gasses that contribute to climate change and global warming. Carbon credits create a market for reducing greenhouse emissions by giving a monetary value to the cost of polluting the air.

The Carbon Credit is this new currency and each carbon credit represents one tonne of carbon dioxide either removed from the atmosphere or saved from being emitted. Carbon credits are also called emission permit. Carbon credit is in the Environment and Pollution Control subject. Carbon credits are certificates awarded to countries that are successful in reducing emissions of greenhouse gases.

GENERATIONOFCARBONCREDITS

Carbon credits are generated as the result of an additional carbon project. Carbon credits can be created in many ways but there are two broad types:

1. Sequestration (capturing or retaining carbon dioxide from the atmosphere) such as afforestation and reforestation activities.
2. Carbon Dioxide Saving Projects such as use of renewable energies

These credits need to be authentic, scientifically based and Verification is essential. Carbon credit trading is an innovative method of controlling emissions using the free market.

NEEDFORCARBONCREDITS

Over millions of years, our planet has managed to regulate concentrations of greenhouse gases through sources (emitters) and sinks (reservoirs). Carbon (in the form of CO2 and methane) is emitted by volcanoes, by rotting vegetation, by burning of fossil fuels and other organic matter. But CO2 is absorbed, by trees, forests or by some natural phenomenon like photosynthesis and also oceas to some extent.

TYPES OF CARBON CREDIT

There are two main markets for carbon credits:
A) Compliance Market credits
B) Verified Market credits (VERs)

VALUE OF CARBON CREDITS

Carbon credits create a market for reducing greenhouse gases emissions by giving a monetary value to the cost of polluting the air such as carbon emitted by burning of fossil fuels. This means that carbon becomes a cost of business and is seen like other inputs such as raw materials or labor.

Carbon credits are measured in tonnes of carbon dioxide.
1 credit = 1 tonne of CO2.
Each carbon credit represents one metric ton of C02 either removed from the atmosphere or saved from being emitted. The carbon credit market creates a monetary value for carbon credits and allows the credits to be traded.
For each tonne of carbon dioxide that is saved or sequestered carbon credit producers may sell one carbon credit.

CARBON SEQUESTRATION or CARBON CAPTURE AND STROAGE or SCRUBBING OF CO_2

Carbon sequestration is the capture of carbon dioxide (CO_2) and may refer specifically to:

- "The process of removing carbon from the atmosphere and depositing it in a reservoir." When carried out deliberately, this may also be referred to as carbon dioxide removal, which is a form of geoengineering.
- The process of carbon capture and storage, where carbon dioxide is removed from flue gases, such as on power stations, before being stored in underground reservoirs.
- Natural biogeochemical cycling of carbon between the atmosphere and reservoirs, such as by chemical weathering of rocks.

Carbon sequestration describes long-term storage of carbon dioxide or other forms of carbon to either mitigate or defer global warming and avoid dangerous climate change. It has been proposed as a way to slow the atmospheric and marine accumulation of greenhouse gases, which are released by burning fossil fuels.

Carbon dioxide is naturally captured from the atmosphere through biological, chemical or physical processes. Some anthropogenic sequestration techniques exploit these natural processes, while some use entirely artificial processes.

Carbon dioxide may be captured as a pure by-product in processes related to petroleum refining or from flue gases from power generation.CO_2 sequestration includes the storage part of carbon capture and storage, which refers to large-scale, permanent artificial capture and sequestration of industrially produced CO_2 using subsurface saline aquifers, reservoirs, ocean water, aging oil fields, or other carbon sinks.

STEPS:

A) Capturing or Scrubbing
B) Transportation
C) Sequestration or Storage

A) CAPTURING or SCRUBBING OF CO_2:

TECHNOLOGIES:

Broadly, three different types of technologies for scrubbing of CO_2 exist:

1. post-combustion,
2. pre-combustion, and
3. oxyfuel combustion
4. Chemical looping

1. **Post-Combustion:** In post combustion capture, the CO_2 is removed after combustion of the fossil fuel — this is the scheme that would be applied to fossil-fuel burning power plants. Here, carbon dioxide is captured from flue gases at power stations or other large point sources. The technology is well understood and is currently used in other industrial applications, although not at the same scale as might be required in a commercial scale power station.

