Unit -IV

ENVIRONMENTAL POLLUTION

To live a healthy & normal life, a conductive environment (clear & passage) is required for all living beings (human, plants, animals etc). The un-polluted environment has a specific composition. When this composition is changed it is termed as environmentally polluted, the substance which causes pollution is called pollutants.

Environment pollution can be defined as an undesirable change in physical, chemical (or) biological characteristics of any component of environment (air, water soil etc) causing harmful effects to life " *Environment pollutions* are of following types:

- ✓ Air pollution
- ✓ Noise (sound) pollution
- ✓ Water pollution
- ✓ Thermal pollution
- ✓ Marine pollution
- ✓ Soil pollution ✓ Nuclear pollution **AIR POLLUTION:**

Atmospheric air composes of 78% N_2, 21% O_2 & remaining 1 % of gases like CO_2, CO, NO, etc. when this concentration is disturbed; it leads to air pollution & also effects man & his environment. The substances which cause pollution are gases, particulate matter or radioactive substances etc.

Gases include oxides of S (SO_2, SO_3), N (NO, NO_2, NO_3), C (CO_2, CO), volatile organic compounds etc. particulate matter includes smoke, dust, soot, fumes, aerosols, liquid droplets, pollen grains etc.
Radioactive substances include Rn^{222}, I^{131}, Sr^{90}, Pt^{239}, etc.

Classification of Air Pollutants:

Based on source & origin, pollutants are classified into: 1) primary 2) secondary

Primary Pollutants: These are directly emitted from any source. E.g.: CO, SO_2, SO_3, NO, NO_2, NO_3, radioactive substances etc.

Secondary Pollutants: These are formed by interaction of primary pollutants or with constituents of atmosphere. E.g.: PAN (Peroxy Acetyl Nitrate) Photo chemical SMOG (smoke + fog) etc.

Sources of Air Pollution (REASONS): The sources of air pollution may be
A) Natural or B) Man –made (Anthropogenic)

A) **Natural Sources**: The natural sources are volcanic eruption, fires in forests, sea salt sprays, biological decay marshes, extra terrestrial bodies, pollen grains, spores, radioactivity materials etc. B)

Man-Made (Anthropogenic): Manmade sources include thermal power plant (major sources for generating electricity, nuclear power plant without proper installation-pollutants SO_2 & fly ash), vehicular (or) auto mobile emission (another major source of air pollution which releases CO (77%), NO, NO_2 (8%), hydro carbons (14%) Diesel vehicles produce more SPM than petrol vehicles SPM (Suspended Particular Matter), fossil fuel burning, agricultural activities, fertilizers, textile mills, tanneries, refineries, chemical industries, papers & pulp mills etc.
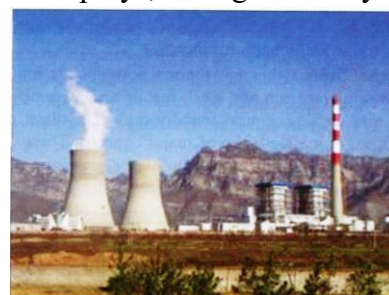

Fig. 5.1 Thermal Power Plants emit fly ash and SO_2.

Air Pollution inside the Home (Indoor)

The important indoor air pollutants is Rn. Rn gas & its radioactive daughters are responsible for lung cancer death every year. Rn is emitted from building materials like bricks, concrete, tiles etc & also present in ground water, natural gas & will be emitted while we use it.

Under developed and developing countries (INDIA) use fuels like coal, dung cakes, wood, kerosene for heating purpose. Complete combustion of these fuels produces CO_2, which doesn"t make harm. But incomplete combustion of these substances produces toxic gases such as CO, SO_2, black soot. The other pollutants

are HCHO, Benzo-(a)Pyrene(BAP) BAP is present in cigarette smoke which causes cancer. But a House wife using a wood fuel inhales BAP equivalent to 20 Packets of cigarette a day.
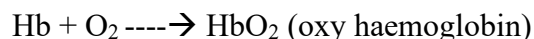
Effects of Air Pollution

Air pollution shows adverse on human, plants, animals, aquatic life & also on other materials.

1. Effects on Human Health:

Human respiratory system is very specific and so it prevents & protects from air pollution. Bigger particles (>10 μm) can be trapped by hair and sticky mucous lining in the nose. Smaller particles will be trapped by mucous present in the trancheo-bronchial system present in the lungs. These smaller particles are sent back into throat by which it can be removed by splitting (or) swallowing into mouth.

Continuous expose of air pollutants (including cigarette smoke), heavily effects these natural systems which causes cancer, asthma, chronic bronchitis, emphysema(air sacs damage) Suspended particles also cause severe damages to lung tissues and the effects are cancer, asthma, bronchitis etc. SO_2 severely affects the respiratory system that to when they combine with suspended particles forms sulphate particles, which goes deep into lung and effects severely. NO_2 also irritate lung and causes chronic bronchitis & emphysema.

Normally Haemoglobin (Hb) present in blood carry O_2 form lungs to different parts of the body.

Fig. 5.2 Lower respiratory system of human beings (a and b) and cross section of bronchial lining showing cilia and goblet cells.

$$Hb + O_2 ----\rightarrow HbO_2 \text{ (oxy haemoglobin)}$$

But CO has 210 times affinity with Hb. When CO is inhaled by the body, it combines with Hb & form carboxy haemoglobin and such that stops the transport of O_2 to all parts of the body. This causes suffocation and long exposure leads to dizziness, unconsciousness and finally death.

$$Hb + CO --------\rightarrow CO\text{-}Hb \text{ (carboxy haemoglobin)}$$
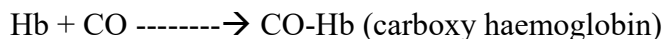
Many other pollutants like benzene, (from unleaded petrol) formaldehyde, polychlorinated biphenyls, toxic metals, dioxanes causes mutations, reproductive problems & cancer. Asbestos, Be, Hg, As, radioactive substances causes lung diseases and also affects organs like kidney, liver, spleen, brain etc.

2. Effects on Plants:

As we have lungs & sweat pores for respiration and sweating (cooling), same like that plants have stomata (leaf pores) through gases diffuses in and out. For the sake of photosynthesis the stomata will open for intake of CO_2, in addition air pollutants also enter into it and thereby affect photosynthesis.

Normally leaves have a protection layer (cuticle) made up of waxy substances which protects from dehydration, diseases, pests, frost. Some of the terms are discussed below:

Necrosis   : Damage of leaf structure (cause dead areas in leaf)

Chlorosis ` : Yellowing of leaf due to decrease in chlorophyll content

Abscission : Falling of leaves (dropping)

Epinasty   : Curling of leaves

If the pollutant settles in the stomata, reduces the function of sunlight and finally results in the death of plants.

