

## MODULE IV

### ENVIRONMENTAL POLLUTION

#### 1.0 Pollution

Pollution is the effect of undesirable changes in our surroundings that have harmful effects on plants, animals and human beings. This occurs when only short-term economic gains are made at the cost of the long-term ecological benefits for humanity. No natural phenomenon has led to greater ecological changes than have been made by mankind. During the last few decades we have contaminated our air, water and land on which life itself depends with a variety of waste products.

From an ecological perspective pollutants can be classified as follows:

**Degradable or non-persistent pollutants:** These can be rapidly broken down by natural processes. Eg: domestic sewage, discarded vegetables, etc.

**Slowly degradable or persistent pollutants:** Pollutants that remain in the environment for many years in an unchanged condition and take decades or longer to degrade. Eg: DDT and most plastics.

**Non-degradable pollutants:** These cannot be degraded by natural processes. Once they are released into the environment they are difficult to eradicate and continue to accumulate. Eg: toxic elements like lead or mercury.

#### 1.1 Air pollution

Air pollution occurs due to the presence of undesirable solid or gaseous particles in the air in quantities that are harmful to human health and the environment. Air may get polluted by natural causes such as volcanoes, which release ash, dust, sulphur and other gases, or by forest fires that are occasionally naturally caused by lightning. However, unlike pollutants from human activity, naturally occurring pollutants tend to remain in the atmosphere for a short time and do not lead to permanent atmospheric change. Pollutants that are produced in the atmosphere when certain chemical reactions take place among the primary pollutants are called secondary pollutants. Eg: sulfuric acid, nitric acid, carbonic acid, etc.

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

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

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

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

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

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

### **1.1.1 Effects of air pollution on living organisms**

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

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

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

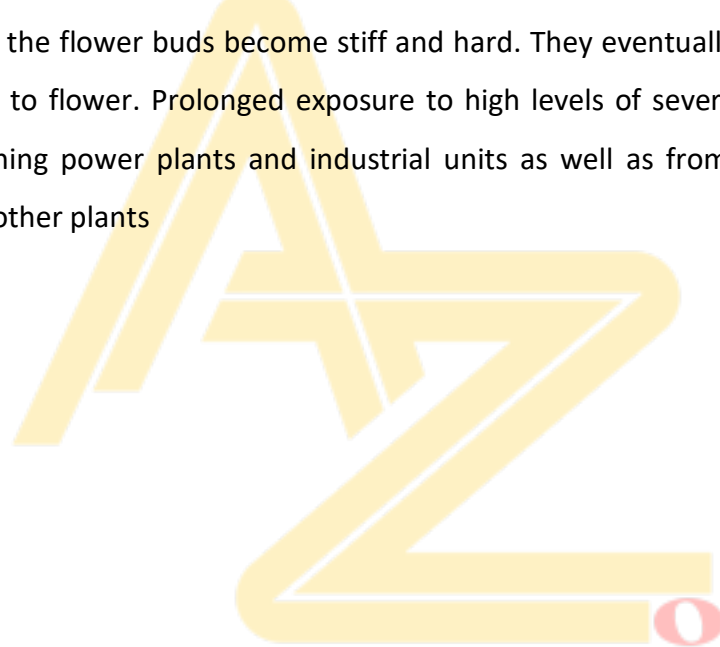
**Nitrogen oxides** especially NO can irritate the lungs, aggravate asthma or chronic bronchitis and also increase susceptibility to respiratory infections such as influenza or common colds

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

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

### **1.1.2 Effects on plants**

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



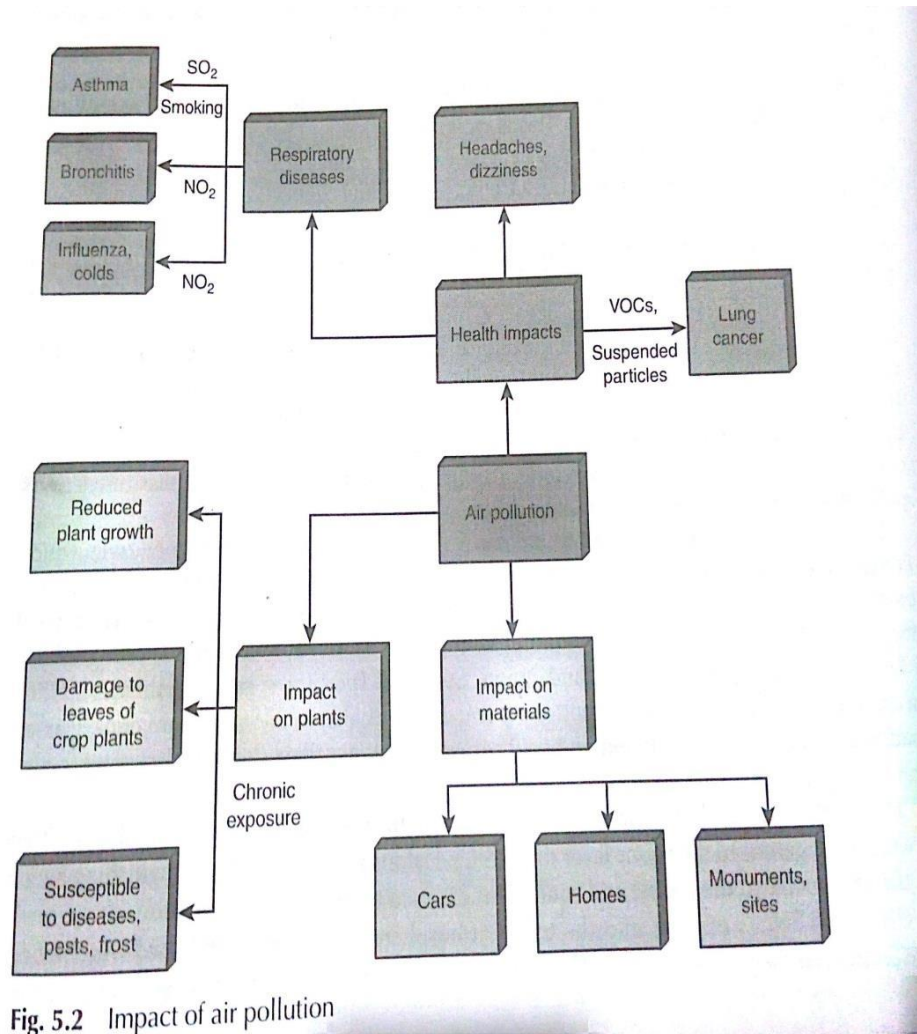


Fig. 5.2 Impact of air pollution

### 1.1.3 Effects of air pollution on materials

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

### 1.1.4 Ozone depletion-What does it do?

Changes in the ozone layer have serious implications for mankind.

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

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

Increased ultra-violet radiation, It weakens the immune system by suppressing the resistance of the whole body to certain infections like measles, chicken pox and other viral diseases that elicit rash and parasitic diseases such as malaria introduced through the skin.

