Ability Enhancement Compulsory Course (AECC-I)

Environmental Studies

Unit 5: Environmental Pollution

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Syllabus

Unit 5

Environmental Pollution (8 lectures)

- Environmental pollution (Air, water, soil, thermal, and noise): causes, effects, and controls; Primary and secondary air pollutants; Air and water quality standards
- Nuclear hazards and human health risks
- Solid waste management: Control measures for various types of urban, industrial waste, Hazardous waste, E-waste, etc; Waste segregation and disposal
- Pollution case studies: Ganga Action plan (GAP), Delhi air pollution and public health issues, Plastic waste management rules, Bhopal gas tragedy, etc

इकाई 5 : पर्यावरण प्रदूषण

- पर्यावरण प्रदूषण: प्रकार, कारण, प्रभाव और नियंत्रण; वायु, जल, मृदा और ध्वनि प्रदूषण
- नाभिकीय खतरे और मानव स्वास्थ्य पर जोखिम
- ठोस अपशिष्ट प्रबंधन: शहरी और औद्योगिक अपशिष्ट के उपाय एवं नियतंत्रन।
- प्रदूषण के प्रकरण अध्ययन।

- **Pollution**: effect of undesirable changes in our surroundings that have harmful effects on plants, animals and human beings. Occurs when only short-term economic gains are made at the cost of the long-term ecological benefits for humanity. No natural phenomenon has led to greater ecological changes than have been made by mankind.
- Ecological perspective pollutants can be classified as follows:
- **Degradable or non-persistent pollutants**: These can be rapidly broken down by natural processes. Eg: domestic sewage, discarded vegetables, etc.
- Pollutants that remain in the environment **Slowly degradable or persistent pollutants**: for many years in an unchanged condition and take decades or longer to degrade. Eg: DDT and most plastics.
- **Non-degradable pollutants**: These cannot be degraded by natural processes. Once they are released into the environment they are difficult to eradicate and continue to accumulate. Eg: toxic elements like lead or mercury.

POLLUTION

Definition

Pollution is an undesirable change in physical, chemical and biological characteristics of our land, air or water caused by excessive accumulation of pollutants (i.e. Substances which cause pollution).

KINDS OF POLLUTION

The pollution is of four major types namely air pollution, water pollution, land pollution and noise pollution.

In terms of origin it may be natural or anthropogenic (man-made).

MORE TO KNOW

Black Lung disease

It is common among coal miners due to the inhalation of carbon particulates which lead to Lung Cancer.

Sources of Air Pollution

A. Natural Sources: can be thunderstorms, emissions of gases and particulates from forest fires, methane emissions from marshy lands, bioaerosols from pollen grains, volatile organic compounds emissions from trees and plant species, volcanic eruptions generates sulphur dioxides emissions and decomposition of organic matter emits carbon dioxide and methane.

Anthropogenic Sources: gasoline exhaust emissions, industrial emissions, mining activities, cooking fuels, construction works, fireworks etc. The details of each emission source categories are as follows:

i. Household works: Coal combustion generates enormous amount of smoke, soot, dust, CO, SO2, NOx. However, burning of LPG releases fewer amounts of pollutants comparatively.

ii. Gasoline Exhaust: Different categories of vehicles like 2 wheelers, 4 wheelers, heavy duty vehicles, etc. release a number of gaseous air pollutants and particulate matter. They mainly includes NOx, SOx, VOCs, CO, O3, PM10, PM2.5 and sometimes lead. Vehicles contribute approximately 70% of air pollution (major source of primary and secondary air pollutants)

iii. Industries:

Industries: a. Chemical Industries: generate SOx, NOx, VOCs and PM. b. Coal Powered Plants: SO2, CO, NOx and PM. c. Electroplating and metallurgical Industries: CO, CO2, NOx, PM, cooper, lead etc.

. Gasoline-fuel industries: petroleum, diesel which emits

Agricultural Practices: agriculturally based chemical fertilizers which includes pesticides and herbicides like chlorinated hydrocarbons, etcOCs, NOx, SOx, CO, PM, O3 etc.

Paper manufacturing industries: PM10, PM2.5, SO2 etc.

Structure of the atmosphere

The atmosphere is normally composed of 79 percent nitrogen, 20 percent oxygen and one percent as a mixture of carbon dioxide, water vapour and trace amounts of several other gases such as neon, helium, methane, krypton, hydrogen and xenon. The general structure of the atmosphere has several important features that have relevance to environmental problems. The atmosphere is divided into several layers.

The innermost layer the *troposphere* extends 17 kilometers above sea level at the equator and about 8 kilometers over the poles. It contains about 75 percent of the mass of the earth's air. The fragility of this layer is obvious from the fact that if the earth were an apple this particular layer would be no thicker than an apple's skin.

Temperature declines with altitude in the troposphere. At the top of the troposphere temperatures abruptly begin to rise. This boundary where this temperature reversal occurs is called the tropopause.

The tropopause marks the end of the troposphere and the beginning of the *stratosphere*, the second layer of the atmosphere. The stratosphere extends from 17 to 48 kilometers above the earth's surface. While the composition of the stratosphere is similar to that of the troposphere it has two major differences. The volume of water vapour here is about 1000 times less while the volume of ozone is about 1000 times greater. The presence of ozone in the stratosphere prevents about 99 percent of the sun's harmful ultraviolet radiation from reaching the earth's surface thus protecting humans from cancer and damage to the immune system. This layer does not have clouds and hence airplanes fly in this layer as it creates less turbulence. Temperature rises with altitude in the stratosphere until there is another reversal. This point is called the stratopause and it marks the end of the stratosphere and the beginning of the atmosphere's next layer, the mesosphere.

In the *mesosphere* the temperature decreases with altitude falling up to –110 oC at the top. Above this is a layer where ionization of the gases is a major phenomenon, thus increasing the temperature. This layer is called the *thermosphere*. Only the lower troposphere is routinely involved in our weather and hence air pollution. The other layers are not significant in determining the level of air pollution.

AIR POLLUTION

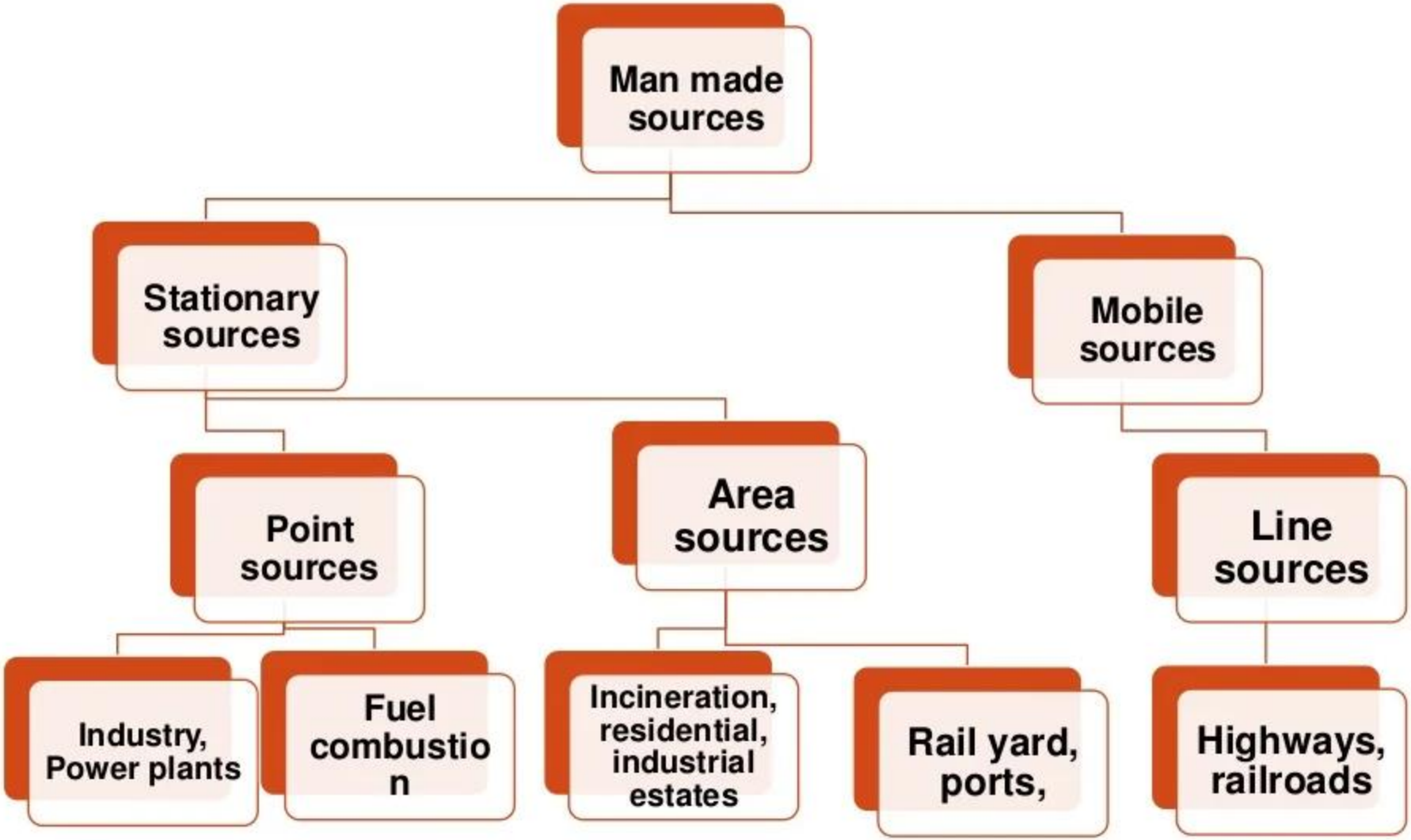
Degradation of air quality and natural atmospheric condition constitute air pollution. The air pollutant may be a gas or particulate matter.

Air pollutants and their effects

Particulate matter – it comprises of small suspended particles such as soot, dust, pesticides, etc., and biological agents (bioaerosols) such as spores, pollen and dust mites. It causes respiratory ailments such as asthma, chronic bronchitis, emphysema etc.,

Carbon monoxide – is a product of incomplete combustion of fossil fuels in automobiles. It is highly poisonous to most animals. When inhaled, carbon monoxide reduces the oxygen carrying capacity of blood.

Man made sources



Types of particulates

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

- Pollutants that are emitted directly from identifiable sources are produced both by natural events (for example, dust storms and volcanic eruptions) and human activities (emission from vehicles, industries, etc.). These are called **primary pollutants.** There are 90% of the primary pollutants that together contribute about total air pollution. These are carbon oxides (CO and CO2), nitrogen oxides, sulphur oxides, volatile organic compounds (mostly hydrocarbons) and suspended particulate matter.

- Pollutants that are produced in the atmosphere when certain chemical reactions take place among the primary pollutants are called secondary pollutants. Eg: Acid rain (Sulfuric acid, nitric acid, carbonic acid), Ozone, PAN etc

Air pollutants and their effects

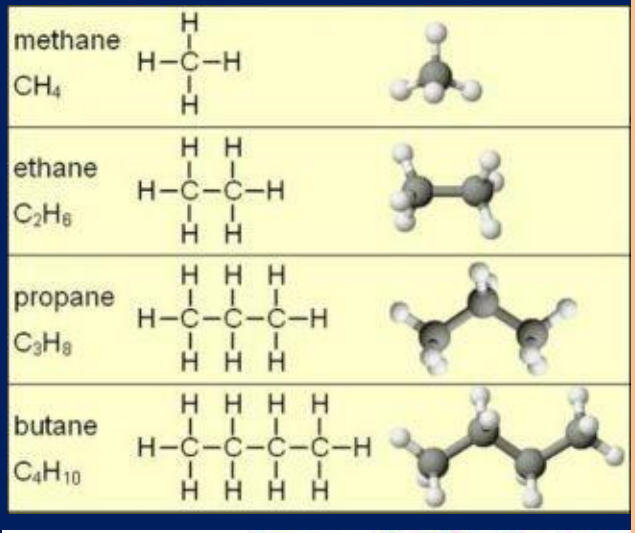
Hydrocarbons – hydrocarbons such as methane, are evolved from soil microbes (methanogens) in flooded rice fields and swamps. They are also generated during the burning of coal and petroleum products.

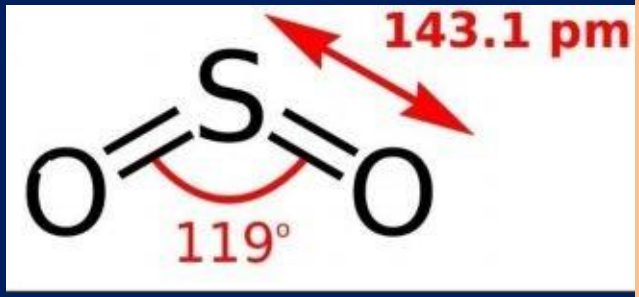
Sulphur dioxide – is released from oil refineries and ore smelters which use the sulphur containing fuels. It causes harmful effects on plants and animals. It causes chlorosis (loss of chlorophyll) and necrosis (localised death of tissues). In human, it causes health problems such as asthma, bronchitis and emphysema.

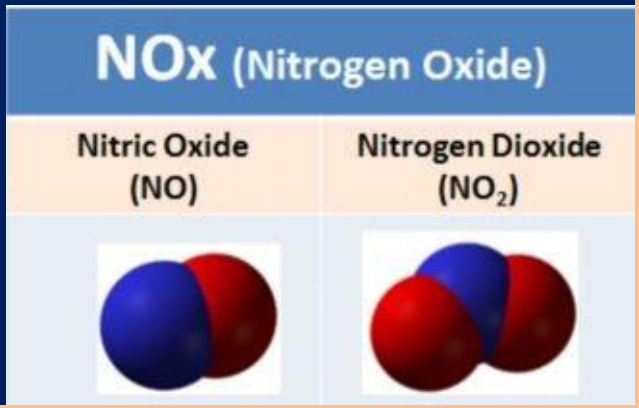
Nitrogen oxides – It causes reddish brown haze (brown air) in traffic congested city air which contributes to heart and lung problems.