SO_2	:	causes bleaching of leaves, chlorosis and injury of leaves
NO_2	:	abscission and suppressed growth
O_3	:	flecks on the leaf surface, primitive causing, necrosis, bleaching.
PAN	:	silvering of lower surface
Fluorides	:	epinasty, abscission and dropping of flowers

3.   Effects on aquatic life: Air pollutants mix up with rain and cause acidic nature in water bodies due to which aquatic will be affected.
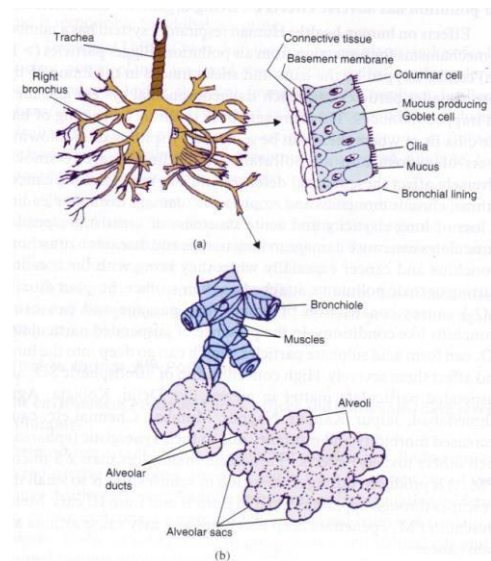
4. Effects on materials: SO_2 and moisture content causes corrosion (sulphuric acid) Due to this, buildings, vehicles, bridges, wires, metals, railway tracks are affected. H_2SO_4 damages metals and lime stone. It also affects papers and so it becomes brittle. Fabrics, leather, paints also been affected. O_3 present in atmosphere affects rubber. NO_2, NO, O_3 affects cotton and rayon fibres.

Control of Air Pollution : Air pollution can be minimised by 1)
Siting of industries after proper environmental impact.
2) By diluting the pollutants (can be achieved by increasing the height of emission of pollutants) 3)
Minimisation of activities such as transportation etc.
4) Modernisation of equipments which reduces pollution.
5) Use of appropriate materials.
6) Use of low „S" content coal. (or) „S" should be removed.
7) Removal of oxides of nitrogen.
8) Vehicles pollution check up - replacement of vehicles. Installation of catalytic converters by which it reduces CO and other pollutants.
9) Using mass transport system, bicycles etc.
10) Replacement of less polluting fuels (H_2 gas) 11) Using of nonconventional sources of energy.
12) Using of biological filters.
13) Plantation.
14) Pollution should reduce at level of source.

Reduction of Air Pollution at Source:
1) The gaseous pollutants can be adsorbed over activated charcoal, silica gel, fuller"s earth etc..., some of the gases can be adsorbed by the liquids (SO_2, adsorbed in liq.NH_3) 2) The gases are condensed and collected.
3) Combustion of pollutants at optimum O_2 and temperature.
4) Many devices are there to control pollution but it is based on flow, rate costs etc.
5) Cyclones: It has cylinders with inverted cone attached at bottom. It has inlet and outlet. The polluted gas is sent tangentially and so due to centrifugal force rotation, the particles (large size) gets deposited in the hopper (down) due to gravity leaving the pure gas outside. However small particles which cause harm to the human cannot be removed by this method.
6) Bag house filters: It consist of filter bags made up of fabrics but are expensive. These bags are hanged in which the polluted gas is passed through, the particles (even smaller ones, can be filtered) filtered leaving the purified gas. Then by shaking the bags the left out substance can be removed. These cannot be operated for moist gases and also some corrosive gases which may affect the life of the filter bags

7) Wet scrubber: The gasses are passed in the chambers in which water is sprayed at the top such that particulate matter (being) made wet. So, the wet particles leave from the top. This wet scrubber also removes toxic and acidic gasses also

8. Electrostatic Precipitators: It consist of electrode (cathode and anode), wires which are attached to each other. The polluted gas is passed through by applying voltage, the dust particles get negatively charged and so attracted by positive electrode and there by removed by cleaning with liquids or scrubbing and the purified gas leaves through outlet.
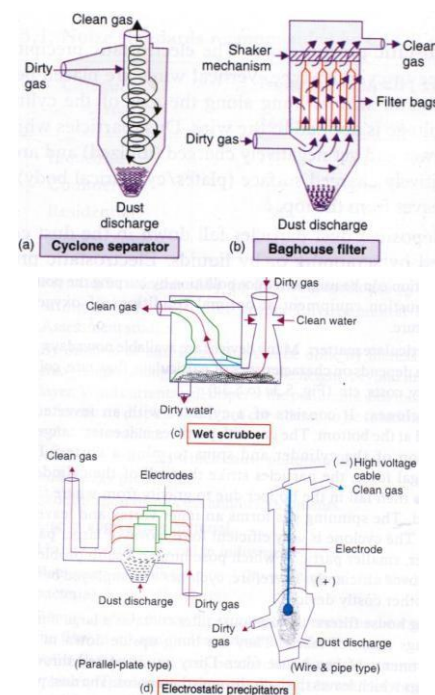
Fig. 5.3 Devices for control of particulate matter.

2. NOISE POLLUTION:

We hear different types of sounds every day. Sound is a mechanical energy. Some sort of sound may be pleasant to someone but may not be pleasant to others so the unpleasant and unwanted sound is called "noise". Sound propagates through air, liquid, solid, etc. Sound is the waves that comprises of compression and rare fractions. The number of compressions and rare fractions per unit time is called frequency, and it is expressed in Hz (hertz) and also called number of cycles per second.

Human can hear wide range of sound pressure. High sound pressure cannot create linear response to human ear. Noise measurement are expressed as sound pressure level (SPL), it is expressed in dB (decibel) The average threshold for a healthy ear is 2×10^{-5} pa. dB is the measure of loudness and frequency.   The central pollution control board (CPCB) recommended permissible levels For different locations as follows:

Area	Category	Noise level in dB	
		day	night
A	Industry	75	70
B	Commercial	65	55
C	Residential	55	45
D	Silent zone	50	40

Different sounds and their loudness :

Source of sound	Sound level(dB)
Rocket engine	160-180
Jet plane take of	140-150
Max. recorded rocket music	130
Thunder cap	120
Auto-horn 1m away	110
Jet fly over at 300m	100
Motor cycle 8m away	80-90
Vacuum cleaner	70
Ac unit 6m away, 30m away,traffic noise	60
Avg. Living room	40-50
Library, Soft whisper	30
Broad casting studio	20
Rusting leaf	10

Note: Threshold of pain (140) / Threshold of hearing(0) <u>Source of noise pollution</u>:

The main sources are transportation (automobiles, rails), industries, celebrations (social /religious), electric home appliances etc. The high level of noise have been recorded in some of the cities of the world

Nanjing (china)	-	150 dB
Rome	-	90 dB
New York	-	88 dB
Mumbai	-	82 dB
Delhi	-	80 dB
Calcutta	-	85 dB

Kathmandu   -   75 dB   **Effects of Noise Pollution:**

i) **Interferes with man's communication:** In a noisy area communication is severely affected. ii) **Hearing damage:** Noise can cause temporary (or) permanent damage of hearing based on intensity & duration of sound

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level. **iii) Physiological & psychological change:** Continuous expose to noise affects the various functions & systems of the body. The effects are hypertension, insomnia (sleeplessness), gastro-intestinal & digestive disorder, ulcer, BP, emotional changes.

Noise Pollution during Diwali:

Diwali is one of the major festivals in India. Fire crackers are burnt for fun and traditional. The noises generated by burning of crackers are beyond 125dB (but as per rules of Environmental (protection) rules, 1999 should not exceed 125dB) After the sound measurements made in various place during Diwali, it is recommended that fireworks should maintain the noise levels of crackers in dB.

According to recent test report on fire crackers produced by the national physical laboratory. New Delhi stated that most of the crackers produce noise beyond 125dB. Some of them are even near the threshold of Pain.