2. **Pre-Combustion:** The technology for pre-combustion is widely applied in fertilizer, chemical, gaseous fuel (H_2, CH_4), and power production. In these cases, the fossil fuel is partially oxidized, for instance in a gasifier. The resulting syngas (CO and H_2O) is shifted into CO_2 and more H_2. The resulting CO_2 can be captured from a relatively pure exhaust stream. The H_2 can now be used as fuel; the carbon dioxide is removed before combustion takes place. There are several advantages and disadvantages when compared to conventional post combustion carbon dioxide capture. The CO_2 is removed after combustion of fossil fuels, but before the flue gas is expanded to atmospheric pressure. This scheme is applied to new fossil fuel burning power plants, or to existing plants where re-powering is an option. The capture before expansion, i.e. from pressurized gas, is standard in almost all industrial CO_2 capture processes, at the same scale as will be required for utility power plants.

3. **Oxy-Fuel Combustion:** In oxy-fuel combustion the fuel is burned in oxygen instead of air. To limit the resulting flame temperatures to levels common during conventional combustion, cooled flue gas is re-circulated and injected into the combustion chamber. The flue gas consists of mainly carbon dioxide and water vapor, the latter of which is condensed through cooling. The result is an almost pure carbon dioxide stream that can be transported to the sequestration site and stored. Power plant processes based on oxy fuel combustion are sometimes referred to as "zero emission" cycles, because the CO_2 stored is not a fraction removed from the flue gas stream (as in the cases of pre- and post-combustion capture) but the flue gas stream itself. A certain fraction of the CO_2 generated during combustion will inevitably end up in the condensed water. To warrant the label "zero emission" the water would thus have to be treated or disposed of appropriately. The technique is promising, but the initial air separation step demands a lot of energy.

4. **Chemical looping combustion (ClC):** Chemical looping uses a metal oxide as a solid oxygen carrier. Metal oxide particles react with a solid, liquid or gaseous fuel in a fluidized bed combustor, producing solid metal particles and a mixture of carbon dioxide and water vapor. The water vapor is condensed, leaving pure carbon dioxide which can then be sequestered. The solid metal particles are circulated to another fluidized bed where they react with air, producing heat and regenerating metal oxide particles that are re circulated to the fluidized bed combustor.

5. **Calcium looping:** A variant of chemical looping is calcium looping, which uses the alternating carbonation and then calcinations of a calcium oxide based carrier as a means of capturing CO_2.

B) TRANSPORT:

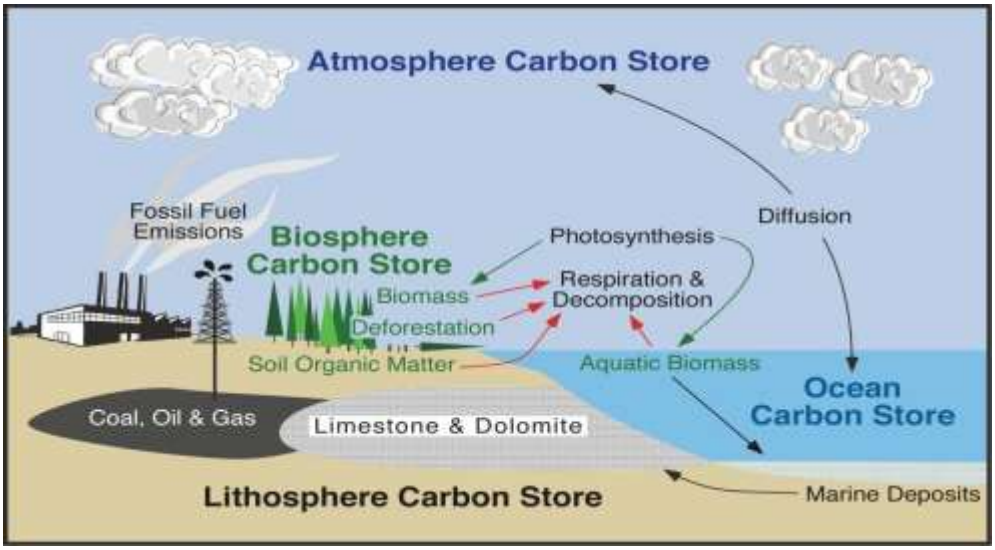
After capture, the CO_2 would have to be transported to suitable storage sites. This is done by pipeline, which is generally the cheapest form of transport. In 2008, there were approximately 5,800 km of CO_2 pipelines in the United States, used to transport CO_2 to oil production fields where it is then injected into older fields to extract oil. The injection of CO_2 to produce oil is generally called Enhanced Oil Recovery or EOR.

