

## 3Unit 4. Environmental Pollution

### Air Pollution

**Air pollution** is the introduction of chemicals, particulate matter, or biological materials that cause harm or discomfort to humans or other living organisms

#### Pollutants

A substance in the air that can cause harm to humans and the environment is known as an air pollutant. Pollutants can be in the form of solid particles, liquid droplets, or gases. In addition, they may be natural or man-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. Rather, they form in the air when primary pollutants react or interact. An important example of a secondary pollutant is ground level ozone — one of the many secondary pollutants that make up photochemical smog. Some pollutants may be both primary and secondary: that is, they are both emitted directly and formed from other primary pollutants.

#### Major primary pollutants produced by human activity include:

- **Sulfur oxides (SO<sub>x</sub>)** - especially sulphur dioxide, a chemical compound with the formula SO<sub>2</sub>. SO<sub>2</sub> is produced by volcanoes and in various industrial processes. Since coal and petroleum often contain sulphur compounds, their combustion generates sulfur dioxide. Further oxidation of SO<sub>2</sub>, usually in the presence of a catalyst such as NO<sub>2</sub>, forms H<sub>2</sub>SO<sub>4</sub>, and thus acid rain
- **Nitrogen oxides (NO<sub>x</sub>)** - especially nitrogen dioxide are emitted from high temperature combustion. Nitrogen dioxide is the chemical compound with the formula NO<sub>2</sub>. It is one of the several nitrogen oxides. NO<sub>2</sub> is one of the most prominent air pollutants.

- **Carbon monoxide** - is a colourless, odorless, 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 major source of carbon monoxide.
- **Carbon dioxide (CO<sub>2</sub>)** - a colourless, odorless, non-toxic greenhouse gas associated with ocean acidification, emitted from sources such as combustion, cement production, and respiration
- **Volatile organic compounds** - VOCs are an important outdoor air pollutant. In this field they are often divided into the separate categories of methane (CH<sub>4</sub>) and non-methane (NMVOCs). Methane is an extremely efficient greenhouse gas which contributes to enhanced global warming. Other hydrocarbon VOCs are also significant greenhouse gases via their role in creating ozone and in prolonging the life of methane in the atmosphere, although 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 leukemia through prolonged exposure. 1,3-butadiene is another dangerous compound which is often associated with industrial uses.
- **Particulate matter** - Particulates, alternatively 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 the gas together. Sources of particulate matter can be man 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 the burning of fossil fuels in vehicles, power plants and various industrial processes also generate significant amounts of aerosols. Increased levels of fine particles in the air are linked to health hazards such as heart disease, altered lung function and lung cancer.
- **Persistent free radicals** connected to airborne fine particles could cause cardiopulmonary disease.
- **Toxic metals**, such as lead, cadmium and copper.
- **Chlorofluorocarbons (CFCs)** - harmful to the ozone layer emitted from products currently banned from use.
- **Ammonia (NH<sub>3</sub>)** - emitted from agricultural processes. Although in wide use, ammonia is both caustic and hazardous.

- **Odors** — such as from garbage, sewage, and industrial processes
- **Radioactive pollutants** - produced by nuclear explosions, war explosives, and natural processes such as the radioactive decay of radon.

### **Secondary pollutants include:**

- **Particulate matter** formed from gaseous primary pollutants and compounds in photochemical smog. Smog is a kind of air pollution; the word "smog" is a portmanteau of 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 smog does not usually come from coal but from vehicular and industrial emissions that are 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<sub>3</sub>)** formed from NO<sub>x</sub> and VOCs. Ozone (O<sub>3</sub>) is a key constituent of the troposphere. It is also an important constituent of certain regions 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 by night. At abnormally high concentrations brought about by human activities (largely the combustion of fossil fuel), it is a pollutant, and a constituent of smog.
- **Peroxyacetyl nitrate (PAN)** - similarly formed from NO<sub>x</sub> and VOCs.

## **Significance of Air Micro flora in Human Health / Hospitals / Industries**

### **Human Health**

The significance of air micro flora in human health relies on the fact that air acts as a medium for the transmission of infectious agents. An adult man inhales about '5m<sup>3</sup> of air per day. Although most of the microorganisms present in air are harmless saprophytes and commensals, less than 1 % of the airborne bacteria are pathogens.

Even though the contamination level is very low, the probability of a person becoming infected will be greatest if he is exposed to a high concentration of airborne pathogens. Carriers, either with the manifestation of corresponding symptoms or without any apparent symptoms, may continuously release respiratory pathogens in the exhaled air.