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

**Effect on climate:** Atmospheric changes induced by pollution contribute to global warming, a phenomenon which is caused due to the increase in concentration of certain gases like carbon dioxide, nitrogen oxides, methane and CFCs. Observations of the earth have shown beyond doubt that atmospheric constituents such as water vapour, carbon dioxide, methane, nitrogen oxides and Chloro Fluro Carbons trap heat in the form of infra-red radiation near the earth's surface. This is known as the 'Green- house Effect'.

#### **1.1.5 Control measures for air pollution**

Air pollution can be controlled by two fundamental approaches: preventive techniques and effluent control.

One of the effective means of controlling air pollution is to have proper equipment in place. This includes devices for removal of pollutants from the flue gases through scrubbers, closed collection recovery systems through which it is possible to collect the pollutants before they escape, use of dry and wet collectors, filters, electrostatic precipitators, etc. Providing a greater height to the stacks can help in facilitating the discharge of pollutants as far away from the ground as possible. Industries should be located in places so as to minimize the effects of pollution after considering the topography and the wind directions. Substitution of raw material that causes more pollution with those that cause less pollution can be done.

#### **1.2 Water Pollution**

**Introduction:** Water is the essential element that makes life on earth possible. Without water there would be no life. We usually take water for granted. It flows from our taps when they are

turned on. Most of us are able to bathe when we want to, swim when we choose and water our gardens.

Although 71% of the earth's surface is covered by water only a tiny fraction of this water is available to us as fresh water. About 97% of the total water available on earth is found in oceans and is too salty for drinking or irrigation. The remaining 3% is fresh water. Of this 2.997% is locked in ice caps or glaciers. Thus only 0.003% of the earth's total volume of water is easily available to us as soil moisture, groundwater, water vapour and water in lakes, streams, rivers and wetlands

**Water availability on the planet:** Water that is found in streams, rivers, lakes, wetlands and artificial reservoirs is called surface water. Water that percolates into the ground and fills the pores in soil and rock is called groundwater. Porous water-saturated layers of sand, gravel or bedrock through which ground water flows are called aquifers. Most aquifers are replenished naturally by rainfall that percolates downward through the soil and rock. This process is called natural recharge. If the withdrawal rate of an aquifer exceeds its natural recharge rate, the water table is lowered. Any pollutant that is discharged onto the land above is also pulled into the aquifer and pollutes the groundwater resulting in polluted water in the nearby wells.

India receives most of her rainfall during the months of June to September due to the seasonal winds and the temperature differences between the land and the sea.

The monsoon in India is usually reasonably stable but varies geographically. In some years the commencement of the rains may be delayed considerably over the entire country or a part of it. The rains may also terminate earlier than usual. They may be heavier than usual over one part than over another. All these may cause local floods or drought. However in India even areas that receive adequate rainfall during the monsoon suffer from water shortages in the post monsoon period due to lack of storage facilities.

When a source of pollution cannot be readily identified, such as agricultural runoff, acid rain, etc, they are said to be **non-point sources of pollution**.

**Point sources of pollution:** When a source of pollution can be readily identified because it has a definite source and place where it enters the water it is said to come from a point source. Eg. Municipal and Industrial Discharge Pipes.



### 1.2.1 Causes of water pollution

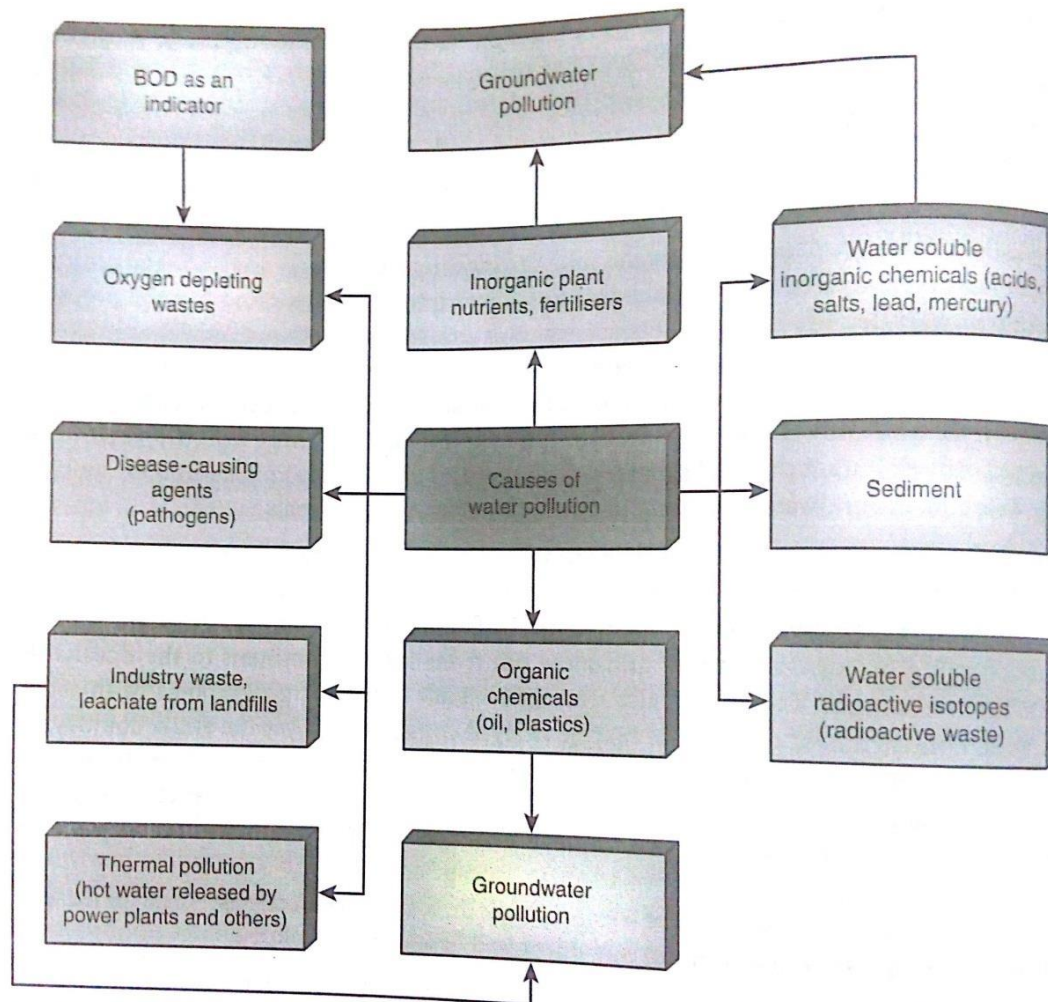


Fig. 5.5 Causes of water pollution

**a). Disease causing agents (pathogens)** which include bacteria, viruses, protozoa and parasitic worms that enter water from domestic sewage and untreated human and animal wastes. Human wastes contain concentrated populations of coliform bacteria such as *Escherichia coli* and *Streptococcus faecalis*. These bacteria normally grow in the large intestine of humans where they are responsible for some food digestion and for the production of vitamin K. These bacteria are not harmful in low numbers. Large amounts of human waste in water, increases the number of these bacteria which cause gastrointestinal diseases. Other potentially harmful bacteria from human wastes may also be present in smaller numbers.



