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MODULE 4:

ENVIRONMENTAL POLLUTION

Air Pollution

Air pollutants come in the form of gases and finely divided solid and liquid aerosols. Aerosols are loosely defined as "any solid or liquid particles suspended in the air". Air pollutants can also be of primary or secondary nature.

Primary air pollutants are the ones that are emitted directly into the atmosphere by the sources (such as power-generating plants).

Secondary air pollutants are the ones that are formed because of reactions between primary pollutants and other elements in the atmosphere, such as ozone.

Possibly one of the most important characteristics of air pollutants is their transboundary nature - they can easily travel and affect the areas far away from their points of origination.

Gaseous Air Pollutants

The following three main types of gaseous air pollutants:

- Sulfur dioxide (SO_2)
- Oxides of nitrogen ($NO_x = NO + NO_2$)
- Ozone (O_3)

Sulfur dioxide and nitric oxide (NO) are the primary air pollutants, and ozone is a secondary pollutant (though there are negligible direct emissions of the gas itself). Nitrogen dioxide (NO_2) is both a primary and secondary air pollutant. Other important gaseous pollutants are: ammonia, carbon monoxide, volatile organic compounds (VOCs) and persistent organic pollutants (POPs) which we discuss below.

Sulfur Dioxide (SO_2)

Sulfur dioxide is a colorless gas with a pungent, suffocating odor. It is a dangerous air pollutant because it is corrosive to organic materials and it irritates the eyes, nose and lungs.

Anthropogenic Sources of Sulfur Dioxide Emissions

Sulfur is contained within all fossil fuels, and is released in the form of sulfur dioxide (SO_2) during fossil fuel combustion. Fossil fuel combustion accounts for almost all anthropogenic (human-caused) sulfur emissions.

Sulfur contents in fossil fuels range between 0.1% and 4% in oil, oil by-products and coal, and up to 40% in natural gas (when immediately extracted from the well; however, the sulfur is efficiently removed during the processing of gas before distribution; therefore, combustion of natural gas is not a major source of sulfur emissions). Historically, the use of coal in

domestic heating was a major source of sulfur dioxide emissions, but it has declined substantially over time. Over the last several decades the industrial use of coal in the UK has also declined, whereas the use of oil and natural gas has gradually increased.

In the UK, the sulfur dioxide emissions declined significantly since 1970, thanks to the introduction of low sulfur fuels, the switch from coal to gas and increased energy efficiency. This trend is possibly true or other industrialized countries as well, though the US as the most important economy in the world is still a large consumer of energy derived from coal. Below is a breakdown of all the significant sources of sulfur dioxide emissions.

• Energy Production

o Electric power generation o Petroleum refining o Other combustion Commercial and residential use Combustion for industry use Production processes Extraction and distribution of fossil fuels Transport

Currently, the most important sources of sulfur dioxide emissions (because of fossil fuel combustion) are electric power generating plants. For example, as of 1998, 66% of all sulfur dioxide emissions in the UK came from power plants. In contrast, transport contributions of sulfur dioxide emissions are among the smallest ones. The biggest sulfur dioxide emitters: US, China and Russia. In fact, you may be surprised to learn that just one Siberian city in Russia - Norilsk - produces 1% of the total global emissions of sulfur dioxide. In 2007, Norilsk was one of the most polluted places on Earth.

Natural Sources of Sulfur Dioxide Emissions

There are also significant sulfur emissions generated by natural sources. The main natural sulfur emissions come in the reduced forms of sulfur compounds such as:

- hydrogen sulfide (H2S)
- carbon disulfide (CS2)
- carbonyl sulfide (COS)

and in the organic forms of:

- methyl mercaptan (CH3SH)
- dimethyl sulfide (DMS) (CH3SCH3)
- dimethyl disulfide (DMDS) (CH3SSCH3)

Most of these compounds get oxidized to sulfur dioxide or to sulfate aerosols in the atmosphere. Marine phytoplankton produce dimethyl sulfide (DMS) which is then oxidized to SO2 in the atmosphere; decay processes in soil and vegetation produce H2S (as one of sulfur compounds); and SO2 is emitted into the atmosphere by volcanoes. Around 90% of all-natural sulfur emissions come in the form of DMS. Most recently the natural sources have been by far surpassed by anthropogenic sources. Natural sources have been estimated to

produce around 24% of all sulfur dioxide emissions, whereas human-caused emissions made up around 76%.

Effects of Sulfur Dioxide Emissions

Sulfur dioxide found in the air produces following effects:

- Irritates eyes, nose, throat
- Damages lungs when inhaled
- As part of acid rain:

acidifies lakes and streams o destroys plant and fish life in lakes and streams o may deplete mineral nutrients in the soil may cause reduction of forest and agricultural yields o corrodes metals o damages surface of buildings.

Nitrogen Oxides

oxides of nitrogen are produced by combustion of all fossil fuels including coal- and gas-fired power stations and motor vehicles. Whereas fuel itself can produce some nitrogen (for example, oil and coal contain around 0.5 - 1.5% of nitrogen, and natural gas contains less than that, most of nitrogen oxides production comes from the reaction of atmospheric nitrogen and oxygen within the combustion chamber. The two main nitrogen oxides are nitric oxide (NO), or nitrogen monoxide, and nitrogen dioxide (NO2) the sum of which is equal to NOx. Nitric oxide (NO) is a colorless gas. Nitrogen dioxide (NO2) is a gas of reddish-brown color with a distinct sharp, biting odor. Combustion of fuels always produces both NO2 and NO. But almost 90% of the NOX combustion product is in the form of NO which is then oxidized to nitrogen dioxide (NO2) in the air. Therefore, only a small percentage of NO2 found in the atmosphere is directly emitted there in this form. The rest has been formed because of chemical reactions in the atmosphere itself.

Anthropogenic Sources of Nitrogen Oxide Emissions

Road transport (motor vehicles) is by far the largest contributor of nitrogen emissions (in contrast, it contributes a very small proportion to sulfur dioxide emissions, as discussed above). For example, road transport contributed nearly half of all nitrogen emissions, followed by contributions from electric power generating plants which only contributed around 20% of total nitrogen emissions. Below is a breakdown of the significant sources of emissions of nitrogen oxides:

- Road transport
- Other Transport
- Energy Production
- Electric power generation

- Petroleum refining
- Other combustion
- Combustion for industry use
- Production processes
- Extraction and distribution of fossil fuels.

Natural Sources of Nitrogen Oxide Emissions

Nitric oxide (NO) is also emitted by soils but there is very little data available for the proper assessment of this area. Some estimates suggest that the soil production of NO may be around 2 - 5% of its production from fossil fuel combustion.

Effects of Nitrogen Dioxide (NO2) Emissions

When inhaled, nitrogen dioxide becomes a serious air pollutant which may:

- Cause pulmonary edema (accumulation of excessive fluid in the lungs)
- Be part of acid rain (destroying fish and plant life in lakes, damaging surfaces of buildings etc.)
- Contribute to photochemical smog.

Ammonia

Ammonia is a colorless, pungent, hazardous caustic gas composed of nitrogen and hydrogen. Ammonia emissions are also grouped as NHy which is a sum of NH3 and NH4.

Sources of Ammonia Emissions

Agriculture is by far the biggest source of ammonia emissions. Livestock farming and animal waste account for the biggest percentage of total ammonia emissions which are due to the decomposition of urea from large animal wastes and uric acid from poultry wastes. Below is a breakdown of the major sources:

- Livestock - contributes more than 50% of all emissions
- Fertilizer application
- Oceans
- Vegetation
- Biomass burning Effects of Ammonia Emissions

Exposure to very high concentrations of gaseous ammonia in the air may result in lung damage and even death.