In addition, there are several pilot programs in various stages to test the long-term storage of CO_2 in non-oil producing geologic formations.

A COA conveyor belt system or ship could also be utilized for transport. These methods are currently used for transporting CO_2 for other applications.

C) SEQUESTRATION or STORAGE:

Various forms have been conceived for permanent storage of CO_2. These forms include gaseous storage in various deep geological formations (including saline formations and exhausted gas fields), liquid storage in the ocean, and solid storage by reaction of CO_2 with metal oxides to produce stable carbonates.



i) GEOLOGICAL STORAGE: Also known as geo-sequestration, this method involves injecting carbon dioxide, generally in supercritical form, directly into underground geological formations. Oil fields, gas fields, saline formations, unmineable coal seams, and saline-filled basalt formations have been suggested as storage sites. Various physical (e.g., highly impermeable cap rock) and geochemical trapping mechanisms would prevent the CO_2 from escaping to the surface.

Enhanced oil recovery: CO_2 is sometimes injected into declining oil fields to increase oil recovery. This option is attractive because the geology of hydrocarbon reservoirs is generally well understood and storage costs may be partly offset by the sale of additional oil that is recovered. Disadvantages of old oil fields are their geographic distribution and their limited capacity, as well as the fact that subsequent burning of the additional oil so recovered will offset much or all of the reduction in CO_2 emissions.

Unmineable coal seams can be used to store CO_2 because the CO_2 molecules attach to the surface of coal. The technical feasibility, however, depends on the permeability of the coal bed. In the process of absorption the coal releases previously absorbed methane, and the methane can be

recovered (enhanced coal bed methane recovery). The sale of the methane can be used to offset a portion of the cost of the CO_2 storage. Burning the resultant methane, however, would produce CO_2, which would negate some of the benefit of sequestering the original CO_2.

II) OCEAN STORAGE:

Another proposed form of carbon storage is in the oceans. Several concepts have been proposed:

- 'Dissolution' injects CO_2 by ship or pipeline into the ocean water column at depths of 1000 – 3000 m, forming an upward-plume, and the CO_2 subsequently dissolves in seawater.
- Through 'lake' deposits, by injecting CO_2 directly into the sea at depths greater than 3000 m, where high-pressure liquefies CO_2, making it denser than water, and forms a downward-plume that may accumulate on the sea floor as a 'lake', and is expected to delay dissolution of CO_2 into the ocean and atmosphere, possibly for millennia.
- Use a chemical reaction to combine CO_2 with a carbonate mineral (such as limestone) to form bicarbonate(s), for example: $CO_2 + CaCO_3 + H_2O \rightarrow Ca(HCO_3)_2(aq)$. However, the aqueous bicarbonate solution must not be allowed to dry out, or else the reaction will reverse.
- Store the CO_2 in solid clathrate hydrates already existing on the ocean floor,[23][24] or growing more solid clathrate.

The environmental effects of oceanic storage are generally negative, and poorly understood. Large concentrations of CO_2 could kill ocean organisms, but another problem is that dissolved CO_2 would eventually equilibrate with the atmosphere, so the storage would not be permanent.In addition, as part of the CO_2 reacts with the water to form carbonic acid, H_2CO_3, the acidity of the ocean water increases.

The bicarbonate approach would reduce the pH effects and enhance the retention of CO_2 in the ocean, but this would also increase the costs and other environmental effects.

GREEN BUILDING or GREEN CONSTRUCTION OR SUSTAINABLE BUILDING

"A green building is one which uses less water, optimizes energy efficiency, conserves natural resources, generates less waste and provides healthier spaces for occupants, as compared to a conventional building."

Green construction or **sustainable building** refers to a structure and using process that is environmentally responsible and resource-efficient throughout a building's life-cycle: from siting to design, construction, operation, maintenance, renovation, and demolition.

Objectives:

Efficiently using energy, water, and other resources
Protecting occupant health and improving employee productivity
Reducing waste, pollution and environmental degradation

Buildings can be rated for their environmentally sustainable construction. One such rating system is the LEED (Leadership in Energy and Environmental Design).
This building rating system was developed by the U.S. Green Building Council (GBC)
The other rating systems are BREEAM (Building Research Establishment's Environmental Assessment method -United Kingdom) and CASBEE (Comprehensive Assessment System for Building Environmental Efficiency-Japan) help consumers determine a structure's level of environmental performance.

