Text

Definition of Air Pollution

Air pollution is the presence of foreign substances in the air. There are some specific definitions available for air pollution:

"*Air pollution is defined as the presence of contaminants or pollutant substances in the air that interfere with human health or welfare, or produce harmful environmental effects"* (the United States Environmental Protection Agency, 2007).

"Air pollution is the presence of substances in air in sufficient concentration and for sufficient time, so as to be, or threaten to be injurious to human, plant or animal life, or to property, or which reasonably interferes with the comfortable enjoyment of life and property" (WHO,1972)

Classification of Air Pollutants

A substance in the air that can cause harm humans and the environment is known as an air pollutant. Pollutants can be in the form of solid particles, liquid droplets, or gases. Besides, they may be natural or human-made.

Pollutants can be classified as primary or secondary. Usually, primary pollutants are directly emitted from a process, such as ash from a volcanic eruption, the carbon monoxide gas from a motor vehicle exhaust or sulfur dioxide released from factories. Secondary pollutants are not emitted directly. Instead, they form in the air when primary pollutants react or interact. An important example of a secondary contaminant is ground-level ozone — one of the many secondary pollutants that make up photochemical smog. Some pollutants may be both primary and secondary: they are both emitted directly and formed from other primary pollutants.

Major primary pollutants produced by human activity include

- **Sulphur oxides (SO_x):** SO_2 is produced by volcanoes and in various industrial processes. Since coal and petroleum often contain sulfur compounds, their combustion generates sulfur dioxide. Further oxidation of SO_2, usually in the presence of a catalyst such as NO_2, forms H_2SO_4 and acid rain. This is one of the causes for concern over the environmental impact of using these fuels as power sources.

- **Nitrogen oxides (NO_x)**: especially nitrogen dioxide is emitted from high-temperature combustion, and are also produced naturally during thunderstorms by electrical discharge. Can be seen as the brown haze dome above or plume downwind of cities. Nitrogen dioxide is the chemical compound with the formula NO_2. It is one of the several nitrogen oxides. This reddish-brown toxic gas has a characteristic sharp, biting odour. NO_2 is one of the most prominent air pollutants.
- **Carbon monoxide (CO):** is a colourless, odourless, non-irritating but very poisonous gas. It is a product by incomplete combustion of fuel such as natural gas, coal or wood. Vehicular exhaust is a significant source of carbon monoxide.
- **Carbon dioxide (CO_2)**: is a colourless, odourless, non-toxic greenhouse gas also associated with ocean acidification, emitted from sources such as combustion, cement production, and respiration. It is otherwise recycled in the atmosphere in the carbon cycle.
- **Volatile organic compounds:** VOCs are an important outdoor air pollutant. They are often divided into separate categories of methane (CH_4) and non-methane (NMVOCs) in this field. Methane is an extremely efficient greenhouse gas that contributes to enhanced global warming. Other hydrocarbon VOCs is also significant greenhouse gases via their role in creating ozone and prolonging methane's life in the atmosphere. However, the effect varies depending on local air quality. Within the NMVOCs, the aromatic compounds benzene, toluene, and xylene are suspected carcinogens and may lead to leukaemia through prolonged exposure. 1,3-butadiene is another dangerous compound that is often associated with industrial uses.
- **Atmospheric particulate matter**: Particulates, referred to as particulate matter (PM) or fine particles, are tiny particles of solid or liquid suspended in a gas. In

contrast, aerosol refers to particles and gas together. Sources of particulate matter can be human-made or natural. Some particulates occur naturally, originating from volcanoes, dust storms, forest and grassland fires, living vegetation, and sea spray. Human activities, such as burning fossil fuels in vehicles, power plants and various industrial processes, also generate significant amounts of aerosols. Averaged over the globe, anthropogenic aerosols—those made by human activities—currently account for about 10 per cent of the total amount of aerosols in our atmosphere. Increased fine particles levels are linked to health hazards such as heart disease, altered lung function, and lung cancer.

- **Chlorofluorocarbons (CFCs):** harmful to the ozone layer emitted from refrigerators, air conditioners used as a coolant and in plastic foam such as a thermocouple.
- **Ammonia (NH_3)**: emitted from agricultural processes. Ammonia is a compound with the formula NH_3. It is usually encountered as a gas with a characteristic pungent odour. Ammonia contributes significantly to terrestrial organisms' nutritional needs by serving as a precursor to foodstuffs and fertilizers. Ammonia, either directly or indirectly, is also a building block for the synthesis of many pharmaceuticals. Although in wide use, ammonia is both caustic and hazardous.
- **Radioactive pollutants:** produced by nuclear explosions, nuclear events, war explosives, and natural processes such as the radioactive decay of radon.

Secondary pollutants include

- **Smog:** is a kind of air pollution; the word "smog" is synchrony of two words, smoke and fog. ***Classic smog*** results from large amounts of coal burning in an area caused by a mixture of smoke and sulfur dioxide. ***Modern*** pollution does not usually come from coal but from vehicular and industrial emissions acted on in the atmosphere by ultraviolet light from the sun to form secondary pollutants that also combine with the primary emissions to form photochemical smog.
- **Ground-level ozone (O_3)**: formed from NO_x and VOCs. Ozone (O_3) is a vital constituent of the troposphere. It is also an essential constituent of some areas of the stratosphere commonly known as the Ozone layer. Photochemical and chemical reactions involving it drive many of the chemical processes that occur in the atmosphere by day and night. At abnormally high concentrations brought about

by human activities (mostly the combustion of fossil fuel), it is a pollutant and a constituent of smog.

- **Peroxyacetyl nitrate (PAN):** similarly formed from NO_x and VOCs.

Minor air pollutants include many little hazardous air pollutants—a variety of persistent organic pollutants, which can attach to particulate matter. Persistent organic pollutants (POPs) are organic compounds resistant to environmental degradation through chemical, biological, and photolytic processes. Because of this, they have been observed to persist in the environment, to be capable of long-range transport, bioaccumulate in human and animal tissue, biomagnify in food chains, and to have potentially significant impacts on human health and the environment.

Sources of Air Pollution

Stationary and Area Sources

A stationary air pollution source refers to an emission source that does not move, also known as a point source. Stationary sources include factories, power plants, dry cleaners and degreasing operations. The term area source is used to describe many small air pollution sources located together whose individual emissions may be below thresholds of concern, but whose collective emissions can be significant. Residential wood burners are an excellent example of a small source, but they can contribute to local and regional air pollution levels when combined with many other short sources. Area sources can also be thought of as non-point sources, such as housing developments, dry lakebeds, and landfills.

Mobile Sources

A mobile source of air pollution refers to a source that is capable of moving under its power. In general, mobile references imply "on-road" transportation, including vehicles such as cars, sport utility vehicles, and buses. Besides, there is also a "non-road" or "off-road" category that includes gas-powered lawn tools and mowers, farm and construction equipment, recreational vehicles, boats, planes, and trains.

Agricultural Sources

Agricultural operations, which raise animals and grow crops, can generate emissions of gases and particulate matter. For example, animals confined to a barn or restricted area (rather than field grazing), produce large amounts of manure. Manure emits various gases, particularly ammonia into the air. This ammonia can be ejected from the animal houses, manure storage areas, or the land after the manure is applied. In crop production, the misapplication of fertilizers, herbicides, and pesticides can potentially result in an aerial drift of these materials and harm may be caused.

Natural Sources

Although industrialization and the use of motor vehicles are overwhelmingly the most significant contributors to air pollution, there are important natural sources of "pollution". Wildland fires, dust storms, and volcanic activity also contribute gases and particulates to our atmosphere.

Unlike the air mentioned above, people or their activities do not cause pollution sources, natural “air pollution”. An erupting volcano emits particulate matter and gases; forest and prairie fires can emit large quantities of "pollutants"; plants and trees naturally emit VOCs that are oxidized, and form aerosols cause a natural blue haze, and dust storms can create large amounts of particulate matter. Wild animals in their natural habitat are also considered natural sources of "pollution". The National Park Service recognizes that each of these sources emits gases and particulate matter into the atmosphere, but we regard these as constituents resulting from natural processes.

Effects of Air Pollution

A variety of air pollutants have known or suspected harmful effects on human health and the environment. In most areas of Europe, these pollutants are principally the combustion products from space heating, power generation, or motor vehicle traffic. Pollutants from these sources may not only prove a problem near these sources but can travel long distances.

Health Effects:

Exposure to air pollution is associated with numerous effects on human health, including pulmonary, cardiac, vascular, and neurological impairments. The health effects vary significantly from person to person. High-risk groups such as the elderly, infants, pregnant women, and sufferers from chronic heart and lung diseases are more susceptible to air pollution. Children are at greater risk because they are generally more active outdoors, and their lungs are still developing. Exposure to air pollution can cause both acute (short-term) and chronic (long-term) health effects. Acute effects are usually immediate and often reversible when exposure to the pollutant ends. Some acute health effects include eye irritation, Headache, and nausea. Chronic effects are generally not direct and tend not to be reversible when exposure to the pollutant ends. Some chronic health effects include decreased lung capacity and lung cancer resulting from long-term exposure to toxic air pollutants. The scientific techniques for assessing air pollution's health impacts include air pollutant monitoring, exposure assessment, dosimetry, toxicology, and epidemiology.

Although in humans, pollutants can affect the skin, eyes and other body systems, they involve the respiratory system primarily. Both gaseous and particulate air pollutants can have adverse effects on the lungs. The lungs are the organs responsible for absorbing oxygen from the air and removing carbon dioxide from the blood-stream. Damage to the lungs from air pollution can inhibit this process and contribute to respiratory diseases such as bronchitis, emphysema, and cancer. This can also put an additional burden on the heart and circulatory system.

Table 1 summarizes the sources, health and welfare effects for the Criteria Pollutants. Hazardous air pollutants may cause other less common but potentially dangerous health effects, including cancer and damage to the immune system, and neurological, reproductive and developmental problems. Acute exposure to some hazardous air pollutants can cause immediate death.

Table 1: Sources, Health and Welfare Effects for Criteria Pollutants.

Pollutant	Description	Sources	Health Effects	Welfare Effects
Carbon Monoxide (CO)	The colourless, odourless gas	Motor vehicle exhaust, indoor sources include kerosene or wood-burning stoves.	Headache reduced mental alertness, heart attack, cardiovascular diseases, impaired fetal development, and death.	Contribute to the formation of smog.
Sulfur Dioxide (SO_2)	Colourless gas dissolves in water vapour to form acid and interact with other gases and particles in the air.	Coal-fired power plants, petroleum refineries, manufacture of sulfuric acid and smelting of ores containing sulfur.	Eye irritation, wheezing, chest tightness, shortness of breath, lung damage.	Contribute to the formation of acid rain, visibility impairment, plant and water damage, aesthetic damage.
Nitrogen Dioxide (NO_2)	Reddish-brown, highly reactive gas.	Motor vehicles, electric utilities, and other industrial, commercial, and residential sources that burn fuels.	Susceptibility to respiratory infections, irritation of the lung and respiratory symptoms (e.g., cough, chest pain, difficulty breathing).	Contribute to smog formation, acid rain, water quality deterioration, global warming, and visibility impairment.
Ozone (O_3)	Gaseous pollutant when it is formed in the troposphere.	Vehicle exhaust and certain other fumes. It is formed from other air pollutants in the	Eye and throat irritation, coughing, respiratory tract problems, asthma, lung damage.	Plant and ecosystem damage.

		presence of sunlight.		
Lead (Pb)	Metallic element	Metal refineries, lead smelters, battery manufacturers, iron and steel producers.	Anaemia, high blood pressure, brain and kidney damage, neurological disorders, cancer, lowered IQ.	Affects animals and plants, affects aquatic ecosystems.
Particulate Matter (PM)	Microscopic particles of soot, dust, or other matter, including tiny droplets of liquids.	Diesel engines, power plants, industries, windblown dust, wood stoves.	Eye irritation, asthma, bronchitis, lung damage, cancer, heavy metal poisoning, cardiovascular effects.	Visibility impairment, atmospheric deposition, aesthetic damage

Source: http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT Delhi/

Effects on Farm Animals:

The process by which farm animals get poisoned is entirely different from how human beings exposed to the polluted atmosphere are poisoned. In the case of farm animals, it is a two-step process:

1) Accumulation of the airborne contaminant in the forage.

2) Subsequent poising of the animals when they eat the contaminated vegetation.

In the case of farm animals, the danger is not in inhaling the polluted air, but rather the ingestion of forage contaminated with pollutants like fluorine from the air. The three pollutants responsible for most livestock damage are fluorine, arsenic and lead. These pollutants originate from industrial sources or dusting and spraying.

Effects on Vegetation:

Air pollutants, such as sulphur dioxide, HF, particulate fluorides, smog, oxidants like ozone, ethylene (from automobiles), NOx, Chlorine and herbicides and weedicide sprays exert toxic effects on vegetation. The damage usually occurs in the form of visual injury such as chlorotic marking, banding, silvering or bronzing of the leaf's underside. Retardation of plant growth may also occur in some cases. The extent of damage to a pant depends upon the nature and concentration of the pollutants, time of exposure, soil and plant condition, stage of growth, relative humidity and the extent of sunlight.

Environmental Effects:

Climate change on a global scale has been attributed to increased emissions of carbon dioxide (CO_2), a greenhouse gas. A global average temperature rise of the only 1ºC could have profound implications. Possible consequences include melting of polar ice caps, increased sea level; and increases in precipitation and severe weather events like hurricanes, tornadoes, heat waves, floods, and droughts. Indirect effects include increases in infectious disease, weather-related deaths, and food and water shortages. All these effects put stress on ecosystems and agriculture and threaten our planet as a whole.

Other atmospheric effects of air pollution include urban smog and reduced visibility, associated with ozone-forming nitrogen oxides and volatile organic compound emissions. Sulphur dioxide and nitrogen oxides combine with water in the atmosphere to cause acid rain, which is detrimental to forests and other vegetation, soil, lakes, and aquatic life. Acid rain also causes monuments and buildings to deteriorate.

Air Pollution Control

The following two basic approaches are used for controlling air pollution:

1. Controlling or confining the pollutants at the source. This can be achieved by:
    - Modifying the process in such a way that pollutants do not form at all beyond permissible concentration.
    - We are reducing the pollutant concentrations to tolerable levels before they are released to the environment, using suitable Equipment we can destroy, alter or trap the pollutants formed.
2. Dilution of the pollutants in the atmosphere to permissible levels before they can reach the receptor. This can be achieved by using tall stacks, controlling the process parameters with due regard to the local meteorological conditions and proper community planning to prevent the accumulation of dangerous ground-level concentrations within the designated areas.

Methods and Equipment used to control gaseous pollutants:

1) **Combustion:** This technique is used when pollutants contain gases or vapours, which are organic. Flame combustion or catalytic combustion of these pollutants converts them into water vapours and relatively innocuous products, such as CO2. The Equipment used for flame combustion includes fume incinerators, steam injection or venture flares and afterburners.
2) **Absorption:** In this technique, the gaseous effluents are passed through scrubbers or absorbers containing a suitable liquid absorbent to remove or modify one or more pollutants present in the gas stream. The efficiency of the gas absorption process depends upon:
    - The chemical reactivity of the gaseous pollutants in the liquid phase.
    - The extent of surface contact between the liquid and the gas.
    - The contact time and
    - The concentration of the absorbing medium.

The types of Equipment used include plate towers, spray towers, packed towers etc. The gas absorption technique is widely used for removing pollutants like NOx, H_2S, SO_2, SO_3 etc.

3) **Adsorption:** In this technique, the gaseous effluents are passed through porous solid adsorbents taken in suitable containers. The effluent gases' organic and inorganic constituents are held at the stable adsorbent interface by physical adsorption or chemisorptions. The efficiency of adsorption depends upon the surface area per unit weight of the adsorbent, other physical and chemical characteristics of the adsorbent and nature and concentration of the gas being adsorbed.

Methods and Equipment used for controlling particulate emissions:

Particulate materials in ambient air may originate from stationary as well as mobile sources. The various devices used may be classified as follows:

1) **Mechanical devices:** These devices mostly operate based on the following two mechanisms:
   - Gravity settling in which the velocity of the horizontal carrier gas is reduced adequately so that the particles settle by gravitational force.
   - A sudden change of direction of the gas flow causes the particles to separate due to their more significant momentum.

Settling chambers, buffer chambers and cyclone separators commonly use mechanical devices to separate particulates from gases.

2) **Filtration Systems:** Dust laden gases are forced through a porous medium such as woven or filled fabric. The particles are trapped and collected in the filters, and the gases devoid of the particles are discharged out. Fibrous or deep-bed filters and cloth bag filters are commonly used. Gas fibre filters have superior chemical resistance.

3) **Electrostatic Precipitators**: When a gas or an air stream containing aerosols, e.g., dust, fumes or mist is passed between two electrodes which are electrically insulated from each other and between which appreciable difference in electrical potential exists, then the aerosols particles get precipitated on the electrodes that are at a lower potential.

Electrostatic precipitators are the devices of choice when

- Vast volumes of gases are to be handled
- Valuable dry material is to be recovered
- Very high collecting efficiency for the removal of fine particulates is essential and
- When the gas temperatures are very high.

4) **Wet Scrubbers**: Wet scrubbers are used

- When fine particles have to be efficiently removed
- When particulates, as well as gaseous contaminants, have to be removed
- When the gases to be treated are combustible
- When the volume of the gases being treated is low.

Wet scrubbers are classified according to the method of particle collection as follows:

- Liquid carriage type where the gas stream containing the particles is allowed to strike a liquid surface within the collector. The liquid carrying the trapped gas particles moves to a location outside the collector for ultimate disposal.
- Particle conditioning type where the dust particles in the gas stream are brought into intimate contact with water so that the particles' sufficient size is increased due to the formation of heavier water particulate agglomerates. These can be more easily separated from the gas stream by any of the collection mechanisms.

Many wet scrubbers are in use in air pollution control, including venture scrubber, gravity spray scrubber, wet impinger scrubber, cyclone spray chambers, and wet centrifugal scrubber.

Units of Measurement of Air Pollution:

The concentration of the air pollutants is most often expressed in one of two ways. One of these, parts per million, is based on volume measurements and represents contaminants' volume in 1 million works of air. The importance of pollutant and air is determined at a standard temperate and pressure of 25ºC and 760 torrs (atmospheric pressure at sea level).

The second way of expressing concentration relates to the mass of pollutants to the air volume containing it. The unit is often used as a microgram per cubic meter (μg/m³), where one microgram is equal to 10^{-6} grams. In heavily polluted areas, milligrams (10^{-3} grams) per cubic meter are used to avoid large numbers. A milligram is 1000 times larger than a microgram, so a concentration of 10,000 μg/m³ becomes 10 mg/ m³.

TEXT

Air pollution: The London Smog and Los Angeles Smog

The London Smog (Industrial Smog-1952)

Smog is a type of air pollution. The word "smog" was made in the early 20th century as a portmanteau of the words smoke and fog to refer to smoky fog. Coinage of the term "smog" is generally attributed to Dr. Henry Antoine Des Voeux in his 1905 paper, "Fog and Smoke" for a meeting of the Public Health Congress.

A fog so thick and polluted, it left thousands dead wreaked havoc on London in 1952. The smoke-like pollution was so toxic it was even reported to have choked cows to death in the fields. It was so thick it brought road, air and rail transport to a virtual standstill. This was certainly an event to remember, but not the first smog of its kind to hit the capital. The smog had become a frequent part of London life, but nothing quite compared to the smoke-laden fog that shrouded the capital from Friday 5 December to Tuesday 9 December 1952. While it heavily affected the population of London, causing a huge death toll and inconveniencing millions of people, the people it affected were also partly to blame for the smog.

During the day on 5th December, the fog was not especially dense and generally possessed a dry, smoky character. When nightfall came, however, the fog thickened. Visibility dropped to a few meters. The following day, the sun was too low in the sky to burn the fog away. That night and on the Sunday and Monday nights, the fog again thickened. In many parts of London, it was impossible at night for pedestrians to find their way, even in familiar districts. In The Isle of Dogs area, the fog there was so thick people could not see their feet.

Formation and cause of Smog 1952

The weather in November and early December 1952 had been very cold, with heavy snowfalls across the region. To keep warm, the people of London were burning large quantities of coal in their homes. Smoke was pouring from the chimneys of their houses and coal was used in the industries released tremendous amount of particulate matter, VOCs, NO_2 and SO_2 into the atmosphere, they can form industrial smog (sometimes called London smog), Under normal conditions, smoke would rise into the atmosphere and disperse, but an anticyclone was hanging over the region. This pushes air downwards, warming it as it descends. This creates an inversion, where air

close to the ground is cooler than the air higher above it. So when the warm smoke comes out of the chimney, it is trapped. The inversion of 1952 also trapped particles and gases area, along with pollution that the winds from the east had brought from industrial areas on the continent.

Early on 5th December, in the London area, the sky was clear, winds were light and the air near the ground was moist. Accordingly, conditions were ideal for the formation of radiation fog. The sky was clear, so a net loss of long-wave radiation occurred and the ground cooled. When the moist air came into contact with the ground it cooled to its dew-point temperature and condensation occurred. Beneath the inversion of the anticyclone, the very light wind stirred the saturated air upwards to form a layer of fog 100-200 meters deep. Along with the water droplets of the fog, the atmosphere beneath the inversion contained the smoke from innumerable chimneys in the London area.

During the period of the fog, huge amounts of impurities were released into the atmosphere. On each day during the foggy period, the following pollutants were emitted: 1,000 tones of smoke particles, 2,000 tons of carbon dioxide, 140 tones of hydrochloric acid and 14 tones of fluorine compounds. In addition, and perhaps most dangerously, 370 tons of sulphur dioxide were converted into 800 tons of sulphuric acid.

Los Angeles Smog (Photochemical Smog)

Photochemical smog is a serious environmental concern, and it poses a health problem to people living in many metropolitan regions around the world. In fact, sometimes levels of ozone - a major component of smog - are so high that school children in Los Angeles, California, are kept from going outside for recess because of the potential health risks

Photochemical smog was first identified in Los Angeles in 1944. Although several other kinds of smog occur, photochemical smog (or Los Angeles- smog) is a yellow-brown haze produced by the reaction of sunlight with exhaust from automobiles and power plants that burn coal. Ozone, nitrogen dioxide, and other volatile organic compounds that make up this smog irritate eyes and nasal passages. These are particularly dangerous to people who have heart disease, asthma, or other respiratory illnesses, and to anyone who exercises or does manual labor outdoors when smog is heavy.

Photochemistry of Los Angeles Smog

As its name implies, photochemical smog forms in the presence of light, so this type of smog is seen most frequently during the hot and sunny summer months. Though the components of photochemical smog might be in the air, if sunlight does not reach them or they are not concentrated enough, the smog will not form. The worst cases of smog occur when winds are calm and smog is trapped near the surface by a temperature inversion, a condition in which cooler air near the Earth's surface has warmer air above it. These ideal smog-forming conditions commonly occur near cities that are adjacent to mountains.

Photochemical smog forms through a series of chemical reactions among compounds in the atmosphere. When nitric oxide (NO), a component of the exhaust from cars and power plants, enters the atmosphere, it reacts with oxygen to produce nitrogen dioxide (NO_2). Sunlight can break nitrogen dioxide down. This process initiates other chemical reactions that lead to the formation of low-level ozone. Although ozone (O_3) that is high in the stratosphere filters out harmful UV radiation, ozone's presence at the ground level poses a health risk. Also, Volatile Organic Compounds (VOCs), molecules that enter the atmosphere from substances such as gasoline, cleaning solvents, and trees, play a crucial role in forming photochemical smog.

While, NO_2 is a major component of photochemical smog, and the focus of this Case Study, several other components of smog also deserve mention because of their role in climate change. These gases include Methane, (CH_4); Nitrous Oxide, (N_2O); and Ozone, (O_3).

Methane (CH4); is a potent, although short-lived greenhouse gas. It is largely an agricultural by product. It is naturally produced in swamps and wetlands and a by-product of coal and oil extraction. Car and truck emissions, pollution from factories, and burning vegetation, produce compounds of carbon and nitrogen that, when acted on by sunlight, produce ozone in the troposphere. This component of photochemical smog is an important greenhouse gas. Concentrations of ozone have risen 30% since the pre-industrial era and it is now considered the 3rd most significant greenhouse gas, behind Carbon Dioxide and Methane.

Nitrous Oxide (NO_2) is another significant, but lesser known, greenhouse gas. It is a product of the use of fertilizers, as well as a by-product of the production of nylon and nitric acid. It is far more potent than CO_2.