Staphylococcus aureus is the most commonly found pathogen in air since the carriers are commonly present. The number of *S. aureus* in air may vary between 0-1/m<sup>3</sup> and 50/m<sup>3</sup>.

Practically speaking, outdoor air doesn't contain disease causing pathogen in a significant number to cause any infection. The purity of outdoor air, however, is an essential part of man's environment. Dispersion and dilution by large volume of air is an inherent mechanism of air sanitation in outside air.

In the case of indoor air chance for the spread of infectious disease is more, especially in areas where people gather in large numbers. For example, in theatres, schools etc.

## **Hospitals**

Although hospitals are the war fields for combating against diseases, there are certain occasions in which additional new infectious diseases can be acquired during hospitalization. Air within the hospital may act as a reservoir of pathogenic microorganisms which are transmitted by the patients.

Infections acquired during the hospitalization are called nosocomial infections and the pathogens involved are called as nosocomial pathogens.

Nosocomial infection may arise in a hospital unit or may be brought in by the staff or patients admitted to the hospital. The common microorganisms associated with hospital infection are *Haemophilus influenzae*, *Streptococcus pneumoniae*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, members of *Enterobacteriaceae* and respiratory viruses.

Development of high antibiotic resistance is a potential problem among nosocomial pathogens. For example, Methicillin Resistant *Staphylococcus aureus* (MRSA) and gentamicin resistant Gram-negative bacilli are of common occurrence. Even antiseptic liquids used would contain bacteria, for example *Pseudomonas*, due to their natural resistance to certain disinfectants and antiseptics and to many antibiotics.

Nosocomial pathogens may cause or spread hospital outbreaks. Nosocomial pneumonia is becoming a serious problem nowadays and a number of pathogens have been associated with it.

Frequent agents are *Staphylococcus aureus*, *Streptococcus pneumoniae*, *Pseudomonas aeruginosa*, *Enterobacter*, *Klebsiella*, *Escherichia coli* and *Haemophilus influenzae*. There are two main routes of transmission for nosocomial pathogens, contact (either direct or indirect) and airborne spread.

## **Industries**

The significance of air flora is well understood in industries in which sterile products are prepared, processed, packaged or stored aseptically. These include food industries, pharmaceutical industries and other fermentation industries.

In food industries, contamination of the food products by microorganisms may lead to spoilage of the products and may cause food borne illness in consumers who take the spoiled foods. This can be prevented by providing aseptic atmosphere for the processing and packaging of food products.

In pharmaceutical and allied industries where aseptic filling is done or aseptic assembly of sterile products is done, sterile atmosphere is required which can be met by providing filtered sterile air. In fermentation industries, where microorganisms are used for the production of antibiotics, enzymes or organic acids, the significance of air micro flora has been well recognized.

## **Air borne diseases:-**

Following is the list of major diseases transmitted by air since air enters the body through the respiratory tracts they are called as respiratory disease.

## **Bacterial diseases**

<b>Pathogen</b>	<b>Disease</b>
1) <i>Corynebacterium diphtheriae</i>	Diphtheria
2) <i>Streptococci species</i>	Septic sore throat

3)	Streptococcus pyogenes	Scarlet fever
4)	Staphylococcus aureus	Rheumatic fever
5)	Mycobacterium tuberculosis	Tuberculosis
6)	Diplococcus Pneumoniae	Pneumonia
7)	Neisseria meningitidis	Meningitis
8)	Bordetella pertusis	Whooping cough
9)	Homophilus influenzae	Sinusitis, Bronchitis
10)	Yersinia pestis	Pneumonic plague

★ **Viral Diseases:-**

	<b>Pathogen</b>	<b>Disease</b>
1)	Mumps virus	Mumps
2)	Myxovirus influenzae (A,B,C)	Influenza
3)	Rhinovirus	common cold
4)	Rubella virus	German measles
5)	Rubeola virus	Measles
6)	Varicella virus	Chicken pox
7)	Variola virus	Small pox

★ **Fungal diseases (Systemic mycoses)**

	<b>Pathogen</b>	<b>Disease</b>
1)	Aspergillus fumigatus	Aspergillosis

- |    |                         |                 |
|----|-------------------------|-----------------|
| 2) | Blastomycesbraziliensis | Blastomycosis   |
| 3) | Candida albicans        | Candidiasis     |
| 4) | Coccidioides immitis    | Coccidiomycosis |
| 5) | Cryptococcus neoformans | Cryptococcosis  |
| 6) | Histoplasma capsulatum  | Histoplasmosis  |

**\* Hypersensitivity.**

- |    |           |          |           |
|----|-----------|----------|-----------|
| 1) | Immediate | Allergic | Reaction  |
| 2) | Delayed   | Allergic | Reactions |

The immediate type affects the upper respiratory tract & cause rhinitis & asthma which delayed type affects the lowers respiratory tract & cause local infections such an cough etc.