TYPE OF CRACKER	NOISE
Atom bomb (timing)	133-137
Chinese cracker (1000 wala, 600 wala)	128,132
Nazi (atom bomb)	135
Magic formula (flower bomb)	134-137
Atom bomb (foiled)	129-133
Hydrogen (bomb)	132-136
Rajan classic (dhamaka)	136
Hydro foiled	130-134
Three sound	112-126
Atom bomb (local)	136

The noise levels are measured under standard conditions i.e., in areas not having noise reflects. In addition of mentioning the permissible levels in crackers, we have to educate people about harmful effect of such noises. This may be achieved through mass media (newspaper & electronic)

Honourable Supreme Court, governments" amended rule 89 of environmental (protection) rules, 1986 passed the following directions:

1) The use of fire crackers generating more than 125dB-145dB shall be prohibited. For serial crackers, the noise should not exceed by 5 log10 (N) dB. N = no. of crackers in series

2) Use of fire crackers should be permitted except 6-10pm and prohibited during 10-6am

3) Fire crackers should not be used nearly (100m) silent zone such as hospitals, institution, courts, government offices etc.

4) The governments should take measures to educate students about the effects of air & noise pollution as a result of burning fire crackers.

Control of Noise Pollution:

1) *Reduction In Source of Noise*:Heavy hold vehicles should not be permitted in densely populated areas.

2) Noise producing machines is placed in such a room that, it should absorb the noise.

3) Necessary caution should be taken to reduce friction (oiling, grease) 4) *Use of Silencers*: Silencers reduces the sound pollution 5) Plantation

6) *Through Law*: Various legal actions should be taken over the noise pollution. Unnecessary horn should not be blown.

WATER POLLUTION:

The physical, chemical and biological changes of water are termed as water pollution, which makes unfit for use.

Sources of Water Pollution: Water is essential for survival of the life. It is used for different purposes like drinking, cooking, bathing, washing, irrigation, industries, etc, and sources are from rivers, lakes, ground water. As water is a universal solvent, most of the substances dissolve in it and it is the reason for water pollution. Pollution of water may be point sources (or) non point sources. Point sources are a specific site which discharges effluents into them; they are industries, power plants, underground coalmines, offshore oil wells etc. The non point sources are run-off

agricultural fields, small drains, rain water, sweeping roads and fields etc, these scatters the particles which pollute the water.

Ground Water Pollution:

6.2% of water is available as ground water (~30times of surface water) Ground water is less subjected to pollution because various contaminants are retained in soil itself. However ground water is polluted due to sceptic tanks, industries (textiles, chemicals), deep well injection, mining etc. Ground water is also polluted by As, F^-, NO_3^- (which causes serious health hazards)

Fig. 5.4 Sewage discharged in Ganga is polluting the river.

Surface water pollution: The major sources are

a) **Sewage:** Due to sewage, surface water is polluted and this is severe in cities.

b) **Industrial Effluents:** Industrial wastes such as toxic chemicals, acids, bases, salts, phenols, cyanides, ammonia, and radioactive substances etc, causes water pollution. It also increases temperature of water bodies and affects the survivals of the species.

c) **Synthetic detergents:** Detergents and soaps used for cleaning which pollutes water.

d) **Agro chemicals:** Fertilizers (NO_3^-, PO_3^{2-}), pesticides (insecticides, fungicides, herbicides) washed by rain water and surface runoff and thereby pollutes water.

e) **Oils:** Oils can be spilled during drilling and shipping which pollutes water.

Effects of water pollution: The main effects are

i) **Oxygen demanding wastes:** There will be a certain amount of oxygen dissolved in water called dissolved oxygen (DO) The amount DO depends on aeration, photosynthetic activity of plants in water, respiration of aquatic life, temperature, pressure etc. The optimum level of DO for survival of aquatic life is 8-15mg/l.

Fishes – 5-8mg/l, carp-3mg/l.

If the organic wastes reach the water bodies, it is oxidised by the micro organisms present in the water. For the oxidation process some amount of DO is utilised, which decreases the DO level of water and thereby affecting the aquatic life and it also releases PO_4^{2-} which causes eutrophication.

ii) **N & P compounds**: If nutrients like N & P are added to the water bodies, plants and algae will grow fast and die soon. After that those are subjected to oxidation which consumes O_2 in addition some foul smelling gases are produced and also changes the concentration of O_2 (which also affects P^H of water)

iii) **Pathogens:** Many waste water (sewages) contain many diseases causing micro-organisms such as bacteria, virus etc. Cholera dysentery, typhoid, jaundices are water born diseases.

iv) **Toxic compounds:** Pollutants such as heavy metals, pesticides, cyanides, organic and inorganic compounds effects aquatic life. The pesticides, methyl mercury etc, gets into bodies of organisms present in water. The toxic substances polluting the water ultimately affect the human health. Substances like DDT are in soluble in water and so get accumulated in lipids of the body called "Bio accumulation". We known the food chain i.e., successive levels of food chains. (zoo plankon   small fish   human)The toxic substances increases from lower to higher level of food chain known as "bio magnification".

Eg: water → zoo plankton → minnows → needle fish → birds

DDT(ppm)0.000001   0.01   0.1   1.0   10

Some heavy metals like Pb, Hg, Cd cause various diseases. Hg in water is converted into CH_3Hg by bacteria this CH_3Hg accumulates in fish. In 1953 people of Japan suffered from numbness of body parts, vision, hearing problem, mental retardness (This disease is called minamata disease occurred due to consumption of fish containing CH_3Hg), due to this disease 50 dead and 700 subjected to paralysis.

➢ Cd caused a disease called ITAI-ITAI in people of Japan; this is due to Cd contaminated rice. The rice fields are irrigated with effluents from mines. Due to this disease bones, liver, kidney, lungs, pancreas, thyroid are affected.

➢ „As" pollution of ground water causes various abnormalities (mostly seen in Bangladesh and West Bengal)

- Increase in nitrate content of drinking water causes blue baby syndrome or methaemoglobinemia. This disease is due to conversion of haemoglobin to non-functional. Nitrates in stomach converted into nitrites which produce cancer causing products.
- Excess of fluorides in drinking water affects teeth & bones (Ca), called Fluorosis.
- Pesticides in drinking water reach finally to humans & cause various problems. So DDT, aldrin, dieldrin, etc, are banned. Recently in AP many suffered from various problems caused due to consumption of cashew contaminated with endosulphan.

Biological oxygen demand (BOD): The amount of biodegradable organic matter is expressed In terms of BOD. The DO is utilised for the oxidation of organic matter present in water.

"The amount of DO required to decompose biodegradable organic matter of a given volume over a period of 5 days at 20 ℃."

More BOD values, less the quality of water. So, from BOD values quality of water can be estimated. **Control of water pollution:** Normally it is easy to reduce water pollution at a point source, but due to absence of proper legislation it becomes difficult. So water pollution can be prevented from non point sources

- Agrochemicals like pesticides and fertilizers uses should be optimised and should not use on slope lands, which finally reaches run offs.
- Substitution of N_2 fixing bacteria instead of use of fertilizers.
- Adaptation of integrated pest management.
- Prevention of run-off. These should be diverted for basin settlement. These fertilizers rich matter used for another fields.
- Separate drainage system should be provided.
- Plantation.

From the point source, water is subjected to treatment before the disposal.