Carbon Monoxide (CO)

Carbon monoxide is a colorless, odorless gas which is highly toxic to humans. The combustion of carbon-based fuels produces carbon dioxide (CO2). But not all such combustion is complete, and this leads to the production of carbon monoxide (CO). Motor vehicles and industry are among the largest anthropogenic sources of carbon monoxide emissions.

Effects of Carbon Monoxide Emissions

Carbon monoxide is the most common type of fatal poisoning in many countries around the world. Exposures to carbon monoxide may lead to:

- Toxicity of the central nervous system and heart
- Severe effects on the baby of a pregnant woman
- Headaches and dizziness
- Problems with getting oxygen supplied to some body parts which may be life-threatening. Volatile Organic Compounds (VOCs)

Volatile organic compounds (VOCs) are defined as organic compounds which easily evaporate and enter the atmosphere. VOCs may include a wide range of organic air pollutants, from pure hydrocarbons to partially oxidized hydrocarbons to organic compounds containing chlorine, sulfur, or nitrogen. Historically, the definition of VOCs did not include methane compounds (non-methane VOCs: NMVOCs) since the atmospheric concentration of methane was a stable natural background. But it was ultimately recognized that methane is also an anthropogenic air pollutant that comes from intensive animal and rice production. Though some of these compounds can have direct toxic effects, they have been grouped together because of their role in ozone formation.

Anthropogenic Sources of Volatile Organic Compounds The major anthropogenic sources of VOCs include:

- Solvent Use (including paints, adhesives, aerosols, metal cleaning and printing)
- Road transport (emissions from fuel / petroleum use)
- Production processes
- Extraction and distribution of fossil fuels

For example, the biggest emissions of NMVOCs are due to solvent use and road transport. Substantial NMVOC emissions occur during the following processes:

- Painting (evaporation of solvents)
- Oil production (flaring and venting of gas)
- Oil refining (flaring and fugitive emissions)

- Distribution of oil or refinery products (evaporation from storage, displacement losses when venting tanks)
- Dry cleaning (final drying of clothes)
- Production of alcoholic drinks (breweries and distilleries)
- Arable farming (crop growing, silage manufacture, sludge spreading)

Natural Sources of Volatile Organic Compounds

Not a lot is known about the natural emissions of VOCs. But we know that forests are the primary natural sources of VOC emissions. And tropical forests are estimated to produce about half of all global natural non-methane VOC emissions. Plants synthesize many organic molecules and release some VOCs (including a range of terpenes) into the atmosphere. In total, around 1000 different compounds (with some of which themselves being families with thousands of their own members) are known to be emitted by natural sources.

Effects of Volatile Organic Compounds VOCs may produce the following effects:

- Some aromatic compounds such as benzene, toluene and xylene are potential carcinogens and may cause leukemia
- Contribute to sick building syndrome indoors
- As facilitators in ozone formation, VOCs may indirectly contribute to respiratory problems and other ozone-related problems

Ozone (O3)

Ozone (O3) is a colorless, poisonous gas with a sharp, cold, irritating odor. Ozone can be found in:

- The stratosphere, one of the upper layers of the atmosphere, where it occurs naturally,
- The troposphere, the lowest layer of the atmosphere, where it occurs both naturally and because of human-generated emissions.

The natural stratospheric ozone is of beneficial nature - it keeps harmful excessive ultraviolet sunlight from reaching the surface of the Earth. Ozone which is formed in the troposphere because of anthropogenic emissions of primary pollutants, has negative effects on humans and the natural environment. And from this point of view it is an air pollutant. This human-caused ozone in the troposphere is a secondary pollutant because it is produced by the reaction of primary pollutants, nitrogen oxides and hydrocarbons [including VOCs], in the presence of sunlight. The tropospheric ozone is the main component of the photochemical smog. A photochemical smog (of brown-yellow color) is a product of the chemical reaction between sunlight, nitrogen oxides and VOCs, which results in the formation of ozone and airborne particles. The process of ozone formation may take several days to complete, and ozone itself may turn out to be far from the sources of original primary pollutant emissions.

Effects of Ozone as an Air Pollutant

Ozone in the troposphere can have the following negative effects on animals (including humans) and the natural environment:

- Irritation of the respiratory system causing coughing, throat irritation and an uncomfortable sensation in the chest
- Susceptibility to respiratory infections
- Compromised lung function harming the breathing process which may become more rapid and more shallow than normal
- Inflammation and damage to the lining of the lungs
- Aggravation of asthma
- Reduction in agricultural yields
- Interference with photosynthesis and suppression of growth of some plant species

Persistent Organic Pollutants (POPs)

Persistent organic pollutants are compounds which are resistant to degradation and persistent in the environment, with half lives of years in the soil or sediment and days in the atmosphere. Such compounds may include dioxins, furans, polychlorinated biphenyls (PCBs) and organochlorine pesticides such as DDT. They enter the food chains via the process of biomagnification, get accumulated in human and animal tissue, and are capable of long range transport through being attached to airborne particles.

Sources of Persistent Organic Pollutants

Some POPs are used as pesticides. Others are used in industrial processes as well as in the production of goods such as solvents, polyvinyl chloride and medicines.

Effects of Persistent Organic Pollutants

Exposure to persistent organic pollutants takes place through diet (specifically, consumption of animal fats), environmental exposure or accidents. POPs may lead to:

- Death and illness including disruption of endocrine, reproductive and immune systems
- Neurobehavioral disorders
- Cancers

Please note that when POPs are present in the atmosphere in the form of aerosols, they may be classified as airborne particles rather than gaseous pollutants.

Airborne Particles as Air Pollutants

Airborne particles present one more type of air pollutants. They are tiny fragments of solid or liquid nature suspended in the air (aerosols). Particles may be primary - when emitted directly into the atmosphere by sources, or secondary - when particles are formed in the atmosphere through the interaction of primary emissions. Solid particles between 1 and 100 |am (micrometers) in diameter are called dust particles, while solid particles less than 1 |am in diameter are called fumes, or smoke.

Anthropogenic Sources of Airborne Particles

Anthropogenic particles account for around 10% of the total amount of particles in the atmosphere. Fossil fuel combustion is one of the main processes which causes vast amounts of particles to be emitted into the atmosphere. The major anthropogenic sources of airborne particles are:

- Road transport
- Power generating plants
- Production processes (such as dust blown away by winds from construction sites)
- Natural Sources of Airborne Particles
- Main natural sources of particles are:
- Erosion of soil by wind which generates dust particles that travel around the globe
- Evaporation of droplets of sea water resulting in sea salt crystals being suspended in the air
- Volcanoes
- Forest fires
- Living vegetation Effects of Airborne Particles

Particles less than 10 |am in diameter are of biggest concern to human and animal health as they can be easily inhaled and get trapped in the respiratory system. Also note that particles of this size have very low gravity-related sedimentation rates and may therefore remain in the atmosphere for days before being washed out by rain or attached to vegetation or buildings. Airborne particles may cause:

- Asthma
- Lung cancer
- Cardiovascular problems Effects of Air Pollution

Global Warming

Most of the solar radiation entering the earth's atmosphere is reflected into the space. However, some of the heat is absorbed by the gases like the carbon dioxide. This serves to

keep the earth warm much like the greenhouses. Greenhouses are glasshouses which maintain a temperature higher than the surroundings for the plants to grow and yield better. The other gases that contribute to this are water vapor, methane, chlorofluorocarbons (CFCs) and nitrous oxide. These gases are called the greenhouse gases. While greenhouse effect is a necessary and natural phenomenon. Every year the temperature is going up due to pollution and the levels of these greenhouse gases is also going up. This is called global warming. According to estimates, at the current rate of increase, the average global temperature will go up by 30°C to 80°C in the next 100 years. This will have the following effects:

- Climate of different regions
- Distribution of plants and animals
- Disturbance in agriculture and food production
- Melting of snow caps and resultant increase in sea levels. This will submerge parts of coastal cities of Calcutta, New York, London and other major cities.