PM: PM10, PM2.5 and PM1:

Bioaerosols: allergic reaction





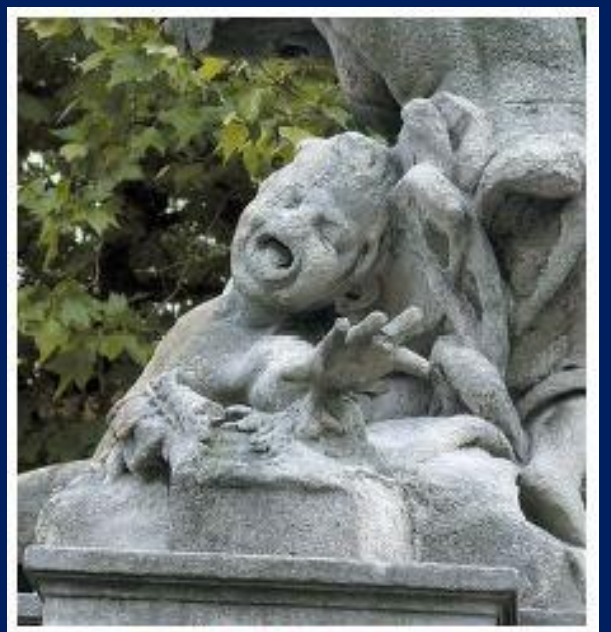


Secondary effects of air pollution

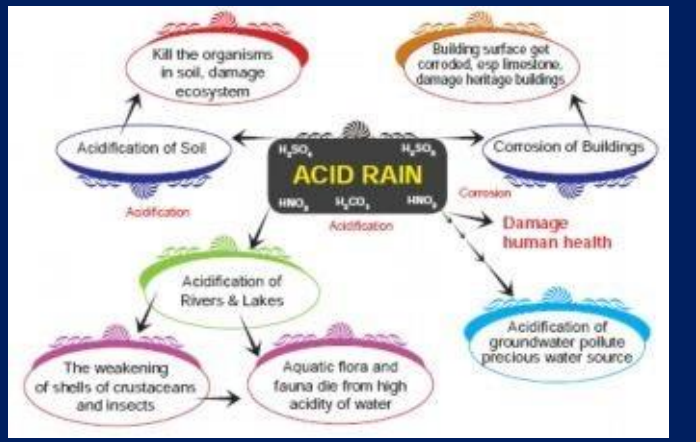
Photochemical smog – Smog is a mixture of smoke and fog. It is formed in the atmosphere under the influence of sunlight by the photochemical reactions of hydrocarbons, oxides of nitrogen and oxygen, resulting in the formation of PAN (Peroxy Acetyl Nitrate).

PAN damages the chlorophyll and thus reduces photosynthesis and growth. It also causes acute irritation of eyes and throat. Visibility of the surrounding is reduced due to smog.

Acid rain – gases such as Sulphur di oxide and Nitrogen oxides are oxidized to form sulphuric and nitric acids along with water, and precipitate as acid rain. It damages building materials, plants and animals. It also makes the soil acidic.



Sculpture affected by acid rain



ral causes such as volcanoes, which release ash, dust, sulphur and other gases, or by forest fires that are occasionally naturally caused by lightning. However, unlike pollutants from human activity, naturally occurring pollutants tend to remain in the atmosphere for a short time and do not lead to permanent atmospheric change.

Pollutants that are emitted directly from identifiable sources are produced both by natural events (for example, dust storms and volcanic eruptions) and human activities (emission from vehicles, industries, etc.). These are called *primary pollutants*. There are five primary pollutants that together contribute about 90 percent of the global air pollution. These are carbon oxides (CO and CO2), nitrogen oxides, sulfur oxides, volatile organic compounds (mostly hydrocarbons) and suspended particulate matter.

Pollutants that are produced in the atmosphere when certain chemical reactions take place among the primary pollutants are called *secondary pollutants*. Eg: sulfuric acid, nitric acid, carbonic acid, etc.

Carbon monoxide is a colourless, odorless and toxic gas produced when organic materials such as natural gas, coal or wood are incompletely burnt. Vehicular exhausts are the single largest source of carbon monoxide. The number of vehicles has been increasing over the years all over the world. Vehicles are also poorly maintained and several have inadequate pollution control equipment resulting in release of greater amounts of carbon monoxide. Carbon monoxide is however not a persistent pollutant. Natural processes can convert carbon monoxide to other compounds that are not harmful. Therefore the air can be cleared of its carbon monoxide if no new carbon monoxide is introduced into the atmosphere.

Sulfur oxides are produced when sulfur containing fossil fuels are burnt.

Nitrogen oxides are found in vehicular exhausts. Nitrogen oxides are significant, as they are involved in the production of secondary air pollutants such as ozone.

Hydrocarbons are a group of compounds consisting of carbon and hydrogen atoms. They either evaporate from fuel supplies or are remnants of fuel that did not burn completely. Hydrocarbons are washed out of the air when it rains and run into surface water. They cause an oily film on the surface and do not as such cause a serious issue until they react to form secondary pollutants. Using higher oxygen concentrations in the fuel-air mixture and using valves to prevent the escape of gases, fitting of catalytic converters in automobiles, are some of the modifications that can reduce the release of hydrocarbons into the atmosphere.

Particulates are small pieces of solid material (for example, smoke particles from fires, bits of asbestos, dust particles and ash from industries) dispersed into the atmosphere. The effects of particulates range from soot to the carcinogenic (cancer causing) effects of asbestos, dust particles and ash from industrial plants that are dispersed into the atmosphere. Repeated exposure to particulates can cause them to accumulate in the lungs and interfere with the ability of the lungs to exchange gases.

Lead is a major air pollutant that remains largely unmonitored and is emitted by vehicles. High lead levels have been reported in the ambient air in metropolitan cities. Leaded petrol is the primary source of airborne lead emissions in Indian cities.

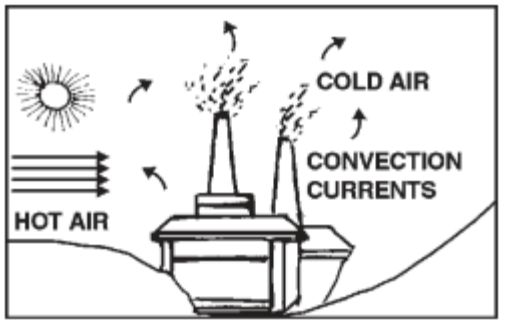
Pollutants are also found indoors from infiltration of polluted outside air and from various chemicals used or produced inside buildings. Both indoor and outdoor air pollution are equally harmful.

What happens to pollutants in the atmosphere?

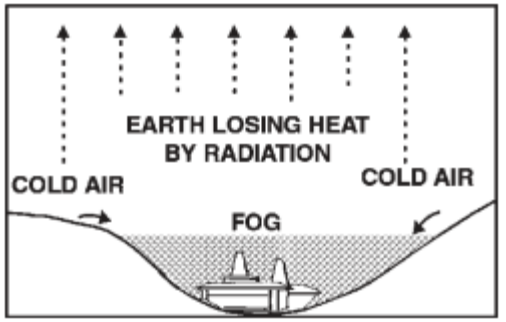
Once pollutants enter the troposphere they are transported downwind, diluted by the large volume of air, transformed through either physical or chemical changes or are removed from the atmosphere by rain during which they are attached to water vapour that subsequently forms rain or snow that falls to the earth's surface. The atmosphere normally disperses pollutants by mixing them in the very large volume of air that covers the earth. This dilutes the pollutants to acceptable levels. The rate of dispersion however varies in relation to the following aspects:

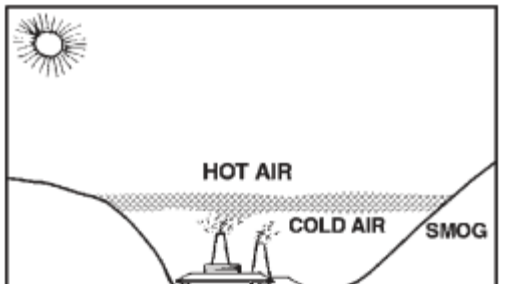
Topography

Normally as the earth's surface becomes warmed by sunlight the layer of air in contact with the ground is also heated by convection. This warmer air is less dense than the cold air above it, so it rises. Thus pollutants produced in the surface layer are effectively dispersed.



However on a still evening, the process is reversed. An hour or two before sunset after a sunny day, the ground starts to lose heat and the air near the ground begins to cool rapidly. Due to the absence of wind, a static layer of cold air is produced as the ground cools. This in turn induces condensation of fog. The morning sun cannot initially penetrate this fog layer. The cold air being dense cannot rise and is trapped by the warm air above. It cannot move out of the area due to the surrounding hills. The topographic features resemble a closed chemical reactor in which the pollutants are trapped. This condition often continues through the cool night and reaches its maximum intensity before sunrise. When the morning sun warms the ground the air near the ground also warms up and rises within an hour or two. This may be broken up by strong winds. In cold regions this situation can persist for several days. Such a situation is known as smog (smoke + fog).

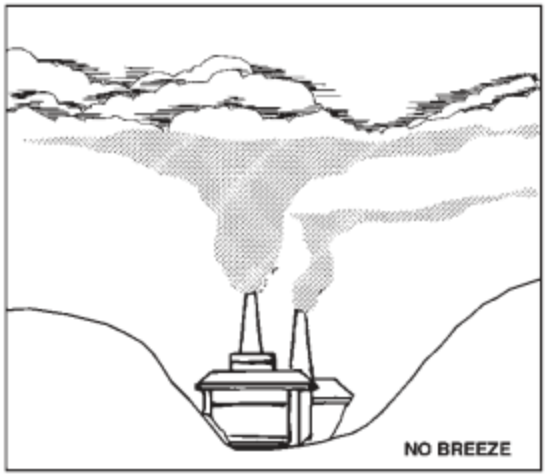


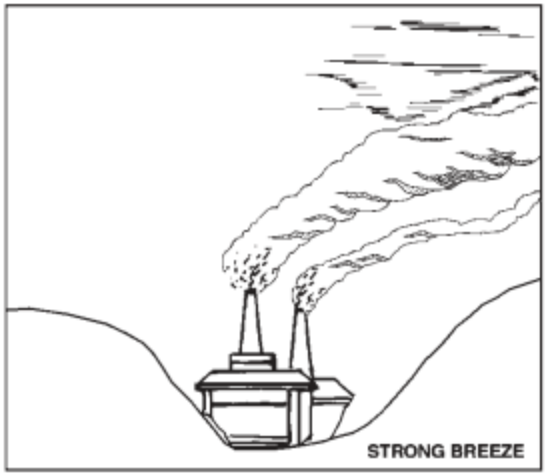


The most well known example is that of the 'London Smog' that occurred in 1952. The city used large quantities of sulphur containing coal for domestic heating that released smoke, with smoke from thermal power plant other industrial establishments. This used to lead to the generation of high levels of smoke containing sulphur oxides. Due to a sudden adverse meteorological condition air pollutants like smoke and sulphur oxides started to build-up in the atmosphere. The white fog accumulated over the city turned black forming a 'pea-soup' smog with almost zero visibility. Within two days of the formation of this smog, people started suffering from acute pulmonary disorders which caused irritation of bronchi, cough, nasal discharges, sore throat, vomiting and burning sensations in the eyes. This event lead to several deaths.

Meteorological conditions

The velocity of the wind affects the dispersa
pollutants. Strong winds mix polluted air m
rapidly with the surrounding air diluting
pollutants rapidly. When wind velocity is
mixing takes place and the concentration
pollutants remains high.





When sulphur dioxide and nitrogen oxides are transported by prevailing winds they form secondary pollutants such as nitric acid vapour, droplets of sulfuric acid and particles of sulphate and nitrate salts. These chemicals descend on the earth's surface in two forms: wet (as acidic rain, snow, fog and cloud vapour) and dry (as acidic particles). The resulting mixture is called acid deposition, commonly called *acid rain*.

Acid deposition has many harmful effects especially when the pH falls below 5.1 for terrestrial systems and below 5.5 for aquatic systems. It contributes to human respiratory diseases such as bronchitis and asthma, which can cause premature death. It also damages statues, buildings, metals and car finishes. Acid deposition can damage tree foliage directly but the most serious effect is weakening of trees so they become more susceptible to other types of damage. The nitric acid and the nitrate salts in acid deposition can lead to excessive soil nitrogen levels. This can over stimulate growth of other plants and intensify depletion of other important soil nutrients such as calcium and magnesium, which in turn can reduce tree growth and vigour.

Effect of Air Pollution

Effects of air pollution on living organisms

Our respiratory system has a number of mechanisms that help in protecting us from air pollution. The hair in our nose filters out large particles. The sticky mucus in the lining of the upper respiratory tract captures smaller particles and dissolves some gaseous pollutants. When the upper respiratory system is irritated by pollutants sneezing and coughing expel contaminated air a Arun cus. Prolonged smoking or exposure to air pollutants can overload or breakdown these natural defenses causing or contributing to diseases such as lung cancer, asthma, chronic bronchitis and emphysema. Elderly people, infants, pregnant women and people with heart disease, asthma or other respiratory diseases are especially vulnerable to air pollution.

Cigarette smoking is responsible for the greatest exposure to carbon monoxide. Exposure to air containing even 0.001 percent of carbon monoxide for several hours can cause collapse, coma and even death. As carbon monoxide remains attached to hemoglobin in blood for a long time, it accumulates and reduces the oxygen carrying capacity of blood. This impairs perception and thinking, slows reflexes and causes headaches, drowsiness, dizziness and nausea. Carbon monoxide in heavy traffic causes headaches, drowsiness and blurred vision.

Sulfur dioxide irritates respiratory tissues. Chronic exposure causes a condition similar to bronchitis. It also reacts with water, oxygen and other material in the air to form sulfur-containing acids. The acids can become attached to particles which when inhaled are very corrosive to the lung.

Nitrogen oxides especially NO_2 can irritate the lungs, aggravate asthma or chronic bronchitis and also increase susceptibility to respiratory infections such as influenza or common colds.

Suspended particles aggravate bronchitis and asthma. Exposure to these particles over a long period of time damages lung tissue and contributes to the development of chronic respiratory disease and cancer.

Many volatile organic compounds such as (benzene and formaldehyde) and toxic particulates (such as lead, cadmium) can cause mutations, reproductive problems or cancer. Inhaling ozone, a component of photochemical smog causes coughing, chest pain, breathlessness and irritation of the eye, nose and the throat.