EXTRA ADDITIONAL TOPICS AND NOTES

SOIL POLLUTION

Definition:
Soil pollution is defined as the build-up in soils of persistent toxic compounds, chemicals, salts, Radioactive materials, or disease causing agents, which have adverse effects on plant growth and animal health. Soil is the thin layer of organic and inorganic materials that covers the Earth's rocky surface. The organic portion, which is derived from the decayed remains of plants and animals, is concentrated in the dark uppermost topsoil. The inorganic portion made up of rock fragments, was formed over thousands of years by physical and chemical weathering of bedrock. Productive soils are necessary for agriculture to supply the world with sufficient food.

There are many different ways that soil can become polluted, such as:

- Seepage from a landfill
- Discharge of industrial waste into the soil
- Percolation of contaminated water into the soil
- Rupture of underground storage tanks
- Excess application of pesticides, herbicides or fertilizer
- Solid waste seepage

The most common chemicals involved in causing soil pollution are:

- Petroleum hydrocarbons
- Heavy metals
- Pesticides
- Solvents

Types of Soil Pollution

- Agricultural Soil Pollution and pollution due to urban activities
  - i) Pollution of surface soil
  - ii) Pollution of underground soil
- Soil pollution by industrial effluents and solid wastes
  - i) Pollution of surface soil
  - ii) Disturbances in soil profile

CAUSES OF SOIL POLLUTION:
Soil pollution is caused by the presence of man-made chemicals or other alteration in the natural soil environment. This type of contamination typically arises from the rupture of underground storage links, application of pesticides, and percolation of contaminated surface water to subsurface strata, oil and fuel dumping, leaching of wastes from landfills or direct discharge of industrial wastes to the soil. The most common chemicals involved are petroleum hydrocarbons,

solvents, pesticides, lead and other heavy metals. This occurrence of this phenomenon is correlated with the degree of industrialization and intensities of chemical usage.
A soil pollutant is any factor which deteriorates the quality, texture and mineral content of the Soil or which disturbs the biological balance of the organisms in the soil. Pollution in soil has adverse effect on plant growth.

Pollution in soil is associated with

- Indiscriminate use of fertilizers
- Indiscriminate use of pesticides, insecticides and herbicides
- Dumping of large quantities of solid waste
- Deforestation and soil erosion

1. Indiscriminate use of fertilizers:

Soil nutrients are important for plant growth and development. Plants obtain carbon, hydrogen and oxygen from air and water. But other necessary nutrients like nitrogen, phosphorus, potassium, calcium, magnesium, sulfur and more must be obtained from the soil. Farmers generally use fertilizers to correct soil deficiencies. Fertilizers contaminate the soil with impurities, which come from the raw materials used for their manufacture. Mixed fertilizers often contain ammonium nitrate (NH_4NO_3), phosphorus as P_2O_5, and potassium as K_2O. For instance, arsenic, lead and cadmium present in traces in rock phosphate mineral get transferred to super phosphate fertilizer. Since the metals are not degradable, their accumulation in the soil above their toxic levels due to excessive use of phosphate fertilizers becomes an indestructible poison for crops.
The over use of NPK fertilizers reduce quantity of vegetables and crops grown on soil over the years. It also reduces the protein content of wheat, maize, grams, etc., grown on that soil. The carbohydrate quality of such crops also gets degraded. Excess potassium content in soil decreases Vitamin C and carotene content in vegetables and fruits. The vegetables and fruits grown on over fertilized soil are more prone to attacks by insects and disease.

2. Indiscriminate use of pesticides, insecticides and herbicides:

The first widespread insecticide use began at the end of World War II and included DDT **(dichlorodiphenyltrichloroethane) and gammaxene**. Insects soon became resistant to DDT and as the chemical did not decompose readily, it persisted in the environment. Since it was soluble in fat rather than water, it biomagnified up the food chain and disrupted calcium metabolism in birds, causing egg shells to be thin and fragile. As a result, large birds of prey such as the brown pelican, ospreys, falcons and eagles became endangered. DDT has been now being banned in most western countries. Ironically many of them including USA still produce DDT for export to other developing nations whose needs outweigh the problems caused by it.
The most important pesticides are DDT, BHC, chlorinated hydrocarbons, organophosphates,
Aldrin, malathion, dieldrin, furodan, etc. The remnants of such pesticides used on pests may get adsorbed by the soil particles, which then contaminate root crops grown in that soil. The consumption of such crops causes the pesticides remnants to enter human biological systems, affecting them adversely.
An infamous herbicide used as a defoliant in the Vietnam War called Agent Orange (dioxin), exposure to Agent Orange.
Pesticides not only bring toxic effect on human and animals but also decrease the fertility of the soil. Some of the pesticides are quite stable and their bio- degradation may take weeks and even months.
Pesticide problems such as resistance, resurgence, and health effects have caused scientists to seek alternatives. Pheromones and hormones to attract or repel insects and using natural enemies