The technical terms (or) parameters are
1) Total solids
2) BOD and COD (Chemical Oxygen Demand)
3) Nitrates and Phosphates.
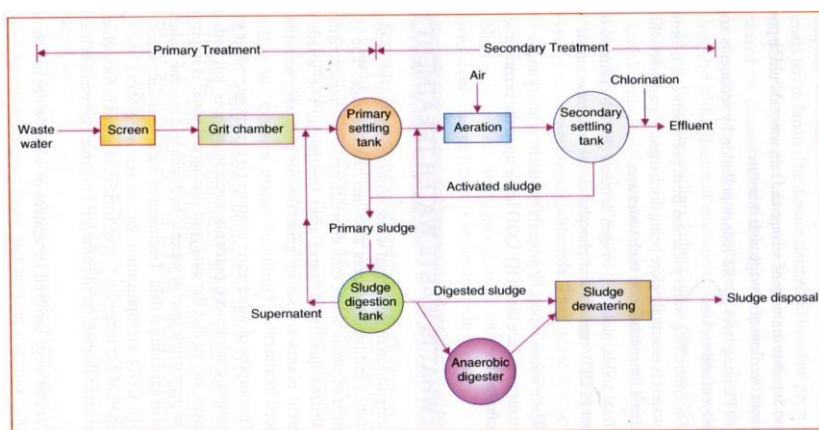4) Oil and greases.
5) Toxic metals etc.

Fig. 5.5 Flow diagram of sewage (waste water) treatment plant.

Waste water treatment: Municipal waste water composition varies from place to place and sometimes industrial wastes also mix with it. The treatment depends upon the characteristics and usage of water after treatment. They are **primary, secondary** and **advanced** treatment. The purpose of waste water treatment is to remove (or) reduce organic and inorganic substance, nutrients, toxic substance, etc. So after the treatment, quality of water is increased with reduction of BOD, COD, Eutropication etc. Due to this biomagnifications is also prevented.

Primary treatment: It is physical process in which debris, large particles are removed by screening and passed through grit chamber, where sand, grit and other solids are settled down. Then waste is passed to sedimentation tank for the removal of suspended particles by gravity. About 35% BOD particles & 60% suspended solids are removed by primary treatment. Polymers remove suspended particles effectively.

Secondary treatment: It is the biological process in which micro organisms are used & remove upto 90% BOD & 90% of suspended particles. Various methods are used for this purpose.

a)   Trickling filters: This consists of a bed of crushed stones or pebbles covered with slime (contain bacteria, algae, fungi, protozoa, worms) When we pass the primary treated water through this, the organic matter present in it are oxidised & removed. Sometimes it may be recycled for better removal.

Fig. 5.6 Cross section of a trickling filter.
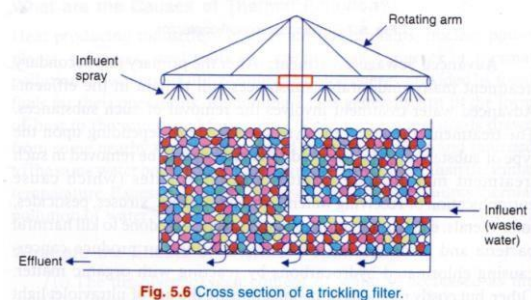
b)   Activated sludge process: After the primary treatment the water goes into a certain tank which contains micro organisms and receives air for maintaining aerobic conditions. After few hours of agitation, the water is passed to settling tank in which solids are settled leaving the water behind. The sludge which is settled is disposed. This treated water can be used for crop lands etc.

c)   Rotating Biological Contacts (RBC): It consists of circular plastic discs arranged on rotating shaft. Micro organisms are grown on the discs which are inserted in the water 40% and remaining 60% subjected to aeration. As the discs rotates in the water absorbs organic matter and receives air when out of the water. By this method organic matter is removed efficiently.

Fig. 5.7 Rotating biological contactor.
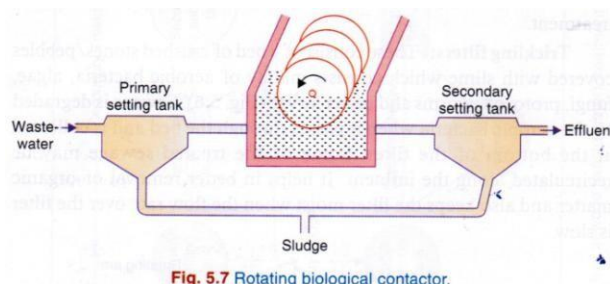
d)   Advanced sewage treatment: After the primary and secondary treatment, if any undesirable substances are still remained in the effluent, then it is subjected to advanced treatment but it depends upon the types of the substances to be removed. The substances to be removed may be nitrates, phosphates, bacteria, viruses, pesticides, toxic metals etc.

Chlorination of water is generally done to kill micro organisms, however chlorine reacts with organic matter and produces chlorinated hydrocarbons which causes cancer. For this alternate method is Ultra Violet & Ozone treatment is there, but its costly. The sludges which are obtained after the treatment are used as fertilizers.

Upflow Anaerobic Sludge Blanket (UASB) Reactor: As it is the effective method, it is gaining important for the treatment of waste water. This method consists of four stages of anaerobic digestion A) Hydrolysis, B) Hydrogenesis, C) Acetogenesis, D) Methanogenesis.
The waste water to be treated is fed into the reactor at the bottom and enters into the chamber followed by the four stages listed above. The influents are converted into CH_4, CO_2, H_2, acetate, new cell matter etc. By this method 80% COD wastes are removed. Biogas (CH_4) & CO_2 produced are separated.

THERMAL POLLUTION

It is defined as waste heat which causes undesirable changes in the natural environment.

Causes of thermal pollution:
Industries, thermal power plants, nuclear power plants, refineries, steel mills etc, are the sources of thermal pollution. The efficiency of power plants are 33% i.e., 66% of energy is converted into waste heat energy. Coolers are maintained for the reduction of heat in which water are circulated. For this purpose water is taken from the nearby water bodies and the heated water is returned to the same which increases temperature of the water bodies. This causes thermal pollution.
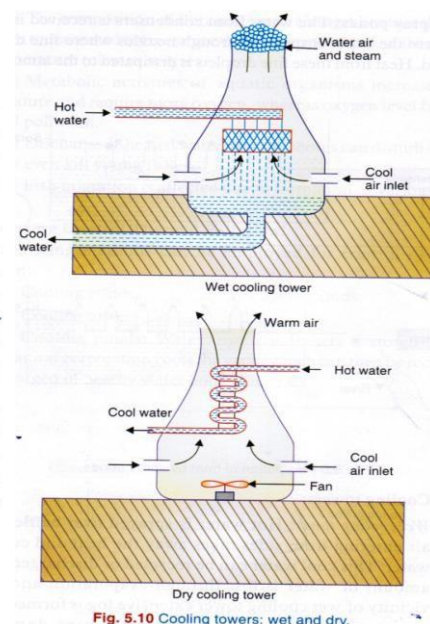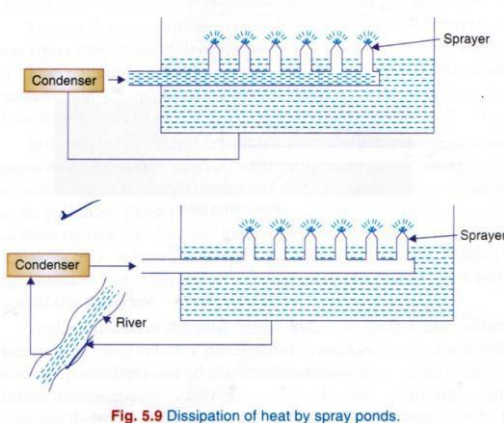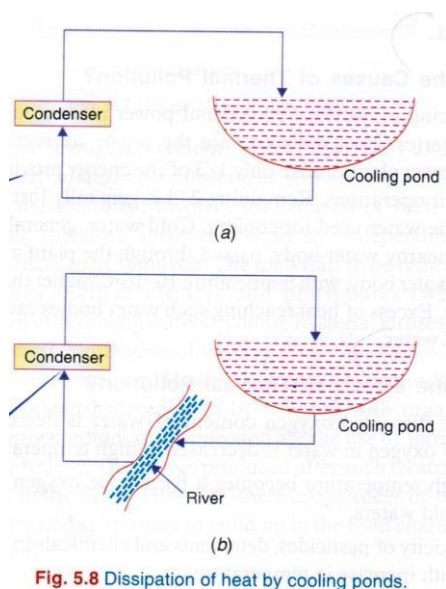
Effects of thermal pollution:
- Due to increase in temperature of water bodies, Dissolved Oxygen (DO) level is decreased.
- High temperature acts as barrier for the penetration of O_2 into deeper parts.