Formation of Acid Rain

Sulphur dioxide and nitrogen oxides react with water in the atmosphere producing sulphuric acid and nitric acid. These acids come down along with the rain. This phenomenon is called acid rain. The pH of acid rain varies from 3-6. The composition of acid rain is sulphuric acid, nitric acid and weak carbonic acid.

It has the following adverse effects on the environment:

- Causes respiratory and skin disorders.
- Affects productivity of plants by damaging the leaves.
- Enters the soil and affects the soil pH and other conditions.
- Enters the ground and river waters which causes harm to the aquatic life.
- Causes damage to marble and thus damages buildings and monuments like the Taj Mahal Aerosol Formation

Aerosol is formed by the dispersion of solid or liquid matter in the atmosphere. There are natural aerosols also in the atmosphere. However, polluting aerosols are formed by the pollutant particulate matter like carbon particles. If the aerosols form a thick layer in the troposphere, they affect the weather conditions by blocking the solar radiation. Aerosols are also deposited on the leaves and affect the photosynthesis. Aerosols disperse the organic metallic pollutants far and wide.

Depletion of Ozone

The stratosphere of the atmosphere has ozone (O3). Ozone is known to absorb the Ultraviolet (UV) rays present in the sun's radiation. The UV rays are believed to cause skin cancer and

mutations. Thus, the ozone protects us from the harmful effects of the UV rays. However, hydrocarbons such as the chlorofluorocarbons (CFCs) destroy the ozone molecules which deplete the ozone layer. Ozone holes

have been detected in the atmosphere which permit the UV rays to reach the earth's surface. The harmful effects of the UV rays are visible in the countries such as Australia and New Zealand where the rate of skin cancer is higher than the other regions of the world.

Photochemical smog

Photochemical smog occurs due to the action of sunlight on air pollutants, generating photochemical reactions. The principal constituents of the photochemical smog are gaseous hydrocarbons (leading to ozone formation) and oxides of nitrogen (NOx) that are a part of automobile exhaust.) The reaction of sunlight with hydrocarbons and NO2 results in a variety of chemical products. One of these is ozone, made up of 3 atoms of oxygen (O3), which is an irritating noxious gas. Other undesirable chemicals such as aldehydes also result from this photochemical reaction. This type of smog is oxidizing in character because of the presence of O3, NO2 and some photochemical oxidants.

While Ozone formed during photochemical reaction in the lowest region of the atmosphere is an air pollutant, in the upper atmosphere, the natural existence of the ozone layer helps protect living organisms from harmful U.V. rays from the Sun. Because sunlight is essential to this type of smog, the concentration of ozone and other measurable chemicals it is maximum around mid-day of summer months and falls of considerably at night. Photochemical smog causes eyes irritation and coughs due to the presence of ozone and can lead to respiratory problems and reduced physical (athletic) ability.

Formation of photochemical smog

When pollutants like hydrocarbons and nitrogen oxides combine in the presence of sunlight, smog is formed. This is a mixture of gases and since it is formed by photochemical reactions, it is called the photochemical smog. The word 'smog' is derived from the two words - smoke and fog. It forms a yellowish-brown haze especially during winter and hampers visibility. It also is a cause of many respiratory disorders and allergies as it contains polluting gases. Photochemical smog is mainly composed of ozone (O3), peroxyacetyl nitrate (PAN) and NOx. It is also known as brown air where solar radiation is intense. In seasons of lesser solar radiation or areas, smog formation is incomplete, and the air is referred to as grey air.

Control of Air Pollution

Air pollution can be controlled by different methods depending on the source and the pollutant. The different methods are: One of the major causes of air pollution are the automobiles. The fuels being used should be lead-free as this will reduce the level of lead in the atmosphere. The carburetor should be cleaned regularly, and good quality fuel should be used. This reduces the smoke emission from the exhaust pipes of the vehicles. Efforts to introduce vehicles running on alternate sources (for example solar energy) of energy should

be made. These methods will go a long way in reducing the occurrence of photochemical smog.

The industrial pollution is best controlled at source. The polluting gases should be passed through filters and other devices such as cyclone collectors, scrubbers, precipitators, etc. so that the particulate matter is removed before the waste gases are released out. The toxic gases should be detoxified. The domestic and industrial smoke producing units should have long chimneys to take the polluting gases far above and then disperse over a larger area. They should also invest in solar cookers or bio gas.

The pollution by Sulphur dioxide is mainly due to coal-based industries. Alternate non-Sulphur containing fuel must be used. It is also possible to remove the Sulphur from the fuel before use. There are many plant species like the neem (Azadirachta indica), bel (Aegle marmelos), gulmohur (Delonix regia), etc. that clean the atmosphere. More trees of such types should be planted. For effective control and prevention of air pollution it is important to educate people and create public awareness about the ill-effects of air pollution.

The following are some methods that may be adopted to control pollution on a large scale:

Combustion

Pollutants in the form of organic gases or vapors can be burnt to convert them into water vapor and relatively less harmful products, such as carbon dioxide.

Absorption

The gaseous effluents may be made to pass through scrubbers or absorbers. These contain a suitable liquid absorbent, which removes or modifies one or more of the pollutants present in the gaseous effluents making it comparatively harmless.

Adsorption

The gaseous effluents are passed through porous solid adsorbents kept in suitable containers. The organic and inorganic constituents of the effluent gases are trapped at the interphase of the solid adsorbent. Adsorbents hold (molecules of a gas or liquid or solute) to its surface, causing a thin film to form.

Methods to Control Particulate Emissions

Particulate emissions may be controlled by using mechanical devices that generally work based on the following:

Gravity

In this process, the particles settle down by gravitational force. Sudden changes in the direction of the gas flow causes the particles to separate out due to greater momentum.

Fabric Filters

The gases containing dust are passed through a porous medium, which is usually woven fabrics. The particles present in the gas are trapped and collected in the filters. The gases freed from the particles are then discharged.

Wet Scrubbers

Wet scrubbers are used in chemical, mining and metallurgical industries to trap Sulphur dioxide, ammonia, metal fumes, etc.

Electrostatic Precipitators

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

Sound Pollution

Most of us are very used to the sounds we hear in everyday life. Loud music, the television, people talking on their phone, the traffic and even pets barking in the middle of the night. These have become a part of the urban culture and rarely disturb us. However, when the sound of the television keeps you from sleeping all night or the traffic starts to give you a headache, it stops becoming just noise and start turning into noise pollution. For many of us, the concept of pollution is limited to nature and resources. However, noise that tends to disrupt the natural rhythm of life makes for one solid pollutant.

Noise pollution takes place when there is either excessive amount of noise or an unpleasant sound that causes temporary disruption in the natural balance. This definition is usually applicable to sounds or noises that are unnatural in either their volume or their production. Our environment is such that it has become difficult to escape noise. Even electrical appliances at home have a constant hum or beeping sound. By and large, lack of urban planning increases the exposure to unwanted sounds. Therefore, understanding noise pollution is necessary to curb it in time.

Causes of Noise Pollution

1. Industrialization: Most of the industries use big machines which can produce large amount of noise. Apart from that, various equipment like compressors, generators, exhaust fans, grinding mills also participate in producing big noise. Therefore, you must have seen workers in these factories and industries wearing ear plugs to minimize the effect of noise.