Effects on plants

When some gaseous pollutants enter leaf pores they damage the leaves of crop plants. Chronic exposure of the leaves to air pollutants can break down the waxy coating that helps prevent excessive water loss and leads to damage from diseases, pests, drought and frost. Such exposure interferes with photosynthesis and plant growth, reduces nutrient uptake and causes leaves to turn yellow, brown or drop off altogether. At a higher concentration of sulphur dioxide majority of the flower buds become stiff and hard. They eventually fall from the plants, as they are unable to flower.

Prolonged exposure to high levels of several air pollutants from smelters, coal burning power plants and industrial units as well as from cars and trucks can damage trees and other plants.

Effects of air pollution on materials

Every year air pollutants cause damage worth billions of rupees. Air pollutants break down exterior paint on cars and houses. All around the world air pollutants have discoloured irreplaceable monuments, historic buildings, marble statues, etc.

Effects of air pollution on the stratosphere

The upper stratosphere consists of considerable amounts of ozone, which works as an effective screen for ultraviolet light. This region called the ozone layer extends up to 60 kms above the surface of the earth. Though the ozone is present upto 60 kms its greatest density remains in the region between 20 to 25 kms. The ozone layer does not consist of solely ozone but a mixture of other common atmospheric gases. In the most dense ozone layer there will be only one ozone molecule in 100,000 gas molecules. Therefore even small changes in the ozone concentration can produce dramatic effects on life on earth.

The total amount of ozone in a 'column' of air from the earth's surface upto an altitude of 50 km is the *total column ozone*. This is recorded in *Dobson Units (DU)*, a measure of the thickness of the ozone layer by an equivalent layer of pure ozone gas at normal temperature and pressure at sea level. This means that 100 DU=1mm of pure ozone gas at normal temperature and pressure at sea level.

Ozone is a form of oxygen with three atoms instead of two. It is produced naturally from the photodissociation of oxygen gas molecules in the atmosphere. The ozone thus formed is constantly broken down by naturally occurring processes that maintain its balance in the ozone layer. In the absence of pollutants the creation and breakdown of ozone are purely governed by natural forces, but the presence of certain pollutants can accelerate the breakdown of ozone. Though it was known earlier that ozone shows fluctuations in its concentrations which may be accompanied sometimes with a little ozone depletion, it was only in 1985 that the large scale destruction of the ozone also called the Ozone Hole came into limelight when some British researchers published measurements about the ozone layer.

Soon after these findings a greater impetus was given to research on the ozone layer, which convincingly established that CFC's were leading to its depletion. These CFCs (chloro-fluro-carbons) are extremely stable, non-flammable, non-toxic and harmless to handle. This makes them ideal for many industrial applications like aerosols, air conditioners, refrigerators and fire extinguishers. Many cans, which give out foams and sprays, use CFCs. (eg: perfumes, room fresheners, etc.) CFCs are also used in making foams for mattresses and cushions, disposable Styrofoam cups, glasses, packaging material for insulation, cold storage etc. However their stability also gives them a long life span in the atmosphere.

Halons are similar in structure to the CFCs but contain bromine atoms instead of chlorine. They are more dangerous to the ozone layer than CFCs. Halons are used as fire extinguishing agents as they do not pose a harm to people and equipment exposed to them during fire fighting.

The CFCs and the halons migrate into the upper atmosphere after they are released. As they are heavier than air they have to be carried by air currents up to just above the lower atmosphere and then they slowly diffuse into the upper atmosphere. This is a slow process and can take as long as five to fifteen years. In the stratosphere unfiltered UV-radiation severs the chemical bonds releasing chlorine from the rest of the CFC. This attacks the ozone molecule resulting in its splitting into an oxygen molecule and an oxygen atom.

Despite the fact that CFCs are evenly distribute over the globe, the ozone depletion is especially pronounced over the South Pole due to the extreme weather conditions in the Antarctic atmosphere. The presence of the ice crystals makes the Cl-O bonding easier. The ozone layer over countries like Australia, New Zealand, South Africa and parts of South America is also depleted.

India has signed the Montreal Protocol in 1992, which aims to control the production and consumption of Ozone Depleting Substances.

Ozone depletion-What does it do?

Changes in the ozone layer have serious implications for mankind.

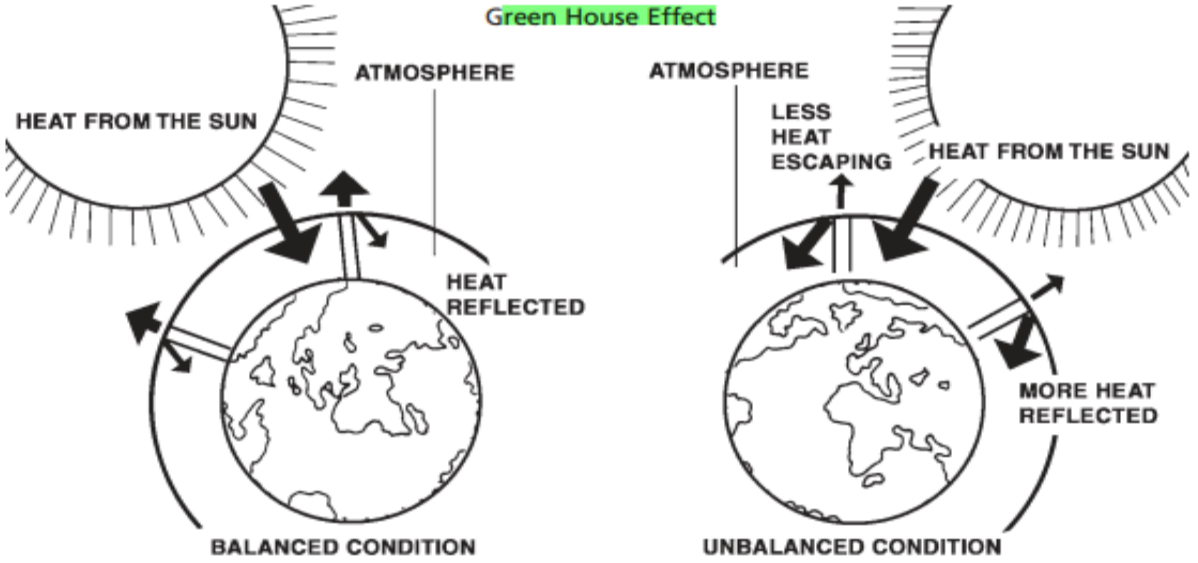
Effects on human health: Sunburn, cataract, aging of the skin and skin cancer are caused by increased ultra-violet radiation. It weakens the immune system by suppressing the resistance of the whole body to certain infections like measles, chicken pox and other viral diseases that elicit rash and parasitic diseases such as malaria introduced through the skin.

Food production: Ultra violet radiation affects the ability of plants to capture light energy during the process of photosynthesis. This reduces the nutrient content and the growth of plants. This is seen especially in legumes and cabbage.

Plant and animal planktons are damaged by ultra-violet radiation. In zooplanktons (microscopic animals) the breeding period is shortened by changes in radiation. As planktons form the basis of the marine food chain a change in their number and species composition influences fish and shell fish production.

Effect on materials: Increased UV radiation damages paints and fabrics, causing them to fade faster.

Effect on climate: Atmospheric changes induced by pollution contribute to global warming, a phenomenon which is caused due to the increase in concentration of certain gases like carbon dioxide, nitrogen oxides, methane and CFCs. Observations of the earth have shown beyond doubt that atmospheric constituents such as water vapour, carbon dioxide, methane, nitrogen oxides and Chloro Fluro Carbons trap heat in the form of infra-red radiation near the earth's surface. This is known as the **'Greenhouse Effect'.** The phenomenon is similar to what happens in a greenhouse. The glass in a greenhouse allows solar radiation to enter which is absorbed by the objects inside. These objects radiate heat in the form of terrestrial radiation, which does not pass out through the glass. The heat is therefore trapped in the greenhouse increasing the temperature inside and ensuring the luxuriant growth of plants.



There could be several adverse effects of global warming.

- With a warmer earth the polar ice caps will melt causing a rise in ocean levels and flooding of coastal areas.
- In countries like Bangladesh or the Maldives this would be catastrophic. If the sea level rises by 3m., Maldives will disappear completely beneath the waves.
- The rise in temperature will bring about a fall in agricultural produce.
- Changes in the distribution of solar energy can bring about changes in habitats. A previously productive agricultural area will suffer severe droughts while rains will fall in locations that were once deserts. This could bring about changes in the species of natural plants, agricultural crops, insects, livestock and micro-organisms.
- In the polar regions temperature rises caused by global warming would have disastrous effects. Vast quantities of methane are trapped beneath the frozen soil of Alaska. When the permafrost melts the methane that will be released can accelerate the process of global warming.

Control of Air Pollution

1. The particulates emitted by industries should be controlled by devices such as scrubbers, cyclone precipitators and filters.
2. Use of unleaded or low sulphur fuel is to be encouraged.
3. Shifting to non-conventional sources (Solar, wind, hydel, tidal energy etc.,) in order to reduce the dependance of conventional sources.
4. Smoking in public (indoor) places should be prohibited bcos cigarette smoke contains carcinogens (benzopyrene), CO, PM2.5-1. An average smoker runs the risk of developing heart and lung diseases.
5. Planting of trees along the road sides and around industrial areas, green belt development, Urban forest, control over construction activities, uses of sustainable material
6. Eradication of Old Vintage Vehicles: (commercial & cars) which are older than 15 years (for petrol) & 10 years for diesel, should be discarded due to their low efficiency and malfunctioning of engines (main reasons for air pollutants in urban atmosphere).
7. Catalytic converters are efficient devices fitted in engines of different set of vehicles and plays an important role in converting noxious gases in to less harmful gases through chemical reaction.

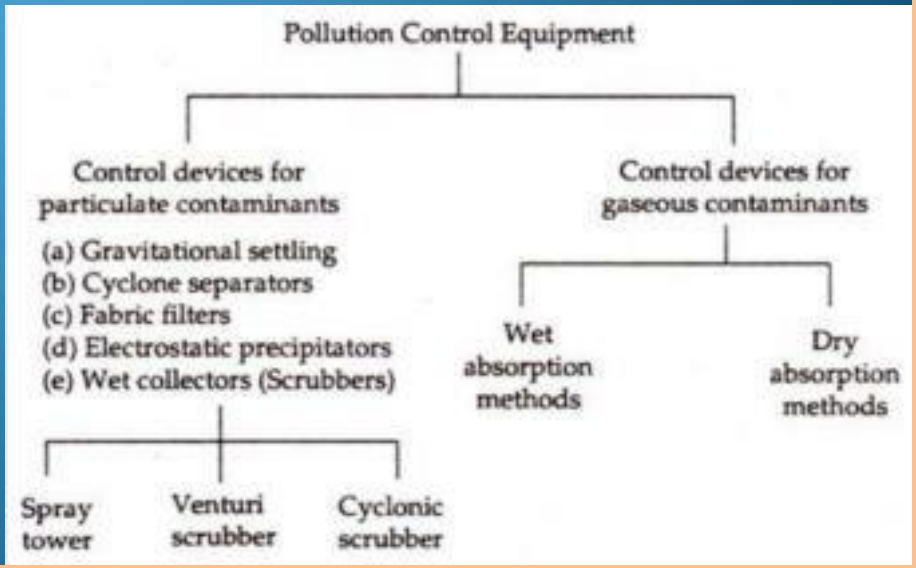
PARTICULATE MATTER POLLUTANT

Particulate matter is the sum of all solid and liquid particles suspended in air, many of which are hazardous. This complex mixture contains for instance dust, pollen, soot, smoke, and liquid droplets.

Temperature and chemical composition of gases to be cleaned from particulants before the selection of proper control device. Information on the physical form of the suspended material, its abrasive properties, size and shape, chemical composition and electrical sensitivity is required for this selection.

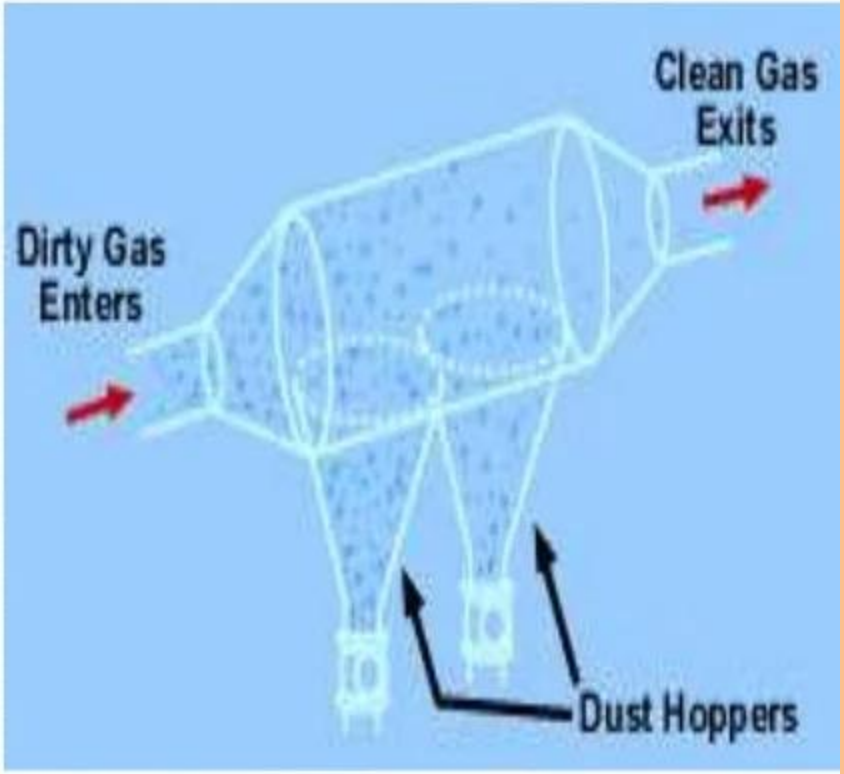
There Five major groups of processes.

a) Settling chambers
b) Inertial separator or Cyclone
c) Electrostatic precipitator
d) Bag houses and filters
e) Wet scrubbers



