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**Module 4: Environmental Pollution** Definition, Cause, effects and control measures of Air pollution, Water pollution, • Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards; Solid waste Management: Causes, effects and control measures of urban and industrial wastes; Role of an individual in prevention of pollution; Pollution case studies; Disaster management: floods, earthquake, cyclone and landslides.

## **Pollution**

Pollution is the introduction of contaminants into the natural environment that causes adverse change. Pollution can take the form of chemical substances or energy, such as noise, heat or light.

### **Air pollution**

Air pollution included harmful gases, dust particles, smoke fumes well as biological molecules present in the earth atmosphere which creates harmful effect on human health as well as environment comes in the categories of Air pollutions. Normally pollution can be natural origin or man mad.

Smoke from industries and automobiles, domestic and commercial sewage, radioactive substances from nuclear plants and discarded household articles (tins, bottles, broken crockery etc.) come under the category of pollutants.

### **Classification of pollutants**

Depending on the existence of the nature we can broadly classify pollutant in two categories.

**1. Quantitative pollutant:** The quantitative pollutant is those pollutant whose concentration level is high due to manmade uncontrolled activity comes in this category. For example, carbon dioxide, if present in the atmosphere in concentration greater than normal due to automobiles and industries, causes measurable effects on humans, animals, plants or property, then it is classified as a quantitative pollutant

**2. Qualitative pollutant:** These are those substances which do not normally occur in nature but are added by man, for example, insecticides. Depending upon the form in which they persist after being released into the environment, the pollutants are categorized into two types, namely primary and secondary pollutants.

#### **Primary Pollutants:**

(a) These are those which are emitted directly from the source and persist in the form in which they were added to the environment. Typical examples of pollutants included under this category are ash, smoke, fumes, dust, nitric oxide, sulphur dioxide, hydrocarbons etc.

(b) **Secondary Pollutants:** These are those which are formed from the primary pollutants by chemical interaction with some constituent present in the atmosphere. Examples are: Sulphur trioxide, nitrogen dioxide, aldehydes, ketones, ozone etc.

Nitrogen oxides and hydrocarbons are two primary pollutants released from automobiles but in the presence of sunlight, they react to form peroxyacyl nitrate (PAN) and ozone, two secondary pollutants which are far more toxic than the primary pollutants from which they are derived.

This phenomenon of increased toxicity by chemical interaction among the pollutants is known as Synergism.

**Secondary air pollution:** Secondary air pollutant generally produced when in the air when two or more primary air pollutant interacts with each other with normal atmospheric constituent.

Example of some secondary air pollutant is ozone, formaldehyde, PAN (proxy acetyl nitrate), Smog, acid and mist etc.

| S.No. | Primary Pollutants                | Secondary Pollutants       |
|-------|-----------------------------------|----------------------------|
| 1.    | Carbon monoxide (CO)              | Ozone (O <sub>3</sub> )    |
| 2.    | Nitrogen Oxide (NO <sub>x</sub> ) | Peroxyacetyl nitrate (PAN) |
| 3.    | Sulphur Oxide (SO <sub>x</sub> )  | Aldehydes                  |
| 4.    | Hydrocarbon (HC)                  | Ketones                    |
| 5.    | Particulates                      | Sulphur trioxide           |

### Harmful effects

CO can cause oxygen deprivation (hypoxia), displacing oxygen in bonding with haemoglobin, causing cardiovascular and coronary problems, increasing risk of stroke, and impairing learning ability, dexterity and sleep. CO is mostly hazardous in relatively confined areas such as tunnels under bridges and overpasses, and in dense urban settings. In unconfined areas or away from population centres, it will stabilize into CO<sub>2</sub> before damage to human health is likely.

It circulates directly into blood through lungs. Carbon monoxide binds to haemoglobin (Hb) in red blood cells, reducing their ability to transport and release oxygen throughout the body because of Carboxyl haemoglobin (CO Hb). The affinity of Carboxylhaemoglobin is 210 times greater to that of oxygen. Low exposures can aggravate cardiac ailments, while high exposures cause central nervous system impairment or death. It also plays a role in the generation of ground-level ozone.

### Causes of Air pollution

1. **Burning of Fossil Fuels:** Sulfur dioxide emitted from the combustion of fossil fuels like coal, petroleum and other factory combustibles is one of the major cause of air pollution. Pollution emitting from vehicles including trucks, jeeps, cars, trains, airplanes cause immense amount of pollution. We rely on them to fulfill our daily basic needs of transportation. But, there overuse is killing our environment as dangerous gases are polluting the environment. Carbon Monoxide caused by improper or incomplete combustion and generally emitted from vehicles is another major pollutant along with Nitrogen Oxides, that is produced from both natural and man made processes.
2. **Agricultural activities:** Ammonia is a very common by product from agriculture related activities and is one of the most hazardous gases in the atmosphere. Use of insecticides, pesticides and fertilizers in agricultural activities has grown quite a lot. They emit harmful chemicals into the air and can also cause water pollution.
3. **Exhaust from factories and industries:** Manufacturing industries release large amount of carbon monoxide, hydrocarbons, organic compounds, and chemicals into the air thereby depleting the quality of air. Manufacturing industries can be found at every corner of the

earth and there is no area that has not been affected by it. Petroleum refineries also release hydrocarbons and various other chemicals that pollute the air and also cause land pollution.

**4. Mining operations:** Mining is a process wherein minerals below the earth are extracted using large equipments. During the process dust and chemicals are released in the air causing massive air pollution. This is one of the reason which is responsible for the deteriorating health conditions of workers and nearby residents.

**5. Indoor air pollution:** Household cleaning products, painting supplies emit toxic chemicals in the air and cause air pollution. Have you ever noticed that once you paint walls of your house, it creates some sort of smell which makes it literally impossible for you to breathe.

Suspended particulate matter popular by its acronym SPM, is another cause of pollution. Referring to the particles afloat in the air, SPM is usually caused by dust, combustion etc.

#### **Effects of Air pollution**

**1. Respiratory and heart problems:** The effects of Air pollution are alarming. They are known to create several respiratory and heart conditions along with Cancer, among other threats to the body. Several millions are known to have died due to direct or indirect effects of Air pollution. Children in areas exposed to air pollutants are said to commonly suffer from pneumonia and asthma.

**2. Global warming:** Another direct effect is the immediate alterations that the world is witnessing due to Global warming. With increased temperatures world wide, increase in sea levels and melting of ice from colder regions and icebergs, displacement and loss of habitat have already signaled an impending disaster if actions for preservation and normalization aren't undertaken soon.

**3. Acid Rain:** Harmful gases like nitrogen oxides and sulfur oxides are released into the atmosphere during the burning of fossil fuels. When it rains, the water droplets combines with these air pollutants, becomes acidic and then falls on the ground in the form of acid rain. Acid rain can cause great damage to human, animals and crops.

**4. Eutrophication:** Eutrophication is a condition where high amount of nitrogen present in some pollutants gets developed on sea's surface and turns itself into algae and adversely affect fish, plants and animal species. The green colored algae that is present on lakes and ponds is due to presence of this chemical only.

**5. Effect on Wildlife:** Just like humans, animals also face some devastating affects of air pollution. Toxic chemicals present in the air can force wildlife species to move to new place and change their habitat. The toxic pollutants deposit over the surface of the water and can also affect sea animals.

#### **CONTROL MEASURES**

The atmosphere has several built-in self cleaning processes such as dispersion, gravitational settling, flocculation, absorption, rain-washout, etc to cleanse the atmosphere. However, control of contaminants at their source level is a desirable and effective method through preventive or control technologies.

**Source control:** Some measures that can be adopted in this direction are:

- 1. Using unleaded petrol**

2. Using fuels with low sulphur and ash content
3. Encouraging people to use public transport, walk or use a cycle as opposed to private vehicles
4. Ensure that houses, schools, restaurants and playgrounds are not located on busy streets
5. Plant trees along busy streets as they remove particulates, carbon dioxide and absorb noise
6. Industries and waste disposal sites should be situated outside the city preferably on the downwind of the city.
7. Catalytic converters should be used to help control emissions of carbon monoxide and hydrocarbons

### Control measures in industrial centers

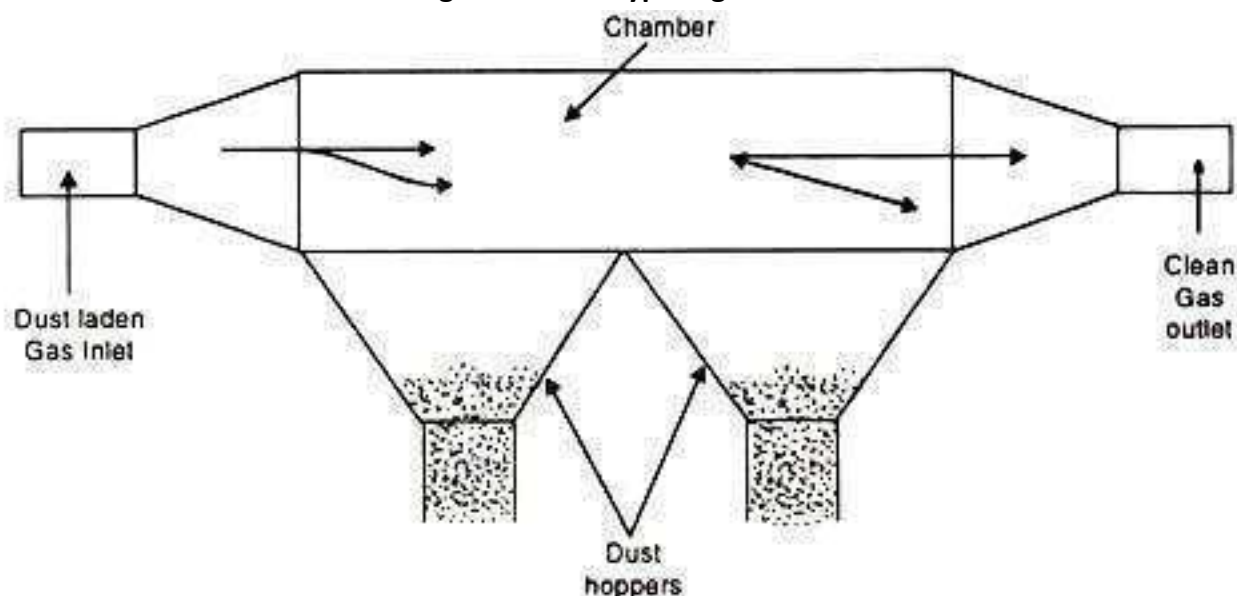
1. Emission rates should be restricted to permissible levels by each and every industry
2. Incorporation of air pollution control equipment in design of plant layout must be made mandatory
3. Continuous monitoring of the atmosphere for pollutants should be carried out to know the emission levels.

### EQUIPMENT USED TO CONTROL AIR POLLUTION

The following equipment is used to control air pollution:

#### 1. Control of SPM by gravitation

Gravitational Settling Chamber A typical gravitational chamber is shown below.



**Fig. 6.4. Horizontal Flow Settling Chamber.**

The dust laden gas enters at the inlet and due to the sudden increase in cross-section the

particulate matter settles at the bottom and can be removed from the dust hoppers as shown  
The clean gas free from particulate matter exits from the outlet

#### **IMPORTANT FACTS:-**

1. Simple to construct and maintain
2. Efficient to remove particles of diameter greater than 50  $\mu$ m from gas streams
3. They are used as pre-cleaners before passing gases through high efficiency collection devices
4. They rely on gravitational settling and are the simplest and oldest mechanical collectors for removal of particulates from gas streams Flow within the chamber must be uniform without macroscopic mixing
5. Dust removal system must be sealed to prevent production of turbulence due to air from leaking into chamber
6. Efficiency of the equipment increases with increased residence time of the waste gas. Hence, the equipment is operated at lowest possible gas velocity
7. The size of the unit depends on: gas velocity which should preferably be less than 0.3 m/s

#### **1. ADVANTAGES**

1. Low capital and energy cost
2. Low maintenance and operating costs
3. Low pressure drop
4. Reliable and Pollutants are collected in dry state
5. Equipment is not subjected to abrasion due to low gas velocity
6. Equipment provides incidental cooling of gas stream
7. Temperature and pressure limitations depend on material of construction

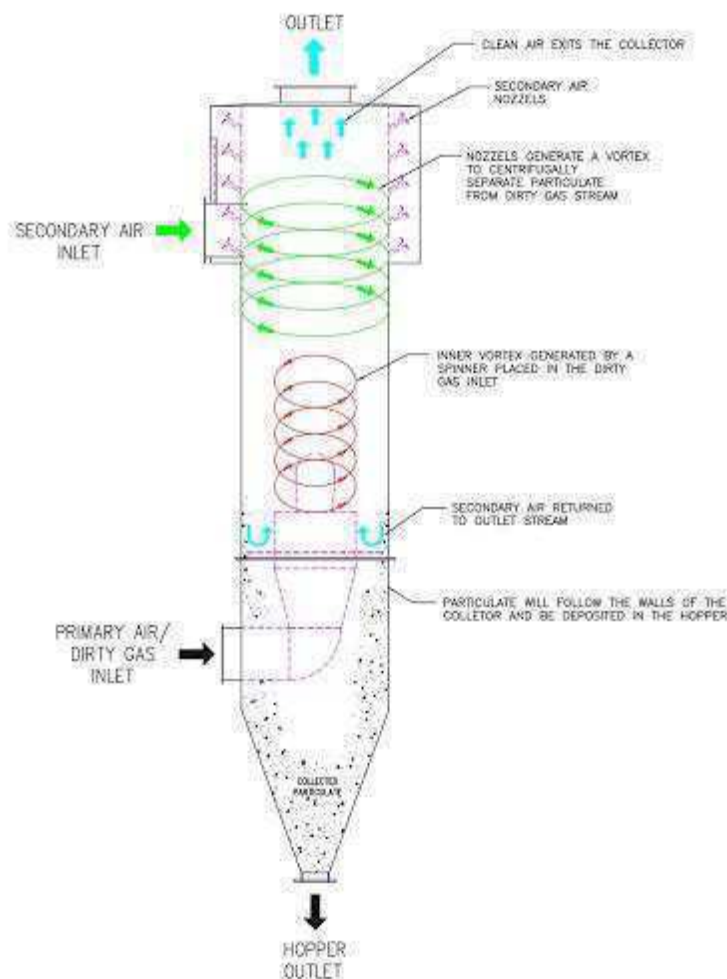
#### **DISADVANTAGES**

1. Low particulate matter collection efficiency
2. Unable to handle sticky materials, Large size
3. Trays in multiple tray settling chamber may warp under high temperatures.