- The levels of toxicity, pesticides, fungicides, detergents increase with increase in temperature.
- With increase in temperature, metabolic activities also increases which finally decreases the DO levels.
- At high temperature flora and fauna gets disturbed and some species may die.
- Aquatic life like fishes are subjected to death due to discharge of heat (treated) water.
- Migration of fishes is affected.

Control of thermal pollution:

1. **Cooling ponds:** The hot water is stored in the ponds. The natural evaporation process cools the water after the recycling process i.e., through rains they come back into earth.
2. **Spray ponds:** The hot water is sent to spray ponds where water is sprayed into the atmosphere through nozzles. When small droplets are formed, the temperature is reduced.
3. **Cooling towers:**
   - ➢ **Wet cooling water:** The hot water is passed through an inlet of wet cooling tower and cool air is passed over it. Cool air removes the heat and also excessive water loss also takes place due to which fog is formed which is a pollutant to the atmosphere.
   - ➢ **Dry cooling tower:** The heated water is passed through an inlet of dry cooling tower and dry air passed over it with help of rotation of fans. This dry air removes heat without water loss but very costly when compared to the wet cooling tower method.

Fig. 5.8 Dissipation of heat by cooling ponds.

Fig. 5.9 Dissipation of heat by spray ponds.

Fig. 5.10 Cooling towers: wet and dry.

MARINE POLLUTION:

☐ The marine sources are   a) Rivers.
b) Catchment area (Agriculture, Industries)
c) Oil drilling & shipment.
d) Leakage of toxic substances, radioactive wastes, etc.

 Most of the rivers ultimately join the oceans finally. The pollutants which are present in the rivers are carried to oceans. The pollutants include sewage sludge, industrials effluents, synthetic detergents, agrochemicals, solid wastes, plastics, metals, waste heat released in industries when these pollutants reaches seas & oceans they becomes diluted and broken down further. Some remains unchanged and some may get biomagnified and affects fisheries & other marine aquatic life.

Tankers & other transportation (ships used for petroleum, refineries, metal industry, paint industry etc) when subjected to accidents leads to marine pollution. During transportation of tankers, the oil is mixed with water and so causes the pollution. (Ballast water to maintain water balance) If oil is dispersed into sea, it spreads to large area and gets adsorbed on sediments.

EFFECTS OF MARINE POLLUTION:

1) Oil in sea water affects flora & fauna.
2) Phytoplankton, zooplankton, algal species, invertebrates, coral reefs, fishes, birds, mammals are affected by oil pollution.
3) Oil disturbs the insulating capacity & also effects mucus layer of the gills of fishes & so leads to death.
4) Due to oil in seas, the buoyancy decreases, due to which birds are drowned.

DISASTERS

1) In Alaska (1989) -3,90,000 of birds dead due to leakage from oil tankers.
2) In France (1978)-20,000 birds dead due to 220 tonnes spillage of oil 3) In Germany (1955)-5,00,000 birds died.
4) During Gulf war (1991) 200 million gallons of oil is spilled which badly affected marine ecosystem.

Control of marine pollution

1) After treatment only the effluents should be discharged to the rivers.
2) Prevention of run- off from non point sources.
3) Separate drainage system has to be provided.
4) Dumping of toxic, hazardous, sewage sludge should be banned.
5) The coastal area should be reserved.
6) Oil ballast should not be dumped into sea.
7) Sensitive coastal areas should be protected by banning drilling activities.

SOIL POLLUTION: (Soil is the upper layer of earth in which organic matter is made available for living matter).
The main sources of soil pollution are: Dumping of various types of materials like **Domestic** and **Industrial wastes**.

Domestic wastes: Garbage, glass, plastics, metallic cones, paper fibres, cloth rags, containers, paints, varnishes etc. Leaches are harmful and toxic, which pollute the soil.

Industrial wastes: Effluents from chemical industries, paper, pulp mills, tanneries, textile mills, steel industries, refineries, pesticides and fertilizers industries, pharmaceuticals, cement industries, food industries, thermal and nuclear power plants, mining etc. (Thermal power plants produce fly ash in huge quantities, which are dumped into the soil)

Industrial wastes may contain same organic and inorganic compounds that are nonbiodegradable. Industrial effluents may contain toxic substances like Hg, Pd, Pb, As etc.

Agro chemicals (pesticides and fertilizers) are used for crops. But they ultimately reach the soil and pertain for a long time, due to which the soil is affected. Eg: DDT, HCHO, Endrin, Lindane, Heptachlor, Endosulphan, etc.

The excreta of animals and human are dumped into the soil. The sewage are also dumped into the soil consists of the disease causing organisms like bacteria, viruses, worms etc.

The explosion of radioactive (substances) devices, discharge of wastes from industries and labs pollute the soil. The radioactive isotopes persist in soil for a long time. Eg : Isotopes of Ra, U, Th, Sr, I_2, Cs etc.

Effects of soil pollution

1) It affects the human (by accumulation in food chain)
2) Various chemicals (acids, pesticides, heavy metals etc.) affects (fertility) of soil by the changes in physical, chemical, biological properties.

3) Death of non target organisms due to persistent toxic chemicals.
4) Diseases due to pathogens (bacteria, caused viruses etc)
5) Vegetation is also affected due to radio isotopes (ground water is also affected) 6) Sr^{90} gets deposited in place of Ca & causes brittleness in bones & teeth.

7) N, P, K fertilizers reaches water bodies and causes eutrophication.
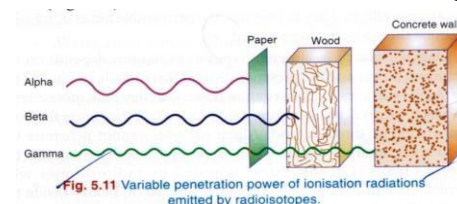
Control of soil pollution
1) Treatment of effluents before disposal.
2) Solid wastes should be properly collected & disposed.
3) Recovery of wastes should be done.
4) Organic wastes & cattle dung are used for biogas production.
5) Microbial degradation technique is introduced (eco friendly).

NUCLEAR HAZARDS:
Radioactive substances are Present in nature; they undergo natural decay when bombarded with fast moving particles. They release energy in the form of α, β, Υ particles.