or sterilization by radiation have been suggested

3. Dumping of large quantities of solid waste:

In general, solid waste includes garbage, domestic refuse and discarded solid materials such as Those from commercial, industrial and agricultural operations. They contain increasing amounts of paper, cardboards, plastics, glass, old construction material, packaging material and toxic or otherwise hazardous substances. Since a significant amount of urban solid waste tends to be paper and food waste, the majority is recyclable or biodegradable in landfills. Similarly, most agricultural waste is recycled and mining waste is left on site.

The portion of solid waste that is hazardous such as oils, battery metals, heavy metals from smelting industries and organic solvents are the ones we have to pay particular attention to. These can in the long run, get deposited to the soils of the surrounding area and pollute them by altering their chemical and biological properties. They also contaminate drinking water aquifer sources. More than 90% of hazardous waste is produced by chemical, petroleum and metal- related industries and small businesses such as dry cleaners and gas stations contribute as well.

4. Deforestation and soil erosion:

Soil Erosion occurs when the weathered soil particles are dislodged and carried away by wind or water. Deforestation, agricultural development, temperature extremes, precipitation including acid rain, and human activities contribute to this erosion. Humans speed up this process by construction, mining, cutting of timber, over cropping and overgrazing. It results in floods and cause soil erosion.

EFFECTS OF SOIL POLLUTION

1. Agricultural
   - Reduced soil fertility
   - Reduced nitrogen fixation
   - Increased erosion
   - Larger loss of soil and nutrients
   - Deposition of silt in tanks and reservoirs
   - Reduced crop yield
   - Imbalance in soil fauna and flora
2. **Industrial**
   - Dangerous chemicals entering underground water
   - Ecological imbalance
   - Release of pollutant gases
   - Release of radioactive rays causing health problems
   - Increased salinity
   - Reduced vegetation
3. **Urban**

   Clogging of drains
   - Inundation of areas
   - Public health problems
   - Pollution of drinking water sources
   - Foul smell and release of gases
   - Waste management problems

CONTROL MEASURES OF SOIL POLLUTION

The following steps have been suggested to control soil pollution. To help prevent soil erosion, we can limit construction in sensitive area. In general, we would need less fertilizer and

fewer pesticides if we could all adopt the three R's: Reduce, Reuse, and Recycle. This would give us less solid waste.

1. Reducing chemical fertilizer and pesticide use Applying bio-fertilizers and manures can reduce chemical fertilizer and pesticide use. Biological methods of pest control can also reduce the use of pesticides and thereby minimize soil pollution.

2. Reusing of materials

Materials such as glass containers, plastic bags, paper, cloth etc. can be reused at domestic levels rather than being disposed, reducing solid waste pollution.

3. Recycling and recovery of materials

This is a reasonable solution for reducing soil pollution. Materials such as paper, some kinds of plastics and glass can and are being recycled. This decreases the volume of refuse and helps in the conservation of natural resources. For example, recovery of one tonne of paper can save 17 trees.

4. Reforesting

Control of land loss and soil erosion can be attempted through restoring forest and grass cover to check wastelands, soil erosion and floods. Crop rotation or mixed cropping can improve the fertility of the land.

5. Solid waste treatment

Proper methods should be adopted for management of solid waste disposal. Industrial wastes can be treated physically, chemically and biologically until they are less hazardous. Acidic and alkaline wastes should be first neutralized; the insoluble material if biodegradable should be allowed to degrade under controlled conditions before being disposed.

MARINE POLLUTION

Pollution of oceans is damaging the marine environment and is becoming a major problem. Marine environment is interesting for various reasons such as Sea food; Navigation; Adventure; Tourism etc, Marine Pollution is harmful and its danger can be identified in a variety of ways.