#### **2. Control of SPM by centrifugation**

**Equipment used: Cyclonic separator:-**

Centrifugation is a process that involves the use of centrifugal force for sedimentation of a heterogeneous mixture with a centrifuge. It involves removal of particulates from air, gas or a liquid stream without use of filters with a vortex separation. When removing particulates from a gaseous stream, a gas cyclone is used while a hydro cyclone is used to remove particulates from a liquid stream. This method can also be used to separate fine droplets of liquid from a gaseous stream. A high speed rotating air flow is formed in a cylindrical or conical container called a cyclone. Air flows in a helical pattern from the top to a narrow bottom as show,



Cyclones use the principle of inertia to remove particulate matter from a gas stream. Several cyclones operating in parallel is known as multicyclone. In a cyclone separator, dirty gas is fed into a chamber where a spiral vortex exists. The large particles hit the inside walls of the container and drop down into the collection hopper. The clean flue gas escapes from the top of the chamber. Cyclones can be used efficiently to remove particles of size 10 microns or more. High efficiency cyclones can remove particles of diameter as small as 2.5 microns. They are the least expensive of all particulate collection devices. They are used as rough separators before the gas is passed through fine filtration systems. Their efficiency is between 50-99%. Cyclone separators work best on flue gases that contain large amount of big particulate matter.

#### ADVANTAGES:

1. Cyclones are less expensive to install or maintain as they do not contain any moving parts



2. It is easy to dispose particulate matter as it is collected in the dry state
3. Space requirement is very less

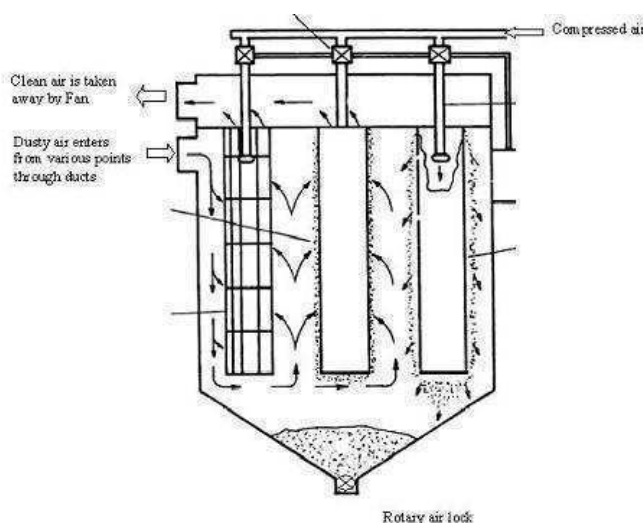
#### DISADVANTAGES:

1. They are not efficient in collecting particulate matter smaller than 10 microns
2. They cannot handle sticky material

#### 3. Control of SPM by filtration

In a fabric filter system, a stream of the polluted gas is made to pass through a fabric that filters out the particulate pollutant and allows the clear gas to pass through. The particulate matter is left in the form of a thin dust mat on the insides of the bag. This dust mat acts as a filtering medium for further removal of particulates increasing the efficiency of the filter bag to sieve more sub micron particles ( $0.5\ \mu\text{m}$ ).

A typical filter is a tubular bag which is closed at the upper end and has a hopper attached at the lower end to collect the particles when they are dislodged from the fabric. Many such bags are hung in a baghouse. For efficient filtration and a longer life the filter bags must be cleaned occasionally by a mechanical shaker to prevent too many particulate layers from building up on the inside surfaces of the bag. A typical bag house filter is shown in the figure below.



#### ADVANTAGES:

- Bag filter is a high quality performance instrument to effectively control particulate emissions and its efficiency is as high as 99%
- Collection efficiency is not affected by sulphur content in fuel
- It is not sensitive to particle size distribution
- It does not require high voltage
- It can be used to collect flammable dust
- Special fiber or filter aids can be used to sub-micron level smoke and fumes



**DISADVANTAGES:**

Fabric life is reduced due to presence of highly acidic or alkaline atmospheres, especially at high temperatures

Maximum operating temperature is 500 F

Collection of hygroscopic materials or condensation of moisture can lead to fabric plugging, loss of cleaning efficiency and large pressure losses.

Certain dusts may require special fabric treatments to aid in reducing leakage or to help in cake removal

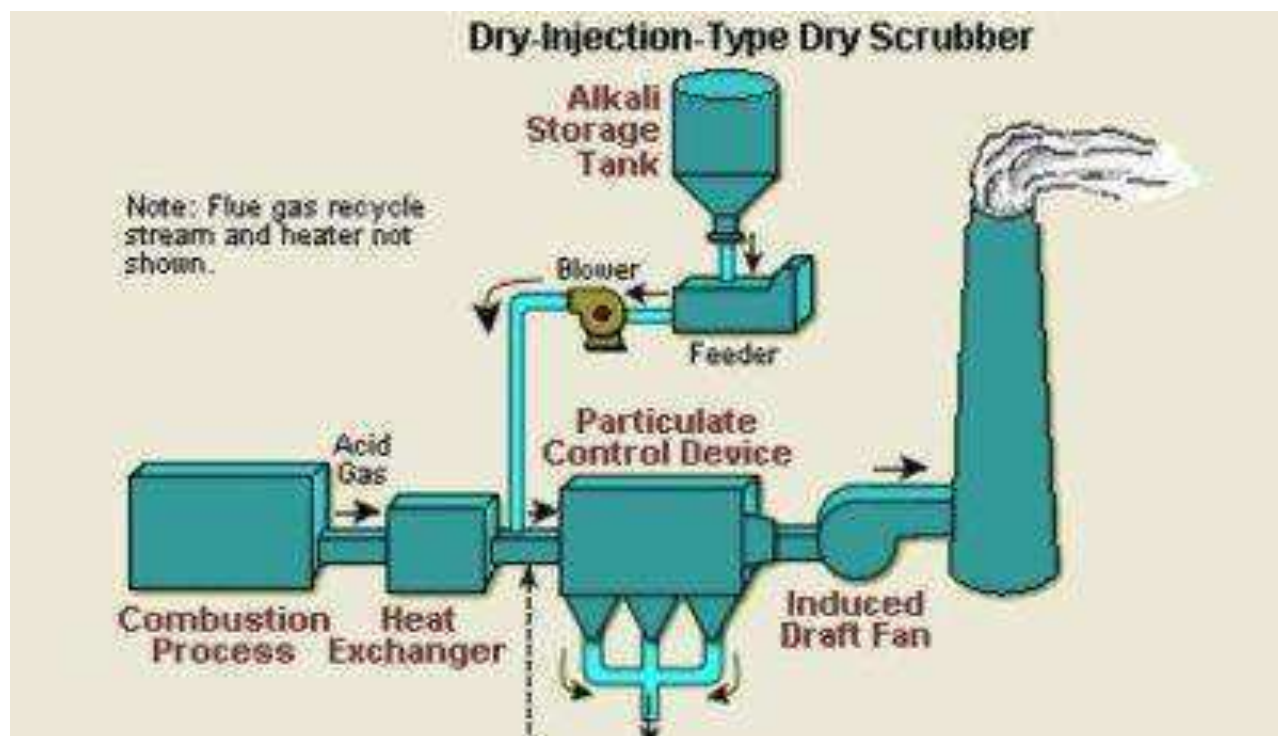
Fabric bags are prone to burning or melting at extreme temperatures.

**4. Control of SPM by scrubbing**

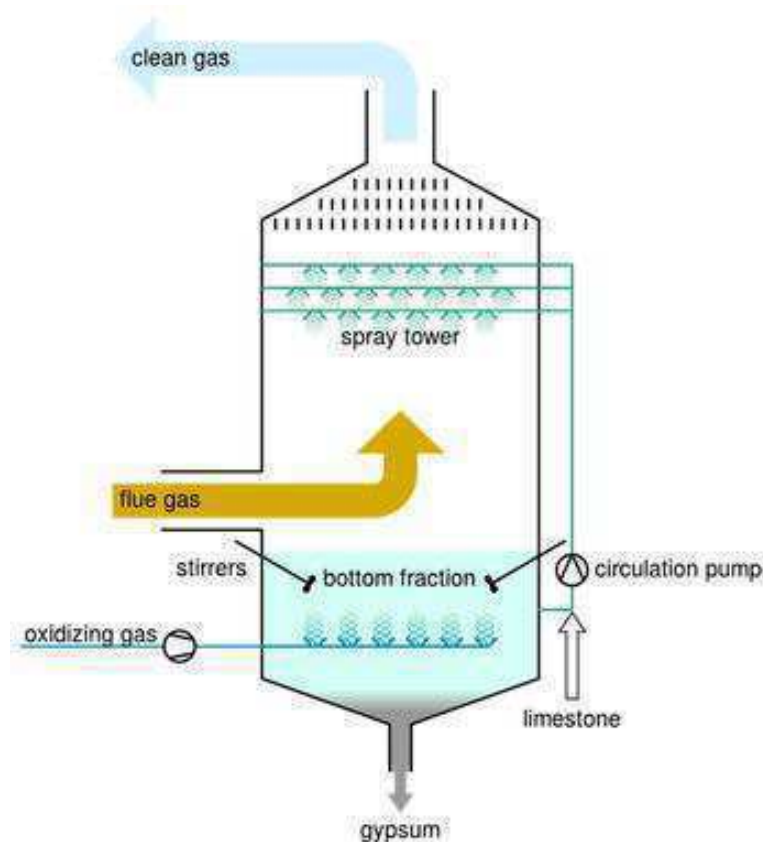
A scrubber is a system used to remove harmful materials from industrial exhaust gases before they are released into the environment. The two main ways to scrub pollutants out of exhaust are:

1. Dry scrubbing and
2. Wet scrubbing

In dry scrubbing, harmful components of exhausted flue gas are removed by introducing a solid substance (usually in the powdered form) in the gas stream.



Wet scrubbing involves removal of harmful components from exhaust by spraying a liquid substance through the gas.



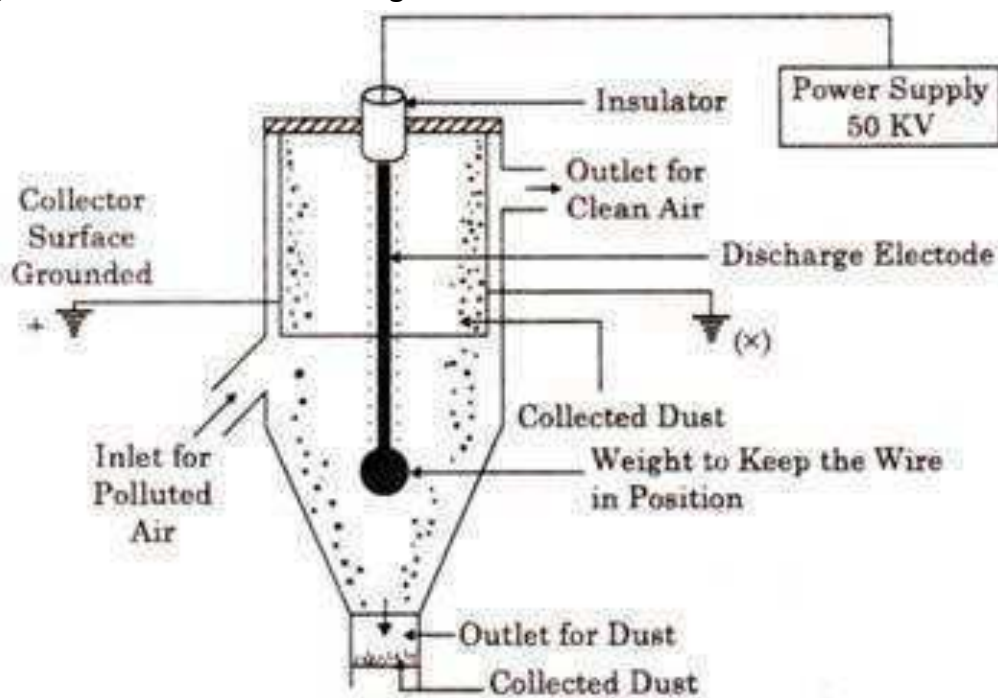
Both methods work similarly and perform the same process of removing pollutants. The difference lies in the materials they use to remove the pollutant from the gas stream. By removing acidic gases from the exhaust before it is released into the atmosphere, scrubbers help in the prevent the formation of acid rain. Scrubbing is sometimes referred to as flue gas desulfurization.

Scrubbing is the most effective technique for the removal of oxides of sulphur and is widely used. Scrubbers remove sulphur oxides from flue gases by passing the gases through a spray of water in a wet scrubber that contains many chemicals, mainly calcium carbonate. If a dry scrubber is used, the flue gas comes in contact with pulverised limestone. The chemical reaction between sulphur dioxide and calcium carbonate yields calcium sulphite. The calcium sulphite either falls out of the gas stream or is removed with other particulates. Scrubbers are highly efficient and remove almost 98% of sulphur from flue gases. However, they are expensive to maintain and install. They are also energy intensive as the flue gas must be reheated after coming into contact with water vapour in the wet scrubber to make the gas buoyant to exit the smoke stacks.