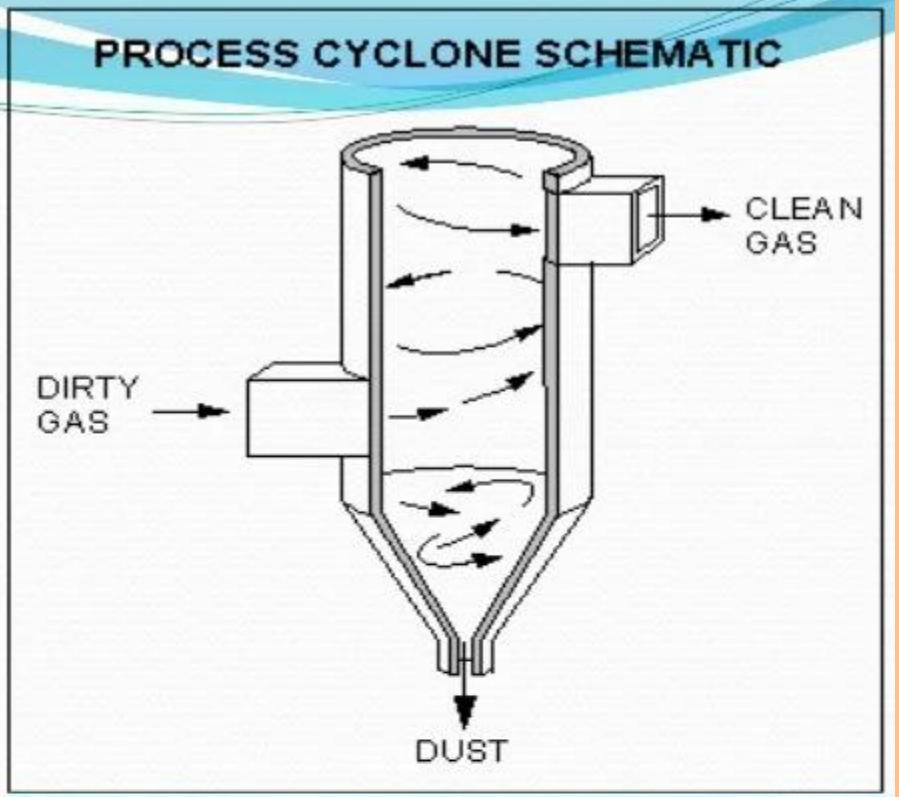
a) SETTLING CHAMBERS

- A simplest device, collecting dust of size >10μm.
- Settling chambers use the force of gravity to remove solid particles. The gas stream enters a chamber where the velocity of the gas is reduced. Large particles drop out of the gas and are recollected in hoppers. Because settling chambers are effective in removing only larger particles, they are used in conjunction with a more efficient control device.
- The size, shape of particles and density and viscosity are important parameters.



b) INERTIAL SEPERATOR OR CYCLONE

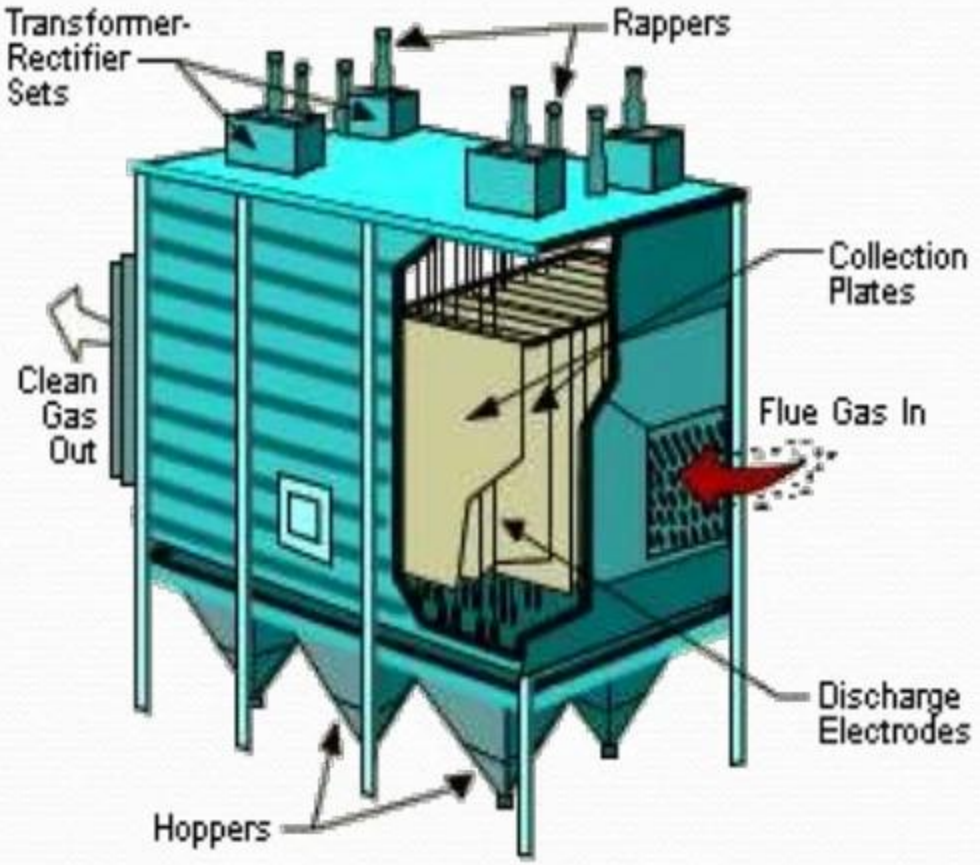
This process is achieved by a sudden change in the direction of gas flow. The dust particle is spinning in a circular path, it is subjected to an outward force. As a result the particles collect on the wall and fall to the bottom of the vessel.



c)ELECTROSTATIC PRECIPITATORS

- Passing the particle laden gases between high voltage discharge electrodes.
- Majority of particles get charged and collected on ground electrodes.
- At intervals both discharge and collecting electrodes are rapped to dislodge collected particles from the electrodes, which then fall into hoppers at the bottom of the precipitator.
- Ele. Precipitator is efficient for the particle size below 0.01µm, can tolorate operating temperature as high as 700°k.

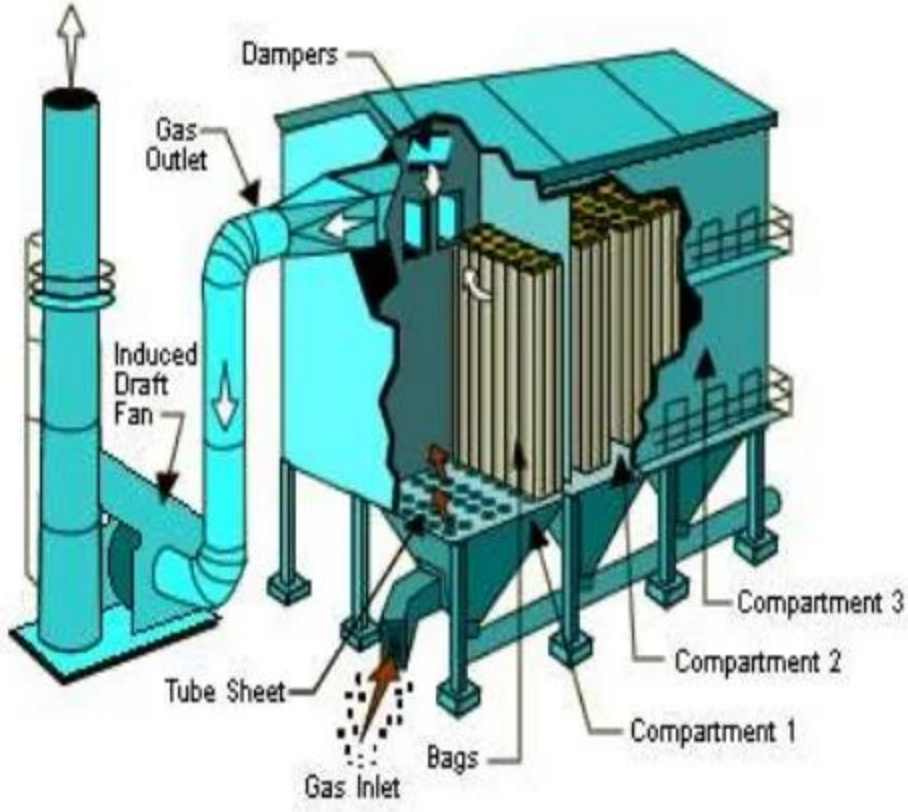
Figure 9. Conventional Electrostatic Precipitator



d) BAG HOUSE AND FILTERS

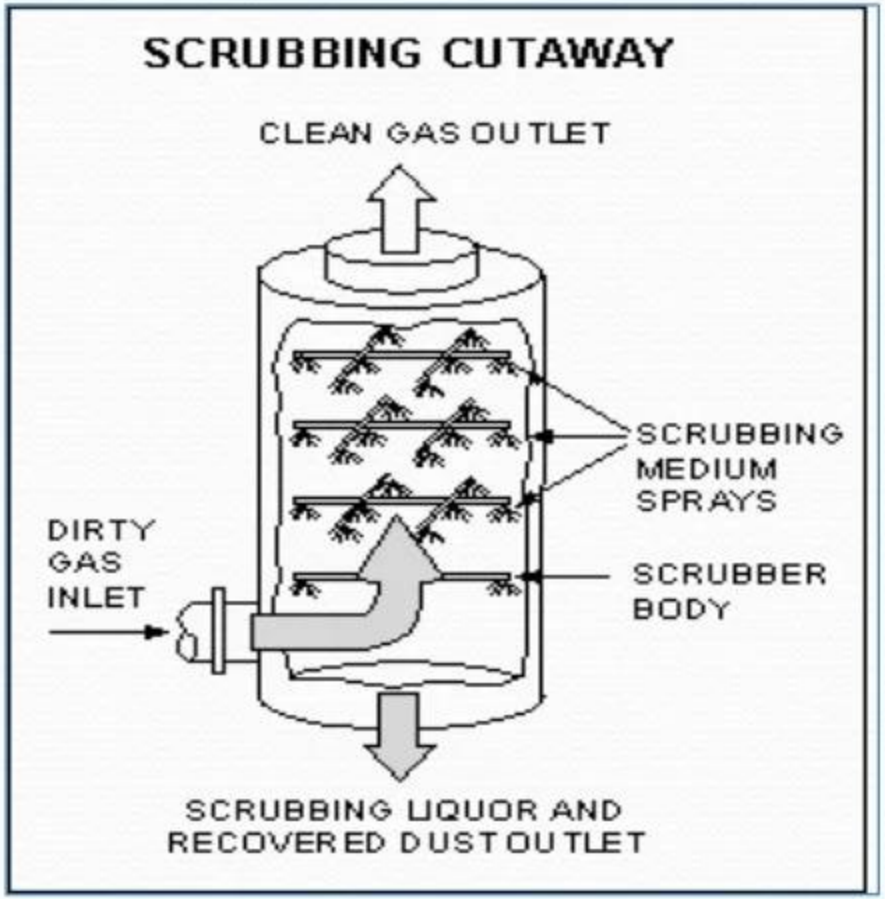
- This method is most often used type of device, which is required to meet any future standards limiting the emission of respirable particles.
- The collection efficiency is very high and even for particle of 0.01µm diameter .
- The Fabric filters, or bag houses , remove dust from a gas stream by passing the stream through a porous fabric.
- The fabric filter is efficient at removing fine particles and can exceed efficiencies of 99% in most applications.

Figure 13. Reverse Air Fabric Filter



E) WET SCRUBBERS

Objective of scrubber is to entrain the particulate matter in liquid droplets. Water subsequently flows from the bottom of the scrubber, the particulate is allowed to settle and clarified water is re-circulated.



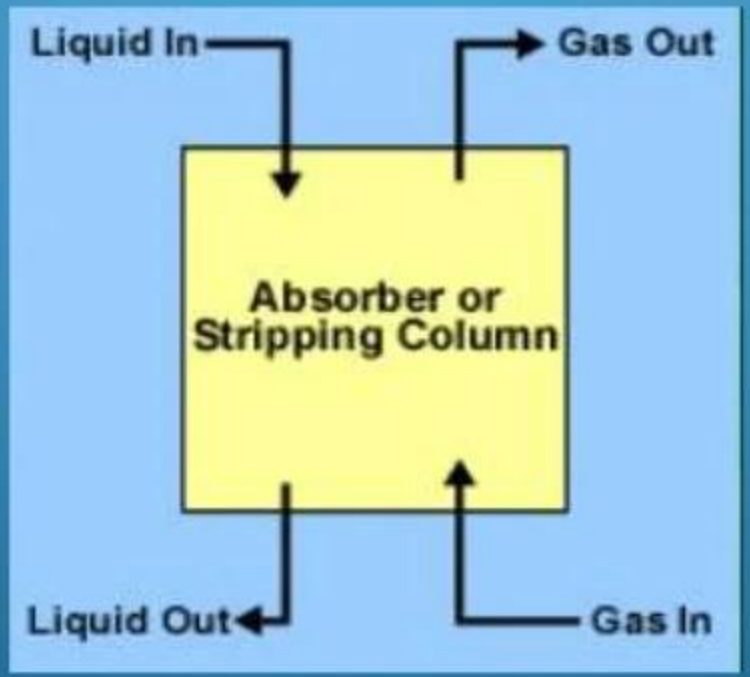
2) GASEOUS POLLUTANTS

The removal methods for gaseous pollutants are designed to concentrate the pollutants in a liquid (absorption) or a solid (adsorption). Sometimes direct conversion of gaseous pollutants is possible by combustion.

The central pollution (prevention and control) board, New Delhi has fixed standard for ambient air quality in India under the Air Act, 1981 beyond which an ambient air can be considered polluted in a legal sense.

a) ABSORPTION

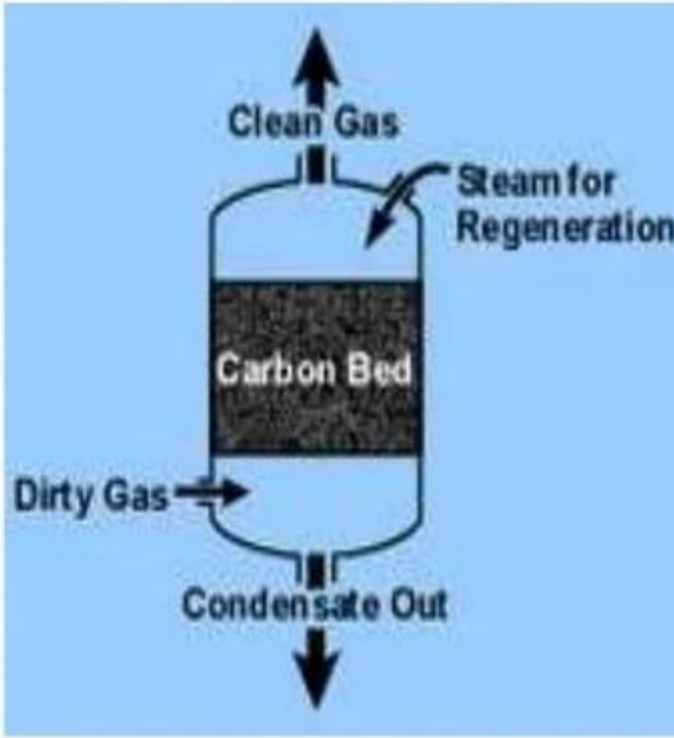
- This processes is selected to remove gaseous pollutants by dissolution into a liquid solvent such as water or in a caustic or acid solution. (most commonly water is used as an absorbent).