α : fast moving; positive –do not penetrate into paper

β : fast moving; negative-do not penetrate into wood ("Al" sheet) Υ

Fig. 5.11 Variable penetration power of ionisation radiations emitted by radioisotopes.

rays –do not penetrate concrete wall **Sources of radio activity:** *The sources are:*
1) Natural sources: - This include cosmic rays (from outer space), Rn^{222}, soil, rocks, air, water, food etc, which contain radioactive substances.
2) Anthropogenic sources: - This includes nuclear power plants, nuclear accidents, x-rays, test laboratories etc, where radioactive substances are used.

Effects of Radiations: Radiations causes harmful changes in the body cells and also at gene level.
1) Genetic damage: Due to radiations, mutations takes place in DNA, thereby causes damage to offspring"s and several generations are affected.
2) Somatic damages: This includes burns, miscarriages, eye cataract, bone cancer, thyroid, breasts, lungs and skin damages.

These adverse effects are observed when it crosses threshold level but for short duration radiations are not affected that much. The damages of different radiations depend on the penetration power. α-particles does not penetrate more than that of β, so α particles do not penetrate into skin but β penetrates and damages internal organs. During mining of "U" radio isotope enters into crust of earth and affect the crops grown there, water bodies and ultimately humans. I^{131} accumulates in thyroid and causes cancer.

Control of nuclear pollution:
1) Check regularly the nuclear power plants.
2) Lab waste should be disposed properly where isotopes are used.

Solid waste management:
With increase in population, there is increase in amount of waste generated also. If the waste generate crosses the threshold limit level, it causes very harm to the life. So we have to manage the waste that is produced. The wastes are grouped into solid, liquid and gases.

Solid wastes are Domestic waste, municipal waste, Bio-medical wastes mining wastes, Agricultural wastes, sewage etc. The sources of above Urban and Industrial wastes are:

Urban wastes:-
✓ **Wastes from homes and shops (Domestic and municipal wastes):** It contains variety of discarded material like polythene bags, metal cans, glass bottles, waste paper, cloths, package materials, shells etc.
✓ **Biomedical wastes:** This includes anatomical wastes, pathological wastes, infectious wastes etc.

- ✓ **Construction & mining wastes:-**This includes debris, rubbles, wood, concrete, heavy metals, „S" etc.
- ✓ **Agricultural- (wastes from horticulture & slaughter houses):** This includes vegetable pants, remains of slaughter animals, pesticides, fertilizers etc.

The urban solid wastes are categorised into two:

i)   Biodegradable:- This wastes can be degraded by micro organisms eg: Vegetable wastes, stale, food, shells, tea leaves, etc.

ii)   Non-Biodegradable:- These wastes cannot be degraded by micro organisms eg: Polythene bags, scrap metals, glass bottles, etc
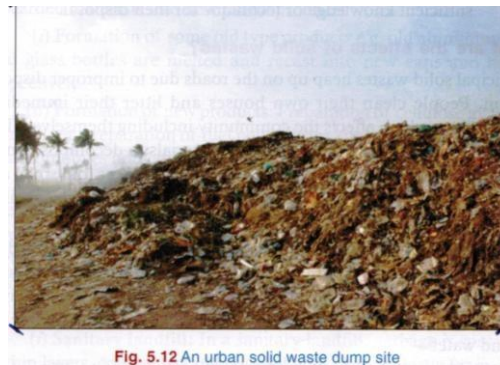

Fig. 5.12 An urban solid waste dump site

Industrial wastes:

This includes large number of materials like packing materials, organic wastes, acids, etc. Sometimes toxic & hazardous substances are released. The wastes from different industries like chemical, metal & mineral processing industries are harmful. Nuclear power plants release radioactive materials (wastes), thermal power plants produce fly ash in large quantities.

Solid wastes from different industries like rubber, plastics, paper, glass, wood, oils, paints, tars, dyes, scrap leather, abrasives, asbestos, batteries etc, are produced. In Europe and North America the laws are stringent against the disposal of wastes. So, they export the wastes to other developing countries which do not even have sufficient knowledge instead of treatment.

Effects of solid wastes:

Municipal solid wastes & home wastes after cleaning is dumped into the surrounding environment, which heaps the roads due to the improper disposal. If wastes consist of biodegradable in the surrounding environment, it is degraded by the microorganisms which produce the foul smell, infectious diseases, etc.

The industrial wastes of toxic metals, hazards substances spread on land and causes physio-chemical changes, which decreases the fertility of the soil. Finally they pollute the ground water also. Sometimes hazardous materials are mixed with garbage, combustible wastes which causes difficult in the disposal. Pesticides, solvents, radioactive materials mixed with papers and other non-toxic materials. Burning of these materials produce dioxans, polychlorinated biphenyls, etc, which causes cancer.

Management of solid waste:

Control measure for reduce wastes, solid waste management includes, Reduce, Reuse, Recycle (3R"s) before disposal.

I.   **Reduction involve of raw materials:** Use of Raw materials depends on waste production. If the amount of raw materials is decreased, the waste production is also decreased.

II. **Reuse of waste materials:** The refillable containers can be reused. Villagers make casseroles and silos from waste paper, etc. Rubbers are made from discarded cycle tubes. These are done due to financial constraints.

III. **Recycling of materials:** The discharged materials are recycled to form new products.

    a) **Formation of some old type products:** Old „Al" cans & glass bottles are melted and recast into new cans & bottles.

    b) **Formation of new products:** This includes preparation of cellulose from paper, preparation of fuel pellets from kitchen waste. From steel cans, automobile & construction materials are prepared.

      The process of Reducing, Reusing, Recycling save money, energy, raw materials & and also reduces pollution. eg: recycling of papers –reduces cutting of trees. And reuse of metals – reduce mining activities.

The following methods are preferred for discarding wastes:

i. Sanitary land fill:
In this type of landfill bottom is covered with impermeable liner (several layers of clay, plastics & sand), this layer protects ground water from contamination. When the garbage is full, this is covered with clay sand, gravel, etc. Due to this bottom & top protection layer, the surroundings are not contaminated. The methane produced as a result of anaerobic decomposition of wastes is utilised as fuel. **ii. Compositing :**
As there are no landfills in cities the bio degradable wastes are decomposed in oxygen rich medium which creates nutrient rich environment, which improves the fertility of soil. **iii. Incineration:**
Burning of large amount of materials in the burning plants is called incineration the burning plants are called incinerators.

Effects due to incineration:

- During incineration high amount of dioxanes, furans, lead, cadmium, fly ash are emitted into the environment.
- To avoid above toxic pollutants the materials should be pre-treated i.e., have to remove plastic & heavy metals.

Role of on individual in prevention of pollution: Everyone has to contribute their own dedication for the control of pollution, because every individual is responsible for the pollution. If each one takes part in the prevention of pollution will have great result in the global level. "Think globally act locally" Everyone has to take following measures for reducing environmental pollution.