**b). oxygen depleting wastes:** These are organic wastes that can be decomposed by aerobic (oxy- gen requiring) bacteria. Large populations of bacteria use up the oxygen present in water to degrade these wastes. In the process this de- grades water quality. The amount of oxygen required to break down a certain amount of organic matter is called the biological oxygen demand (BOD). The amount of BOD in the water is an indicator of the level of pollution. If too much organic matter is added to the water all the available oxygen is used up. This causes fish and other forms of oxygen dependent aquatic life to die. Thus anaerobic bacteria (those that do not require oxygen) begin to break down the wastes. Their anaerobic respiration produces chemicals that have a foul odour and an un-pleasant taste that is harmful to human health.

**c). inorganic plant nutrients:** These are water soluble nitrates and phosphates that cause excessive growth of algae and other aquatic plants. The excessive growth of algae and aquatic plants due to added nutrients is called eutrophication. They may interfere with the use of the water by clogging water intake pipes, changing the taste and odour of water and cause a buildup of organic matter. As the organic matter decays, oxygen levels decrease and fish and other aquatic species die.

**d). water soluble inorganic chemicals** which are acids, salts and compounds of toxic metals such as mercury and lead. High levels of these chemicals can make the water unfit to drink, harm fish and other aquatic life, reduce crop yields and accelerate corrosion of equipment that use this water

**e). organic chemicals,** which include oil, gasoline, plastics, pesticides, cleaning solvents, detergent and many other chemicals. These are harmful to aquatic life and human health. They get into the water directly from industrial activity either from improper handling of the chemicals in industries and more often from improper and illegal disposal of chemical wastes.

**f). Sediment of suspended matter** is another class of water pollutants. These are insoluble particles of soil and other solids that become suspended in water. This occurs when soil is eroded from the land. High levels of soil particles suspended in water, interferes with the penetration of sunlight. This reduces the photosynthetic activity of aquatic plants and algae disrupting the ecological balance of the aquatic bodies. When the velocity of water in streams

and rivers decreases the suspended particles settle down at the bottom as sediments. Excessive sediments that settle down destroys feeding and spawning grounds of fish, clogs and fills lakes, artificial reservoirs etc.

**g). Water soluble radioactive isotopes** are yet another source of water pollution. These can be concentrated in various tissues and organs as they pass through food chains and food webs. Ionizing radiation emitted by such isotopes can cause birth defects, cancer and genetic damage.

**h). Hot water** let out by power plants and industries that use large volumes of water to cool the plant result in rise in temperature of the local water bodies. Thermal pollution occurs when industry returns the heated water to a water source. Power plants heat water to convert it into steam, to drive the turbines that generate electricity.

**i). Groundwater pollution:** While oil spills are highly visible and often get a lot of media attention, a much greater threat to human life comes from our groundwater being polluted which is used for drinking and irrigation. While groundwater is easy to deplete and pollute it gets renewed very slowly and hence must be used judiciously. Groundwater flows are slow and not turbulent hence the contaminants are not effectively diluted and dispersed as compared to surface water. Moreover pumping groundwater and treating it is very slow and costly. Hence it is extremely essential to prevent the pollution of groundwater in the first place. Groundwater is polluted due to:

- Urban run-off of untreated or poorly treated waste water and garbage
- Agricultural practices such as the application of large amounts of fertilizers and pesticides, animal feeding operations, etc. in the rural sector
- Industrial waste storage located above or near aquifers
- Mining wastes
- Poorly designed and inadequately maintained septic tanks
- Leakage from underground storage tanks containing gasoline and other hazardous substances

### 1.2.2 Control measures for preventing water pollution

While the foremost necessity is prevention, setting up effluent treatment plants and treating waste through these can reduce the pollution load in the recipient water. The treated effluent can be reused for either gardening or cooling purposes wherever possible. A few years ago a new technology called the Root Zone Process has been developed by Thermax. This system involves running contaminated water through the root zones of specially designed reed beds. The reeds, which are essentially wetland plants, have the capacity to absorb oxygen from the surrounding air through their stomatal openings. The oxygen is pushed through the porous stem of the reeds into the hollow roots where it enters the root zone and creates conditions suitable for the growth of numerous bacteria and fungi. These micro-organisms oxidize impurities in the wastewaters, so that the water which finally comes out is clean.

### **1.3 Soil Pollution**

Soil is a thin covering over the land consisting of a mixture of minerals, organic material, living organisms, air and water that together support the growth of plant life. Several factors contribute to the formation of soil from the parent material. This includes mechanical weathering of rocks due to temperature changes and abrasion, wind, moving water, glaciers, chemical weathering activities and lichens. Climate and time are also important in the development of soils. Extremely dry or cold climates develop soils very slowly while humid and warm climates develop them more rapidly. Under ideal climatic conditions soft parent material may develop into a centimeter of soil within 15 years. Under poor climatic conditions a hard parent material may require hundreds of years to develop into soil.

Soils vary in their content of clay (very fine particles), silt (fine particles), sand (medium size particles) and gravel (coarse to very coarse particles). The relative amounts of the different sizes and types of mineral particles determine soil texture. Soils with approximately equal mixtures of clay, sand, silt and humus are called loams.

#### **1.3.1 Causes of soil degradation**

##### **Erosion**

Soil erosion can be defined as the movement of surface litter and topsoil from one place to another. While erosion is a natural process often caused by wind and flowing water it is greatly

accelerated by human activities such as farming, construction, overgrazing by livestock, burning of grass cover and deforestation.

Loss of the topsoil makes a soil less fertile and reduces its water holding capacity. The topsoil, which is washed away, also contributes to water pollution clogging lakes, increasing turbidity of the water and also leads to loss of aquatic life.

**Continuous contour trenches** can be used to enhance infiltration of water reduce the run- off and check soil erosion. These are actually shallow trenches dug across the slope of the land and along the contour lines basically for the purpose of soil and water conservation. They are most effective on gentle slopes and in areas of low to medium rainfall. These bunds are stabilized by fast growing tree species and grasses. In areas of steep slopes where the bunds are not possible, continuous contour benches (CCBs) made of stones are used for the same purpose.

**Gradonies** can also be used to convert waste- lands into agricultural lands. In this narrow trenches with bunds on the downstream side are built along contours in the upper reaches of the catchment to collect run-off and to conserve moisture from the trees or tree crops. The area between the two bunds is use for cultivation of crops after development of fertile soil cover.

Some of the ways in which this can be achieved are:

- A bund constructed out of stones across the stream can also be used for conserving soil and water.
- Live check dams which barriers created by planting grass, shrubs and trees across the gullies can be used for this purpose.
- An Earthen check bund is constructed out of local soil across the stream to check soil erosion and flow of water.
- A Gabion structure is a bund constructed of stone and wrapped in galvanized chainlink.
- A Gabion structure with ferrocement impervious barrier has a one inch thick impervious wall of ferrocement at the center of the structure which goes below the ground level upto the hard strata. This ferrocement partition sup- ported by the gabion portion is able to retain the water and withstand the force of the runoff water.