##### 5. Control of SPM by Electrostatic precipitator

An Electrostatic precipitator is mainly used to control particulate matter. An Electrostatic precipitator uses electrostatic forces to separate dust particles from exhaust gases. A number of high-voltage, direct-current discharge electrodes are placed between grounded collecting

electrodes. The contaminated gases flow through the passage formed by the discharge and collecting electrodes as shown in the figure below.



**Fig. 5.4 Electrostatic Precipitator**

Air borne particles receive a negative charge as they pass through the ionized field between the electrodes. These charged particles are then attracted to the oppositely charged electrode and stick to it. The collected material is then removed by rapping or vibrating the electrodes. Cleaning the electrodes is done without interrupting the air flow. The main components of all electrostatic precipitators are:

- a power supply unit to supply high voltage DC power
- ionizing section to impart a charge to the particulates in the gas stream
- an attachment to remove the collected particulates
- a housing to enclose the precipitator zone

The following factors influence the collection efficiency of electrostatic precipitators:

- Larger collection surface areas and lower gas flow rates increase efficiency of electrostatic precipitators due to increased time for the electrical activity to collect the dust particles
- The dust particle migration velocity to the collecting electrodes can be increased by:
  - Decreasing gas velocity
  - Increasing gas temperature and
  - Increasing the voltage field

There are two types of precipitators:

1. Single-stage precipitators that combine an ionization and collection step also known as cottrell precipitators. It is mainly used in mineral processing operations.
2. Low voltage, two stage precipitators that use a similar principle, but in this case, the ionization section is followed by collection plates. It is mainly used for filtration in air-conditioning systems.

**Electrostatic precipitators may be:**

**Plate precipitators** in which particles are collected on flat parallel surfaces about 20 to 30 cm apart with a series of discharge electrodes spaced along the centerline of two adjacent plates. The contaminated particles pass through the passage between the plates and the particles get charged and adhere to the collection plates. The particles are eventually removed by rapping the plates and the dust is collected in the hoppers or bins placed at the base of the precipitator.

**Tubular precipitators** consist of cylindrical collection electrodes with discharge electrodes located on the axis of the cylinder. The contaminated gases flow around the discharge electrode and through the inside of the cylinders. The charged particles are collected on the grounded walls of the cylinder. The collected dust is removed from the bottom of the cylinder. They are generally used for collection of mist or fog or for adhesive, sticky, radioactive or extremely toxic materials.

**Air pollution can be reduced by adopting the following approaches.**

1. Ensuring sufficient supply of oxygen to the combustion chamber and adequate temperature so that the combustion is complete thereby eliminating much of the smoke consisting of partly burnt ashes and dust.
2. To use mechanical devices such as scrubbers, cyclones, bag houses and electrostatic precipitators in manufacturing processes. The equipment used to remove particulates from the exhaust gases of electric power and industrial plants are shown below. All methods retain hazardous materials that must be disposed safely. Wet scrubber can additionally reduce sulphur dioxide emissions.
3. The air pollutants collected must be carefully disposed. The factory fumes are dealt with chemical treatment.

### Water Pollution

Water pollution may be defined as “the alteration in physical, chemical and biological characteristics of water which may cause harmful effects on humans and aquatic life.”

#### **Types of Water Pollution**

##### **Surface Water Pollution**

When hazardous substances come in contact with different sources of water, it leads to surface water pollution. The harmful contaminants from different sources mix or physically dissolve with lakes, lagoons, oceans and lead to surface water pollution.

##### **Ground Water Pollution**

Pesticides and chemicals applied on crops and soil are washed deep into the ground when it rains. The pesticides mix with underground water and lead to ground water pollution.

### **Suspended Matter Pollution**

In this type of pollution, the pollutants enter into water and don't mix with the water molecules. The suspended particles in water form a silt on the waterbed that remove the nutrients from water and make it polluted.

### **Microbial Pollution**

A natural form of water pollution, microorganisms cause this type of water pollution. Most of the microorganisms. Though most of the microorganisms are harmless, however some bacteria and viruses may cause serious health problems.

### **Chemical Water Pollution**

Many industries and farmers use chemicals when working which end up polluting water that we use. Pollutants used to control weeds, insects and pests leech into water and lead to pollution. In addition, metals and solvents from industries also lead to water pollution.

### **Sewage**

Disposing sewage in water is one of the major reasons of water pollution. Sewage disposed into the sea from households as well as factories can cause water pollution. Sewage disposal lead to a number of water-related illnesses such as diarrhea which is a leading cause of death among children.

### **Industrial Waste**

Many factories and manufacturers pour industrial waste such as toxic chemicals into the water bodies before treatment which leads to water pollution. As a result of dumping toxic chemicals, the oxygen levels in water decreases leading to pollution.

### **Dumping of Solid Waste**

Another major reason of water pollution is littering by humans. Dumping solid waste such as plastics, cardboards, Styrofoam contaminate water and make water unsuitable for consumption. Mass dumping of solid waste clog the water bodies and lead to water pollution.

### **Radioactive Wastes**

Discharging of radioactive wastes (waste fuel that comes from nuclear power plants) into the sea is also one of the water pollution causes. High concentrations of radioactive wastes can lead to a number of health problems such as cancer and other serious illnesses.

Those were only some of the causes of water pollution. In addition to the sources mentioned above, there are many other reasons that contaminate water and lead to a number of health problems. Now, that we have understood about the causes, let us study about the effects of water pollution as well. This will help you comprehend, the consequences of water contamination.

### **Effects of Water Pollution**

#### **Groundwater contamination**

Pesticides and fertilizers used for the cultivation of crops and vegetables contaminate the groundwater, which damages the ecosystem. This can also pollute the nearby lands and water when it rains, as rain water washes these chemicals which is soaked by groundwater or

takes them to marine areas. If this groundwater is supplied to your home through bore-wells or tube-wells, it can lead to a number of health problems.

#### Affects Aquatic Life

Solid wastes that we throw in the river/lakes or in sea can have an impact on the aquatic animals. This not only disrupts the eco-system as many species of aquatic animals are in danger of extinction. People who consume sea food are also at a risk of facing health issues when they consume the contaminated food items.

#### High TDS in water

Water is a best solvent which easily dissolves a variety of substances. The amount of dissolved solids present in water determine whether water is suitable for consumption. The TDS level in water needs to be less than 500 mg/litre to make it suitable for consumption. Presence of high amount of TDS can lead to a number of health problems in human beings.

Pollutants include:

1. Sewage
2. Industrial effluents and chemicals
3. Oil and other wastes

Chemicals in air dissolve in rain water, fertilizers, pesticides and herbicides leached from land pollute water.

**TYPES, EFFECTS AND SOURCES OF WATER POLLUTION** Water pollution is any chemical, biological or physical change in water quality that has a harmful effect on living organisms or makes water unsuitable for desired uses.

**Infectious agents**  
Ex: Bacteria, Viruses, Protozoa, and parasitic worms.

**Human sources**  
Human and animal wastes

**Effects:** Variety of diseases.

**Oxygen demanding wastes** (Dissolved oxygen): This degradation consumes dissolved oxygen in water. Dissolved Oxygen (DO) is the amount of oxygen dissolved in a given quantity of water at a particular pressure and temperature.

The saturated point of DO varies from 8 to 15 mg/L Ex: Organic wastes such as animal manure and plant debris that can be decomposed by aerobic (oxygen-requiring) bacteria.

Human sources: Sewage, Animal feedlots, paper mills and food processing facilities.

**Effects:** Large populations of bacteria decomposing these wastes can degrade water quality by depleting water of dissolved oxygen. This causes fish and other forms of oxygen-consuming aquatic life to die.

**Inorganic chemicals**

**Ex:** Water soluble inorganic chemicals:

1. Acids
2. Compounds of toxic metals such as lead (Pb), arsenic (As) and selenium (Se)
3. Salts such as NaCl in oceans and fluoride (F<sup>-</sup>) found in some soils

**Human sources:** Surface runoff, industrial effluents and household cleansers **Effects:** Inorganic chemicals can:

1. Make freshwater unusable for drinking and irrigation
2. Cause skin cancer and neck damage
3. Damage nervous system, liver and kidneys
4. Harm fish and other aquatic life
5. Lower crop yields
6. Accelerate corrosion of metals exposed to such water

**Organic chemicals**

**Ex:** Oil, Gasoline, Plastics, Pesticides, Cleaning solvents and Detergents.

**Human Sources:** Industrial effluents, household cleansers and surface runoff from farms.

**Effects:**

1. Can threaten human health by causing nervous system damage and some cancers.
2. Harm fish and wildlife.

**Plant nutrients**

**Ex:** Water soluble compounds containing nitrate, Phosphate and Ammonium ions.

**Human sources:** Sewage, manure and runoff of agricultural and urban fertilizers.

**Effects:**

1. Can cause excessive growth of algae and other aquatic plants, which die, decay, deplete dissolved oxygen in water thereby killing fish
2. Drinking water with excessive levels of nitrates lower the oxygen carrying capacity of the blood and can kill urban children and infants.

**Sediment**



Ex: Soil, silt, etc.  
Human Sources: Land erosion

Effects:

1. Causes cloudy water thereby reducing photosynthetic activity
2. Disruption of aquatic food chain
3. Carries pesticides, bacteria and other harmful substances
4. Settles and destroys feeding and spawning grounds of fish
5. Clogs and fills lakes, artificial reservoirs, stream channels and harbours.

Radioactive materials:  
 Ex: Radioactive isotopes of:

1. Iodine
2. Radon
3. Uranium
4. Cesium and
5. Thorium

Human sources: Nuclear power plants, mining and processing of uranium and other ores, nuclear weapon production and natural sources.

Effects: Genetic mutations, birth defects and certain cancers.

Heat (Thermal pollution)  
 Ex: Excessive heat

Human sources: Water cooling of electric power plants and some types of industrial plants. Almost half of whole water withdrawn in United States each year is for cooling electric power plants.

Effects

1. Low dissolved oxygen levels thereby making aquatic organisms more vulnerable to disease, parasites and toxic chemicals.
2. When a power plant starts or shuts down for repair, fish and other organisms adapted to a particular temperature range, can be killed by an abrupt temperature change known as thermal shock.

Point and non-point sources of water pollution:  
Point sources These are pollutants that are discharged at specific locations through pipes, ditches or sewers into bodies of surface waters.

1. Ex: Factories, sewage treatment plants, abandoned underground mines and oil tankers.

2. Non point sources These pollutants cannot be traced to a single point of discharge. They are large land areas or air-sheds that pollute water by runoff, subsurface flow or deposition from the atmosphere.

Ex: Acid deposition, runoff of chemicals into surface water from croplands, livestock feedlots, logged forests, urban streets, lawns, golf courses and parking lots.

### Control measures of water pollution

1. Administration of water pollution control should be in the hands of state or central government

2. Scientific techniques should be adopted for environmental control of catchment areas of rivers, ponds or streams

3. Industrial plants should be based on recycling operations as it helps prevent disposal of wastes into natural waters but also extraction of products from waste.

4. Plants, trees and forests control pollution as they act as natural air conditioners.

5. Trees are capable of reducing sulphur dioxide and nitric oxide pollutants and hence more trees should be planted.

6. No type of waste (treated, partially treated or untreated) should be discharged into any natural water body. Industries should develop closed loop water supply schemes and domestic sewage must be used for irrigation.

7. Qualified and experienced people must be consulted from time to time for effective control of water pollution.

8. Public awareness must be initiated regarding adverse effects of water pollution using the media.

9. Laws, standards and practices should be established to prevent water pollution and these laws should be modified from time to time based on current requirements and technological advancements.

10. Basic and applied research in public health engineering should be encouraged.

Following are the control measures of water pollution:

1. Stabilisation of ecosystem:

It involves following practices:

(a) Reduction of waste at source

(b) Harvesting and removal of biomass

(c) Trapping of the nutrients.

(d) Fish management.

2. Using water hyacinth to remove water pollutants:

Water hyacinth is extremely efficient in absorbing and concentrating dissolved nutrients from water in which it lives.

### 3. Using chemical methods:

Several chemical methods have been devised for the treatment of industrial effluents before discharging them in water bodies, like

#### (a) Ion Exchange:

It is a reversible reaction where in an ion from solution is exchanged for a similar charged ion attached to an immobile solid particle which is either naturally occurring inorganic zeolite or synthetically produced organic resins.

#### (b) Reverse Osmosis:

It involves the purification of water with the semipermeable membrane. When used as pre-treatment steps for deionization systems, reverse osmosis will remove feed water bacteria, organics and silica and reduce the dissolved salt content by greater than 95% only.

#### (c) Precipitation:

This process transform dissolved contaminants into an insoluble solid, facilitating the contaminant's subsequent removal from the liquid phase by sedimentation or filtration.

#### (d) Coagulation:

Chemical coagulation enhances the removal of colloidal particles by destabilising and chemically precipitating them and accumulating the precipitated material into larger floc particles which can either removed by gravity setting or filtration.

### 4. Cooling methods:

For preventing thermal pollution such methods are used like cooling waste water effluent, evaporation tower, cooling ponds, dry cooling towers, wet cooling towers etc.

### 5. Recycling, Renovation, Recharge and Reuse (4R concept) of waste water:

The waste water consisting of domestic sewage industrial effluents, thermal and radioactive pollutants receive some sort of treatment before mixing into water bodies. Urban sewage and sludge etc may be recycled and reused to generate cheaper fuel, gas and electricity.

### Soil pollution

Soil pollution

Soil pollution is defined as, "contamination of soil by human and natural activities which may cause harmful effect on living organisms".