Chlorofluorocarbons (CFCs) are entirely man-made. They were synthesized for use as refrigerants and cleaning solvents in the 1920s. Their production has been banned since 1978, but they remain in the atmosphere due to their long half-lives.

Impacts of the smog

Smog poses a serious threat to human health. It is particularly dangerous to very young children, the elderly, and anyone with respiratory disease. Some constituents of smog can also damage vegetation and agricultural crops. Smog conditions are worse in large cities, but due to atmospheric circulation, smog also affects rural communities that are downwind. Smog continues to grow worldwide as the human population increases and more countries become industrialized.

•About 4,000 people were known to have died in 1952 as a result of the smog, but it could be many more.

- Many people suffered from breathing and respiratory disease related problems
- Press reports claimed the smog had asphyxiated cattle at Smithfield.
- Travel was disrupted for days
- Response to the smog

A series of laws were brought in to avoid a repeat of the situation. This included the Clean Air Acts of 1956 and 1968. These acts banned emissions of black smoke and decreed residents of urban areas and operators of factories must convert to smokeless fuels.

People were given time to adapt to the new rules, however, and fogs continued to be smoky for some time after the Act of 1956 was passed. In 1962, for example, 750 Londoners died as a result of a fog, but nothing on the scale of the 1952 Great Smog has ever occurred again. This kind of smog has now become a thing of the past, thanks partly to pollution legislation and also to modern developments, such as the widespread use of central heating.

In brief, the chronological history of air pollution control in the UK is:

- 1905 Des Voeux coins the word smog

- 1926 Public Health (Smoke Abatement Act) alkali inspectors able to inspect unregistered works
- 1956 Clean Air Act introduced as private members bill by Gerald Nabarro MP (banned dark smoke emissions)
- 1968 Clean Air Act introduced by Robert Maxwell MP (limits for grit dust and fumes, chimney heights etc.
- 1990 Environmental Protection Act: covers integrated pollution control down to local level
- 1996 Environment Agency and SEPA take over functions of the National Rivers Authority, HMIPI and the Scottish River Purification Authorities
- 1997 National Air Quality Strategy published
- 1998 Local authorities take up duties for review and assessment of local air quality management
- 2005 Review of National Air Quality Strategy

Case Study 2: Industrial Disaster: Bhopal Gas Episode – A Case Study

Industrialization has a great impact on our lives. Philosophers have been warning us about the danger of industrialization. Some of the major industrial accidents that took place in the past.

We realize the price paid for progress only when a nightmarish incident like Bhopal Gas Tragedy involving loss of numerous lives and many after effects occurs on December 3rd 1984, in the city of Bhopal, a highly toxic cloud of methyl isocyanate (MIC) vapour burst from the union carbide pesticide plant.

Of the 800000 people living in Bhopal at the time, 2000 died immediately and 300000 were injured (Stix, 1999) MIC was a major component for the production of the pesticide Sevin by the Union carbide factory at Bhopal. This incident we now refer to as the as the Bhopal gas tragedy is one of the worst commercial industrial disaster in history. It is described as a low probability-high consequence accident. The tumultuous outcome of the accident was a cumulative effect of the following seven reasons (Bowonder, 1987)

- Large release of chemical from the plant
- Release of colorless, odorless MIC, which is highly toxic
- Heavily populated areas adjacent to the plant

- ❖ Calm weather conditions, bringing the vapor cloud down
- ❖ Leak occurs at night when people are sleeping
- ❖ Failure or late warnings
- ❖ Unqualified and unaware people working at the plant

Approximately 40 tons of Methyl Iso-Cyanate spilled over and caused the world's worst disaster (Verma 1986, 1989). The number of people died in the incident was over 3000 and the number of people injured ranged between 2,00,000 to 6,00,000 (Kumar 1994; Kumar 1995; Sriramachari and Chandra 1997).

The Bhopal plant of Union Carbide India Limited (UCIL) is the second of its own kind in the World and only plant built outside U.S.A. It is one of the leading pesticides units in the country and has a licensed capacity of 5000 tones of Pesticides (UCC, 1984) in the procedure for manufacturing the pesticides Sevin and Temik, methyl-isocyanate (MIC) was used as an intermediate. The chemical reactions involved are as follows (Behl et al., 1978, UCC 1985).

- $2C + O_2 \rightarrow 2CO$
- $2CO \rightarrow 2COCl_2$ (Phosgene)
- $COCl_2 + CH_2NH_2 \rightarrow CH_3NHCOCl + HCl$

(Phosgene + methylamine) (Methyl carbamoyl Chloride)

- $CH_3NHCOCl \rightarrow CH_3NCO$ (MIC) $+HCl$
- MIC+α-napthol + CCl_4 → 1-napthyl methylcarbamate

MIC reacts with water exothermically, generating heat above its boiling point and thu s turns from liquid to vapor. Hence the existence of even a small amount of water can be sufficient to produce enough heat to cause and ruptures and leaks.

MIC was manufactured primarily to make the pesticide Carbaryl (Sevin) as well as smaller quantities of Aldicarb (Temic) and butylphenyl methylcarbamate, all destined for the Indian market (Merkenzie ,1984). Carbaryl was produced by reacting MIC with a slight excess of alpha-Napthol in the presence carbontetrachloride (NEERI, 1990) and was sold as the pesticide Sevin.

Cause of leakage of Methyl Isocyanate from tank 610: On the night of the disaster water inadvently entered the MIC storage tank where over two metric tons of MIC were

being stored. The addition of water to the tank caused an exothermic chemical reaction resulting in a rapid rise in pressure of and temperature. The heat generated by the reaction, the presence of higher than normal concentration of chloroform and presence of an iron catalyst resulted into such a fast reaction that the gas formed could not be contained by the safety system. (UCC 1985) As A result, MIC and other reaction products in liquid and vapour form escaped from the plant into the surrounding areas causing devastating effect on the people living in the shanty settlements just over the fence.(UCC 1985, Gupta et al., 1988) .The safety systems which in any case were designed for such a runaway situation were non functioning .The scrubber designed to neutralize any escaping gas by spraying caustic soda was empty and the flare tower meant to burn off any gases from the scrubber was under repair .Hypothesis for the disaster included sabotage, prolonged bulk storage over 40 tones of MIC, non functioning refrigeration systems, the failure of safety measures and malfunctioning of neutralization facilities (Mackenzie 1984,UCC 1985 ,Milne 1988)

Impacts of the disaster on Human Health:

There are many impacts of the tragedy some of them are as follows:

1. Impact on Health

- Most of the information on the medical consequences of Union Carbide disaster in Bhopal has been detained by the Indian Council of Medical Research (ICMR, 1985). The ICMR has established that the toxins from the Union Carbide factory have caused damage to the lungs, brains, kidneys, muscles as well as gastrointestinal, reproductive, immunological and other systems bronchial asthma, Chronic Obstructive Airways disease (Gupta et al., 1988; Rastogi et al., 1988; Saxena et al., 1988; Bhandari et al., 1990; Cullinan et al., 1996 and Culillan et al., 1997).
- Recurrent chest infections and fibrosis of the lungs (ICMR, 1987-1991) are the principal effects of exposure induced lung injury. The prevalence of pulmonary tuberculosis among the exposed population has been found to be 3-4 times than that of national average

- The acute symptoms were burning in the respiratory tract and eyes, breathlessness, stomach pains and vomiting. Those living close to the factory had very severe acute as well as long term symptoms.
- The worst hit were children below 2 years, old people and persons with previous pulmonary diseases, like chronic bronchitis and emphysema (Kulling P, Lorin H.1987).
- The lungs were enlarged and oedematous, showed congestion, haemorrhage and consolidation, with microscopic findings such as bronchiolitis and pulmonary oedema.
- In addition, the consistency of the brain was softened through cerebral oedema.
- The kidneys showed congestion and tubular necrosis.
- In a large number, the liver showed fatty degeneration.
- Women's reproductive health was affected. Immediately after the gas leak, the stillbirth rate increased by up to 300 % and the perinatal and neonatal mortality rate by 200 %.

Health care

- In the immediate aftermath of the disaster, the health care system became overloaded. Within weeks, the State Government established a number of hospitals, clinics and mobile units in the gas-affected area to treat the victims.
- The Government of India had focused primarily on increasing the hospital-based services for gas victims thus hospitals had been built after the disaster.
- It was directed by the Supreme Court to finance a 500-bed hospital for the medical care of the survivors. Thus, Bhopal Memorial Hospital and Research Centre (BMHRC) was inaugurated in 1998 and was obliged to give free care for survivors for eight years. BMHRC was a 350-bedded super speciality hospital where heart surgery and hemodialysis were done however; there was dearth of gynaecology, obstetrics and paediatrics. Eight mini-units (outreach health centres) were started and free health care for gas victims were to be offered till 2006.

Case study 3

Chernobyl Nuclear Power Plant disaster

Chernobyl is situated in the north of the Ukraine (formerly known as the USSR) by the river Dniprodzerzhirisk. Chernobyl is approximately 80 miles (which is 120 kilometers) north of the capital city of the Ukraine, Kiev. The accident at the Chernobyl atomic power station on April 26, 1986, was dangerous and vast, with long-term adverse consequences. It now is viewed as one of the national disasters of the century. The most significant damage resulting from the accident was the radioactive contamination of an enormous amount of territory, where conditions became harmful to life. The amount of radioactive material released was 400 times more than the amount the atomic bombing of Hiroshima released. The fallout would be detected in almost all parts of Europe. Equally damaging have been the losses and discomforts that residents of the contaminated areas have endured. The incident gave rise to the necessity of developing a special legal regime for the damaged territories and creating a new legal institute to defend people in the Chernobyl "ecological disaster area".

Events of the accident

RBMK reactor 4 (RBMK means in Russian: a channel-type reactor of a large power) at the Chernobyl Nuclear Power Plant was due to temporarily close for routine maintenance on April 25 1986. The personnel decided this would be the perfect opportunity to run a particular test on this reactor. This test was to ensure that during a shutdown, enough electrical power would be available to run the emergency equipment and the water-cooling supply until the diesel power came on. Here is the sequence of events that ended in the disaster.

- April 26-1986, 1:24 am - plant exploded
- 8 tones of fuel were ejected into atmosphere including plutonium, graphite moderator, iodine-131, and cesium- 137
- 12 X 1018 Bq of radioactivity were released
- May 2-3-1986, 45 000 people were evacuated
- May 4-1986, 169 000 people were evacuated
- Later another 219 000 evacuated, to comprise 4300 square kilometers of contaminated area

Causes of the accident:

There was not one cause of this accident, there were several which all contributed to it. This accident happened while testing an RMBK reactor. A chain reaction occurred in the reactor and got out of control, causing explosions and a huge fireball which blew off the heavy concrete and steel lid on the reactor. These are the causes:

1. Design fault in RBMK reactor
2. A violation of procedures
3. Breakdown of communication
4. Lack of a 'Safety Culture' in the power plant

Consequences of the accident

1. Environmental consequences

•The radioactive fallout caused radioactive material to deposit itself over large areas of ground. It has had an effect over most of the northern hemisphere in one way or another. In some local ecosystems within a 6-mile (10km) radius of the power plant the radiation is lethally high especially in small mammals such as mice and coniferous trees. Luckily within 4 years of the accident nature began to restore itself, but genetically these plants may be scarred for life

•Will cost $400 billion and 200 years to totally clean up

2. Health effects

- Caused 31 deaths instantly
- May have caused 300000 deaths
- Upwards of 20 million people exposed to radioactivity
- 400 times more radiation was released by the disaster than had been by the atomic bombing of Hiroshima. The radiation would later be detected in almost all parts of Europe. Over one million people could have been adversely affected by the radiation.
- The radiation would cause numerous problems, including Down's Syndrome, chromosomal aberrations, mutations, leukemia, thyroid cancer, and birth defects.
- There was a huge increase in Thyroid Cancer (Thyroid Cancer is cancer of the thyroid gland, a gland found near the larynx that secretes growth and metabolism hormones) in Ukranian children (from birth to 15 years old).

3. Psychological consequences:

There has been an increase in psychological disorders such as anxiety, depression, helplessness and other disorders which lead to mental stress. These disorders are not a consequence of radiation, but a consequence from the stress of evacuation, the lack of information given after the accident and the stress of knowing that their health and their children's health could be affected.

4. Economic, political and social consequences:

The worst contaminated areas were economically, socially and politically declining as the birth rate had decreased and emigration numbers had substantially risen which had caused a shortage in labour force. These areas could not evolve industrially or agriculturally because of strict rules that were introduced because the area was too contaminated. The few products made were hard to sell or export because people were aware that it had come from the Ukraine and so were scared of being affected, this caused a further economic decline. Socially people have been limited on their activities making everyday life very difficult.

Now in the year 2000, everything is looking a lot better and is starting to rise again and probably in about 10 years time almost everything will be as good as normal in the Ukraine.

Conclusion

- This is a great example of the risks of research with volatile materials
- This is also a great example of the policy of secrecy and its impact.
- An excellent case study of what not to do
- A constant reminder of the failures of the past and a lesson for future

TEXT

Water pollution

Water pollution is any contamination of water bodies with chemicals or other foreign substances detrimental to humans, plants, or animal health. These pollutants include fertilizers and pesticides from agricultural runoff; sewage and food processing waste; lead, mercury and other heavy metals; chemical wastes from industrial discharges and chemical contamination from hazardous waste sites. Human activities very often add these contaminants. Worldwide, nearly 2 billion people drink contaminated water that could be harmful to their health. Water pollution occurs when pollutants are directly or indirectly discharged into water bodies without adequate treatment to remove toxic compounds. Water pollution is a major global problem that requires ongoing evaluation and revision of water resource policy at all levels (international down to individual aquifers and wells). It has been suggested that it is the leading worldwide cause of deaths and diseases and accounts for more than 14,000 people daily. An estimated 580 people in India die of water pollution related sickness every day. About 90% of China's cities suffer from some degree of water pollution, and nearly 500 million people lack access to safe drinking water. In addition to the acute problems of water pollution in developing countries, developed countries continue to struggle with pollution problems.

Transport and chemical reactions of water pollutants

Rivers eventually carry most water pollutants into the oceans. In some areas of the world, the influence can be traced a hundred miles from the mouth by studies using hydrology transport models. Advanced computer models such as S.W.M.M. or the D.S.S.A.M. Model have been used in many locations worldwide to examine pollutants' fate in aquatic systems. Indicator filter feeding species such as copepods have also been used to study pollutant fates in the New York Bight. The highest toxin loads are not directly at the Hudson River's mouth, but 100 kilometres south, since several days are required for incorporation into planktonic tissue. The Hudson discharge flows south along the coast due to Coriolis force.

Further south then is oxygen depletion, caused by chemicals using up oxygen and by algae blooms, caused by excess nutrients from algal cell death and decomposition.

Fish and shellfish kills have been reported; because toxins climb the food chain after small fish consume copepods, then large fish eat smaller fish. Each successive step up the food chain causes a stepwise concentration of pollutants such as heavy metals (e.g. mercury) and persistent organic pollutants such as D.D.T. This is known as biomagnification, which is occasionally used interchangeably with bioaccumulation. The giant gyres (vortexes) in the oceans trap floating plastic debris. The North Pacific Gyre, for example, has collected the so-called "Great Pacific Garbage Patch" that is now estimated at 100 times the size of Texas. Plastic debris can absorb toxic chemicals from ocean pollution; potentially poisoning anything that eats it. Many of these long-lasting pieces wind up in the stomachs of marine birds and animals. This results in obstruction of digestive pathways that leads to reduced appetite or even starvation. Many chemicals undergo reactive decay or chemically change, especially over long periods in groundwater reservoirs. A particular class of such chemicals is the chlorinated hydrocarbons such as trichloroethylene (used in industrial metal degreasing and electronics manufacturing) and tetrachloroethylene used in the dry cleaning industry. These chemicals, which are carcinogens themselves, undergo partial decomposition reactions leading to new hazardous chemicals (including dichloroethylene and vinyl chloride). Groundwater pollution is much more difficult to abate than surface pollution because groundwater can move great distances through unseen aquifers. Non-porous aquifers such as clays partially purify water of bacteria by simple filtration (adsorption and absorption), dilution, and in some cases, chemical reactions and biological activity; however, in some cases, the pollutants merely transform to soil contaminants. Groundwater that moves through cracks and caverns is not filtered and can be transported as quickly as surface water. This can be aggravated by the human tendency to use natural sinkholes as dumps in Karst topography areas. There are a variety of secondary effects stemming not from the original pollutant but a derivative condition. An example is a silt-bearing surface runoff, which can inhibit sunlight's penetration through the water column, hampering photosynthesis in aquatic plants.

Measurement of water pollution

Water pollution may be analyzed through several broad categories of methods, i.e., physical, chemical and biological. Most involve the collection of samples, followed by specialized analytical tests. Some methods may be conducted *in situ*, without

sampling, such as temperature. Government agencies and research organizations have published standardized, validated analytical test methods to facilitate the comparability of results from disparate testing events.

Sampling: Sampling of water for physical or chemical testing can be done by several methods, depending on the accuracy needed and the contaminant's characteristics. Many contamination events are sharply restricted in time, most commonly in association with rain events. For this reason, grab samples are often inadequate for fully quantifying contaminant levels. Scientists gathering this type of data often employ auto-sampler devices that pump increments of water at either time or discharge intervals.

Physical testing: Common physical tests of water include temperature, solids concentrations (e.g., total suspended solids (T.S.S.)) and turbidity.

Chemical testing: Water samples may be examined using the principles of analytical chemistry. Many published test methods are available for both organic and inorganic compounds. Frequently used techniques include pH, biochemical oxygen demand (B.O.D.), chemical oxygen demand (C.O.D.), nutrients (nitrate and phosphorus compounds), metals (including copper, zinc, cadmium, lead and mercury), oil and grease, total petroleum hydrocarbons (T.P.H.) and pesticides.

Biological testing: Biological testing involves using plant, animal, and microbial indicators to monitor the health of an aquatic ecosystem. Depending on the type of assessment, the organisms may be identified for bio surveys (population counts) and returned to the water body, or dissect them for bioassays to determine toxicity.

Control of water pollution

1. **Domestic sewage:** Domestic sewage is typically 99.9 per cent water with 0.1 per cent pollutants. Although found in low concentrations, these pollutants pose a risk on a large scale. In urban areas, centralized sewage treatment plants typically treat domestic sewage. Well-designed and operating systems (i.e., secondary treatment or better) can remove 90 per cent or more of these pollutants. Some plants have different approaches to extract nutrients and pathogens. Most municipal plants are not specifically designed to treat toxic pollutants found in industrial wastewater. Cities with sanitary sewer overflows or

combined sewer overflows employ one or more engineering approaches to reduce discharges of untreated sewage including:

I. Utilizing a green infrastructure approach to improve storm water management capacity throughout the system and reduce the hydraulic overloading of the treatment plant
II. Repair and replacement of leaking and malfunctioning equipment
III. Increasing the overall hydraulic capacity of the sewage collection system.

A household or business not served by a municipal treatment plant may have an individual septic tank, which treats the wastewater on-site and discharges into the soil. Alternatively, domestic wastewater may be sent to a nearby privately owned treatment system (e.g. in a rural community).

2. **Industrial wastewater:** Some industrial facilities generate ordinary domestic sewage that can be treated by municipal facilities. Industries that generate wastewater with high concentrations of conventional pollutants (e.g. oil and grease), toxic pollutants (e.g. heavy metals, volatile organic compounds) or other nonconventional pollutants such as ammonia, need specialized treatment systems. Some of these facilities can install a pre-treatment system to remove the toxic components and then send the partially treated wastewater to the municipal system. Industries generating large volumes of wastewater typically operate their own complete on-site treatment systems. Some initiatives have been thriving at redesigning their manufacturing processes to reduce or eliminate pollutants through pollution prevention. Heated water generated by power plants or manufacturing plants may be controlled with:

I. cooling ponds, human-made bodies of water designed for cooling by evaporation, convection and radiation
II. cooling towers, which transfer waste heat to the atmosphere through evaporation and heat transfer cogeneration, a process where waste heat is recycled for domestic and industrial heating purposes.

3. **Agriculture wastewater**

- **Nonpoint source wastewater treatment:** Sediment washed off fields is the largest agricultural pollution source in the United States. Farmers may utilize erosion controls to reduce runoff flows and retain soil on their fields. Standard techniques include contour ploughing, crop mulching, crop rotation,

planting perennial crops and installing riparian buffers. Nutrients (nitrogen and phosphorus) are typically applied to farmland as commercial fertilizer; animal manure; or spraying of municipal or industrial wastewater (effluent) or sludge. Nutrients may also enter runoff from crop residues, irrigation water, wildlife and atmospheric deposition. Farmers can develop and implement nutrient management plans to reduce the excess application of nutrients and reduce the potential for nutrient pollution. To minimize pesticide impacts, farmers may use Integrated Pest Management (I.P.M.) techniques (which can include biological pest control) to maintain control over pests, reduce reliance on chemical pesticides and protect water quality.

- **Point source wastewater treatment:** Farms with large livestock and poultry operations, such as factory farms, are called concentrated animal feeding operations or feedlots in U.S. Animal slurries are usually treated by containment in anaerobic lagoons before disposal by spray or trickle application to grassland. Constructed wetlands are sometimes used to facilitate treatment of animal wastes. Some animal slurries are treated by mixing with straw and composted at high temperature to produce bacteriologically sterile and friable manure for soil improvement.

4. **Construction site storm water:** Sediment from construction sites is managed by installing erosion controls such as mulching and hydro seeding and sediment controls such as sediment basins and silt fences. Using spill prevention prevents discharge of toxic chemicals such as motor fuels and concrete washout and control plans and specially designed containers (e.g. for concrete washout) and structures such as overflow controls and diversion berms.
5. **Urban runoff (storm water):** Effective control of urban runoff involves reducing the velocity and flow of storm water and reducing pollutant discharges. Local governments use a variety of storm water management techniques to minimize the effects of urban runoff. These techniques called best management practices (B.M.P.s) in U.S. may focus on water quantity control, while others focus on improving water quality, and some perform both functions. Pollution prevention practices include low impact development techniques, installation of green roofs and improved chemical handling (e.g. management of motor fuels & oil, fertilizers and pesticides). Runoff mitigation systems include infiltration

basins, bio retention systems, constructed wetlands, retention basins and similar devices. Thermal pollution from runoff can be controlled by storm water management facilities that absorb the runoff or direct it into groundwater, such as bio retention systems and infiltration basins. Retention basins tend to be less effective at reducing the temperature, as may heat the sun's water before being discharged to a receiving stream.

What can we do to minimize water pollution?

- Fertilize garden and yard plants with manure or compost instead of commercial inorganic fertilizer.
- Minimize your use of pesticides.
- Do not apply fertilizer or pesticides near a body of water.
- Grow or buy organic foods.
- Do not drink bottled water unless tests show that your tap water is contaminated. Merely refill and reuse plastic bottles with tap water.
- Compost your food wastes.
- Do not use water fresheners in toilets.
- Do not flush unwanted medicines down the toilet.
- Do not pour pesticides, paints, solvents, oil, antifreeze, or other products containing harmful chemicals down the drain or onto the ground.

Governments, local councils and laws

Many governments have stringent laws that help minimize water pollution. These laws are usually directed to industries, hospitals, schools and market areas to dispose of, treat and manage sewage. In many developed cities, waste or sewage treatment is very efficient and designed to minimize water bodies' pollution. There are also lots of organizations and groups that help educate people about the dangers of water pollution. It is always great to join these groups because they regularly encourage other community members to have a better attitude towards water.

Several forms of legislation have been passed in recent decades to try to control water pollution. The Clean Water Act (C.W.A.) is the primary federal law in the United States governing water pollution. Passed in 1972, the act established the goals of eliminating releases of high amounts of toxic substances into water, eliminating additional water

pollution by 1985 and ensuring that surface waters would meet standards necessary for human sports and recreation by 1983. In effect, the principal body of law is based on the Federal Water Pollution Control Amendments of 1972 that was a significant expansion of the Federal Water Pollution Control Act of 1948. Consequential amendments were enacted in the Clean Water Act of 1977 and the Water Quality Act of 1987. The Clean Water Act does not directly address groundwater contamination. Groundwater protection provisions are included in the Safe Drinking Water Act, Resource Conservation and Recovery Act, and the Superfund act.

WATER POLLUTION - CASE STUDIES

The Love Canal Tragedy: This occurred in the Suburb of Niagara falls, New York. Love canal was built by William Love that was later dug up and was used to dump sealed steel drums of chemical wastes by Hooker Chemicals and Plastic Co. between 1942-53. In 1953, the dumpsite was covered with clay and topsoil by the company and sold to the City Board of Education, which built an elementary school on this site. Houses were also built near to the school. In 1976, the residents started complaining of foul smell. Children playing in the canal area received chemical burns. In 1977, the corroded steel containers started leaking the chemicals into storm sewers, the basement of homes and the school playground. About 26 toxic organic compounds were identified. The dumpsite was covered with clay, and the leaking wastes were pumped to the new treatment plant. The affected families were relocated.