Sources & causes of marine pollution:

Marine pollution originates from one of two sources --- the land or the sea which are explained below:

Marine Oil Pollution: Oil is basically an important pollutant which destroys marine environment.

The various sources of oil pollution are:

Run-off oil from streets; disposal of lubricants from machines; Off shore oil and gas exploitation from off-shore drilling; blowouts at off-shore drilling rigs; oil escaping under high pressure from a bore hole in the ocean floor. **Waste chemicals, mud and accumulation of toxic substances in the ocean in the form of mercury, dioxin, PCBs, PAHs (Poly Aromatic Hydrocarbons) Radioactivity. benzene; xylene (colorless, flammable liquids) and heavy metals such as lead; copper; nickel, mercury also cause for marine pollution during the off shore drilling activities. Both dumping and exploitation of ocean resources cause ocean pollution also.**

PAHs: It is a chemical compound and organic pollutant. These occur in oil, coal and tar deposits and are produced as byproducts of fuel burning.

PAHs are lipophilic meaning they mix more easily in oil than water.

Eg for PAHs are: Acenaphthene; Anthracene; Benzopyrene; Chrysene; Coronene; Fluorene; Pyrene.

Other sources from land: The major sources of marine pollution originating from the land vary from country to country. Effluents are discharged either directly into the sea or enters the coastal waters through rivers. Thousands of barrels of oil burn when oil wells were set on fire. Tanker accidents on land carry oil to the nearby streams / canals and cause for marine Pollution. Due to burning of oil, smoke, SO2, NO2, CO is added towards atmospheric contamination.

The effects of oil pollution depend mainly on the following factors:
Type of oil and its viscosity, amount / quantity released, distance covered, time, average water temp etc..

Effects of Marine Pollution:

S No	Source	Effect
1	Sewage & run- off from forestry;	Depletes oxygen in water causes killing of fishes.
2	Sediments from mining	Sediments clog in the gills of fishes
3	Sewage from municipalities, towns; cities etc…	Contaminate sea food
4	Industrial discharge; pesticides from farms	Cause disease in coastal marine life
5	Oil from off shore drilling; industries/ automobiles	Low level contamination kill larvae whereas high level contamination causes death for sea fishes
6	Litter (rubbish), waste, plastics	Marine life disturbs
7	Hot water from power plants	Kills corals.

Marine Pollution Abatement / Prevention & control measures of Marine pollution:

The following are the some of the control measures for marine pollution:

1. Improving existing sewage disposal facilities
2. Ensuring individual houses have sewage disposal systems (such as septic tanks).
3. Large resorts should use and manage their own packaged treatment plants.
4. Marine planning and management should be considered as processes such as land – sea interaction; inter disciplinary co-operation; participation of public & private sector organizations; balance between protection and development public participation
5. Oil tankers are double hulled (two layered bottom) to reduce the chance of oil leakage
6. Recycling facilities for used oil.

NOISE POLLUTION

Everyone knows that sound is a form of energy that is capable of causing disturbances in human beings. Ears are the hearing organs in human beings.
A thin membrane is called Tympanum (or) ear drum receives the vibrations produced by sound to a limited extent. Human ear is capable of perceiving about 85 decibels of sound. Beyond the limit, the ear drum cannot bear sound.
In nature, we hear different types of sounds. Sound is a kind of vibration which travel through air, water, and are sensed by the ear. This is from music, speech, etc from radio / television / computers etc., one thing in this matter is that we can increase the volume of sound or decrease as per our taste whereas, a noise is a sound which cannot be heard clearly and only mixed sounds will be heard.

For eg: in an office one is talking on mobile, phone ringing another side, ring tones in some person's hands, loud conversations with one and another etc., this is called noise. One cannot increase or decrease the volume of noise. In general, a sound is a vibration from a particular machine, place or material which can be heard clearly whereas a noise a mixed vibrations that will come to us from all directions. A sound can be clear and can be able to hear, whereas a noise will not be clear and cannot be heard.

SOURCES OF NOISE:

Noise is an unwanted sound and noise pollution occurs through different sources:

1. Vehicles produce noise that leads to noise pollution.
2. Automobile industry is another source of noise pollution.
3. Noise pollution is very common in industrial areas where machines are working for factories making more noise.

The sources of noise are more in urban and industrial areas, than in rural areas. The sources of noise may be stationary or mobile. The stationary sources include industries, loud speakers, mining operations, use of machineries, TV, Radio and Grinders etc. The mobile sources include Road Traffic, Highway Noise, Railway Traffic and Air Traffic.