Or

Soil pollution is the addition of chemicals to the soil in quantities that are toxic to the environment and its residents. This addition is mostly by human activities such as mining, modern practices in agriculture, deforestation, indiscriminate dumping of human generated trash and unregulated disposal of untreated wastes of various industries

Pollution by agricultural practises has come up ever since the demand for food has increased, proportional to the increase in population. To increase the yield of farms and fields the farmers have had to resort to additional chemical fertilizers, pesticides, weedicides, hormonal treatments for the animals, nutrient laden feed and many such practices which changed the way farming was done traditionally.

|             |    |         |    |        |        |
|-------------|----|---------|----|--------|--------|
| Composition | of | soil    | is | listed | below: |
| COMPONENT   |    |         |    |        | %      |
| Organic     |    | mineral |    | matter | 45     |

|         |        |    |
|---------|--------|----|
| Organic | matter | 05 |
| Soil    | water  | 25 |
| Soil    | air    | 25 |

### **TYPES, EFFECTS AND SOURCES OF SOIL POLLUTION**

Soil pollution mainly occurs due to the following:

1. Industrial wastes
2. Urban wastes
3. Agricultural practices
4. Radioactive pollutants
5. Biological agents

**Industrial wastes** – Disposal of Industrial wastes is the major problem for soil pollution

**Sources:** Industrial pollutants are mainly discharged from various origins such as pulp and paper mills, chemical fertilizers, oil refineries, sugar factories, tanneries, textiles, steel, distilleries, fertilizers, pesticides, coal and mineral mining industries, drugs, glass, cement, petroleum and engineering industries etc.

**Effect:** These pollutants affect and alter the chemical and biological properties of soil. As a result, hazardous chemicals can enter into human food chain from the soil or water, disturb the biochemical process and finally lead to serious effects on living organisms.

**Urban wastes** – Urban wastes comprise of both commercial and domestic wastes consisting of dried sludge and sewage. All the urban solid wastes are commonly referred to as refuse.

**Constituents of urban refuse:** This refuse consists of garbage and rubbish materials like plastics, glasses, metallic cans, fibres, paper, rubbers, street sweepings, fuel residues, leaves, containers, abandoned vehicles and other discarded manufactured products. Urban domestic wastes though disposed off separately from industrial wastes, can still be dangerous. This happens because they are not easily degraded.

**Agricultural practices** – Modern agricultural practices pollute the soil to a large extent. With the advancing agro-technology, huge quantities of fertilizers, pesticides, herbicides and weedicides are added to increase the crop yield. Apart from these farm wastes, manure, slurry, debris, soil erosion containing mostly inorganic chemicals are reported to cause soil pollution

**Radioactive pollutants/** - Radioactive substances resulting from explosions of nuclear testing laboratories and industries giving rise to nuclear dust radioactive wastes, penetrate the soil

and accumulate giving rise to land/soil pollution.  
Ex:

1. Radio nuclides of Radium, Thorium, Uranium, isotopes of Potassium (K-40) and Carbon (C-14) are commonly found in soil, rock, water and air.
2. Explosion of hydrogen weapons and cosmic radiations include neutron, proton reactions by which Nitrogen (N-15) produces C-14. This C-14 participates in Carbon metabolism of plants which is then into animals and human beings.
3. Radioactive waste contains several radio nuclides such as Strontium90, Iodine-129, Cesium-137 and isotopes of Iron which are most injurious. Strontium get deposited in bones and tissues instead of calcium.
4. Nuclear reactors produce waste containing Ruthenium-106, Iodine-131, Barium-140, Cesium-144 and Lanthanum-140 along with primary nuclides Sr-90 with a half life 28 years and Cs-137 with a half life 30 years. Rain water carries Sr-90 and Cs-137 to be deposited on the soil where they are held firmly with the soil particles by electrostatic forces. All the radio nuclides deposited on the soil emit gamma radiations.
5. Biological agents – Soil gets a large amount of human, animal and bird excreta which constitute a major source of land pollution by biological agents.

Ex: 1. Heavy application of manures and digested sludge can cause serious damage to plants within a few years

**Control measures of soil pollution:**

1. Soil erosion can be controlled by a variety of forestry and farm practices.

Ex: Planting trees on barren slopes

Contour cultivation and strip cropping may be practiced instead of shifting cultivation

Terracing and building diversion channels may be undertaken.

Reducing deforestation and substituting chemical manures by animal wastes also helps arrest soil erosion in the long term.

2. Proper dumping of unwanted materials: Excess wastes by man and animals pose a disposal problem. Open dumping is the most commonly practiced technique. Nowadays, controlled tipping is followed for solid waste disposal. The surface so obtained is used for housing or sports field.
3. Production of natural fertilizers: Bio-pesticides should be used in place of toxic chemical pesticides. Organic fertilizers should be used in place of synthesized chemical fertilizers. Ex: Organic wastes in animal dung may be used to prepare compost manure instead of throwing them wastefully and polluting the soil.

4. **Proper hygienic condition:** People should be trained regarding sanitary habits.

Ex: Lavatories should be equipped with quick and effective disposal methods.

5. **Public awareness:** Informal and formal public awareness programs should be imparted to educate people on health hazards by environmental education.

Ex: Mass media, Educational institutions and voluntary agencies can achieve this.

6. **Recycling and Reuse of wastes:** To minimize soil pollution, the wastes such as paper, plastics, metals, glasses, organics, petroleum products and industrial effluents etc should be recycled and reused.

Ex: Industrial wastes should be properly treated at source. Integrated waste treatment methods should be adopted.

7. **Ban on Toxic chemicals:** Ban should be imposed on chemicals and pesticides like DDT, BHC, etc which are fatal to plants and animals. Nuclear explosions and improper disposal of radioactive wastes should be banned.

### Causes of Soil Pollution

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- **Indiscriminate Use of Chemical fertilizers**

These are mostly nitrogen and phosphorus based chemicals like ammonia and nitrates that are most often than not, used in larger than required quantities and tend to accumulate in the soil.

- **Chemical pesticides**

Controlling pests are a farmer's need if a good crop is to be reaped. Pesticides and insecticides like organochlorines, organophosphates and carbonates are used regularly. These also contaminate the ground not only in the fields, but also in the places of manufacture, storage and disposal. They also tend to bio accumulate i.e. they collect in the body of the insects and then enter the food chain and lead to chronic poisoning of the higher level animals. Some pesticides also are absorbed naturally by the plants themselves and stored their different parts.

- **Heavy metals**

Cadmium, fluoride, radioactive elements like uranium are regularly found in the parent minerals from which the fertilisers are obtained. Dangerous metals such as Mercury, Lead, Arsenic, Chromium, and Nickel are seen in traces in Zinc rich wastes from the steel industries which are used as fertilizers. These are often not removed from the because of the high cost involved.

- **Excessive tillage of the land**

Overturning, digging or stirring leads to release of greenhouse gases produced in the ground such as nitrous oxide

- **Soil erosion**

Loss of soil material due to poor management causes soil to become infertile. Soil erosion is followed by deforestation, storm water runoff, overgrazing and excess of agriculture practices, constructions, mining. The soil sediments settling elsewhere on land or in water cause differences to occur in the environments there. In water it causes murkiness reducing visibility for fish and other animals sourcing their food. It leads to reduced penetration of sunlight and affects the process of photosynthesis causing reduction in oxygen levels of the water. Heavy pollutants and nutrients are bound to the sediment particles and carried into the water contaminating it. Faster rate of soil erosion changes the topography of a place.

- **Animal management**

The disposal of manure and other associated waste material from animal farms are also a reason for soil pollution. They cause pollution of the air as well as the water. 18 per cent of Greenhouse gases are said to be generated by farm animals. The large amounts of manure created, carry pathogens that are harmful for humans too.

- **Landfills and other waste dumping issues.**

Human generated sewage is a major cause for soil pollution. At the same time waste products such as plastics, glass, metals, Batteries, paper, fibres and rubber etc. add to the contamination as most of these are non-biodegradable. Much of the trash can be recycled such as paper, metal and glass, etc. Leaching of toxic materials occur at landfills. The more dangerous substances found in landfills are oils, battery metals, heavy metals from smelting industries and organic solvents.

- **Acid rain**

Air pollutants, sulphur dioxides, nitrous oxide and others combine with rain water, form acids and reach the soil. This is called acid rain. It reduces the pH of the soil ie it makes it acidic. It changes the nutrient content of the soil. These changes have adverse effects on the plants growing here, the insects and the other animal's dependant on the land.

### **Mechanisms (Types of Soil pollution)**

#### **Leaching and Ground Water Poisoning**

When chemicals accumulate in the soil, depending on its water solubility and soil structure it percolates through reaching the ground water, causing its contamination. This also depends on the rainfall. For example after applying pesticides on crops in sandy areas, if excessive irrigation is done , the pesticide chemicals leach into ground. Leaching occurs not only in the fields, but also at the manufacturing, mixing and disposal sites.

#### **Water runoff**

Only a fraction of fertilisers and other chemical additives are utilised on the fields. The major bulk mixes in the runoff water and flows into the nearby watercourses. This is mainly in the form of nitrates and phosphates.

#### **Barrenness of the ground**



Many times the ground becomes barren and cannot support any flora or fauna on it. Use of excessive fertilizer progressively reduces the nutrient content of the foods such as proteins and vitamins in grains and vegetables.

### Prevention of soil pollution

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- Managing and regulating the chemical waste disposal by industries is vital to soil health. Treatment of the wastes before disposal to remove chemicals and heavy metals at any cost must be done
- Prevention can never be a solo effort. The state governments, farmers' organisations, collectives and cooperatives, educational institutions and conservation groups need to work together for regulating and reducing farming related soil pollution.
- Planning the application of fertilizer at the right time, in the right quantity with the correct methods can reduce the accumulation of chemicals.
- Planting certain grasses and clovers that can absorb and recycle the additional nutrients and prevent soil erosion. Planting rows of trees and shrubs around fields and along the borders of the stream or lake also help in the same way.
- Over tilling of the soil must be avoided to prevent soil erosion and soil compaction.
- Managing the correct disposal of human and animal wastes and treating the sewage before release makes a big difference in the magnitude of soil and water pollution
- Composting, solid liquid separation, anaerobic digestion and lagoons are different ways of managing animal manure. Of these anaerobic digestion is the most effective. It involves the use of anaerobic bacteria and heat. The products of this process are nutrient rich liquid used as fertiliser and methane gas that can be burned to produce electricity and heat. Anaerobic digestion is a best method for controlling odour associated with manure management.
- Afforestation or planting of more trees is always good for binding the soil.

### Effects of soil pollution

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Since soil pollution is not a lone standing entity, its effects are carried over as water pollution and air pollution. It affects every aspect of the environment and every organism from the earthworm to humans. Some of the adverse effects are as follows:

#### Human health

Since we are dependent on the land for our food, pollution from the soil is transferred to us in this manner. Bio accumulation of toxins occurs in our bodies, causing chronic poisoning, and leading to various diseases. Reproductive health, birth and developmental defects, neurologic effects, malnutrition, and mutations in the cells of the body leading to cancers; all these are on the increase today.

#### Growth of plants

Plants will not be able to adapt to sudden changes occurring in the soil. Fungi and bacteria found in the soils cannot bind the soil due to chemical changes and this causes soil erosion.

Large tracts of land become barren; unable to support any life on it. Even the plants that do grow on these lands will absorb the toxins and transfer to the food chain.

#### **Air pollution**

Toxic dust rises from landfills along with foul odour, pollutes the air and causes adverse effects to the people who live near them.

#### **Marine pollution**

Marine pollution refers to the contamination or presence of pollutants in oceans and seas. The word 'marine' comes from the Latin word for 'sea' and it is related to similar words, such as 'mariner'. Ocean pollution is become ever more of a problem in the present day.

Marine pollution can be defined as anything that contaminates the sea. Common marine pollutants include chemicals, small plastic beads in exfoliants and also toxic bio-matter (such as sewage). But, noise – due to excessive traffic around the ocean – can also be defined as pollution if it disrupts marine life.

Pollution can vary depending on the context and the purpose for which seawater is being used. For example, normal seawater has some small particles of plants or sand in, and when the sea is considered as the habitat of marine animals, one would not think of these particles as pollutants – whereas one would definitely define toxic chemicals as pollutants. However if somebody wanted to use this brine for cooking in, they might see the sand and plants as polluting our cooking water.

#### **Causes/Sources of Marine Pollution**

##### **1. Toxic chemicals in water.**

Chemical runoff from industry can really endanger marine life. Industrial waste pumped into the sea, household cleaners poured down the sink, and even chemicals in the atmosphere (for instance due to the discharge of industrial wastes through factory chimneys) that dissolve into the sea can pollute our oceans significantly.

##### **2. Oil spillages.**

This is usually an accidental form of industrial dumping, whereby leaks in oil tankers cause vast quantities of oil to pour into the ocean. Accidental oil spills can devastate marine life.

##### **3. Small particles.**

The tiny plastic beads in exfoliating creams and other small particles that we pour down the drain without thinking wind up polluting the ocean.

##### **4. Plastic, Litter, and human waste.**

Plastic bags, aluminum cans, trash and other human waste constitute a major pollutant of the world's oceans. A huge 'island' of trash roughly the size of Texas was recently found in the Pacific ocean for instance, demonstrating the vast scale of this problem.

##### **5. Sewage.**

Whether or not it is treated with toxic chemicals, sewage pollutes the clear, clean water of the oceans. This is another type of industrial dumping. Sometimes, sewage is not pumped directly into the sea but into rivers, and then the untreated water of rivers carries it into the sea.

##### **6. The shipping industry.**

Gases (which dissolve in the sea), chemicals and sewage from container ships are major pollutants.

#### 7. Dissolved greenhouse gases.

Greenhouse gases from human fossil fuel consumption are making the sea more acidic.