Arsenic pollution in groundwater: the toxic heavy metal arsenic severely contaminates West Bengal & Bangladesh. The first report of arsenic pollution in West Bengal came in 1975 and that in Bangladesh in 1993. Familiar people were found to be ingesting low doses of arsenic for 10-14 years after which white or black spots called melanosis started mottling the skin. Later on, these spots converted into leprosy like skin lesions, eventually rotting into gangrenous ulcers. Long exposures often lead to bladder and lung cancer. In West Bengal, 40 million out of 90 million people have exposure to arsenic threat due to contaminated water. The 24 Parganas, Hooghly and Murshidabad districts and Behala and S. Eastern fringes of Kolkata lie in Arsenic Risk Zone. Excessive use of lead arsenate and Cu arsenite as pesticides in great yielding varieties of summer paddy and jute crops are the significant causes of arsenic pollution. Arsenic contaminated tube wells in the state are being painted red while safe water tube wells are painted green for use.

CONCLUSION

To combat water pollution, we must understand the problems and become part of the solution. The issues associated with water pollution can disrupt life on our planet to a great extent. Congress has passed laws to combat water pollution, thus acknowledging that water pollution is, indeed, a severe issue. But the government alone cannot solve the entire problem. It is ultimately up to us, to be informed, responsible and involved when it comes to the issues we face with our water. We must become familiar with our local water resources and learn about disposing of harmful household wastes to not end up in sewage treatment plants that can't handle them or landfills not designed to receive hazardous materials. In our yards, we must determine whether additional nutrients are needed before fertilizers are applied and look for alternatives where fertilizers might runoff into surface waters. We have to preserve existing trees and plant new trees and shrubs to help prevent soil erosion and promote infiltration of water into the soil.

TEXT

Nuclear Pollution

Any undesirable effect caused to the environment due to radioactive substances or radiations is called nuclear pollution. Pollution from radiation is a severe environmental concern arising from pollutants released in the environment through human activities. Nuclear pollution happens when radioactive element comes into contact with other elements in the environment and emits short wave electromagnetic rays, which are a severe threat to living organisms. Some elements in this world are naturally radioactive, while some others are made to be. The radioactive substances present in nature undergo natural radioactive decay in which unstable isotopes with excess protons and neutrons spontaneously give out fast-moving particles, high-energy radiations or both, at a fixed rate until a new stable isotope is formed. The time it takes for halfway of the decaying process is called the half-life, which differs for each radioactive element. It possibly takes up to 4.5 billion years (Uranium 238) and as short as 8 days (Iodine 131). Unstable, radioactive nuclei are called radionuclides. They occur naturally or can be produced by various physical means. The naturally occurring radionuclides are isotopes of heavy elements, from a lead (82 protons in the nucleus) to uranium (92 protons in the nucleus). The high-energy radiation emitted from radioisotopes removes electrons from atoms and attach them to other atoms, consequently producing positive and negative ion pairs. Such high-energy radiations are known as ionizing radiations. The type of radiation emitted from one radioisotope differs from another. Radionuclides release energy either in the form of Gamma rays, Alpha particles and beta particles. These ionization radiations have variable penetration power and ionization.

• Alpha particles can be blocked by a piece of paper and human skin. Alpha particles are fast-moving positively charged particles. Alpha radiation is highly ionizing but lacks penetration power.

• Beta particles are high speed negatively charged electrons. Beta radiation is somewhat less ionizing but somewhat more penetrating as well. Beta particles can penetrate through the skin, while it can be blocked by glass and metal pieces.

• Gamma rays are a high-energy form of radiation with no mass and no charge. Gamma rays are less ionizing but have incredibly high penetrating powers. Gamma rays can penetrate easily to human skin and damage cells on its way through, reaching far, and can only be blocked by a very thick, robust and massive piece of concrete.

Another type of radioactive emissions is neutron rays. Neutrons are large and uncharged particles that are emitted from radionuclides. The neutron particles are highly penetrating because they have no electric charge. They are neither deflected nor slowed by the passage near charged particles. They move in a straight path until they collide with nuclei of other atoms. They can induce radioactivity in non-radioactive substances. Neutrons are produced in atomic bombs and nuclear reactors. Significant radiation hazards are the result of exposure to gamma rays or neutron rays. All these radiation forms are called ionizing radiation because they possess enough energy to rip electrons away from atoms, leaving charged atoms called ions. These ions are the primary cause of damage in tissues. Radioactive substances, radiation and the environment, are the concerns to a radiation ecologist. There are two critical areas of radiation ecology, (I) effects of radiation on organisms in the biosphere, and (ii) the fate of radioactive substances released into the environment. The ratio of a radionuclide in the organism to that of the environment is called the concentration factor. When released into the environment, radioactive substances are either dispersed or diluted, but they may also become concentrated in living organisms, and during food chain, transfers called biomagnification. Other than naturally occurring radioisotopes; significant amounts are generated by human activity, including nuclear power plants, the manufacture of nuclear weapons, and atomic bomb testing.

Causes of nuclear pollution

Nuclear waste and radiation pollution involve any process that emanates radiation in the environment from several sources. The most common ones include:

• **Mining and refining uranium:** Mining of radioactive ores, e.g.) uranium and phosphate ores, involve crushing and processing radioactive ores, which generates radioactive by-products. Surface or underground mining obtains low-grade uranium ore containing 0.2 % uranium by weight. After mining the ore undergoes a milling process where it is crushed and treated with a solvent to concentrate the uranium and produces yellowcake (U3O8), a material containing 70 to 90 % uranium oxide.

Naturally occurring uranium has only 0.7 per cent of fissionable U-235, which is not high enough for most types of reactors. Hence, it is necessary to increase U-235 by enrichment, though; it is a complicated and expensive process. The enrichment process increases the U-235 content from 0.7 to 3 per cent. Fuel fabrication, a method known as Fuel fabrication, converts the enriched material into a powder compacted into pellets. The fabrication of the elements produces solid, liquid and gaseous wastes (three kinds of radioactive pollutants). These pellets are sealed in metal fuel rods about 4 meters in length, 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, new ones must replace the spent fuel rods. However, the spent rods are still very radioactive containing about one per cent U-235 and one per cent plutonium. These rods are a significant source of radioactive waste material produced by a nuclear reactor. At each step in the cycle (fig. 2), there is a danger of exposure to harmful radiation and poses several attendant health and environmental concerns

• **Operations conducted by nuclear power stations:** Nuclear power uses sustained nuclear fission to generate heat and electricity. The nuclear reaction produces highly radioactive waste. The nuclear fuel contains U-235. Nuclear fuel does not burn like fossil fuels, but the reaction that drives nuclear energy release in power plants is nuclear fission when an atomic nucleus is split apart. Atoms don't split spontaneously. Inside a nuclear reactor, U-235 atom undergoes fission when neutrons strike them and once they split, uranium atoms give off the enormous amount of energy. U-235 is housed in long fuel rods that are located in the reactor core. U-235 atoms naturally emit neutrons that bombard other uranium atoms, causing them to split. The heat released during fission is then transferred to the water that bathes the fuel rods in the reactor core. The heated water around the reactor core heats water in another closed system. In the latter, hot water is converted to steam, which drives a turbine that generates electricity. The steam is then cooled, and the water is used again. Most nuclear plants are cooled by water and are called light water reactors (LWRs). Other reactors use coolants such as liquid sodium but operate on the same principle and are called liquid metal fast breeder reactor (LMFBR). The radioactive emissions to the air vary with the type of reactor; they include nuclear fission products and neutron generated nuclides. Gaseous wastes include several radionuclides, viz. Tritium-3,

Carbon-14, Argon-85, Krypton-85, Iodine-131 and xenon-137. Liquid wastes contain Tritium-3 and radioactive isotopes of iron, cobalt, etc. Another nuclear power plant operation involves reprocessing the spent fuel that includes chemical treatment to separate the reusable components of uranium-235, uranium-238, and plutonium-239 from the waste fission products. In this process, gaseous waste fission products such as Tritium-3, Krypton-85 and Iodine -131, and large quantities of liquid wastes containing half-life nuclides and some high activity solid wastes are produced.

When a U-235 nucleus splits, it produces two smaller nuclei, called daughter nuclei or fission fragments. Over 400 different pieces can form during uranium fission, many of them are radioactive. When U-235 nuclei split, they also release neutrons, which strike other nuclei in the fuel rods, creating a chain reaction. The heat generated by fission is so intense that if the chain reaction is not carefully controlled and temperature rise not checked would soon melt the contents of the core and walls of the nuclear reactor with massive leakage of uranium and its many radioactive products and thus send tons of molten slag through the floor of the containment building. It is known as a meltdown. A full collapse would be an environmental hazard releasing high radioactivity levels in the air, soil and surface and groundwater, and subsequent storage and processing of these fuel rods with associated high radioactivity pose several problems. Three Mile Island nuclear power plant leakages in the USA in 1979 and meltdown of Chernobyl nuclear power plant in the USSR in 1986 are the examples of nuclear plant accidents causing escape of radionuclides in the atmosphere.

The nuclear fuel cycle begins when uranium mined, enriched, and manufactured into nuclear fuel, (1) which is delivered to a nuclear power plant. After usage in the power plant, the spent fuel is given to a reprocessing plant (2) or a final (3) for geological disposition. In reprocessing, 95% of spent fuel can potentially be recycled to be returned to usage in a power plant (4).

• **Nuclear explosions and detonations of nuclear weapons:** Of all the activities concerning nuclear weapons, testing has been the most destructive human health and the environment. A nuclear blast is responsible for nuclear pollution carried out for performing nuclear tests and making atomic weapons. China, France, India, Pakistan, Russia, the US and UK have collectively conducted over 2000 nuclear explosions for testing purposes - approximately 500 above ground and the rest underground. Due to

this explosion, about 15 to 20% of the radioactive particles enter into the stratosphere. Nuclear blasts are very rapid and based on a rough estimate; in an explosion, about 50% of the energy goes to the discharge, 33% as heat and 17% or so as radioactivity (Wagner, 1971). The nuclear explosion matter is vaporized to hot gas with very high pressure (several billion atmospheres) by heating at very high temperature (108 ^{0}C). An intense shower of many kinds of radiation releases in the atmosphere falls back to the earth near the blast within hours. Once they enter into the air, they continue to fall on the planet. The radioactive dust that falls to the ground after the atomic explosion is called radioactive fallout. The half-life of the radionuclides so produced varies from a few seconds to thousand years. strontium-90 with 28 years and caesium-137 with 30 years. Strontium-89 with 50 days and carbon-14 with more than 5000 years.strontium-90, caesium-137 being the most dangerous radioactive fallout materials from nuclear tests contaminates the environment for many years. It has been estimated that global fallout from atomic testing will lead to over 2 million cancer fatalities alone, not counting other health effects. (Radioactive Heaven and Earth. IPPNW. Apex Press. New York. 1991). The amount of radioactive fallout produced depends not only on the type and size of the atom bomb but also on the mixing of environmental materials with radionuclides. The radioactive specks of dust fuse with iron, silica and particulate matters in the vicinity and form relatively insoluble particles. The smaller particles adhere tightly to the leaf tissue, which is ingested by the grazing animals, and thus the radioactive fallout passes into man through the food chain. The best example of fallout is the nuclear bomb attack on Hiroshima and Nagasaki, Japan in 1945 by the United States of America. As a result of a nuclear bomb attack, nearly 2, 25,000 people had died due to long-term exposure to radiation from the bomb blast within five years of attack due to radiation effect and cancer. Moreover, the nuclear tests, which are conducted under the ground or oceans, also release radiation. Earlier, explosive atomic weapons tests have been conducted in the air, earth, underground, or sea. Except for underground tests, most of these tests produce significant quantities of radionuclides, e.g. C-14, Sr-90, I-131, Cs-137.

• **Defense weapon production:** In addition to the potential damage of a nuclear weapon explosion, there is also the issue of existing environmental harm caused by weapon production. Production of atomic weapons involves the generation of large quantities of waste material and contamination of surrounding areas. This process

generates large amounts of waste that frequently ends up in oceans, rivers, and soil. Nuclear weapons produce nuclear waste called Transuranic (TRU) waste. TRU materials have been generated in the US since the 1940s. Most of this waste originates Clean-up and containment of radioactive products that are dangerous for thousands of years presents the biggest challenge. But there are also risks in the dismantlement of nuclear weapons, including hazards to workers and environmental risks associated with non-nuclear aspects such as missile destruction. For example, according to the Intermediate-Range Nuclear Forces Treaty, hundreds of Pershing missiles were burned in the open air or exploded on a test stand at the Pueblo Army Depot in Colorado, United States. These procedures release clouds of toxic hydrochloric acid when the missiles solid fuel combines with moisture.

• **Decommissioning of nuclear weapons:** The decommissioning of nuclear weapons causes slightly more radioactive pollution than production. However, the waste (alpha particles) is still of low risk and not dangerous unless ingested.

• **Nuclear waste handling and disposal:** Transportation of nuclear wastes from one place to another by modes of transportation (air, land, water, sea) possibly brings severe hazards to the environment if they are not maintained carefully. Nuclear wastes may generate radiation over a long period of times. The radioactivity may contaminate and propagate through air, water, and soil as well. Thus, their effects may not be easily distinguishable and are hard to predict. Additional, some nuclear waste location may not be identified. The main problem with radiation waste cannot be degraded or treated chemically or biologically. The decaying process of radioactive waste takes a very long time because some radioactive wastes have a half-life of more than 10,000 years and are dangerous insignificant amount of time. The low-level wastes from power plants and other facilities, including hospitals and laboratories, are hazardous for about 300 years, and high-level waste can be dangerous for tens of thousands of years. Thus, the only options are to contain the waste by storing it in tightly closed containers shielded with radiation-protective materials or, if ordering is not possible, to dilute it. The waste may also be contained by storage in areas remote from biological habitats with little or no life, e.g.) small caves or abandoned salt mines. However, in time, the shields (natural or artificial) may be damaged. Additionally, past waste disposal practices may not have used appropriate measures to isolate the radiation. Thus, such areas need to be carefully identified, and access restrictions promptly imposed.

• Medical waste: Several radioactive isotopes are used in medicine, either for treatment or diagnostics. Radioactive medical waste tends to contain beta particle and gamma-ray emitters. In diagnostic nuclear medicine, several short-lived gamma emitters such as technetium-99m are used. These can be left over a short period after which they can be disposed of as regular waste. X-rays are the most significant humanmade radiation. X-ray machines are used for diagnostic purposes and in radiotherapy. X-rays penetrate the human body as gamma rays do. X-ray exposure causes cumulative effects on human beings.

EFFECTS OF NUCLEAR POLLUTION

1.Biological effects of ionizing radiation: Ionization radiations bring about more dangerous consequences than other toxicants. The radiations cause the most severe disorders escaped from nuclear power plants and atomic explosions. Their effects may continue in subsequent generations. The principal result of exposure of the whole body to penetrating ionizing radiation is the shortening of the exposed organisms' lives. The length of life is shortened. Studies have shown that the health effects due to radiation are dependent on the level of dose, kind of radiation, duration of exposure and types of cells irradiated. Radiation effects can be somatic or genetic. They bring about the following two types of undesirable effects on organisms.

a. Somatic effects: These are the direct results of radiation action on the function of body cells, tissues and organs. It causes damages cell membranes, mitochondria and cell nuclei resulting in abnormal cell functions, cell division, growth and death. Radiologists, uranium mineworkers and painters of radium dials suffer most. The somatic effects may be immediate or delayed. High radiation exposures have much toxicity and can kill an animal quickly. A dose of 400 to 500 roentgen on the whole body is fatal in about 50% of man, and 600 to 700 in practically every case. The victim declines in vitality and dies from anaemia, infection and haemorrhage. Parts of the body differ insensitivity. The most sensitive tissues from acute doses are intestines, lymph nodes, spleen and bone marrow. The radiation destroys the body's immune response. The effects of low penetrating radiation are less severe than the penetrating ones. In delayed effects, the patient may survive for months or years. Delayed radiation effects include eye cataracts, leukaemia, malignant tumours, and cardiovascular disorders, premature ageing and reduced life span. Diagnostic x-ray

exposure of pregnant women may increase the risk of cancer in a child. More evidence of degree and kind of damage from radiation come from studies of Nagasaki and Hiroshima survivors.

b.Genetic effects: Both background natural and humanmade radiation bring about genetic products. Studies on Drosophila have shown that mutation rates go very high due to radiation exposures. Background reactions differ in different parts of the earth. Most genetic effects are brought about by humanmade radiations, most important of which are exposure during medicare and power plants. People in the industry, research and medicine using radionuclides are exposed more than others. The most significant damage is in dividing cells, chiefly the gonads. The effects include mutation, which is changes in the genetic makeup of cells where these effects are mainly due to the damages to DNA molecules, lethal effects on egg or embryo. People have blood cancer and bone cancer if exposed to doses around 100 to 1000 roentgen. Instantaneous deaths can occur on exposure in the event if disasters are many. The intensity of radiation affects the rate of mutation. Generally, higher animals are more susceptible to genetic damage than lower animals as insects. Genetic effects also occur in plants.

Example of effects on human health: The Chernobyl explosion led to increased cancer prevalence in young children in Belarus, the Russian Federation, and Ukraine. According to the Greenpeace 2006 report, "Chernobyl Catastrophe Consequences on Human Health," over 2 billion people have been exposed to the radioactive fallout, which will result in 250,000 cases of cancer, nearly half of them fatal. Ionization radiations can cause brain damages. High exposure to radiation early on in gestation can have damaging effects on the brain, notes the U.S. Centers for Disease Control (CDC). Infants between the eighth and 15th weeks of pregnancy exposed to the atomic bombs dropped on Hiroshima and Nagasaki during World War II were discovered to have a greater incidence of brain damage, with side effects including lower IQs and some cases, severe mental retardation.

2. EFFECTS ON THE ENVIRONMENT

The environmental impact of nuclear power results from the nuclear fuel cycle, operation, and the effects of accidents. The possibility of over-heated fuel releasing

massive quantities of fission products to the environment can cause catastrophic risks to the ground.

a. Contaminated water:

According to the World Health Organization (WHO), nuclear accidents may produce fallout, polluting water supplies for years after the incident. The 1986 explosion of a nuclear generator in Chernobyl (Ukraine) created a sizeable radioactive cloud which polluted existing water supplies and produced contaminated rain in nearby countries.

b. Increase in water temperature:

Nuclear power plants release heat into the water like thermal power stations. The water temperature in the nuclear power station area is higher than without it, disturbing the balance of water evaporation. Also, the amount of salt in water increases. Such changes lead to the extinction of some species of animals.

C. Contaminated soil and plants:

Nuclear radiation can contaminate soil that leads to plants which pose a health threat to individuals. Researchers explored the Marshall Islands, an area widely known for nuclear bomb testing by the US military in the 1950s and 1960s. They found that current soil samples and local foods, including coconut meat, contained radiation levels significant enough to pose a health risk to individuals.

TEXT

INTRODUCTION

Garbage is generally referred to “Waste” and is also termed as rubbish, trash, junk, unwanted or undesired material. Litter refers to waste disposed of improperly. As per the Municipal Solid Waste (Management & Handling) Rule, 2000 garbage is define as Municipal Solid Waste which includes commercial and residential wastes generated in a municipal or notified areas in either solid or semi-solid form excluding industrial hazardous wastes but including treated bio-medical wastes.

Causes of Solid Waste Generation

Human and animal activities generate different kinds of wastes (Table 1). These wastes are generally in solid form, and may cause pollution of land, water, and air unless treated and disposed of. Some of the main causes of solid waste generation are as follows:

1. Population increase, 2. Growing urbanization, 3 Industry, 4 Mining and 5 Transport

Classification of materials comprising municipal solid wastes

Food wastes: The animal, fruit, or vegetable residues (also called garbage) resulting from the handling, preparation, cooking and eating of foods. Because food wastes are putrescible, they will decompose rapidly, especially in warm weather.

Rubbish: Combustible and non-combustible solid wastes, excluding food wastes or putrescible materials. Typically combustible rubbish consists of materials such as paper, cardboard, plastics, textiles, rubber, leather, wood, furniture, and garden trimmings. Non- combustible rubbish consists of items such as glass, crockery, tin cans, aluminium cans, ferrous and non-ferrous metals, dirt and construction material

Ashes and residues: Materials remaining from the burning wood, coal, coke, and other combustible wastes. Ashes and residues are normally composed of fine, powdery materials, cinders, clinkers, and small amounts of burned and partially burned materials.

Demolition and construction wastes: Wastes from razed buildings and other structures are classified as demolition wastes. Wastes from the construction, remodeling, and repairing of residential, commercial, and industrial buildings and similar structures are classified as construction wastes. These wastes may include dirt, stones, concrete, bricks, plaster, lumber, shingles, and plumbing, heating, and electrical parts. They are usually of an inert nature. The main exception is asbestos, where special disposal is required.

Special wastes: Wastes such as street sweepings, roadside litter, catch-basin debris,

dead animals, trash like abandoned vehicles, electrical appliances are classifies as special wastes

Treatment plant wastes and dredged soil: The solid and semisolid wastes from water, sewage and industrial wastewater treatment facilities are included in this classification. Sewage sludge is slurry of fine organic-rich particles with a highly variable chemical composition depending on the sources of the effluent and the type and efficiency of the treatment processes. Sewage sludges tend to concentrate heavy metals and water-soluble synthetic organic compounds, but they may also contain greases, oils and bacteria.

Dredged materials are excavated from river estuaries, harbors and other waterways to aid navigation. It is estimated that 10% of dredged materials is contaminated by oil, heavy metals, nutrients and organochlorine compounds.

Main Sources of Municipal Waste

Some of the main sources of municipal waste are: Household waste, commercials, street sweeping, hotels and restaurants, clinics and dispensaries, construction and demolition, horticulture and sludge

Types of solid waste

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

- Household waste is generally classified as municipal waste,
- Industrial waste as hazardous waste, and

- ❖ Biomedical waste or hospital waste as infectious waste

Municipal solid waste

Municipal solid waste consists of household waste, construction and demolition debris, sanitation residue, and waste from streets. This garbage is generated mainly from residential and commercial complexes (Figure 1). With rising urbanization and change in lifestyle and food habits, the amount of municipal solid waste has been increasing rapidly and its composition changing. In 1947 cities and towns in India generated an estimated 6 million tonnes of solid waste; in 1997 it was about 48 million tonnes. More than 25% of the municipal solid waste is not collected at all; 70% of the Indian cities lack adequate capacity to transport it and there are no sanitary landfills to dispose of the waste. The existing landfills are neither well equipped nor well managed and are not lined properly to protect against contamination of soil and groundwater. The annual per capita generation of municipal solid waste in India is 150 to 200 kg. In India, more than 1400 sq. km of land, which is the size of the city of Delhi, would be required to dispose of solid waste by the year 2047.

Over the last few years, the consumer market has grown rapidly leading to products being packed in cans, aluminium foils, plastics, and other such non-biodegradable items that cause incalculable harm to the environment.

Composition of Municipal Solid Waste in USA

In the United States, the largest component (more than one third) of municipal solid waste (MSW) is paper and paper products. Only small fraction (7%) is actually garbage.

Composition of Municipal Solid Waste in India

In India the biodegradable portion dominates the bulk of Municipal Solid Waste. Generally the biodegradable portion is mainly due to food and yard waste

With rising urbanization and change in lifestyle and food habits, the amount of municipal solid waste has been increasing rapidly and its composition changing. There are different categories of waste generated, each take their own time to degenerate

The type of litter we generate and the approximate time it takes to degenerate:

Organic waste such as vegetable and fruit peels, leftover foodstuff, etc.: A week or two.

Paper: 10–30 days

Cotton cloth: 2–5 months

Wood: 10–15 years

Woolen items: 1 year

Tin, aluminium, and other metal items such as cans: 100–500 years

Plastic bags: One million years

Glass bottles: undetermined

Industrial waste

The major generators of industrial solid wastes are the thermal power plants producing coal ash, the integrated Iron and Steel mills producing blast furnace slag and steel melting slag, non-ferrous industries like aluminum, zinc and copper producing red mud and tailings, sugar industries generating press mud, pulp and paper industries producing lime and fertilizer and allied industries producing gypsum.

