BLOCK 5
CHAPTER 1
ENVIRONMENTAL POLLUTION

POLLUTION & POLLUTANTS, TYPES OF POLLUTION, CAUSES, EFFECTS, TREATMENT AND CONTROL MEASURES FOR VARIOUS TYPES OF POLLUTANTS

INTRODUCTION

Pollution is defined as an 'undesirable change in the physical, chemical or biological characteristics of air, water and land brought about by man's activities that may harmfully affect living organisms and other resources'.

Man, in his quest for a better life and more conveniences, is getting more and more dependent on technology and industries. These industries and the modern lifestyle are together making life easier and convenient for man. However, the same factors are also contributing towards the pollution of environment. Based on the component of environment being polluted, we have air pollution, water pollution and soil pollution.

The substances that actually cause pollution are called the pollutants. They may be the industrial gases, industrial effluents let out into the rivers, soapy water, domestic wastes, medical wastes, etc.

Pollutants may be classified into two types based on bacterial activity. They are:

Biodegradable pollutants

Non-biodegradable pollutants

Biodegradable pollutants get broken down under natural conditions due to the action of micro-organisms. Therefore they are considerably less harmful. They behave as pollutants only in very large quantities. Example: excreta, sewage, pollen grains, etc.

Non-biodegradable pollutants cannot be broken down under natural conditions by the action of micro-organisms or they take an extremely long time to be broken down.

Example: Common plastics, DDT, metal wastes such as lead, mercury, arsenic, etc.

Based on the environmental component being polluted the following types of pollution are commonly addressed:

Following are the types of Environmental pollution.

1. Air pollution
2. Water pollution
3. Soil pollution
4. Noise pollution
5. Marine pollution
6. Thermal pollution
7. Nuclear pollution

Air Pollution

Air pollution can result from both human and natural actions. Natural events that pollute the air include forest fires, volcanic eruptions, wind erosion, pollen dispersal, evaporation of organic compounds and natural radioactivity. Pollution from natural occurrences is not very often.

Causes of Air Pollution

Human activities that result in air pollution include:

1. Emissions from industries and manufacturing activities

Waste incinerators, manufacturing industries and power plants emit high levels of carbon monoxide, organic compounds, and chemicals into the air. This happens almost everywhere that people live. Petroleum refineries also release lots of hydrocarbons into the air.

2. Burning Fossil Fuels

After the industrial age, transportation has become a key part of our lives. Cars and heavy duty trucks, trains, shipping vessels and airplanes all burn lots of fossil fuels to work. Emissions from automobile engines contain both primary and secondary pollutants. This is a major cause of pollution, and one that is very difficult to manage. This is because humans rely heavily on vehicles and engines for transporting people, good and services.

Fumes from car exhaust contain dangerous gases such as carbon monoxide, oxides of nitrogen, hydrocarbons and particulates. On their own, they cause great harm to people who breathe them. Additionally, they react with environmental gases to create further toxic gases

3. Household and Farming Chemicals

Crop dusting, fumigating homes, household cleaning products or painting supplies, over the counter insect/pest killers, fertilizer dust emit harmful chemicals into the air and cause pollution. In many case, when we use these chemicals at home or offices with no or little ventilation, we may fall ill if we breathe them.

Aerosols: An aerosol can be defined as a system of solid or liquid particles suspended in air or other gaseous environment. Aerosols vary in size and composition, they can be naturally or manmade generated.

Types of aerosols

- **Mists:** Mists means a light dispersion of minute water droplets suspended in the atmosphere. The formation of mist reduces the visibility. It is not possible to see the things beyond few meters.
- **Fog:** Fog refers to the visible aerosols. It is dispersion of water or ice in the atmosphere near earth's surface reducing visibility less than half-kilo meter particles size 40-1.0 microns.
- **Fumes:** These are solid particles generated by condensation from the gaseous state, generally after volatilization from melted substances, and often accompanied by a chemical reaction such an oxidation
- **Smoke**: Smoke consists of finely divided particles produced by incomplete combustion. The size is of the particles is less than 1 micron. The size of particulates.
- Coal smokes particles range from 0.2-0.01.
- Oil smoke particles from 1.0- 0.03. microns
- **Dust:** It is produced by crushing and grinding etc; of the organic material.
- They are generally over 20 microns in diameter. Although some are small.
- Fly ash, from chimneys varies from 3-80 microns.
- Cement 10-150 microns-, and
- Foundry dust 1-200 microns.
- **Smog**: The term 'smog' was originally used in 1905 in London to denote a combination of smoke and fog. Smog contains harmful substances
- Smog is the combination of smoke and fog. (smoke+fog =smog) by 1944 smoke was known to cause glazing, silvering, bronzing and sometimes of the lower surface of leaf sensitive species resulting in serious losses.
- The fog does not contain hydrocarbons, carbon monoxide and other harmful substances.

Harmful Effects of air pollution

(a) It affects respiratory system of living organisms and causes bronchitis, asthma, lung cancer,

pneumonia etc. Carbon monoxide (CO) emitted from motor vehicles and cigarette smoke affects the central nervous system.

(b) Due to depletion of ozone layer, UV radiation reaches the earth. UV radiation causes skin cancer, damage to eyes and immune system.

(c) Acid rain is also a result of air pollution. This is caused by presence of oxides of nitrogen and sulfur in the air. These oxides dissolve in rain water to form nitric acid and sulfuric acid respectively. Various monuments, buildings, and statues are damaged due to corrosion by acid present in the rain. The soil also becomes acidic. The cumulative effect is the gradual degradation of soil and a decline in forest and agricultural productivity.

(d) The green house gases, such as carbon dioxide and methane trap the heat radiated from earth. This leads to an increase in earth's temperature.

Treatment of Air pollution

As mentioned above, air pollutants can be gaseous or particulate matters. Different techniques for controlling these pollutants are discussed below:

a. Methods of controlling gaseous pollutants

1**. Combustion** – This technique is used when the pollutants are in the form of organic gases or vapors. During flame combustion or catalytic process, these organic pollutants are converted into water vapor and relatively less harmful products, such as CO2.

2. Absorption – In this technique, the gaseous effluents are passed through scrubbers or absorbers. These contain a suitable liquid absorbent, which removes or modifies one or more of the pollutants present in the gaseous effluents.

3. Adsorption – The gaseous effluents are passed through porous solid adsorbents kept in suitable containers. The organic and inorganic constituents of the effluent gases are trapped at the interface of the solid adsorbent by physical adsorbent.

b. Methods to control particulate emissions

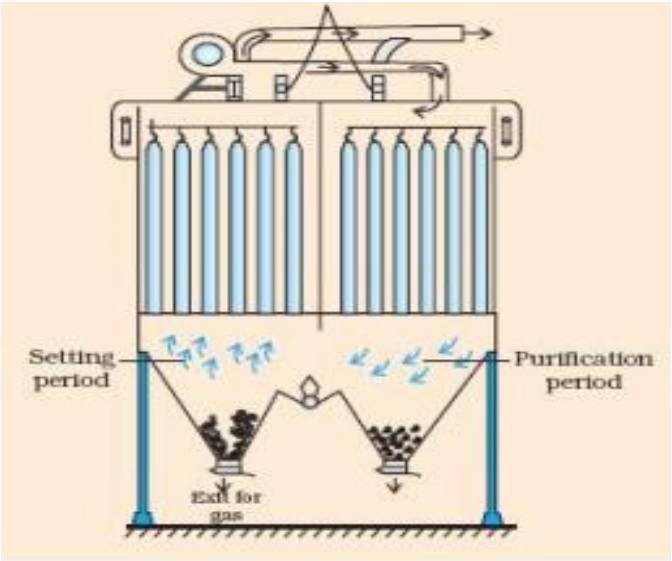
1. Mechanical devices generally work on the basis of the following:

(i) Gravitational Chamber: In this process, the particles settle down by gravitational force.

(ii) Sudden change in direction of the gas flow. This causes the particles to separate out due to greater momentum.

2. Fabric Filters: The gases containing dust are passed through a porous medium. These porous media may be woven or filled fabrics. The particles present in the gas are trapped and collected in

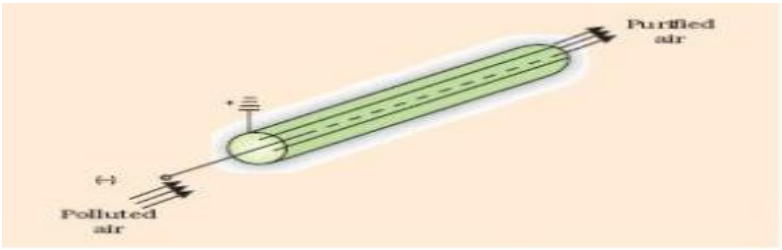
the filters. The gases freed from the particles are discharged.



A typical bag filter

3. Wet Scrubbers: Wet scrubbers are used in chemical, mining and metallurgical industries to trap SO2, NH3, metal fumes, etc.

4. Electrostatic Precipitators: When a gas or an air stream containing aerosols in the form of dust, fumes or mist, is passed between two electrodes, then, the aerosol particles get precipitated on the electrode.



Electrostatic precipitator

c. Other practices in controlling air pollution - Apart from the above, following practices also help in controlling air pollution.

(i) Use of better designed equipment and smokeless fuels, hearths in industries and at home.

(ii) Automobiles should be properly maintained and adhere to recent emission-control standards.

(iii) More trees should be planted along road side and houses.

(iv) Renewable energy sources, such as wind, solar energy, ocean currents, should fulfil energy needs.

(v) Tall chimneys should be installed for vertical dispersion of pollutants

d. General air pollution control devices / equipments for industries

The commonly used equipments / process for control of dust in various industries are (a) Mechanical dust collectors in the form of dust cyclones; (b) Electrostatic precipitators – both dry and wet system; (c) particulate scrubbers; (d) Water sprayer at dust generation points; (e) proper ventilation system and (f) various monitoring devices to know the concentration of dust in general body of air.

The common equipments / process used for control of toxic / flue gases are the (a) process of desulphurisation; (b) process of denitrification; (c) Gas conditioning etc. and (d) various monitoring devices to know the efficacy of the systems used.

Control of Air pollution

a) Checking the air pollution by strict imposition of laws on factories.

b) Reducing vehicular traffic and encouraging public transport vehicles than individual vehicles.

c) Use of unleaded petrol.

d) Regular check of exhaust gases from vehicles to declare their status in respect of pollution.

e) Ban and imposition of fines on polluting vehicles.

f) Strict control measures to take care of accidental pollution by industries.

g) Safe burial of atomic wastes.

h) Raising the height of chimneys of factories so that pollutant gas released from chimneys will reach upper strata of atmosphere.

i) Ban on illegal burning of hazardous materials and illegal handling of radioactive materials.

Water Pollution

Water pollution is the contamination of water bodies (e.g. lakes, rivers, oceans, aquifers and groundwater),very often by human activities

Water pollution occurs when pollutants (particles, chemicals or substances that make water contaminated) are discharged directly or indirectly into water bodies without enough treatment to get rid of harmful compounds. Pollutants get into water mainly by human causes or factors.

Water pollution is the second most imperative environmental concern along with air pollution.

Any change or modification in the physical, chemical and biological properties of water that will have a detrimental consequence on living things is water pollution.

Causes of water pollution

1)Industrial waste

Industries cause huge water pollution with their activities. These come mainly from:

a)Sulphur – This is a non-metallic substance that is harmful for marine life.

b)Asbestos – This pollutant has cancer-causing properties. When inhaled, it can cause illnesses such as asbestosis and some types of cancer.

c)Lead and Mercury – These are metallic elements and can cause environmental and health problems for humans and animals. It is also poisonous. It is usually very hard to clean it up from the environment once it get into it because it in non-biodegradable.

d)Nitrates & Phosphates– These are found in fertilizers, are often washed from the soils to nearby water bodies. They can cause eutrophication, which can be very problematic to marine environments.

e)Oils – Oils forms a thick layer on the water surface because they do not dissolve in water. This can stop marine plants receiving enough light for photosynthesis. It is also harmful for fish and marine birds. A classic example is the BP oil spill in 2012 with killed thousands of animal species.

f)Oil pollution from oil industries - Routine shipping, run-offs and dumping of oils on the ocean surfaces happen every day. Oil spills make up about 12% of the oil that enters the ocean. Oil spills cause major problems, and can be extremely harmful to local marine wildlife such as fish, birds and sea otters and other aquatic life. Because oil does not dissolve, it stays on the water surface and suffocates fish. Oil also gets caught in the feathers of sea birds stopping them from flying. Some animals die as a result.

2)Sewage and waste water

Every day, we cook, do laundry, flush the toilet, wash our cars, shower and do many things that use water. Think about how we use water in schools, hospitals and public places.

Where do you think all the water, liquid waste, toilet and urine ends up? In many developed communities, this waste water and soluble waste (called sewage) is treated, cleaned and dumped into the sea or river. Even though they are treated, they are never the same as fresh water.

In some not-so-developed countries, the sewage is not treated, but quickly dumped into the sea or water bodies. This is VERY dangerous because they contaminate the environment and water bodies and bring many deadly diseases to us.

3)Septic Tanks

Every domestic (home) toilet is connected to septic tank usually located outside the house. Each time poop is flushed down the toilet, it goes into this tank, where the solid part is separated from the liquid part. Biological processes are used to break down the solids and the liquid is usually drained out into a land drainage system. From this stage, it can escape into the soil and nearby water bodies.

4)Ocean and marine dumping

Again, think of the rubbish we all make each day. Paper waste, food waste, plastic, rubber, metallic and aluminium waste. In some countries, there are deposited into the sea. All these waste types take time to decompose. Example, it is know that paper takes about 6 weeks, aluminium takes about 200 years and glass takes even more. When these end up in the sea, they harm sea animals and cause a lot of deaths.

5)Underground storage and tube leakages

Many liquid products (petroleum products) are stored in metal and steel tubes underground. Other sewage systems run in underground tubes. Overtime, they rust and begin to leak. If that happens, they contaminate the soils and the liquids in them end up in many nearby water bodies.

6)Atmospheric

Atmospheric deposition is the pollution of water bodies caused by air pollution. Each time the air is polluted with sulphur dioxide and nitrogen oxide, they mix with water particles in the air and form a toxic substance. This falls as acid rain to the ground, and gets washed into water bodies. The result is that, water bodies also get contaminated and this affects animals and water organisms.

Effects of Water Pollution

- Groundwater contamination from pesticides causes reproductive damage within wildlife in ecosystems.

- Sewage, fertilizer, and agricultural run-off contain organic materials that when discharged into waters, increase the growth of algae, which causes the depletion of oxygen. The low oxygen levels are not able to support most indigenous organisms in the area and therefore upset the natural ecological balance in rivers and lakes.

- Swimming in and drinking contaminated water causes skin rashes and health problems like cancer, reproductive problems, typhoid fever and stomach sickness in humans. Which is why it's very important to make sure that your water is clean and safe to drink?

- Industrial chemicals and agricultural pesticides that end up in aquatic environments can accumulate in fish that are later eaten by humans. Fish are easily poisoned with metals that are also later consumed by humans. Mercury is particularly poisonous to small children and women. Mercury has been found to interfere with the development of the nervous system in fet uses and young children.

- Ecosystems are destroyed by the rising temperature in the water, as coral reefs are affected by the bleaching effect due to warmer temperatures. Additionally, the warm water forces indigenous water species to seek cooler water in other areas, causing an ecological damaging shift of the affected area.

- Human-produced litter of items such as plastic bags and 6-pack rings can get aquatic animals caught and killed from suffocation.

- Water pollution causes flooding due to the accumulation of solid waste and soil erosion in streams and rivers.

- Oil spills in the water causes animal to die when they ingest it or encounter it. Oil does not dissolve in water so it causes suffocation in fish and birds.

Treatment of water: Water treatment is a process of making water suitable for its application or returning its natural state.

Water treatment involves science, engineering, business, and art. The treatment may

include mechanical, physical, biological, and chemical methods. As with any technology, science is the foundation, and engineering makes sure that the technology works as designed. The appearance and application of water is an art.

General Wastewater Treatment

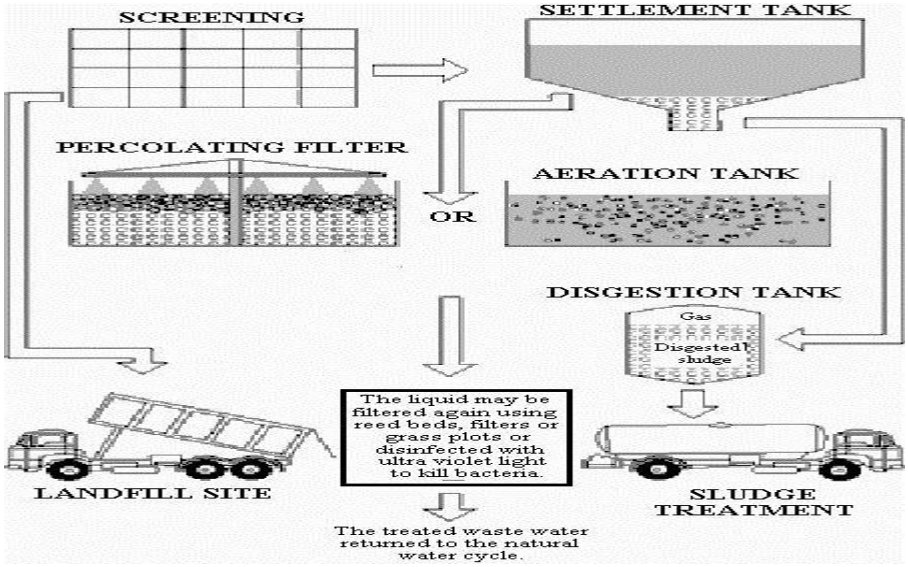
Water is a renewable resource. All water treatments involve the removal of solids, bacteria, algae, plants, inorganic compounds, and organic compounds. Removal of solids is usually done by filtration and sediment. Bacteria digestion is an important process to remove harmful *pollutants*. Converting used water into environmentally acceptable water or even drinking water is wastewater treatment.

Sewage Treatment

As a general discussion, let us look at a typical process in sewage treatment. A flow diagram for a general sewage treatment plant is given below:

Sewage is screened to remove large solid chunks, which are disposed in LANDFILL SITE. It flows over to the SETTLEMENT TANK to let the fine particles to settle. The settlement is called the activated SLUDGE. The supernatant is then PERCOLATING FILTERED and/or AERATED. The water can be filtered again, and then disinfected (chlorinated in most cases). When there is no other complication, the water is returned to nature back to the ecological cycle.

The SLUDGE removed from the settlement is composed of living biological material. A portion of it may be returned to the AERATION TANK, but the raw SLUDGE is digested by both microorganisms. Anaerobic (without oxygen) and aerobic (with air) bacteria digestions are used. At the digestion stage, carbon dioxide, ammonia, and methane gases are evolved. Volume of the digested sludge is reduced, and it is acceptable as a fertilizer supplement in farming.



Wastewater Treatment

Although the sewage water may be discharged back to the ecological system after AERATED DIGESTION and PERCOLATING FILTRATION, but in some cases, further treatment is required. Some general consideration of water treatment is given below.