#### Effects of Marine Pollution

##### 1. Oxygen depletion.

Seawater is full of dissolved oxygen, however decomposing sewage and other biomatter in oceans can result in a condition known as 'hypoxia' or oxygen depletion. This makes it hard for oxygen loving marine life – plants, fish and animals – to survive in the oceans.

##### 2. Higher acidity.

Toxic chemicals make our oceans more acidic. Again, this makes them poisonous to marine life and causes harm to fish and marine mammals as well as marine plants and corals.

##### 3. Choking marine life.

Small pieces of plastic and other litter are increasingly being found in the stomach of fish, turtles and other marine animals. These pieces of trash choke marine animals and hamper their digestion, with an often fatal result.

##### 4. Spoiling birds' feathers.

Oil spills coat the feathers of marine birds and strip them of the natural oils that birds use to keep their feathers waterproof and to maintain their own body temperatures. As a result, marine birds can overheat or get too cold, and they find it hard to stay afloat as their feathers get soggy. They will also find it difficult to fly when their feathers are clogged with oil.

##### 5. Blocking out the sunlight.

Pollutants such as oil or litter can block out the sunlight from sea plants which need sunlight for photosynthesis.

##### 6. Dangers to human health.

Human swimmers and water sports lovers can become endangered by swimming in a polluted sea.

#### Control Measures/ Solutions for Marine Pollution

##### 1. Be careful with our chemicals.

Climate change and marine pollution are both results of excess human interference in the natural world. If we choose eco-friendly household cleaners and take measures to reduce the fumes we release into the air (for instance, by choosing public transport over cars) we can reduce the impact of our lives on the oceans.

Further, careful site monitoring to prevent or stop any chemical or oil spills at all times will reduce the instances of oil spills.

##### 2. Don't flush or rinse away harmful particles.

If we do not flush plastics down the toilet, and if we do not pour oils and exfoliating beads down the faucet, we prevent these particles from reaching our oceans. Switch to exfoliants that use natural materials like seeds, sugar or sand instead – and recycle all plastics!

##### 3. Campaign.

Influence the decisions of policymakers and factory bosses to make them more eco-friendly by lobbying, writing letters, spreading the word on social media and campaigning. Motivating

the shipping companies to use safe and environmentally friendly vessels are among the key measures that can be taken here.

#### 4. Volunteer at an oil spill site.

Volunteers are always needed at oil spill sites to save the lives of marine birds by washing the oil from their feathers and caring for them until they are ready to fly, swim and dive under water again. Intervention is always needed as soon as possible to ensure that these birds do not suffer any ill effects to their health.

#### 5. Volunteer at a beach cleanup – or organize one yourself.

Rid your local beach of litter by getting together with the rest of the community to pick up the trash left behind by careless picnickers, boat crews and more. Joining together as a community to care for the natural world is a wonderful way to remind everyone how intimately we are connected to nature, and how much we depend on it. Working together with other people also helps to keep us motivated and reminds us that we are not alone in our quest to care for the environment.

#### 6. Ensuring no debris is released into the ocean.

Recycling our plastics and other recyclable, and disposing of our waste responsibly is key here.

### Noise pollution

Noise is defined as, "the unwanted, unpleasant or disagreeable sound that causes discomfort to all living beings". Sound intensity is measured in decibels (dB), that is the tenth part of the longest unit Bel. One dB is the faintest sound that a human ear can hear.

TYPES OF NOISE: Environmental noise has been doubling every ten years. Noise is classified as:

1. Industrial Noise
2. Transport Noise and
3. Neighbourhood noise

Industrial Noise: It is sound with a high intensity sound caused by industry machines. Sources of such noise pollution is caused by machines from machines in various factories, industries and mills. Noise from mechanical saws and pneumatic drills is unbearable and a nuisance to the public.

The Indian Institute of Oto-Rino Laryngology, Chennai reported that increasing industrial pollution damages the hearing ability by at least 20%. Workers in steel industry, who work close to heavy industrial blowers are exposed to 112dB for eight hours suffer from occupational pollution.

Transport Noise: Transport noise mainly consists of traffic noise from road, rail and aircraft. The number of automobiles on roads like motors, scooters, cars, motor cycles, buses, trucks and diesel engine vehicles have increased enormously in the recent past further aggravating the problem of transport noise. Noise levels in most residential areas in metropolitan cities is hovering around the border line due to increased vehicular noise pollution. This high level of noise pollution leads to deafening in the elderly.

**Neighbourhood noise:** This type of noise includes disturbance from household gadgets and community. Common sources being musical instruments, TV, VCR, Radios, Transistors, Telephones, and loudspeakers etc. Statistically, ever since the industrial revolution, noise in the environment has been doubling every ten years.

### **Causes of Noise pollution**

Noise pollution can be caused by several phenomenon including industrial activity, and social activity (such as explosion of fire crackers, loud parties), and surface travel. The many causes of noise pollution are discussed below:

1. **Fire crackers:** Fire crackers are exploded to make huge sound during celebrations and festive occasions. It is common sight to witness the firing of crackers at live concerts. These high levels of sound is extremely problematic for people, especially elderly and sick people.
2. **Transportation vehicles:** Noise pollution is severest in the cities. All forms of machine powered vehicles cause noise pollution. The different modes of transportation (land, air and water), produces enough sound and collectively causes massive disturbance to the human mind and body. During the last few decades, the world is moving at unprecedented speed. People use surface transportation vehicles such as cars, vans, buses, trams, bullet trains. There are metro rails in major cities. Long distances are very often covered in an airplane or a bullet train. Airports and railway stations are busy throughout day and night. Far away places can be reached in hours. People take the water route to travel via motor ships, boats, yacht, and helicopters. Many people even own private air-crafts. The ever-increasing usage of various modes of transport is the major cause for noise pollution.
3. **Microphones and Loud Speakers:** Loud speakers and microphones are used during social, political and other special events. Large public gatherings are held. To make sure that the announcements and speeches are audible a large audience, microphones and loud speakers are used. Though these public gatherings are generally held for welfare and entertainment of the public, the nearby residents suffer from loud noise.
4. **Factories and industries:** In large cities, there are large number of factories, mills and industries. Industries such as steel industry, shipping industry, aircraft, wires, switch gears and automobiles cause industrial noise. These industrial sites produce immense environmental noise to disturb the habitats of nearby residential areas. Large scale industries are often sites as a major cause of NIHL – Noise Induced Hearing Loss (read more about NIHL in Wikipedia). The workers and employees working in factories suffer from occupational noise (read more about occupational noise in Wikipedia). They are constantly exposed to noise of the working machinery. Their auditory system is at risk. Long-term exposure to industrial noise may lead to hearing disability.
5. **Domestic household appliances:** A majority of domestic household appliances that we use in everyday life causes noise pollution. Home theaters and televisions are played non-stop. The air cooler is supported by a large and powerful fan. The mixer grinders are used in grinding food materials. The juicer extracts juices from the fruits. The air purifier is used to purify the air. Washing machines are used for washing clothes. Loud music are played on advanced music systems. The smart phone keeps ringing.

6. **Building and construction sites near residential areas:** The building and construction activity involves use of sound producing equipment such as cement-mixer, road-roller, crane, etc. Cement mixers uses a revolving drum to mix cement, sand, small stones and water to create concrete. The sound of cement mixers are annoying.

7. **Office Equipment:** In offices, a wide variety of equipment is used. Many of the office equipment make noise. Paper shredders are used to cut papers. Printers are widely used for printing texts and pictures. A manual type writer, is used for typing. Fax machines are used to send or receive scanned texts or images through telecommunication lines. Phones keep ringing. And people keep talking to business partners, and clients over phone. When doors are opened and shut hard, it makes noise.

All the above activities produce enough noise to disturb the health and mind of human-beings and other living bodies.

### Effects of Noise pollution

1. Noise pollution affects both human and animal health. It leads to:
  1. contraction of blood vessels
  2. making skin pale
  3. excessive adrenalin in the blood stream which is responsible for high blood pressure.
  4. Blaring sounds are known to cause mental distress
  5. Heart attacks, neurological problems, birth defects and abortion
2. Muscle contraction leading to nervous breakdown, tension, etc
3. The adverse reactions are coupled with a change in hormone content of blood, which in-turn increases heart beat, constriction of blood vessels, digestive spasms and dilation of the pupil of the eye.
4. Adverse affects health, work efficiency and behaviour. Noise pollution may cause damage to the heart, brain, kidneys, liver and may produce emotional disturbance.
5. The most immediate and acute effect of noise is impairment of hearing that diminishes some part of the auditory system. Prolonged exposure to noise of certain frequency pattern leads to chronic damage to the inner ear.
6. Impulsive noise may cause psychological and pathological disorders
7. Ultrasonic sound can affect the digestive, respiratory, cardiovascular system and semicircular canals of the internal ear.
8. The brain is adversely affected by loud and sudden noise by jets and airplanes. People are subjected to psychiatric illness.
9. Recent reports suggest that blood is thickened by excessive noise.
10. The optical system of human beings is also affected by noise pollution. Severe noise pollution causes:
  1. Pupillary dilation
  2. Impairment of night vision and
  3. Decrease in rate of colour perception

Or

**Effect on Human beings:** Noise pollution affects the human mind and body negatively. The ill-effects of noise pollution are many. It is the major cause for several ailments. The quality of human life gets disrupted. The lives of the children, the aged or the ailing people become miserable.

1. **Loss of hearing and deafness:** Noise above the tolerable threshold is the leading cause for loss of hearing and deafness.
2. **Cardiac disturbance:** Noise increase the risk of cardiac disturbance including coronary artery disease or ischemic heart disease (IHD).
3. **Sleeplessness:** Noise may make people restless and tired. It may cause disrupted sleeping pattern or may keep people away from sound sleep. In the long-term, due to tiredness and lack of sleep, the immune system may get compromised.
4. **Headache:** Human mind can tolerate sound only to a limited extent. Excess noise causes headache.
5. **Stress, tension and aggressiveness:** Loud noises can be very stressful. Constant exposure to irritating sound may cause stress and tension. The behavior of people often becomes aggressive. Other than psychological imbalance, it causes physical illness such as increased blood pressure, cardiac disturbance and insomnia.
6. **Irregular blood pressure:** For good health, it is very important to maintain normal pressure in the arteries both during the heartbeat and between the heartbeat. Noise may contribute to fluctuations in the levels of blood pressure.
7. **Mental imbalance and nervous debility:** Mental illness is among the worst negative effects of noise pollution. People may find it difficult to cope with their normal routine life. Human mind cannot accept sound beyond a certain level. Excess sound may lead to mental imbalance and nervous disability.
8. **Psychological imbalance:** It may also cause psychological imbalance.
9. **Difficulty in talking:** Due to excessive noise, it becomes very difficult to talk on roads or inside malls

**Effect on Animals:** Noise pollution is hazardous for animals, both wild and domestic. It impairs hearing. Sometimes, it changes the reproductive behavior of the animals. Noise disrupts the communication among animals. Some animals cannot live in noisy atmosphere resulting in loss of habitat. In the presence of noise, some animals raise the level of their voice. For example, many marine animals raise their voice when large ships pass near them. The increased voice further adds to the noise already present. Marine animals are sensitive to noise.

**Control**

**measures:**

1. **SOURCE CONTROL:** This includes source modification such as acoustic treatment to machine surface, design changes, limiting operational timings, etc



2. **TRANSMISSION PATH INTERVENTION:** This includes containing the source inside a sound insulating enclosure, constructing a noise barrier or provision of sound absorbing materials along the path.
3. **RECEPTOR CONTROL:** This includes protection of the receiver by altering the work schedule or provision of personal protection devices such as ear plugs for operating noisy machinery. The measure may include dissipation and deflection methods.
4. **OILING:** Proper oiling will reduce noise from the machine.

#### Preventive

#### measures:

1. Prescribing noise limits for vehicular traffic
2. Ban on honking (usage of horns) in certain areas
3. Creation of silence zones near schools and hospitals
4. Redesigning buildings to make them noise proof
5. Reduction of traffic density in residential areas
6. Giving preference to mass public transport system.

Some effective measures should be taken to solve the problem. The following measures can be taken to prevent noise pollution:

- Better town planning and ensuring that residential towns are set up at places away from heavy industrial units can help in combating the problem of noise pollution.
- Significant control over noise pollution caused by transportation vehicles can be controlled by making smooth roads, and by disallowing heavy carriage vehicles on roads near residential units.
- To prevent and control noise pollution it is necessary to create public awareness. Only law is not sufficient. People must be made aware of the harmful consequences and irreversible injuries caused of noise pollution such as deafness, mental illness, etc.
- There should be minimum use of sound producing instruments. There should be proper regulations for the use of loudspeakers, microphones, and other devices that produce noise beyond that are beyond the toleration limits of human-beings.
- The Pollution Control Board and the High Court have already taken effective measures to bring sound pollution under control. Adequate measures should be taken to ensure that noise related restrictions are not violated.
- Anti-pollution laws should be enacted and enforced.
- Ban on fire crackers should be imposed and electric horns should be replaced by bulb horns. Further, use of horns in residential areas should be monitored and regulated.
- Usage of quieter machinery should be encouraged.

#### Thermal pollution

Thermal pollution can be simply explained as the addition of surplus heat to water and ejecting it back to the water bodies. So how does it happen? Well, numerous industries take

water from natural water resources for their industrial purposes. Maximum of this water is used as coolant as it is used to cool down the machines of any factory or plant.

Afterwards, this used water with altered and much high temperature is ejected back to the natural resources including lakes, ponds, seas, etc. This causes sudden increase in temperature of natural water bodies too. The altered water also creates disturbance in the oxygen level of water bodies. This in turn, harms the marine life and local ecosystems. Therefore, thermal pollution caused in water by spilling back the industrial waste and used water in it, causing adverse effects, is known as thermal pollution.