Stationary sources:

a) Industrial noise: The main categories of industrial activity that are particularly relevant to the study of noise are the following:

Product fabrication, Product assembly, Power generation by means of generators, Combusting process in furnaces (burning of gases)

b) Noise from construction works: Construction noise, a major source of noise pollution is emitted by construction equipment. The sources of noise are dozers excavators, front end loaders, soil compactors, cranes, air compressors, concrete vibrators, riveting steel structure during the casting, dismantling of construction materials etc...

c) Noise from other sources: These include sources such as sirens, barking dogs, ambulances, Police vehicles, Fire engines etc.

(2) Mobile sources:

Road traffic: Of all sources of noise pollution, road traffic is the most prevalent and perhaps the most source of noise pollution. More people are exposed to noise from motor vehicles and the noise depends on various factors such as Road location, Road design, Vehicle standards, Driver behaviors, Horns, Traffic density. ,

Noise of common road vehicles

Vehicle type	**Noise (db)**
Medium road traffic (Main roads)	70- 80
Heavy road traffic (High ways)	80- 90
Buses & Trucks upto 3.5 tons	85- 95
Trucks upto 3.5-12 tons	90-100
Motor cycles	90-105

It can be observed that motor cycles with their exposed engines and inadequate silencing arrangements are notorious noise producers, which produce more than 30 times sound than a small passenger car.

a) Railway traffic: Noise from railway traffic is not serious nuisance as compared to the road

traffic noise. The level of noise associated with rail traffic is related to the type of engine, the speed of the train, track type and condition. The majority of noise emitted by trains is produced by the engine (or) by the interaction of wheels with the tracks, horns, warning signals at crossings etc..,

b) Air traffic: The noise of air craft is different from that of road traffic in the sense it is intermittent. Noise is maximum during takeoff and landing. Noise made by jet planes is more disturbance than that of propeller driven air craft. Supersonic air craft produce noise at high levels due to its intensity.

EFFECTS OF NOISE:

At 120 decibels the ear registers pain but hearing damage begins about 85 decibels. Apart from hearing loss, noise can cause lack of sleep, irritation, indigestion, ulcers, High B.P., Heart diseases , Stress etc.,.

1. **Annoyance (Feeling slightly angry):** One of the most important effects of noise on human is annoyance. Due to this breathing rate affects.
2. **Noise- induced hearing loss:** Exposure to noise for a long enough duration results in damage to the inner ear and thus decreases one's ability to hear. The louder the noise the less time it takes to cause hearing loss.
3. **Effects on sleep:** Noise disturbs sleep. It has been found that the cases related to various levels of noise are associated with sleep disturbances. Sleep disturbance by noise depends on the characteristics of the noise such as frequency, loudness and whether the noise is continuous or intermittent.

Other effects: There are many other effects of noises such involve aggression (ready to attack). People may turn mad and nerves may not function normally, People may be deformed in many ways including increased stress and strain, nonfunctioning of hands, legs etc due to noise pollution if exposed continuously.

CONTROL MEASURES:

Noise pollution could be controlled by either reducing the noise at the source or by preventing its transmission.

The first step in the prevention of noise pollution is to control the noise at source itself.

For eg: Lubrication of machines reduces the noise produced, Tightening the loose nuts, Reducing the vibrations produced by machines etc…

Failing to control the noise at its source, the second step is to prevent its transmission for eg: keeping the noise machine covered in an enclosure so that the sound does not escape and reach the receivers, construction of noise barriers on road sides, sound proof the buildings by using heavy curtains on the windows, acoustical tiles on the ceiling and walls, by sealing the cracks in the walls to reduce the noise coming from outside.

If the noise levels are not able to bring down to the desired levels in some cases, the only alternative is to follow:

- Avoiding horns except in emergency situations.
- Sound proof or eco-generators and Turning down the volume of stereos.
- Conducting the awareness programs

THERMAL POLLUTION

Thermal pollution is also known as heat pollution and occurs when heat is released into water or air that produces undesirable effects. Sudden heat release usually due to forest fire or volcanoes or human induced activities. Thermal pollution is also the addition of excess undesirable heat to water that makes it harmful to human, animal or aquatic life.