Treatment by activated carbon is mostly due to adsorption or absorption. When a chemical species is adhered to the surface of a solid, it is an **adsorption**. When partial chemical bonds are formed between adsorbed species or when the absorbate got into the channels of the solids, we call it **absorption**. However, these two terms are often used to mean the same, because to distinguish one from type from the other is very difficult.

a)Treatment by activated carbon

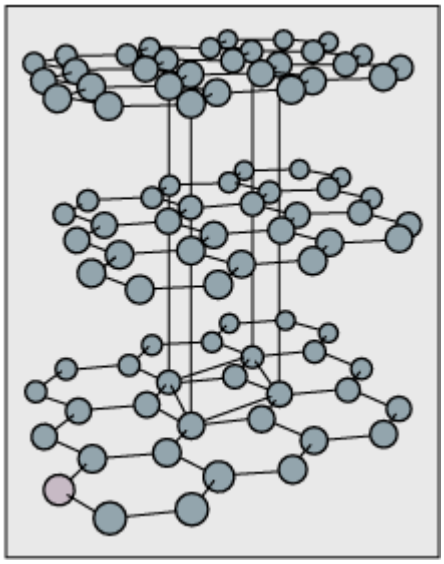
Application of activated charcoal for the removal of undesirable order and taste in drinking water has been recognized at the dawn of civilization. Using bone char and charred vegetation, gravel, and sand for the filtration of water for domestic application has been practised for thousands of years. Active research and production of activated charcoal was accelerated during the two world wars. The use of poison gas prompted the development of masks. They are still in use today.

Charcoal absorbs many substances, ranging from colored organic particulates to inorganic metal ions. Charcoal has been used to remove the colour of raw sugar from various sources.

Charcoal consists of microcrystalline of graphite. The particles are so small in charcoal that they were considered amorphous. The crystal structure of graphite consists of layers of hexagonal networks, stacked on top of each other. Today, making activated carbon is a new and widely varied industry. Other molecules attach themselves to the porous surface and dangling carbons in these

microcrystalline.

Carbon containing substances are charred at less than 900 K to produce carbon in the manufacture of activated carbon. However, the carbon is activated at 1200 K using oxidizing agent to selectively oxidize portions of the char to produce pores in the material. Because of the special process to produce used, these materials with high surface to mass ratio, they are called activated carbon rather than activated charcoal. Factors affecting the absorption are particle size, surface area, pore structure, acidity (pH), temperature, and the nature of the material to be absorbed. Usually, adsorption (absorption) equilibria and rate of adsorption must be considered for effective applications.



b)Coagulation, flocculation and sedimentation

Natural and wastewater containing small particulates. They are suspended in water forming a colloid. These particles carry the same charges, and repulsion prevents them from combining into larger particulates to settle. Thus, some chemical and physical techniques are applied to help them settle. The phenomenon is known as coagulation. A well known method is the addition of electrolyte. Charged particulates combine with ions neutralizing the charges. The neutral particulates combine to form larger particles, and finally settle down.

Another method is to use high-molecular-weight material to attract or trap the particulates and settle down together. Such a process is called flocculation. Starch and multiply charged ions are often used.

Historically, dirty water is cleaned by treating with alum, $Al_2(SO_4)_3 \cdot 12\ H_2O$, and lime, $Ca(OH)_2$. These electrolytes cause the pH of the water to change due to the following reactions:

$Al_2(SO_4)_3 \cdot 12\ H_2O$, -> $Al_{(aq)}^{3+} + 3\ SO_{4(aq)}^{2-} + 12\ H_2O$
$SO_{4(aq)}^{2-} + H_2O$ -> $HSO_{4(aq)}^{-} + OH^-$ (causing pH change)
$Ca(OH)_2$ -> $Ca_{(aq)}^{2+} + 2\ OH^-$ (causing pH change)

The slightly basic water causes $Al(OH)_3$, $Fe(OH)_3$ and $Fe(OH)_2$ to precipitate, bringing the small particulates with them and the water becomes clear. Some records have been found that Egyptians and Romans used these techniques as early as 2000 BC.
Suspension of iron oxide particulates and humic organic matter in water gives water the yellow muddy appearance. Both iron oxide particulates and organic matter can be removed from coagulation and flocculation. The description given here is oversimplified, and many more techniques have been applied in the treatment of water. Coagulation is a major application of lime in the treatment of wastewater.

Other salts such as iron sulfates $Fe_2(SO_4)_3$ and $FeSO_4$, chromium sulfate $Cr_2(SO_4)_3$, and some special polymers are also useful. Other ions such as sodium, chloride, calcium, magnesium, and potassium also affect the coagulation process. So do temperature, pH, and concentration.

Sedimentation let the water sit around to let the floculated or coagulated particles to settle out. It works best with relatively dense particles (e.g. silt and minerals), while flotation works better for lighter particles (e.g. algae, color). A settling tank should be big enough so that it takes a long time (ideally 4 hours +) to get through. Inlets and outlets are designed so the water moves slowly in the tank. Long and narrow channels are installed to let the water to snake its way through the tank. The settled particles, sludge, must occasionally be removed from the tanks. The water is next ready to be filtered. Sedimentation is used in pre-treatment and wastewater treatment.

C)Filtration

Filtration is the process of removing solids from a fluid by passing it through a porous medium. Coarse, medium, and fine porous media have been used depending on the requirement. The filter media are artificial membranes, nets, sand filter, and high technological filter systems. The choice of filters depends on the required filtering speed and the *cleanness* requirement. The flow required for filtration can be achieved using gravity or pressure. In pressure filtration, one side of the filter medium is at higher pressure than that of the other so that the filter plane has a pressure drop. Some portion of this filter type must be enclosed in a container.
The process of removing the clogged portion of the filter bed by reversing the flow through the bed and washing out the solid is called back washing. During this process, the solid must be removed out of the system, but otherwise the filters must be either replaced or taken out of service to be cleaned.

d)Aeration

Bringing air into intimate contact with water for the purpose of exchanging certain components between the two phases is called **aeration**. Oxygenation is one of the purposes of aeration. Others are removal of volatile organic substances, hydrogen sulfide, ammonia, and volatile organic compounds.

A gas or substance dissolved in water may further react with water. Such a reaction is called **hydration**. Ionic substance dissolve due to hydration, for example:

$$HCl\ (g) + x\ H_2O = H(H_2O)_x^+ + Cl_{(aq)}^-$$

$$H_2S = H_{(aq)}^+ + HS_{(aq)}^-$$

These reactions are reversible, and aeration may also causes dehydration resulting in releasing the gas from water. Henry's law is applicable to this type of equilibrium for consideration. Methods of aeration are

- Diffused aeration - Air bubbles through water.
- Spray aeration - Water is sprayed through air.
- Multiple-tray aeration - Water flows through several trays to mix with air.
- Cascade aeration - Water flows downwards over many steps in the form of thin water falls.
- Air stripping - A combination of multiple tray and cascade technique plus random packed blocks causing water to mix thoroughly with air.

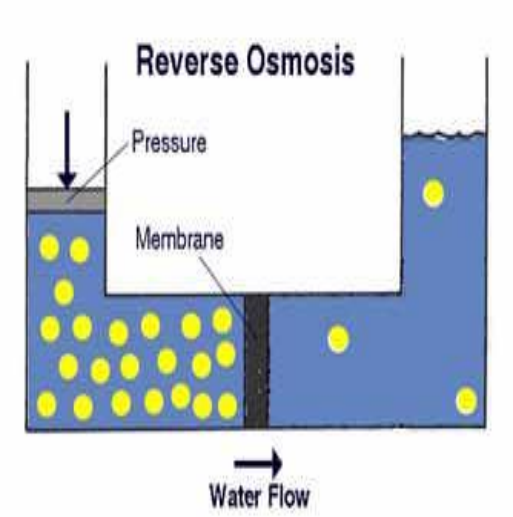
e)Reverse osmosis water filter system

In the following discussion, a dilute solution and a concentrated solution are considered. The dilute solution can be clean water whereas the concentrated solution contains undesirable solute (electrolyte or others).

When a compartment containing a dilute solution is connected to another compartment containing a concentrated solution by a semipermeable membrane, water molecules move from the dilute solution to concentrated solution. This phenomenon is called **osmosis**. Pig bladders are natural semipermeable membranes. As the water molecules migrate through the semipermeable membrane, water level in the solution will increase until the (osmotic) pressure prevents a net migration of water molecules in one direction. A pressure equivalent to the height difference is called the **osmotic pressure**.

By applying pressure in the higher concentration solution, water molecules migrate from a high concentration solution to a low concentration solution. This method is called **reverse osmosis**

water filter system. The concept of reverse osmosis is illustrated in the diagram



In this technique, the membrane must be able to tolerate the high pressure, and prevent solute molecules to pass through. This technology certainly works, and it has been used to convert salt (ocean or sea) water into fresh water. With this technique, the water with higher concentration is discharged. Thus, this technology is costly in regions where the water cost is high. Free drinking water also uses reverse osmosis filter system for domestic applications.

Control of water pollution

With increasing urbanisation and expanding agricultural and industrial production, water pollution problems have progressively become more serious and necessitated the adoption of suitable control measures for ameliorating pollution.

For a given body of water, the desired level of quality is usually specified in terms of parameters such as dissolved oxygen concentration, nutrient levels etc. The intended beneficial uses of the water resource are generally the basis on which the required quality criteria are formulated. Sources of pollution should then be regulated so as to achieve and maintain the minimum required water quality. This is usually accomplished through effluent discharge standards which specify the compliance requirements for the disposal of effluents in the environment.

Approaches to controlling sources of water pollution may be grouped into three broad categories: (1) minimisation of waste or pollutant generation, (2) Treatment prior to disposal of waste streams at source, and (3) "in-situ" reduction or elimination of pollution.

1)Minimisation of Pollutant Generation

Reduction of the quantity of waste or pollutants generated by an activity is obviously the most desirable approach to pollution control. Since it conserves resources that would otherwise be

wasted, and at the same eliminates the cost of removing pollutant after they are produced, it is the cheapest and most effective alternative. For non-point pollution sources, this is perhaps the only practicable method of pollution control. Yet, this approach has not been exploited by society to its fullest extent.

As a general rule, a resource becomes a waste when it can no longer be economically utilised or recovered. It is then disposed of in the environment in the cheapest manner possible. Availability of economical technology for resource processing and usage has been a main determinant of when the resource is discarded as waste.

In the past, decisions concerning resource usage or waste disposal have been governed largely by immediate economic considerations and have not always considered the effects of these actions on the quality of the environment. As accountability for environmental damage gains increased recognition, fostered by a growing desire within society for sustainable development and a cleaner environment, more attention and effort will undoubtedly be devoted to reducing resources going to waste and causing pollution.

Minimising soil erosion by improved agricultural practices (e.g. by minimising surface runoff and leaving crop residues in the ground), more efficient use of nutrients (e.g., though the use of slow release fertilisers) and the development and use of biological pest control techniques in preference to the use of non-biodegradable toxic chemicals are some of the measures for minimising water pollution from agriculture.

Considerable potential also exists in many industries to reduce waste generation. Development and use of non-polluting technology to modify or replace existing manufacturing processes, and recycling or recovering materials that would otherwise be wasted are two approaches which not only reduce pollutant generation, but can sometimes even result in a saving for the industry by minimising or eliminating the need for waste treatment for pollutant removal.

In other cases, it may be more practical to segregate strong and weak waste streams to facilitate materials or energy recovery. Good house keeping practices, such as for example minimising spillage and materials wastage, can also lead to waste reduction and savings in production cost.

2) Wastewater Treatment at Source

In nature, a variety of different mechanisms operate to degrade and transform waste materials into stable, harmless end products such as carbon dioxide. This cleansing ability is often

referred to as the "self-purification" or "assimilative" capacity. When the quantities of wastes to be disposed of are large, however, the natural purification processes become overloaded and can no longer assimilate the wastes without adversely affecting environmental quality. Man-made treatment systems are then needed to reduce pollutant loads to acceptable levels for discharge. For the most part, these purification systems make use of the same mechanisms as in the natural environment to bringing about waste stabilisation.

The multitude of different wastewater treatment technologies can be classified as physical, chemical and biological processes, depending on the nature of the purification mechanism employed. The character of the pollutants and the form (suspended or dissolved) in which they are present usually determine the most suitable process for their removal. For example, gross suspended solids and floatable materials such as oil and fat are readily removed by physical processes such as sedimentation or flotation respectively.

BIOLOGICAL METHODS are effective and economical when the waste water contains mostly biodegradable pollutants such as organic matter. A key advantage of biological processes is that the microorganisms involved in waste stabilisation are themselves produced in the process.

For dilute wastes - including general domestic wastewaters, "aerobic" biological processes (activated sludge, oxidation ponds and aerobic biofilter) are usually favoured since they are capable of producing an effuent with very low residual pollutant concentrations. These processes, however, require oxygen, in proportion to the pollutant load present. Oxygen is supplied through aeration, which is a significant cost component.

For strong wastes, "anaerobic" biological treatment in enclosed vessels is generally preferred as they proceed in the absence of oxygen, and in addition produce a useful, energy-rich by-product in the form of methane. The effluent from anaerobic processes, however, contain higher levels of residual organic materials and may require further polishing treatment (often in aerobic processes).

CHEMICAL TREATMENT is used when the pollutant of interest is non- biodegradable and is not amenable to removal by simple physical means (e.g. when it occurs in dissolved form). Heavy metals are typically removed by chemical precipitation, while toxic substances such as cyanide may be chemically oxidised. An important disadvantage of chemical treatment methods is that they generally require dosing with a chemical which can prove to be quite expensive. In addition, disposal of the chemical sludge produced in these processes may also pose some problems.

When a community based treatment system is impractical, it is still possible to provide a degree of treatment prior to discharging sewage into the environment. A popular method used for

individual homes and small groups of residences is the SEPTIC TANK. It consists of a simple baffled tank which traps most of the solids in the waste water and also affords some decomposition of soluble organic matter. The effluent is disposed of into the ground through a system of leach drains. As solids progressively accumulate in the tank, it is necessary to periodically dislodge the system, typically every 3 to 7 years.

As deep swearing in built-up areas is very expensive, other more efficient alternatives to the septic tank are also desirable for on- site use. In recent years, a number of new systems, which are essentially miniature versions of the biological processes used for large-scale plants have become available.

3 In-situ Pollution Control

Waste minimisation and treatment help prevent pollution from occurring and should be the principal approaches to water quality maintenance. Occasionally, however, when a water body is already adversely affected, it will be necessary to consider action aimed at helping the ecosystem recover from the impact of pollution. Methods to facilitate this are collectively grouped under in-situ control techniques.

Aeration of lakes and reservoirs, especially when they are thermally stratified (in summer), has been used to prevent anaerobic conditions from occurring. Forced circulation of water in stratified lakes is an alternative method. Dredging nutrient rich superficial sediments from highly eutrophic lakes, while very expensive, has sometimes helped reduce occurrence of severe algal blooms. Addition of aluminium or iron salts to assist the precipitation of phosphorus has also been practiced in some lakes to control dissolved phosphorus levels in the water.

SOIL POLLUTION

Soil pollution is defined as the build-up in soils of persistent toxic compounds, chemicals, salts, radioactive materials, or disease causing agents, which have adverse effects on plant growth and animal health.

Soil is the thin layer of organic and inorganic materials that covers the Earth's rocky surface. The organic portion, which is derived from the decayed remains of plants and animals, is concentrated in the dark uppermost topsoil. The inorganic portion made up of rock fragments, was formed over thousands of years by physical and chemical weathering of bedrock. Productive soils are necessary for agriculture to supply the world with sufficient food.

Causes of soil pollution

1)Industrial Activity: Industrial activity has been the biggest contributor to the problem in the last century, especially since the amount of mining and manufacturing has increased. Most industries are dependent on extracting minerals from the Earth. Whether it is iron ore or coal, the by products are contaminated and they are not disposed off in a manner that can be considered safe. As a result, the industrial waste lingers in the soil surface for a long time and makes it unsuitable for use.

2)Agricultural Activities: Chemical utilization has gone up tremendously since technology provided us with modern pesticides and fertilizers. They are full of chemicals that are not produced in nature and cannot be broken down by it. As a result, they seep into the ground after they mix with water and slowly reduce the fertility of the soil. Other chemicals damage the composition of the soil and make it easier to erode by water and air. Plants absorb many of these pesticides and when they decompose, they cause soil pollution since they become a part of the land.

3)Waste Disposal: Finally, a growing cause for concern is how we dispose of our waste. While industrial waste is sure to cause contamination, there is another way in which we are adding to the pollution. Every human produces a certain amount of personal waste products by way or urine and feces.

While much of it moves into the sewer the system, there is also a large amount that is dumped directly into landfills in the form of diapers. Even the sewer system ends at the landfill, where the biological waste pollutes the soil and water. This is because our bodies are full of toxins and chemicals which are now seeping into the land and causing pollution of soil.

4. Accidental Oil Spills: Oil leaks can happen during storage and transport of chemicals. This can be seen at most of the fuel stations. The chemicals present in the fuel deteriorates the quality of soil and make them unsuitable for cultivation. These chemicals can enter into the groundwater through soil and make the water undrinkable.

5. Acid Rain: Acid rain is caused when pollutants present in the air mixes up with the rain and fall back on the ground. The polluted water could dissolve away some of the important nutrients found in soil and change the structure of the soil.

Effects of Soil Pollution

1. Effect on Health of Humans: Considering how soil is the reason we are able to sustain ourselves, the contamination of it has major consequences on our health. Crops and plants grown on polluted soil absorb much of the pollution and then pass these on to us. This could explain the

sudden surge in small and terminal illnesses.

Long term exposure to such soil can affect the genetic make-up of the body, causing congenital illnesses and chronic health problems that cannot be cured easily. In fact, it can sicken the livestock to a considerable extent and cause food poisoning over a long period of time. The soil pollution can even lead to widespread famines if the plants are unable to grow in it.

2. Effect on Growth of Plants: The ecological balance of any system gets affected due to the widespread contamination of the soil. Most plants are unable to adapt when the chemistry of the soil changes so radically in a short period of time. Fungi and bacteria found in the soil that bind it together begin to decline, which creates an additional problem of soil erosion.

The fertility slowly diminishes, making land unsuitable for agriculture and any local vegetation to survive. The soil pollution causes large tracts of land to become hazardous to health. Unlike deserts, which are suitable for its native vegetation, such land cannot support most forms of life.

3. Decreased Soil Fertility: The toxic chemicals present in the soil can decrease soil fertility and therefore decrease in the soil yield. The contaminated soil is then used to produce fruits and vegetables which lacks quality nutrients and may contain some poisonous substance to cause serious health problems in people consuming them.

4.Toxic Dust: The emission of toxic and foul gases from landfills pollutes the environment and causes serious effects on health of some people. The unpleasant smell causes inconvenience to other people.

5.Changes in Soil Structure: The death of many soil organisms (e.g. earthworms) in the soil can lead to alteration in soil structure. Apart from that, it could also force other predators to move to other places in search of food.