### 1.3.2 Excess use of fertilizers

Fertilizers are very valuable as they replace the soil nutrients used up by plants. The three primary soil nutrients often in short supply are potassium, phosphorus and nitrogen compounds. These are commonly referred to as macronutrients. Certain other elements like boron, zinc and manganese are necessary in extremely small amounts and are known as micronutrients. When crops are harvested a large amount of macronutrients and a small amount of micronutrients are removed with the crops. If the same crop is grown again depleted levels of these nutrients can result in decreased yields. These necessary nutrients can be returned to the soil through the application of fertilizers. In addition to fertilizers a large amount of pesticides (chemicals used to kill or control populations of unwanted fungi, animals or plants often called pests) are also used to ensure a good yield. Pesticides can be subdivided into several categories based on the kinds of organisms they are used to control. Insecticides are used to control insect populations while fungicides are used to control unwanted fungal growth. Mice and rats are killed by rodenticides while plant pests are controlled by herbicides.

### **1.3.3 Problems with pesticide use**

Pesticides not only kill the pests but also a large variety of living things including humans. They may be persistent or non-persistent. Persistent pesticides once applied are effective for a long time. However as they do not break down easily they tend to accumulate in the soil and in the bodies of animals in the food chain.

The use of DDT has been banned in some countries. India still however permits the use of DDT though for purposes of mosquito control only. Persistent pesticides become attached to small soil particles which are easily moved by wind and water to different parts thus affecting soils elsewhere. Persistent pesticides may also accumulate in the bodies of animals, and over a period of time increase in concentration if the animal is unable to flush them out of its system thus leading to the phenomenon called bioaccumulation. When an affected animal is eaten by another carnivore these pesticides are further concentrated in the body of the carnivore. This phenomenon of acquiring increasing levels of a substance in the bodies of higher trophic level organisms is known as biomagnification.

Other problems associated with insecticides are the ability of insect populations to become resistant to them thus rendering them useless in a couple of generations. Most pesticides kill

beneficial as well as pest species. They kill the predator as well as the parasitic insects that control the pests. Thus the pest species increase rapidly following the use of a pesticide as there are no natural checks to their population growth. The short term and the long-term health effects to the persons using the pesticide and the public that consumes the food grown by using the pesticides are also major concerns. Exposure to small quantities of pesticides over several years can cause mutations, produce cancers, etc.

#### **1.3.4 Excess salts and water**

Another problem with irrigation is water logging. This occurs when large amount of water is used to leach the salts deeper into the soil. However if the drainage is poor this water accumulates underground gradually raising the water table. The roots of the plants then get enveloped in this saline water and eventually die.

Irrigated lands can produce crop yields much higher than those that only use rainwater. However this has its own set of ill effects. Irrigation water contains dissolved salts and in dry climates much of the water in the saline solution evaporates leaving its salts such as sodium chloride in the topsoil. The accumulation of these salts is called salinization, which can stunt plant growth, lower yields and eventually kill the crop and render the land useless for agriculture. These salts can be flushed out of the soil by using more water. This practice however increases the cost of crop production and also wastes enormous amounts of water. Flushing salts can also make the downstream irrigation water saltier.

#### **1.4 Marine Pollution**

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

- Waste through pipes directly discharging wastes into the sea. Very often municipal waste and sewage from residences and hotels in coastal towns are directly discharged into the sea

- Pesticides and fertilizers from agriculture which are washed off the land by rain, enter water courses and eventually reach the sea.
- Petroleum and oils washed off from the roads normally enter the sewage system but storm water overflows carry these materials into rivers and eventually into the seas
- Ships carry many toxic substances such as oil, liquefied natural gas, pesticides, industrial chemicals, etc. in huge quantities some- times to the capacity of 350,000 tonnes. Ship accidents and accidental spillages at sea therefore can be very damaging to the marine environment
- Offshore oil exploration and extraction also pollute the seawater to a large extent.

#### **1.4.1 Pollution due to organic wastes**

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

#### **1.4.2 Control measures**

Pollution load on marine waters is through the introduction of sewage treatment plants. This will reduce the biological oxygen demand (BOD) of the final product before it is discharged to the receiving waters.

Various stages of treatment such as primary, secondary or advanced can be used depending on the quality of the effluent that is required to be treated.



**Primary treatment:** These treatment plants use physical processes such as screening and sedimentation to remove pollutants that will settle, float or, that are too large to pass through simple screening devices. This includes stones, sticks, rags, and all such material that can clog pipes.

**Secondary treatment:** The main objective of secondary treatment is to remove most of the BOD. There are three commonly used approaches: trickling filters, activated sludge process and oxidation ponds. Secondary treatment can remove at least 85 percent of the BOD.

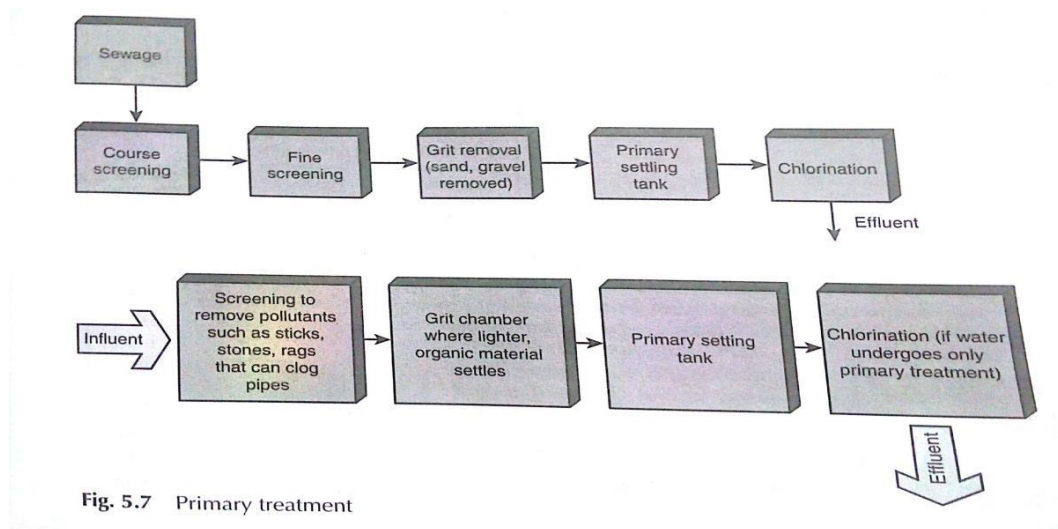


Fig. 5.7 Primary treatment

### 1.4.3 Pollution due to oil

Oil pollution of the sea normally attracts the greatest attention because of its visibility. There are several sources through which the oil can reach the sea,

- Tanker operations,
- All ships need periodic dry docking for servicing, repairs, cleaning the hull, etc. During this period when the cargo compartments are to be completely emptied, residual oil finds its way into the sea.
- Bilge and fuel oils
- Offshore oil production
- Tanker accidents