Industrial waste as hazardous waste/ Biomedical waste as infectious

Modern society produces large quantities of hazardous waste which are generated by chemical manufacturing companies, petroleum refineries, paper mills, smelters and other industries. 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.

Industrial and hospital waste is considered hazardous as they may contain toxic substances. In the industrial sector, the major generators of hazardous waste are the

metal, chemical, paper, pesticide, dye, refining, and rubber goods industries. Direct exposure to chemicals in hazardous waste such as mercury and cyanide can be fatal while as, Hospital waste contaminated by chemicals like formaldehyde and phenols as disinfectants used in hospitals is considered hazardous. Hospital waste is generated during the diagnosis, treatment, or immunization of human beings or animals or in research activities in these fields or in the production or testing of biological. It may include wastes like sharps, soiled waste, disposables, anatomical waste, cultures, discarded medicines, chemical wastes, etc. These are in the form of disposable syringes, swabs, bandages, body fluids, human excreta, etc. This waste is highly infectious and can be a serious threat to human health if not managed in a scientific and discriminate manner. It has been roughly estimated that of the 4 kg of waste generated in a hospital at least 1 kg would be infected.

Certain types of household waste are also hazardous. Hazardous wastes could be highly toxic to humans, animals, and plants; are corrosive, highly inflammable, or explosive; and react when exposed to certain things e.g. gases. India generates around 7 million tonnes of hazardous wastes every year, most of which is concentrated in four states: Andhra Pradesh, Bihar, Uttar Pradesh, and Tamil Nadu. Household wastes that can be categorized as hazardous waste include old batteries, shoe polish, paint tins, old medicines, and medicine bottles.

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.

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. 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. Ignitable wastes are those that burn at relatively low temperatures (less than 60 ºC) and are capable of spontaneous combustion during storage,

transport or disposal. For example, gasoline, paint thinners, and alcohol. Corrosive wastes are those that destroy materials and living tissue by chemical reaction such as, acids and bases. Infectious wastes include human tissue from surgery, used bandages and hypodermic needles, microbiological materials, 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

Challenging waste

Plastics

Plastic with its exclusive qualities of being light yet strong and economical, has invaded every aspect of our day-to-day life. It has many advantages: it is durable, light, easy to mould, and can be adapted to different user requirements. Once hailed as a 'wonder material', plastic is now a serious worldwide environmental and health concern, essentially due to its non- biodegradable nature. In India, the plastic industry is growing phenomenally. Plastics have use in all sectors of the economy -infrastructure, construction, agriculture, consumer goods, telecommunications, and packaging thus becomes the source of generation of waste plastics

Environmental effects of solid waste

The group at risk from the unscientific disposal of solid waste include – the population in areas where there is no proper waste disposal method, especially the pre-school children; waste workers; and workers in facilities producing toxic and infectious material. Other high-risk group includes population living close to a waste dump and those, whose water supply has become contaminated either due to waste dumping or leakage from landfill sites. Uncollected solid waste also increases risk of injury, and infection.

In particular, organic domestic waste poses a serious threat, since they ferment, creating conditions favourable to the survival and growth of microbial pathogens. Direct handling of solid waste can result in various types of infectious and chronic diseases with the waste workers and the rag pickers being the most vulnerable.

Occupational hazards associated with waste handling

Infections:

- ❖ Skin and blood infections resulting from direct contact with waste, and from infected wounds.
- ❖ Eye and respiratory infections resulting from exposure to infected dust, especially during landfill operations.
- ❖ Different diseases that results from the bites of animals feeding on the waste.
- ❖ Intestinal infections that are transmitted by flies feeding on the waste

Chronic diseases

- ❖ Incineration operators are at risk of chronic respiratory diseases, including cancers resulting from exposure to dust and hazardous compounds.

Accidents

- ❖ Bone and muscle disorders resulting from the handling of heavy containers.
- ❖ Infecting wounds resulting from contact with sharp objects.
- ❖ Poisoning and chemical burns resulting from contact with small amounts of hazardous chemical waste mixed with general waste.
- ❖ Burns and other injuries resulting from occupational accidents at waste disposal sites or from methane gas explosion at landfill sites.

Waste from agriculture and industries can also cause serious health risks. Other than this, co-disposal of industrial hazardous waste with municipal waste can expose people to chemical and radioactive hazards. Uncollected solid waste can also obstruct storm water runoff, resulting in the forming of stagnant water bodies that become the breeding ground of disease. Waste dumped near a water source also causes contamination of the water body or the ground water source. Direct dumping of untreated waste in rivers, seas and lakes, results in the accumulation of toxic substances in the food chain through the plants and animals that feed on it.

Waste treatment and disposal sites can also create health hazards for the neighborhood. Improperly operated incineration plants cause air pollution and improperly managed and designed landfills attract all types of insects and rodents that spread disease. Exposure to hazardous waste can affect human health, children being more vulnerable to these pollutants. In fact, direct exposure can lead to diseases

through chemical exposure as the release of chemical waste into the environment leads to chemical poisoning.

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.

Lead, mercury and arsenic are hazardous substances that are often referred to as heavy metals. Lead can affect red blood cells by reducing their ability to carry oxygen and shortening their life span. Lead may also damage nerve tissue that can result in brain disease. Mercury is a cumulative poison (it builds up in the body over long periods of time) and is known to cause brain damage. PCBs (Polychlorinated biphenyls) 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. Vinyl chloride can cause deafness, vision problems, circulation disorders and bone deformities. Vinyl chloride can also cause birth defects.

We may not realize it but many household chemicals can be quite toxic to humans as well as wildlife. Most of the dangerous substances in our homes are found in various kinds of cleaners, solvents and products used in automotive care. When these products are used incorrectly they have the potential to be harmful.

Impact of plastics on environment

The unhygienic use and disposal of plastics and its effects on human health has become a matter of concern. Coloured plastics are harmful as their pigment contains heavy metals that are highly toxic. Some of the harmful metals found in plastics are copper, lead, chromium, cobalt, selenium, and cadmium. Conventional plastics have been associated with reproductive problems in both wildlife and humans. Studies have shown a decline in human sperm count and quality, genital abnormalities and a rise in the incidence of breast cancer. Dioxin a highly carcinogenic and toxic by-product of

the manufacturing process of plastics is one of the chemicals believed to be passed on through breast milk to the nursing infant. Burning of plastics, especially PVC releases this dioxin and also furan into the atmosphere. Thus, conventional plastics, right from their manufacture to their disposal are a major problem to the environment Polythene bags are not only causing harm to the environment and blocking drains but are also proving fatal to stray cattle. It is estimated that thousands of cattle die in the capital (Delhi) due to the consumption of plastic bags thrown in the dustbins. When a veterinary surgeon, Dr. H. Jadeja (founder member of SPCA (Society for the Prevention of Cruelty to Animals in Bhuj), operated on a seriously ill cow in Bhuj as stated he found 4000 plastic bags in its stomach along with other non-digestible waste. At the Delhi zoo a swamp deer and a Sangai (deer found in Manipur) died due to consumption of plastic bags.

In most industrialized countries, colour plastics have been legally banned. In India, the Government of Himachal Pradesh has banned the use of plastics and so has Ladakh district. Other states should emulate their example.

Control measures of urban and industrial wastes

Solid waste management

Solid waste management encompasses the planning, design, financing, construction and operation of facilities for segregation, collecting, storage, transporting, processing/treatment, recycling and final disposal of the residual solid waste material. A typical waste management system in a low- or middle-income country like India includes the following elements:

- • Waste generation and storage
- • Segregation, reuse, and recycling at the household level
- • Primary waste collection and transport to a transfer station or community bin
- • Street sweeping and cleansing of public places
- • Management of the transfer station or community bin
- • Secondary collection and transport to the waste disposal site
- • Waste disposal in landfills

But in most of the Indian cities open dumping is the Common practices which is adversely affecting on environment and Public health.

Some are the main Control measures of urban and industrial wastes which are generally used everywhere includes the following components:

1.Segregation,

2. Source reduction,

3. Resource Recovery,

4 Recycling,

5. Disposal

1.Segregation:

Certain things that are not needed around the house are kept aside to be sold to the kabadiwala or the man who buys old items. These items are newspapers, used bottles, magazines, carry bags, old exercise books, oilcans, etc. This is one form of segregation, which is done as a routine in all households in India. Separating our waste is essential as the amount of waste being generated today causes immense problem. Segregation of municipal solid waste can be clearly understood by schematic representation. Certain items are not biodegradable but can be reused or recycled. In fact, it is believed that a larger portion can be recycled, a part of it can be converted to compost, and only a smaller portion of it is real waste that has no use and has to be discarded.

Household waste should be separated daily into different bags for the different categories of waste such as wet and dry waste, which should be disposed of separately. One should also keep a bin for toxic wastes such as medicines, batteries, dried paint, old bulbs, and dried shoe polish. Wet waste, which consists of leftover foodstuff, vegetable peels, etc., should be put in a compost pit and the compost could be used as manure in the garden. Dry waste consisting of cans, aluminium foils, plastics, metal, glass, and paper could be recycled. If we do not dispose of the waste in a more systematic manner, more than 1400 sq. km of land, which is the size of the city of Delhi, would be required in the country by the year 2047 to dispose of it.

Door-to-door collection of waste is another method of segregation, but it is not a common practice as yet in India except in the metros where some private organizations are doing such work.

The role of the rag pickers: Rag pickers are the people who are actually going through the garbage bins to pick out the ‘rags’. These rag pickers, women, children, and men from the lowest rung in the society, are a common sight in most cities and towns around the country. Rag picking is considered the most menial of all activities and it is people who have no other alternative that are generally driven to it. Rag pickers contribute a great deal to waste management as they scavenge the recyclable matter thereby saving the municipality of the cost and time of collecting and transporting this to the dumps.

The rag picker has a special role to play in the segregation of waste in India. He is one of the focal points for the recycling of waste. He is the person who, in spite of all the dangers that he faces, goes on relentlessly picking through the garbage bin, looking for waste that could be useful to him (Figure 5). He sells all the material he picks to the whole sellers and retailers who in turn sell it to the industry that uses this waste matter as raw material. The main items of collection are plastics, paper, bottles, and cans.

2. Source reduction: Source reduction is one of the fundamental ways to reduce waste. Using less material when making a product, reuse of products on site, designing products or packaging to reduce their quantity can do this. 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.

3. Resource Recovery: Numerous thermal processes, now in various stages of development, recover energy in one form or another from solid waste. These systems fall into two groups: combustion processes and pyrolysis processes.

Combustion processes: Pyrolysis, also called destructive distillation, is the process of chemically decomposing solid wastes by heat in an oxygen-reduced atmosphere. This result in a gas stream containing primarily hydrogen, methane, carbon monoxide,

carbon dioxide, and various other gases and inert ash, depending on the organic characteristics of the material being pyrolyzed

4. Recycling: Recycling involves the collection of used and discarded materials processing these materials and making them into new products thus; 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. It reduces the amount of waste that is thrown into the community dustbins thereby making the environment cleaner

The steps involved in the process prior to recycling include:

a) Collection of waste from doorsteps, commercial places, etc.

b) Collection of waste from community dumps.

c) Collection/picking up of waste from final disposal sites

Some materials such as aluminum and steel can be recycled many times. Metal, paper (Old copies, Old books, Paper bags, Newspapers, Old greeting cards and Cardboard box), glass and plastics (Containers, Bottles, Bags and Sheets) 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. Studies have revealed that 7 %-15% of the waste is recycled. If recycling is done in a proper manner, it will solve the problems of waste or garbage. However, even if recycling is a viable alternative, it presents several problems.

The problems associated with recycling are either technical or economical. Plastics are difficult to recycle because of the different types of polymer resins used in their production. Since each type has its own chemical makeup different plastics cannot be recycled together. Thus separation of different plastics before recycling is necessary. Similarly in recycled paper the fibers are weakened and it is difficult to control the

colour of the recycled product. Recycled paper is banned for use in food containers to prevent the possibility of contamination. It very often costs less to transport raw paper pulp than scrap paper. Collection, sorting and transport account for about 90 percent of the cost of paper recycling. The processes of pulping, deinking and screening wastepaper are generally more expensive than making paper from virgin wood or cellulose fibers. Very often thus recycled paper is more expensive than virgin paper. However as technology improves the cost will come down.

5. Disposal Methods: As cities are growing in size with a rise in the population, the amount of waste generated is increasing becoming unmanageable. The local corporations have adapted different methods for the disposal of waste – open dumps, landfills, sanitary landfills, and incineration plants. One of the important methods of waste treatment is composting

Open dumps: Open dumps refer to uncovered areas that are used to dump solid waste of all kinds. The waste is untreated, uncovered, and not segregated. It is the breeding ground for flies, rats, and other insects that spread disease. The rainwater run-off from these dumps contaminates nearby land and water thereby spreading disease. In some countries, open dumps are being phased out.

Landfills: Landfills are generally located in urban areas where a large amount of waste is generated and has to be dumped in a common place. Unlike an open dump, it is a pit that is dug in the ground. The garbage is dumped and the pit is covered thus preventing the breeding of flies and rats. At the end of each day, a layer of soil is scattered on top of it and some mechanism, usually earth-moving equipment is used to compress the garbage, which now forms a cell. Thus, every day, garbage is dumped and becomes a cell. After the landfill is full, the area is covered with a thick layer of mud and the site can thereafter be developed as a parking lot or a park. Landfills have many problems. All types of waste is dumped in landfills and when water seeps through them it gets contaminated and in turn pollutes the surrounding area. This contamination of groundwater and soil through landfills is known as leaching

Sanitary landfill:

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:

• Solid waste is placed in a suitably selected and prepared landfill site in a carefully prescribed manner.

• The waste material is spread out and compacted with appropriate heavy machinery.

• The waste is covered each day with a layer of compacted soil.

The problems with older landfills are associated with groundwater pollution. Pollutants seeping out from the bottom of a sanitary landfill (leachate) very often percolate down to the groundwater aquifer no matter how thick the underlying soil layer. Today it is essential to have suitable bottom liners and leachate collection systems along with the installation of monitoring systems to detect groundwater pollution. The organic material in the buried solid waste will decompose due to the action of microorganisms. In a modern landfill, refuse is spread in thin layers, each of which is compacted by a bulldozer before the next is spread. When about 3 m (about 10 ft) of refuse has been laid down, it is covered by a thin layer of clean earth, which also is compacted.

At first the waste decomposes aerobically until the aerobic microorganisms use up the oxygen that was present in the freshly placed fill. The anaerobes take over producing methane that is poisonous and highly explosive when mixed with air in concentrations between 5 and 15 percent. Providing impermeable barriers in the landfill can control the movement of gas. A venting system to collect the blocked gas and vent it to the surface where it can be safely diluted and dispersed into the atmosphere is thus a necessary component of the design of sanitary landfills

Incineration 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 815oC for about one hour. Incineration can reduce the municipal solid waste by about 90 percent in volume and 75 percent in weight.

Plasma gasification: Plasma is a highly ionized or electrically charged gas. An example in nature is lightning, capable of producing temperatures exceeding 12,600 °F (6,980 °C). A gasifier vessel utilizes proprietary plasma torches operating at +10,000 °F (5,540 °C) (the surface temperature of the Sun) in order to create a gasification zone of up to 3,000 °F (1,650 °C) to convert solid or liquid wastes into a syngas. When municipal solid waste is subjected to this intense heat within the vessel, the waste's molecular bonds break down into elemental components. The process results in elemental destruction of waste and hazardous materials.

Composting: Organic matter constitutes 35%–40% of the municipal solid waste generated in India. This waste can be recycled by the method of composting, one of the oldest forms of disposal. It is the natural process of decomposition of organic waste that yields manure or compost, which is very rich in nutrients. Composting is a biological process in which microorganisms, mainly fungi and bacteria, convert degradable organic waste into humus like substance. This finished product, which looks like soil, is high in carbon and nitrogen and is an excellent medium for growing plants. The process of composting ensures the waste that is produced in the kitchens is not carelessly thrown and left to rot. It recycles the nutrients and returns them to the soil as nutrients. Apart from being clean, cheap, and safe, composting can significantly reduce the amount of disposable garbage. The organic fertilizer can be used instead of chemical fertilizers and is better specially when used for vegetables. It increases the soil's ability to hold water and makes the soil easier to cultivate. It helped the soil retain more of the plant nutrients.

Vermi-Composting: Vermi-composting has become very popular in the last few years. In this method, worms are added to the compost. These help to break the waste and the added excreta of the worms makes the compost very rich in nutrients. Country's first aerobic composting plant was set up in Mumbai (1992). In Vermi composting, 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. This soil can be used as manure for farms and gardens.

Steps for Vermi-Compost

1. Dig a pit about half a meter square, one meter deep.
2. Line it with straw or dried leaves and grass.
3. Organize the disposal of organic waste into the pit as and when generated.
4. Introduce a culture of worms that is now produced commercially.
5. Ensure that the contents are covered with a sprinkling of dried leaves and soil every day.
6. Water the pit once or twice a week to keep it moist.
7. Zurn over the contents of the pit every 15 days.
8. In about 45 days the waste will be decomposed by the action of the microorganisms.
9. The soil derived is fertile and rich in nutrients

Four R's of Waste management

Four Rs (Refuse, Reuse, Recycle and Reduce) to be followed for waste management

- Refuse. Instead of buying new containers from the market, use the ones that are in the house. Refuse to buy new items though you may think they are prettier than the ones you already have.
- Reuse. Do not throw away the soft drink cans or the bottles; cover them with homemade paper or paint on them and use them as pencil stands or small vases
- Recycle. Use shopping bags made of cloth or jute, which can be used over and over again. Segregate your waste to make sure that it is collected and taken for recycling.
- Reduce. Reduce the generation of unnecessary waste, e.g. carry your own shopping bag when you go to the market and put all your purchases directly into it.

Solid waste management: Segregation at source

Dubai generates about 10,000 tonnes of solid waste a day, one of the highest rates in the world. However, according to official figures, only one per cent of it gets recycled regularly. One of the hindrances is the issue of sorting at the source, which is largely ignored by waste generators. Separation of waste by users helps increase recycling as it prevents recyclable waste getting mixed with wet waste or waste that cannot be recycled.

The result revealed that there is about 19 per cent of paper, 23 per cent of plastic, 6 per cent of metals and more than 3 per cent of wood wastes arriving into Dubai's landfills. These numbers prove further opportunities for segregation of recyclables in order to minimize land filling. Most of these materials are originated from industrial and commercial establishments. Therefore the Dubai Municipality announced that waste segregation in colour-coded recycling bins will be mandatory for industrial and commercial establishments, towers and shopping centers in Dubai from 4 September 2011, this circular is intended for all such establishments, which includes commercial towers and shopping centers as well,". The approved colour coding of recyclable materials is blue for papers, green for plastics, yellow for cans and red for glass

Srinagar Municipal Corporation (SMC) in Jammu and Kashmir has started from the year 2013, segregation of solid waste at source level and in this regard issuance of color coded twin bins has been distributed free of cost among 10,000 households in 10 administrative wards.

Preventive measures

Proper methods of waste disposal have to be undertaken to ensure that it does not affect the environment around the area or cause health hazards to the people living there.

At the household-level proper segregation of waste has to be done and it should be ensured that all organic matter is kept aside for composting, which is undoubtedly the best method for the correct disposal of this segment of the waste. In fact, the organic part of the waste that is generated decomposes more easily, attracts insects and causes disease. Organic waste can be composted and then used as a fertilizer.

Disposal of hospital and other medical waste requires special attention since this can create major health hazards. This waste generated from the hospitals, health care

centers, medical laboratories, and research centers such as discarded syringe needles, bandages, swabs, plasters, and other types of infectious waste are often disposed with the regular non-infectious waste.

Landfill sites should be located at a safe distance from all human settlement. Landfill sites should be well lined and walled to ensure that there is no leakage into the nearby ground water sources.

Role of individuals towards taking care of environment

Concepts that help individuals contribute towards a better quality of our environment and human 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?

• 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

• 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

• Don’t use throwaway paper and plastic plates and cups when reusable versions are available

• 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

• Choose items that have the least packaging or no packaging

• Start individual or community composting or vermicomposting plants in your neighborhood and motivate people to join in.

• Do not litter wastes along 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.

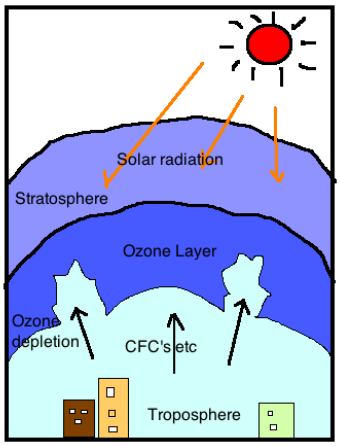
• Learn about the biodiversity of your own area. Understand the natural and cultural assets. This would help you to develop a sense of pride in your city/town/village and will also help you understand the problems facing their survival because of waste generation

It is important that you do not get discouraged at the first sign of trouble. Do not dwell on the negative aspects. But take positive actions wherever you can to make the world a better place to live in

• Take care to put into practice what you preach. Remember environment protection begins with YOU

What is Ozone Layer Depletion?

Ozone layer depletion means the thinning of the ozone layer present in the upper atmosphere. That is harmful to nature and the atmosphere. Ozone layer depletion is one of the major problems for the atmosphere and also for all the living beings including the flora and fauna of this earth.



What is the Ozone Layer?

The ozone layer is the layer present in the Stratosphere. It absorbs the harmful ultraviolet rays that come from the sun. Moreover, it causes harmful radiation that has a high concentration of ozone (O3) which is harmful to living beings on the earth.

The ozone layer is basically present in the lower stratosphere that is near about 20 to 35 kilometers above the earth. Moreover, the thickness of the ozone layer may differ depending upon the seasonal and geographical changes.

The ozone layer is important for the earth because it protects the earth from the harmful ultraviolet radiation. This radiation comes from the sun and is harmful to the earth's surface

The flora and the fauna would not be able to survive if the earth will be directly affected by the harmful ultraviolet rays. Moreover, humans and animals on earth will face a lot of problems because of excess heating.

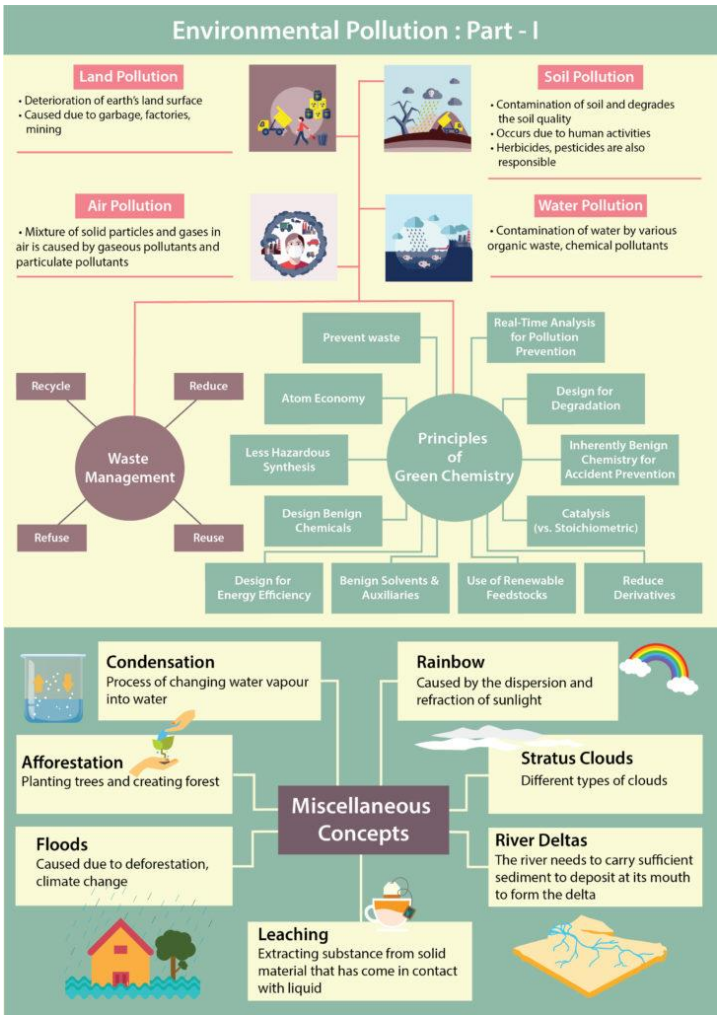
Causes of Ozone Layer Depletion

According to the studies done by the scientists the cause of the ozone layer depletion is human activity. All the activities are done by human beings. Through which the chemicals are made that contain chlorine or bromine. These are basically called ODS that stands for Ozone-Depleting Substance.