Treatment of soil pollution

Soil pollution can occur as a result of industrialization, urbanization and farming. Among the most notable contaminants are heavy metals, which may result from any number of causes. A grave problem with soil pollution is that it offers no visible warning signs and may continue unnoticed for a significant period of time. But multiple treatment techniques are employed to destroy, isolate and/or eliminate soil contaminants.

a) Thermal Treatment

Thermal treatment methods generally heat and destroy pollutants through soil. The heat can also destroy or evaporate some chemicals. In turn, evaporated pollutants move more easily than those in solid form. Once treatment begins, pollutants are steered into and contained within underground wells before getting pumped to the surface. Above-ground treatment techniques can then purify the contaminants. Thermal treatment, which has proven particularly successful with non-aqueous phase liquids (NAPLs), often keeps soil in place and is thus called in situ. Examples of thermal treatment techniques include steam injection, hot water injection and radio frequency heating.

b)Phytoremediation

Phytoremediation is a process that uses plants to stabilize or destroy soil contaminants. A number of different mechanisms exist for this process, including phyto-stabilization and phyto-accumulation. In the former, chemical compounds produced by plants are used to immobilize contaminants. The latter process uses plant shoots and leaves to store contaminants that usually contain metals. The plants are specifically chosen for their abilities to absorb large quantities of lead. Poplar trees are among the most widely chosen plants for phytoremediation and require a large surface area of land. In addition to metals, phytoremediation may also be used against pesticides, explosives, fuels and volatile or semi-volatile organic compounds.

c)Soil Vapor Extraction

Soil vapor extraction (SVE) is an in situ remediation technology that leaves the soil as-is, without moving or digging. The technique uses a vacuum to emit a controlled flow of air through the soil. Volatile and some semi-volatile contaminants are then removed. Ground water pumps may be used during the procedure to mitigate water upwelling caused by the vacuums. After contaminants are removed, other remediation measures may be necessary if soil cleaning objectives have not been met. SVE projects typically require one to three years for completion, and field pilot studies are necessary prior to the procedure for determining feasibility and system configuration.

d**)Biosparging**

Bioosparging is a treatment technique using natural microorganisms, like yeast or fungi, to decompose hazardous soil substances. Some microorganisms can ingest dangerous chemicals without harm. In turn, those pollutants are rendered into less toxic or nontoxic substances, usually in the form of carbon dioxide and water. To be successful, biosparging requires active and healthy microorganisms. This is encouraged via increased bacterial growth in the soil, which creates

optimal living conditions. After the contaminants are regulated, the microorganisms reduce in number because their food source is gone. Biosparging can occur under aerobic and anaerobic conditions.

e)Electric Resistance Heating

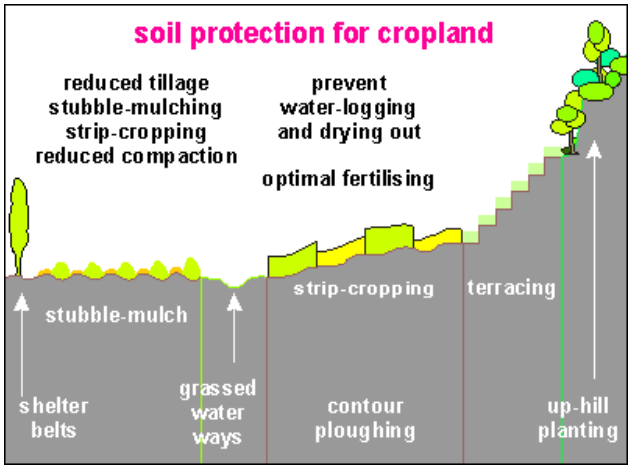
Electric resistance heating works by sending an electrical current into soil through multiple electrodes. Those electrodes are strategically placed to ensure an entire area is reached. As the electrical current passes through the subsurface, it encounters resistance that heats the soil. The soil turns gradually hotter until contaminant compounds reach boiling temperatures. They then evaporate, and vapour extraction techniques are used to remove fumes. Once the vapours are removed, treatment can begin at the soil's surface level. Benefits of this technique include low levels of disruption, and clean-up that typically occurs within six to 10 months.

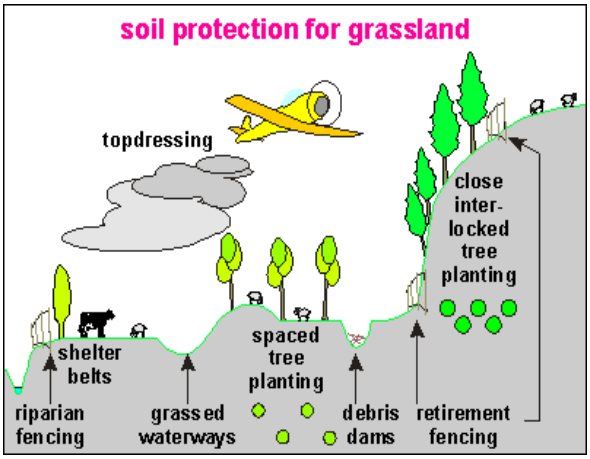
f)Land farming

Land farming occurs above-ground and reduces contaminant concentrations with biodegradation. This is an ex situ process --- polluted soil is excavated, combined with bulking agents and nutrients and then returned to the earth. The soil is spread, tilled and occasionally turned to improve oxygen flow. Improved microbial activity ensues, and with controlled soil conditions, contaminants are degraded. Land farming allows soil to be completely purified of certain pollutants, and it is a simple technique that does not require process controls. The petroleum industry uses land farming to prevent chemical build-up within soil. Other successfully treated wastes include diesel fuel and wood preservatives.

Control of soil pollution

1.Use of pesticides should be minimized.
2. Use of fertilisers should be judicious.
3. Cropping techniques should be improved to prevent growth of weeds.
4. Special pits should be selected for dumping wastes.
5. Controlled grazing and forest management.
6. Wind breaks and wind shield in areas exposed to wind erosion
7. Planning of soil binding grasses along banks and slopes prone to rapid erosin.
8. Afforestation and reforestation





Marine Pollution

Pollution is the introduction of harmful contaminants that are outside the norm for a given ecosystem. Common man-made pollutants that reach the ocean include pesticides, herbicides, chemical fertilizers, detergents, oil, sewage, plastics, and other solids. Many of these pollutants collect at the ocean's depths, where they are consumed by small marine organisms and introduced into the global food chain. Scientists are even discovering that pharmaceuticals ingested by humans but not fully processed by our bodies are eventually ending up in the fish we eat.

Causes of marine pollution

From plastic bags to pesticides - most of the waste we produce on land eventually reaches the oceans, either through deliberate dumping or from run-off through drains and rivers. This includes:

a)Oil

Oil spills cause huge damage to the marine environment - but in fact are responsible for only around 12% of the oil entering the seas each year. According to a study by the US National Research Council, 36% comes down drains and rivers as waste and runoff from cities and industry.

b)Fertilizers

Fertilizer runoff from farms and lawns is a huge problem for coastal areas. The extra nutrients cause eutrophication - flourishing of algal blooms that deplete the water's dissolved oxygen and suffocate other marine life.

Eutrophication has created enormous dead zones in several parts of the world, including the Gulf of Mexico and the Baltic Sea.

c)Seas of garbage

Solid garbage also makes its way to the ocean. Plastic bags, balloons, glass bottles, shoes, packaging material – if not disposed of correctly, almost everything we throw away can reach the sea.

Plastic garbage, which decomposes very slowly, is often mistaken for food by marine animals. High concentrations of plastic material, particularly plastic bags, have been found blocking the breathing passages and stomachs of many marine species, including whales, dolphins, seals, puffins, and turtles. Plastic six-pack rings for drink bottles can also choke marine animals.

This garbage can also come back to shore, where it pollutes beaches and other coastal habitats.

d)Sewage disposal

Although it's hard to imagine raw sewage being dumped into the ocean, it happens on a regular basis. The oceans are vast and can break down this vile liquid, but it still causes many adverse effects on marine life. Sewage includes "black water" from toilets and also water from laundry, food preparation and sinks, referred to as "gray water". Imagine all of the toxic cleaning products and other household substances that are flushed down the sink finding their way into the ocean! Sometimes, sludge from sewage treatment is also dumped into the ocean. Consider what happens when it rains and all of the grime from the streets is washed into the sewer system, which could eventually wash out to sea.

In many parts of the world, sewage flows untreated, or under-treated, into the ocean. For example, 80% of urban sewage discharged into the Mediterranean sea is untreated.

This sewage can also lead to eutrophication. In addition, it can cause human disease and lead to beach closures.

e)Toxic chemicals

Almost every marine organism, from the tiniest plankton to whales and polar bears, is contaminated with man-made chemicals, such as pesticides and chemicals used in common consumer products.

Some of these chemicals enter the sea through deliberate dumping. For centuries, the oceans

have been a convenient dumping ground for waste generated on land. This continued until the 1970s, with dumping at sea the accepted practise for disposal of nearly everything, including toxic material such as pesticides, chemical weapons, and radioactive waste.

Also enter the sea from land-based activities. Chemicals can escape into water, soil, and air during their manufacture, use, or disposal, as well as from accidental leaks or fires in products containing these chemicals. Once in the environment, they can travel for long distances in air and water, including ocean currents.

Effects of Marine Pollution

The effects of the marine pollution are as huge and varied as the causes themselves.

1)The oil pollution results in disruptions to the cycle of coral reefs, clogging of the gills of fishes thereby resulting in their death and hampering the process of photosynthesis of marine plants leading to their end.

2)Oil pollution on a large scale also indirectly affects areas that may not have seen the spill. The disposal of toxic wastes has both direct and indirect effect on marine life and equally hazardous consequence on the human race as we are closely linked with aquatic life forms in many ways.

3)Toxins along with garbage deplete the oxygen content of the water thus making it impossible for many life forms including bigger species like whales, dolphins, penguins, shark, iguana and seals to survive.

4)Some of the substances such as the normal DDTs and pesticides accumulate in the fatty acids of animals and results in the failure of reproductive system of some of the species especially mammals.

5)Apart from these, activities like farming, forestry and mining if not done with care lead to sediments being deposited in the waters and impacts adversely both plant as well as animal life in the oceans. This is one of the main effects of marine pollution.

6)Plastic debris discarded fishing nets and other similar items that are there purely because of human negligence act as severe agents of marine pollution and have an effect that cannot be imagined unless witnessed. The large scale death of animals due to plastic consumption like the sea turtles who consume it thinking it to be jellyfish is an example.

Control measures for oil pollution:

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

Noise Pollution

In simple terms noise is unwanted sound. Sound is a form of energy which is emitted by a vibrating body and on reaching the ear causes the sensation of hearing through nerves . Sounds produced by all vibrating bodies are not audible. The frequency limits of audibility are from 20 HZ to 20000 HZ.

A noise problem generally consists of three inter-related elements -the source, the receiver and the transmission path. This transmission path is usually the atmosphere through which the sound is propagated, but can include the structural materials of any building containing the receiver

Causes of noise pollution

1.Public/Private Transportation Vehicle – these are one of the daily causes of noise pollution in our streets, public hi-way, etc. Why? Because in every kind of vehicle it creates disturbing sounds by starting the engines, blowing of horns, playing music from car amplifier, etc. As a result the city has now become exposed from these types of unavoidable and uncontrollable noise.

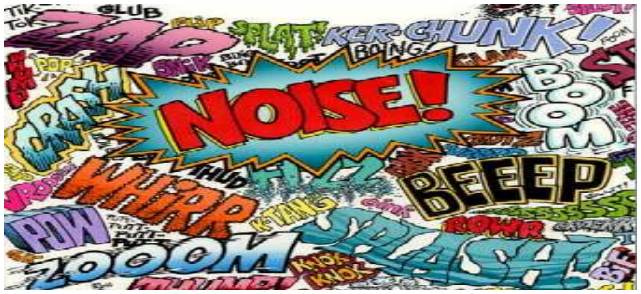
2. Industrial Machinery – there are so many various examples of industrial machinery that creates severe disturbing and hazardous sounds to the industrial workers. The multiple kinds of industrial machinery are huge generators, large compressors, cranes, furnaces, exhaust fans and many more. It is through these objects that adds distractions and complications in our ambience.

3. Construction Sites – we all know that every construction area uses huge equipments as part of their job like pay loader, crane, cement mixer, bulldozer, etc. These construction items are expected to perform vibrations and loud noise that can affect illnesses to all construction workers.

4. Loud Speaker – using loud speaker in public or private areas like residential, commercial establishment, public market, concert arena, etc., can definitely and instantly contributes disturbing sounds in our community or environment. The sounds from the loud speakers can immediately

spread in our atmosphere and undoubtedly becomes one of the causes of noise pollution.

.5.Big Events – we all love celebrating big events such as birthdays, anniversaries, house parties, festivals. But, do you realize how much noise you and your special visitors can create unpleasant and very disturbing sounds in your external surroundings or neighbourhood? While you and your friends are enjoying your special occasion, your angry neighbourhoods are having difficulties in their sleeping hours.



These are the common causes and very prominent distractions in our precious space or environment. But there are still many ways to avoid and to decrease the sounds of these unlikable and harmful sounds in your local area. With a strong understanding about the main cause of noise pollution in your area, you will surely find the perfect solution of this kind of dilemma.

Effects of noise pollution

Generally, problems caused by noise pollution include stress related illnesses, speech interference, hearing loss, sleep disruption, and lost productivity. Most importantly, there are two major effects we can look at:

Hearing:The immediate and acute effect of noise pollution to a person, over a period of time, is impairment of hearing. Prolonged exposure to impulsive noise to a person will damage their eardrum, which may result in a permanent hearing disorder.

Effects on general health: Health effects of noise include anxiety and stress reaction and in extreme cases fright. The physiological manifestations are headaches, irritability and nervousness, feeling of fatigue and decreases work efficiency. For example, being pounded by the siren of fire fighters, police or ambulance in your city all night everyday leave people (especially elderly people) stressed and tired in the morning.

Its is worth noting that these effects may not sound troubling, but the truth is, with time, the consequences can be very worrying.

Control and prevention of noise pollution

Noise generation is associated with most of our daily activities. Due to various adverse impacts on noise on humans and environment , noise should be controlled. The techniques employed for noise control can be broadly classified as,

- Control at source
- Control in transmission path
- Using protective equipment

1) Noise control at source

The noise pollution can be controlled at the source of generation itself by employing techniques like -

- Reducing the noise levels from domestic sectors
- Maintenance of automobiles
- Control over vibrations
- Low voice speaking
- Prohibition on use of loud speakers
- Optimum selection and maintenance of machinery

2)Control in transmission path

- Installation of barriers
- Appropriate design of building
- Installation of panels or enclosures
- Green belt development

3)Protective equipment

The first step in the technique of using protective equipment is to gauge the intensity of the problem , identification of the sufferer and his exposure the noise levels.The usage of protective eauipment and the worker's exposure to high noise levels can be minimised by -job rotation, exposure reduction , hearing protection.

Thermal pollution

Thermal Pollution, harmful increases in water temperature in streams, rivers, lakes, or occasionally, coastal ocean waters. Thermal pollution is caused by either dumping hot water from factories and power plants or removing trees and vegetation that shade streams, permitting sunlight to raise the temperature of these waters. Like other forms of water pollution, thermal pollution is widespread, affecting many lakes and vast numbers of streams and rivers in the and other parts of the world. A temperature increases as small as 1 or 2 Celsius degrees (about 2 to 4 Fahrenheit degrees) can kill native fish, shellfish, and plants, or drive them out in favor of other species, often with undesirable effects.

Causes/Sources of thermal pollution:

Industrial Effluents- Industries require cooling water for heat removal and cooling purposes. This heated water when discharged into the water system increases the temperature of water body.

Nuclear Power plants-Nuclear power plants emit large quantity of heat and traces of radioactive substances which increases the temperature of water bodies.

Coal- fired power plants- It is one of the major source of thermal pollution.

Domestic sewage-When the domestic sewage is disposed off into water bodies like river, lakes etc it increases the temperature of receiving water.

Radioactive waste- Dumping of radioactive waste in marine system increases the temperature when these substances radiate energy.

Effects of Thermal pollution:

There are two types of effects of thermal pollution

Thermal shock: Due to decrease in DO levels there is suffocation of plants and animal species which creates anaerobic conditions .The sudden change in the temperature causes harm to the aquatic organisms.

Thermal enrichment: The heated water is used for irrigation purposes to extend plant growing seasons. The warmer water also increases the metabolic rate of aquatic organisms (which in turn decreases the life expectancy of these organisms). The speedy growth is beneficial for commercial purposes.

Prevention/control of thermal pollution

Thermal pollution from power plants and factories is relatively easy to control. Instead of discharging heated water into lakes and streams, power plants and factories can pass the heated water through cooling towers or cooling ponds, where evaporation cools the water before it is discharged.

Alternatively, power plants can be designed or refitted to be more efficient and to produce less waste heat in the first place. In a process called *cogeneration*, the excess heat energy from generating electricity can be used in another manufacturing process that needs such energy. Where homes or other buildings are located near industrial plants, waste hot water can be used for heating—an arrangement often found in Scandinavian towns and cities, and proposed for use in.

To prevent thermal pollution due to devegetation, the prescription is simple: do not devegetate. Landowners can leave strips of trees and vegetation along streams and shorelines. Grazing livestock can be kept away from streamsides by fencing. All efforts to control erosion also have the effect of keeping water clearer and, thus, cooler.

As a practical matter, however, thermal pollution from devegetation is quite hard to control because it is caused by the cumulative effect of many peoples' actions, most of which are individually minor. Regulations focus on a few of the most important threats.

Grazing management plans, for instance, are intended to counter thermal pollution and other problems on lands owned by the federal government. In the , regulations governing logging on both public and private lands supposedly protect streamside's, though enforcement is often lax. Elsewhere, streamside protection is largely up to private landowners, encouraged and aided by such advisory organizations as the federal Natural Resources Conservation Service and cooperative Resource Conservation District.

Nuclear pollution

Since the discovery of nuclear fission occurred in 1938, following nearly five decades of work on the science of radioactivity and the elaboration of new nuclear physics, nuclear technology are served for civilian uses such as power plant and medical, industrial, commercial, food processing and agriculture applications. Unfortunately, nightmares occur : 6 August 1945, "Little Boy"(uranium gun-type device) was detonated over the Japanese city of Hiroshima; three days later, "Fat Man"(plutonium implosion-type device) was exploded over Nagasaki, Japan;

March 1979, Three Mile Island accident; April 1986, Chernobyl disaster; September 1999, Tokaimura nuclear accident; March, 2010, Fukushima Daiichi nuclear disaster……

Causes of nuclear pollution

Nuclear wastes come from a number of sources: Operations conducted by nuclear power stations produce radioactive waste. Nuclear waste may generate low to medium radiation over long period of times. The radioactivity may contaminate and propagate through air, water, and soil as well. The main issue is the fact that nuclear waste cannot be degraded or treated chemically or biologically. Nuclear-fuel reprocessing plants in northern Europe are the biggest sources of man-made nuclear waste in the surrounding ocean. Radioactive traces from these plants have been found as far away as Greenland.