Sources of Thermal Pollution:

Various sources of thermal pollution include

Thermal Power Plants ; Nuclear Power Plants ; Petroleum Refineries; Steel Plants; Metallurgical industries; Paper Mills; Chemical Plants. Coal fired power plants constitute major sources of thermal pollution. Nuclear plants discharge much heat and also traces of toxic radioactive substances. Many industries use water for cooling purpose and thus the heat effluents are finally discharged into water.

Temperature and its effects: Temperature plays an important role in determining the conditions in which living things can survive.

Birds and mammals require a narrow range of body temp for survival whereas aquatic species can exist at a certain range of temperatures.

Thermal pollution increases water temperature causing a change (lowering) of dissolved oxygen levels. This disrupts and causes decay of plant and animal species.

For eg: The warmer water increases the metabolic rate of fish and other animals in the sea; this decreases the life expectancy of aquatic animals.

Management of Thermal Pollution:

Thermal Pollution is controlled by the following methods:

1. Cooling Towers are designed to control the temperature of water which transfers some of the heat from the water to the surrounding atmosphere by evaporation. There are two types of cooling towers namely wet cooling towers and dry cooling towers.
2. Cooling ponds are employed for thermal discharges. Heated effluents on the surface of water in cooling ponds maximize dissipation of heat to the atmosphere.
3. Artificial lakes are manmade bodies of water which offer possible alternative. The heating effluents are discharged into lake at one end and the water for cooling purpose may be withdrawn from the other end

3.1.7 NUCLEAR HAZARDS

Radioactivity is the phenomenon of emission of energy from radioactive isotopes (i.e., unstable isotopes), such as Carbon-14, Uranium-235, Uranium-238, Uranium-239, Radium-226, etc. The emission of energy from radioactive substances in the environment is often called as 'Radioactive Pollution'.

Sources/causes of nuclear hazards

The sources of radioactivity are both natural and man-made. The natural sources include:

a) **Natural sources:**

1) Emissions from radioactive materials from the Earth's crust.

People have been exposed to low levels of radiation from these natural sources for several millennia. But it is the man-made sources which are posing a threat to mankind.

b) **Man-Made Sources:** The man-made sources of radioactivity are nuclear wastes (i.e., waste material that contains radioactive nuclei) produced during the:

1) Mining and processing of radioactive ores;
2) Use of radioactive material in nuclear power plants;
3) Use of radioactive isotopes in medical, industrial and research applications; and
4) Use of radioactive materials in nuclear weapons.
The greatest exposure to human beings comes from the diagnostic use of X-rays, radioactive isotopes used as tracers and treatment of cancer and other ailments.

Effects of nuclear hazards:
The effects of radioactive pollutants depend upon half-life, energy releasing capacity, rate of diffusion and rate of deposition of the contaminant. Various atmospheric conditions and climatic conditions such as wind, temperature and rainfall also determine their effects.
The effects may be somatic (individual exposed is affected) or genetic (future generations) damage. The effects are cancer, shortening of life span and genetic effects or mutations.

Some of the possible effects are listed as under:

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

2) Exposure at low doses of radiations (100-250 rads), men do not die but begin to suffer from fatigue, nausea, vomiting and loss of hair. But recovery is possible.

3) Exposure at higher doses (400-500 rads), the bone marrow is affected, blood cells are reduced, natural resistance and fighting capacity against germs is reduced, blood fails to clot, and the irradiated person soon dies of infection and bleeding.

4) Higher irradiation doses (10,000 rads) kill the organisms by damaging the tissues of heart, brain, etc.

5) Workers handling radioactive wastes get slow but continuous irradiation and in course of time develop cancer of different types.6) Through food chain also, radioactivity effects are experienced by man.

But the most significant effect of radioactivity is that it causes long range effects, affecting the future of man and hence the future of our civilization.

Control measures:

On one hand, the peaceful uses of radioactive materials are so wide and effective that modern civilization cannot go without them; on the other hand, there is no cure for radiation damage. Thus the only option against nuclear hazards is to check and prevent radioactive pollution. For this:

1) Leakages from nuclear reactors, careless handling, transport and use of radioactive fuels, fission products and radioactive isotopes have to be totally stopped;
2) Safety measures should be enforced strictly;
3) Waste disposal must be careful, efficient and effective;
4) There should be regular monitoring and quantitative analysis through frequent sampling in the risk areas;
5) Preventive measures should be followed so that background radiation levels do not exceed the permissible limits;
6) Appropriate steps should be taken against occupational exposure; and
7) Safety measures should be strengthened against nuclear accidents.