The ozone layer depletion was observed by the researchers in the early 1970s. Furthermore, the ozone-depleting substances are said to be Eco-friendly and they are very popular for the last some decades and are still in use.

These ozone depletion substances float and then reach the stratosphere. Therefore, the formation of chlorine and bromine takes place and these chemicals cause the depletion of the ozone layer at a very high speed.

They are capable of breaking down the molecules of the ozone layer. One chlorine molecule has a capacity to breakdown thousands of molecules present in the ozone layer, therefore, it results in the depletion of the ozone layer.



Natural Causes of Depletion of the Ozone Layer

It is found that the ozone layer gets affected by some natural causes that are sun-spots and stratospheric winds. However, these cause a very nominal contribution to the ozone layer depletion which is near about 1 to 2 percent and therefore these effects are temporary. Some major volcanic eruptions have also contributed to the depletion of the ozone layer. Two of them are (Chichon in 1983) and another one is (Mt. Pinatubo in 1991).

Man-made Causes of Depletion of the Ozone Layer

Human activities are the main cause of the depletion of the ozone layer. It occurs due to the excessive use of the man-made chemicals that are bromine and chlorine which release from the man-made compounds such as:

- Chlorofluorocarbons (CFCs)

- CFCs (chlorofluorocarbons)
- Halon
- CH3CCl3 (Methyl chloroform)
- CCl4 (Carbon tetrachloride)
- H CFCs (hydro-chlorofluorocarbons)
- Chlorofluorocarbons
- Methyl bromide

Solutions to Ozone Layer Depletion

Less use of Fuel: by reducing the usage of the fuels and petroleum used in vehicles nowadays we can help in reducing the ozone layer depletion

Less use of pesticides: pesticides helps in growing your farms and plants but cause harm to the ozone layer and contribute to ozone layer depletion.

Limited use of harmful chemicals for cleaning: the chemicals used for making cleaning products results in depletion of the ozone layer.

Acid rain, or acid deposition, is a broad term that includes any form of precipitation with acidic components, such as sulfuric or nitric acid that fall to the ground from the atmosphere in wet or dry forms. This can include rain, snow, fog, hail or even dust that is acidic. Acidity and alkalinity are measured using a pH scale for which 7.0 is neutral. The lower a substance's pH (less than 7), the more acidic it is; the higher a substance's pH (greater than 7), the more alkaline it is. Normal rain has a pH of about 5.6; it is slightly acidic because carbon dioxide (CO_2) dissolves into it forming weak carbonic acid. Acid rain usually has a pH between 4.2 and 4.4.

Acid rain results when sulfur dioxide (SO_2) and nitrogen oxides (NOX) are emitted into the atmosphere and transported by wind and air currents. The SO_2 and NOX react with water, oxygen and other chemicals to form sulfuric and nitric acids. These then mix with water and other materials before falling to the ground.

While a small portion of the SO_2 and NOX that cause acid rain is from natural sources such as volcanoes, most of it comes from the burning of fossil fuels. The major sources of SO_2 and NOX in the atmosphere are:

Burning of fossil fuels to generate electricity. Two thirds of SO_2 and one fourth of NOX in the atmosphere come from electric power generators.

Vehicles and heavy equipment.

Manufacturing, oil refineries and other industries.

Winds can blow SO_2 and NOX over long distances and across borders making acid rain a problem for everyone and not just those who live close to these sources.

Effects of Acid Rain

Acid rain is very harmful to agriculture, plants, and animals. It washes away all nutrients which are required for the growth and survival of plants. Acid rain affects agriculture by the way how it alters the composition of the soil.

Acid rain effect on plants

It causes respiratory issues in animals and humans.

When acid rain falls down and flows into the rivers and ponds it affects the aquatic ecosystem. As it alters the chemical composition of the water, to a form which is actually harmful to the aquatic ecosystem to survive and causes water pollution.

Acid rain also causes the corrosion of water pipes. Which further results in leaching of heavy metals such as iron, lead and copper into drinking water.

It damages the buildings and monuments made up of stones and metals.

Effects of acid rain on monuments

Real-Life Examples

Taj Mahal, one of the 7 wonders of the world, is largely affected by acid rain. The city of Agra has many industries which emit the oxides of sulphur and nitrogen in the atmosphere. People continue to use low-quality coal and firewood as a domestic fuel, adding to this problem.

Effects of acid rain on Taj Mahal

The formation of calcium sulphate results in the corrosion of this beautiful monument.

Statue of Liberty which is made of copper has also been damaged by the cumulative action of acid rain & oxidation for over 30 years and is, therefore, becoming green.

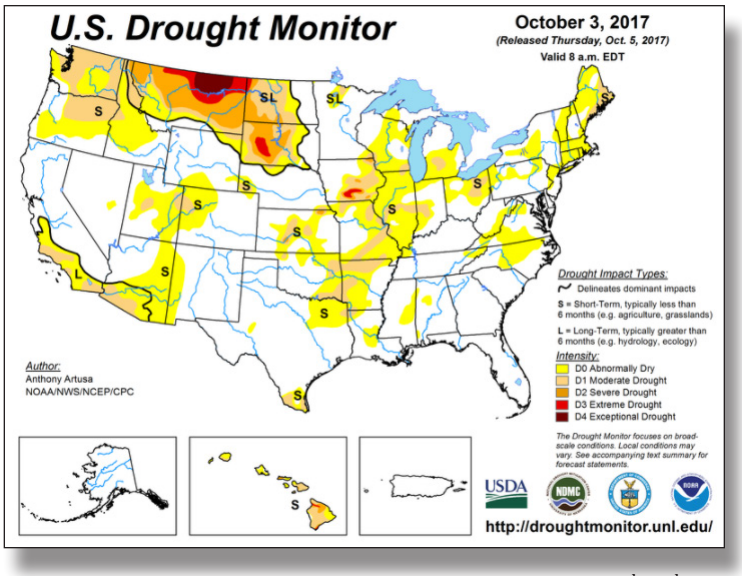
Drought

June 2018

What Is Drought?

Drought is a deficiency in precipitation over an extended period. It is a normal, recurrent feature of climate that occurs in virtually all climate zones. The duration of droughts varies widely. There are cases when drought develops relatively quickly and lasts a very short period of time, exacerbated by extreme heat and/or wind, and there are other cases when drought spans multiple years, or even decades. Studying the paleoclimate record is often helpful in identifying when long-lasting droughts have occurred.

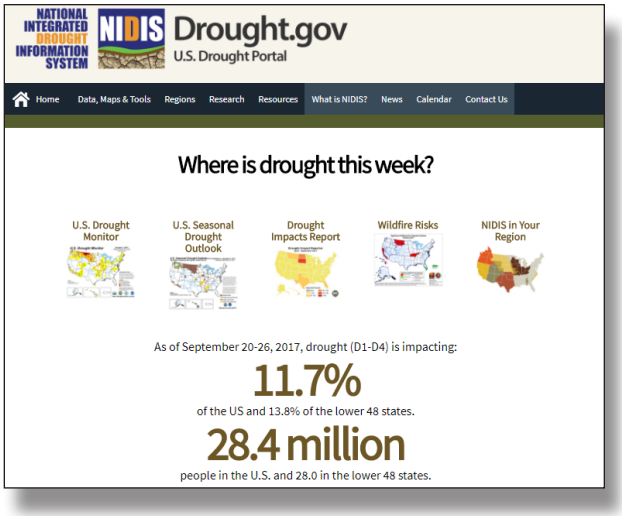
How Is Drought Monitored And Assessed?

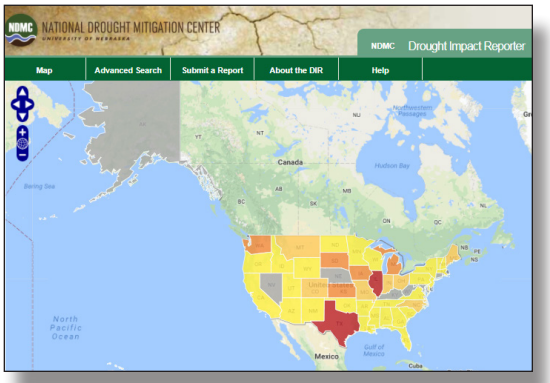


www.drought.gov

The U.S. Drought Monitor (USDM) is a weekly product that provides a general summary of current drought conditions. Multiple drought indicators, including various indices, outlooks, field reports, and news accounts are reviewed and synthesized. In addition, numerous experts from agencies and offices across the country are consulted. The result is the consensus assessment presented on the USDM map.
http://droughtmonitor.unl.edu http://drought.unl.edu

The USDM is an integral monitoring component in the National Integrated Drought Information System (NIDIS), which was established by Congressional Act in 2006 to implement an integrated drought monitoring and forecasting system at federal, state, and local levels. NIDIS includes drought monitoring, forecasting, response, research, and education components as part of its early warning system. These components are featured within the U.S. Drought Portal.





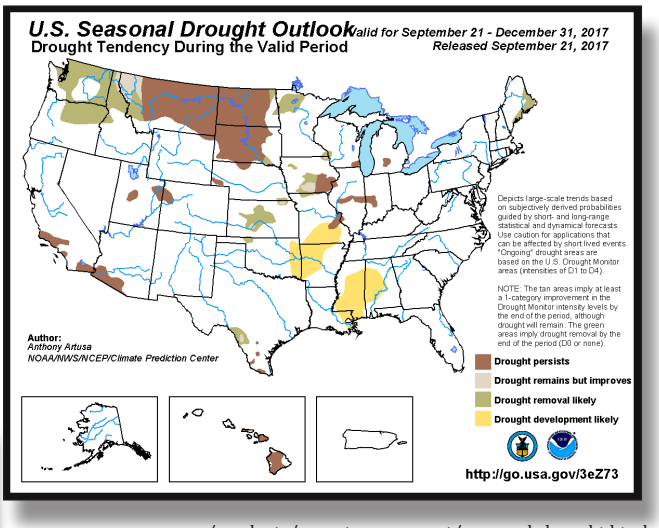
droughtreporter.unl.edu

Drought Impact Reporter: The goal of the National Drought Mitigation Center's Drought Impact Reporter is to collect, quantify, and map reported drought impacts for the United States and provide access to the reports through interactive search tools. Users can submit their own drought impact reports through the tool's easy web interface.

For drought monitoring, forecasting, and information go to:
www.drought.gov

The U.S. Monthly and Seasonal Drought Outlooks (MDO, SDO) show predicted trends for areas experiencing drought depicted in the U.S. Drought Monitor, as well as indicating areas where new droughts may develop. The NOAA Climate Prediction Center issues this monthly product in conjunction with their long-lead temperature and precipitation outlooks on the third Thursday (SDO) and last day (MDO) of each month. The general large-scale trends depicted are based upon numerous indicators, including short and long-range forecasts. A discussion detailing the atmospheric, hydrologic, and climatic conditions affecting the drought trends is included.

Human factors, such as water demand and water management, can exacerbate the impact that drought has on a region. Because of the interplay between a natural drought event and various human factors, drought means different things to different people. In practice, drought is defined in a number of ways that reflect various perspectives and interests.



www.cpc.ncep.noaa.gov/products/expert_assessment/seasonal_drought.html

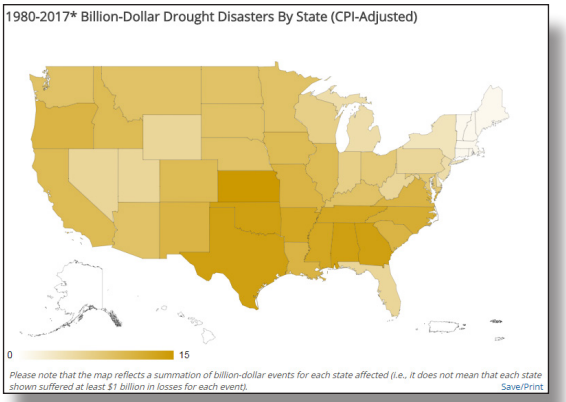
Common Types of Drought

Meteorological Drought
Meteorological Drought is based on the degree of dryness (rainfall deficit) and the length of the dry period.

Hydrological Drought
Hydrological Drought is based on the impact of rainfall deficits on the water supply such as stream flow, reservoir and lake levels, and ground water table decline.

Agricultural Drought
Agricultural Drought is based on the impacts to agriculture by factors such as rainfall deficits, soil water deficits, reduced ground water, or reservoir levels needed for irrigation.

Socioeconomic Drought
Socioeconomic drought is based on the impact of drought conditions (meteorological, agricultural, or hydrological drought) on supply and demand of some economic goods. Socioeconomic drought occurs when the demand for an economic good exceeds supply as a result of a weather-related deficit in water supply.



https://www.ncdc.noaa.gov/billions

Why is Drought Important?

The United States is vulnerable to the social, economic, and environmental impacts of drought. More than 100 years of U.S. weather records indicate that there have been three or four major drought events during that period. Two of these, the 1930s Dust Bowl drought and the 1950s drought, each lasted five to seven years and covered large areas of the continental United States.

Droughts are among the most costly weather related events. According to the National Centers for Environmental Information (NCEI), the United States has sustained 212 weather and climate disasters since 1980 where overall damages/costs reached or exceeded $1 billion (including Consumer Price Index (CPI) adjustment to 2017). The total cost of these 212 events exceeds $1.2 trillion.

The distribution of damage from U.S. billion-dollar disaster events from 1980 to present (as of July 7, 2017) is dominated by tropical cyclone losses. Tropical cyclones have caused the most damage ($580.7 billion, CPI-adjusted) and also have the highest average event cost ($16.6 billion per event, CPI-adjusted). Drought ($232.5 billion, CPI-adjusted), severe storms ($200.0 billion, CPI-adjusted) and inland flooding ($118.7 billion, CPI-adjusted) have also caused considerable damage based on the list of billion-dollar events. Severe storms have caused the highest number of billion-dollar disaster events (89), while the average event cost is the lowest ($2.2 billion, CPI-adjusted). Tropical cyclones and flooding represent the second and third most frequent event types (35 and 28), respectively. Tropical cyclones are responsible for the highest number of deaths (3,210), followed by drought/heatwave events (2,993) and severe storms (1,578).

Additional information can be found at:
www.drought.unl.edu/DroughtBasics/TypesofDrought.aspx

Earthquakes: Definition, Causes, Measures and Other Details (With diagram)
Earthquakes: Definition, Causes, Measures and Other Details (With diagram)!

The sudden shaking or rolling of the earth's surface is called an earthquake. Actually earthquakes occur daily around the world (according to one estimate, about 8000 occur every year), but most of them are too mild to be noticeable. We know of them only because they are recorded by instruments called seismographs (the Greek word seismos means 'earthquake').

How Earthquakes Occur:

Perhaps you remember that the earth is made up of three layers. At its heart is a core of iron, consisting of a solid sphere surrounded by a layer of hot, molten iron. Around the core is a mantle of soft, paste like rocks. And over the mantle rests the hard layer of rocks we call the crust. This crust is not a uniform, faultless shell. It is more like a jigsaw of blocks that fit together. The huge blocks that make up the crust are called tectonic plates.

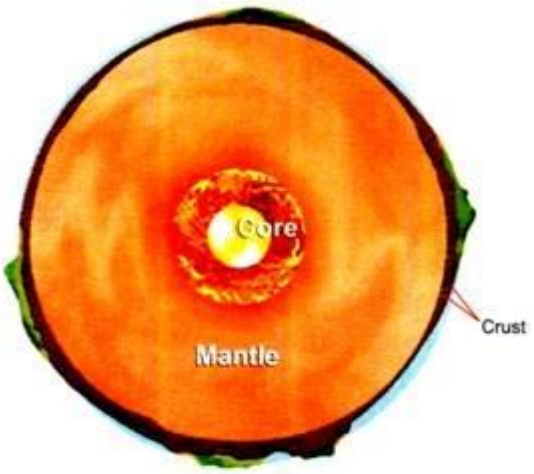


Fig. 14.1 The plates of the crust float on the soft mantle.

The heat inside the earth sets up a current in the mantle, keeping it in constant motion. This makes the plates of the crust move continually, like rafts on a gentle ocean. The movement sometimes causes the edges of the plates to grind against each other with a lot of force.

They may then get deformed, displaced, crushed or fractured. They may also slide under each other or move apart. Such changes in the plates send a tremor or set up vibrations through the crust, causing what we call an earthquake.

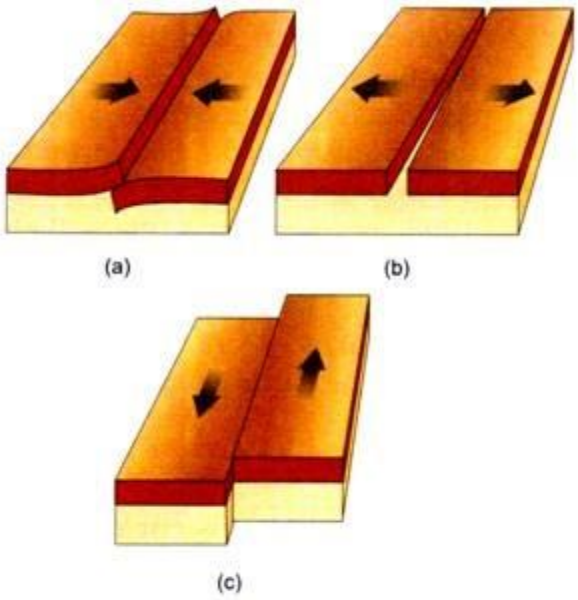


Fig. 14.2 The edges of tectonic plates may (a) slip under each other, (b) move apart or (c) get displaced.

Weak points:

Over millions of years, the movements of the tectonic plates have created mountains and valleys on the surface of the earth. They have also created certain weak points, called faults, in the crust. Most faults occur along the boundaries of the tectonic plates and these are the zones where earthquakes occur.

Especially vulnerable is a horseshoe-shaped zone called the Circum-Pacific Belt, or the Pacific Ring of Fire. It circles the Pacific Ocean, from Chile up to the coast of North America, and then around to Japan, the Philippines and New Zealand. Another zone is around the Mediterranean. Figure 14.3 shows the boundaries of the tectonic plates and the earthquake-prone zones of the world.

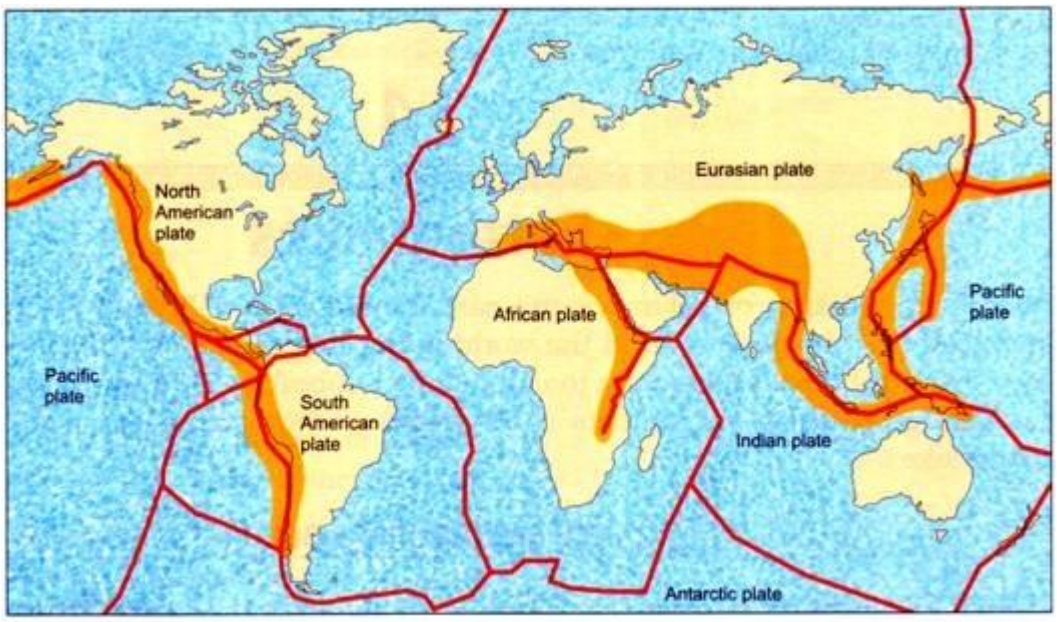


Fig. 14.3 The earthquake-prone zones (shaded) are along the boundaries of the tectonic plates.

The earthquake-prone zones in India are the Himalayan region, the Ganga-Brahmaputra basin, the Kachchh region, and the Andaman and Nicobar Islands. However, major earthquakes have occurred elsewhere in the country too.

For example, the earthquake that struck Maharashtra in 1993 occurred in a place (Latur and Osmanabad districts) that used to be considered safe from the point of view of earthquakes. More than 9000 people died in the earthquake.

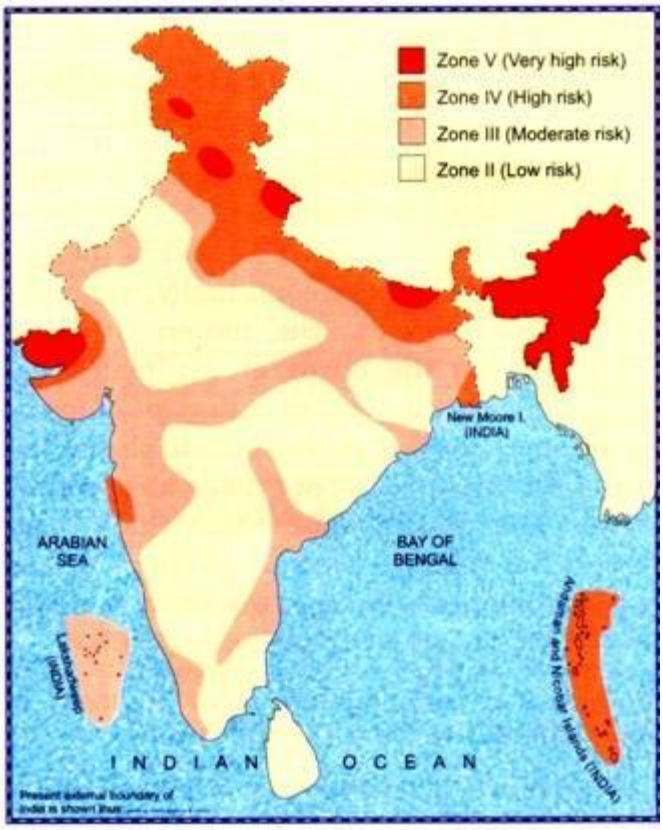


Fig. 14.4 About 50% of our country is prone to earthquakes.

Other causes:

Earthquakes can occur due to reasons other than plate movements. Volcanic activity can cause earthquakes, as can human activities like nuclear explosions carried out underground. The collapse of mines has also been known to cause minor earthquakes.

Dams:

The build-up of pressure due to the storage of a large amount of water in the reservoirs behind large dams is considered to be a potential cause of earthquakes. The earthquake that occurred in Koyna (Maharashtra) in 1967, for example, is thought to have been caused by the Koyna dam.

The dam was completed in 1963 and several tremors were felt as the reservoir was being filled. The earthquake that occurred in 1967 was quite strong. It killed 200 people and injured 1500. It also caused cracks in the dam.

Measuring an Earthquake:

Earthquakes usually start at a depth of less than 100 km below the ground. The point of origin, called the seismic focus or hypo-centre, is located with the help of seismographs. (Seismographs across the world are constantly noting the vibrations of the crust.)

Vibrations spread out from the hypocentre, like ripples in a pool of water. The location on the surface of the earth directly above the hypocentre is called the epicentre. It normally bears the brunt of the destructive power of these vibrations. That is to say, this is where the maximum damage normally occurs.

The extent of the damage depends on the strength of the vibrations or the energy associated with them. It also depends on the density of population (how many people live in an area) and the way buildings are constructed.

The nature of the soil is another factor which determines the extent of damage. If the soil is loose and damp, the damage is greater than if it is hard and firm. This is why the severity of an earthquake is measured in two ways—in terms of its magnitude and in terms of its intensity.

Richter scale:

The magnitude of an earthquake depends on the energy of the vibrations. It is measured by seismographs on a scale called the Richter scale. The range of this scale is from 0 to 10. The energy of the vibrations increases by steps of about 30 on this scale.

In other words, the vibrations of an earthquake measuring 6 on this scale would be 30 times more energetic than those of a quake measuring 5. Earthquakes measuring 9 or more on this scale are rare. Those measuring from 8 to 8.9 are quite devastating, while those between 7 and 7.9 are considered major. Even moderate (5 to 5.9) and strong (6.0 to 6.9) earthquakes are quite destructive in densely populated areas.