- As the gas stream passes through the liquid, the liquid absorbs the gas. Absorption is commonly used to recover products or to purify gas streams that have high concentrations of organic compounds.
- Among several considerations in absorption unit design, the most important is the selection of a suitable liquid solvent, determination of the limits of absorption efficiency, selection of appropriate equipment for liquid-gas contact and capital cost of the unit.

b) ADSORTION

Adsorption is a process where gases, vapours or liquids are concentrated on a solid surface as a result of surface or chemical force (physical adsorption and chemisorptions respectively). The amount of adsorbed substances depends directly on the internal surface area of solid and the kinetics of the process.



The most important adsorbents in industrial use to-days are Bauxite, activated carbon, activated alumina, silica gel and molecular sieves.

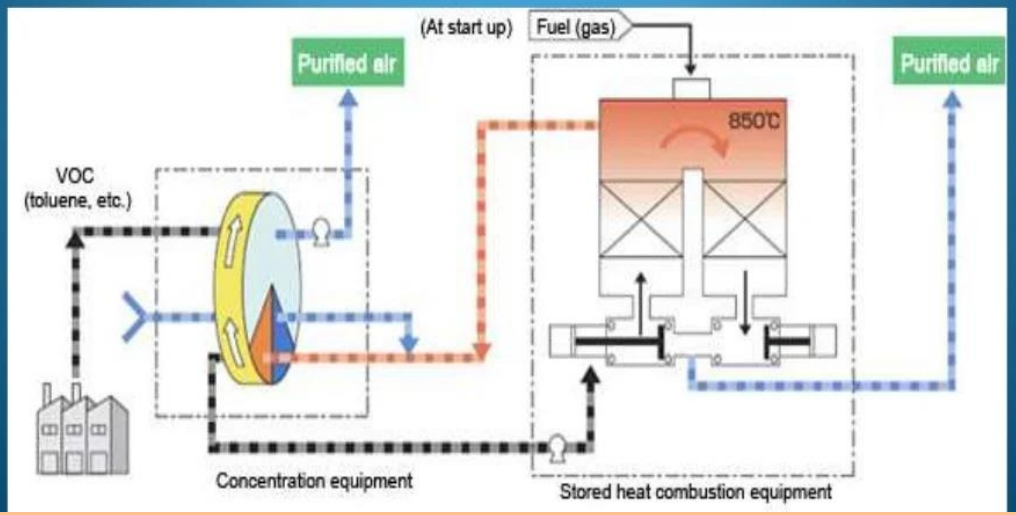
c) COMBUSTION

This method for the removal of VOCs since they can be decompose to CO_2 and H_2O.

The Direct and indirect or catalytic methods are used.

The catalytic method is preferred when low temperature of the process is desired.

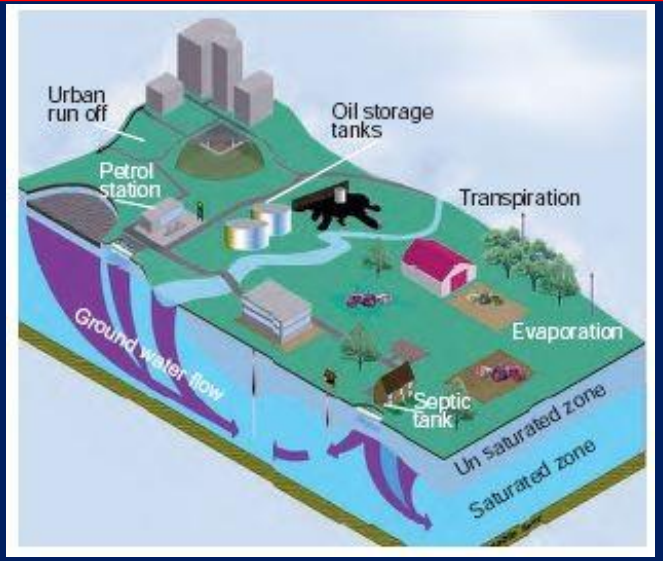
The most commonly used catalysts are the Cu, Ni, V and Zn compounds. IF the concentrations of air pollutants are high, a combination of sorption methods and catalytic reaction is used.



WATER POLLUTION

Water pollution is defined as the adding of unwanted substances or the change of physical and chemical characteristics of water in any way which makes it unfit for human consumption.

It is caused by waste products of industries (effluents), domestic sewage, oil spillage, agricultural and industrial run off etc.,



MORE TO KNOW

REVERSE OSMOSIS (RO)

It is the most efficient way of obtaining purified drinking water. During this process, pressure is applied on the solution which has more concentration. This reverses the natural direction of water flow and osmosis from high gradient to low gradient. This process involves energy expenditure. The membranes used for RO process have a dense barrier layer which allow only the water to pass through and prevents the passage of solutes. Hence, it is best suited for **desalination** of sea water (removal of salt).

Sources and effects of water pollution

Industrial wastes –The industrial effluents containing heavy metals and chemicals (As, Cd, Cu, Hg, Zn, nickel, Cr, etc, are directly released into the water bodies such as lakes, ponds and rivers without proper treatment. These wastes contaminate the water bodies and make them unsuitable for human consumption. Hot water is another noted pollutant from industries.

Sewage and municipal effluents account for 75% of the pollution load.

in rivers while the remaining 25% is from industrial effluents and non-point pollution sources.

MORE TO KNOW

MINAMATA DISEASE

Mercury poisoning due to the consumption of fish captured from mercury contaminated **Minamata Bay** in **Japan** was detected in **1952**. Mercury compound in waste water are converted by bacterial action into extremely toxic **methyl mercury** which can cause numbness of limbs, lips and tongue. It can also cause deafness, blurring of vision and mental derangement.

MORE TO KNOW

Biological magnification of **DDT** (Dichloro diphenyl trichloroethane) is seen in aquatic food chain. The concentration of DDT gradually increases at each trophic level. DDT inhibits calcium carbonate deposition in the oviducts of certain birds which result in the laying of thin shelled eggs. These eggs can easily break during incubation and the developing embryos are destroyed.

Causes of Water Pollution

1. **Disease-causing agents** (pathogens-bacteria, viruses, protozoa and parasitic worms) that enter water from domestic sewage and untreated human and animal wastes. Human wastes contain concentrated populations of coliform bacteria such as Escherichia coli and Streptococcus faecalis. These bacteria normally grow in the large intestine of humans where they are responsible for Vit. K, but high no causes diseases.
2. **Oxygen depleting wastes**. Organic wastes that can be decomposed by aerobic bacteria. Large populations of bacteria use up the oxygen present in water to the amount of oxygen required to break down a certain amount of organic matter is called the **biological oxygen demand (BOD).** The amount of BOD in the water is an indicator of the level of pollution. This causes low O2 : fish and other forms of oxygen dependent aquatic life to die. Thus anaerobic bacteria begin to break down the wastes. Form chemicals that have a foul odour and an unpleasant taste
3. Inorganic plant nutrients. Water soluble nitrates and phosphates that cause excessive growth of algae and other aquatic plants. The excessive growth of algae and aquatic plants due to added nutrients is called **eutrophication**. Clogging water intake pipes, changing the taste and odour of water and cause a build up of organic matter. Organic matter decays, O2 levels decrease and aquatic species die.

4.**Water soluble inorganic chemicals (a**cids, salts and toxic metals such as mercury and lead): High levels of these chemicals can make the water unusable, harm fish and other aquatic life, reduce crop yields and accelerate corrosion etc.
5. **Sediment of suspended matter (**soil and other solids that suspended) due to soil errosion, reduces photosynthetic activity of aquatic plants/ algae: disrupting the ecological balance.
6. **Water soluble radioactive isotopes:** concentrated in various tissues and organ as they pass through food chains and food webs. Ionizing radiation emitted can cause birth defects, cancer and genetic damage.
7. **Hot water**
8. **Oil/oil spill:** surface runoff from roads and parking lots pollutes groundwater. Leakage from underground oil tanks, Accidental oil spills from large transport tankers at sea have been causing significant environmental damage

The quantity of fertilizers applied in a field is often many times more than is actually required by the plants. The chemicals in fertilizers and pesticides pollute soil and water. While excess fertilizers cause **eutrophication, pesticides cause bioaccumulation and bio magnification**.

Biomagnification: Process of a buildup of certain chemical/ toxins (heavy metals, mercury) at the higher trophic levels of a food chain is termed as **Biomagnification.** These substances increase and accumulate, it moves up in a food chain.

Bioaccumulation: Process of accumulating toxic chemicals (pollutants, pesticides/toxins) directly into the human body either through air, water, food intake, or directly through the skin is termed as Bioaccumulation. it increases the risk of chronic poisoning and other severe health disorders.

Biomagnification	**Bioaccumulation**
Definition	
An increased concentration of a toxic chemical, the higher an animal is on the food chain.	Accumulation of a toxic chemical in the tissue of a particular organism.
Causes	
An increase in the level as one moves higher in the food chain.	An increase in the concentration of a substance inside an organism
Level of concentration of pollutant	
An increase in the concentration of pollutants as they move from one trophic level to the next.	An increase in the concentration of a pollutant in an organism.
Food Chain	
takes place between two given trophic levels.	takes place within a given trophic level
Example	
Pollutants/absorbed toxins from microscopic aquatic organisms into the small fish, consumed by the larger fish and other aquatic animals.	Buildup or accumulation of mercury in fishes and other aquatic animals.

Sources and effects of water pollution..

1. Many industries use water as a coolant for the machinery and release of hot waste water into the water bodies causing thermal pollution which affect both the plant and animal life.

2. The surface run off - the surface run off from agricultural land is contaminated with pesticides and residues of inorganic fertilizers.

3. The run off from urban and industrial are rich in organic and inorganic compounds. These pollutants contaminate both surface and ground water resources.

Sources and effects of water pollution...

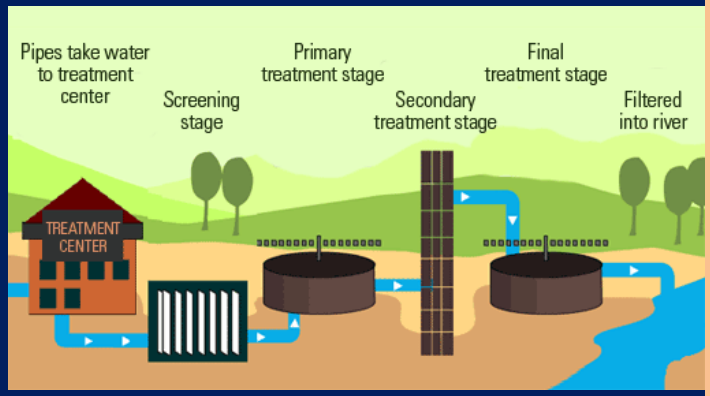
4. **Oil spills** – An oil spill is an accidental discharge of petroleum products in oceans and estuaries from capsized oil tankers, offshore drilling and exploration operations. It can cause drastic damage to the marine and coastal bio diversity.

5. **Domestic Sewage** – It is rich in organic matter and detergents. Decomposition of organic matter increases the nutrient content of the water bodies.

6. Availability of excess nutrients results in algal bloom on the surface of water resulting in the deficiency of oxygen content (BOD – Biological Oxygen Demand). This in turn leads to the death of aquatic organisms. This process is known as Eutrophication.

Control of water pollution

1. Sewage treatment plants should be installed to treat sewage before releasing into water bodies.
2. Excessive use of pesticides, herbicides and fertilizers should be avoided.
3. Biological control of insect pests and organic farming is to be followed in order to reduce the dependence on pesticides and inorganic fertilizers.
4. By legislation and strict enforcement.
5. By creating social awareness among people about the water pollution and the need for pure water.



Ground water

- Groundwater is easy to deplete and pollute it gets renewed very slowly and hence must be used judiciously.
- groundwater and treating it is very slow and costly

Ground water is polluted due to:

- Urban run-off of untreated or poorly treated waste water and garbage
- Industrial waste storage located above or near aquifers
- farming practices (excessive fertilizers and pesticides etc.)

Leakage from underground storage tanks containing gasoline and other hazardous substances

- Leachate from landfills
- Poorly designed and inadequately maintained septic tanks
- Mining wastes

SOIL POLLUTION

Soil is a thin covering over the land consisting of a mixture of minerals, organic material, living organisms, air and water that together support the growth of plant life. Soils vary in their content of clay (very fine particles), silt (fine particles), sand (medium size particles) and gravel (coarse to very coarse particles). The relative amounts of the different sizes and types of mineral particles determine soil texture. Soils with approximately equal mixtures of clay, sand, silt and humus are called loams.

Soil pollution is the unfavorable alteration of soil by the addition or removal of substances which decrease soil productivity and ground water quality.