### 1.4.4 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.

#### **1.4.5 Effects of marine pollution**

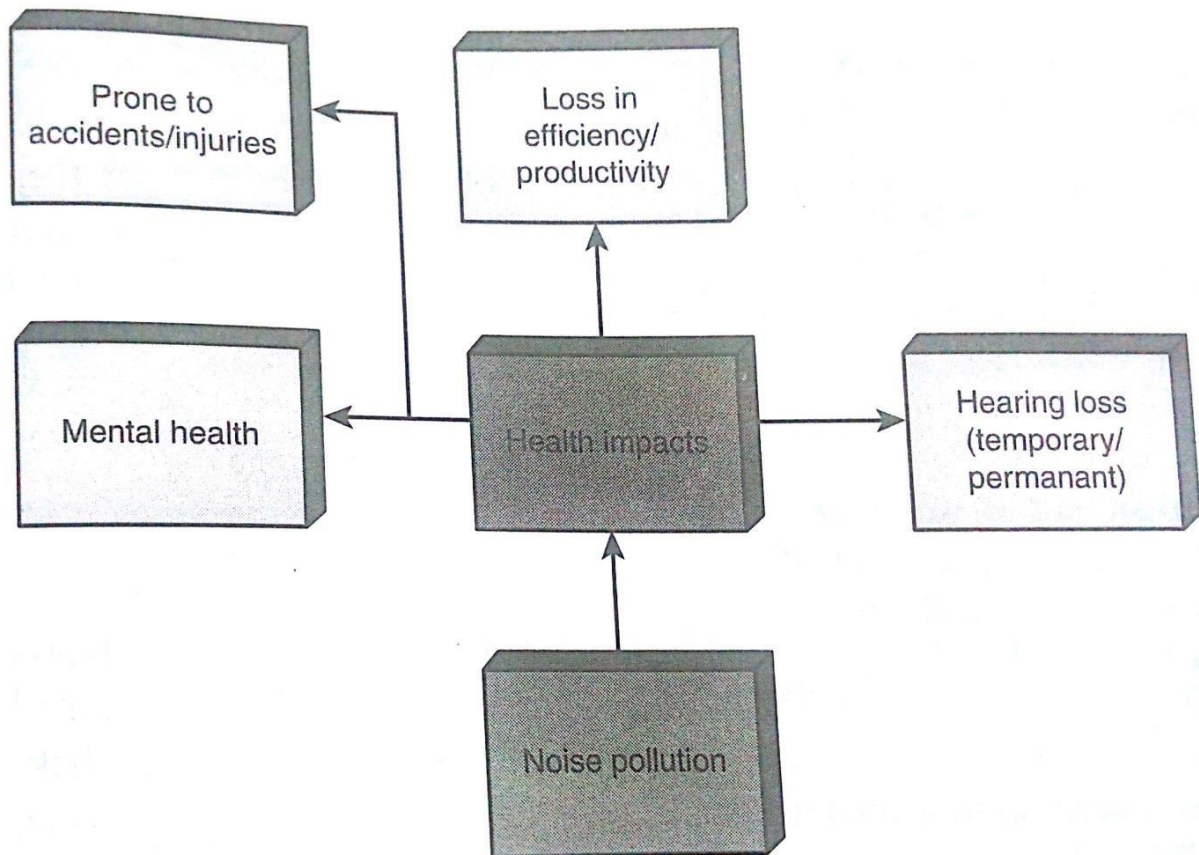
- Apart from causing eutrophication a large amount of organic wastes can also result in the development of red tides. These are phytoplankton blooms of such intensity that the area is discolored. Many important commercially important marine species are also killed due to clogging of gills or other structures.
- Oil slicks damage marine life to a large extent. Salt marshes, mangrove swamps are likely to trap oil and the plants, which form the basis for these ecosystems thus suffer. For salt marsh plants, oil slicks can affect the flowering, fruiting and germination
- When liquid oil is spilled on the sea it spreads over the surface of the water to form a thin film called an oil slick. The rate of spreading and the thickness of the film depend on the sea temperature and the nature of the oil.
- Fish and shellfish production facilities can also be affected by oil slicks. The most important commercial damage can however also come from tainting which imparts an unpleasant flavour to fish and seafood and is detectable at extremely low levels of contamination. This reduces the market value of seafood

#### **1.5 Noise Pollution**

Noise may not seem as harmful as the contamination of air or water but it is a pollution problem that affects human health and can contribute to a general deterioration of environmental quality. Noise is undesirable and unwanted sound. Not all sound is noise. . Sound is measured in a unit called the 'Decibel'.

There are several sources of noise pollution that contribute to both indoor and outdoor noise pollution. Noise emanating from factories, vehicles, playing of loudspeakers during various

festivals can contribute to outdoor noise pollution while loudly played radio or music systems, and other electronic gadgets can contribute to indoor noise pollution. There are however some very harmful effects caused by exposure to high sound levels. These effects can range in severity from being extremely annoying to being extremely painful and hazardous.



**Fig. 5.12** Impact of noise pollution

### 1.5.1 Effects of noise pollution on physical health

The most direct harmful effect of excessive noise is physical damage to the ear and the temporary or permanent hearing loss often called a temporary threshold shift (TTS). People suffering from this condition are unable to detect weak sounds. However hearing ability is usually recovered within a month of exposure. In Maharashtra people living in close vicinity of Ganesh mandals that play blaring music for ten days of the Ganesh festival are usually known to

suffer from this phenomenon. Permanent loss, usually called noise induced permanent threshold shift (NIPTS) represents a loss of hearing ability from which there is no recovery.

Below a sound level of 80 dBA hearing loss does not occur at all. However temporary effects are noticed at sound levels between 80 and 130 dBA. About 50 percent of the people exposed to 95 dBA sound levels at work will develop NIPTS and most people exposed to more than 105 dBA will experience permanent hearing loss to some degree. A sound level of 150 dBA or more can physically rupture the human eardrum.

### **1.5.2 Effects of noise pollution on mental health**

Noise can also cause emotional or psychological effects such as irritability, anxiety and stress. Lack of concentration and mental fatigue are significant health effects of noise. It has been observed that the performance of school children is poor in comprehension tasks when schools are situated in busy areas of a city and suffer from noise pollution.

Thus noise is just more than a mere nuisance or annoyance. It definitely affects the quality of life. It is thus important to ensure mitigation or control of noise pollution. As noise interferes with normal auditory communication, it may mask auditory warning signals and hence increases the rate of accidents especially in industries. It can also lead to lowered worker efficiency and productivity and higher accident rates on the job.

### **1.5.3 Noise Control techniques**

There are four fundamental ways in which noise can be controlled: Reduce noise at the source, block the path of noise, increase the path length and protect the recipient. In general, the best control method is to reduce noise levels at the source.