Modified Mercalli scale:

This scale measures the intensity of an earthquake over a range of I to XII, depending on the impact it has. Earthquakes of intensity level I, termed instrumental, are merely recorded by instruments, and are hardly felt by anyone. An earthquake of intensity level XII is termed catastrophic.

Table 14.1 The modified Mercalli scale

Level		Effect
I	(Instrumental)	Hardly felt
II	(Feeble)	Felt by a few
III	(Slight)	Felt noticeably by many indoors
IV	(Moderate)	Felt by most indoors; windows may rattle
V	(Rather strong)	Felt by almost all indoors, many outdoors; windows may break
VI	(Strong)	Felt by all; glassware break, things fall off shelves
VII	(Very strong)	Difficult to stand; furniture breaks, negligible damage to buildings
VIII	(Destructive)	Some damage to well-built structures
IX	(Ruinous)	General panic; considerable damage to well-built structures
X	(Disastrous)	Some well-built structures destroyed, rails destroyed
XI	(Very disastrous)	Most structures destroyed, bridges and rails destroyed
XII	(Catastrophic)	Almost everything destroyed; ground moves in waves

Impact of Earthquakes:

The most terrifying thing about earthquakes is that they occur without warning. This is what makes it so difficult to protect people and property from destruction. Most earthquakes last less than a minute, but they can bring down entire cities and kill thousands in a matter of a few moments.

The tremors during an earthquake can make buildings collapse. They can twist railway tracks, destroy bridges, open up cracks in the ground and damage dams. They can start up fires and cause floods and landslides. The collapse of buildings is usually the cause of death and injuries, though floods and fires (caused by earthquakes) have also been known to cause great human suffering.

For example, in 1923, 160,000 people were killed in an earthquake which destroyed the city of Tokyo and the port of Yokohama (in Japan). Most of the damage in Tokyo was done by fires started by overturned charcoal braziers (a kind of chullah). Similarly, in 1906, an earthquake

damaged gas lines and water lines in San Francisco. There was no water to put out the fires caused by the gas escaping from the gas lines.

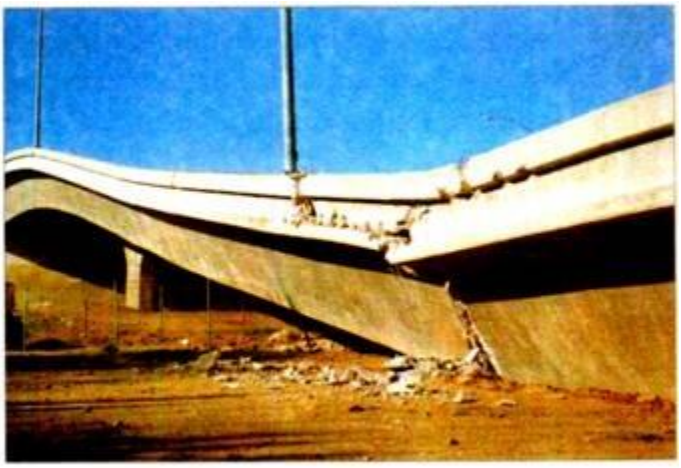


Fig. 14.5 This flyover was destroyed by an earthquake.

Earthquakes in India:

i. In January 2001, more than 20,000 people died in an earthquake in Gujarat. About 16 million people were affected and the loss was more than Rs 200 billion. The magnitude of the earthquake was 6.9 on the Richter scale.

ii. In May 1997, Jabalpur (Madhya Pradesh) suffered an earthquake of magnitude 6.0. More than 8000 houses collapsed and 40,000 were damaged. The death toll was 39.

iii. In October 1991, an earthquake of magnitude 6.6 on the Richter scale struck Uttarkashi (in Uttarakhand). More than 750 people died and 5000 people were injured. Earthquakes of similar magnitude occur in this earthquake-prone zone every 8 or 9 years.

iv. In 1988, 1004 were killed and 16,000 were injured in an earthquake of magnitude 6.6 in Bihar. Many were saved because they were sleeping outdoors.

vi. India has suffered some of the greatest (more than 8.0 on the Richter scale) earthquakes in the world. There were four such (Assam: 1897, Kangra: 1905, Bihar-Nepal: 1934 and Assam-Tibet: 1950) from 1897 to 1950. Fortunately we have not had such great earthquakes since then.

After the quake:

It becomes difficult to carry out rescue and relief operations after an earthquake because of the destruction of roads, railways, bridges and communication lines. Hospitals and health centres get overcrowded.

Diseases spread due to the shortage of basic amenities like drinking water (water pipes get damaged) and the crowding of shelters where the homeless are accommodated. The cleaning up of debris, reconstruction of buildings and rehabilitation of people can take months or even longer.

Tsunamis:

Tsunami is a Japanese word meaning 'harbour wave'. Earthquakes below the sea can cause tsunamis. The waves are usually not very high in the deep sea, where they originate. But when they reach the coast, they rise high like massive walls of water.

They sweep over the land, submerging everything in sight within a very short time. And when they recede, they take with them everything that they have touched. The tsunami which hit south and Southeast Asia in 2004 was triggered by an earthquake near Sumatra, measuring 9.0 on the Richter scale. Nearly 3, 00,000 people were killed in the disaster.

Fig. 14.6 The village on this island (Flores Island, Indonesia) was wiped out by a tsunami—137 people were killed.

Protection from Earthquakes:

The greatest damage caused by an earthquake is usually due to the destruction of buildings. So we will discuss how buildings are protected from damage before considering the general safety measures that people can take during an earthquake.

Protecting buildings:

As the ground vibrates during an earthquake, the buildings on the ground also start vibrating. The only problem is that a building is fixed to the ground. So the whole building cannot move. The bottom remains where it is, while the top sways back and forth and gets pushed and pulled sideways.

This sets up a lot of stress in the building. And when the stress becomes too much, the building cracks or even collapses. It is somewhat like holding one end of a rubber band firmly and pulling the other end. The rubber band stretches and breaks, unless you let the other end go.

Fig. 14.7 The Transamerica Pyramid in San Francisco is an earthquake-resistant building.

Put simply, there are two ways of protecting buildings—strengthening them or allowing them to move with the vibrations of the ground.

Strengthening buildings:

There are many ways of strengthening buildings. One way is to divide the walls into rectangular areas and insert diagonal pieces in them. This stops the walls from getting ‘squashed’ when a sideways force acts on them.

Try to squash an empty matchbox sideways. Then insert matches into the box as shown in Figure 14.7(a) and try to squash it again. Is it more difficult to squash it this time? This is how diagonal pieces protect walls. They are used to protect roofs too.

Fig. 14.8 (a) It is more difficult to squash a matchbox when you support the sides with matches (b) than a matchbox without support.

Allowing movement:

Since stresses arise in buildings because the bottom is fixed, the best way to protect them is to allow the bottom to move. This can be done by placing bearings between the foundation and the bottom of a building. A building placed on bearings can move back and forth and sideways with the vibrations of the ground. Bearings can be of different types. A type used often has layers of rubber with a stiff steel plate in between.

Safety measures:

Here are some steps we can take to stay as safe as possible during an earthquake:

1. Stay away from windows, glass objects, mirrors and things that can fall like book cases and cabinets.

2. Crawl under a table or bed or crouch near an inner wall or doorway and protect your head and face with your arms. Hold on to something that is unlikely to fall [drop, cover, hold).

3. Do not use the lift.

4. Turn off the power supply.

Fig. 14.9 Drop, cover, hold

5. If you are outdoors, stay away from trees, buildings, poles, and so on.

6. be ready for the aftershocks that follow an earthquake.

7. People in earthquake-prone areas should be particular about fixing tall, heavy furniture to the wall and anchoring heavy appliances well. They should avoid placing breakable and heavy objects on high shelves.

Tuberculosis (TB)

- What Is Tuberculosis?
- Tuberculosis Symptoms
- Tuberculosis Prevention
- Tuberculosis Treatment

What is Tuberculosis?

Tuberculosis -- or TB, as it's commonly called -- is a contagious infection that usually attacks your lungs. It can spread to other parts of your body, like your brain and spine. A type of bacteria called *Mycobacterium tuberculosis* causes it.

In the early 20th century, TB was a leading cause of death in the United States. Today, most cases are cured with antibiotics. But it takes a long time. You have to take meds for at least 6 to 9 months.

In the 20th century, TB was a leading cause of death in the United States. Today, most cases are cured with antibiotics. But it takes a long time. You have to take meds for at least 6 to 9 months.

Tuberculosis Types

A TB infection doesn't mean you'll get sick. There are two forms of the disease:

Latent TB. You have the germs in your body, but your immune system stops them from spreading. That means you don't have any symptoms and you're not contagious. But the infection is still alive in your body and can one day become active. If you're at high risk for re-activation -- for instance, you have HIV, your primary infection was in the past 2 years, your chest X-ray is abnormal, or your immune system is compromised --- your doctor will treat you with antibiotics to lower the risk for developing active TB.

Active TB. This means the germs multiply and can make you sick. You can spread the disease to others. Ninety percent of adult cases of active TB are from the reactivation of a latent TB infection.

Tuberculosis Signs and Symptoms

There aren't any for latent TB. You'll need to get a skin or blood test to find out whether you have it.

There are usually signs if you have active TB disease. They include:

- A cough that lasts more than 3 weeks
- Chest pain
- Coughing up blood
- Feeling tired all the time

- Night sweats
- Chills
- Fever
- Loss of appetite
- Weight loss

If you have any of these symptoms, see your doctor to get tested. Get medical help right away if you have chest pain.

Tuberculosis Causes and How TB Is Spread

Tuberculosis is caused by bacteria that spread through the air, just like a cold or the flu. When someone who has it coughs, sneezes, talks, laughs, or sings, tiny droplets that contain the germs are released. If you breathe in these germs, you can get it.

TB can spread from person to person, but it isn't easy to catch. You usually have to spend a lot of time around someone who has a lot of bacilli in their lungs. You're most likely to catch it from co-workers, friends, and family members.

Tuberculosis germs don't thrive on surfaces. You can't get the disease from shaking hands with someone who has it or by sharing their food or drink.

Tuberculosis Diagnosis

There are two common tests for tuberculosis, but they don't tell you whether you have latent or active TB:

- **Skin test.** This is also known as the Mantoux tuberculin skin test. A health care worker injects a small amount of fluid into the skin of your lower arm. After 2 or 3 days, they'll check for swelling in your arm to determine your results. If your results are positive, you probably have been infected with TB bacteria. But the results can be false positive. If you've gotten a tuberculosis vaccine called bacillus Calmette-Guerin (BCG), the test could say you have TB when you really don't. The results can also be false negative, saying that you don't have TB when you really do, if your infection is recent. You might get this test more than once.
- **Blood test.** These tests, also called interferon-gamma release assays or IGRAs, measure the response when TB proteins are mixed with a small amount of your blood.

If you have a positive skin or blood test, your doctor will probably give you a chest X-ray or CT scan to look for changes in your lungs. They also might test for TB bacteria in your sputum, the mucus that comes up when you cough. These results will help diagnose latent or active TB.

Tuberculosis Treatment

Your treatment will depend on whether you have latent TB or active TB.

- If you have latent TB, your doctor will probably give you medications to kill the bacteria so you don't develop active TB. If you start to see any of the symptoms of active TB, call your doctor right away.
- Your doctor will treat active TB with a combination of medications. You'll take them for 6 to 12 months.

Whether you have latent or active TB, it's important to finish taking all of your medications, even if you feel better after starting them.

Tuberculosis Risks

You can get TB only if you come into contact with others who have it. Other things that could increase your risk include:

- A friend, co-worker, or family member has active TB.
- You live in or have traveled to an area where TB is common, like Russia, Africa, Eastern Europe, Asia, Latin America, and the Caribbean.
- You're part of a group in which TB is more likely to spread, or you work or live with someone who is. This includes homeless people, people with HIV, people in jail or prison, and people who inject drugs into their veins.
- You work or live in a hospital or nursing home.
- You're a health care worker for patients at high risk of TB.
- You're a smoker.**Tuberculosis Complications**

Tuberculosis Complications

A healthy immune system fights the TB bacteria. But if you have any of the following, you might not be able to fend off active TB disease:

- HIV or AIDS
- Diabetes
- Severe kidney disease
- Head and neck cancers
- Cancer treatments such as chemotherapy
- Low body weight and malnutrition
- Medications for organ transplants
- Certain drugs to treat rheumatoid arthritis, Crohn's disease, and psoriasis

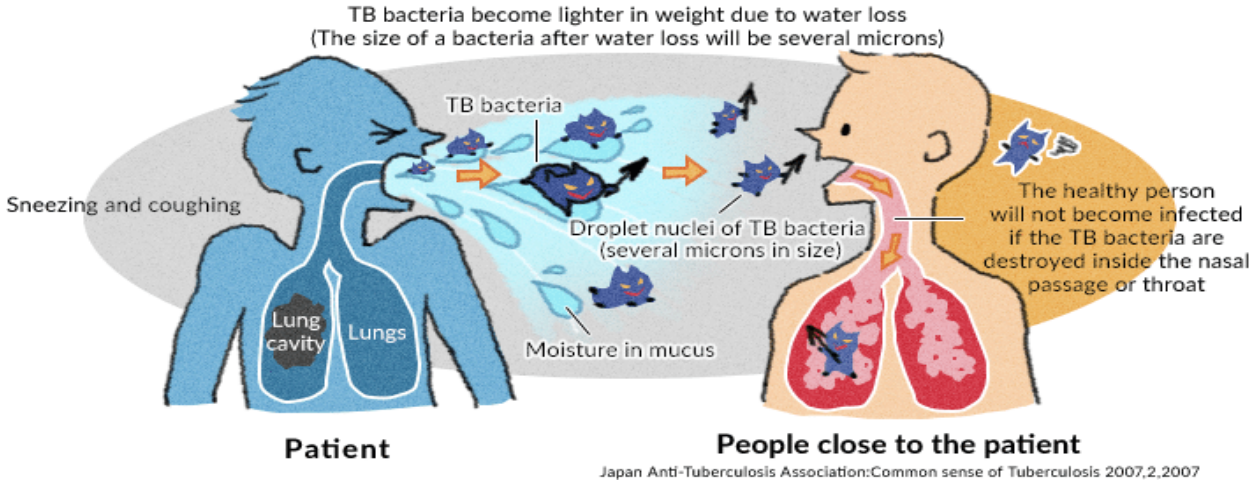
Babies and young children also are at greater risk because their immune systems aren't fully formed.

Tuberculosis Prevention

To help stop the spread of TB:

- If you have latent TB, take all of your medication so you don't develop active TB, which is contagious.
- If you have active TB, limit your contact with other people at work, school, or home. Cover your mouth when you laugh, sneeze, or cough. Wear a surgical mask when you're around other people during the first weeks of treatment.
- If you're traveling to a place where TB is common, avoid getting close to or spending a lot of time in crowded places with people who have TB.

Children in countries where TB is common often get the BCG vaccine. It isn't recommended in the United States. Other vaccines are being developed and tested



TEXT

Concept of ethics

The scope of ethics is much broader than the realm of law. Ethics are the explicit, philosophical reflection on moral beliefs and practices. Ethics is a conscious stepping back and reflecting on morality. Ethics extends to all our duties and obligations, virtues and vices, as we interact with each other. Thus, ethics is the general study of goodness, right action, Meta-ethics and Moral psychology.

Concept of environmental ethics

Environmental ethics is the discipline in philosophy that studies the moral relationship of human beings to, and also the value and moral status of, the environment and its nonhuman contents. Environmental ethics is one of the most important modern environmental conservation and sustainable development tools and involves in the early history of human civilizations. It has already been a global issue due to its implications in the development discoursed. Considering the environmental ethics, it is very easy for all to carry out their duties and responsibilities properly that may lead to the sustainable development which we could not hope for; a peaceful and happy environment for our generations on this earth. It is in fact a human virtue supported by the religions on this earth. It is interlinked with the sustainable environment and development. It teaches us to be healthy and friendly to the global environment and development. This virtue is basically based on the international humanitarian law, international human rights, and course the international environmental law under the public international law. The modern societies including the United Nations Organization (UNO) and its specialized agencies, International Union for Conservation of Nature (IUCN) and other national and regional organizations, etc; have been playing critical role in the process of implementing on the need for the environmental ethics for our society in order to attain the sustainable development.

Ethics is as old as Philosophy - and older. Environmental ethics is very new. Because ethics is, in large part, the critical study of personal and collective responsibility towards vulnerable things - most acutely, toward persons, social institutions and human communities. Until recently, nature was believed to be too large and too permanent to be vulnerable. Now, at last, the science of ecology has shown us that this is not so. We now know that nature itself is imperiled by deliberate human action,

and reciprocally, that human beings are affected by the way they deal with nature. So now we see that our dealings with nature are matters of moral responsibility. Hence, we need environmental ethics. Environmental ethics is the part of environmental philosophy, which considers extending the traditional boundaries of ethics from solely including humans to including the non-human world. It exerts influence on a large range of disciplines including environmental law, environmental sociology, eco-theology, ecological economics, ecology and environmental geography. There are many ethical decisions that human beings make with respect to the environment. For example:

•Should we continue to clear cut forests for the sake of human consumption?

•Should we continue to propagate?

•Should we continue to make gasoline powered vehicles?

•What environmental obligations do we need to keep for future generations?

•Is it right for humans to knowingly cause the extinction of a species for the convenience of humanity?

Environmental ethics refer to discussions of how humans ought to treat the built and natural environment. The job of environmental ethics is to outline our moral obligations in the face of such concerns. In a nutshell, the two fundamental questions that environmental ethics must address are: what duties do humans have with respect to the environment, and why? The latter question usually needs to be considered prior to the former; in order to tackle just what our obligations are, it is usually thought necessary to consider first why we have them. For example, do we have environmental obligations for the sake of human beings living in the world today, for humans living in the future, or for the sake of entities within the environment itself, irrespective of any human benefits? Environmental ethics is a multidisciplinary activity. It draws on expertise in physics, biology, economics, law, sociology, psychology and philosophy. Roughly speaking, we can distinguish between descriptive and normative environmental ethics. The descriptive aim is to describe and explain what attitudes people have to questions like those mentioned above. Sociologists and anthropologists usually undertake this part. The normative aim is to critically assess the attitudes people have on these issues. This task depends on scientific knowledge and philosophical considerations about logic, value theory, normative ethical theory and the clarification of central concepts like those of welfare, value and nature.

Need of Environmental ethics

Suppose that putting out natural fires, culling feral animals or destroying some individual members of over-populated indigenous species is necessary for the protection of the integrity of a certain ecosystem. It is often said to be morally wrong for human beings to pollute and destroy parts of the natural environment and to consume a huge proportion of the planet's natural resources. If that is wrong, is it simply because a sustainable environment is essential to (present and future) human well-being? Or is such behaviour also wrong because the natural environment and/or its various contents have certain values in their own right so that these values ought to be respected and protected in any case? These are among the questions investigated by environmental ethics. Some of them are specific questions faced by individuals in particular circumstances, while others are more global questions faced by groups and communities. Yet others are more abstract questions concerning the value and moral standing of the natural environment and its nonhuman components.

In the literature on environmental ethics the distinction between instrumental value and intrinsic value (meaning ‘non-instrumental value’) has been of considerable importance. The former is the value of things as means to further some other ends, whereas the latter is the value of things ascends in them regardless of whether they are also useful as means to other ends. Many traditional western ethical perspectives, however, are anthropocentric or human-centred in that either they assign intrinsic value to human beings alone (i.e., what we might call anthropocentric in a strong sense) or they assign a significantly greater amount of intrinsic value to human beings than to any nonhuman things such that the protection or promotion of human interests or well-being at the expense of nonhuman things turns out to be nearly always justified (i.e., what we might call anthropocentric in a weak sense).

Early development of environmental ethics

The academic field of environmental ethics grew up in response to the work of scientists such as Rachel Carson and events such as the first Earth Day in 1970, when environmentalists started urging philosophers to consider the philosophical aspects of environmental problems. Two papers published in Science had a crucial impact: Lynn White’s "The Historical Roots of our Ecologic Crisis" (1967) and Garrett Hardin's "The Tragedy of the Commons" (1968). Also influential was Garett Hardin's later essay called ‘Exploring New Ethics for Survival’, as well as an essay by Aldo Leopold in his

‘A Sand County Almanac’, called "The Land Ethic," in which Leopold explicitly claimed that the roots of the ecological crisis were philosophical.

Thus, nature was the focus of much nineteenth and twentieth century philosophy, but contemporary environmental ethics only emerged as an academic discipline in the 1970s. The questioning and rethinking of the relationship of human beings with the natural environment over the last thirty years reflected an already widespread perception in the 1960s that the late twentieth century faced a “population time bomb” and a serious environmental crisis. Among the accessible work that drew attention to a sense of crisis was Rachel Carson's Silent Spring (1963), which consisted of a number of essays earlier, published in the New Yorker magazine detailing how pesticides such as DDT, aldrin and dieldrin concentrated through the food-web. On the other hand, historian Lynn White Jr., in a much-cited essay published in 1967 on the historical roots of the environmental crisis, argued that the main strands of Judeo-Christian thinking had encouraged the over-exploitation of nature by maintaining the superiority of humans over all other forms of life on earth, and by depicting all of nature as created for the use of humans. White's thesis is widely discussed in theology, history, and has been subject to some sociological testing as well as being regularly discussed by philosophers (like Whitney, 1993; Attfield, 2001). Around the same time, the Stanford ecologist, Paul Ehrlich, published The Population Bomb (1968), warning that the growth of human population threatened the viability of planetary life-support systems. The call for a “basic change of values” in connection to the environment reflected a need for the development of environmental ethics as a new sub-discipline of philosophy. The new field emerged almost simultaneously in three countries - the United States, Australia, and Norway. In the first two of these countries, direction and inspiration largely came from the earlier twentieth century American literature of the environment. For instance, the Scottish emigrant John Muir (founder of the Sierra Club and “father of American conservation”) and subsequently the forester Aldo Leopold had advocated an appreciation and conservation of things “natural, wild and free”.

Main approaches of environmental ethics

The general goal of the environmental ethics is that the learner understands the moral supremacy of human beings to members of other species on earth. It seeks rational arguments to assign moral status to nature and environment and its non-human elements. It is one of the most important tools for modern environmental conservation natural resource management and sustainable development involving the basic

values, duties and responsibilities of human beings. Environmental Ethics emerged as a new sub-discipline of philosophy in the early past till that time philosophy has been questioning human actions towards environment. Environmental ethics has two views on those matters: the anthropocentric and non-anthropocentric. early 1970s. Actions towards nature are dealt with in an anthropocentric way. Thus, environmental ethics has two main approaches, including:

i. Anthropocentric approach

In the anthropocentric view animals, plants, ecosystems and the whole nature have only an "instrumental value" regarding human beings and their interests. The only acceptable reason to conserve and cultivate nature is that satisfaction of basic human needs like nourishing the body and maintaining health depends on nature. Also the reluctance by using natural resources (like animals, fossil fuels, minerals etc.) could be justified only in respect to the needs and interests of contemporary humans or at most still future generations. However, some more moderate anthropocentrics may concede that at least an aesthetic argument for protecting nature could be added to this instrumental view of nature: they base the need to conserve and cultivate nature on nature's sensual attractions for us, the pleasure for instance we take in walking through a forest or swim in a lake.

ii. Non-anthropocentric approach

The non-anthropocentric view pays attention to rational arguments for giving moral status to non-human beings, to elements of nature and environment. But moral status is not the same as intrinsic value. According to the Dutch philosopher, Wouter Achterberg environmental ethics is trying to expand the narrow morality to the relations between human beings and other organisms. When 'intrinsic value' is used to justify that expand the concept ‘intrinsic value', meaning that beings or entities have certain essential properties, is essential. Because of those properties they deserve moral consideration or an attitude of moral respect towards them the proper thing to do. The non-anthropocentric view is presented by four kinds of theories:

(1) pathocentrism,

(2) biocentrism,

(3) ecocentrism and

(4) holism.

The essence of the four can be found by looking at the meaning of the Greek roots. ‘Pathos’ - means ‘feeling’. Pathocentrism says that making sentient beings suffer is wrong. Bios - means ‘life’. Thus, biocentrism says, creatures that live have moral status. The Greek word ‘eco’ can be translated by house. In ecology is the surrounding a being is living in. Mostly there is interdependence between the being(s) and the surrounding nature and environment. That interdependence is also the characteristic of an ecosystem. So the moral status of an ecosystem and his members is at stake in ecocentrism. Holism is derived from ‘holos’ and concerns ‘the whole’. The elements of the whole, of the ecosystem, are depending on the well-being of that whole. That is the argument to give moral status to the whole and its elements. Every kind of theory has its representatives. Some important ones are introduced. Each philosopher represents a vision within the four kinds of theory. The visions are related to the important basic ethical theories: utilitarianism and deontology. The anthropocentric and non-anthropocentric views, the different kinds of theory and their representatives are helpful to ethical decision making. Using the step-by-step scheme or the basic attitudes of human beings towards nature and environment does this.