2. Poor Urban Planning: In most of the developing countries, poor urban planning also plays a vital role. Congested houses, large families sharing small space, fight over parking, frequent fights over basic amenities lead to noise pollution which may disrupt the environment of society.

3. Social Events: Noise is at its peak in most of the social events. Whether it is marriage, parties, pub, disc or place of worship, people normally flout rules set by the local administration and create nuisance in the area. People play songs on full volume and dance

till midnight which makes the condition of people living nearby worse. In markets, you can see people selling clothes via making loud noise to attract the attention of people.

4. Transportation: Large number of vehicles on roads, aero planes flying over houses, underground trains produce heavy noise and people get it difficult to get accustomed to that. The high noise leads to a situation wherein a normal person loses the ability to hear properly.

5. Construction Activities: Under construction activities like mining, construction of bridges, dams, buildings, stations, roads, flyovers take place in almost every part of the world. These construction activities take place every day as we need more buildings, bridges to accommodate more people and to reduce traffic congestion. The down point is that this construction equipment is too noisy.

6. Household Chores: We people are surrounded by gadgets and use them extensively in our daily life. Gadgets like TV, mobile, mixer grinder, pressure cooker, vacuum cleaners, washing machine and dryer, cooler, air conditioners are minor contributors to the amount of noise that is produced but it affects the quality of life of your neighborhood in a bad way.

While this form of pollution may seem harmless, it in fact has far reaching consequences. The adverse effects on the health of the environment are quite severe. Not only is the local wildlife affected by the pollution, humans also face many problems due to it.

Effects of Noise Pollution

1. Hearing Problems: Any unwanted sound that our ears have not been built to filter can cause problems within the body. Our ears can take in a certain range of sounds without getting damaged. Man made noises such as jackhammers, horns, machinery, airplanes and even vehicles can be too loud for our hearing range. Constant exposure to loud levels of noise can easily result in the damage of our ear drums and loss of hearing. It also reduces our sensitivity to sounds that our ears pick up unconsciously to regulate our body's rhythm.

2. Health Issues: Excessive noise pollution in working areas such as offices, construction sites, bars and even in our homes can influence psychological health. Studies show that the occurrence of aggressive behavior, disturbance of sleep, constant stress, fatigue and hypertension can be linked to excessive noise levels. These in turn can cause more severe and chronic health issues later in life.

3. Sleeping Disorders: Loud noise can certainly hamper your sleeping pattern and may lead to irritation and uncomfortable situations. Without a good night sleep, it may lead to problems related to fatigue and your performance may go down in office as well as at home. It is therefore recommended to take a sound sleep to give your body proper rest.

4. Cardiovascular Issues: Blood pressure levels, cardio-vascular disease and stress related heart problems are on the rise. Studies suggest that high intensity noise causes high blood pressure and increases heart beat rate as it disrupts the normal blood flow. Bringing

them to a manageable level depends on our understanding noise pollution and how we tackle it.

5. Trouble Communicating: High decibel noise can put trouble and may not allow two people to communicate freely. This may lead to misunderstanding and you may get difficult understanding the other person. Constant sharp noise can give you severe headache and disturb your emotional balance.

6. Effect on Wildlife: Wildlife faces far more problems than humans because noise pollution since they are more dependent on sound. Animals develop a better sense of hearing than us since their survival depends on it. The ill effects of excessive noise begin at home. Pets react more aggressively in households where there is constant noise. They become disoriented more easily and face many behavioral problems. In nature, animals may suffer from hearing loss, which makes them easy prey and leads to dwindling populations. Others become inefficient at hunting, disturbing the balance of the eco-system.

Species that depend on mating calls to reproduce are often unable to hear these calls due to excessive man-made noise. As a result, they are unable to reproduce and cause declining populations. Others require sound waves to echo-locate and find their way when migrating. Disturbing their sound signals means they get lost easily and do not migrate when they should. To cope up with the increasing sound around them, animals are becoming louder, which may further add to the pollution levels. Therefore, understanding noise pollution can help us lower the impact it has on the environment.

As of now, there do not exist many solutions to reduce sound pollution. On a personal level, everybody can help reducing the noise in their homes by lowering the volume of the radio, music system and the television. Listening to music without headphones is also a good step forward. Removal of public loudspeakers is another way in which the pollution can be countered. As is controlling the sound levels in clubs, bars, parties and discos. Better urban planning can help in creating 'No-Noise' zones, where honking and industrial noise are not tolerated. It is only when our understanding noise pollution is complete, can we take steps to eradicate it completely.

Measurement of Sound Pollution

Noise pollution refers to any unpleasant, damaging or irritating noise that has the potential to harm people, wildlife or the environment. The decibel (dB) is the main unit used to measure the intensity or loudness of sounds. A sound can also be measured by its pitch, which is the frequency of sound vibrations per second. For example, a low pitch produced by a deep voice, makes fewer vibrations per second than a high voice. Sounds with higher pitch, such as a cry or sound from a violin, have a high rate of vibrations. Sound is usually recorded with a microphone. However, in a sound level meter, a sound sensor is used. Sound sensors work like microphones but are much more accurate.

Working of Sound Sensor

The response of a sound sensor to a nearby sound is approximately proportional to the sound pressure, which is the air pressure produced by the propagating sound. For example, if we talk with a piece of paper placed just in front of our mouth, the resulting air pressure causes the paper to move. A similar observation can be made by feeling vibrations from a loud speaker.

Industrial Noise Pollution

Industrial Noise

Industrial Noise refers to noise that is created in the factories which is jarring and unbearable. Sound becomes noise only it becomes unwanted and when it becomes more than that it is referred to as "noise pollution". Heavy industries like shipbuilding and iron and steel have long been associated with Noise Induced Hearing Loss (NIHL).

Industrial Noise Pollution

This is posing to be a big challenge with very passing day and is a threat to safety and health of the people who are working in the industry and common people as well. It has been scientifically proved that noise more than 85 decibels can cause hearing impairment and does not meet the standards set for healthy working environment. Moreover, it can also cause accidents. The problem has been viewed and analyzed from all the perspectives, but the solution probably is not so easy to achieve since there is a lot of contradiction between legislation, guidance and documents. Industrial Noise resulting to noise pollution has many reasons such as industries being close to human habitats which prevents the noise from decaying before it reaches human ear.

Effects of Industrial Noise Pollution

It has already been stated that continuous exposure to noise pollution leads to hearing impairment, but it has various other effects as well which are as follows:

- It can result into increase in blood pressure
- Increased stress
- Fatigue
- Stomach ulcers
- vertigo
- Headaches.
- Sleep disturbance
- Annoyance
- Speech Problems

- Dysgraphia, which means writing learning impairment
- Aggression
- Anxiety

Industrial Noise adversely affects the workers and they suffer from various health problems as I have listed above. High volume leads to increased adrenaline levels, which leads to the constriction of blood vessels, which normally happens when the individual is tensed, afraid, anxious or extremely happy and excited. The work pressure and the noise pollution both lead to a typical situation, which leads to clinical as well as psychological stress. The blood pressure, due to the constriction of blood vessels (vasoconstriction), remains high for the major part of the day. The human dislike towards anything that is not pleasant, yet compelling leads to emotional stress and depression which is a term for a quite a severe situation. Statistically there is a rise in the number of workers dying of cardiac arrests and cerebral attacks is on an increase considerably due to industrial noise pollution in railway yards, factories etc.