Thermal pollution is not only caused by the hot water but also by the cold water that is discharged by various industries into the rivers or seas containing warm water.

Or

An increase in the optimum water temperature by industrial process (steel factories, electric power houses and atomic power plants) may be called as “Thermal Pollution.” Many industries generate their own power and use water to cool their generator.

Or

Thermal pollution is defined as the addition of excess of undesirable heat to water thereby making it harmful to man, animal or aquatic life. Thermal pollution may also cause significant departures from nor activities of aquatic communities.

**Sources of Thermal Pollution:**  
The following sources contribute to thermal pollution.

1. Nuclear power plants
2. Coal fired plants
3. Industrial effluents
4. Domestic sewage
5. Hydro-electric power

1. Nuclear power plants: Nuclear power plants including drainage from hospitals, research institutions, nuclear experiments and explosions, discharge a lot of heat that is not utilized along with traces of toxic radio nuclides into nearby water streams. Emissions from nuclear reactors and processing installations are also responsible for increasing the temperatures of water bodies. The operations of power reactors and nuclear fuel processing units constitutes the major contributor of heat in the aquatic environment. Heated effluents from power plants are discharged at 10 C higher than the receiving waters that affects the aquatic flora and fauna.

2. Coal-fired power plants: Coal fired power plants constitute a major source of thermal pollution. The condenser coils in such plants are cooled with water from nearby lakes or rivers. The resulting heated water is discharged into streams thereby raising the water temperature by 15C. Heated effluent decreases the dissolved content of water resulting in death of fish and other aquatic organisms. The sudden fluctuation of temperature also leads to "thermal shock" killing aquatic life that have become acclimatized to living in a steady temperature.

3. Industrial effluents: Industries like textile, paper, pulp and sugar manufacturing release huge amounts of cooling water along with effluents into nearby natural water

bodies. The waters polluted by sudden and heavy organic loads result in severe drop in levels of dissolved oxygen leading to death of several aquatic organisms.

4. **Domestic Sewage**: Domestic sewage is discharged into rivers, lakes, canals or streams with minimal treatment or without any treatment. These wastes have a higher organic temperature and organic load. This leads to decrease in dissolved oxygen content in the receiving waters resulting in the set-up of anaerobic conditions causing release of foul and offensive gases in water. Eventually, this leads to development of anoxic conditions resulting in rapid death of aquatic organisms.

5. **Hydro-electric power**: Generation of hydroelectric power sometimes leads to negative thermal loading in water systems. Apart from electric power industries, various factories with cooling requirement contribute to thermal loading.

#### Thermal pollution in streams by human activities

1. Industries and power plants use water to cool machinery and discharge the warm water into a stream
2. Stream temperature rises when trees and tall vegetation providing shade are cut.
3. Soil erosion caused due to construction also leads to thermal pollution
4. Removal of stream side vegetation
5. Poor farming Practices also lead to thermal pollution

#### **Causes of Thermal Pollution**

1. Water used as coolant & ejected back into water bodies – Mainly, the water that is used as coolant and transferred back to natural water bodies is the chief reason for thermal pollution. This kind of activity is mostly done by production; manufacturing and power plants. These plants use water to cool down their machines and eject back the hot water into water bodies. Thus, the natural water goes through a sudden rise in temperature.
2. Release of cold water – Just as we mentioned before, many industries liberate very cool water from their reservoirs. This water when mixed up with warm water rivers, lakes or ponds creates a disbalance in the flora and fauna of affected water bodies.
3. Growing industrial activities – It gives a repenting feeling to know that thermal pollutants are increasing day by day because of the growing industrial activities. Therefore, thermal pollution is also growing each day.
4. Chemical pollutants discharged into water – There are copious factories that discharge their chemical waste directly into natural water bodies. This does not only causes thermal pollution but also makes the water poisonous.

5. **Livestock waste mixed into water** – This is another major cause of thermal pollution. Many industries dispose their livestock waste into water without analyzing upon the hazardous consequences of this act.
6. **Water discharged from urban areas** – Many urban areas like parking places, roads, etc., deposit rain water and discharge the heated water back into water bodies. The heated water disturbs the normal temperature of natural water bodies.
7. **Human waste, household & personal care products** – These products go into sewage water which pollutes the water in ponds, seas and other water bodies.
8. **Deforestation & soil erosion** – Soil erosion makes natural water bodies to rise beyond their normal level. Thus, they get more exposed to sunlight. Hence, the temperature of water rises. Forests absorb much of sun rays and save water bodies from getting too much heat. However, deforestation disturbs this cycle and provides augmented temperature of water.
9. **Natural Geo-thermal activities** – Natural geothermal activities can stimulate lava and can cause a rise in water temperature, making way for thermal pollution.
10. **Unawareness among people** – Growing thermal pollution is also the result of unawareness among people. Even after knowing the hazardous effects of thermal pollution on environment, there are abundant industries which are continuously using ways that encourage this pollution.

#### **Effects of Thermal Pollution**

1. **Thermal shock resulting in rise in temperature of water bodies** – When industries and factories dispose the water, used as coolant, back into water bodies the temperature suddenly raises to an abnormal level. The sudden and abnormal temperature level acts as a thermal shock for aquatic life, which is adapted to living in a specific temperature and cannot, handle the abrupt change in water temperature.
2. **Depleted level of oxygen in natural water** – When warm water discharged by industries enters the natural water bodies, they get heated up. The warm water causes an unusual growth of plants and expansion of algae. The algae expansion in water reduces the level of oxygen in water.
3. **Contamination of water** – Thermal pollution also results in contamination of water because various chemicals and other wastes get mixed up with the water that is disposed off back to rivers, ponds, lakes, etc., by various factories. If this contamination of water keeps on increasing, humans can suffer from shortage of water.
4. **Reduced solubility of oxygen** – Reduced solubility of oxygen in water bodies is another disappointing effect of thermal pollution. This less solubility of oxygen in water mainly affects the metabolism of water animal.

5. **Adverse effect on water plants –** Change in temperature levels is extremely harmful for the aquatic plants. These plants cannot cope up with the sudden alteration in water temperature. Hence, more and more aquatic plants are depleting each day because of thermal pollution
6. **Adverse effects on water animals –** The whole marine life gets disturbed because of thermal pollution. The contaminated water makes the natural water poisonous and has an adverse effect on animals living in it. Also, the reduced level of oxygen makes it difficult for water animals to survive.
7. **Effect on population of water animals –** When the temperature in natural water bodies gets disturbed because of thermal pollution, the cycle of animal population gets disturbed too. For example, sometimes the fish start laying eggs too soon and sometime they do it too late. The whole productivity of river gets disturbed too.
8. **Disturbance in biological activities of water animals –** Thermal pollution leads to a disturbance in quality and temperature of water in various water bodies. This altered quality and temperature directly affect all the biological activities of animals, thus disturbing the cycle of nature.
9. **Unfavorable Effect on Water Biodiversity –** Thermal pollution largely affects the water bio diversity. The rise in temperature of water results in increased metabolic activity of some water animals. Hence, they start consuming more food in short time. This also leads to shortage of certain water resources. Some animals which are unable to stand the raised temperature start moving to other regions. Therefore, the whole natural system of water bio diversity gets disturbed.
10. **Unexpected Migration of Water Animals –** When water animals find it difficult to survive in the changed water because of thermal pollution, they start for an unexpected migration, making way for a disturbed ecosystem.

### **Control Measures for Thermal Pollution**

After reading about so many harmful effects of thermal pollution, and the disturbance that it causes in nature's cycle, you must definitely be wondering that whether there is any solution for the same. The good point is that of course, there is a solution for thermal pollution. As man has created the problem of thermal pollution, he should be the one to work out for its solution too!

The best part about the solution for thermal pollution problem is that we can definitely make a huge and positive difference if we start following just few steps. Without discussing these solutions, we cannot reach a positive conclusion.

So let us glance through some effective ways that can help reduce thermal pollution at a significant extent:

1. **Use less electricity** – All of us know that power plants are the main reasons behind growing thermal pollution. This is so because power plants use water as a cooling agent for cooling down their machines. This used water, which is much higher in temperature, is discharged back into the rivers, seas or lakes. We can make a significant contribution in controlling thermal pollution by consuming less electricity,. The use of less electricity will lead to less workload on power plants and these plants will not have to use their machines too much, meaning controlled use of water as coolant. Hence, switch off fans when you are not sitting in that room, switch off unnecessary lights, use solar products and techniques. All such steps will help us use lesser electricity.
2. **Use of Better Technologies** – Science has gifted us with plentiful inventions, discoveries, techniques and knowledge. Incorporating good techniques ensure a good lifestyle for human race. Use of better technologies is strongly recommended for solving the problem of thermal pollution. There are technologies available which help in the cooling down of machines. If machines will be cooled down with the help of technologies, the use of water as coolant will come to a much reduced level. Various industries and power plants should look out for appropriate technologies that serve the purpose without encouraging the steady problem of thermal pollution.
3. **Holding back the water for good** – If factories or plants cannot stop using water as a coolant, there is another option available for them. After using the water as coolant, they should store that water somewhere else for a temporary period. Instead of discharging back the heated water into water bodies, the temporarily collected heated water can be used for various other purposes too. Storing the heated water for a particular time will help in bringing back the high temperature of water to a normal level.
3. **Plantation of more trees upon the banks of rivers, seas & other water bodies** – This is also a good way to control thermal pollution. The trees around sources of water help in absorbing the harsh sun rays and prevent them from falling directly upon the water. This helps in prevention of heating of water bodies. Planting more trees also helps in controlling the problem of soil erosion because the strong roots of trees hold the soil firmly and stop it from erosion. Trees do not only help in controlling thermal pollution but also aid in a better environment including fresh air and peaceful scenic views. We should also encourage our coming generations to plant more and more trees.
5. **Artificial Lakes** – Industries, factories or plants which are serious about storing and reusing the heated water, used as coolant, can work out on artificial lakes. These are artificial lakes where the heated water can be stored easily. These lakes are very helpful for normalizing the temperature of hot water. This way, the hot water will not be disposed back to the lakes, rivers, etc., and will be used in other suitable tasks. Actually, the artificial lakes or ponds use evaporation or convection technique for cooling down the water. These artificial lakes or ponds generally contain two ends. From one end, the hot water is transferred into the lake; it is processed through evaporation or other

technique and finally, when it cools down, it is taken out from the other end. The evaporated heat dissolves in the air.

5. Recycling used water – Smart people always find intelligent solutions for even the most difficult of problems. If people start working upon the ideas of recycling the used water in plants and factories, the problem of thermal pollution will definitely be lessened to a significant extent. Every plant or industry should make it a rule that water used as coolant will not be spilled back into water bodies. Rather, it will be recycled for further tasks. In today's era, we often hear news about the shortage of water and thousands of people dying because of the same. Just ask yourself that isn't it our duty to save water and use it for good?

7. Spreading awareness among people – Environment can be made better with a united effort. Making more and more people aware about the problem of thermal pollution will be very beneficial in the long run. Groups of people can initiate a discussion with different plants and industries. These groups can discuss the harmful effects of thermal pollution on aquatic life and our environment. We can also aware others about the consistent problem of thermal pollution by gaining the right knowledge about thermal pollution.

8. Suitable arrangements in urban places – Places like parking spaces, drainage pipes, sewerage tanks, etc., should have proper arrangements so that the water does not get collected at those spaces. When the water is accumulated at these spaces, it gets heated up and gets mixed with seas, ponds, lakes, etc., thus making way for thermal pollution. Hence, by making appropriate arrangements at such places, we can stop water from getting accumulated.

9. Co-generation – Co-generation is also a wonderful idea to combat thermal pollution. In the process of co-generation, the useless heat from hot water can be recycled and used smartly in many tasks by industries.

10. Cooling towers – Cooling towers is also a good idea when talking about the solutions for thermal pollution. The purpose of using cooling towers is the same as artificial lakes. The cooling towers also use the hot water of industries, process it by transferring its heat and transform hot water into cold water. This cool water can be recycles and used again for different industrial purposes.

Generally, the cooling towers are of two types. This includes the wet cooling tower and the dry cooling tower. In wet cooling tower, the heated water gets spread upon the flow-directing panels. Afterwards, the high-speed cold air is passed upon it. Henceforth, the hot water gets cooled down.

In dry cooling towers, the heated water is made to flow in circular elongated pipes. Again, the cold air blows are passed upon these pipes that help in bringing down the temperature of hot water.



Nuclear radiation has catastrophic effects on the health of humans such as foetus damage, leukemia, permanent physical deformation, skin burns and even death in case if the person comes in contact with severe radiations. It also releases toxic minerals in the environment causing pollution

### **CAUSES OF NUCLEAR POLLUTION**

- **Nuclear weapons testing-**

Beginning with the Second World War when Japan was subdued after the use of the nuclear bombs on the cities of Hiroshima and Nagasaki, countries have been in the race to develop their own nuclear arms, in the name of defence, but more to threaten rival nations. These were led by US, Russia, Britain, France and China. Nowadays N. Korea, Iran and many of the developing countries are equipped to build these weapons as well.

Testing the weapons involves explosions in the atmospheric layer called stratosphere. The exploded debris emitting radiation then falls back to the earth. Some of the radiation is absorbed by our atmosphere. But some of it reaches the earth falling on areas that are far away from the site where the weapon was released initially. This is called Fallout. When these particles settle on the vegetation and are consumed by animals they enter into the food chain. When fallout settles over the sea, the ecosystem of the sea gets affected and again entering the food chain.

- **Nuclear Power Plants**

Intense Nuclear energy from radioactive fuel is used to heat water to steam. The steam is then used to turn the turbines that in turn work the generators to produce electricity. Small amounts of radiation are released during this process into the water which may then dispose off indiscriminately causing nuclear pollution.