- Mining and refining of uranium and thorium. Mining of radioactive ores (such as uranium and phosphate ores) involve the crushing and processing of radioactive ores and generate radioactive by-products.

- Nuclear fuel cycle (used in many industrial, medical and scientific processes).

The sources of radiation pollution involve any process that emanates radiation in the environment. The most common ones that can pose moderate to serious health risks include:

- Nuclear weapons – probably the highest amounts of human-induced radiation pollution have been generated in the mid twenty century through various experimental or combat nuclear detonations (that ended the Second World War). Nuclear fuel cycle (used in many industrial, medical and scientific processes).
- Defense weapon production – may also release radioactivity from the handled radioactive materials (usually of high health risks). However, unless accident occurs, the current standards will not allow the release of any significant amount of radiation.
- Nuclear accidents – an already classic example of such accident is the nuclear explosion, 1986 at a former Soviet nuclear power plant from Chernobyl and explosion, 1979 at Three Mile Island nuclear-power generating plant near Harrisburg, PA. The effects are still seen today. Even accidents from handling medical nuclear materials or wastes could have radiation health effects on workers.

Negative impact on health and environment

Dose of 25 rems (unit of radiation needed to damage cells) causes changes in blood, above

100 rems cause nausea, vomiting, headache and loss of leucocytes whereas 300 rems and above cause internal harm including damage to nerve cells. The immediate effects occur within few days such as hair loss, subcutaneous bleeding, change in metabolism and proportion of cells. The delayed effects occur in few months or years which included genetic mutations and tumors formation. The free radicals slowly and steadily destroy proteins, membranes, and nucleic acids in human body. The most sensitive regions exposed to radiation are actively dividing cells such as skin, gonads, intestine, and bone marrow.

Nuclear accidents may produce fallout which can pollute water supplies for years after the incident. The organism lives in water show sensitivity to the radiations. The 1986 explosion of a nuclear generator in Chernobyl (Ukraine) created a large radioactive cloud which polluted existing water supplies and produced contaminated rain in nearby countries. The radiations which are harmful influence nature and occur in the coastal areas. The fishes and water polluted by the radiation. Nuclear radiation can contaminate soil, leading to plants which contain radiation and pose a health threat to individuals. Researchers explored the Marshall Islands, an area widely known for nuclear bomb testing by the U.S. military in the 1950s and 1960s. They found that current soil samples and local foods, including coconut meat, contained radiation levels significant enough to pose a health risk to individuals. Radiation also damages chromosomes. It increases the frequency of chromosomal aberrations and causes genetic mutations. Such genetic changes may adversely affect plant metabolism or change their characteristics in subsequent generations.

Ways to handle nuclear pollution

Verification is a proven technique in the disposal and long-term storage of nuclear waste or other hazardous wastes. Waste is mixed with glass-forming chemicals in a melter to form molten glass that then solidifies in canisters, immobilizing the waste. The final waste form resembles obsidian and is a non-leaching, durable material that effectively traps the waste inside. The waste can be stored for relatively long periods in this form without concern for air or groundwater contamination. Nuclear reprocessing technology was developed to chemically separate and recover fissionable plutonium from irradiated nuclear fuel. Reprocessing serves multiple purposes, whose relative importance has changed over time. Originally reprocessing was used solely to extract plutonium for producing nuclear weapons. With the commercialization of nuclear power, the reprocessed plutonium was recycled back into MOX nuclear fuel for thermal reactors. The reprocessed uranium, which constitutes the bulk of the spent fuel material, can in

principle also be re-used as fuel, but that is only economic when uranium prices are high. Finally, the breeder reactor can employ not only the recycled plutonium and uranium in spent fuel, but all the actinides, closing the nuclear fuel cycle and potentially multiplying the energy extracted from natural uranium by more than 60 times.

CHAPTER 2

SOLID WASTE MANAGEMENT, DISASTER MANAGEMENT

Solid waste is the unwanted or useless solid materials generated from combined residential, industrial and commercial activities in a given area. It may be categorised according to its origin (domestic, industrial, commercial, construction or institutional); according to its contents (organic material, glass, metal, plastic paper etc); or according to hazard potential (toxic, non-toxin, flammable, radioactive, infectious etc).

Management of solid waste reduces or eliminates adverse impacts on the environment and human health and supports economic development and improved quality of life. A number of processes are involved in effectively managing waste for a municipality. These include monitoring, collection, transport, processing, recycling and disposal.

Why should we do Solid Waste Management?

Solid waste management becomes necessary and relevant when the structure of the society changes from agricultural with low-density and widespread population to urban, high-density population. Furthermore, industrialization has introduced a large number of products which nature cannot, or can only very slowly, decompose or digest. Hence, certain industrial products contain substances which, due to low degradability or even toxic characteristics, may build up in nature to levels representing a threat to humanity's future use of the natural resources - that is, drinking water, agricultural soil, air and so on.

The objective of solid waste management is to prevent pollution of the natural environment.

A solid waste management system should be based on technical studies and overall planning procedures including:

- studies and estimates on waste composition and amounts
- studies on collection techniques
- studies on processing and disposal facilities
- studies on prevention of pollution of the natural environment
- studies on occupational health and safety standards
- Feasibility studies.

The studies must include protection of the natural environment and occupational health and safety aspects, taking the possibilities of sustainable development into consideration. As it seldom is possible to solve all problems at one time, it is important at the planning stage to note that it is

helpful to set up a list of priorities. The first step in solving environmental and occupational hazards is to recognize the existence of the hazards.

Solid waste can be classified into different types depending on their source:

1) Industrial waste as hazardous waste 2) Household waste is generally classified as municipal solid waste 3)Biomedical waste or hospital waste as infectious waste and 4) E-waste Electronic wastes such as TV's, refrigerators and computer waste.

Industrial waste

Detection of traces of toxic chemicals in drinking water supplies, in polar ice caps, groundwater sources and episodes such as those in Minamata Bay, Japan and Love Canal, USA have focused the attention of the public worldwide on the risks posed by the inappropriate disposal of hazardous waste and accidental release of toxic chemicals into the environment. In India the concern and need to manage the hazardous waste generated in the country in a scientific manner was felt only in the mid-eighties after the occurrence of the Bhopal gas tragedy on 2/3 December 1984. The Government's attention was then drawn towards environmental damage and the casualties that hazardous chemical substances and toxic wastes can cause. The MoEF (Ministry of Environment and Forests) enacted an umbrella act i.e., The Environment (Protection) Act in 1986. Subsequent to this Act, in order to prevent indiscriminate disposal of hazardous waste, the MoEF promulgated the Hazardous Wastes (Management and Handling) Rules in 1989, and efforts to inventories hazardous waste generation were 1initiated.Due to the liberalised policy the pace of industrialization has been accelerated, which has resulted in increasing amounts of hazardous wastes every year. This along with a growing amount of municipal solid waste due to rapid urbanisation and hospital waste continues to remain a daunting issue of environmental concern to India.

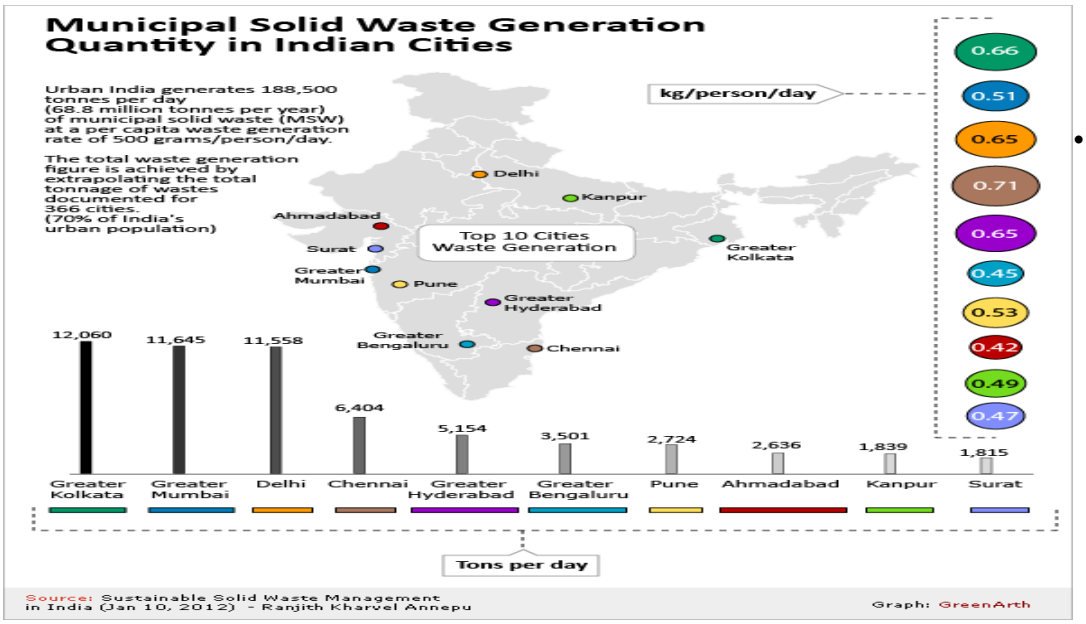
Municipal solid waste

Municipal solid waste (MSW), also called Urban Solid Waste, and is a waste type that includes predominantly household waste (domestic waste) with sometimes the addition of commercial wastes, construction and demolition debris, sanitation residue, and waste from streets collected by a municipality within a given area. They are in either solid or semisolid form and generally exclude industrial hazardous wastes. MSW can be broadly categorized into five broad categories as-

•Biodegradable waste: food and kitchen waste, green waste (vegetables, flowers, leaves, fruits), paper (can also be recycled).

•Recyclable material: paper, glass, bottles, cans, metals, certain plastics, etc.

•Inert waste: construction and demolition waste, dirt, rocks, debris.



Composite wastes: waste clothing, Tetra Packs, waste plastics such as toys.

•Domestic hazardous waste(also called "household hazardous waste") & toxic waste: medication, e-waste, paints, chemicals, light bulbs, fluorescent tubes, spray cans, fertilizer and pesticide containers, batteries, shoe polish.

Sources of waste, waste generator and solid waste contents can be tabulated as below:

Source	**Typical waste generator**	**Solid waste contents**
Residential	Single and multifamily dwellings	Food wastes, paper, cardboard, plastics, textiles, leather, yard wastes, wood, glass, metals, ashes, special wastes (e.g., bulky items, consumer electronics, batteries, oil, tires), and household hazardous wastes
Industrial	Light and heavy manufacturing. Fabrication, construction sites, power and chemical plants	Housekeeping wastes, packaging, food wastes, construction and demolition materials, hazardous wastes, ashes, special wastes.
Commercial	Stores, hotels, restaurants, markets, office buildings etc	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes.
Institutional	Schools, hospitals, prisons, government centres	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes.
Construction and demolition	New construction sites, road repair, renovation sites, demolition of buildings	Wood, steel, concrete, dirt, etc

Municipal services	street cleaning, landscaping, parks, beaches, other recreational areas, water and wastewater treatment plants	Street sweepings; landscape and tree trimmings; general wastes from parks, beaches, and other recreational areas; sludge.
Process(manufacturing etc)	Heavy and light manufacturing, refineries, chemical plants, power plants, mineral extraction and processing.	Industrial process wastes, scrap materials, off-specification products, slay tailings.
Agriculture	Crops, orchards, vineyards, dairies, feedlots, farms.	Spoiled food wastes, agricultural wastes, hazardous wastes (e.g., pesticides)

Disposal methods

Improper and unscientific techniques adopted for MSW disposal are economically non - viable and socially unacceptable, due to this selection of proper disposal method is necessary. Quantity and characteristics of the MSW are two major factors, which are to be considered as the basis for the design of efficient, cost effective and environmentally compatible disposal method. One can choose the appropriate disposal method which is generally categorized as follows:

For large Scale disposal:

1.Open dumps

The cheapest and the oldest easy method of MSW disposal is 'open dumping' where the waste is dumped in low - lying areas on the city outskirts and levelled by bull - dozers from time to time. Open dumping is not a scientific way of waste disposal. Open dumps refer an uncovered site used for disposal of waste without environmental controls. The waste is untreated, uncovered, and not segregated. In spite of its simplicity in execution, the financial involvement for this traditional method of waste management has been quite high particularly for the big metropolis. Uncontrolled, open dumps are not a sound practice. Open dumps are exposed to flies and rodents. It also generates foul smell and unsightly appearance. Loose waste is dispersed by the action of wind. Drainage from dumps contributes to pollution of surface and ground water and also the rainwater run-off from these dumps contaminates nearby land and water thereby spreading disease. A WHO Expert Committee (1967) condemned dumping as “a most unsanitary method that creates public health hazards, a nuisance, and severe pollution of the environment. Dumping should be outlawed and replaced by sound procedures”

2.Landfill

Disposing of waste in a landfill involves burying the waste, and this remains a common practice in most countries. Landfills are generally located in urban areas where a large amount of waste is generated and has to be dumped in a common place. The equipment required to operate is relatively inexpensive and can be used for other municipal operations as well. Serious threat to community health represented by open dumping or burning is avoided in this method. Landfills are often established in abandoned or unused quarries, mining voids or borrow pits. Unlike an open dump, it is a pit that is dug in the ground. The waste is dumped and the pit is covered at the dumping ground with debris/ soil and spread evenly in layers. At the end of each day, a layer of soil is scattered on top of it and some mechanism, usually an earthmoving equipment is used to compress the garbage, which now forms a cell. Thus, every day, garbage is dumped and becomes a cell. The organic waste undergoes natural decomposition and generates a fluid, which is known a leachate, and is very harmful to the ecosystem. After the landfill is full, the area is covered with a thick layer of mud and the site can thereafter be developed as a parking lot or a park.

Sanitary landfills

An alternative to landfills or modern landfill which solves the problem of leaching to some extent is a sanitary landfill which is more hygienic and built in a methodical manner. Designed “landfill” means a waste disposal site for the deposit of residual solid waste in a facility designed with protective measures against pollution of ground water, surface water and air fugitive dust, wind-blown litter, bad odour, fire hazard, bird menace, pests or rodents, Greenhouse gas (Methane) emissions, slope instability and erosion. These are lined with materials that are impermeable such as plastics and clay, and are also built over impermeable soil. Deposited waste is normally compacted to increase its density and stability, and covered to prevent attracting vermin (such as mice or rats). Many landfills also have landfill gas extraction systems installed to extract the landfill gas. Gas is pumped out of the landfill using perforated pipes and flared off or burnt in a gas engine to generate electricity. Fully operated landfills may even enhance property values. Constructing sanitary landfills is very costly and they are having their own problems.

A properly-designed and well-managed landfill can be a hygienic and relatively inexpensive method of disposing of waste materials. Older, poorly-designed or poorly-managed landfills can create a number of adverse environmental impacts such as wind-blown litter, attraction of vermin, and generation of liquid leachate. Another common byproduct of landfills is gas (mostly composed of methane and carbon dioxide), which is produced as organic waste

breaks down anaerobically. This gas can create odor problems, kill surface vegetation, and mainly is a greenhouse gas

3.Incineration

The process of burning waste in large furnaces is known as incineration. Incineration is a disposal method that involves combustion of waste material. Incineration and other high temperature waste treatment systems are sometimes described as "thermal treatment". Incineration is carried out both on a small scale by individuals and on a large scale by industry. It is used to dispose of solid, liquid and gaseous waste. Incineration facilities generally do not require as much area as landfills. Waste-to-energy or energy-from-waste is broad terms for facilities that burn waste in a furnace or boiler to generate heat, steam and/or electricity. At the end of the process all that is left behind is ash. This method produces heat that can be used as energy. Incinerators convert waste materials into heat, gas, steam, and ash. It is recognized as a practical method of disposing of certain hazardous waste materials (such as biological medical waste).

Incineration of waste is a thermal process, which reduces the waste to 15-20 per cent. However, due to lower calorific value of waste, this process has not been fully exploited. Combustion in an incinerator is not always perfect and there have been concerns about micro-pollutants in gaseous emissions from incinerator stacks. Particular concern has focused on some very persistent organics such as dioxins which may be created within the incinerator and which may have serious environmental consequences in the area immediately around the incinerator. Both the fly ash and the ash that is left in the furnace after burning have high concentrations of dangerous toxins such as dioxins and heavy metals. Disposing of this ash is a problem. The ash that is buried at the landfills leaches the area and cause severe contamination. Incineration is a controversial method of waste disposal, due to issues such as emission of gaseous pollutants. Improperly operated incineration plants cause air pollution. Burning garbage is not a clean process as it produces tones of toxic ash and pollutes the air and water. Cost of incinerator and additional investment on pollution control devices make the process capital - intensive. Under Indian conditions large scale incineration plants are economically non - viable in view of their capital - intensive character and the low calorific value of city garbage available.

For Small Scale disposal:

1.Composting

Decomposition and stabilization of solid organic waste material has been taking place in nature ever since life appeared on this planet. Composting is the process of decomposition and stabilization of organic matter under controlled condition. Waste materials that are organic in

nature, such as plant material, food scraps, and paper products, can be recycled using biological composting and digestion processes to decompose the organic matter. It is a biological process in which micro-organisms, mainly fungi and bacteria, convert degradable organic waste into humus like substance. The resulting organic material is then recycled as mulch or compost for agricultural or landscaping purposes. In addition, waste gas from the process (such as methane) can be captured and used for generating electricity. The intention of biological processing in waste management is to control and accelerate the natural process of decomposition of organic matter. There is a large variety of composting and digestion methods and technologies varying in complexity from simple home compost heaps, to industrial-scale enclosed-vessel digestion of mixed domestic waste. Methods of biological decomposition are differentiated as being aerobic or anaerobic methods, though hybrids of the two methods also exist.

Organic matter constitutes 35%–40% of the municipal solid waste generated in India. This waste can be recycled by the method of composting, one of the oldest forms of disposal. Apart from being clean, cheap, and safe, composting can significantly reduce the amount of disposable garbage. Each one MT of wet garbage can yield 200 to 300 kgs of organic fertilizer. It increases the soil's ability to hold water and makes the soil easier to cultivate.

Vermi-composting is very successful at community level but it is yet to develop at commercial scale. Manual composting is carried out in smaller urban centres. Although mechanical composting plants were set up in cities but presently, only few plants out of them continues to be in operation. The high cost of mechanical composting plants and the non - utilization of by-products are among the factors which make the process an uneconomic proposition. The most critical link in the process of composting is the segregation operation. Hand sorting of garbage at the compost plant is expensive and unsanitary. Depending upon the availability of land and its topography, economic viability, Types of waste, quantity of waste and social conditions; one can choose any one or more or Combination of two of the said techniques for waste disposal .

Managing Solid waste: Best practices

Due to current lavishing lifestyle trade, continuous waste generation is an obvious phenomenon. For better management of solid waste, periodic review of each steps involved in waste management like Generation, Collection, Disposal etc should be conducted & accordingly implementation of "Best Practices" is necessary.

Best practices for waste management can be achieved by well known '3 Rs' principle. '3 Rs' principle (Reduce, Reuse, Recycle)

Reduce:

•The most uncontrollable phase in Solid waste management is ‘Waste generation’.
Generated solid waste particularly from Non-point sources is always a challenge for local administration, so best practice is to reduce the generation of Solid waste.