Areas of environmental ethics

Environmental ethics is theory and practice about appropriate concern for, values in, and duties to the natural world. Today, thousands of works have been published, by policymakers, lawyers, environmental professionals, foresters, conservation biologists, ecologists, philosophers, economists, sociologists, historians, business persons, citizens - all with an ethical concern about human uses of and relations to the natural environment.

Human power to affect nature has dramatically escalated, for example, with species loss or global warming. Industrialization, advanced technologies, global capitalism, consumerism and exploding populations raise the profound questions:

- •Are humans in a sustainable relationship with their environment?
- •Have they distributed the benefits derived from natural re-sources equitably?
- •Have they been sensitive enough to the values present in and the welfare of the myriads of other species that inhabit the same biosphere?

There are following primary areas of environmental ethics:

1.Humanistic and Naturalistic Ethics

Humans are evidently helped or hurt by the condition of their environment. Environmental quality is necessary, though not sufficient, for quality of human life. Humans dramatically rebuild their environments; still, their lives, filled with artifacts, are lived in a natural ecology where resources like soil, air, water, etc. are matters of life and death. Culture and nature have entwined destinies, similar to the way minds are inseparable from bodies. So, ethics needs to be applied to the environment. That requires an anthropocentric or humanistic ethics. Many philosophers such as Bryan Norton, maintain that environmental ethics must be largely; if not entirely, of this kind. Holders of this ethic are concerned about the environment because they believe it will serve human ends.

a. Humanistic Ethic: According to holders of the humanistic perspective, humans can have no duties to natural world but have serious duties only to each other, with nature often instrumental in such duties. The environment is the wrong kind of primary target for an ethic; nature is a means, not an end in itself; nothing there counts morally; and nature has no intrinsic value.

b. Naturalistic Ethic: A naturalistic ethics is one in which humans are concerned about appropriate respect and duty towards nature. Environmental ethics does require that ethics be applied to the environment, analogously to business, medicine, engineering, law and technology. Yet it is more radical than such humanist application; it revises traditional ideas about what is of moral concern to include animals, plants, endangered species, ecosystems and even Earth as a whole - at least occasionally. Our responsibilities to Earth, to ecosystems, animals and plants, might be thought vague beside our concrete responsibilities to our children or next door neighbours. Such a call must be more ecological, less paternalistic, a call for appropriate respect for the non-human species with which we co-inhabit this planet. Nature has equipped homo sapiens, the wise species, with a conscience to direct the fearful power of the brain and hand. So, we ought to develop an environmental ethics that optimizes values in nature, complementary to human values.

2.Human, Animal and Land Ethic

J. Baird Callicott finds a three-way division of ethics. On one corner of the ethical triangle is ethical humanism, on the second corner is animal welfare or rights (animal ethics), and on the third corner does AIdo Leopold advocate the land ethics. Wild animals are what they are only where they are, adapted creatures fitting in niches in ecosystems. They ought to be respected for what they are in themselves, but such an

ethic has also to enlarge to consider the ecology of animal life. A wolf caged in a zoo really isn't a wolf anymore. The appropriate unit for moral concern, according to a proponent of the "land ethic," is the fundamental unit of development and survival. One might first think there will be no conflict between these two types of naturalistic ethic - humane concern for animal welfare and ecological concern for biotic community. Doubtless this is often so, but it is clearly not always so. Animal moralists may forbid hunting or recommend rescuing injured wild animals; a proponent of a land ethic may recommend culling to control populations or letting nature take its course.

3.Biocentrism and Respect for Life

Biocentrism respects life, with the focus on any and all living beings. Albert Schweitzer said: "A man is truly ethical only when he obeys the compulsion to help all life which he is able to assist, and shrinks from injuring anything that lives. Life as such is sacred to him. He tears no leaf from a tree, plucks no flower and takes care to crush no insect." Over 96% of species are invertebrates or plants, only a tiny fraction of individual organisms are sentient animals. An animal-based ethics can value everything else only instrumentally. This is little better than humans valuing everything, higher animals included, as their own resources. A deeper respect for life must value directly all living things. Fishermen in Atlantic coastal bays toss beer bottles overboard, to dispose of trash. Small crabs, attracted by the residual beer, make their way inside the bottles and become trapped, unable to get enough foothold on the slick glass neck to work their way out. They starve slowly; then one dead crab becomes bait for the next victim, an indefinitely resetting trap. Are those bottle traps of ethical concern? Or is the whole thing out of sight, out of mind, with crabs too mindless to care about? Biocentrists argue that crabs count morally, because they are alive and put in jeopardy by human carelessness, regardless of whether they can suffer much. True, one crab may not count very much, but, according to the biocentrist, it is a mistake to say it does not count at all.

Considering plants makes the biocentrist's differences with an animal rights ethic even clearer. A plant is a spontaneous life system, self-maintaining with a controlling program (though with no controlling centre, no brain). They are not subjects of a life, and in that familiar sense, they do not have goals. Yet the plant grows, reproduces, repairs its wounds, and resists death, maintaining a botanical identity. In 1880s a tunnel was cut through a giant Sequoia tree in what is now Yosemite National Park.

Driving through this tree amused millions of people. But there is a serious conviction. Using trees for serious human needs is justified, but not this. Sequoia sempervirens, the species line has been around million years, with each of its individual sequoia trees defending a good of its kind. This ought to be respected for what it is in itself. Biocentrists claim that environmental ethics is not merely an affair of psychology, but of biology. Man is the only measurer of things, but man does not have to make himself the only measure he uses. Life is a better measure.

4.Deep Ecology

Deep ecology is a term coined by Norwegian philosopher Aarne Naess who is the world's oldest environmental philosopher and called deep ecology as ecosophy. Deep ecologists asks us to look deeply into our relationship with nature; to develop self-realization through a feeling of oneness with nature; to reject materialism; and to go beyond the concerns of 'shallow' or 'reformist' anthropocentric concerns about issues such as pollution. Deep ecologists argue that ecology, deeply understood, teaches that humans, like all other species, are what they are only in their connections with their natural environment. Deep ecology emphasizes the ways in which humans can and ought to extend through a web-work of connections, taking a model from ecology. On this view, humans have such entwined destinies with the natural world that their richest quality of life involves a larger identification with these communities. Such transformation of the personal self will result in an appropriate care for the environment.

In human society one's personal identity is bound up with human relationships; one is a father, a mother, a brother, a sister, also a citizen of a community, a state, a nation, a club or interest group, an owner or employee in a business, a teacher, or a physician. A person is educated into a heritage, critically interiorizes it, and invests his or her life in this civic community. But personal identity is just as much bound up with nature, the air we breathe, the sunshine and the rain, the food we eat, the landscapes on which we reside. Environmental health is as necessary as bodily health. Ecology dissolves any firm boundary between humans and the natural world. Ecology does not know an encapsulated ego over or against his or her environment. Ecological thinking is a kind of vision across boundaries. Paul Shepard puts it forcefully, "We must affirm that the world is a part of our own body." Human life is always incarnate spirit in flesh and blood intricately linked with the environment in which one lives, moves and has one's being.

As per Warwick Fox, "the central intuition of deep ecology is the idea that there is no firm ontological divide in the field of existence. The world simply is not divided up into independently existing subjects and objects, nor is there any bifurcation in reality between the human and the non-human realms. To the extent that we perceive boundaries; we fall short of deep ecological consciousness." Here is the deep ecology platform:

i. The well-being and flourishing of human and nonhuman life on Earth have value in themselves (intrinsic value, inherent value). These values are independent of the usefulness of the nonhuman world for human purposes.

ii. Richness and diversity of life forms contribute to the realization of these values and are also value in themselves.

iii. Humans have no right to' reduce this richness and diversity except to satisfy vital needs.

iv. The flourishing of human life and cultures is compatible- with a substantial, decrease of the human population.

v.Present human interference with the nonhuman world is excessive and the situation is rapidly worsening

vi.Policies must therefore be changed. These policies affect basic economic, technological and ideological structures. The resulting state of affaire will be deeply different from the present

vii.The ideological change is mainly that of appreciating life-quality (dwelling in situations of inherent value) rather than adhering to an increasingly higher standard of living. There will be a profound awareness of the difference between big and great.

viii.Those who subscribe to the foregoing points have an obligation directly or indirectly to try to implement the necessary changes.

Deep ecologists are thus radical environmentalists, leaving many at once stimulated and puzzled by these claims, which lift ecology into a metaphysics, almost like a religion, also wondering whether people can or must go this "deep" for an adequate environmental ethics.

5.Theology and the Environment

A theological environmental ethics sees the natural world as God's creation. Humans are and ought to be trustees or stewards of this creation. For an ethic that can genuinely motivate people is required it should not just be an admiration of creation. There must be disciplining, reformation of human life. The creation can be enjoyed

and preserved only if there is justice and love in the land. How nature works is the province of physics, geology, biology. How human nature works and ought to work requires also theology, philosophy and ethics. Humans must repair their broken wills, curb innate self-interest and reform corrupt social forces. There really is no scientific guidance of life. Monotheistic religions, such as Christianity, Judaism and Islam, urge the stewardship of creation; or they may prefer to speak of caring or reverence for a sacred creation. Eastern religions such as the yang and yin of Taoism or the ahimsa, non-injury and respect for life traditions in Hinduism and Buddhism are in harmonious balance. Native Americans and indigenous people in Africa, Australia and South America have claimed that their traditions also respect the natural world.

Biology and theology are not always easy disciplines to join. One conviction they do share is that the ecosystemic Earth is prolific. Biology and religion have increasingly joined in recent years in admiration for this marvellous planet. No other species can be either responsible for or religious towards the creation, but Homo sapiens are given a responsibility to oversee the creativity within the natural system humans inherit.

6.Expanding Communities

By another account, environmental ethics involves a series of expanding communities. Peter Wenz calls this “the concentric circle theory.” Richard Sylvan and Van Plumwood use a tree-ring analogy. J. Baird Callicott uses a "tree ring" model with "inner social circles," then animal, plants and a "land ethic" in circles further out. In the moral self's most immediate circle are duties to one's family and nearby neighbours. After that come the duties to one's local community, to one's nation, heritage, or religious communities. More globally, one has duties to humans trans-nationally, to persons whom we affect by our business or foreign policies, the broad duties of human rights. We ought not to harm the Mexicans by exploiting their poverty for cheap labour. But we also have duties to help the starving Ethiopians. Another circle includes claims made by future generations. Environmental ethics adds circles of duty to the natural world, first to domestic animals, such as livestock or pets, to animals used in medical research, or kept in zoos. Beyond, there are duties to wild animals. If one hunts, hunt humanely. If one develops natural areas, one has a duty to minimize and mitigate the loss of habitat to wildlife. In a still outer circle, one passes to the flora. Another circle is that of endangered species. The next to outermost circle is the land ethic. The outermost circle is a planetary ethic, an Earth ethics with a concern for the whole system of life.

7.Axiological Environmental Ethics

Axiology is value theory, from the Greek word, ‘axios,’ meaning worthy, valuable, also as ‘axiom’ meaning axle or axis, the pivot about which everything turns. An axiological environmental ethics identifies multiple values in nature. A better approach than concentric circles, or biocentrism, or animal rights, or a land ethic, is to locate domains of value. One ought critically to assess values at stake, sometimes in culture, sometimes in nature, appraise outcomes and act to optimize value. According to this view, value is present on Earth at multiple, interwoven levels -intrinsic, instrumental and systemic. Humans value nature as their life-support system (economically, recreationally, scientifically, aesthetically) as a repository for genetic diversity, as cultural symbols, and so on. Humans may assign such values to natural things or they may come into existence in human interactions with nature. Ecosystems are the sources and systems of life, having generated myriads of species over evolutionary time. An adequate ethics will need to optimize all of these relevant values, humanistic and naturalistic.

8.Sustainable development and Sustainable Biosphere

According to the U.N. World Commission on Environment and Development "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs." The terms "sustainable" coupled with "development" conveys continued growth but not such that degrades the environment for the future. All human beings have the fundamental right to an environment adequate for their health and well-being. Humanity has the ability to make development sustainable. The meeting of essential needs requires not only a new era of economic growth for nations in which the majority are poor, but an assurance that those poor get their fair share of the resources required to sustain that growth. At the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro, June 1992, the norm of sustainable development was crucial. Environmental ethics is inextricably coupled with development ethics. The Rio Declaration began with: "Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature." Sustainable development has proved an umbrella idea, permitting various interpretations.

"Sustainable development" has become a key term both in international treaties and covenants and in domestic planning. Sustainable development must close the gap between the rich and the poor and also between and within the nations. Even if there were an equitable distribution of wealth, the human population cannot go on escalating without people becoming more and poorer, because the pie has to be constantly divided into smaller pieces. There are three problems; overpopulation, overconsumption, and mal-distribution. Such an ethic is humane and appealing. According to the political ecology view, the Earth is regarded as a natural resource what really counts is meeting people's needs. The goal is to sustain the things that humans' value like GNP or GDP, profits, trade opportunities, natural or man-made capital, substitutable resources, per capita income, and adequate food. Nature is not ultimately important, but is provisionally important. According to J. Ronald Engel, Sustainable development may be defined as the kind of human activity that nourishes and perpetuates the historical fulfillment of the whole community of life on Earth that puts human and biotic communities together comprehensively in a more promising outlook. Humans should build sustainable cultures that fit in with the ecological carrying capacities.

9.Bioregionalism

Living on regional landscapes is emphasis of bioregionalism. The most workable ethic is one in which persons identify with their geography. It is true that one ought to have concern for endangered species, vanishing wildlife, intrinsic natural values, or wilderness conservation but that is not what orients day-to-day behaviour. Politically it is possible is concern about the countryside of everyday's experience. After all, ecology is about living at home (Greek: 'oikos' - house). That is where the land ethic really operates.

Myriads of peoples live on thousands of kinds of landscapes. Communities need to define sustainable development and environmental ethics for themselves. According to Kirkpatrick Sale a bioregion is a place defined by its life forms, its topography and its biota, rather than by human dictates. It is a region governed by nature and not legislature. A focus on bioregions permits ecosystem management. Bioregionalism appeals to geographers, landscape architects, developers, state legislators, county commissioners about a quality environment.

We do live on one Earth, with some planetary concerns, like global warming. But the modern world is becoming a global monoculture, with international markets, free trade,

World Bank loans, transnational corporations, electronic communications, satellite TV, websites and e-mail, jet planes, and people living in giant cities. This reduces local colour and diversity, the distinctive cultural patterns worked out in response to the particulars of landscapes.

Environmental ethics requires a feeling of identity with local place. Bioregions vary widely and are not all that easy to identify. Bioregionalism does recognize that life is incarnate in place.

10. Ecofeminism

According to Karen Warren, "Ecological feminism is the position that there are important connections like historical, experiential, symbolic and theoretical between the domination of women and the domination of nature." Women have often been supposed to be less rational, more emotional, closer to nature. In many cultures women have been the primary managers of households. As gatherers of food women were more important than the hunting men. As growers of food, gatherers of fuel, or carriers of water, women are both more important providers and more sensitive to the human-nature interconnections.

Nature is often thought of as "Mother Nature". The etymological root of "nature" is "giving birth." Ecofeminism provides the framework for a distinctively feminist and environmental ethics.

The future of environmental ethics

Given the increasing concern for the environment and the impact that our actions have upon it, it is clear that the field of environmental ethics is here to stay. However, it is less clear in what way the discipline will move forward. There is evidence for at least three future developments. First of all, environmental ethics needs to be and will be informed by changes in the political efforts to ameliorate environmental problems. Environmental ethics concerns by formulating our moral obligations regarding the environment. Given this, the effectiveness of states and governments in 'getting there' will affect the types of ethics that emerge. For example, the Kyoto Protocol might be regarded as the first real global attempt to deal with the problem of climate change. Ethicists need to respond not just by castigating those they blame for the failure rather they must propose alternative and better means of resolving the problems we face. Alternatively, perhaps businesses should take the lead in tackling these problems. Once it is recognized that we have environmental obligations, all areas of ethics are

affected, including just war theory, domestic distributive justice, global distributive justice, human rights theory and many others.

Finally, environmental ethics will of course be informed by our scientific understanding of the environment whether it be the changes in our understanding of how ecosystems work, or the changes in the evidence concerning the environmental crisis, it is clear that such change will inform and influence those thinkers writing on our environmental obligations

TEXT

INTRODUCTION:

‘We do not inherit the Earth from our ancestors,
We borrow it from our children” Lakota.

As far as our knowledge is concerned, Earth is the only place in the universe to sustain life. Yet human activities are progressively reducing the planet's life-supporting capacity at a time when rising human numbers and consumption are making increasingly heavy demands. Environment and economy are interdependent and need each other. Hence, a development that ignores its repercussions on the environment will destroy the environment that sustains life forms. Humanity's relationship with the biosphere will continue to deteriorate until a new international economic order is achieved. A new environmental ethic adopted, human population stabilize, and sustainable development modes become the rule rather than the exception. What is needed is sustainable development, which will allow all future generations to have a potential average quality of life that is at least as high as that which is being enjoyed by the current generation. The concept of sustainable development was emphasized by the United Nations Conference on Environment and Development (UNCED), which defined it as: 'Development that meets the need of the present generation without compromising the ability of the future generation to meet their own needs'. In 1992, the World Bank described sustainable development with a laconic phrase "sustainable development is development that continues" (World Development Report, 1992). Significantly more comprehensive descriptions of the concept exist as well. In 1992,(Rio - 1st Principle "Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature.")the Rio de Janeiro Declaration on Environment and Development described sustainable development as the long-term continuous development of the society aimed at the satisfaction of humanity's need at present and in the future via rational usage and replenishment of natural resources, preserving the Earth for future generations. The IUCN(The World Conservation Union) 1991 defined it as that development which tends to improve the quality of life while living within the carrying capacity of ecosystems”. Sustainability can also be described as our responsibility to proceed in a way that will sustain life that will allow our children, grandchildren and

great-grandchildren to live comfortably in a friendly, clean, and healthy world(Thomas Jefferson Sustainability Council). National Strategy of Sustainable Development (2003) defined sustainable development as the society's development that creates the possibility for achieving overall wellbeing for the present and the future generations through combining environmental, economic, and social aims of the society without exceeding the allowable limits of the effect on the environment. Pearce, Markandya and Barbier (1989) provided a more generalized definition of sustainable development that includes the creation of a social and economic system that guarantees support for the following aims: increase in the real income, the improvement of the level of education, and the improvement in the populations' health and in the general quality of life. The most appropriate definition that best expresses the idea of sustainable development is provided in the report of the Brundtland commission, "Our Common Future" stating that Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

It has to be noted that the definition of sustainable development used in the report "Our Common Future" was, in fact, a specific turn-point from the previously dominating attitude "growth or environment" towards a possibility of – which is the essential contribution of Brundtland Commission report – complementing each other economic growth and environment. One could even say that the idea of perfect complementary interaction between the environment and development is one of the interpretations of the Brundtland Commission's philosophy. This idea emphasizes not only quantity, but also the quality of economic growth, and people's wellbeing existing beside economic growth. This idea deals with development rather than only change and the quality of life rather than only with real income. The concept of Sustainability and sustainable development highlights the need for the strategy to ensure that future generations' interests are taken into account when looking at the needs of the present. It encompasses a wide range of environmental and other global concerns, but it is essential to recognize sustainable development is concerned with people - and the quality of life they enjoy. As the 1st Principle of the Rio Declaration on Environment and Development (agreed at the United Nation's Earth Summit held in Rio de Janeiro) clarifies, the individual's needs and rights are the primary concern.

The critical aspects of sustainable development are:

a)Intergenerational equity: this emphasizes that we should minimize any adverse impacts on resources and environment for further generations, i.e. we should hand over a safe, healthy and resourceful environment to our future generations. This can be possible only if we stop overexploitation of resources, reduce waste discharge and emissions and maintain ecological balance.

b) Intra-generational Equity: This emphasizes that the development processes should minimize the wealth gaps between nations. The human development report of the United Nation (2001) highlights that technology's benefits should seek to achieve intragenerational equity goals. The technology should address developing countries' problems, producing drought-tolerant varieties for uncertain calamities, vaccines for infectious disease, clean fuels for domestic and industrial use. This type of technological development will support developing countries' economic growth and help narrow the wealth gap and lead to Sustainability.

Until now development has been human-oriented, that too mainly for a few rich nations. They have touched the most incredible heights of scientific and technological development, but at what cost?

The air we breathe, the water we drink, and the food we eat have all been badly polluted. Our natural resources are dwindling due to overexploitation. If growth continues the same way, very soon we will be facing a doom's day as suggested by Meadow et al. 1972, in their world-famous academic report 'The Limits to Growth". This is unsustainable development which will lead to a collapse of the interrelated systems of this Earth. In a globalized world, individual actions are no longer restricted to their immediate surroundings. They imply the boundaries of nations and issues such as climate change, water shortages, and biodiversity loss can no longer be seen in isolation from each other or the broader context in which they occur. Global efforts to engage with threats to economic stability, environmental damage and a growing number of social issues present clear signs that current global trends are unsustainable. Action is needed now to create a sustainable future, protect our way of life and preserve the integrity of biodiversity and ecosystems." Activities are sustainable if:

- ❖ • There is a balance between resources used and resources regenerated.
- ❖ • Resources are as clean or cleaner at end-use as a beginning.
- ❖ • The viability, integrity, and diversity of natural systems are restored and maintained.
- ❖ • They lead to enhanced local and regional self-reliance.

- • They help create and sustain community and a culture of the place.
- • Each generation preserves the legacies of future generations.

History of the Concept:

The concept of sustainable development was initially synonymous with Sustainability and is often still used in that way. Both terms derive from the older forestry term "sustained yield", which in turn is a translation of the German word "nachhaltiger Ertrag" is dating from 1713 (Grober, U.2007; Finn, D. 2009). According to different sources, the concept of Sustainability in the sense of a balance between resource consumption and reproduction was applied to forestry in the 12th to 16th century (Ehnert, I. 2009). 'Sustainability' is a semantic modification, extension and transfer of the term 'sustained yield'. This had been the doctrine and, indeed, the 'holy grail' of foresters all over the world for more or less two centuries. The essence of 'sustained yield forestry' was described by William A. Duerr, a leading American expert on forestry: "To fulfill our obligations to our descendents and to stabilize our communities, each generation should sustain its resources at a high level and hand them along undiminished. The sustained yield of timber is an aspect of man's most fundamental need: to sustain life itself." Little anticipation of the Brundtland-formula (Grober, U. 2007). The concept of sustainable development and its current interpretations has its roots in forest management (Quigley, M. 2008). The history of the concept of Sustainability is, however, much older. Already in 400 BCE, Aristotle referred to a similar Greek concept in talking about household economics. This Greek household concept differed from modern ones in that the household had to be self-sustaining at least to a certain extent and could not just be consumption-oriented (Ehnert, I. 2009). The first use of the term "sustainable" in the modern sense was by the Club of Rome in March 1972 in its epoch-making report on the 'Limits to Growth", written by a group of scientists led by Dennis and Donella Meadows of the Massachusetts Institute of Technology. Describing the desirable "state of global equilibrium", the authors used the word "sustainable": "We are searching for a model output that represents a world system that is: 1. sustainable without sudden and uncontrolled collapse; and 2. capable of satisfying the basic material requirements of all of its people"(Grober, U.2007; Finn, D. 2009).

Challenges of sustainable development

The challenges of sustainable development and its consequences are visible.

Population: Population is a significant challenge for sustainable development. At the beginning of the 21st century, the Earth's population reached 6 billion and is expected to level out between 10 and 11 billion over the next 50 years. The fundamental challenges will be shortages of drinking water and arable land for food production.

Poverty is another major challenge because almost 25% of the world’s population lives on less than USD 1 per day.

Inequality continues to be a serious obstacle to sustainable development with the number of people suffering from undernourishment. The fall of food prices over the past 30 years may have contributed to increases in consumption, but in many regions of the world arable terrains are limited, and new ones' creation has a destructive effect on the remaining ecosystems. In the future, the growth of food production should not come at the expense of nature. By 2010 the current step of biodiversity loss should be significantly slowed.

The shortage of drinking water in many regions of the world is a significant barrier to sustainable development. It is expected that, at the current rate of growth, every second person will suffer from water shortage by the year 2025.