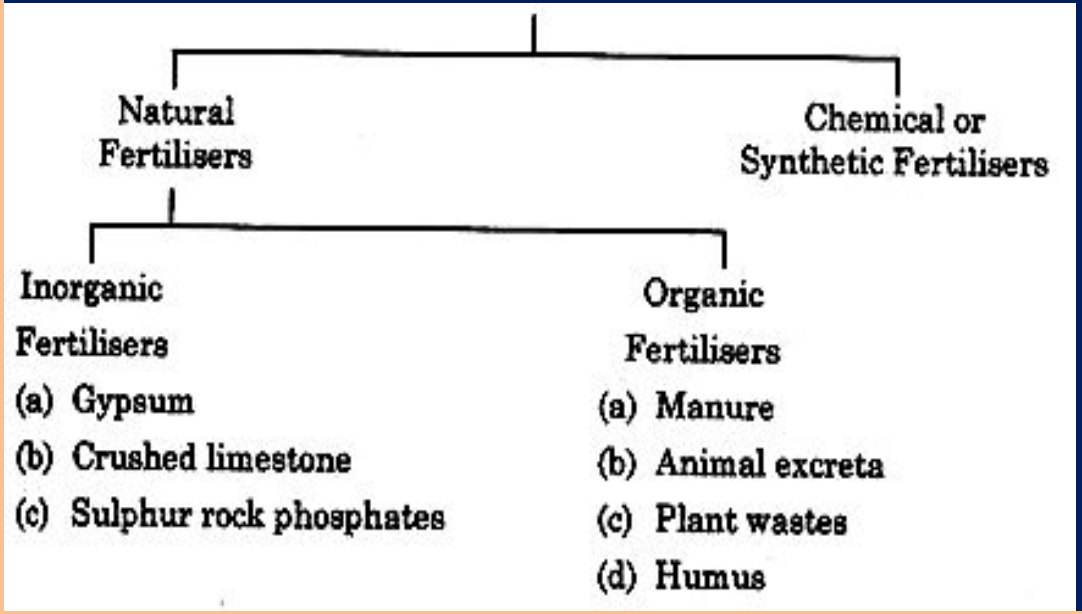
It usually results from different human activities like dumping of waste, use of agro chemicals, mining operations and urbanization.

SOIL POLLUTION : Causes and effects

- The industrial solid waste and sludge contain toxic organic and inorganic compounds as well as heavy metals.
- The radio active waste from nuclear power plants and nuclear explosions also contaminate the soil.
- Fly ash contains fine particulates which are released from thermal power plants. It settle on the ground and cause pollution.
- The domestic waste is rich in organic matter and undergo decomposition.
- The hospital waste contains a variety of pathogens that can seriously affect human health.

SOIL POLLUTION : Causes and effects

Agricultural chemicals such as pesticides, insecticides and inorganic fertilizers may pollute drinking water and can change the chemical properties of the soil adversely affecting the soil organisms.



CONTROL OF SOIL POLLUTION

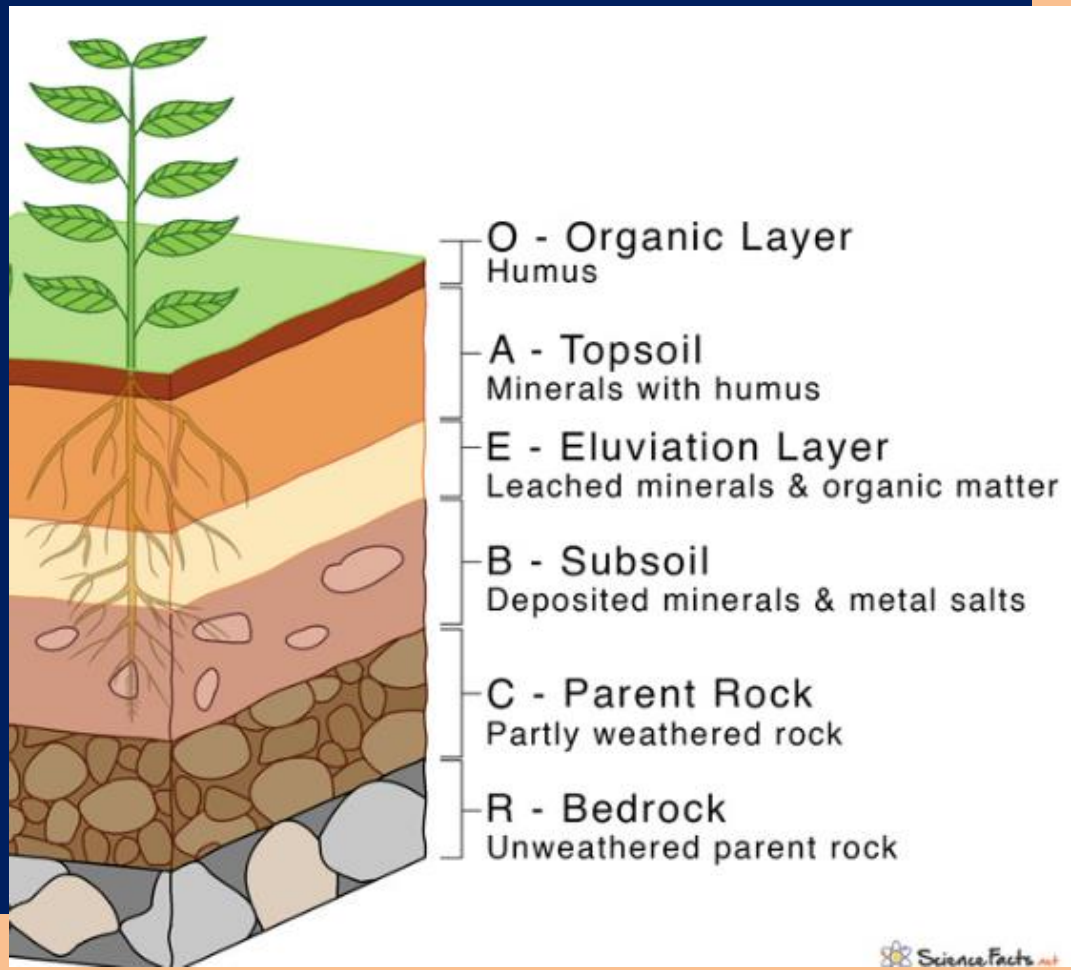
Soil pollution is the unfavorable alteration of soil by the addition or removal of substances which decrease soil productivity and ground water quality.

It usually results from different human activities like dumping of waste, use of agro chemicals, mining operations and urbanization.

- Management of soil wastes include collection and categorization of wastes. Recovery of resources like scrap metals, plastics, etc., for recycling and reuse and safe disposal with a minimum environmental hazards is to be followed. Other notable methods of waste disposal include incineration (burning in the presence of oxygen) and pyrolysis (burning in the absence of oxygen). Afforestation and reforestation should be undertaken on a large scale to prevent soil erosion and loss of soil nutrients.

Soil profile: Top layer or the surface litter layer called O horizon consists mostly (freshly fallen/partially decomposed leaves, animal waste, other organic materials etc. A horizon consists of partially decomposed organic matter (humus) and some inorganic mineral particles. The roots of most plants are found in these two upper layers.

B horizon/ Subsoil contains less organic material and fewer organisms than the A horizon. The area below the subsoil is called the C horizon and consists of weathered parent material. This parent material does not contain any organic materials. The chemical composition of the C-horizon helps to determine the pH of the soil and also influences the soil's rate of water absorption and retention.



RADIOACTIVE POLLUTION

The emission of protons, electrons and electromagnetic radiations released by the disintegration of radioactive substances such as radium, thorium, uranium, etc,. cause air, water and land pollution.

Effects :-

- The ionising radiations can cause mutations.
- Strontium-90 accumulates in bones causing bone cancer.
- Iodine-131 can damage bone marrow, spleen, lymph nodes and can cause leukemia (blood cancer).

Nuclear explosion

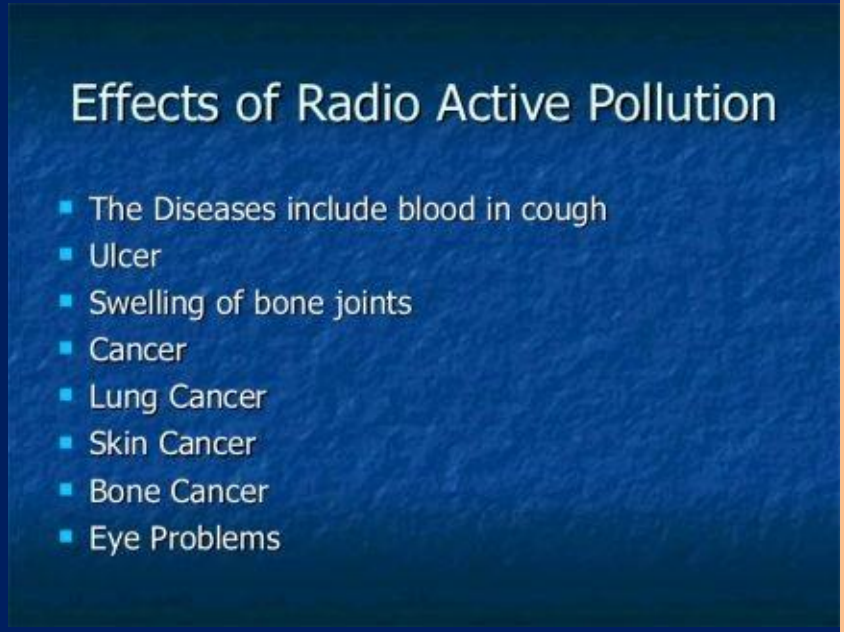
MORE TO KNOW

Chernobyl disaster (Ukraine)

The explosion at the Chernobyl nuclear power station was undoubtedly the world's worst nuclear disaster. The deadly radioactive material was released into the atmosphere. The inhabitants of Chernobyl were exposed to radioactivity which was hundred times greater than Hiroshima bomb. Babies were born with infirmities and people suffered from serious diseases like thyroid cancer.

RADIOACTIVE POLLUTION: PREVENTIVE MEASURES

- **Care should be taken to prevent the leakage of radioactive substances from nuclear reactors.**
- **Radioactive wastes should be disposed off safely.**
- **Strict measures should be followed in the construction and maintenance of nuclear power plants to prevent nuclear accidents.**
- **Control or prevention of nuclear tests.**



MORE TO KNOW

Various laws and rules have been promulgated by the government of India from time to time to control pollution. Some of them are 1974 - Water (prevention, control of pollution) Act.

1980 - Forest Act.

1981 - Air (prevention, control of pollution) Act.

1986 - Environmental pollution Act.

1988 - Motor vehicles Act

NOISE POLLUTION

- Noise may be defined as an unwanted and unpleasant sound that may have adverse effects on animals and humans.
- The unit of sound level is decibels (db).
- Noise level above 120 db is considered harmful to human beings.

MORE TO KNOW

Jet Aircraft (take off)	145 db
Heavy city traffic	90 db
Vaccum cleaner	85 db
Window Air conditioner	60 db
Normal speech	60 db

NOISE POLLUTION..

Sources

- The different sources associated with noise pollution are industrial machinery, road, rail and air transport, loudspeakers, construction equipments, household appliances, crackers, etc,.

Effects

- Noise seriously affects heartbeat, breathing, and can cause constriction of blood vessels.
- It can cause headache, sleeplessness, irritability and may seriously affect the productive performance of human.

NOISE POLLUTION…

- Loud noises (above 130 db) can cause damage to the ear drum, hair cells of cochlea (organ of hearing) and thereby resulting in temperory or permanent loss of hearing.
- It can also seriously affect the concentration of students while learning.

Effects of noise pollution

- Generally, problems caused by noise pollution include stress related illnesses, speech interference, hearing loss, sleep disruption, and lost productivity.
- Rise in blood pressure
- Physical development of fetous.
- Reduce concentration.
- Causes serious mental disorders.

Decibels	Sources	Intensity
170 – 200	stun grenades/space shuttle engine	shatters eardrum
140 – 170	jet engine/firearms/rock concert peak level	damage to eardrum
120 – 130	thunder/jackhammer/loud car stereo	damage to eardrum
90 – 110	train/motorcycles/chainsaw/ marching band	extremely loud
80 – 90	most alarm clocks/vacuum cleaners	extremely loud
60 -70	street noise/conversation/dishwasher/ AC	loud
50 – 55	rain/normal office or home noise/AC	medium
30 – 40	library/whispers/sleeping bedroom/PC	low
0 - 20	almost total quiet	

NOISE POLLUTION: Control measures

- The industries should be established away from residential areas.
- Trees should be planted along roadside or highways to reduce noise levels.
- The industrial machinery and motor vehicles should be properly maintained in order to minimize the noise.
- The use of loudspeakers and bursting of crackers should be restricted.
- Effort must be made to create awareness among people about the harmful effects of noise and the need to control it.

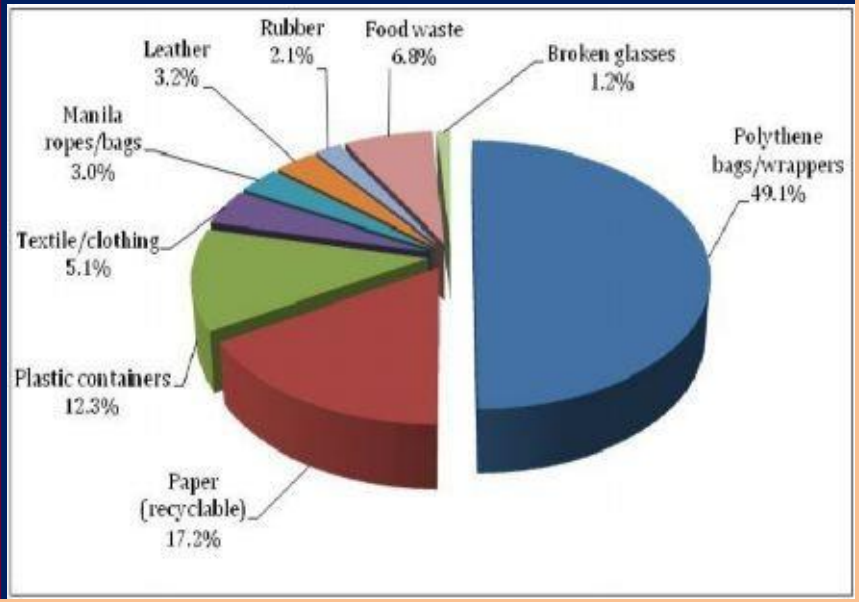
Waste Generation in India

- India produces 55 million tons of municipal solid waste annually at present.
- Per capita generation of waste varies from 200 gm to 600 gm per capita / day.
- Average generation rate at 0.4 kg per capita per day in towns.
- Collection efficiency ranges between 50% to 90% of the solid waste are generated.

4.7 million tonnes of garbage generated daily in the world.