•The reduction of waste can happen only when everybody reduces waste generation in the first place.

•Every individual has to contribute in doing so. There is urgent need of public awareness about waste generation. There should be awareness at all levels of Society, which will motivate them to change their casual habits which creates waste.

•Public- Private Partnership should be engaged in this awareness activity.

•Definite Point Sources of waste generation like Hotels, Restaurant, and Shopping Complexes etc should contribute their space for disposal in their area itself, which ultimately reduces the burden of Collection.

•For Public Gatherings and Events organised in public places for any reason (including for processions, exhibitions, circuses, fairs, political rallies, commercial, religious, socio-cultural events, protests and demonstrations, etc.), it will be the responsibility of the Organiser of the event or gathering to ensure the cleanliness of that area.

Reuse:

•Utilization value of any item should be known to people who are using it.

•NGOs working for under privilege society should work for establishing centres which provides goods for secondary use. Such centres can be set up at the source.

•Private sector involvement should be encouraged, repairing facilities should be offered so goods can be used as per its utilization value.

Large production companies of Electronic appliances, gadgets etc should establish the collection centres, where damaged items can be repaired & reused.

•NGOs, Self help group etc can organize workshop, seminars which encourage people to use waste material to create some decorative articles.

Recycle:

•The process of transforming materials into secondary resources for manufacturing new products is known as Recycling.

•Waste recycling leads to less utilization of raw materials, saves on landfill space, reduces the amount of energy required to manufacture new products. In fact recycling can prevent the creation of waste at the source.

•Promoting/motivating citizens to start segregation of waste at source involving NGO's, co-operatives, private, Commercial & industrial sectors for appropriate mass awareness campaigns
•Source separation: by keeping recyclables and organics waste separate at source, ie at the point of generation facilitate reuse, recycling, and composting.
•Segregate the waste in the house -keep two garbage bins and see to it that the biodegradable and the non-biodegradable is put into separate bins and dispose off separately. Biodegradable waste can be recycled.
•Dry waste consisting of cans, aluminium foils, plastics, metal, glass, and paper could be recycled.
•There should be recycling plant at local level.
•Wet garbage from hotel, resident can be recycled by establishing composting or vermi-composting plant in the vicinity. This will produce good manure that can be used for gardens and lawns.
•The least technically complex and most cost-effective solution should be chosen.
•Separation of waste for efficacious recycling and environmentally friendly purchasing habits are two areas for effective management.
•Local Bio-degradable waste processing units, wherever possible set up small scale processing units (composting or bio-methanation) in public parks, playgrounds, recreation grounds, gardens,markets.
•Waste should be also seen as a 'resource' and not just a problem.

DISASTER MANAGEMENT

The United Nation defines a disaster as a serious disruption of the functioning of a community or a society. Disasters involve widespread human, material, economic or environmental impacts, which exceed the ability of the affected community or society to cope using its own resources.

The Red Cross and Red Crescent societies define disaster management as the organisation and management of resources and responsibilities for dealing with all humanitarian aspects of emergencies, in particular preparedness, response and recovery in order to lessen the impact of disasters.

Types of disasters

There is no country that is immune from disaster, though vulnerability to disaster varies. There are four main types of disaster.

- Natural disasters: including floods, hurricanes, earthquakes and volcano eruptions that have immediate impacts on human health and secondary impacts causing further death and suffering from (for example) floods, landslides, fires, tsunamis.
- Environmental emergencies: including technological or industrial accidents, usually involving the production, use or transportation of hazardous material, and occur where these materials are produced, used or transported, and forest fires caused by humans.
- Complex emergencies: involving a break-down of authority, looting and attacks on strategic installations, including conflict situations and war.
- Pandemic emergencies: involving a sudden onset of contagious disease that affects health, disrupts services and businesses, brings economic and social costs.

Any disaster can interrupt essential services, such as health care, electricity, water, sewage/garbage removal, transportation and communications. The interruption can seriously affect the health, social and economic networks of local communities and countries. Disasters have a major and long-lasting impact on people long after the immediate effect has been mitigated. Poorly planned relief activities can have a significant negative impact not only on the disaster victims but also on donors and relief agencies. So it is important that physical therapists join established programmes rather than attempting individual efforts.

Local, regional, national and international organisations are all involved in mounting a humanitarian response to disasters. Each will have a prepared disaster management plan. These plans cover prevention, preparedness, relief and recovery

Disaster preparedness

These activities are designed to minimise loss of life and damage – for example by removing people and property from a threatened location and by facilitating timely and effective rescue, relief and rehabilitation. Preparedness is the main way of reducing the impact of disasters.

Community-based preparedness and management should be a high priority in physical therapy practice management.

Disaster relief

This is a coordinated multi-agency response to reduce the impact of a disaster and its long-term results. Relief activities include rescue, relocation, providing food and water, preventing disease and disability, repairing vital services such as telecommunications and transport, providing temporary shelter and emergency health care.

Disaster recovery

Once emergency needs have been met and the initial crisis is over, the people affected and the communities that support them are still vulnerable. Recovery activities include rebuilding infrastructure, health care and rehabilitation. These should blend with development activities, such as building human resources for health and developing policies and practices to avoid similar situations in future.

Disaster management is linked with sustainable development, particularly in relation to vulnerable people such as those with disabilities, elderly people, children and other marginalised groups.

Flood mitigation

The lower plain regions of India in particular Bihar, Uttar Pradesh and West Bengal in respect of the Ganga and Assam in respect of the Brahmaputra suffer from the adverse effects of floods every year. The Ganga Brahmaputra basin receives maximum run off within the three monsoon months. Based on hydrological studies carried out, it is estimated that only 18 percent of the rainwater can be stored in dams, reservoirs, etc. while 82 percent of the rainwater flows through rivers ultimately into the sea. Floods are therefore a recurring phenomenon in our country.

Different measures have been adopted to reduce the flood losses and protect the flood plains. Depending upon the nature work, Flood protection and flood management measures may be broadly classified as under:

(a) Engineering / Structural Measures

(b) Administrative / Non-Structural Measures

Engineering /Structural Measures

The engineering measures for flood control which bring relief to the flood prone areas by reducing flood flows and thereby the flood levels are –

(a) an artificially created reservoir behind a dam across a river

(b) a natural depression suitably improved and regulated, if necessary or

(c) by diversion of a part of the peak flow to another river or basin, where such diversion would not cause appreciable damage.

(d) by constructing a parallel channel bye passing a particular town/reach of the river prone to flooding.

The engineering methods of flood protection, which do not reduce the flood flow but reduce spilling, are:

(a) embankments which artificially raise the effective river bank and thereby prevent spilling and

(b) channel and drainage improvement works, which artificially reduce the flood water level so as to keep the same, confined within the river banks and thus prevent spilling.

Administrative / Non-structural Measures

The administrative methods endeavour to mitigate the flood damages by;

(a) Facilitating timely evacuation of the people and shifting of their movable property to safer grounds by having advance warning of incoming flood i.e. flood forecasting, flood warning in case of threatened inundation

(b) Discouraging creation of valuable assets/settlement of the people in the areas subject to frequent flooding i.e. enforcing flood plain zoning regulation.

Providing absolute protection to all flood prone areas against all magnitude of floods is neither practically possible nor economically viable. Such an attempt would involve stupendously high cost for construction and for maintenance. Hence a pragmatic approach in flood management is to provide a reasonable degree of protection against flood damages at economic cost through a combination of structural and non-structural measures.

Flood Plain Zoning

Flood-plain zoning is a concept central to flood plain management. This concept recognises the basic fact that the flood plain of a river is essentially its domain and any intrusion into or developmental activity therein must recognise the river's 'right of way'. Flood-plain zoning measures aim at demarcating zones or areas likely to be affected by floods of different magnitudes

or frequencies and probability levels, and specify the types of permissible developments in these zones, so that whenever floods actually occur, the damage can be minimised, if not avoided. Unfortunately, while all generally endorse this approach in principle, scant attention is given to it in actual practice, leading to increased flood damages. The Central Water Commission (CWC) has been continuously impressing upon the states the need to take follow-up action to implement the flood plain zoning approach. A model draft bill for flood plain zoning legislation was also circulated by the union government in 1975 to all the states.

There has been passive resistance on the part of the states to follow up the various aspects of flood plain management including possible legislation.

Flood Proofing

Flood proofing measures adopted in India in the past, consisted in raising a few villages above pre-determined flood levels and connecting them to nearby roads or high lands. Under this programme, several thousand villages were raised in Uttar Pradesh in the fifties. In West Bengal and Assam also land-fills were attempted in villages to keep houses above flood levels even though nearby agricultural lands were liable to inundation. During X Plan, the Government of Bihar had also constructed, with Central assistance, the raised platforms for safety of the people in flood prone areas of North Bihar.

Cyclone mitigation

India is highly vulnerable to natural hazards especially earthquakes, floods, drought, cyclones and landslides. Indian sub-continent is the worst affected region of the world, having a coast line of 7516 kms. (5400 kms along the mainland, 132 kms in Lakshadweep and 1900 kms in Andaman and Nicobar Islands) is exposed to nearly 10% of the world's Tropical Cyclones. There are 13 coastal states/UTs encompassing 84 coastal districts which are affected by cyclones (Fig. 1). Four States (Andhra Pradesh, Odisha, Tamil Nadu and West Bengal) and one UT (Pondicherry) on the East Coast and One State (Gujarat) on the West Coast are more vulnerable to cyclone disasters. 40% of the total population lives within 100 km of coastline. Analysed data for the period 1980-2000 shows that on an average, annually 370 million people are exposed to cyclones in India. Cyclones occur in the month of May-June and October-November, with primary peak in November and secondary peak in May.

In the face of increasing menace of various hazards, mitigation would remain the key and the most effective strategy to reduce the risks of cyclone. Structural mitigation measures generally refer to capital investment on physical constructions or other development works, which include

engineering measures and construction of hazard resistant and protective structures and other protective infrastructure. Non-structural measures refer to awareness and education, policies techno-legal systems and practices, training, capacity development etc.

Structural Mitigation

1.Risk Mapping, Assessment and Analysis

The first and probably the most complex task of mitigation is to map the hazard, risks and vulnerabilities, analyse and assess the levels of risks and monitor it continuously. It is only on the basis of such a knowledge base that a proper and effective strategy for mitigation and preparedness can be developed

2. Sea Wall and Embankments

Among the structural mitigation measures sea walls and embankments are probably the most effective and capital intensive investment to mitigate the risks of water and climate related disasters. If sea walls are essential to protect coastal cities and harbors, saline water embankments are recommended to protect rural settlements and to prevent saline water ingress into agricultural and horticultural land. Further, saline embankments have the potential to kill the mangroves due to chocking of saline water. Therefore such embankments should be constructed in limited areas where vegetative protection would not be adequate to prevent the ingress of saline water into habitations. Construction and protection of all the flood protection embankments, ring bunds and other bunds are very useful in preventing the flooded water to get into the agricultural land. Dams and levees can also be constructed which can be used as temporarily storing space which reduced the chances of lower plains getting flooded.

3. Bio-Shields

Bio shields usually consist of mangroves, casuarinas salicornia, laucaena, atriplex, palms, bamboo and other tree species and halophytes and other shrub species that inhabit lower tidal zones. These can block or buffer wave action with their stems, which can measure up to 30 meter high and several meters in circumference. They trap sediment in their roots; thereby maintain a shallow slope on the seabed that absorbs the energy of tidal surges. They also break the high velocity of winds and thus protect agricultural crops and shelters besides providing shelter and grazing lands for the livestock and farms. They reduce evaporation from the soil, transpiration from the plants and moderate extreme temperatures. They protect fertile coastal agricultural land from erosion. Systematic regeneration of the bio-shields in the coastal belts wherever feasible is the most natural and cost effective method of protecting these areas from storm surges and erosion.

4. Shelter

A large number of people in the coastal areas live in thatched houses which cannot withstand the high velocity of various types of disasters resulting in extensive damages of such houses and deaths and injuries of a large number of poor people. The poor economic conditions of the people may not permit them to rebuild their houses as per the disaster resistant designs and specifications. Therefore, community shelters constructed at appropriate places within the easy access of the habitations of the vulnerable communities can provide an immediate protection from deaths and injuries due to the collapse of houses. Such shelters are spacious enough to accommodate a few hundred people of the neighboring hamlets and provide provisions of drinking water, sanitation, kitchen, etc. During the normal season such shelters can be utilized as schools, dispensaries or other community purposes.

5. Disaster Resistant Housing & Infrastructure.

The loss to the houses and other infrastructures during disasters is mainly due to the absence of appropriate design criteria for construction of buildings and infrastructure which can withstand the pressures of such disasters. Bureau of Standards of various countries have developed revised de sign norms which are followed for new constructions. However, the compliance standards of such norms have not been very effective largely due to inadequacies of properly trained engineers. The problem is even more complex for the large number of existing structures that have already been constructed without adherence to the revised norms. Such buildings can only be retrofitted with an additional cost which the house owners find reluctant to invest. Various advanced countries have passed legislations which has made retrofitting mandatory. In the developing countries the focus is confined more to strengthening the lifeline buildings which would play a critical role during emergency operations such as hospitals, emergency operation centers, police control rooms etc, leaving other unsafe structures and habitations as ‘acceptable risks’, for which adequate preparedness measures should be developed.

6. Early Warning and Communication

Early warning of disasters and its dissemination to the community is an important preparatory measure to reduce the losses of life and property during disasters. Due to heavy investments involved in the installation, operation and management of modern early warning

system, it is also considered as an essential component of structural mitigation. For example, powerful Doppler radar systems can now track the movement of atmospheric depression and accurate early warnings can be issued 48-72 hours in advance about the probability of cyclone, its intensity and wind speed, direction and possible location of the land fall. Such warnings are broadcast through the radio and television network for the information of people in the vulnerable areas. Based on the data generated by the system numerical modelling on storm surge and flooding can forecast the inundation level from where the affected population can be evacuated to safer places.

Non Structural Mitigation

1. Community Based Disaster Preparedness

Communities are the first real time responder to any disaster situation. However developed or efficient a response mechanism could be there would always be a time gap between the disaster and the actual response from the government and other agencies. Therefore if the communities are mobilized and trained to assess their own risk through participatory risk assessment process,develop their own contingency plans and set up their own teams for evacuation, search and rescue, emergency shelter, first aid etc, the risks of disasters can be managed with significant reduction in number of deaths and injuries.

2. Risk Transfer and Risk Financing

Mounting economic losses due to disasters cannot be compensated by the Government whose role would be limited to providing ex-gratia relief to the next of kin of persons who have died or to those sustained injuries and to provide support for the reconstruction of houses and livelihood regeneration for the poor and lower middle class people. Government support would also be necessary for reconstruction of the damaged public assets. The risks of industrial, commercial and other infrastructure and assets in the private and household sector can only be secured through the mechanism of risk financing and risk insurance. As the country develops, the share of private sector in the GDP would increase and, therefore, risk financing would be assuming increasing importance. In the developed countries nearly ninety percent of the assets are covered by insurance against natural disasters which has encouraged collateral investment on disaster resistant housing and infrastructure so as to reduce the premium for insurance. This has been a win-win situation for the private and individual sector in transferring their risks to the insurance companies, for the insurance companies in generating business and for the government in reducing its expenditure on relief and reconstruction while at the same time encouraging private investments for better safety

standards for buildings and infrastructure. The experiences gained in this regard need to be further adapted according to the conditions of low and middle income countries. Various innovative services and products like micro insurance, micro credit etc. have been developed in many countries for increasing the resilience of local communities. Micro credit is particularly playing an importance role in retrofitting the vulnerabilities of the poorer sections of the community, especially the women, in the developing countries.

3.Capacity development and training.

Capacity development is the most cost effective method of reducing the vulnerabilities of the people living in the vulnerable areas. The vulnerable communities have a certain degree of capacities built into their social systems and practices acquired through inherited experiences of generations. But such indigenous capacities are often overwhelmed by the vagaries of nature due to various anthropogenic factors like the degradation of environment, changing land uses, pressures of population on settlements climate change etc. Therefore,the local capacities have to be continuously upgraded and further developed according to the changing needs and the developments of science and technology and other improved practices in various sectors. The challenge of capacity development is to transfer the new horizons of knowledge into actionable modules at the local levels for the local people by the local community. Such capacities can be developed through meetings, interactions, discussions, exposure visits and trainings. Training is particularly necessary for cutting edge functionaries within and outside the government at various levels in different sectors to impart them with necessary skill for disaster risk reduction and management. Training programmes have to be practical, scenario based and exercise and problem solving oriented so that the functionaries are aware of their specific responsibilities and are able to discharge those responsibilities efficiently before, during and after the disasters. Training is also required for those Community members who would be part of the community response teams for the initial critical hours and days till specialized assistance from the government and non-governmental agencies from the outside are organized. Such trainings may include maroon search and rescue, first aid, evacuation, temporary shelter management, arrangements of drinking water and sanitation, provision of cooked food etc. Such trainings can be better organized by a core group of community trainers who can be trained intensively by the specialized government and non-government agencies.

4. Awareness and Education

While training and capacity development target specific groups according to their specific training needs, awareness generation is more of a general in nature which sensitizes common masses about the risks, vulnerabilities of disasters and the preventive, mitigate and preparedness measures that can be taken at the government, community, household and individual level. Electronic, print and folk media can play important roles in awareness generation on a large scale. Awareness and sensitization programme can also be organized for more specific and limited audience such as parliamentarians, policy makers, media and other selected audience. Disaster management has already been included in the educational curriculum of the schools in many countries. For example, civil engineering and architectural courses can have curriculum on earthquake resistant housing and infrastructure. Medical and mental health sciences can have course module on emergency health and trauma management for cyclone affected people, while IT and Communication sciences may have courses on Early Warning and Communication. Such curriculum at various levels of general and professional courses would help to develop necessary professional expertise to support the disaster risk mitigation and preparedness programmes of the government and other agencies at different levels.

5.Contingency Plans

The disastrous consequences in the absence of a pre-disaster contingency plan have been demonstrated repeatedly in many countries on a number of occasions. Therefore, one of the most critical elements of disaster risk management is to have a contingency plan in readiness, which would clearly delineate the roles and responsibilities of various agencies within and outside the government, define the exact functions to be performed by them, the process to be followed in the performance of these functions, the tools and equipments to bekept in readiness, procurements to be made, evacuation drills to be followed, the emergency medical plan to be put in place etc. Such a contingency plan should be prepared vertically at the national, provincial, district and sub-district and community level and horizontally for the different sectors – police, civil defense, health, fire services, food and civil supplies, agriculture, fisheries, water supply, roads and bridges and so on.

Standard operating procedure should be laid down for each activity to avoid any confusion and to ensure coordination among the various agencies involved in the response, relief, rehabilitation and reconstruction programmes after the disasters. Such contingency plan should be reviewed periodically to update them according to changing situations and also to create awareness among all the stakeholders. The best way to keep the contingency plan in readiness is to conduct mock drills at least once in a year so that the operational difficulties in implementation of the plan

are sorted out at the ground level and the various agencies within and outside the government can work together in a coordinated and efficient manner when the disaster would actually strike. Such mock drills again should be conducted at various levels to ensure operational readiness of the system.