- Prevention is better than control; we should be in a position to prevent.
- Use eco friendly products.
- Reduction in use of CFC"s (Chloro Fluoro Carbons)
- Should ban polystyrene cups having CFC"s which destroys the ozone layer.
- Use refrigeration with no CFC"s.
- Chemicals from peaches & plums are used to clean chips & circuit of systems instead of CFC"s.
- The devices which do not pollute environment should be used instead of polluting devices inspite of cost.
- Reduce dependency on fossil fuels, use H_2 fuels.
- Save power, save nation (electricity).
- Use of renewable resources.
- Should increase energy efficiency.
- Reduce, Reuse and Recycle of wastes.
- Mass transport systems (one bus instead 10 cars) ☐ Optimum level of pesticides should be used.
- Use of rechargeable batteries.
- Use of less hazards chemicals (vinegar, baking soda, borax)
- Do not litter polythene bags, which affect different animals like cows, etc. ☐ Use of phosphate free – detergents, shampoos, etc (eutrophication) ☐ Use of organic manure of fertilizers.
- Optimum level of wastes should be used.
- Reduce deforestation instead plant trees which reduces CO_2 etc.
- Over population should be controlled.

Pollution case studies: A series of air pollution disasters have occurred in the past 75 years.
Donara air pollution disaster: Donara is small town in USA in which steel mill, Zn, H_2SO_4 etc are situated, more it is adjacent to that of Manongala River (which is horse shoe shaped with hills on all sides). More over due to anticyclone air conditions, there was no air movement. So, fog is formed as a result of cold air accumulation at the

bottom of river, which is persisted for 4 consecutive days (cold air which is trapped below warm layer is called inversion). Due to this the deadly pollutants emitted by steel mill, „Zn‟ smelter, H_2SO_4 plants got trapped, concentrated and remained for 4 days. As a result 6000 towns, 14000 inhabitants fell ill and 20 of them died. **Bhopal Gas Tragedy:** This is the world‟s worst accident that occurred on early hours of 3rd December 1984 in Bhopal. Union Carbide Factory synthesises a pesticide namely Methyl Iso-Cyanate (MIC). Accidently reaction mixture got over heated by the entry of water, so it exploded and eventually no safety devices are in working condition, due to which 40 tons of MIC leaked into atmosphere (contains 40 Kg Phosgene). MIC even at low concentration affects skin, lungs and eyes. But high concentration removes O_2 from lungs and causes death. About 5100 persons were killed, of which 2600 due to direct exposure and 2500 due to effects of exposure. About 65000 people were affected by different disorders & 1000 became blind. Totally ($ 570 million) spent to clean up and settle.

Note: This tragedy can be prevented by safety measures, which costs $ 1 million.

Love Canal Tragedy: This occurred in a suburb of Niagara Falls, New York. Love Canal was built by William Love. The wastes from Hooker chemicals & Plastics Corporation were dumped into it during 1942-53, but later it was covered with clay and top soil and sold to City Board of Education, which built an elementary school. Houses also built near the school and started complaining about the foul smell (due to leakage from corroded steel containers containing chemicals). About 26 organic compounds were identified. The wastes are pumped out for treatment and families were relocated.

Arsenic pollution in ground water:

The toxic heavy metal Arsenic is contaminated in West Bengal & Bangladesh (1978 & 1993). Due to continuous exposure (nearly for 10-15 years) white or black spots are formed known as melanosis. Later stages spots are converted to leprosy like skin lesions, encrusting the palms and soles etc. Long exposure affects bladder and causes lung cancer. Children are more affected to arsenicosis. If they are affected from arsenicosis, they are isolated from schools, Women remains single (by broken marriage). In west Bengal 40 out of 90 million are exposed to arsenic threat.

WHO prescribed the max permissible limits of arsenic as 10 mg/L. Earlier Arsenic entered into ground water by Ganga delta, but now days these arsenic pollution is due to man. The main source is excessive usage of Lead Arsenate & Copper Arsenite pesticides. To differentiate Arsenic contaminated tube wells painted red while safe tube wells green.

Chernobyl nuclear disaster: This worst nuclear disaster in human life took place at Chernobyl, Ukraine(USSR) This nuclear plant produces 1000 MW electrical energy. On 25th April 1986, it is shut down for repairs. All top executives were busy for May Day. Anyhow plant was switched-on at 1:23hr on April 26, 1986, due to faulty operation it is exploded. After explosion the temperature suit up to 2000 degree centigrade, volcanic cloud of molten mass is formed. The gases spread over most of northern atmosphere, Poland, Denmark, Sweden, Norway, (which were affected).

On the first day of accident 31 persons died and 239 people were hospitalised. Since the plume was rich in I^{131}, Cs^{134}, Cs^{137}, people was feared that they would be affected from cancer (thyroid, leukaemia). I^{131} is contaminated in milk products by which children are affected. Totally 2000 people died and many suffered from skin lashes, loss of hair, nausea, anaemia, (blood abnormalities, haemorrhage), eye diseases, reproductive failure etc.

This disaster caused damage to agriculture, several fields, trees, shrubs, plants etc, are damaged. However nuclear energy is cheap and non-polluting but improper management causes disasters.

Pollution problem areas of India as identified by CPCB

S. No.	Name	State/U.T.
1.	Bhadravati	Karnataka
2.	Chembur	Maharashtra
3.	Digboi	Assam
4.	Dhanbad	Bihar
5.	Durgapur	W.B.
6.	Govindgarh	Punjab
7.	Greater Cochin	Kerala
8.	Howrah	W.B.
9.	Jodhpur	Rajasthan
10.	Kala-Amb	H.P.
11.	Korba	M.P.
12.	Manali	T.N.
13.	Nagda-Ratlam	M.P.
14.	Najafgarh Drain Basin	Delhi
15.	North Arcot	T.N.
16.	Pali	Rajasthan
17.	Parwanoo	H.P.
18.	Patancheru-Bollaram	A.P.
19.	Singrauli	U.P.
20.	Talcher	Orissa
21.	Vapi	Gujarat
22.	Vishakhapatnam	A.P.
23.	Tarapur	Maharashtra
24.	Ankleshwar	Gujarat

(Contd.)

Source: Annual Report CPCB, 2002-2003.

Disaster management:

Some natural accidents take place in the environment such as earth quakes, volcanoes, flood, landslides etc, which affects the human life. We human beings are affected and only the witness for such activities.

Earth quakes: Sudden movements of earth's crust leads to earth quakes. The earth's crust has several tectonic plates of solid rock which normally moves along their boundaries, when some external force (or) friction is acted on it & it stops moving. As a result, stress is developed due to which fractures are occurred causing earth quakes. The point of the fault is known as epicentre.

Earth quakes are measured in Richter scale:

Value (Richter scale)	level of earth quake
4	Insignificant
4-4.9	Minors
5-5.9	Damaging
6-6.9	Destructive
7-7.9	Major
7-8	Great

➢ The largest earth quake recorded in Chile (9.5 on Richter scale) on may 22 1960, which affected 90000 sq. km & killed 6000 people.

➢ In India, the massive earth quake took place at Bhuj town, Gujarat, which killed 20-30,000 people. (Severity of earth quake is equal to 5.3 mega ton hydrogen bomb)

➢ In china 8, 30,000 people killed in 1556 due to tsunami. The earth quakes are due to anthropogenic activities.

Some of the manmade activities causing earth quakes are: i) Confined to a lake behind a dam.

ii) Underground nuclear testing.

iii) Disposal of liquid water in deep water bodies.

Preventive measures for earth quakes:

1) By constructing earth quake resistant building in earth quake prone zones.

2) Some sort of structures is placed in the building such that it can absorb the vibrations. 3) Construction of wooden houses (Japan).