Human health is also an obstacle to sustainable development. In many cases, deaths in developing countries area voidable. Humanity should direct more attention and money in the coming years to the struggle against diseases. The imminent task is to reduce the death rate among children under five years of age by two-thirds, and the death rate of young mothers by 75% by 2015.

Consumption of energy is a significant challenge for sustainable development. Consumption of all forms of life is continually rising. Access to reliable, sustainable and environmentally friendly energy sources and services and national programmes for energy effectiveness, is a critical task for the next 10-15 years.

Deforestation is a particularly significant challenge before sustainable development. The world's forests diminish mainly due to expansion of agriculture. In the coming years, improving the recovery and management of the forests will be of utmost importance.

Model for Sustainable Development (Three Pillar Basic Model)

Moving towards sustainable development presents tremendous challenges. Man has all the tools necessary for achieving it. However, we tend to forget that to survive, and we need to adapt to nature and not vice-versa. We need to develop the ability to choose which respects the relationship between the three "Es" – economy, ecology and equality. If all the three “e’s" are incorporated in countries' national goals, it would be possible to develop a sustainable society. Models help us understand the concepts of Sustainability better. Thus, achieving sustainable development requires more effective, open, and productive association among the people themselves. Models help us gather, share, and analyze information; they help coordinating work; and educate and train professionals, policymakers, and the public in general.

The 'three-circle model'' is one of the most well-known models created using the three dimensions -Economy, Environment and Society. Fig. 1 shows three interlocking circles with the triangle of environmental (conservation), economic (growth), and social (equity) dimensions. Sustainable Development is modelled on these three pillars. This model is called 'three pillars' or 'three circles model'. It is based on the society, but does not explicitly consider' human quality of life'.

Thus, Sustainable development does not focus solely on environmental issues. More broadly, it encompasses the three general policy areas(or pillars) namely economy, (economic pillar: economic growth and efficient use of financial resources and their impacts on financial efficiency), environment (environmental pillar: pollution prevention, efficient natural resources management and environmental compliance and best practices, and their effects on the natural environment) and society(social pillar: health, equity, diversity, security and access to social services and their impacts on people)This model shows the interaction among three components with the ‘middle zone of sustainability’’ which recognizes the interdependence of biological, economic and social systems(Spies, 2003).

In business, the notion of three integrated aspects is sometimes called 'triple bottom line''-increasing profits, improving the planet, and improving people's lives. Thus

'A transition to Sustainability involves moving from linear to cyclical processes and technologies. The only processes we can rely on indefinitely are cyclical; all linear processes must eventually come to an end" (Robert, 2011).

Some of the essential measures for Sustainable Development are as follows.

A)Using appropriate technology is one which is locally adaptable, eco-friendly, resource-efficient and culturally suitable. It mostly involves local resources and local

labour. Indigenous technologies are more useful, cost-effective and Sustainable. The technology should use less of resource and should produce minimum waste.

B)Reduce, Reuse, Recycle approach: The 3-R process advocating minimization of resource use, using them again and again instead of passing it on to the waste stream and recycling the materials goes a long way in achieving the goals of Sustainability. It reduces pressure on our resources as well as reduces waste generation and pollution (Fig 3).

C)Promoting environmental education and awareness: 'There is a Chinese proverb If you plan for one year, plant rice if you plan for ten years plant trees, and plan for 100 years to educate people". Creating a sustainable community requires that individuals and organizations have the knowledge, skills, values, capacity and motivation to respond to the complex sustainability issues they encounter in their personal and working lives. Making environmental education, the centre of all learning process will significantly help change people's thinking and attitude towards our Earth and the environment. Introducing the subject right from the school stage will inculcate a feeling of belongingness to Earth in the small children. Earth thinking will gradually get incorporated into our thought and action, which will significantly transform our lifestyles into sustainable ones. Providing information and raising awareness is essential, but building individual and organizational capacity and motivation to innovate and implement solutions. Education for Sustainability's focus on building capacity to re-orient the way we live and work makes it an essential element in shifting towards Sustainability. Education for Sustainability aims to tackle the underlying causes of unsustainable trends.

D) Resource utilization as per carrying Capacity: Any system can sustain a limited number of organisms on a long-term basis known as its carrying capacity. In the case of human beings, the carrying capacity concept becomes all the more complicated. Unlike other animals, human beings need food to live and need so many different things to maintain the quality of life. If carrying capacity of a system is crossed (say, by an overpopulation of resource), environmental degradation starts and continues till it reaches a point of no return. **Carrying capacity has two essential components:**

‘Supporting capacity’’ i.e. the capacity to regenerate and ‘Assimilative capacity,'' i.e. the ability to tolerate different stresses. To attain Sustainability, it is essential to utilize the resources based on the systems above two properties. Consumption should not

exceed regeneration, and changes should not be allowed to occur beyond the system's tolerance capacity.

Thus, sustainable development encompasses an essential ethical component, a manifested right of every person to the proper and fair share of the planet's resources (Moldan and Dahl 2007; Ciegis et al., 2008). In the broader sense, Sustainability is associated with the equity in distribution, i.e. the distribution of possibilities for development between the present and the future generations. Sustainable development may be defined as a better quality of life of the present and the future generations.

Indian perspective

In India, it is not only the physical and biological diversity that is enormous. This is land of physical, ecological, social, cultural and linguistic diversity. India has often been described as a rich land with poor people. Growing population (Population explosion) or we can say is an overpopulated nation it is tough to maintain a balance and create a sustained environment. The nexus between poverty and environmental degradation can hardly be overemphasized. This is a significant issue. The biggest challenge the vast majority of people are directly dependent on the country's natural resources for the basic needs of food, fuel, shelter, and fodder. Agricultural growth is also significant as it is the basic need (food) of humans. Besides this, some other challenges like human settlements, energy crisis, biodiversity threats and other increasing environmental issues like water pollution, air pollution and waste management. The last few decades have made it evident that economic development can no longer be viewed in isolation from environmental protection and social progress. The nature of issues confronting us and increasing interdependence among nations necessitates that countries collaborate, in the spirit of multilateralism to chart a sustainable course of development. As a large complex democracy, committed to enhancing the quality of life of its people, and actively involved with the international coalition for sustainable development, the path that India has taken, is taking and needs to take, will, we think, be of interest to those who believe that a better world is not just essential, but possible. Policies and programmes for achieving sustainable development in India aim to fulfil its commitment towards social progress, accelerated economic growth and increased environmental conservation. Sustainable development has been embedded in the planning process of the country since the 1990s. India has remained at the forefront of the evolution of critical sustainable development policies and strategies. It has

supported the development of global institutions, agreements and procedures that are fair and equitable.

As a member of the United Nations, India is committed to realising the international development goals. India is one of the founding members of the International Labour Organization (ILO), it is also a party to several major international treaties on human rights, which include the International Convention on the Elimination of All Forms of Racial Discrimination (1968), International Covenant on Civil and Political Rights (1979), Convention on the Elimination of All Forms of Discrimination against Women (1993), and Convention on the Rights of the Child (1992). India is a party to most multilateral environmental agreements. It signed the United Nations Framework Convention on Climate Change (UNFCCC). It acceded to the Kyoto Protocol in August 2002. India became a signatory to the Convention on Biological Diversity (CBD) in December 1993 and ratified the convention in February 1994. The United Nations Convention to Combat Desertification (UNCCD) has designated it as the host country for the Asian Regional Action Programme on Agroforestry and Soil Conservation, under the Thematic Programme Network (TPN).

Sectoral reforms were introduced in the 1990s across sectors, including industry, agriculture, investment, trade, banking and finance, infrastructure, and focused on opening up India's market to international competition, removing controls over private sector involvement in most areas of economic activity and eliminating trade barriers. In the financial markets, these reforms took the form of liberalizing access to foreign capital and encouraging foreign investment. Domestic capital markets also expanded with the strengthening of institutions, including banks and regulatory bodies. This has resulted in the Indian economy witnessing high annual average growth rates of 5.7 per cent during 1991–2000, which increased to 7.2 per cent from 2001–2010. A decline in poverty has also accompanied the increased growth rates.

Policies, programmes and targeted schemes have been introduced to eradicate poverty, either through a direct focus on employment generation, training and building-up assets of the poor, or indirectly through a focus on human development, emphasizing health, education, and women's empowerment. Emphasis has also been on promoting financial inclusion. Literacy rates have been continuously rising and are estimated to be 82.14 per cent for men and 65.46 per cent for women as per the 2011 Census of India. Health indicators have also improved, although India is still not on target to meet some key Millennium Development Goals(MDGs) by 2015.

Environmental protection and conservation have been promoted through various policy measures across forestry, pollution control, water management, climate change, clean energy, and marine and coastal environment.

The National Environment Policy, 2006 responds to India's commitment to a clean environment and intends to mainstream environmental concerns in all development activities. There has been a net gain of 728 km2 in forest cover and 1,106 km2 in tree cover in 2009 compared to 2005. India has successfully reduced its energy intensity concerning GDP from the 1980s to the early years of the 21stcentury (TERI, 2006). The country is also making progress in the spread of renewable energy, amounting to about 11percent of the country's total grid Installed capacity as on March 2011.

India has a plethora of laws, which deal with the three pillars of sustainable development —environment, social and economic. Most of these show a high degree of integration or interrelationship between the different pillars of sustainable development. From the above discussion, it can be concluded that we must plan for 'Development without Destruction'' and manage our environment based on the ethical principle of socio-economic equality and ecological Sustainability. Environment management and sustainable development should go hand in hand. Changes in the way we develop our economy, eat and drink, live and move, use and discard (as waste) the Earth's resources, enjoy our lifestyle are needed to be changed quickly to bring us back into balance with our life support systems on Earth.

TEXT

Background:

The significant problems in India and many other developing countries of Asia, Africa, and Latin American are growing populations, rapid urbanization, industrial growth, inadequate food supply and depletion of natural resources. In recent years environmental pollution has emerged as a new addition to this growing list, and when this word is mentioned immediately, people start thinking about air and water pollution. But there is another type of pollution known as noise pollution. It is slowly emerging as a national problem. Noise is a potential hazard to health, communication and enjoyment of social life. Slowly and slowly, noise is interfering the human comfort, health and quality of modern life. Although a soft rhythmic sound in the form of music and dance stimulates brain activities, removes boredom, fatigue, and also to increase the the workability of an individual while performing household works. It can also have harmful effects on our hearing, state of mind, general health and intellect of even our social relationships.

The word "noise" is derived from the Latin word "nausea" meaning sickness. Noise, defined as unwanted or excessive sound, is an undesirable by-product of our modern way of life. We experience noise in number of ways. On some occasions, we can be both the cause and the victim of noise, such as operating noisy appliances or equipment. There are also instances when we experience noise generated by others just as people experience second-hand smoke. While in both cases, noises are equally damaging. Second-hand noise is more troubling because it negatively impacts us but is put into the environment by others, without our consent. The air into which second-hand noise is emitted and on which it travels is common for all people. It belongs not only to one person or group but to everyone. Therefore, people, businesses, and organizations do not have unlimited rights to broadcast noise as they please, as if the effects of noise were limited only to their private property. On the contrary, they should use the commons in ways compatible with or do not detract from other uses. People, businesses, and organizations that disregard the obligation to not interfere with others' use and enjoyment of the commons by producing noise pollution are, in many ways, acting like a bully in a schoolyard.

In the World Health Organization (WHO) statements, "large city noise is considered to be the third most hazardous pollution". At the time air pollution incurs a large bill to pay

when it comes to stopping the escalation of global warming; urban noise pollution is, in fact, another problematic issue for which the academic community does not see possible short term plans to save the situation. It is only long term strategic planning that might realize some recovery to the current increasing levels of noise. Noise will be a more extensive and severe social problem in the future if adequate precautions are not taken accordingly.

Basic Physics of sound

Sound: Sound is a vibratory disturbance created by a moving or vibrating source, in the pressure and density of a gaseous, liquid medium or in the elastic strain of a stable capable of being detected by the hearing organs. The sound may be thought of as mechanical energy of a vibrating object transmitted by pressure waves through a medium to human (or animal) ears. The medium of the main concern is air. Sound (and noise) is a process that consists of three components:

1) The sound source
2) The sound path
3) The sound receiver

All three components must be present for sound to exist. Without a source to produce sound, there is no sound. Likewise, without a medium to transmit sound pressure waves, there is also no sound. Finally, sound must be received, i.e. a hearing organ, sensor, or object must be present to perceive, register, or be affected by sound or noise. There are many different sound sources, paths, and receivers in most situations, instead of just one of each. Acoustics is the field of science that deals with the production, propagation, reception, effects, and control of sound.

Speed of Sound: When the surface of an object vibrates in the air, it compresses a layer of air as the surface moves outward, and produces a rarefied zone as the surface moves inward. This result in a series of high and low air pressures waves (relative to the steady ambient atmospheric pressure) alternating in sympathy with the vibrations. These pressure waves- not the air itself - move away from the source at the sound speed, or approximately 343 m/s (1126 ft/sec) in the atmosphere of 20°C.

Frequency (f): The number of times per second that a wave passes from a period of compression through a period of rarefaction and starts another period of contraction is known as frequency. It is expressed in Hertz (Hz). High frequencies are sometimes more conveniently expressed in Kilo Hertz (KHz) units or thousands of Hertz. The frequency of sound pressure waves increases, as their wavelength shortens, and vice

versa. The extreme range of frequencies that can be heard by the healthiest human ears spans from 16 to 20 Hz on the low end to about 20000 Hz (or 20 kHz) on the high end. Frequencies are heard as the pitch or tone of the sound. High pitched sounds produce high frequencies, and low pitched sounds make low frequencies. Sound below 16 Hz is called infrasound, while high-frequency sound above 20000 Hz is called ultrasound. Both infra and ultrasound are not audible to humans.

Wavelength: The distance between the crests of both curves of the sound. The distance travelled by a sound pressure wave through one complete cycle is referred to as the wavelength. The duration of one process is called the period. The period is the inverse of the frequency.

Sound pressure or acoustic pressure: The local pressure deviation from the ambient (average, or equilibrium) atmospheric pressure is caused by a sound wave. Proper air pressure can be measured using a microphone, and in water using a hydrophone in pascal (Pa).

Sound pressure level (SPL) or sound level: A logarithmic measure of a sound relative's sufficient sound pressure relative to a reference value. It is measured in decibels (dB) above a standard reference level. The commonly used "zero" reference sound pressure in air or other gases is 20 μPa RMS, which is usually considered the human hearing threshold.

Because of the wide range of pressure stimuli, it is convenient to measure sound pressures on a logarithmic scale, called the decibel (dB) scale. Although a decibel scale is a means for comparing two sounds, we can define a decibel scale of sound level by comparing sounds to a reference sound with a sound pressure level of 0 dB.

Definitions of Noise:

Some selected definitions of noise are as follows:

•Blum defines noise a distractor and interfering with the efficiency.

•J. Tiffin defined noise as a sound that is disagreeable for the individual and disturbs the standard way of an individual.

•According to the encyclopedia, Britannica acoustic noise is defined as any undesired sound that is pleasant to some ears and may be extremely unpleasant to others depending on several psychological factors. The sweetest music if it disturbs a person trying to concentrate or sleep is noise to him. In other words, any sound may be noise, if circumstances cause it to be disturbing.

•In the electronic communication system, the term noise pollution may refer to perturbations that get interfered with communications. Environmental noise pollution is not a new phenomenon but has grown worst with time.

•Noise is a subjective term for any unwanted or unpleasant sound beyond the level required for a particular activity. It differs from rank to rank, place to place and time to time.

Types of Noise: There are two types of noise.

(1) Steady noise: Continuous noise of sudden or gradual onset and long duration (more than 1 second), e.g. aircraft noise, power plant noise, propeller noise, and pressurization system noise. According to the Occupational Safety and Health Administration (OSHA), the maximum permissible continuous exposure level to steady noise in a working environment is 90 dB for 8 hours.

(2) Impulse/blast noise: Noise pulses of sudden onset and brief duration (less than 1 second) that usually exceed an intensity of 140 dB, e.g. firing a handgun, detonating a firecracker, backfiring of a piston engine, the high-volume squelching of radio equipment, and a sonic boom caused by breaking the sound barrier. The eardrum may be ruptured by intense levels (140dB) of impulse/blast noise.

Noise and environment

The noise has been recognized as a pollutant because its damaging effects are subtle. Noise as a pollutant produces a contaminated environment that becomes a nuisance and affects a person's health, activities, and mental abilities. Noise pollution level is rising higher and higher in the cities. However, the movement against noise pollution is weak in India; most people do not consider it a pollutant. Instead, they think it a part of routine life. Each year, noise pollution increases in quality and quantity, and most people adapt to it by accepting impaired hearing and other damages to health silently and unconsciously (Dhaliwal and Kansal, 1996).

Noise pollution has not been an entirely new phenomenon, but a problem that has grown steadily worst with time. In China, till the 3rd century B.C., the noise was used as torture; instead of hanging men for dangerous crimes. In the USA, noise is ranked 2nd only to corruption, whereas in India every occasion, the sentiment is manifested noisily. This means that we don't take cognizance of this "silent killer" (Kapoor and Singh, 1995). These surveys further display that noise is perceived now in many advanced countries to be the major negative factor affecting humans' quality of life.

The importance of noise as a pollutant, having a deleterious effect on the peace of mind and the beauty of the environment, increases every day. A man is facing an increasing problem with electronic pollution our peaceful home environment has been dramatically polluted with noisy as well as heavy equipment and appliances, e.g. Air coolers, A.C.'s, generators, exhaust fans, T.V.'s, stereo systems, tape recorders, pressure cookers, hair dries, washing machines etc. which prove to be quite irritating and disturbing. The noise produced from heavy vehicles, blowing of horns, motorbikes, megaphones, factories, workshops, stone crushers, trains, tractors, radios etc. is tremendously high.

Noise has been a form of pollution where the unwanted sound gets dumped into the atmosphere without knowing its adverse effects. According to Robert Koch, a Nobel prize winner German bacteriologist, "A day will come when man will have to fight merciless noise as his worst enemy of health" According to him noise like smog has been a slow agent of death, if it continues for next 30 years as it has for the past 30 yrs, it could become lethal (Chhatwal et al., 1993).

Measurement of noise

The quantification of some levels to determine whether they have been hazardous to health and welfare or exceed local legally accepted or adopted limits is a complex task depending upon both the purpose of measurement and the result's desired accuracy. A wide range of measurement techniques is available for the measurement of noise. Acoustic instruments have been used for decades to quantify sound's physical properties

and classify them based on physical parameters like amplitude and duration. Noise is measured in Decibel (dB), where deci means ten and bel means the logarithm of the ratio of any two acoustical or electrical intensities. A variety of instruments has been developed from time to time to measure and evaluate noise. These are Sound Level Meters, Octave Band analyzers, Noise dosemeters, Noise average meters, Noise survey meters, Statistical analyzers, Recorders, Acoustic calibrators and Sound Scope meters.

Equipment for the measurement and monitoring of noise should be carefully selected depending upon the particular type of situation, i.e., whether the noise is steady-state, impulsive or intermittent and climate, temperature and humidity will play an essential role in noise level. The equipment types must meet the specifications of the IEO

(International electro-technical commission) and ISO (International organization for standardization). 1)Sound level meter

It is used for the evaluation of sound pressure on a linear or weight scale. It can measure the range from 20 dB to 140dB at frequencies between 3.5Hz to 20KHz. A sound level meter's essential parts include a microphone, amplifier, weighing filters, and a display meter reading in dB.

2)Noise analyzer

This is fed directly or from magnetic tape recorders and consists essentially of a sound level meter feeding both the statistical analyzer and a noise average meter. It can be coupled to give an analogue or digital recording to the processed data with both periodic and cumulative evaluation for print out. It also provides a digital display.

3)Noise survey meter

This is the simplest and cheapest of the instruments used to measure and analyze steady noise. It can be used to identify areas requiring a further detailed examination for monitoring noise levels in areas where the frequency characteristics have been determined earlier.

4)Sound scope meter

This is designed to combine the qualities of a sound level meter and an octave band analyzer in a small unit. It is not suitable for analyzing intermittent noise, unless used in combination with the magnetic tape recorder.

5)Noise integrator

This instrument can measure intermittent noise by giving a periodic or average noise level when used in conjugation with a noise survey meter. A weighed frequency response signal is fed into the integrator from noise survey meter, which acts as a microphone pick up. The integrating unit of instrument collects the noise for a period of 5seconds and gives an indication that is proportional to the integrated noise. The pointer then moves back to zero and after a pause of 1second starts the next measurement. It provides "time Vs total noise" value expressed in those limits, and it is possible to predict from it the anticipated hearing loss that could result from a 5 year expose to a particular noise level.

6)Noise dose meter

It is used to integrate automatically; the sound energy received concerning its intensity and duration. It is simple, small and access total noise exposure at the workplace; the dose may be expressed as a proposition of the maximum permitted amount.

7)Acoustic calibrator

The acoustic calibrator is used to calibrate the sound level meter. It is portable and battery operated and is placed over the microphone of the sound level meter. A pure tone of known frequency and intensity level is generated by the calibrator, compared with the meter reading of sound level meter (SLM). Adjustments are made as required. A sound level meter requires regular calibration to ensure that its measurement performance remains within the specifications. It has to be calibrated once in 2 years and after energy repair. It has to be done, before and after the measurements are taken in the field.

Sources of noise pollution

Since the sources of noise pollution are numerous, they may be broadly classified into.

1.Industrial sources

2.Non-industrial sources

1.Industrial sources: The Industrial sources of noise pollution include, noise from heavy machinery of various industries operating in cities and the noise from vehicles such as cars, motors, trucks, trains, motorcycle, aircraft, defence equipment, explosions etc. Industrial noise varies in loudness, frequency components and uniformity. Some industries such as textiles mills with many simultaneous machines produce steady noise with many momentary or impact noises superimposed on it. In contrast, others show continuous background noise at relatively low levels with intermittently occurring periods of higher noise levels. Such non-uniform noises are found to be more annoying than steady noise and are most challenging to evaluate.

Industrial noises also vary in their frequency characteristics. Large slow-moving machines generally produce low-frequency noises, and high-speed machines make a noise of high frequency. Long term exposure to high working levels of industrial noise causes some degree of hearing loss. More significant the time of exposure more incredible is the degree of loss. The Indian Standards Institute (ISI) has set the standard that 90dB noise level should not be exceeded in industrial areas as beyond that workers are likely to suffer hearing loss.

2.Non industrial sources: Among the non-industrial sources of noise pollution, the important ones are loudspeakers, road traffic, air traffic, construction work, noise at home and urban noise etc.

a)Loudspeaker: One of the widespread human-made sources of noise pollution is the use of loudspeakers. It was invented to provide relief, but alas, this device's improper use came to have a noisy effect on us. Every occasion is celebrated with high volume sounds using loudspeakers in India, be it religious or non-religious, public or private. Various companies or agencies to popularize their product also use loudspeakers for advertisement purpose.

b)Construction work: Due to the urbanization construction of large buildings at a breakneck speed. The construction work is directly related to the noise, which has also gone up. During the demolition of old buildings or construction of new buildings, giant machines like Jack-hammers, compressors, rock drills etc., are continuously being used. Noise pollution, due to construction work is second in intensity to transportation noise. Perhaps only because these sources tend to be more sporadic construction noise has been generally regulated as a temporary nuisance even though in most large states it continues day after day and year after year.

c)Road traffic: Road traffic has become a noise source as no regulation is being observed in blowing horns even in the sensitive areas. The use of defective silencer pipes etc. has also aggravated the problem.

d)Aircraft noise: It is a much more localized problem than transport noise since it occurs only at major airports. But is now increasing steadily, especially at the international airports and constitutes a severe problem. The problem is also aggravating due to jet planes' use where the noise is much more problematic due to its high pitch. Many people live around airports, and there is no estimate available of the number of people affected by the noise around the major and minor airports and air force basis. Noise annoyance from aircraft sources is higher than traffic noise for the people who live around or very close to the airport.

e)Noise at home: When it comes to household, the noise inside our homes is perhaps our worst enemy. We have equipped our homes with valuable electronic gadgets like vacuum cleaners, dishwashers, washing machines, driers, refrigerator, T.V.'s, stereo system, radios and so on. All these home appliances are quite noisy. Besides these sources of noise at home, there are many animals responsible for creating noise pollution, like the chirping of birds, buzzing of bees, barking of dogs and galloping of a horse etc.

f)Urban noise: The distribution pattern for urban noise is quite complex; it differs from place to place and from time to time. A noise base exists 24hr per day consisting of

household noise, heating cooling and ventilating noise, ordinary atmospheric noise, noise from power plants, shopping centres with roof-mounted equipment, hostels and other buildings that do not change night hours.