EARTHQUAKE MITIGATION		
Before the Disaster	During the Disaster	After the Disaster
• Check for hazards in the home • Identify safe places in each room • Locate safe places outdoors • Ensure all family members know how to respond after an earthquake • Have disaster supplies on • Develop an emergency communications plan in case of separation during the earthquake • Ask an out-of-state relative or friend to serve as the family contact	• If indoors: Take cover under a piece of heavy furniture or against an inside wall and stay inside • If outdoors: Move into the open, away from buildings, street lights, and utility wires and remain there until shaking stops • If in a moving vehicle: Stop quickly, stay in vehicle, move to a clear area away from buildings, trees, overpasses, or utility wires	• Be prepared for after shocks • Help injured or trapped persons and give first aid where appropriate • Listen to a battery operated radio for emergency information • Stay out of damaged buildings and return home only when authorities say it is safe

Disasters cannot be totally prevented. However early warning systems, careful planning and preparedness on part of the vulnerable community would help in minimizing the loss of life and property due to these disasters.

CHAPTER 3 POPULATION EXPLOSION, HUMAN HEALTH, VALUE EDUCATION

For the last 50 years, world population multiplied more rapidly than ever before, and more rapidly than it is projected to grow in the future. In 1950, the world had 2.5 billion people; and in 2005, the world had 6.5 billion people. By 2050, this number could rise to more than 9 billion.

In 1800, the vast majority of the world's population (85 percent) resided in Asia and Europe, with 65 percent in Asia alone. By 1900, Europe's share of world population had risen to 25 percent, fueled by the population increase that accompanied the Industrial Revolution. Some of this growth spilled over to the Americas, increasing their share of the world total.

The growth of the last 200 years appears explosive on the historical timeline. The overall effects of this growth on living standards, resource use, and the environment will continue to change the world landscape long after.

India's population

Population wise, is second in the world after another Asian giant China. India's population crossed one billion marks on May 11, 2000. The population increased to 1,027 million in March 2001 (531.3 million males and 495.7 million females).India accounts for a meagre 2.4 per cent of the world surface area of 135.79 million sq km, but it supports 16.7 per cent of the world population. It is estimated that at the present rate of growth (1.93 per cent during 1991-2001) will overtake by 2050.

In a population Census is conducted every ten years. This Census throws light on basic facts relating to ’s population. First such Census was conducted way back in 1872, followed by second in 1881. Since then, these have been conducted regularly. Last such Census was conducted in 2001. The next Census will fall due in the year 2011.

It is clear from the size of India’s population that whereas during the first 60 years (1901 to 1961), population increased by about 200 million, during the next 40 years (1961 to 2001), it increased by about 588 million. In the next 40 years it is expected to increase by 620 million.

The Causes

The causes of population growth can be grouped into two parts which account for this rapid increase—*(i) Natural Growth* and *(ii)* Migration.

(i) Natural Growth: Natural growth of population is defined as the difference between the birth-rate and the death-rate prevailing in . In , the natural growth rate has been increasing by each passing year. The following major factors are responsible for the prevailing high birth-rate in the country.

First, the major cause of the high birth-rate is the widespread poverty. The incidence of

pregnancy and the number of children born in a poor household is generally larger.

Second, the birth rate in a country is determined by three factors like *(i)* number of women in the reproductive age; *(ii)* number of married women in the reproductive age; and *(iii)* the average age at marriage among females. Similarly, child marriage and marriage at an early age are common phenomena in the country.

Third, family planning is not an accepted norm among the couples in the country, especially among the low-income groups. The major reason, again is, poverty, rather than their illiteracy or ignorance about family planning methods, as is generally believed.

Further, improved medical and health facilities help people grow well. Epidemics like cholera, HIV/AIDS, smallpox, cancer, plague, tuberculosis, *etc*., used to take a heavy toll in the past, have been checked to a great extent. Better housing and sanitary conditions have also controlled the death rate.

(ii) Migration: Migration and the influx of refugees from other neighbouring countries like Pakistan, Nepal, Myanmar, Bhutan, Sri Lanka and Bangladesh, in particular, has also been responsible for increasing the number of people in our country. However, total influx of such population, as proportion of the total population, has never been significant.

Remedies

India is the first country in the world that has adopted family planning as the official policy. The family planning programme is comprised the following:

(i) using various means of communications to persuade people to adopt the small family norm of one or two children;

(ii) making available family planning methods through different outlets in urban, semi-urban and rural areas;

(iii) establishing of family planning centres to make available the various services related to family planning;

(iv) financial assistance to acceptors and motivators of family planning methods like sterilisation;

(v) making health services available to lower mortality among infants;

(vi) provision of nutrition, immunisation and other protective and preventive measures against diseases, *etc*;

(vii) promoting female education and employment;

(viii) arrangement for education in health and biology of reproduction;

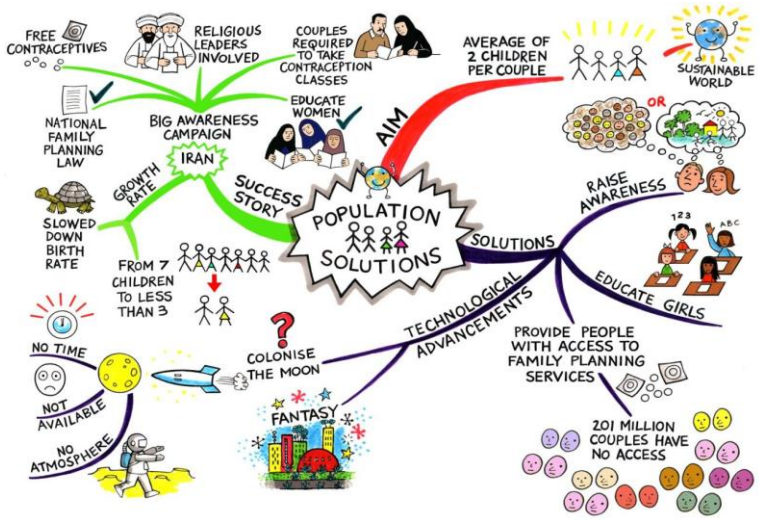
(ix) promotion of delayed marriages;

(x) creating greater awareness of opportunities for legal termination of pregnancies; and *(xi)* more

intensive research in family planning methods and practices.

Though the message of family planning has reached every nook and corner of country, yet the response, in terms of its adoption, especially among the low income groups, has not been very encouraging.

A proper population policy should be two-fold. *Firstly*, it should aim at a quick economic development. *Secondly*, it should aim at controlling the rate of multiplication of the existing population. In other words, while population should slaen in its pace to enable production to catch up with it, production must, on its part, take strides not only to catch up with population but also to outstrip it.



Environmental and Human health

A clean environment is essential for human health and well-being. However, the interactions between the environment and human health are highly complex and difficult to assess. This makes the use of the precautionary principle particularly useful. The best-known health impacts are related to ambient air pollution, poor water quality and insufficient sanitation. Much less is known about the health impacts of hazardous chemicals. Noise is an emerging environment and health issue. Climate change, depletion of stratospheric ozone, loss of biodiversity, and land degradation can also affect human health.

Transport, especially in urban areas, is one of the key contributors to human exposure to air pollution and noise.

Much less is known about the health impacts of chemicals. There is growing concern about

the effects of exposure to mixtures of chemicals at low levels and for long periods over our lifetime, in particular during early childhood and pregnancy.

Human health has always been threatened by natural hazards such as storms, floods, fires, landslides and droughts. Their consequences are being worsened by a lack of preparedness and by human actions such as deforestation, climate change and biodiversity loss.

Environmental Health

Humans interact with the environment constantly. These interactions affect quality of life, years of healthy life lived, and health disparities. The World Health Organization (WHO) defines environment, as it relates to health, as "all the physical, chemical, and biological factors external to a person, and all the related behaviors."Environmental health consists of preventing or controlling disease, injury, and disability related to the interactions between people and their environment.

The 6 themes of the Environmental Health topic area draw attention to elements of the environment and their linkages to health.

1)Outdoor Air Quality

Poor air quality is linked to premature death, cancer, and long-term damage to respiratory and cardiovascular systems. Progress has been made to reduce unhealthy air emissions, but, in 2008, approximately 127 million people lived in U.S. counties that exceeded national air quality standards. Decreasing air pollution is an important step in creating a healthy environment.

2)Surface and Ground Water

Surface and ground water quality applies to both drinking water and recreational waters. Contamination by infectious agents or chemicals can cause mild to severe illness. Protecting water sources and minimizing exposure to contaminated water sources are important parts of environmental health.

3)Toxic Substances and Hazardous Wastes

The health effects of toxic substances and hazardous wastes are not yet fully understood. Research to better understand how these exposures may impact health is ongoing. Meanwhile, efforts to reduce exposures continue. Reducing exposure to toxic substances and hazardous wastes is fundamental to environmental health.

4)Homes and Communities

People spend most of their time at home, work, or school. Some of these environments may expose people to:

- Indoor air pollution

- Inadequate heating and sanitation
- Structural problems
- Electrical and fire hazards
- Lead-based paint hazards

These hazards can impact health and safety. Maintaining healthy homes and communities is essential to environmental health.

5)Infrastructure and Surveillance

Prevention of exposure to environmental hazards relies on many partners, including State and local health departments. Personnel, surveillance systems, and education are important resources for investigating and responding to disease, monitoring for hazards, and educating the public. Additional methods and greater capacity to measure and respond to environmental hazards are needed.

6)Global Environmental Health

Water quality is an important global challenge. Diseases can be reduced by improving water quality and sanitation and increasing access to adequate water and sanitation facilitie

Climate and Health

Over the last 50 years, human activities – particularly the burning of fossil fuels – have released sufficient quantities of carbon dioxide and other greenhouse gases to trap additional heat in the lower atmosphere and affect the global climate. In the last 100 years, the world has warmed by approximately 0.75^{o}C. Over the last 25 years, the rate of global warming has accelerated, at over 0.18^{o}C per decade·

Sea levels are rising, glaciers are melting and precipitation patterns are changing. Extreme weather events are becoming more intense and frequent.

What is the impact of climate change on health?

Although global warming may bring some localized benefits, such as fewer winter deaths in temperate climates and increased food production in certain areas, the overall health effects of a changing climate are likely to be overwhelmingly negative. Climate change affects social and environmental determinants of health – clean air, safe drinking water, sufficient food and secure shelter.

Climate change affects the social and environmental determinants of health – clean air, safe drinking water, sufficient food and secure shelter.

- Global warming that has occurred since the 1970s caused over 140 000 excess deaths annually by the year 2004.
- The direct damage costs to health (i.e. excluding costs in health-determining sectors such as agriculture and water and sanitation), is estimated to be between US$ 2-4 billion/year by 2030.
- Many of the major killers such as diarrhoeal diseases, malnutrition, malaria and dengue are highly climate-sensitive and are expected to worsen as the climate changes.
- Areas with weak health infrastructure – mostly in developing countries – will be the least able to cope without assistance to prepare and respond.
- Reducing emissions of greenhouse gases through better transport, food and energy-use choices can result in improved health.

Infectious diseases

Many infectious diseases have re-emerged with a vengeance. Loss of effective control over diseases such as malaria and tuberculosis, have led to a return of these diseases decades after being kept under stringent control.

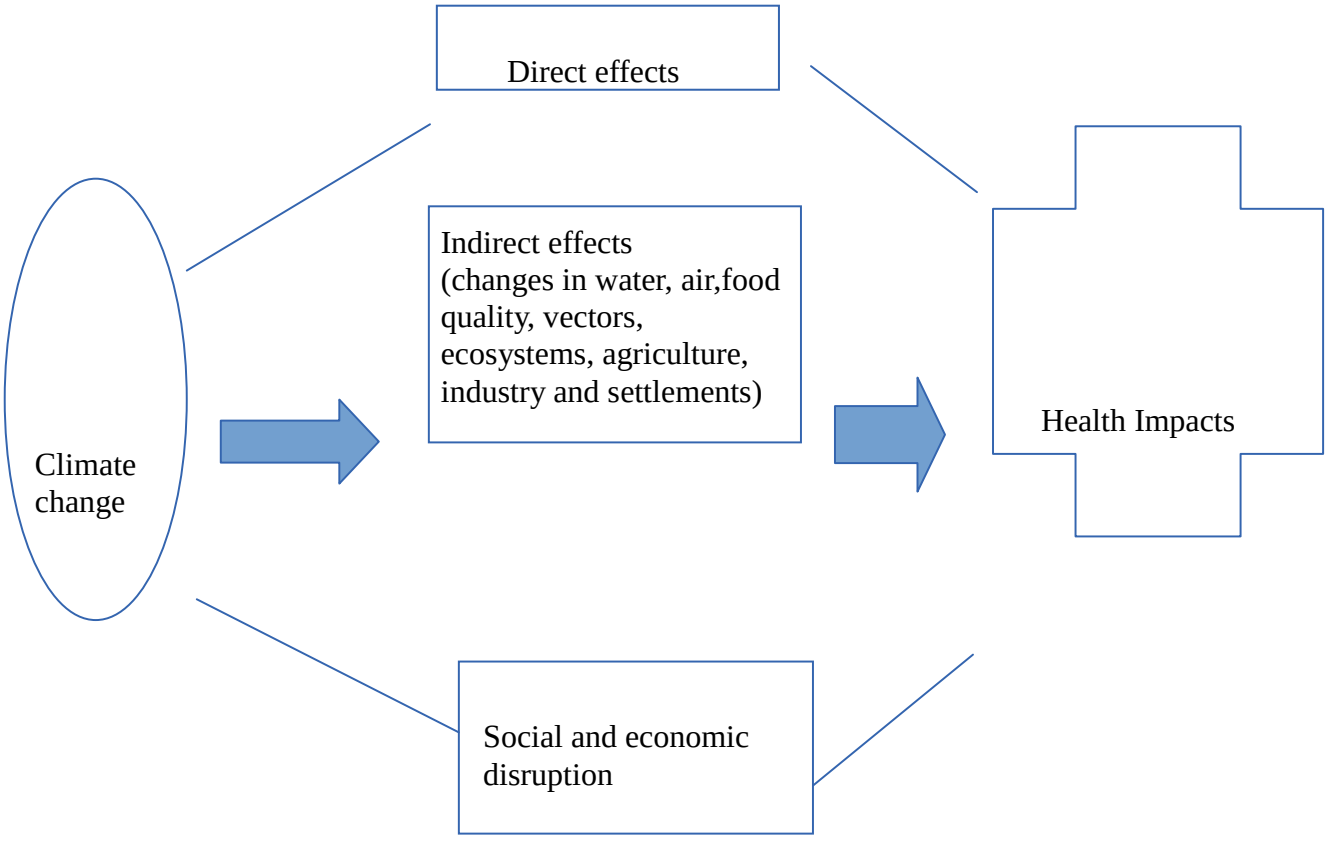
Other diseases were not known to science earlier and seem to have suddenly hit our health and our lives during the last few decades. AIDS, due to the Human Immunodeficiency Virus (HIV)caused through sexual transmission and Severe Acute Respiratory Syndrome (SARS) are two such examples. While these cannot be directly related to environmental change, they affect the environment in which we live by forcing a change in lifestyles and behaviour patterns. For example the SARS outbreak prevented people from several countries from traveling to other countries for months, severely affecting national economies, airline companies and the tourism industry.

While antibiotic resistance is a well-known phenomenon there are other reasons for the re-emergence of diseases. Overcrowding due to the formation of slums in the urban setting leads to several health hazards, including easier spread of respiratory diseases. Inadequate drinking water quality and poor disposal of human waste due to absence of a closed sewage system and poor garbage management are all urban health issues. This has led to a comeback of diseases such as cholera and an increased incidence of diarrhoea and dysentery as well as infectious hepatitis (jaundice)

Environmental factor	Disease favoured	Evidence
Warm	Dengue, Malaria	Primarily tropical distribution, Seasonal transmission pattern
Cold	Influenza	Seasonal transmission pattern
Dry	Meningococcal meningitis, Coccidian do mycosis	Associated with arid conditions, dust storms
Wet	Cryptosporidiosis Rift Valley Fever	Associated with flooding

- Weather fluctuations and seasonal-to-internal climate variability influence many infectious diseases.
- The potential disease impacts of global climate change remain highly uncertain.
- Climate change may affect the evolution and emergence of infectious diseases.
- Recent technological advances will aid efforts to improve modeling of infectious disease epidemiology.

Schematic diagram of pathways by which climate change affects health, and concurrent direct-acting and modifying (conditioning) influences of environmental, social and health-system factors



1)Tuberculosis

TB kills approximately 2 million people each year. In India the disease has re-emerged and is now more difficult to treat. A global epidemic is spreading and becoming more lethal. The spread of HIV/AIDS and the emergence of multidrug-resistant tuberculosis is contributing to the increasing morbidity of this disease. In 1993, the World Health Organization (WHO) declared that tuberculosis had become a global emergency. It is estimated that between 2002 and 2020, approximately 1000 million people will be newly infected, over 150million people will get sick, and 36 million will die of TB – if its control is not rapidly strengthened.

Factors Contributing to the rise in tuberculosis

• TB kills about 2 million people each year (in-cluding persons infected with HIV).

• More than 8 million people become sick with TB each year, one person in the world every second!

• About 2 million TB cases per year occur in sub-Saharan Africa. This number is rising rapidly as a result of the HIV/AIDS epidemic.

• Around 3 million TB cases per year occur in South-east Asia.

• Over a quarter of a million TB cases per year occur in Eastern Europe.

2)Malaria

Malaria is a life-threatening parasitic disease transmitted by mosquitoes. The cause of malaria, a single celled parasite called plasmodium,was discovered in 1880. Later it was found that the parasite is transmitted from person to person through the bite of a female Anopheles mosquito, which requires blood for the growth of her eggs.

Today approximately 40% of the world's population, mostly those living in the world's poorest countries, risk getting malaria. The disease was once more widespread but it was successfully eliminated from many countries with temperate climates during the mid 20th century.Today malaria has returned and is foundthroughout the tropical and sub-tropical regions of the world and causes more than 300 million acute illnesses and at least one million deaths annually (WHO).There are several types of human malaria.Falciparum malaria is the most dangerous type of infection and is most common in Africa south of the Sahara, where it accounts for extremely high mortality rates. There are also indications of the spread of P. falciparum malaria in India and it has reappeared in areas where it had been eliminated.

3)Diarrhoea

Though several types of diarrhoea which give rise to loose motions and dehydration occur all over the world, this is especially frequently observed in developing countries. It causes 4% of all deaths. In another 5% it leads to loss of health. It is caused by gastrointestinal infections which kill around 2.2 million people globally each year. Most of these are children in developing countries. The use of contaminated water is an important cause of this group of conditions. Cholera and dysentery cause severe, sometimes life threatening and epidemic forms of these diseases.

Diarrhoea is the frequent passage of loose or liquid stools. It is a symptom of various gastrointestinal infections. Depending on the type of infection, the diarrhoea may be watery (for example in cholera caused by vibrio cholera) or passed with blood and mucous (in dysentery caused by an amoeba, E Histolitica).