Source reduction can be done by effectively muffling vehicles and machinery to reduce the noise. In industries noise reduction can be done by using rigid sealed enclosures around machinery lined with acoustic absorbing material. Isolating machines and their enclosures from the floor using special spring mounts or absorbent mounts and pads and using flexible couplings for interior pipelines also contribute to reducing noise pollution at the source. However one of the best methods of noise source reduction is regular and thorough maintenance of operating machinery. Noise levels at construction sites can be controlled using proper construction planning and scheduling techniques. Locating noisy air compressors and

other equipment away from the site boundary along with creation of temporary barriers to physically block the noise can help contribute to reducing noise pollution. Most of the vehicular noise comes from movement of the vehicle tires on the pavement and wind resistance. However poorly maintained vehicles can add to the noise levels. Traffic volume and speed also have significant effects on the overall sound. For example doubling the speed increases the sound levels by about 9 dBA and doubling the traffic volume (number of vehicles per hour) increases sound levels by about 3 dBA. A smooth flow of traffic also causes less noise than does a stop-and-go traffic pattern. Proper highway planning and design are essential for controlling traffic noise. Establishing lower speed limits for highways that pass through residential areas, limiting traffic volume and providing alternative routes for truck traffic are effective noise control measures. The path of traffic noise can also be blocked by construction of vertical barriers alongside the high- way. Planting of trees around houses can also act as effective noise barriers. In industries different types of absorptive material can be used to control interior noise. Highly absorptive interior finish material for walls, ceilings and floors can decrease indoor noise levels significantly. Sound levels drop significantly with increasing distance from the noise source. Increasing the path length between the source and the recipient offers a passive means of control. Municipal land-use ordinances pertaining to the location of airports make use of the attenuating effect of distance on sound levels. Use of earplugs and earmuffs can protect individuals effectively from excessive noise levels. Specially designed earmuffs can reduce the sound level reaching the eardrum by as much as 40 dBA. However very often workers tend not to wear them on a regular basis despite company requirements for their use.

### **1.6 Thermal Pollution**

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

### 1.6.1 Effects

The warmer temperature decreases the solubility of oxygen and increases the metabolism of fish. This changes the ecological balance of the river. Within certain limits thermal additions can promote the growth of certain fish and the fish catch may be high in the vicinity of a power plant. However sudden changes in temperature caused by periodic plant shutdowns both planned and unintentional can change result in death of these fish that are acclimatized to living in warmer waters.

Tropical marine animals are generally unable to withstand a temperature increase of 2 to 3°C and most sponges, mollusks and crustaceans are eliminated at temperatures above 37°C. This results in a change in the diversity of fauna as only those species that can live in warmer water survive.

### 1.6.2 Control measures:

Thermal pollution can be controlled by passing the heated water through,

- To construct a large shallow pond. Hot water is pumped into one end of the pond and cooler water is removed from the other end. The heat gets dissipated from the pond into the atmosphere
- To use a cooling tower. These structures take up less land area than the ponds. Here most of the heat transfer occurs through evaporation. Here warm waters coming from the condenser is sprayed downward over vertical sheets or baffles where the water flows in thin films. Cool air enters the tower through the water inlet that encircles the base of the tower and rises upwards causing evaporative cooling.

### 1.7 Nuclear Hazards

Nuclear energy can be both beneficial and harmful depending on the way in which it is used. We routinely use X-rays to examine bones for fractures, treat cancer with radiation and diagnose diseases with the help of radioactive isotopes. Approximately 17 % of the electrical energy generated in the world comes from nuclear power plants. However on the other hand it is impossible to forget the destruction that nuclear bombs caused the cities of Hiroshima and Nagasaki. The radioactive wastes from nuclear energy have caused serious environmental damage.



In order to appreciate the consequences of using nuclear fuels to generate energy it is important to understand how the fuel is processed. Low-grade uranium ore, which contains 0.2 percent uranium by weight, is obtained by surface or underground mining. After it is mined the ore goes through a milling process where it is crushed and treated with a solvent to concentrate the uranium and produces yellow cake a material containing 70 to 90 percent uranium oxide. Naturally occurring uranium contains only 0.7 percent of fissionable U-235, which is not high enough for most types of reactors. Hence it is necessary to increase the amount of U-235 by enrichment though it is a difficult and expensive process. The enrichment process increases the U-235 content from 0.7 to 3 percent. Fuel fabrication then converts the enriched material into a powder, which is then compacted into pellets. These pellets are sealed in metal fuel rods about 4 meters in length which is then loaded into the reactor. As fission occurs the concentration of U-235 atoms decreases. After about three years, a fuel rod does not have enough radioactive material to sustain a chain reaction and hence the spent fuel rods must be replaced by new ones. The spent rods are however still very radioactive containing about one percent U-235 and one percent plutonium. These rods are a major source of radioactive waste material produced by a nuclear reactor. Initially it was thought that spent fuel rods could be reprocessed to not only provide new fuel but also to reduce the amount of nuclear waste. However the cost of producing fuel rods by reprocessing was found to be greater than the cost of producing fuel rods from ore. Presently India does operate reprocessing plants to reprocess spent fuel as an alternative to storing them as nuclear waste. At each step in the cycle there is a danger of exposure and poses several health and environmental concerns.

### **1.8 Solid Waste Management: Causes, Effects and Control Measures of Urban and Industrial Waste**

Around most towns and cities in India the approach roads are littered with multi-coloured plastic bags and other garbage. Waste is also burnt to reduce its volume. Modern methods of disposal such as incineration and the development of sanitary landfills, etc. are now attempting to solve these problems. Lack of space for dumping solid waste has become a serious problem in several cities and towns all over the world. Dumping and burning wastes is not an acceptable



practice today from either an environmental or a health perspective. Today disposal of solid waste should be part of an integrated waste management plan. The method of collection, processing, resource recovery and the final disposal should mesh with one another to achieve a common objective.

### **1.8.1 Characteristics of municipal solid waste**

Municipal solid waste contains a wide variety of materials. It can contain food waste such as vegetable and meat material, left over food, egg shells, etc. which is classified as wet garbage as well as paper, plastic, tetrapacks, plastic cans, newspaper, glass bottles, cardboard boxes, aluminum foil, metal items, wood pieces, etc. which is classified as dry garbage.

### **1.8.2 Control measures of urban and industrial wastes**

An integrated waste management strategy includes three main components:

1. Source reduction
2. Recycling
3. Disposal

**Source reduction** is one of the fundamental ways to reduce waste. This can be done by using less material when making a product, reuse of products on site, designing products or packaging to reduce their quantity. On an individual level we can reduce the use of unnecessary items while shopping, buy items with minimal packaging, avoid buying disposable items and also avoid asking for plastic carry bags.

**Recycling** is reusing some components of the waste that may have some economic value. Recycling has readily visible benefits such as conservation of resources reduction in energy used during manufacture and reducing pollution levels. Some materials such as aluminum and steel can be recycled many times. Metal, paper, glass and plastics are recyclable. Mining of new aluminum is expensive and hence recycled aluminum has a strong market and plays a significant role in the aluminum industry. Paper recycling can also help preserve forests as it takes about 17 trees to make one ton of paper. Crushed glass (cullet) reduces the energy required to manufacture new glass by 50 percent. Cullet lowers the temperature requirement of the glassmaking process thus conserving energy and reducing air pollution. However even if recycling is a viable alternative, it presents several problems.