Some people also suffer from headaches, which decrease their efficiency levels and hamper the quality of their work. That leads to crises in workplace as well as home. Workers are always agitated and excited that result into carelessness. Workers also become fatigued and in some cases over fatigued which should ring the alarm for organizations that want to grow. The worst part of Industrial Noise pollution is it affects the unborn baby in a womb and that too in the early days after conception since the fetus is sensitive to sounds and high decibels affects the growth of its organs.

The problems that the Industrial workers face are sleep disorders and behavioral changes. They experience increased levels of stress. They fail to achieve harmony thus leading to a lot of minor psychological problems, which are too common to be noticed. They are irritated and annoyed; therefore, fail to interact with a person around them and this gradually leads them to become "loners". They withdraw from the society and some in extreme circumstances might have "tremors", speech problems and many other behavioral problems. It is high time that the rules and regulations that are already made should be applied and followed so that we can cope with the ever-increasing problem of noise pollution that is concentrated in the industry environment.

Water & Soil Pollution

Over two thirds of Earth's surface are covered by water; less than a third is taken up by land. As Earth's population continues to grow, people are putting ever-increasing pressure on the planet's water resources. In a sense, our oceans, rivers, and other inland waters are being "squeezed" by human activities—not so they take up less room, but so their quality is reduced. Poorer water quality means water pollution.

We know that pollution is a human problem because it is a relatively recent development in the planet's history: before the 19th century Industrial Revolution, people lived more in

harmony with their immediate environment. As industrialization has spread around the globe, so the problem of pollution has spread with it. When Earth's population was much smaller, no one believed pollution would ever present a serious problem. It was once popularly believed that the oceans were far too big to pollute. Today, with around 7 billion people on the planet, it has become apparent that there are limits. Pollution is one of the signs that humans have exceeded those limits.

According to the environmental campaign organization WWF: "Pollution from toxic chemicals threatens life on this planet. Every ocean and every continent, from the tropics to the once-pristine polar regions, is contaminated."

Water pollution can be defined in many ways. Usually, it means one or more substances have built up in water to such an extent that they cause problems for animals or people. Oceans, lakes, rivers, and other inland waters can naturally clean up a certain amount of pollution by dispersing it harmlessly. If you poured a cup of black ink into a river, the ink would quickly disappear into the river's much larger volume of clean water. The ink would still be there in the river, but in such a low concentration that you would not be able to see it. At such low levels, the chemicals in the ink probably would not present any real problem. However, if you poured gallons of ink into a river every few seconds through a pipe, the river would quickly turn black. The chemicals in the ink could very quickly influence the quality of the water. This, in turn, could affect the health of all the plants, animals, and humans whose lives depend on the river.

Thus, water pollution is all about quantities: how much of a polluting substance is released and how big a volume of water it is released into. A small quantity of a toxic chemical may have little impact if it is spilled into the ocean from a ship. But the same amount of the same chemical can have a much bigger impact pumped into a lake or river, where there is less clean water to disperse it.

Water pollution almost always means that some damage has been done to an ocean, river, lake, or other water source. A 1969 United Nations report defined ocean pollution as: "The introduction by man, directly or indirectly, of substances or energy into the marine environment (including estuaries) resulting in such deleterious effects as harm to living resources, hazards to human health, hindrance to marine activities, including fishing, impairment of quality for use of sea water and reduction of amenities." Fortunately, Earth is forgiving and damage from water pollution is often reversible.

Types of Water Pollution

When we think of Earth's water resources, we think of huge oceans, lakes, and rivers. Water resources like these are called surface waters. The most obvious type of water pollution affects surface waters. For example, a spill from an oil tanker creates an oil slick that can affect a vast area of the ocean. Not all of Earth's water sits on its surface, however. A great deal of water is held in underground rock structures known as aquifers, which we cannot see and seldom think about. Water stored underground in aquifers is known as groundwater.

Aquifers feed our rivers and supply much of our drinking water. They too can become polluted, for example, when weed killers used in people's gardens drain into the ground. Groundwater pollution is much less obvious than surface-water pollution, but is no less of a problem. In 1996, a study in Iowa in the United States found that over half the state's groundwater wells were contaminated with weed killers.

Surface waters and groundwater are the two types of water resources that pollution affects. There are also two different ways in which pollution can occur. If pollution comes from a single location, such as a discharge pipe attached to a factory, it is known as point-source pollution. Other examples of point source pollution include an oil spill from a tanker, a discharge from a smoke stack (factory chimney), or someone pouring oil from their car down a drain. A great deal of water pollution happens not from one single source but from many different scattered sources. This is called nonpoint-source pollution.

When point-source pollution enters the environment, the place most affected is usually the area immediately around the source. For example, when a tanker accident occurs, the oil slick is concentrated around the tanker itself and, in the right ocean conditions, the pollution disperses the further away from the tanker you go. This is less likely to happen with nonpoint source pollution which, by definition, enters the environment from many different places at once. Sometimes pollution that enters the environment in one place has an effect hundred or even thousands of miles away. This is known as transboundary pollution. One example is the way radioactive waste travels through the oceans from nuclear reprocessing plants in England and France to nearby countries such as Ireland and Norway.

Indication of Water Pollution

There are two main ways of measuring the quality of water. One is to take samples of the water and measure the concentrations of different chemicals that it contains. If the chemicals are dangerous or the concentrations are too great, we can regard the water as polluted. Measurements like this are known as chemical indicators of water quality. Another way to measure water quality involves examining the fish, insects, and other invertebrates that the water will support. If many different types of creatures can live in a river, the quality is likely to be very good; if the river supports no fish life at all, the quality is obviously much poorer. Measurements like this are called biological indicators of water quality.

Causes of Water Pollution

Most water pollution doesn't begin in the water itself. Take the oceans: around 80 percent of ocean pollution enters our seas from the land. Virtually any human activity can influence the quality of our water environment. When farmers fertilize the fields, the chemicals they use are gradually washed by rain into the groundwater or surface waters nearby. Sometimes the causes of water pollution are quite surprising. Chemicals released by smokestacks (chimneys) can enter the atmosphere and then fall back to earth as rain, entering seas, rivers, and lakes and causing water pollution. That's called atmospheric deposition. Water pollution has many different causes, and this is one of the reasons why it is such a difficult problem to solve.

Sewage

With billions of people on the planet, disposing of sewage waste is a major problem. According to 2015 and 2016 figures from the World Health Organization, some 663 million people (9 percent of the world's population) don't have access to safe drinking water, while 2.4 billion (40 percent of the world's population) don't have proper sanitation (hygienic toilet facilities); although there have been great improvements in securing access to clean water, relatively little progress has been made on improving global sanitation in the last decade. Sewage disposal affects people's immediate environments and leads to water-related illnesses such as diarrhea that kills 525,000 children under five each year. (Back in 2002, the World Health Organization estimated that water-related diseases could kill as many as 135 million people by 2020.) In developed countries, most people have flush toilets that take sewage waste quickly and hygienically away from their homes.

Yet the problem of sewage disposal does not end there. When you flush the toilet, the waste must go somewhere and, even after it leaves the sewage treatment works, there is still waste to dispose of. Sometimes sewage waste is pumped untreated into the sea. Until the early 1990s, around 5 million tons of sewage was dumped by barge from New York City each year. According to 2002 figures from the UK government's Department for the Environment, Food, and Rural Affairs (DEFRA), the sewers of Britain collect around 11 billion liters of waste water every day, some of it still pumped untreated into the sea through long pipes. The New River that crosses the border from Mexico into California once carried with it 20-25 million gallons (76-95 million liters) of raw sewage each day; a new waste water plant on the US-Mexico border, completed in 2007, substantially solved that problem. Unfortunately, even in some of the richest nations, the practice of clumping sewage into the sea continues. In early 2012, it was reported that the tiny island of Guernsey (between Britain and France) has decided to continue dumping 16,000 tons of raw sewage into the sea each day.