Depending on the type of infection, it may last a few days, or several weeks. Severe diarrhoea can become life threatening due to loss of excessive fluid and electrolytes such as Sodium and Potassium in watery diarrhoea. This is particularly fatal in infants and young children. It is also dangerous in malnourished individuals and people with poor immunity. The impact of repeated diarrhoea on nutritional status is linked in a vicious cycle in children.Chemical or non-infectious intestinal conditions can also result in diarrhoea.

4)Cancer

Infectious agents are linked with 22% of cancer deaths in developing countries and 6% in industrialized countries. Viral hepatitis B and C cause cancer of the liver. Human papilloma virus infection causes cancer of the cervix. The bacterium Helicobacter pylori increases the risk of

stomach cancer. In some countries the parasitic infection schistosomiasis increases the risk of bladder cancer. Liver fluke increases the risk of cancer of the bile ducts. Preventive measures include vaccination and prevention of infection. Excessive solar ultraviolet radiation increases the risk of all types of cancer of the skin. Avoiding excessive exposure to the sun, use of sunscreens and protective clothing are effective preventive measures. Asbestos is known to cause lung cancer. Aniline dyes have been linked to bladder cancer. Benzene can lead to leukaemia (blood cancer). The prevention of certain occupational and environmental exposure to several chemicals is an important element in preventing cancer.

5.HIV/AIDS

The Human Immunodeficiency Virus (HIV) causes Acquired Immunodeficiency Syndrome (AIDS) through contact with tissue fluids of infected individuals, especially through sexual contact. As it reduces an individual's resistance to disease, it causes infected individuals to suffer from a large number of environment related diseases and reduces the ability of infected individuals to go about their normal lives. It affects their income generation and/or their ability to utilise natural resources. As more and more people are affected, this disease will also have impacts on our natural resource base, as utilisation patterns change to unsustainable levels. The inability of the disease. Behavioural change, where the number of individuals who have multiple partners, towards strictly single partners, reduces the risk of HIV/AIDS and thus reduces incidence of the disease in society. However, the most important measure to prevent AIDS is the proper use of condoms that form a barrier to the spread of the virus during intercourse.

Water-related diseases

More than 2 million people die each year from diseases such as cholera, typhoid, and dysentery that are spread by contaminated water or by a lack of water for hygiene. These illnesses have largely been eradicated in developed nations, although outbreaks can still occur.

Water-related illnesses fall into four major categories:

- **Waterborne diseases**, including cholera, typhoid, and dysentery, are caused by drinking water containing infectious viruses or bacteria, which often come from human or animal waste.
- **Water-washed diseases**, such as skin and eye infections, are caused by lack of clean water for washing.
- **Water-based diseases**, such as schistosomiasis, are spread by organisms that develop in water and then become human parasites. They are spread by contaminated water and by eating insufficiently cooked fish.

- **Water-related insect vectors**, such as mosquitoes, breed in or near water and spread diseases, including dengue and malaria. This category is not directly related to water supply or quality.

Water, sanitation and hygiene have important impacts on both health and disease.

Water-related diseases include:

- those due to micro-organisms and chemicals in water people drink;
- diseases like schistosomiasis which have part of their lifecycle in water;
- diseases like malaria with water-related vectors;
- drowning and some injuries;
- and others such as legionellosis carried by aerosols containing certain micro-organisms.

Water also contributes to health, for example through hygiene.

In developing countries four-fifths of all the illnesses are caused by water-borne diseases, with diarrhoea being the leading cause of childhood death.

The global picture of water and health has a strong local dimension with some 1.1 billion people still lacking access to improved drinking water sources and some 2.4 billion to adequate sanitation. Today we have strong evidence that water-, sanitation and hygiene-related diseases account for some 2,213,000 deaths annually and an annual loss of 82,196,000 Disability Adjusted Life years.

WHO estimates indicate that worldwide over 2 billion people are infected with **schistosomes** and soil transmitted helminthes and 300 million of these suffer serious illness as a result.

Malaria kills over a million people every year, and a large percentage of them are under five as well, mainly in Africa South of the Sahara. In 2001 the estimated global burden of malaria amounted to 42.3 million DALYs, constituting 10 % of Africa's overall disease burden. Malaria causes at least 396.8 million cases of acute illness each year. Pregnant women are the main adult risk group. As one of the major public health problems in tropical countries, it has been claimed that malaria has reduced economic growth in African countries by 1.3 % each year over the past 30 years

An estimated 246.7 million people worldwide are infected by **schistomiasis**, and of these 20 million suffer severe consequences of the infection, while 120 million suffer milder symptoms. An estimated 80% of transmission takes place in Africa south of the Sahara (*).

Diarrhoea occurs worldwide and causes 4% of all deaths and 5% of the health loss to disability.

In Bangladesh alone, some 35 million people are exposed, on a daily basis, to elevated levels of **arsenic** in their drinking water, which will ultimately threaten their health and shorten their life expectancy.

After the Tsunami attack in Asia on Sunday the 26th of December 2004 people faced the threat of water borne diseases linked to flooding, like Shigellosis, Cholera, Hepatitis A, Leptospirosis, Typhoid Fever, Malaria and Dengue fever.

Prevention

Clean water is a pre-requisite for reducing the spread of water-borne diseases. It is well recognised that the prevalence of water-borne diseases can be greatly reduced by provision of clean drinking water and safe disposal of faeces.

Water is disinfected to kill any pathogens that may be present in the water supply and to prevent them from growing again in the distribution systems. Disinfection is then used to prevent the growth of pathogenic organisms and to protect public health and the choice of the disinfect depends upon the individual water quality and water supply system. Without disinfection, the risk from waterborne disease is increased.

The two most common methods to kill microorganisms in the water supply are: oxidation with chemicals such as chlorine, chlorine dioxide or ozone, and irradiation with ultraviolet(UV) radiation

Risks due to chemicals in food

Chemicals are the building blocks of life and are important for many, if not all, aspect of human metabolism. However, human exposure to chemicals at toxic levels, as well as nutritional imbalances, are known or suspected to be involved in causing cancer, cardiovascular disease, kidney and liver dysfunction, hormonal imbalance, reproductive disorders, birth defects, premature births, immune system suppression, musculoskeletal disease, impeded nervous and sensory system development, mental health problems, urogenital disease, old-age dementia, and learning disabilities. Possibly a significant part of these disorders and diseases can be attributed to chemical exposure, and for many (environmental) chemicals food is the main source of human exposure. Consequently, the protection of our diet from these hazards must be considered one of the essential public health functions of any country.

1)Pesticides

Fruits and vegetables that contain pesticide residues can be a health risk for people of all ages. Research by scientists at the Harvard University School of Public Health published in

"Pediatrics" in June 20101 discovered exposure to organophosphates may contribute to the prevalence of attention deficit hyperactivity disorder in children. Children who switch to organic produce no longer have significant levels of organophosphates in their urine, according to research by scientists at Emory University published in "Environmental Health Perspectives" in April 2008. Exposure to a combination of the pesticide maneb and the herbicide paraquat increases risks of Parkinson's disease, especially in young people, according to research by scientists at the University of California in Berkeley published in the "American Journal of Epidemiology" in April 2009.

2)Preservatives

Manufacturers use preservatives such as nitrites and sulfites in processed foods to inhibit growth of microorganisms and increase shelf life. Yet these preservatives increase the health risk. Nitrites are common preservatives used in processed meats and fish to prevent bacterial growth. The body converts nitrites to carcinogenic substances called nitrosamines. Research by Susanna Larsson at the Karolinska Institute in Stockholm published in the "International Journal of Cancer" in August 2006 found that increased nitrosamine consumption from processed meat increases the risk of stomach cancer. Sulfites used to preserve dried fruits, fruit juices, wine and beer may increase the risk of asthma attacks, according to the Cleveland Clinic.

3)Artificial Colors

Artificial colors increase consumer appeal but may also increase the risk of disease. The Center for Science in the Public Interest, a consumer advocacy group, reports that caramel coloring used in many popular cola soft drinks contains two chemicals called 2-methylimidazole and 4-methylimadazole that cause cancers of the lungs, liver and thyroid and leukemia. Food colorings such as Yellow No. 5, 6 and10 and Red No. 40 can increase the risk of or exacerbate hyperactive behavior in children.

4)Fats and Sweeteners

Industrially produced fats and sweeteners common in processed foods are bad for the health. Manufacturers use transfats -- which increase your risk of coronary artery disease -- in breads, cookies, margarine and microwave popcorn. High-fructose corn syrup, a sweetener used in soft drinks, salad dressings and desserts, can increase your risk of obesity, according to research by scientists at Louisiana State University in Baton Rouge published in "The American Journal of Clinical Nutrition" in April 2004. Piedmont Hospital in Atlanta reports eating high-fructose corn syrup can increase the risk of diabetes.

Cancer and environmental health

Cancer develops over several years and has many causes. Several factors both inside and outside the body contribute to the development of cancer. In this context, scientists refer to everything outside the body that interacts with humans as the “environment.

Factors Outside the Body (Environmental Factors)

Exposure to a wide variety of natural and man-made substances in the environment accounts for at least two-thirds of all the cases of cancer . These environmental factors include lifestyle choices like cigarette smoking, excessive alcohol consumption, poor diet, lack of exercise, excessive sunlight exposure, and sexual behavior that increases exposure to certain viruses . Other factors include exposure to certain medical drugs, hormones, radiation, viruses, bacteria, and environmental chemicals that may be present in the air, water, food, and workplace. The cancer risks associated with many environmental chemicals have been identified through studies of occupational groups that have higher exposures to these chemicals than the general population.

The importance of the environment can be seen in the differences in cancer rates throughout the world and the change in cancer rates when groups of people move from one country to another. For example, when Asians, who have low rates of prostate and breast cancer and high rates of stomach cancer in their native countries, immigrate to the United States, their prostate and breast cancer rates rise over time until they are nearly equal to or greater than the higher levels of these cancers in the United States. Likewise, their rates of stomach cancer fall, becoming nearly equal to the lower U.S. rates. Lifestyle factors such as diet, exercise, and being overweight are thought to play a major role in the trends for breast and prostate cancers, and infection with the Helicobacter pylori bacterium is an important risk factor for stomach cancer. Recently, the rapid rise in the rates of colorectal cancer in Japan and China suggests an environmental cause such as lifestyle factors. Different environmental exposures are linked to specific kinds of cancer. For example, exposure to asbestos is linked primarily to lung cancer, whereas exposure to benzidine, a chemical found in certain dyes , is associated with bladder cancer. In contrast, smoking is linked to cancers of the lung, bladder, mouth, colon, kidney, throat, voice box, oesophagus, lip, stomach, cervix, liver, and pancreas.

The following substances in the environment are known to cause or are likely to cause cancer in human:

- Tobacco
- Diet/Weight/Physical Inactivity
- Alcoholic drinks
- Ultraviolet radiation
- Viruses and bacteria
- Ionizing radiation
- Pesticides
- Medical drugs
- Solvents
- Fibers, fine particles, and dust
- Dioxins
- Polycyclic aromatic hydrocarbons (PAHs)
- Metals
- Diesel exhaust particles
- Toxins from fungi
- Vinyl chloride
- Benzedrine

HOW DO PUBLIC HEALTH OFFICIALS SET ACCEPTABLE EXPOSURE LEVELS FOR ENVIRONMENTAL CHEMICALS?

1)Linear Dose Response

One of the first considerations by regulatory agencies such as the Environmental Protection Agency, Food and Drug Administration, and Occupational Safety and Health Administration is to determine whether a carcinogen exhibits linear or threshold-like dose-response behavior. Even though government scientists conduct rigorous scientific reviews to evaluate everything that is known about a cancer-causing substance, there is frequently not enough information to distinguish between these two kinds of dose responses. Unless there is compelling evidence for a threshold-like mechanism, agencies assume, to protect the public health, that the dose response is linear. This means that they assume that any exposure, no matter how small, would have some risk.

2)Threshold-Like Dose Response

In the case of carcinogens exhibiting threshold-like dose responses, other factors such as age, gender, genetic makeup, and diet are taken into consideration. For example, the potentially greater health effects on children of pesticide residues on food are taken into consideration when setting acceptable exposure levels of pesticides. Moreover, if the cancer testing is done in rats and mice, scientists consider the possibility that people are more sensitive than rats or mice to the cancer-causing effects of a particular chemical. These factors can result in setting acceptable levels of exposure as much as 1,000 times below the level that causes a substantial increase in cancer in rodents. This approach gives more confidence that the acceptable level of exposure set by a regulatory agency will indeed protect the public health.

3)Risks Versus Benefits

Another factor adding to the difficulty of regulating the exposure to environmental chemicals is that many substances that may cause cancer in people also have some benefits. Pharmaceuticals represent the best example of when benefit/risk analyses are routinely conducted. In the case of cancer chemotherapy drugs, we know that while they may be effective in treating or preventing cancer, they also may increase the risk of second cancers developing years after the treatment. However, since cancer is often immediately life-threatening, the benefits usually outweigh the risks. Tamoxifen, for example, which is effective in preventing the recurrence of breast cancer in many women, also increases the risk of uterine cancer, blood clots, and strokes. The benefits and risks were rigorously analysed by the Food and Drug Administration, the National Cancer Institute, and the World Health Organization, and they all concluded that the benefits of tamoxifen for women who have had breast cancer or for a relatively small number of women who are at high risk of developing breast cancer strongly outweigh the serious risks associated with the drug.

Another example is pesticides. The use of pesticides has increased crop yields and has significantly benefited agricultural production. Yet there is concern over potential health effects of pesticide residues on foods consumed by humans. These potential risks are reduced by setting maximum residue levels on fruits, vegetables, and other produce and by using pesticides that are not Carcinogenic.

4)Uncertainty and Public Debate

Public health officials are in the best position to accurately identify carcinogens when evidence is available from all levels—human, animal, and laboratory, but this is seldom the case. Therefore, they often have to exercise scientific judgment and make decisions in the face of

uncertainty. In these circumstances, public health agencies operate under the principle that public health protection is paramount. These decisions are debated in open public forums involving scientists from diverse disciplines, and interested members of industry, environmental groups, and the public.

VALUE EDUCATION

Values deal with ones own principles and standards from which we judge what is right and wrong behaviour. Value education in the context of our environment is expected to bring about a new sustainable way of life. Education both through formal and non-formal processes must thus address understanding environmental values, valuing nature and cultures, social justice, human heritage, equitable use of resources, managing common property resources and appreciating the cause of ecological degradation.

Values in environment education must bring in several new concepts. Why and how can we use less resources and energy? Why do we need to keep our surroundings clean? Why should we use less fertilisers and pesticides in farms? Why is it important for us to save water and keep our water sources clean? Or separate our garbage into degradable and non-degradable types before disposal? All these issues are linked to the quality of human life and go beyond simple economic growth. They deal with a loveand respect for nature. These are the values that will bring about a better humanity, one in which we can live healthy, productive and happy lives in harmony with nature.

Environmental values based on the Constitution of India

Article 48A:"The state shall endeavour to protect and improve the environment and to safeguard the forests and wildlife in the country."

Article 51A (g): The constitution expects that each citizen of the country must "protect and improve the natural environment, including forests, lakes, rivers and wildlife, and to have compassion for all living creatures."

1)Strategies for sustainable living

The Sustainable strategy is for business, local government, and community organisations to provide leadership and support for action to reduce climate change and move us toward more sustainable lifestyles. This is all about how small, easy changes can have positive impacts on the environment, our health and wellbeing - and save us money too!

- Avoid bottled water
- Buy an energy efficient car

- Install solar hot water
- Install energy efficient appliances and fixtures
- Mulch your patch
- Generate your own electricity
- Insulate, shade and weather proof your house
- Recycle building waste
- Harvest and use rainwater

2)Valuing nature

In reality, most ecosystems deliver a variety of services and benefits to humans. These benefits can be direct or indirect and tangible or intangible (beautiful landscapes foster cultural identity and human well being). They can be provided locally and at global scale (forests influence local rainfall but also sequester carbon and help regulate climate change). They can be scattered and in some cases are even more important to future generations – all of which makes measuring their value challenging , yet critical. Indeed, the systematic under-valuation of ecosystem services and failure to capture their values is one of the main causes of today's biodiversity and ecosystem crisis.

The loss of biodiversity and ecosystem services has direct economic repercussions that are systematically underestimated. Ensuring that the value of natural capital is visible to economies can help society pave the way for more targeted and cost-effective solutions. Valuing natural capital should not be equated with its sale on the open market, but rather as an indicator of its importance in sustaining human and economic prosperity.

It is necessary to "demonstrate" the value of ecosystems and biodiversity in economic terms to ensure balanced and informed decision-making. This is particularly true when policymakers and businesses make decisions impacting ecosystems based on a cost and benefit calculation. A failure to demonstrate ecosystem values in such cases can easily lead to perverse policy and business decisions. For instance, when considering the conversion of wetlands for agricultural or industrial use, a policymaker would not have the full picture if the value of the wetland in terms of water filtration and flood control services is ignore.

The results of a valuation exercise for the city of Kampala, Uganda, showed that the nearby Nakivubo Swamp provided an economic value of between US$1 million and US$1.75 million a year in wastewater purification and nutrient retention services. Researchers concluded that the services provided by the Nakivubo Swamp created a much cheaper means of treating Kampala's wastewater than the expansion and maintenance of new wastewater facilities. Moreover, public funds were simply not available to replicate the natural ecosystem services provided by the swamp.

Despite these findings, policy makers have been slow to protect the area and the wetland's ability to remove nutrients and pollutants has been greatly reduced over the past decade. However, in 2008, the Kampala Sanitation Programme proposed a new plan to reduce the pollutant load by expanding existing sewage treatment facilities in Kampala and rehabilitating and increasing the Nakivubo wetland area in order to re-establish its original ecosystem services.

3)Environmental justice

Environmental justice is the social justice expression of environmental ethics. The environmental justice is to challenge the unfair distribution of toxic, hazardous and dangerous waste facilities, which were disproportionately located in low income communities of color. The idea of environmental justice draws heavily from civil rights, public health, abor and community organizing efforts. This is to check the unfair distribution of environmental risks and resources, and promotes efforts to prevent pollution from impacting low income communities. It complements traditional environmentalism's efforts to protect nature by making the poor and marginalized the object of special concern. Its power lies in its appeal to a fundamental ethic of fairness. The argument is that it is unjust for politically marginalized, low income communities of color to suffer such a heavy burden of polluting activities.

Environmental justice concerns are always embedded in a broader vision for justice in society. They are not distinct from efforts to enhance economic justice and political power for marginalized communities. Environmental justice carries a critique (whether explicit or implicit) of any environmentalism that is disconnected from the needs of poor and vulnerable people. A chief distinguishing feature of environmental justice is that it never considers environmental issues separate from social justice efforts.