**Disposal** of solid waste is done most commonly through a sanitary landfill or through incineration. A modern sanitary landfill is a depression in an impermeable soil layer that is lined with an impermeable membrane. The three key characteristics of a municipal sanitary landfill that distinguish it from an open dump are:

- The waste is covered each day with a layer of compacted soil.
- The waste material is spread out and compacted with appropriate heavy machinery
- Solid waste is placed in a suitably selected and prepared landfill site in a carefully prescribed manner

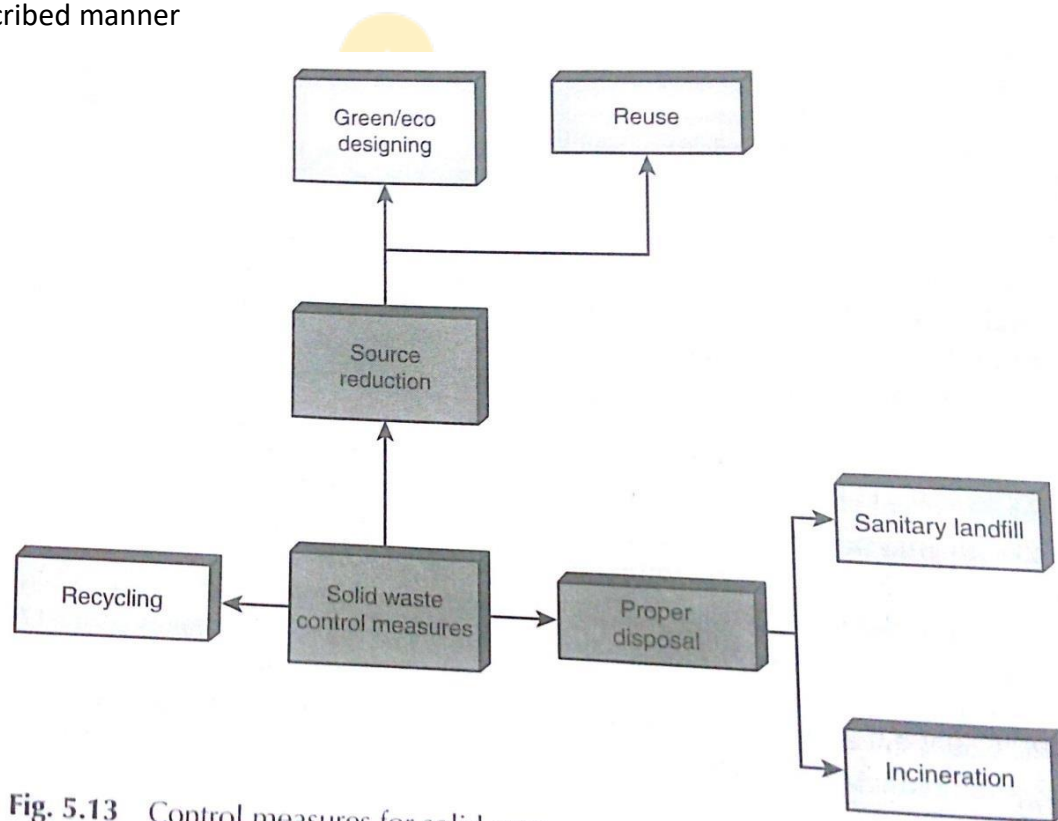


Fig. 5.13 Control measures for solid waste

### 1.8.3 Incineration

It is the process of burning municipal solid waste in a properly designed furnace under suitable temperature and operating conditions. Incineration is a chemical process in which the combustible portion of the waste is combined with oxygen forming carbon dioxide and water, which are released into the atmosphere. This chemical reaction called oxidation results in the release of heat. For complete oxidation the waste must be mixed with appropriate volumes of air at a temperature of about 815° C for about one hour. Incineration can reduce the municipal

solid waste by about 90 percent in volume and 75 percent in weight. The risks of incineration however involve air- quality problems and toxicity and disposal of the fly and bottom ash produced during the incineration process. Fly ash consists of finely divided particulate matter, including cinders, mineral dust and soot. Most of the incinerator ash is bottom ash while the remainder is fly ash. The possible presence of heavy metals in incinerator ash can be harmful. Thus toxic products and materials containing heavy metals (for example batteries and plastics) should be segregated. Thus extensive air pollution control equipment and high-level technical supervision and skilled employees for proper operation and maintenance is required.

#### **1.8.4 Vermicomposting**

Nature has perfect solutions for managing the waste it creates, if left undisturbed. The bio-geochemical cycles are designed to clear the waste material produced by animals and plants. We can mimic the same methods that are present in nature. All dead and dry leaves and twigs decompose and are broken down by organisms such as worms and insects, and is finally broken down by bacteria and fungi, to form a dark rich soil-like material called compost.

These organisms in the soil use the organic material as food, which provides them with nutrients for their growth and activities. These nutrients are returned to the soil to be used again by trees and other plants. This process recycles nutrients in nature.

#### **1.9 Hazardous wastes**

Hazardous wastes are those that can cause harm to humans or the environment. Wastes are normally classified as hazardous waste when they cause or significantly contribute to an increase in mortality or an increase in serious irreversible or incapacitating reversible illness or pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported or disposed of.

##### **1.9.1 Characteristics of hazardous wastes**

A waste is classified as a hazardous waste if it exhibits any of the four primary characteristics based on the physical or chemical properties of toxicity, reactivity, ignitability and corrosivity. In addition to this waste products that are either infectious or radioactive are also classified as hazardous

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Toxic wastes are those substances that are poisonous even in very small or trace amounts. Some may have an acute or immediate effect on humans or animals causing death or violent illness. Others may have a chronic or long term effect slowly causing irreparable harm to exposed persons. Acute toxicity is readily apparent because organisms respond to the toxin shortly after being exposed. Chronic toxicity is much more difficult to determine because the effects may not be seen for years. Certain toxic wastes are known to be carcinogenic, causing cancer and others may be mutagenic causing biological changes in the children of exposed people and animals.

**Corrosive wastes** are those that destroy materials and living tissue by chemical reaction. For example, acids and bases.

**Ignitable wastes** are those that burn at relatively low temperatures (less than 60° C) and are capable of spontaneous combustion during storage, transport or disposal. For example, gasoline, paint thinners, and alcohol.

**Reactive wastes** are those that have a tendency to react vigorously with air or water, are unstable to shock or heat, generate toxic gases or explode during routine management. For example, gunpowder, nitroglycerine, etc.

**Radioactive waste** is basically an output from the nuclear power plants and can persist in the environment for thousands of years before it decays appreciably

**Infectious wastes** include human tissue from surgery, used bandages and hypodermic needles, microbiological materials, etc.

### 1.9.2 Environmental problems and health risks caused by hazardous wastes

As most of the hazardous wastes are disposed of on or in land the most serious environmental effect is contaminated groundwater. Once groundwater is polluted with hazardous wastes it is very often not possible to reverse the damage.

Pesticides are used increasingly to protect and increase food production. They form residues in the soil which are washed into streams which then carry them forwards. The residues may persist in the soil or in the bottom of lakes and rivers. Exposure can occur through ingestion, inhalation and skin contact resulting in acute or chronic poisoning. Today we have an alternative to the excess use of pesticides through the use of Integrated Pest Management

(IPM). The IPM system uses a wide variety of plants and insects to create a more natural process. The natural balance between climate, soil and insect populations can help to prevent an insect from overpopulating an area and destroying a particular crop

Lead, mercury and arsenic are hazardous substances which are often referred to as heavy metals. Lead is an abundant heavy metal and is relatively easy to obtain. It is used in batteries, fuel, pesticides, paints, pipes and other places where resistance to corrosion is required. Most of the lead taken up by people and wildlife is stored in bones. Lead can affect red blood cells by reducing their ability to carry oxygen and shortening their life span. Lead may also damage nerve tissue which can result in brain disease.