In theory, sewage is a completely natural substance that should be broken down harmlessly in the environment: 90 percent of sewage is water. In practice, sewage contains all kinds of other chemicals, from the pharmaceutical drugs people take to the paper, plastic, and other wastes they flush down their toilets. When people are sick with viruses, the sewage they produce carries those viruses into the environment. It is possible to catch illnesses such as hepatitis, typhoid, and cholera from river and sea water.

Nutrients

Suitably treated and used in moderate quantities, sewage can be a fertilizer: it returns important nutrients to the environment, such as nitrogen and phosphorus, which plants and animals need for growth. The trouble is, sewage is often released in much greater quantities than the natural environment can cope with. Chemical fertilizers used by farmers also add nutrients to the soil, which drain into rivers and seas and add to the fertilizing effect of the sewage. Together, sewage and fertilizers can cause a massive increase in the growth of algae or plankton that overwhelms huge areas of oceans, lakes, or rivers. This is known as a

harmful algal bloom (also known as an HAB or red tide, because it can turn the water red). It is harmful because it removes oxygen from the water that kills other forms of life, leading to what is known as a dead zone. The Gulf of Mexico has one of the world's most spectacular dead zones. Each summer, according to studies by the NOAA, it grows to an area of around 5500-6000 square miles (14,000-15,500 square kilometers), which is about the same size as the state of Connecticut.

Waste water

A few statistics illustrate the scale of the problem that waste water (chemicals washed down drains and discharged from factories) can cause. Around half of all ocean pollution is caused by sewage and waste water. Each year, the world generates perhaps 5-10 billion tons of industrial waste, much of which is pumped untreated into rivers, oceans, and other waterways. In the United States alone, around 400,000 factories take clean water from rivers, and many pump polluted waters back in their place. However, there have been major improvements in waste water treatment recently. Since 1970, in the United States, the Environmental Protection Agency (EPA) has invested about $70 billion in improving water treatment plants that, as of 2015, serve around 88 percent of the US population (compared to just 69 percent in 1972). However, another $271 billion is still needed to update and upgrade the system.

Factories are point sources of water pollution, but quite a lot of water is polluted by ordinary people from nonpoint sources; this is how ordinary water becomes waste water in the first place. Virtually everyone pours chemicals of one sort or another down their drains or toilets. Even detergents used in washing machines and dishwashers eventually end up in our rivers and oceans. So, do the pesticides we use on our gardens. A lot of toxic pollution also enters waste water from highway runoff. Highways are typically covered with a cocktail of toxic chemicals—everything from spilled fuel and brake fluids to bits of worn tires (themselves made from chemical additives) and exhaust emissions. When it rains, these chemicals wash into drains and rivers. It is not unusual for heavy summer rainstorms to wash

toxic chemicals into rivers in such concentrations that they kill large numbers of fish overnight. It has been estimated that, in one year, the highway runoff from a single large city leaks as much oil into our water environment as a typical tanker spill. Some highway runoff runs away into drains; others can pollute groundwater or accumulate in the land next to a road, making it increasingly toxic as the years go by.

Chemical waste

Detergents are relatively mild substances. At the opposite end of the spectrum are highly toxic chemicals such as polychlorinated biphenyls (PCBs). They were once widely used to manufacture electronic circuit boards, but their harmful effects have now been recognized and their use is highly restricted in many countries. Nevertheless, estimated half million tons of PCBs were discharged into the environment during the 20th century. In a classic example of transboundary pollution, traces of PCBs have even been found in birds and fish in the

Arctic. They were carried there through the oceans, thousands of miles from where they originally entered the environment. Although PCBs are widely banned, their effects will be felt for many decades because they last a long time in the environment without breaking down.

Another kind of toxic pollution comes from heavy metals, such as lead, cadmium, and mercury. Lead was once commonly used in gasoline (petrol), though its use is now restricted in some countries. Mercury and cadmium are still used in batteries (though some brands now use other metals instead). Until recently, a highly toxic chemical called tributyltin (TBT) was used in paints to protect boats from the ravaging effects of the oceans. Ironically, however, TBT was gradually recognized as a pollutant: boats painted with it were doing as much damage to the oceans as the oceans were doing to the boats.

The best-known example of heavy metal pollution in the oceans took place in 1938 when a Japanese factory discharged a significant amount of mercury metal into Minamata Bay, contaminating the fish stocks there. It took a decade for the problem to come to light. By that time, many local people had eaten the fish and around 2000 were poisoned. Hundreds of people were left dead or disabled.

Radioactive waste

People view radioactive waste with great alarm—and for good reason. At high enough concentrations it can kill; in lower concentrations it can cause cancers and other illnesses. The biggest sources of radioactive pollution in Europe are two factories that reprocess waste fuel from nuclear power plants: Sellafield on the north-west coast of Britain and Cap La Hague on the north coast of France. Both discharge radioactive waste water into the sea, which ocean currents then carry around the world. Countries such as Norway, which lie downstream from Britain, receive significant doses of radioactive pollution from Sellafield. The Norwegian government has repeatedly complained that Sellafield has increased radiation levels along its coast by 6-10 times. Both the Irish and Norwegian governments continue to press for the plant's closure.

Oil Pollution

When we think of ocean pollution, huge black oil slicks often spring to mind, yet these spectacular accidents represent only a tiny fraction of all the pollution entering our oceans. Even considering oil by itself, tanker spills are not as significant as they might seem: only 12 percent of the oil that enters the oceans comes from tanker accidents; over 70 percent of oil pollution at sea comes from routine shipping and from the oil people pour down drains on land. However, what makes tanker spills so destructive is the sheer quantity of oil they release at once — in other words, the concentration of oil they produce in one very localized part of the marine environment. The biggest oil spill in recent years (and the biggest ever spill in US waters) occurred when the tanker Exxon Valdez broke up in Prince William Sound in Alaska in 1989. Around 12 million gallons (44 million liters) of oil were released into the pristine wilderness—enough to fill your living room 800 times over! Estimates of the marine

animals killed in the spill vary from approximately 1000 sea otters and 34,000 birds to as many as 2800 sea otters and 250,000 sea birds. Several billion salmon and herring eggs are also believed to have been destroyed.

Plastics

Plastic is one of the most common materials, used for making virtually every kind of manufactured object from clothing to automobile parts; plastic is light and floats easily, so it can travel enormous distances across the oceans; most plastics are not biodegradable (they do not break down naturally in the environment), which means that things like plastic bottle tops can survive in the marine environment for a long time. (A plastic bottle can survive an estimated 450 years in the ocean and plastic fishing line can last up to 600 years.)

While plastics are not toxic in quite the same way as poisonous chemicals, they nevertheless present a major hazard to seabirds, fish, and other marine creatures. For example, plastic fishing lines and other debris can strangle or choke fish. (This is sometimes called ghost fishing.) About half of all the world's seabird species are known to have eaten plastic residues. In one study of 450 shearwaters in the North Pacific, over 80 percent of the birds were found to contain plastic residues in their stomachs. In the early 1990s, marine scientist Tim Benton collected debris from a 2km (1.5 mile) length of beach in the remote Pitcairn islands in the South Pacific. His study recorded approximately a thousand pieces of garbage including 268 pieces of plastic, 71 plastic bottles, and two dolls heads.

Other forms of pollution

These are the most common forms of pollution —but by no means the only ones. Heat or thermal pollution from factories and power plants also causes problems in rivers. By raising the temperature, it reduces the amount of oxygen dissolved in the water, thus also reducing the level of aquatic life that the river can support.