- **Improper disposal of spent nuclear fuel.**

Spent nuclear fuel contains very active radioactive atoms that remain so sometimes almost for 600yrs or more. These must be disposed of in a very careful manner, with strict regulations in well designated spaces. But the fact is many governments tend to approve of dumping nuclear fuel as far from their country as possible. The favourite dumping ground of many countries was the Pacific Ocean. Greenpeace an organisation dedicated to preserving the environment and saving the earth from pollution has brought attention to this activity and opposes it with fervour.

Some plants store spent fuel in underground water pools as these release a high amount of heat and need to be cooled down. There is always the danger of seepage into the land nearby, contaminating ground water and surrounding lands.

- **Accident/Damage to Nuclear power plants**

This most famous of these was the Chernobyl Nuclear Disaster in Russia in 1986. The fallout of this accident was felt over three countries- Russia, Ukraine and Belarus. The area surrounding the reactor is still polluted and not suitable for inhabitation or farming.

The other more recent accident was the Fukushima Daichii nuclear disaster on March 11<sup>th</sup>, 2011. An earthquake followed by a tsunami caused the main reactors and supplementary generators severe damage. Inadequate preparation to deal with an incident of this scale was also a factor that leads to hydrogen explosions and the seepage of radioactive material in the ground water.

### Effects of Nuclear Pollution

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The effect of nuclear pollution is seen on every organism in the environment from the bacteria to plants to human beings. Nothing is spared.

- The immediate and closest to the source, experience Radiation Sickness. In small doses of 75-200 rems. One experiences vomiting, fatigue and loss of appetite. At higher exposures of 300 rem and more changes in the blood cells and bleeding occurs. Above 600 rems there is loss of hair, loss of immunity usually resulting in death in a few days to weeks. Radiation causes changes in the cell and gene structure of rapidly multiplying cells of the body, such as bone marrow, skin, intestines, lymphoid tissue and embryo.
- Those exposed from a distance may not show any immediate symptom. But the tendency to develop various forms of cancers and have a shortened life span is seen. Radiation also causes cell mutations which can be transferred to the next generation.
- Foetuses are affected with birth defects and cancers. They may also have a shorter life span.
- Plants die and some show genetic changes and stunted growth. Animals are also affected and do not survive for too long.
- The radiation in the atmosphere will not dissipate quickly. Every water source will also be affected. In fact it may take years or centuries to reach a point where such a space may become habitable.
- An average person will be exposed to about 180 milli rem of radiation in a year from exposure to natural radiation, medical and dental X rays, Colour TVs, airport baggage X rays etc.

### Prevention of Nuclear pollution

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- Whilst undergoing procedures for X rays or radiation therapy, correct protection gear such as lead aprons must be worn. This includes pregnant women. Using lead sheathed walls in imaging facilities is also mandatory.
- As a lay person one must be aware of the dangers of nuclear pollution. If living in the vicinity of a nuclear plant or hearing of one being planned, one should use one's right to make sure the governing bodies are planning thoroughly on the building, implementing and disposal of the wastes. Make certain that the authorities are prepared in case of a disaster, to handle all the situations such as containing the contamination to arranging an evacuation.

- While working at a radiation facility or in nuclear plant workers are always monitored for the amount of radiation they have been exposed to.
- Radioactive wastes are actually recyclable to a good extent because usable fuel is still being created in the wasted material which can then be reprocessed.
- Governments are authorising research on developing better means for disposal of radioactive wastes. The most feasible method now appears to be deep underground storage of wastes.
- Power plants must ensure that the radioactive fuel and wastes are being transported and disposed of in safe containers which are long lasting and unbreakable.
- Governing agencies need to make sure that radioactive material does not fall into wrong hands that will, for a profit sell these to people who are in the business of war mongering.

Nuclear energy is a clean source of energy, inexpensive and extensive too. With a small amount of fuel a large amount of energy can be generated. Though there have been mishaps in the past and wrongful use of this energy, there is still great potential for it. Any well intentioned effort must be backed by good research, a well-designed plan and proper back up plans for any setbacks. The safety of the environment and the people must always come first.

### Solid waste management

Rapid population growth and urbanization in developing countries has led to people generating enormous quantities of solid waste and consequent environmental degradation. The waste is normally disposed in open dumps creating nuisance and environmental degradation. Solid wastes cause a major risk to public health and the environment. Management of solid wastes is important in order to minimize the adverse effects posed by their indiscriminate disposal.

**Types of solid wastes:** Depending on the nature of origin, solid wastes are classified into

1. URBAN OR MUNICIPAL WASTES
2. INDUSTRIAL WASTES and
3. HAZARDOUS WASTES

### SOURCES OF URBAN WASTES

Urban wastes include the following wastes:

**Domestic wastes** containing a variety of materials thrown out from homes

Ex: Food waste, Cloth, Waste paper, Glass bottles, Polythene bags, Waste metals, etc.

**Commercial wastes:** It includes wastes coming out from shops, markets, hotels, offices, institutions, etc.

Ex: Waste paper, packaging material, cans, bottle, polythene bags, etc.

**Construction wastes:** It includes wastes of construction materials.

Ex: Wood, Concrete, Debris, etc.

**Biomedical wastes:** It includes mostly waste organic materials

Ex: Anatomical wastes, Infectious wastes, etc.

### Classification of urban wastes

Urban wastes are classified into:

**Bio-degradable wastes** - Those wastes that can be degraded by micro organisms are called bio-degradable wastes

Ex: Food, vegetables, tea leaves, dry leaves, etc.

**Non-biodegradable wastes**: Urban solid waste materials that cannot be degraded by micro organisms are called non-biodegradable wastes.

Ex: Polythene bags, scrap materials, glass bottles, etc.

### SOURCES OF INDUSTRIAL WASTES

The main source of industrial wastes are chemical industries, metal and mineral processing industries.

Ex:

Nuclear plants: It generated radioactive wastes

Thermal power plants: It produces fly ash in large quantities

Chemical Industries: It produces large quantities of hazardous and toxic materials.

Other industries: Other industries produce packing materials, rubbish, organic wastes, acid, alkali, scrap metals, rubber, plastic, paper, glass, wood, oils, paints, dyes, etc.

### EFFECT OF IMPROPER SOLID WASTE MANAGEMENT

1. Due to improper disposal of municipal solid waste on the roads and immediate surroundings, biodegradable materials undergo decomposition producing foul smell and become a breeding ground for disease vectors.
2. Industrial solid wastes are the source for toxic metals and hazardous wastes that affect soil characteristics and productivity of soils when they are dumped on the soil
3. Toxic substances may percolate into the ground and contaminate the groundwater.
4. Burning of industrial or domestic wastes (cans, pesticides, plastics, radioactive materials and batteries) produce furans, dioxins and polychlorinated biphenyls that are harmful to human beings.

Solid waste management involves waste generation, mode of collection, transportation, segregation of wastes and disposal techniques.

### STEPS INVOLVED IN SOLID WASTE MANAGEMENT:

Two important steps involved in solid waste management are:

Reduce, Reuse and Recycle of Raw Materials

Discarding wastes

Reduce - If usage of raw materials is reduced, the generation of waste also gets reduced

**Reuse** - Refillable containers that are discarded after use can be reused

Rubber rings can be made from discarded cucle tubes and this reduces waste generation during manufacture of rubber bands.

**Recycle**- Recycling is the reprocessing of discarded materials into new useful products

Ex: Old aluminium cans and glass bottles are melted and recast into new cans and bottles

Preparation of cellulose insulation from paper

Preparation of automobile body and construction material from steel cans

This method (Reduce, Reuse & Recycle), i.e, 3R's help save money, energy, raw materials and reduces pollution.

### DISCARDING WASTES:

The following methods are adopted for discarding wastes:

1. Landfill
2. Incineration and
3. Composting

**LANDFILL:** Solid wastes are placed in a sanitary landfill in which alternate layers of 80 cm thick refuse is covered with selected earth-fill of 20 cm thickness. After 2-3 years solid waste volume shrinks by 25-30% and land is used for parks, roads and small buildings. This is the most common and cheapest method of waste disposal and is mostly employed in Indian cities.

**Advantages:**

It is simple and economical Segregation of wastes is not required Landfilled areas can be reclaimed and used for other purposes Converts low-lying, marshy waste-land into useful areas. Natural resources are returned to soil and recycled.

**Disadvantages:**

Large area is required Land availability is away from the town, transportation costs are high Leads to bad odour if landfill is not properly managed. Land filled areas will be sources of mosquitoes and flies requiring application of insecticides and pesticides at regular intervals. Causes fire hazard due to formation of methane in wet weather.

### INCINERATION:

It is a hygienic way of disposing solid waste. It is suitable if waste contains more hazardous material and organic content. It is a thermal process and very effective for detoxification of all combustible pathogens. It is expensive when compared to composting or land-filling. In this method municipal solid wastes are burnt in a furnace called incinerator. Combustible substances such as rubbish, garbage, dead organisms and non-combustible matter such as glass, porcelain and metals are separated before feeding to incinerators. The non-combustible materials can be left out for recycling and reuse. The leftover ashes and clinkers

may account for about 10 to 20% which need further disposal by sanitary landfill or some other means.

The heat produced in the incinerator during burning of refuse is used in the form of steam power for generation of electricity through turbines. Municipal solid waste is generally wet and has a high calorific value. Therefore, it has to be dried first before burning. Waste is dried in a preheater from where it is taken to a large incinerating furnace called "destructor" which can incinerate about 100 to 150 tonnes per hour. Temperature normally maintained in a combustion chamber is about 700 C which may be increased to 1000 C when electricity is to be generated.

#### ADVANTAGES

Residue is only 20-25% of the original and can be used as clinker after treatment  
 Requires very little space  
 Cost of transportation is not high if the incinerator is located within city limits  
 Safest from hygienic point of view  
 An incinerator plant of 3000 tonnes per day capacity can generate 3MW of power.

#### DISADVANTAGES

Its capital and operating cost is high  
 Operation needs skilled personnel  
 Formation of smoke, dust and ashes needs further disposal and that may cause air pollution.

#### COMPOSTING

It is another popular method practiced in many cities in our country. In this method, bulk organic waste is converted into fertilizer by biological action. Separated compostible waste is dumped in underground trenches in layers of 1.5m and finally covered with earth of 20cm and left for decomposition. Sometimes, actinomycetes are introduced for active decomposition. Within 2 to 3 days biological action starts. Organic matter is destroyed by actinomycetes and lot of heat is liberated increasing the temperature of compost by 75C and the refuse is finally converted into powdery brown coloured odourless mass called humus that has a fertilizing value and can be used in agriculture. Humus contains lot of Nitrogen essential for plant growth apart from phosphates and other minerals.

#### ADVANTAGES

Manure added to soil increases water retention and ion-exchange capacity of soil.  
 This method can be used to treat several industrial solid wastes.  
 Manure can be sold thereby reducing cost of disposing wastes  
 Recycling can be done

#### DISADVANTAGES

Non-consumables have to be disposed separately  
 The technology has not caught-up with the farmers and hence does not have an assured market.

### **Role of an Individual in Prevention of Pollution!**

Over population and pollution are potent ecological forces impinging upon man by affecting the quality of the environment. All efforts aimed at bringing more and more people above the poverty line actually increase the pressure on natural resources.

Careless management of natural resources is disrupting the ecological processes so much so that earth's life supporting capacity is being substantially threatened.

Unmindful exploitation of the finite resources of the biosphere has a severe ecological backlash because no development is sustainable unless it is environmentally compatible.

Environmental compatibility demands that the economic and social development should be linked with environmental management.

- (a) Control of environmental pollution
- (b) Conservation of natural resources
- (c) Land management
- (d) Development of non polluting sources of energy
- (e) Environmental education
- (f) Environmental laws.

Pollution is the burning issue of the day at the global level. A combined effort to control pollution has to be made by all government agencies, technologists, industrialists, agriculturists and last but not the least the common man.

5. An international conference on "Human Environments" was held in Stockholm in 1971, to emphasise the need to control pollution.

Efforts are required to be made by each individual to control pollution. These efforts include:

6. (a) Installation of proper sewage disposal methods.
7. (b) Dumping of non biodegradable wastes in low lying areas.
8. (c) Installation of gober gas plants in areas of high availability of cow dung.
9. (d) Reduction of smoke emission and treatment of chimney smoke to remove solid carbon particles.
10. (e) Judicious use of fertilisers, pesticides and detergents (Detergents of low- level phosphate content are less harmful).
11. (f) Growing plants like *Pyrus* (apple), *Pinus* (chir) and *Vitis* (grapes) is advocated because of their capability of metabolizing gaseous nitrogenous pollutants like nitrogen dioxide etc. and plants like *coleus*, *ficus* (banyan) can fix Carbon monoxide.
12. Skilled personnel with know-how to tackle the problems arising from pollution and for devising environmental pollution control measures are working in many institutions in India. Important ones amongst them are:
  13. (a) National Environmental Engineering Research Institute (NEERI), Nagpur.
  14. (b) Bhaba Atomic Research Centre (BARC), Mumbai
  15. (c) National Committee of Environmental Planning and Co-ordination (NCEPC), New Delhi.
  16. (d) Central Drug Research Institute (CDRI), Lucknow.
  17. (e) Councils of Scientific and Industrial Research (CSIR).
  18. (f) Central Public Health Engineering Research Institute (CPHERI), Nagpur.



19. Scientists have rightly said that, 'in the course of our progress from one age to another, we have simply passed from a say-age to sew-age.

### Disaster management

Disaster is a natural or human , caused phenomenon, which causes serious disruption of the functioning of a community or a society causing widespread human, material, economic and environmental losses which elicited the ability of the affected community, society to cope using its resources.