Mercury occurs in several different forms. Mercury is used in the production of chlorine. It is also used as a catalyst in the production of some plastics. Industrial processes such as the production of chlorine and plastics are responsible for most of the environmental damage resulting from mercury. Our body has a limited ability to eliminate mercury. In the food web mercury becomes more concentrated as it is taken up by various organisms. In an aquatic environment, mercury can be absorbed by the plankton which are then consumed by fish. In addition, fish take up mercury through their gills and by eating other fish contaminated with mercury. Generally older the fish greater is the mercury concentration in its body. Birds that eat the fish concentrate even more mercury in their bodies. It is a cumulative poison (it builds up in the body over long periods of time) and is known to cause brain damage.

Thousands of chemicals are used in industry every day. When used incorrectly or inappropriately they can become health hazards. PCBs (Polychlorinated biphenyls) are resistant to fire and do not conduct electricity very well which makes them excellent materials for several industrial purposes. Rainwater can wash PCBs out of disposal areas in dumps and landfills thus contaminating water. PCBs do not break down very rapidly in the environment and thus retain their toxic characteristics. They cause long term exposure problems to both humans and wildlife. PCBs are concentrated in the kidneys and liver and thus cause damage. They cause reproductive failure in birds and mammals.

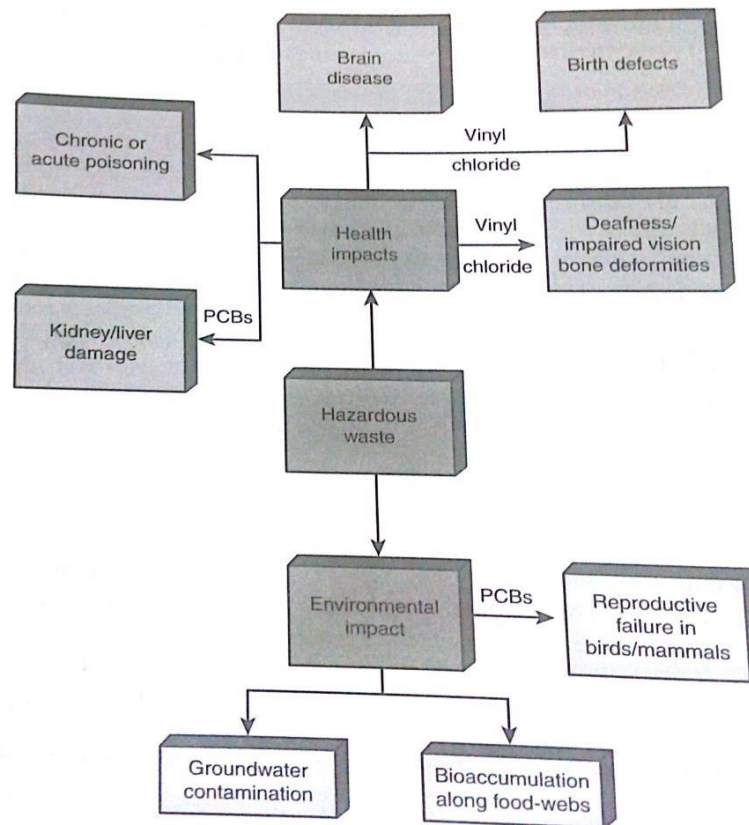


Fig. 5.15 Impact of hazardous waste

Vinyl chloride is a chemical that is widely used in the manufacture of plastic. Usually people are only exposed to high levels of vinyl chloride if they work with it or near it but exposure can also occur from vinyl chloride gas leaks. After a long continuous exposure (one to three years) in humans, vinyl chloride can cause deafness, vision problems, circulation disorders and bone deformities. Vinyl chloride can also cause birth defects.

It is essential to substitute the use of PCBs and vinyl chloride with chemicals that are less toxic. Polyvinyl chloride use can be lowered by reducing our use of plastics. Thus by reducing waste, encouraging recycling and using products that are well made and durable we can greatly reduce our consumption of these chemicals thus curtailing our exposure to these substances.

## 2.0 Role Of An Individual In Prevention Of Pollution

- Develop respect or reverence for all forms of life.
- Each individual must try to answer four basic questions:

Where do the things that I consume come from?

What do I know about the place where I live?

How am I connected to the earth and other living things?

What is my purpose and responsibility as a human being

Try to plant trees wherever you can and more importantly take care of them.

They reduce air pollution

- Reduce the use of wood and paper products wherever possible. Manufacturing paper leads to pollution and loss of forests which releases oxygen and takes up carbon dioxide. Try to recycle paper products and use recycled paper wherever possible.

From the mail you receive reuse as many envelopes that you can

Do not buy furniture, doors, window frames made from tropical hardwoods such as teak and mahogany. These are forest based

- Help in restoring a degraded area near your home or join in an afforestation program.

Use pesticides in your home only when absolutely necessary and use them in as small amounts as necessary. Some insect species help to keep a check on the populations of pest species

- Advocate organic farming by asking your grocery store to stock vegetables and fruits grown by an organic method. This will automatically help to reduce the use of pesticides.

Reduce the use of fossil fuels by either walking up a short distance using a car pool, sharing a bike or using public transport. This reduces air pollution

- Shut off the lights and fans when not needed.
- Don't use aerosols spray products and commercial room air fresheners. They damage the ozone layer.
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Reduce the use of fossil fuels by either walking up a short distance using a car pool, sharing a bike or using public transport. This reduces air pollution

- Shut off the lights and fans when not needed.
  - Don't use aerosols spray products and commercial room air fresheners. They damage the ozone layer.
- Do not pour pesticides, paints, solvents, oil or other products containing harmful chemicals down the drain or on the ground.
- Buy consumer goods that last, keep them as long as possible and have them repaired as far as possible instead of disposing them off. Such products end up in landfills that could pollute ground water.
  - Buy consumer goods in refillable glass containers instead of cans or throwaway bottles
  - Use rechargeable batteries
  - Try to avoid asking for plastic carry bags when you buy groceries or vegetables or any other items. Use your own cloth bag instead
- Use sponges and washable cloth napkins, dish towels and handkerchiefs instead of paper ones.
  - Choose items that have the least packaging or no packaging
  - Recycle all newspaper, glass, aluminum and other items accepted for recycling in your area. You might have to take a little trouble to locate such dealers
  - Set up a compost bin in your garden or terrace and use it to produce manure for your plants to reduce use of fertilizers
- Try to lobby and push for setting up garbage separation and recycling programs in your localities.
- Don't use throwaway paper and plastic plates and cups when reusable versions are available.

- Start individual or community composting or vermicomposting plants in your neighborhood and motivate people to join in.
- Do not litter the roads and surroundings just because the sweeper from the Municipal Corporation will clean it up. Take care to put trash into dustbins or bring it back home with you where it can be appropriately disposed.
- Learn about the biodiversity of your own area. Understand the natural and cultural assets. This would help you to develop a sense of pride in your city/town/village and will also help you understand the problems facing their survival..
- Take care to put into practice what you preach. Remember environment protection begins with YOU.