Case study: 2004 Asian tsunami (Indian Ocean earth quake)

This occurred on December 26, 2004 & it is one of the deadliest disasters in modern history known as Asian tsunami (also known as Boxing Day tsunami as it occurred on Boxing Day). The measure on Richter scale is 9.1 to 9.3 & the epicentre is on west coast of Sumitra, Indonesia. A series of waves upto 30m were araised in the

Indian ocean which killed more than 1.86 lakh people of south, south-east Asia, Indonesia, Sri Lanka, India, Thailand with covering on area of 1200 km.

It is the second largest earth quake with duration of 500 to 600 seconds which resulted in vibration of entire planet about 1 cm. The total energy released by the earth quake has been estimated is 3.35×18^{10}J (=0.8 GT of TNT). If the damage is far away from the source, then it is known as „tele-tsunami". In deep of oceans, tsunami waves are harmless but at the coastal areas it becomes largely destructive (thus origin place of tsunami is safe). Due to this coastline of Kerala, Sri Lanka (west coast), Somalia (although greater distance), Bangladesh (comparatively less) are affected less.

No tsunami warning systems are placed in Indian Ocean. It is difficult to defect as it originates from the deep of ocean and so costly network of sensors are required. Pacific Ocean has warning system as it experiences more tsunamis (Ring of fire). Now United Nations stared working on Indian Ocean warning system.

Environmental aspects: (man-made reasons for tsunamis):
1. Destruction of coral reefs (Indonesia, Sri Lanka & Bangladesh destroyed them)
2. Many reef areas are exploded around Indian Ocean with explosives.
3. Removal of coastal mangroves & coastal dunes.

Note: Surin Island saved from tsunami waves due to struck of the waves in coral reefs.

Effects:
1. The effects of the tsunami will continue for many years.
2. Damages to eco system (coastal wetlands, mangroves, forests etc).
3. Huge loss to animal & plant biodiversity.
4. Mixing of salt & sewage water with fresh water.

Note: The United Nation Environment Programme (UNEP) is helping the local government to restore the ecology of the region.

Floods:

The overflow of water due to heavy rains (or) sudden snow melt which causes inundation of surrounding land is called floods. Floods don"t cause damage to property as remaining natural disasters does. However they cause economic loss (wipe off agricultural lands), health problems (water borne diseases), etc. In India, Uttar Pradesh has 20% of 40 million hectares of flood prone zone. On average every year one major disaster hits India causing huge economic loss also loss to human life.

Fig. 5.14 A building washed away in flash floods of 2012 in Uttarakhand.

Reasons:
1. Due to anthropogenic activities like constructive of roads, parking space, buildings etc, which are covered with hard surface and doesn"t allow water to percolate.
2. Deforestation. **Preventive measures:**
   1. Have to restore wet lands.
   2. Replace ground cover on water courses.
   3. Building check dams on small streams.
   4. Instead of buildings on flood plains, it should be used for wild life habitat, tanks, etc.

Landslides:

This occurs due to gravitational pull of coherent rock of soil masses. Slow land slips don"t cause damage but sudden rock slides & mud slides are dangerous. Landslides are governed by the forces which tend to pull the earth down slope and resisting forces which tend to resist such movement.

Factors & reasons:
1. Chemical action of water causing weathering of rocks.
2. Earth quakes & vibrations etc.
3. Disturbances in resistant rock overlying rock of low pressure.
4. Saturation of unconsolidated sediments with water.
5. Unconsolidated sediments exposed due to logging, road (or) house building.

Landslides are minimised by:
1. Draining the surface & sub-surface water.
2. Providing slope support like gabions (wired stone blocks).
3. Concretes support at the base of slope.

Fig. 5.15 Landslide (site near Rishikesh)

Cyclones:
These are recurring phenomenon in the tropical coastal regions. Tropical cyclones move like a spinning top at the sped of 10-30 KMPH & may lasts for a week with diameter of 100 to 1500 KM.

Different names of cyclones in different areas:

Places	Names
Atlantic, Caribbean, North Eastern Pacific	Hurricanes
Western pacific	Typhoons
Indian Ocean	Cyclones
Sea around Australia	Willy Willies.

Reasons:
1. Heat & moisture.
2. Temperature above 26 °C on sea surface.

➢ More storms occur in the Bay of Bengal (5-6 per year) than in the Arabian Sea.

➢ The following cause severe damage to land.
   a) Hurricane winds (74 Miles/hr)
   b) Rains.
   c) Storm surge (500-100 Miles wide dome of water)

➢ Sea water with combined force rushes in lands & inundates the low lying areas. **Remedies:**

i) It is difficult to stop it.

ii) Some long term measure can prevent it, they are
   a) Plantation-coastal belt.
   b) Construction of dams, dykes, embankments, storm shelter and wind breaks.
   c) Providing proper drainage & wide roads for quick evacuation.

Fig. 5.16 The cyclone Katrina

Case study-hurricane Katrina:
➢ It was formed on August 23, 2005 in Atlantic Ocean with a speed of 280 KMPH.

➢ It was the one of most damaging hurricanes with 1800 deaths & 75 billion us dollars economic loss.

➢ This affected Bahamas, South Florida, Cuba, Louisiana, Mississippi, Alabama, Florida Panhandle & most of Eastern North America.
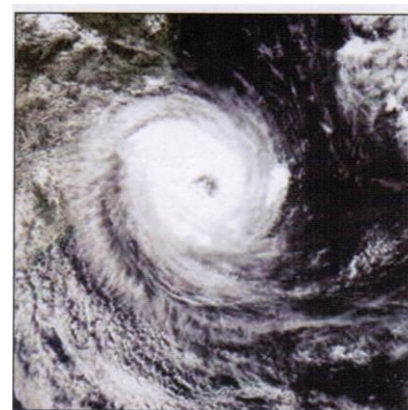
Damages caused are:

a) Interruption of oil supply & Commodities like Grain.   b) In some areas complete devastation of coastal areas.

c) In Dauphin islands, the sand was forcibly transported across island.

d) Chandeleur Islands were completely wiped off.

e) Several species lost their breeding places due to destruction of coastal land.

 Eg:- Marine mammals, turtles, red-head ducks, sand hill cranes, etc.

f) Nearly 20% of local marshes were completely destroyed.

g) 16 National Wild Life Reverses were forced to close (among this Breton National Wild Life affected maximum).

h) During cleaning & removal of water process, these were pumped into Lake Pontchantrain. Due to this it was contaminated with bacteria, heavy metals, pesticides, toxic chemicals, gallons of oil, etc, as a result aquatic life was badly affected.

Frequently occurring natural disaster in India:

S. No	Type	location / area	Affected population	
1.	Floods	8 major river valleys spread over 40 million of area in the entire country.	260	Hectares
2.	Drought	Spread in 14 states A.P., Bihar, Haryana, J & K, Karnataka, M. P., Maharastra, Odissa, Rajasthan, T. N., U. P., W.B., & Himachal Pradesh-covering 116 districts.	86	
3.	Earth quakes	Nearly 55% of the total area of the country falling in the Seismic zone IV to V.	400	
4.	Cyclones	Entire 5700 KM long coastline of southern peninsular, India covering 9 states (Gujarat, Maharastra, Goa, Karnataka, Kerala, T. N., A. P., Orissa & W.B.) Union territories (Pondy, Lakshadweep, Andaman& Nicobar)	10	
5.	Landslide	Entire Sub Himalayan Region & Western Ghats.	10	

All THE BEST Dr. Dayalan V M

E KEERTHIGA

G MUNI HEMALATHA

P BABITHA