Another type of pollution involves the disruption of sediments (fine-grained powders) that flow from rivers into the sea. Dams built for hydroelectric power or water reservoirs can reduce the sediment flow. This reduces the formation of beaches, increases coastal erosion (the natural destruction of cliffs by the sea), and reduces the flow of nutrients from rivers into seas (potentially reducing coastal fish stocks). Increased sediments can also present a problem. During construction work, soil, rock, and other fine powders sometimes enters nearby rivers in large quantities, causing it to become turbid (muddy or silted). The extra sediment can block the gills of fish, effectively suffocating them. Construction firms often now take precautions to prevent this kind of pollution from happening.

Effects of Water Pollution

Some people believe pollution is an inescapable result of human activity: they argue that if we want to have factories, cities, ships, cars, oil, and coastal resorts, some degree of pollution is almost certain to

result. In other words, pollution is a necessary evil that people must put up with if they want to make progress. Fortunately, not everyone agrees with this view. One reason people have woken up to the problem of pollution is that it brings costs of its own that undermine any economic benefits that come about by polluting.

Take oil spills, for example. They can happen if tankers are too poorly built to survive accidents at sea. But the economic benefit of compromising on tanker quality brings an economic cost when an oil spill occurs. The oil can wash up on nearby beaches, devastate the ecosystem, and severely affect tourism. The main problem is that the people who bear the cost of the spill (typically a small coastal community) are not the people who caused the problem in the first place (the people who operate the tanker). Yet, arguably, everyone who puts gasoline (petrol) into their car—or uses almost any kind of petroleum-fueled transport—contributes to the problem in some way. So, oil spills are a problem for everyone, not just people who live by the coast and tanker operates.

Sewage is another good example of how pollution can affect us all. Sewage discharged into coastal waters can wash up on beaches and cause a health hazard. People who bathe or surf in the water can fall ill if they swallow polluted water—yet sewage can have other harmful effects too: it can poison shellfish (such as cockles and mussels) that grow near the shore. People who eat poisoned shellfish risk suffering from an acute—and sometimes fatal—illness called paralytic shellfish poisoning. Shellfish is no longer caught along many shores because it is simply too polluted with sewage or toxic chemical wastes that have discharged from the land nearby.

Pollution matters because it harms the environment on which people depend. The environment is not something distant and separate from our lives. It's not pretty shoreline hundreds of miles from our homes or a wilderness landscape that we see only on TV. The environment is everything that surrounds us that gives us life and health. Destroying the environment ultimately reduces the quality of our own lives—and that, most selfishly, is why pollution should matter to all of us.

Water Treatment

Wastewater Effluent

Over 5,000 people die worldwide every day from drinking or bathing in water containing the same contaminants that are removed at wastewater treatment plants. Wastewater effluent is the final product of all earlier treatment processes, and it can be discharged to a stream, river, bay, lagoon or wetland. Sometimes effluent is used to irrigate a golf course, green belt or park, or to recharge groundwater.

Wastewater Effluent must be in such a state of purity that the receiving waters into which it is released are not adversely affected, and these ecosystems are not harmed. There are many constituents in wastewater that can harm the receiving

Pollutant	Typical concentrations	Typical concentrations in

	before treatment	effluent
Suspended Solids	125 mg/L	30 mg/L

1. Suspended Solids

These are solids that stay in suspension instead of settling out of wastewater. These solids give the effluent turbidity. Turbidity is problematic in receiving waters of wastewater effluent. It raises the temperature of the water and blocks the sun from oxygen-producing plants and algae, thus reducing the dissolved oxygen of the receiving water.

2. BOD5

BOD stands for biochemical oxygen demand. BOD is an indirect measurement of the organic matter present in the water. The test is done by measuring the amount of dissolved oxygen used by microorganisms like bacteria to consume organic matter in the water. The BOD5 is the biochemical oxygen demand after five days, the standard time frame used to measure the dissolved oxygen in effluent. Proper levels of dissolved oxygen are necessary to keep fish and other aquatic organisms alive and healthy.

3. Nitrogen

Nitrogen is present in wastewater effluent from many sources, including human feces and fertilizer. Nitrogen can be a limiting nutrient to algae growth. Hence, nitrogen must be removed before discharge to prevent algal blooms which are disruptive to the ecological balance in the receiving waters. Some wastewater treatment plants use algae to consume the nitrogen, and then kill the algae before discharge.

4. Phosphorous

Phosphorous can also be a limiting nutrient to algae. The most common process used to remove phosphorus is chemical precipitation. However, this can lead to changes in pH.

5. pH

pH refers to the acidity of the effluent. Domestic wastewater before treatment typically has a pH of 6.5 to 8.5, but a final effluent of 7.0-7.2.

6. Pharmaceuticals and Pathogens

These wastewater constituents include caffeine, steroids, antibiotics and hormones from urine and other sources. Levels in effluent have only recently been studied for their effect on plants and animals. The most concerning are those meant to "stimulate a physiological response in humans, plants, or animals". These can cause reproductive system mutation, increase the number of cases of cancer, or lead to the development of antibiotic resistant strains of bacteria.

7. Sludge

The other product of wastewater treatment is sludge. This dense liquid contains all the chemicals and pathogens removed in either primary or secondary treatment, so it must be handled appropriately. Sludge must be disposed in accordance with permit issued by the EPA or approved state program.

Primary Treatment

Primary treatment removes suspended solids from the wastewater by sedimentation. Sedimentation uses gravity to let the solid particles settle into a sedimentation basins (also known as clarifiers or settling tanks. The accumulated settled solids are removed by mechanical scrapers and pumps. These "solid" waste products are referred to as raw sludge. The oil and grease (or "scum") that floats to the surface is skimmed and removed for additional processing.

Secondary Treatment

After primary treatment, the goal of secondary treatment is to remove the soluble Biochemical Oxygen Demand (BOD) and to provide additional removal of suspended solids from the wastewater. Wastewater treatment is not just done with pumps, settling, and chlorine. The removal of the excess organic matter is done by soliciting the help of microorganisms. These microorganisms convert colloidal and carbonaceous organic matter into various gases and protoplasm. Protoplasm is organic matter that contributes to the BOD, and secondary treatment is not complete until the protoplasm is removed as well. However, cellular protoplasm has a slightly higher specific gravity than water and therefore settles to the bottom of tanks where it can be removed from the effluent.

Tertiary Treatment

When wastewater is to be recycled or when eutrophication of natural bodies of water is an issue, tertiary treatment can be used on wastewater effluent. Tertiary treatment removes contaminants that are remaining from the previous primary or secondary treatments. The main contaminants of concern with tertiary treatment are nitrogen and phosphorus. In excess, they can cause harmful algae blooms in the natural receiving water that wastewater effluent will eventually flow into. This can lead to a dead zone in the receiving body where most naturally existing organisms have been died due to dissolved oxygen depletion caused by the algae. Many modern treatment methods incorporate physical, chemical, and biological processes in the same operation making the distinction between primary, secondary, and tertiary somewhat arbitrary. For purposes of this discussion, tertiary treatment is defined as an optional last step of a wastewater treatment process.

SOIL POLLUTION Soil Profile

If one could dig a massive trench (hole), about 50-100ft vertically downwards into the ground, you will notice that you would have cut through various layers of soil types. A look at the layers from a distance gives one a cross-section view of the ground (beneath the surface) and the kind of soils and rocks it is made up of.