### **FLOODS ARE NATURAL PHENOMENA. FLOODS ARE WATER RELATED DISASTER**

A flood occurs when the Geomorphic Equilibrium in the river system is disturbed because of intrinsic or extrinsic factors or when a system crosses the geomorphic threshold. (a) Flooding in a river due to aggradations of river bed (intrinsic threshold); (b) Flooding in a river due to heavy rainfall (extrinsic threshold)

Floods in major cities especially during rainy season are proving to disastrous not only to the environment but also have serious implications for human life and property.

### **Types of floods**

- Flash floods
- River floods
- Coastal Floods
- Urban Flood

According to their duration flood can be divided into different categories: •Slow-Onset Floods: Slow Onset Floods usually last for a relatively longer period, it may last for one or more weeks, or even months. •Rapid-Onset Floods: Rapid Onset Floods last for a relatively shorter period, they usually last for one or two days only. •Flash Floods: Flash Floods may occur within minutes or few hours after heavy rainfall, tropical storm, failure of dams or levees or releases of ice dams. And it causes the greatest damages to society.

### **FLOODS IMPACTS**

- Human Loss
  - Property Loss
  - Affects the Major Roads
  - Disruption of Air / Train / Bus services
  - Spread of Water-borne Communicable Diseases
  - Communication Breakdown
  - Electricity Supply Cut off
  - Economic and Social Disruption
  - Increase in Air / Water Pollution
- 6/11/2013 Floods- Disaster Management

### **Flood forecasting**

- Anticipating floods before they occur allows for precautions to be taken and people to be warned so that they can be prepared in advance for flooding conditions.
- For example, – Farmers can remove animals from low-lying areas and utility services can put in place emergency provisions to re-route services if needed. Emergency services can also

make provisions to have enough resources available ahead of time to respond to emergencies as they occur.

- In order to make the most accurate flood forecasts for waterways, it is best to have a long time-series of historical data that relates stream flows to measured past rainfall events
- Radar estimates of rainfall and general weather forecasting techniques are also important components of good flood forecasting. **Flood Control**
  - In many countries around the world, waterways prone to floods are often carefully managed. Defences such as levees, bunds, reservoirs, and weirs are used to prevent waterways from overflowing their banks.
  - In the riparian zone near rivers and streams, erosion control measures can be taken to try and slow down or reverse the natural forces that cause many waterways to meander over long periods of time.
  - Flood controls, such as dams, can be built and maintained over time to try and reduce the occurrence and severity of floods as well. **Flood benefits**
    - Floods (in particular more frequent or smaller floods) can also bring many benefits, such as – Recharging ground water, – Making soil more fertile and increasing nutrients in some soils.
    - Flood waters provide much needed water resources in arid and semi-arid regions where precipitation can be very unevenly distributed throughout the year.
    - Freshwater floods particularly play an important role in maintaining ecosystems in river corridors and are a key factor in maintaining floodplain biodiversity.
    - Flooding can spread nutrients to lakes and rivers, which can lead to increased biomass and improved fisheries for a few years.
    - For some fish species, an inundated floodplain may form a highly suitable location for spawning with few predators and enhanced levels of nutrients or food.
    - Fish, such as the weather fish, make use of floods in order to reach new habitats. Bird populations may also profit from the boost in food production caused by flooding

## Earthquake

Earthquake is a natural disaster that can be broadly defined as a series of vibrations that are induced from the earth's crust. A sudden movement of the earth's crust, sudden release of extreme energy, shaking or trembling of the crust of the earth due to shifting of rocks under the earth's surface or underground volcanic forces can be called as earthquakes. This is often accompanied by terrible noise. These waves can sometimes traverse half a hemisphere destroying the cities completely. The location where earthquake starts is called hypocenter or focus. The location just above the hypocenter is called epicenter. The main earthquake is called main shock. There are many aftershocks that occur after the mainshock. The amount of energy released during earthquake is called magnitude.

## CAUSES OF EARTHQUAKES

Most of the scientists believe that earthquakes are formed due to the movement of the earth's plates. It is a very natural phenomenon and a theory commonly known as plate tectonics. As, we all know earth is divided into 3 layers namely – Crust, Mantle and Core. The

outermost layer of earth is known as the crust which is made up of granite and basalt. About 70% of the crust is ocean. The crust has several continental plates which drift every year. The second layer is called mantle. 80% of the earth is mantle. The mantle consists of lithosphere which is the upper mantle and asthenosphere which is the lower mantle. The core is the innermost layer of the earth. One third of the mass of the earth is core. The core has a liquid outer core made up of iron and it is very dense. It also has a solid inner core made of nickel and iron. The magnetic field of the earth is created when the liquid outer layer spins. So, as discussed above, the earth's crust is made up of several large and hard plates. These plates move slowly and continuously above the mantle. So collision and stress is caused among the plates. The stress among the plates can also occur when one plate goes over the other or when the sides of the plates collide. As the stress increases, the crust breaks and the energy is released. This released energy moves to and fro in the form of waves called seismic waves. Thus these naturally created waves shake the earth forming earthquakes.

### MEASUREMENT OF EARTHQUAKES

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The first widely used gadget for measuring earthquakes were the Richter scale which was developed by a Charles Richter in the year 1934. According to this scale, the largest wave was recorded in a seismometer and then the distance between the earthquake and the seismometer was measured. But unfortunately, the measurements in this Richter scale were not accurate. Main 2 devices are used by seismologist to measure earthquakes. They are: seismograph and seismoscope. Seismograph is an instrument to measure seismic waves of the earthquakes. Seismoscope is an instrument to measure the time or occurrence of earthquakes. Nowadays earthquakes are calculated by its magnitude and intensity. Logarithmic scale is the base for calculating magnitudes. This means that the higher the whole number on the magnitude, the motion recorded by the seismograph goes up ten times. This scale has no upper limit. Thus, magnitude is the amount of seismic energy at the hypocenter of the earthquakes. Intensity on the other hand is observed by the ground shaking of the people and buildings. This varies from place to place. According to the U.S geological center, the earthquakes are assigned to a class as per their magnitude. The classes are as under-

- Great : magnitude is 8.0 or above- tremendous damage
- Major : magnitude 7.0 – 7.9- heavy damage
- Strong : magnitude 6.0 – 6.9- severe damage
- Moderate : magnitude 5.0 – 5.9- considerable damage
- Light : magnitude 4.0 – 4.9- moderate damage
- Minor : magnitude 3.0 – 3.9- light damage
- Micro : magnitude less than 3.0- slight tremble.

### TYPES OF EARTHQUAKES

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There are many classifications for earthquakes. Some of the classifications are as under:

- On the basis of origin

- On the basis of dept of focus
- On the basis of magnitude and intensity

#### Origin:

On the basis of origin, earthquakes are divided into tectnotic and non tectnotic earthquakes.

Tectnotic earthquakes occur when the earth's plates shift due to some geographical force.

Non tectnotic earthquakes occur due to the surfaces and collapse of the cavity roofs.

Dept of focus:

Here the depth of the focus is measured and further analyzed by seismograph. Here the further sub divisions are:

- Surface earthquakes : these earthquakes have depth of focus of less than 10,000 meters and are called surface earthquakes.
- Normal earthquakes : these earthquakes have depth of focus between 10-50 kilometers and are called normal earthquakes.
- Intermediate earthquakes : these earthquakes have depth of focus between 50-300 kilometers and are called intermediate earthquakes.
- Deep earthquakes : these earthquakes have depth of focus between 500-700 kilometers and are called deep earthquakes.

Magnitude and intensity :

Sometimes earthquakes are measured on the basis of magnitude i.e. the amount of seismic energy at the epicenter and intensity i.e. the total damage and destruction caused due to earthquakes.

Earthquakes can be again classified into:

- Shallow fault earthquakes : When the rock breaks under the feet it is called a fault. So earthquakes occur within and through these faults. These faults are close to the surface of the earth, a small quake can cause a lot of damage.
- Subduction zone earthquakes : These earthquakes happen in the Subduction area of the earth along the Subduction zone. Huge shift in land level happens during this earthquake. The waves that occur are tremendously high and spread over a larger area.
- Deep earthquakes : These earthquakes occur in the deep ocean slabs beneath the continental crust of the earth.

#### EFFECTS OF EARTHQUAKES

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1. Causes widespread damage and loss of human life.
2. Causes ground displacement along the fault.
3. The shaking of the ground causes landslides and avalanches.
4. Causes rupturing of dams and can cause floods and tsunamis.
5. The broken electric lines and gas lines due to the earthquakes can cause fire.
6. Kills and injures hundreds.
7. The entire city can be devastated.

### 8. Liquefaction of the soil takes place

To conclude, earthquakes are the most powerful and destructive natural force which is hazardous to mankind. Earthquakes are unpredictable disasters that arise with no warning and have plagued humans throughout history. The energy released earthquakes fracture the surface of the earth. Forecasting earthquakes are a bit difficult but earthquake warning systems have been developed. Earthquake engineering and earthquake insurance have to be developed in a larger angle so as to prepare for the aftereffects. But not all earthquakes are bad. Sometimes when earthquakes are created, it has even created notable landmarks in the world. So the place of occurrence is very important before stamping it as good or bad.

### Land slides

A landslide is defined as the movement of a mass of rock, debris, or earth down a slope. Landslides are a type of "mass wasting," which denotes any down-slope movement of soil and rock under the direct influence of gravity. The term "landslide" encompasses five modes of slope movement: falls, topples, slides, spreads, and flows. These are further subdivided by the type of geologic material (bedrock, debris, or earth). Debris flows (commonly referred to as mudflows or mudslides) and rock falls are examples of common landslide types.

### Causes of Landslides

#### Natural Causes of Landslides

##### Climate

Long-term climatic changes can significantly impact soil stability. A general reduction in precipitation leads to lowering of water table and reduction in overall weight of soil mass, reduced solution of materials and less powerful freeze-thaw activity.

##### Earthquakes

Seismic activities have, for a long time, contributed to landslides across the globe. Any moment tectonic plates move, the soil covering them also moves along.

### 3. Weathering

Weathering is the natural procedure of rock deterioration that leads to weak, landslide-susceptible materials. Weathering is brought about by the chemical action of water, air, plants and bacteria.

### 4. Erosion

Erosion caused by sporadic running water such as streams, rivers, wind, currents, ice and waves wipes out latent and lateral slope support enabling landslides to occur easily.

### 5. Volcanoes

Volcanic eruptions can trigger landslides. If an eruption occurs in a wet condition, the soil will start to move downhill instigating a landslide. Stratovolcano is a typical example of volcano responsible for most landslides across the globe.

### 6. Forest fires

Forest fires instigate soil erosion and bring about floods, which might lead to landslides

### 7. Gravity

Steeper slopes coupled with gravitational force can trigger a massive landslide.

### Human causes of landslides

#### 1. Mining

Mining activities that utilize blasting techniques contribute mightily to landslides. Vibrations emanating from the blasts can weaken soils in other areas susceptible to landslides. The weakening of soil means a landslide can occur anytime.

#### 2. Clear cutting

Clear cutting is a technique of timber harvesting that eliminates all old trees from the area. This technique is dangerous since it decimates the existing mechanical root structure of the area.

### Effects of Landslides

#### 1. Lead to economic decline

Landslides have been verified to result in destruction of property. If the landslide is significant, it could drain the economy of the region or country. After a landslide, the area affected normally undergoes rehabilitation. This rehabilitation involves massive capital outlay. For example, the 1983 landslide at Utah in the United States resulted in rehabilitation cost of about \$500 million. The annual loss as a result of landslides in U.S. stands at an estimated \$1.5 billion.

#### 2. Decimation of infrastructure

The force flow of mud, debris, and rocks as a result of a landslide can cause serious damage to property. Infrastructure such as roads, railways, leisure destinations, buildings and communication systems can be decimated by a single landslide.

#### 3. Loss of life

Communities living at the foot of hills and mountains are at a greater risk of death by landslides. A substantial landslide carries along huge rocks, heavy debris and heavy soil with it.

#### 4. Affects beauty of landscapes

The erosion left behind by landslides leaves behind rugged landscapes that are unsightly. The pile of soil, rock and debris downhill can cover land utilized by the community for agricultural or social purposes.

#### 5. Impacts river ecosystems

The soil, debris, and rock sliding downhill can find way into rivers and block their natural flow. Many river habitats like fish can die due to interference of natural flow of water. Communities depending on the river water for household activities and irrigation will suffer if flow of water is blocked.

### Types of Landslides

#### • Falls

Falls are sudden movements of loads of soil, debris, and rock that break away from slopes and cliffs. Falls landslides occur as a result of mechanical weathering, earthquakes, and force of gravity.

#### • Slides

This is a kind of mass movement whereby the sliding material breakaways from underlying stable material. The kinds of slides experienced during this type of landslide include rotational and transitional. Rotational slides are sometimes known as slumps since they move with rotation.

Transitional slides consist of a planer or 2 dimensional surface of rupture. They involve landslide mass movement following a roughly planar surface with reduced rotation or backward slanting. Slides occur when the toe of the slope is undercut. They move moderately, and the consistency of material is maintained.

- **Topples**

Topple landslides occur when the topple fails. Topple failure encompasses the forward spinning and movement of huge masses of rock, debris, and earth from a slope. This type of slope failure takes place around an axis near or at the bottom of the block of rock. A topple landslide mostly lead to formation of a debris cone below the slope. This pile of debris is known as a Talus cone.

- **Spreads**

They are commonly known as lateral spreads and takes place on gentle terrains via lateral extension followed by tensile fractures.

- **Flows**

This type of landslide is categorized into five; earth flows, debris avalanche, debris flow, mudflows, and creep, which include seasonal, continuous and progressive.

Flows are further subcategorized depending upon the geological material, for example, earth, debris, and bedrock. The most prevalent occurring landslides are rock falls and debris flow.





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