Environmental justice is a profoundly anthropocentric ethic, meaning that human beings are the central moral concern. Endangered species and the health of ecosystems are not dismissed as inconsequential, but human welfare and social equity are presented as central concerns. Thus, concern for environmental justice has the potential to appeal to a broader human audience, those interested in human well-being. Many environmental justice groups argue that every individual and community has a right to clean air and water; this movement proposes a clean environment as a human right. More recently, groups working for sustainable development have argued that human beings have a right to sustainable development. As the world grows increasingly concerned with global climate disruption, some groups are advancing ethical arguments for reducing gas emissions based on the principles of environmental justice.

4)Equitable use of resources

An unfair distribution of wealth and resources, based on a world that is essentially only for the rich, will bring about a disaster of unprecedented proportions. Equitable use of resources is now seen as an essential aspect of human well-being and must become a shared point of view among all socially and environmentally conscious individuals. This includes an appreciation of the fact that economically advanced countries and the rich in even poor nations consume resources at much greater levels than the much larger poorer sectors of humanity in the developing world. In spite of the great number of people in the more populous developing countries, the smaller number of people in developed countries uses more resources and energy than those in the developing world. This is equally true of the small number of rich people in poor countries whose per capita use of energy and resources, and the generation of waste based on the one time use of disposable products, leads to great pressures on the environment. The poor while polluting the environment have no way to prevent it. The rich damage the environment through a carelessness that proves only that they have no appreciation for environmental safety. As we begin to appreciate that we need more sustainable lifestyles we also begin to realize that this cannot be brought about without a more equitable use of resources.

CHAPTER 4
ROLE OF IT IN ENVIRONMENT AND HUMAN HEALTH

Information technology has tremendous potential in the field of environmental educational and health as in any other field like business, economics, politics or culture.

Development of Internet facilities, worldwide web, geographical information system (GIS) and information through satellites has generated a wealth of up-to-date information on various aspects of environment and health. A number of software have been developed for environment and health studies, which are user friendly.

Database:

Database is the collection of inter-related data on various subjects. It Ls usually in computerized form and can be retrieved whenever required. In the computer the information of database is arranged in a systematic manner that is easily manageable and can be very quickly retrieved.

The Ministry of Environment and Forests, Government of India has taken up the task of compiling a database on various biotic communities. The comprehensive database includes wildlife database, conservation database, forest cover database etc. Database is also available for diseases like HIV/AIDs, Malaria, and Fluorosis etc.

National Management Information System (NM1S) of the Department of Science and technology has compiled a database on Research and Development Projects along with information about research scientists and personnel involved.

Environmental Information System (ENVIS):

The Ministry of Environment and Forests, Government of India has created an information System called Environmental Information System (ENVIS). With its headquarters in Delhi, it functions in 25 different centers all over the country.

The ENVIS centers work for generating a network of database in areas like pollution control, clean technologies, remote sensing, coastal ecology, biodiversity, western Ghats and eastern environmental management, media related to environment, renewable energy, desertification, mangroves, wildlife, Himalayan ecology, mining etc.

The National Institute of Occupational Health provides computerized information on occupational health i.e., the health aspects of people working in various hazardous and non-

hazardous industries, safety measures etc.

Remote Sensing and Geographical Information System (CIS): Satellite imageries provide us actual information about various physical and biological resources and also to some extent about their state of degradation in a digital form through remote sensing.

We are able to gather digital information on environmental aspects Eke water logging, desertification, deforestation, urban sprawl, river and canal network, mineral and energy reserves and so on. Geographical Information System (GI3) has proved to be a very effective tool in environmental management.

GIS is a technique of superimposing various thematic maps using digital data on a large number of inter-related or inter-dependent aspects several useful software's have been developed for working in the field of GIS. Different thematic maps containing digital information on a number of aspects like water resources, industrial growth, human settlements, road network, soil type, forest land, crop land or grass land etc. are superimposed in a layered form in computer using software. Such information is very useful for future land vice planning.

Even interpretations of polluted zones, degraded lands or diseased cropland can be made on GIS. Planning for locating suitable areas for industrial growth is now being done using GIS by preparing Zoning Atlas.

GIS serves to check unplanned growth and related environmental problems. Our satellite data also helps in providing correct, reliable and verifiable information about forest cover, success of conservation efforts etc.

They also provide information of atmospheric phenomena like approach of monsoon, ozone layer depletion, inversion phenomena, smog etc. We are able to discover many new reserves of oils, minerals etc. with the help of information generated by remote sensing satellites. Thus remote sensing and GIS play a key role in resource mapping, environmental conservation, management, and planning and environmental impact assessment.

It also helps in identifying several disease-infected areas, which are, prone to some vector-borne diseases like malaria, schistosomiasis etc. based upon mapping of such areas.

The World Wide Web with resources material on every aspect, class-room activities, digital files of photos, power- point lecture presentations, animations, web-exercises and quiz has proved to be extremely useful both for the students and the teachers of environmental studies.

The role of online learning centre website has the following features:

(a) Student-friendly features:

These include practice quiz, how to study tips, hyperlinks on every chapter topics with detailed information, web exercises, case studies, environmental maps, key- terms, career information, current articles, and interactive encyclopaedia and how to contact your elected officials.

(b) Teacher-friendly features:

These include in addition to above supplement resources charts, additional case studies, answers to web exercises, solutions to critical thinking, questions, editing facility to add or delete questions and create multiple version of same test etc.

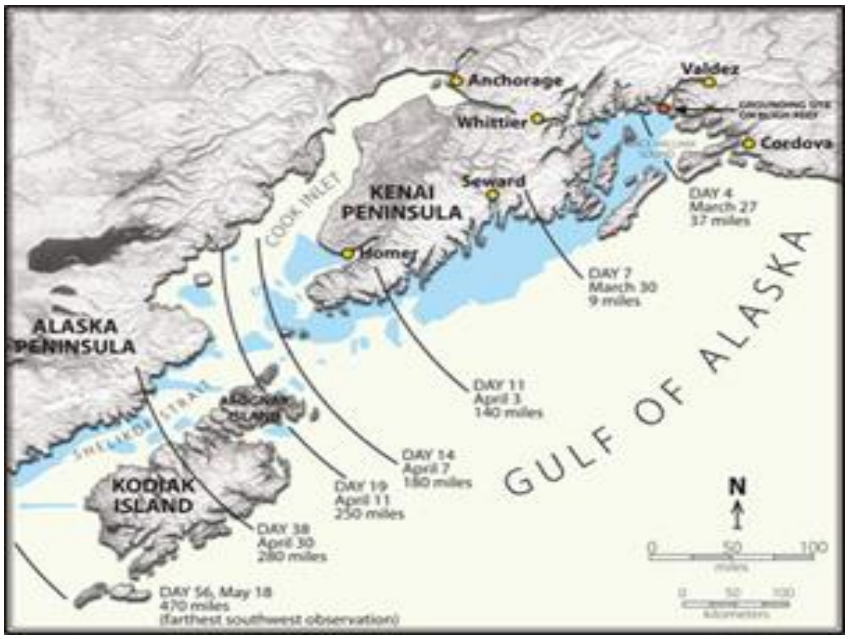
Information technology is expanding rapidly with increasing applications and new avenues are being opened with effective role in education, management and planning in the field of environment and health.

CHAPTER 5 CASE STUDY EXXON OIL SPILL

EVS 2014\Video\seismic seconds the bhopal gas disaster part1.flv

CASE STUDY 1 EXXON OIL SPILL

On March 23, 1989 the *Exxon Valdez* an oil super tanker operated by Exxon and under the command of Captain Joseph J. Hazelwood left the port of Valdez headed for Long beach, CA with 53,094,510 gallons of oil on board. Shortly after midnight on March 24, 1989, the super tanker collided with Bligh Reef, a well-known navigation hazard, ruptured 8 of its 11 cargo tanks and spilled 11 million gallons of crude oil into the pristine waters of Prince William Sound. The result was catastrophic. Although the spill was radioed in shortly after the collision Exxon's response was slow. In fact, there was no recovery effort for three days while Exxon searched for clean-up equipment. During that time millions of gallons of oil began to spread down the coast. Days later as the clean-up effort began the oil slick was no longer containable. It eventually extended 470 miles to the southwest, contaminated hundreds of miles of coastline and utterly destroyed the ecosystem.



Here are some of the most startling statistics about the effects of the Exxon Valdez spill on marine, wildlife and the region's economy:

- The amount of oil spilled could fill 125 Olympic-sized swimming pools.
- As many as 2,800 sea otters, 300 harbor seals, 900 bald eagles and 250,000 seabirds died in the days following the disaster.
- 1,300 miles of coastline were hit by the oil spill.

- 1,000 harlequin ducks were killed by the oil spill, in addition to many chronic injuries that occurred as a result of the long term effects of the spill.
- The clean-up required about 10,000 workers, 1,000 boats and roughly 100 airplanes and helicopters.
- Four deaths were directly associated with clean-up efforts.
- The spill caused over $300 million of economic harm to more than 32 thousand people whose livelihoods depended on commercial fishing.
- Tourism spending decreased by eight percent in south central Alaska and by 35 percent in southwest Alaska in the year after the spill.
- There was a loss of 9,400 visitors and $5.5 million in state spending.
- Many fish populations were harmed during the spill. For example, sand lance populations went down in 1989 and 1990, herring returns were significantly fewer in 1992 and 1994 and adult fish had high rates of viral infections.
- Pink salmon embryos continued to be harmed and killed by oil that remained on stones and gravel of stream banks through at least 1993. As a result, the southwestern part of Prince William Sound lost 1.9 million or 28 percent of its potential stock of wild pink salmon. By 1992, this part of the sound still had 6 percent less of the wild pink salmon stock than was estimated to have existed if the spill had not occurred.
- Two years following the Exxon Valdez spill, the economic losses to recreational fishing were estimated to be $31 million.
- Twelve years after the spill, oil could still be found on half of the 91 randomly selected beaches surveyed.
- Three species of cormorant, the common loon, the harbor seal, the harlequin duck, the pacific herring and the pigeon guillemot still have not fully recovered.

Oily rocks glisten in the sun on Green lsland in Prince William Sound.

A Red Necked Grebe, covered in oil, found on Knights Island, about 35 miles from the spill

Toxic effects linger

After 25 years, to the naked eye, Prince William Sound may appear "normal." But if you look beneath the surface, oil continues to contaminate beaches, national parks, and designated wilderness. In fact, the Office of Technology Assessment estimated beach clean-up and oil skinning only recovered 3-4% of the *Exxon Valdez* oil and studies by government scientists estimated that only 14% of the oil was removed during clean-up operations.

After two decades later, the ecosystem still suffers. Substantial contamination of mussel beds persists and this remarkably unweather oil is a continuing source of toxic hydrocarbons. Sea otters, river otters, Barrow's goldeneyes, and harlequin ducks have showed evidence of continued hydrocarbon exposure in the past few years.

The depressed population of Pacific herring – a critical source of food for over 40 predators including seabirds, harbor seals and Steller sea lions – is having severe impacts up the food chain. Wildlife population declines continue for harbor seal, killer whales, harlequin ducks, common loon, pigeon guillemot, and pelagic, red-faced cormorant, and double-crested cormorants.

Exxon-funded scientists have repeatedly dismissed evidence of on-going effects to wildlife from the massive 1989 oil spill by claiming that oil seeps contribute a bigger background source of hydrocarbons in bottom sediments in Prince William Sound. Yet, they dismiss coal as a possible source due to ignoring location of known deposits and other factors about its "fingerprint." A new study by the National Marine Fisheries Service concluded that the source is coal, and that coal hydrocarbons are not chemically available to impact wildlife.

Oil is more toxic than thought.

Even before the spill, scientists knew that a drop of oil could kill a bird's egg. But after studying the impact of the Valdez spill, they now believe oil pollution is at least 100 times more

toxic to fish than previously known. It is also more persistent.

In Katmai National Park wilderness, oil remained along the rocky coast with only slight weathering compared to freshly spilled oil after more than 5 years. Chemically, it was like 11-day old Exxon Valdez crude, with high concentrations of toxic polynuclear aromatic hydrocarbons (PAH's). In the past, it was presumed that wave action would have rapidly removed oil in such areas. Future releases of toxic oil can still affect wildlife.

New studies by the National Marine Fisheries Service show that even very low levels of weathered Exxon Valdez oil (0.5 to 1 part per billion PAH's) are toxic at the early life stages of salmon and herring.This data on toxicity to salmon eggs shows that current Alaska water quality standards allow hydrocarbon levels that can impair reproduction.

Exxon Valdez spill resulted in profound physiological effects to fish and wildlife. These included reproductive failure, genetic damage, curved spines, lowered growth and body weights, altered feeding habits, reduced egg volume, liver damage, eye tumors, and debilitating brain lesions.

Conclusion

The *Exxon Valdez oil spill* is not just an awful memory. Oil from one of the most devastating environmental disasters in U.S. history still clings to boulder-strewn beaches in the Gulf of Alaska and could stick around for decades. Researchers have presented evidence of a lingering, foamy, and mousse-like emulsion.

CASE STUDY 2 BHOPAL GAS TRAGEDY

On the night of 3 December 1984 the lethal gas Methyl Iso-cyanate (MIC) alongside other noxious fumes, engulfed the city of Bhopal and killed thousands. It is thought that the disaster has claimed 25,000 lives thus far, and adversely affected over 500,00. Gross negligence by Union Carbide is widely viewed as the cause of the tragedy.

December 3, 1984 has become a memorable day for the city of Bhopal in Madya Pradesh county, India. Shortly after midnight, a poisonous gas cloud escaped from the Union Carbide India

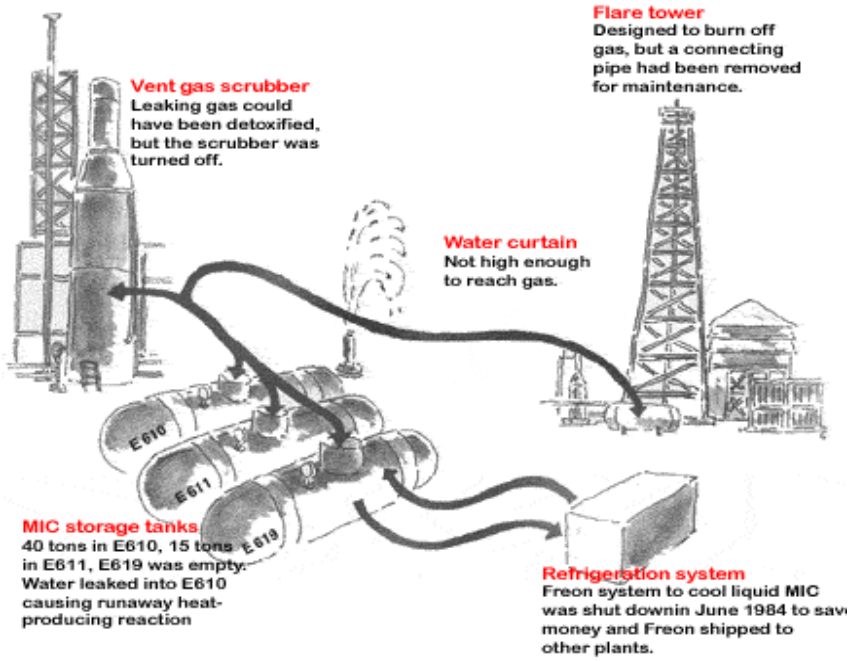
Limited (UCIL) pesticide factory. The cloud contained 15 metric tons of methyl isocyanate (MIC), covering an area of more than 30 square miles. The gas leak killed at least 4.000 local residents instantly and caused health problems such as oedema for at least 50.000 to perhaps 500.000 people. These health problems killed around 15.000 more victims in the years that followed. Approximately 100.000 people still suffer from chronic disease consequential to gas exposure, today. Research conducted by the BBC in 2004 pointed out that this pollution still causes people to fall ill, and ten more die every year. This event is now known as the worst industrial environmental disaster to ever have occurred.(Note that the numbers of victims are not absolute, as they are different for every organization that describes the accident in books or on their websites. Particularly the Union Carbide company states a much lower total number of victims.)

The cause of the accident has been researched after the disaster. Apparently water ended up in MIC storage tanks, causing an exothermal reaction that released an amount of poisonous gas large enough to open the safety valves. Normally scrubbers would intercept escaping gas, but these were temporarily out of order for repair.

Research showed that factory personnel neglected a number of safety procedures. There were no valves to prevent water from entering the storage tanks. The cooling installation of the tanks and the flaring installation that might have flared the gas that was released were out of order.

Safety was very low in this factory of Union Carbide, compared to its other locations. The safety procedures were neglected because of budget cuts.

Union Carbide was accused of deliberate evasion of regular safety procedures. During lawsuits where victims demanded compensation, documents were revealed which proved that Union Carbide regularly used untested technology in the Bhopal factory. When the gas leak occurred doctors were not informed of the nature of the gas. This caused the correct treatment and emergency measures to be held off.



Overview of events that led to the Bhopal disaster (Bhopal Medical Appeal, 2002)

About the cause of the accident it is claimed that: "A thorough investigation was conducted by the engineering consulting firm Arthur D. Little. Its conclusion: the gas leak could only have been caused by deliberate sabotage. Someone purposely put water in the gas storage tank, causing a massive chemical reaction. Process safety systems had been put in place that would have kept the water from entering into the tank by accident."

After a long procedure in February 1989 eventually a settlement was achieved. Union Carbide promised to pay 470 million dollars compensation. Only a very small part of this compensation was paid to survivors of the environmental disaster. Union Carbide states on its website that it paid the full settlement to the Indian government within 10 days' time. In 2004 the Supreme Court forced the Indian government to pay the remaining 330 million dollars compensation to the victims and their families.

Today, the location is still polluted with thousands of tons of toxic chemicals, such as hexachord benzene and mercury. These chemicals are stored in open barrels. Rainfall causes rinsing out of pollution to local drinking water sources. According to BBC research, some wells even contain up to 500 times the legal limit of these toxins. Local residents still suffer from a number of diseases, which appear to be very uncommon among people that do not live in the disaster area.

As for levels of contamination, a major water and soil study was conducted by Greenpeace in 1999. After testing samples in and around the factory, deadly chemicals were found everywhere, including in hand pumps that gushed out drinking water. In the water, levels of carbon tetrachloride and chloroform were found several hundred-times higher than the US Environmental Protection Agency limits. In the soil, levels of mercury were found to be anywhere up to 6 million times higher than those found in uncontaminated soil. Similarly, organ chlorides such as the banned pesticide.

DDT were present throughout the region.

More recent reports include one released in 2009 by the Sambhavna Trust which show a presence of large quantities of the aforementioned chemicals, as well as nickel, chromium, lead and others in vegetables, and even in the breast milk of nursing mothers. As a result of ongoing and horrific *birth* defects, mothers in the area had become too scared to breast feed their own children.

‘People are ill in the communities. Babies are sick. There are many deformed births. It’s as if they really hate us. As if they’re trying to punish us for protesting when they gassed us before and killed our families.’ These were the words of Sunil Kumar, an orphaned community leader (following the catastrophe), who went on to commit suicide some years ago.

As each monsoon washes more and more chemicals in to the area’s ground water, an ever increasing number of people are becoming sick. According to the International Campaign for Justice in Bhopal, upwards of 150,000 remains chronically ill and over 50,000 are not able to work.