This cross section view is called a Soil Profile. The profile is made up of layers, running parallel to the surface, called Soil Horizons. Each horizon may be slightly or very different from the other above or

below it. Each horizon tells a story about the makeup, age, texture and characteristics of that layer. Most soils have three major horizons. These are A Horizon, B Horizon and C Horizon. Aside these three, there are also the O, E and R horizons.

The O-Horizon:

The O horizon is very common in many surfaces with lots of vegetative cover. It is the layer made up of organic materials such as dead leaves and surface organisms, twigs and fallen trees. It has about 20% organic matter. It is possible to see various levels of decomposition occurring here (minimal, moderately, highly and completely decomposed organic matter). This horizon is often black or dark brown in color, because of its organic content. It is the layer in which the roots of small grass are found.

O (humus or organic A (topsoil)

E (eluviated horizon)

B (subsoil)

C (parent material)

The A-Horizon:

The A horizon may be seen in the absence of the O horizon, usually known as the topsoil. It is the top layer soils for many grasslands and agricultural lands. Typically, they are made of sand, silt and clay with high amounts of organic matter. This layer is most vulnerable to wind and water erosion. It is also known as the root zone.

The E-Horizon:

The E horizon is usually lighter in color, often below the O and A horizons. It is often rich in nutrients that are leached from the top A and O horizons. It has a lower clay content and are common in forested lands or areas with high quality O and A horizons.

The B-Horizon:

The B-horizon has some similarities with the E-horizon. This horizon is formed below the O, A & E horizons and may contain high concentrations of silicate clay, iron, aluminum and carbonates. It is also called the illuviation zone because of the accumulation of minerals. It is the layer in which the roots of big trees end.

The C-Horizon:

The C horizon lacks all the properties of the layers above it. It is mainly made up of broken bedrock and no organic material. It has cemented sediment and geologic material. There is

little activity here although additions and losses of soluble materials may occur. The C horizon is also known as saprolite.

The R-Horizon:

The R horizon is bedrock, material, compacted and cemented by the weight of the overlying horizons. It is the unweathered parent material. Rock types found here include granite, basalt and limestone.

Soil Pollution

With the rise of concrete buildings and roads, one part of the Earth that we rarely see is the soil. It has many different names, such as dirt, mud and ground. However, it is definitely very important to us. The plants that feed us grow in soil and keeping it healthy is essential to maintaining a beautiful planet. However, like all other forms of nature, soil also suffers from pollution. The pollution of soil is a common thing these days, and it happens due to the presence of man-made elements.

The main reason why the soil becomes contaminated is due to the presence of man-made waste. The waste produced from nature itself such as dead plants, carcasses of animals and rotten fruits and vegetables only adds to the fertility of the soil. However, our waste products are full of chemicals that are not originally found in nature and lead to soil pollution.

Main Causes of Soil Pollution

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

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

3. Waste Disposal: Finally, a growing cause for concern is how we dispose of our waste. While industrial waste is sure to cause contamination, there is another way in which we are adding to the pollution. Every human produces a certain amount of personal waste products by way or urine and feces. While much of it moves into the sewer the system, there is also a large amount that is dumped directly into landfills in the form of diapers. Even the sewer system ends at the landfill, where the biological waste pollutes the soil and water. This is

because our bodies are full of toxins and chemicals which are now seeping into the land and causing pollution of soil.

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

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

Effects of Soil Pollution

1. Effect on Health of Humans: Considering how soil is the reason we are able to sustain ourselves, the contamination of it has major consequences on our health. Crops and plants grown on polluted soil absorb much of the pollution and then pass these on to us. This could explain the sudden surge in small and terminal illnesses. Long term exposure to such soil can affect the genetic make-up of the body, causing congenital illnesses and chronic health problems that cannot be cured easily. In fact, it can sicken the livestock to a considerable extent and cause food poisoning over a long period of time. The soil pollution can even lead to widespread famines if the plants are unable to grow in it.

2. Effect on Growth of Plants: The ecological balance of any system gets affected due to the widespread contamination of the soil. Most plants are unable to adapt when the chemistry of the soil changes so radically in a short period of time. Fungi and bacteria found in the soil that bind it together begin to decline, which creates an additional problem of soil erosion. The fertility slowly diminishes, making land unsuitable for agriculture and any local vegetation to survive. The soil pollution causes large tracts of land to become hazardous to health. Unlike deserts, which are suitable for its native vegetation, such land cannot support most forms of life.

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

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

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

Control measures of soil pollution

A number of ways have been suggested to curb the current rate of pollution. Such attempts at cleaning up the environment require plenty of time and resources to be pitched in. Industries have been given regulations for the disposal of hazardous waste, which aims at minimizing the area that becomes polluted. Organic methods of farming are being supported, which do not use chemical laden pesticides and fertilizers. Use of plants that can remove the pollutants from the soil is being encouraged. However, the road ahead is quite long and the prevention of soil pollution will take many more years.

1. Soil erosion can be controlled by a variety of forestry and farm practices. Ex: Planting trees on barren slopes Contour cultivation and strip cropping may be practiced instead of shifting cultivation, Terracing and building diversion channels may be undertaken. Reducing deforestation and substituting chemical manures by animal wastes also helps arrest soil erosion in the long term.

2. Proper dumping of unwanted materials: Excess wastes by man and animals pose a disposal problem. Open dumping is the most commonly practiced technique. Nowadays, controlled tipping is followed for solid waste disposal. The surface so obtained is used for housing or sports field.

3. Production of natural fertilizers: Bio-pesticides should be used in place of toxic chemical pesticides. Organic fertilizers should be used in place of synthesized chemical fertilizers. Ex: Organic wastes in animal dung may be used to prepare compost manure instead of throwing them wastefully and polluting the soil.

4. Proper hygienic condition: People should be trained regarding sanitary habits. Ex: Lavatories should be equipped with quick and effective disposal methods.

5. Public awareness: Informal and formal public awareness programs should be imparted to educate people on health hazards by environmental education. Ex: Mass media, Educational institutions and voluntary agencies can achieve this.

6. Recycling and Reuse of wastes: To minimize soil pollution, the wastes such as paper, plastics, metals, glasses, organics, petroleum products and industrial effluents etc. should be recycled and reused. Ex: Industrial wastes should be properly treated at source. Integrated waste treatment methods should be adopted.

7. Ban on Toxic chemicals: Ban should be imposed on chemicals and pesticides like DDT, BHC, etc. which are fatal to plants and animals. Nuclear explosions and improper disposal of radioactive wastes should be banned.

Solid Waste Treatment:

Proper methods should be adopted for management of solid waste disposal. Industrial wastes can be treated physically, chemically and biologically until they are less hazardous. Acidic and alkaline wastes should be first neutralized; the insoluble material if biodegradable should be allowed to degrade under controlled conditions before being disposed. As a last resort,

new areas for storage of hazardous waste should be investigated such as deep well injection and more secure landfills. Burying the waste in locations situated away from residential areas is the simplest and most widely used technique of solid waste management. Environmental and aesthetic considerations must be taken into consideration before selecting the dumping sites.

Incineration of other wastes is expensive and leaves a huge residue and adds to air pollution. Pyrolysis is a process of combustion in absence of oxygen or the material burnt under controlled atmosphere of oxygen. It is an alternative to incineration. The gas and liquid thus obtained can be used as fuels. Pyrolysis of carbonaceous wastes like firewood, coconut, palm waste, corn combs, cashew shell, rice husk paddy straw and saw dust, yields charcoal along with products like tar, methyl alcohol, acetic acid, acetone and a fuel gas. Anaerobic/aerobic decomposition of biodegradable municipal and domestic waste is also being done and gives organic manure. Cow dung which releases methane into the atmosphere, should be processed further in 'gobar gas plants' to produce 'gobar gas' and good manure.