55 million tons of MSW is generated in India per year

The estimated annual increase in per capita waste generation is about **1.33 % per year**



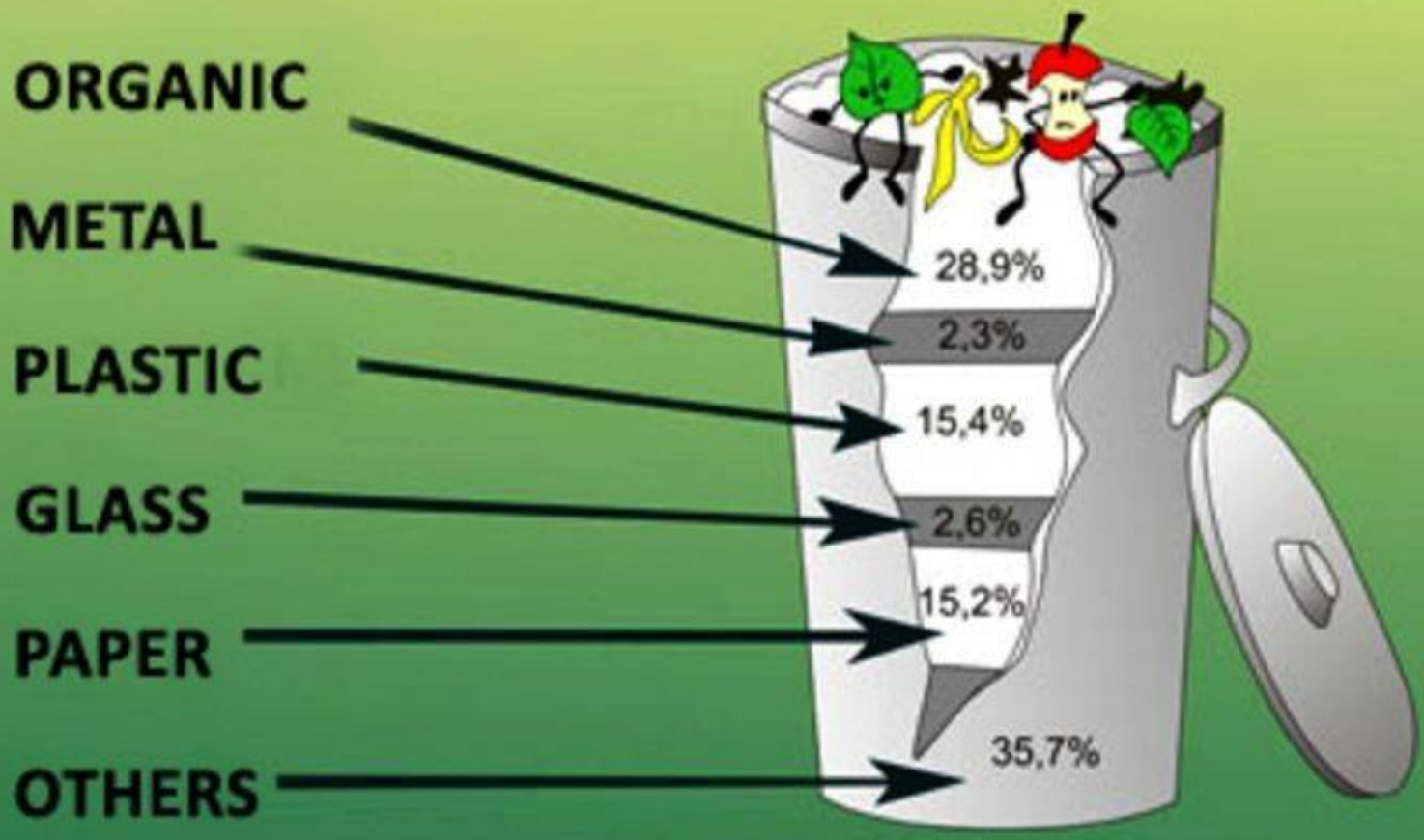
WHAT IS SOLID WASTE?

WASTE : any material, Thrown away" regarded as useless and unwanted
(at a certain time and place)

- MSW: Most of the non-hazardous solid waste from a city, town or village that requires routine collection and transport to processing or disposal site. Sources of MSW include private homes, commercial establishments and institutions as well as industrial Solid or semi-solid material which are non soluble in nature are solid waste.
- Solid waste includes agricultural refuse, demolition waste, industrial waste, mining residues, municipal garbage, sewage sludge, etc. Bio-degradable: can be degraded paper, wood, fruits etc. Non-biodegradable: cannot degraded plastics, bottles, machines, containers etc.

COMPOSITION OF HOUSEHOLD WASTE

Organic waste is compostable!



TYPES OF SOLID WASTE

- Solid waste can be classified into different types depending on their source:
- Household waste or municipal waste: includes food, paper, cardboard, plastic, textiles, leather, glass, metal, ashes, electronics waste etc.
- Industrial waste: includes toxic chemicals, oil, debris from construction site, packaging waste, ashes etc.
- Biomedical waste or hospital waste: medicine bottles, expired medicines, syringes, medical instruments such as scissors, blades etc.

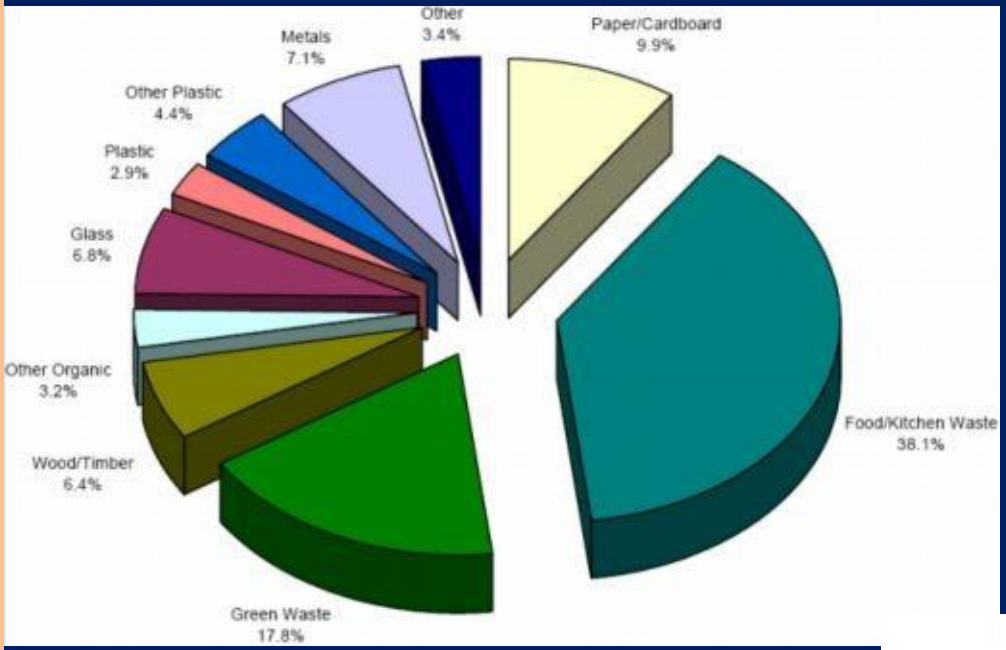
TYPES OF SOLID WASTE

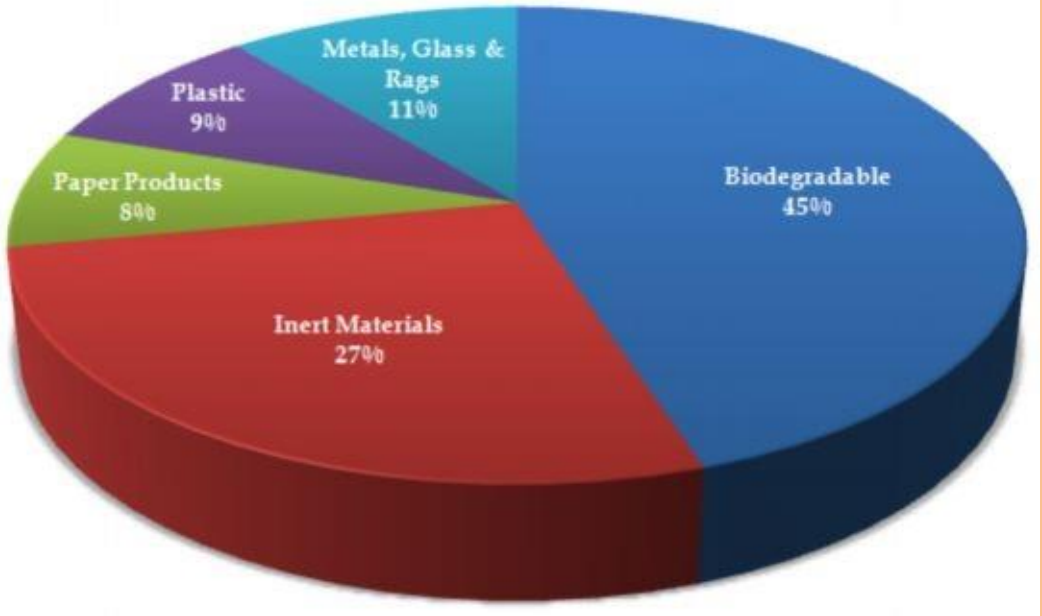
Agricultural waste: includes pesticides, crops, water coming from the fields also consists of small amount of toxic chemicals.

Nuclear waste: includes radioactive substances coming from reactors, fuel (uranium, thorium, plutonium etc). Its highly dangerous and requires proper disposal.

Hazardous waste: includes toxic chemical, acids, corrosive, ignitable and reactive materials, gases etc.

SOLID WASTE COMPOSITION





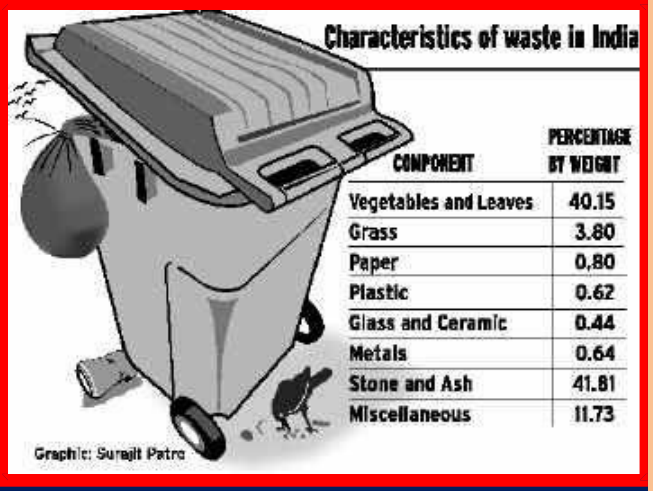
MAGNITUDE OF PROBLEM

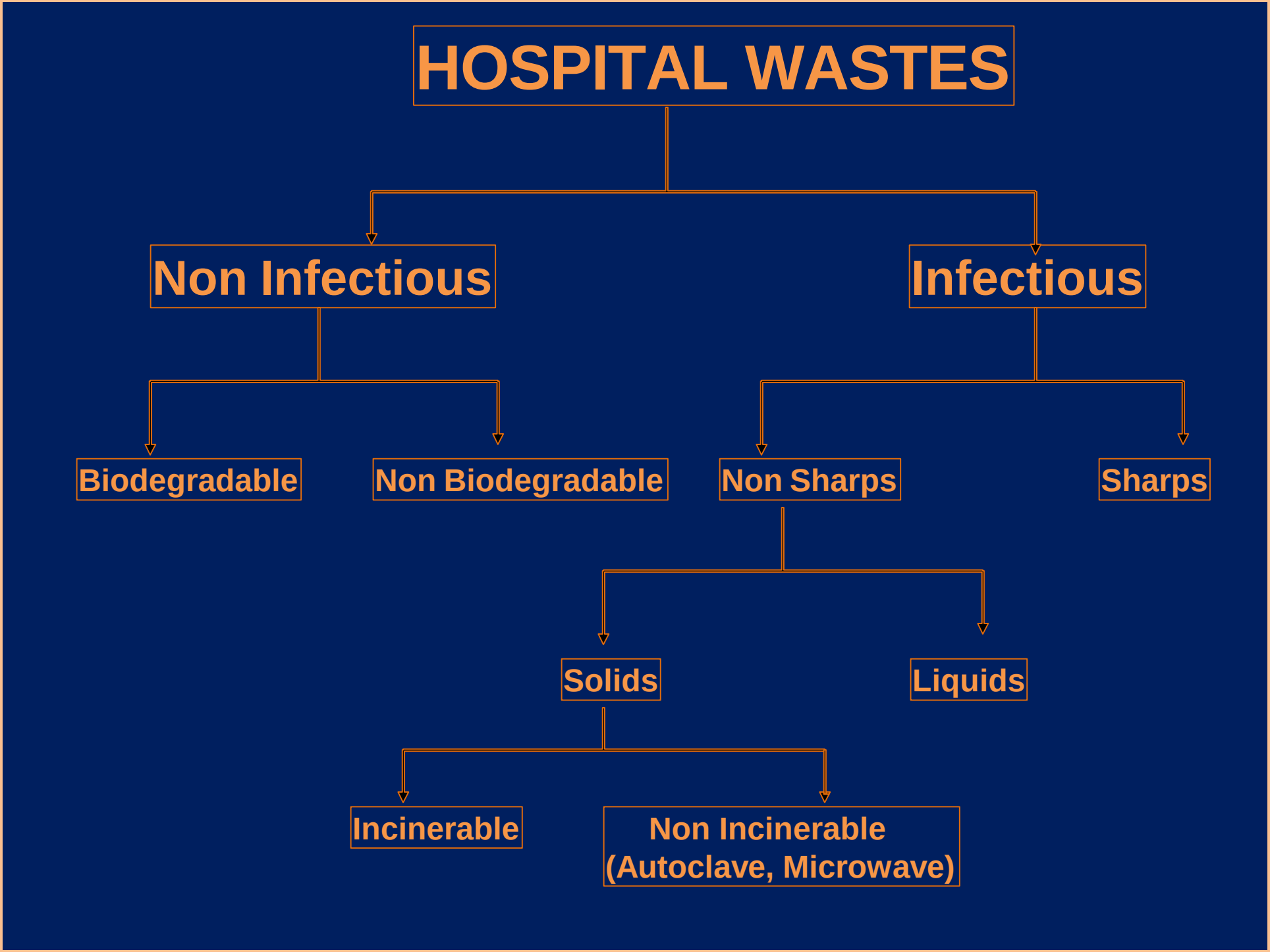
- **Per capita waste generation increasing by 1.3% per annum**
- **With urban population increasing between 3 – 3.5% per annum**
- **Yearly increase in waste generation is around 5% annually India produces 42.0 million tons of municipal solid waste annually at present.**
- **Per capita generation of waste varies from 200 gm to 600 gm per capita / day.**
- **<u>Collection efficiency ranges between 50% to 90%</u> of the solid waste generated.**

Municipal Solid Waste in India

- 30% - 55% Compostable / Bio-degradable Matter
  (can be converted into manure)
- 40% - 45% Inert material
  (to go to landfill)
- 5% - 10% Recyclable materials (Recycling)
- These percentages vary from city to city depending on food habits

New Delhi:
Capital of India



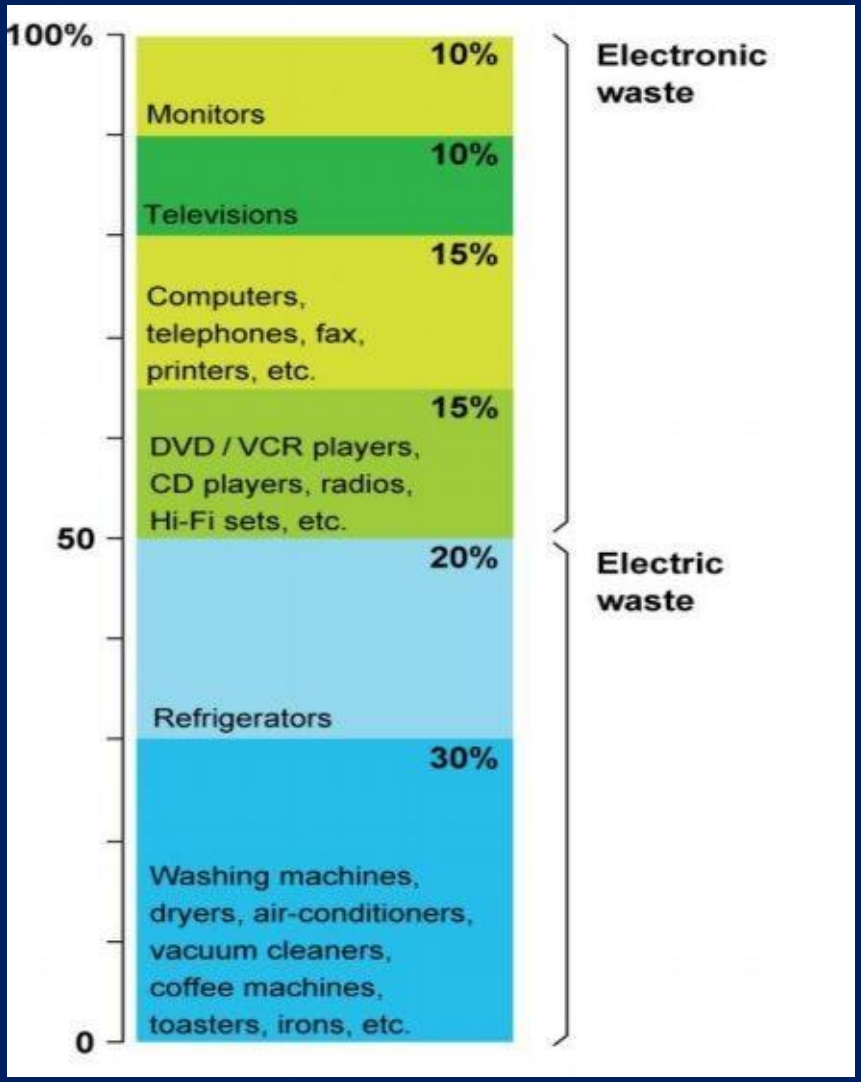

HOSPITAL WASTES
Non Infectious
Infectious
Biodegradable
Non Biodegradable
Non Sharps
Sharps
Solids
Liquids
Incinerable
Non Incinerable
(Autoclave, Microwave)

COLOUR CODING

COLOUR CODING	TYPE OF CONTAINER	WASTE CATEGORY	TREATMENT OPTIONS as per Schedule I
Yellow	Plastic Bag	Cat.. 1, 2, 3 and 6	Incineration / deep burial
Red	Disinfected container / Plastic Bag	Cat. 3, 6, and 7	Autoclaving / Microwaving / Chemical Treatment
Blue / White Translucent	Plastic Bag / puncture proof container	Cat. 4, Cat. 7	Autoclaving / Microwaving / Chemical treatment and destruction shredding
Black	Plastic Bag	Cat. 5, 9 and 10 (Solid)	Disposal in secured landfill

E-waste

- E-waste comprises of waste electronics goods which are not fit for their originally intended use.
- Such electronics goods may be television, telephones, radios, computers, printers, fax machines, DVDs and CDs etc.



TOXIC CHEMICALS IN E-WASTE

- Lead – Affects Central and Peripheral Nervous system, Kidney Damage, Inhibits oxygen carrying capacity of blood
- Cadmium – Toxic, stores in Kidney, Neural damage
- Mercury – Chronic damage to brain, Respiratory and skin disorders
- Chromium – DNA disorders, Asthma
- Barium – Muscle weakness, kidney damage
- Beryllium – Lung cancer, beryllicosis, skin diseases
- PVC – Hormonal problems, Reproductive issues

EFFECTIVE MANAGEMENT OF E-WASTE

- Massive awareness to consumers
- Setting up of more collection centers and collection points
- Manufactures responsibility to provide good standard materials and assurance for recycling
- Fair Trade principles
- More recycling units by providing subsidized financial supports
- Proper training to Workers dealing recycling units
- Ban on importing e-waste from other countries
- Proper monitoring and evaluation system by the regulators in all levels
- Sell or dump of e-waste only to government authorized recyclers
- Green and energy efficient devices by the manufactures
- Donate used electronics to charitable organizations
- Recovery of valuable metals like Cu, Al, Au, and Ag through recycling
- Use of available best strategies

Methods of Waste Disposal

- Landfills
- Incineration
- Source reduction
- Composting
- Recycling

Land filling

- Most municipal solid waste in India is deposited in landfills
- It is the most traditional method of waste disposal
- Source of groundwater pollution
- Waste is directly dumped into disused quarries, mining voids or borrow pits.
- It is generally used for domestic waste

Incineration

- Prior to 1940, incineration was common in North America and western Europe.
- Many incinerators were eliminated because of foul odors and gritty smoke
- Currently, about 15% of municipal solid waste is incinerated.

Incineration

Pros:

- Reduce volume 90%, weight 75%
- Heat from burning converted to electricity

Cons:

- Create air pollution
- Concentrates toxins in ash
- More costly than landfills, as long as space available

Composting

- Involves using micro-organisms for decomposition of biodegradable waste.
- Harnessing natural decomposition to transform organic material into compost
- Materials such as plants, food scraps, and paper products can be decomposed into the organic matter.
- The organic matter that is produced from recycling can be agricultural uses.
- Usually this method of recycling is done by putting the materials in a container and let to stay there until it decomposes.

OCEAN DUMPING

- Ocean dumping is the dumping or placing of materials in the ocean, often on the continental shelf.
- A wide range of materials is involved, including carbage construction and demolition debris, sewage sludge, dredge material, waste chemicals, and nuclear waste.
- Sometime hazardous and nuclear waste are also disposed but these are highly dangerous for aquatic life and human life also.

ADVANTAGES

- Convenient
- Inexpensive
- Source of nutrients for fishes and marine mammals.
- Vast amount of space is available.
- All type of wastes are disposed.

DISADVANTAGES

- There are three main direct public health risks from ocean dumping:
- Occupational accidents, injuries and exposures
- exposure of the public to hazardous or toxic materials washed up on beach sand.
- human consumption of marine organisms that have been contaminated by ocean disposal.
- Highly dangerous for aquatic life.

Recycling

- It is basically processing or conversion of a waste item into usable forms.
- Recyclable materials include many kinds of glass, paper, metal, plastic, textiles, and electronics.
- But recycling is not a solution to managing every kind of waste material.
- For many items like plastic bags, plastic wrap, yogurt cups, margarine container etc. recycling technologies are unavailable or unsafe.

Recycling

Benefits

- Saves money, raw materials, and land.
- Encourages individual responsibility.
- Reduces pressure on disposal systems.
- Japan recycles about half of all household and commercial wastes.
- Lowers demand for raw resources.
- Reduces energy consumption and air pollution.

Waste Management

5-R PRINCIPLE: One of the widely used waste reduction strategy can be used by people in towns and cities and is known as 5-R principle

Reduce: The reduction of waste generation, avoiding disposable or single use plastic

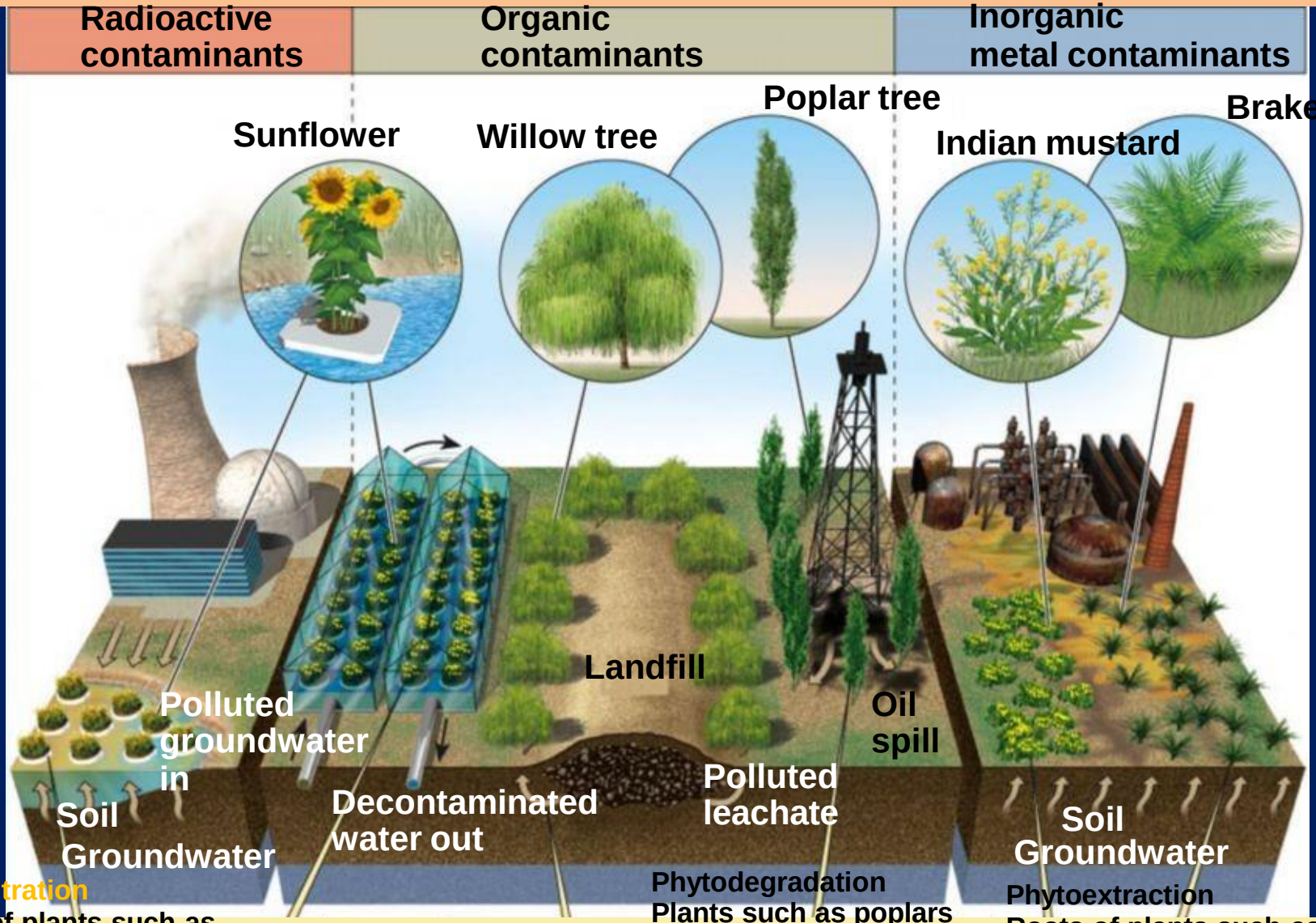
Reuse: The habit of re-using the commodities should be promoted. Donate books, clothes, **Recycle:** Segregation of waste is paramount for recycling of waste. Segregation of paper,
metals, glasses, and plastics from the organic waste is very important.

Recover: Recovery is where more resources are required i.e mechanical, technical to convert and reprocess the waste into energy. This means that energy can be generated in form of heat and can be converted into other forms as per requirement and resources.

Refuse: waste generated is dumped accordingly in landfills and dumpsites. The waste collected from the city or town in these areas remain for a longer period of time.

Recycling Benefits, Incentives

- Recycling saves *money*, *energy*, *raw materials*, and *land space*, while also **reducing pollution**.
- Recycling *encourages* individual **awareness and responsibility**.
- **Japan** - probably the most *successful* recycling program in the world
- Creating **incentives** for recycling - public policies, consumer demand
- Some make a **living** by gathering up recyclables!!



Rhizofiltration
Roots of plants such as sunflowers with dangling roots on ponds or in green-houses can absorb pollutants such as radioactive strontium-90 and cesium-137 and various organic chemicals.

Phytostabilization
Plants such as willow trees and poplars can absorb chemicals and keep them from reaching groundwater or nearby surface water.

Phytodegradation
Plants such as poplars can absorb toxic organic chemicals and break them down into less harmful compounds which they store or release slowly into the air.

Phytoextraction
Roots of plants such as Indian mustard and brake ferns can absorb toxic metals such as lead, arsenic, and others and store them in their leaves. Plants can then be recycled or harvested and incinerated.

MAIN ISSUES

- ABSENCE OF SEGREGATION OF WASTE AT SOURCE
- LACK OF TECHNICAL EXPERTISE AND APPROPRIATE INSTITUTIONAL ARRANGEMENT
- UNWILLINGNESS TO INTRODUCE PROPER COLLECTION, SEGREGATION, TRANSPORTATION AND TREATMENT / DISPOSAL SYSTEMS
- INDIFFERENT ATTITUDE OF CITIZENS TOWARDS WASTE MANAGEMENT DUE TO LACK OF AWARENESS
- LACK OF COMMUNITY PARTICIPATION TOWARDS WASTE MANAGEMENT AND HYGIENIC CONDITIONS