The Immediate allergy causing microorganisms include large fungal spores such as these of Puccini Alternation, cladosporium species.

The delayed allergy causing microorganism, include small fungal spores such as these of Actionmycetes, Aspergillus & Penicillium species.

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**Water pollution: causes hazards & control of human water borne diseases**

**Water pollution** is the contamination of water bodies (e.g. lakes, rivers, oceans and groundwater). Water pollution occurs when pollutants are discharged directly or indirectly into water bodies without adequate treatment to remove harmful compounds.

Contaminants that enter a waterway from a single, identifiable source, such as a pipe or ditch. Examples of sources in this category include discharges

from a sewage treatment plant, a factory, or a city storm drain. Contaminated storm water washed off of parking lots, roads and highways, called urban runoff, is sometimes included under the category of NPS pollution. However, this runoff is typically channeled into storm drain systems and discharged through pipes to local surface waters,

The specific contaminants leading to pollution in water include a wide spectrum of chemicals, pathogens, and physical or sensory changes such as elevated temperature and discoloration. While many of the chemicals and substances that are regulated may be naturally occurring (calcium, sodium, iron, manganese, etc.) High levels of pathogens may result from inadequately treated sewage discharges

Contaminants may include organic and inorganic substances.

**Organic** water pollutants include:

- Detergents
- Disinfection by-products found in chemically disinfected drinking water, such as chloroform
- Food processing waste, which can include oxygen-demanding substances, fats and grease
- Insecticides and herbicides, a huge range of organohalides and other chemical compounds
- Petroleum hydrocarbons, including fuels (gasoline, diesel fuel, jet fuels, and fuel oil) and lubricants (motor oil), and fuel combustion byproducts, from stormwater runoff<sup>[16]</sup>
- Tree and bush debris from logging operations
- Volatile organic compounds (VOCs), such as industrial solvents, from improper storage.
- Chlorinated solvents, which are dense non-aqueous phase liquids (DNAPLs), may fall to the bottom of reservoirs, since they don't mix well with water and are denser.
  - Polychlorinated biphenyl (PCBs)
  - Trichloroethylene
- Perchlorate
- Various chemical compounds found in personal hygiene and cosmetic products



A garbage collection boom in an urban-area stream in Auckland, New Zealand.

**Inorganic** water pollutants include:

- Acidity caused by industrial discharges (especially sulfur dioxide from power plants)
- Ammonia from food processing waste
- Chemical waste as industrial by-products
- Fertilizers containing nutrients--nitrates and phosphates--which are found in stormwater runoff from agriculture, as well as commercial and residential use<sup>[16]</sup>
- Heavy metals from motor vehicles (via urban stormwater runoff)<sup>[16][17]</sup> and acid mine drainage
- Silt (sediment) in runoff from construction sites, logging, slash and burn practices or land clearing sites

### **Waterborne diseases**

**Waterborne diseases** are caused by pathogenic microorganisms which are directly transmitted when contaminated fresh water is consumed. Contaminated fresh water, used in the preparation of food, can be the source of foodborne disease through consumption of the same microorganisms.

Waterborne disease can be caused by protozoa, viruses, or bacteria, many of which are intestinal parasites.

### **Protozoal diseases**

Amoebiasis	( <i>Entamoeba histolytica</i> )
Giardiasis	( <i>Giardia lamblia</i> )

### **Bacterial Infections**

Cholera	<i>Vibrio cholerae</i>
Dysentery	<i>Shigella dysenteriae</i>
Typhoid fever	<i>Salmonella typhi</i>
Leptospirosis	<i>Leptospira</i>
Botulism	<i>Clostridium botulinum</i>

## **Viral Infections**

Adenovirus infection	Adenovirus
Gastroenteritis	Astrovirus, Calicivirus, Enteric Adenovirus, and Parvovirus
Hepatitis A	Hepatitis A virus (HAV)
Poliomyelitis (Polio)	Poliovirus
SARS (Severe Acute Respiratory Syndrome)	Coronavirus



## **Waste water pollution**

There are mainly three types of wastes –

- 1. Domestic waterborne wastes**
- 2. Industrial waterborne wastes**
- 3. Ground, Surface and Atmospheric waterborne wastes**

### **1. Domestic waterborne wastes**

This includes human fecal matter excretion and wash waters and everything that goes down the drains of home and into a sewage system.

### **2. Industrial waterborne wastes**

This is classified into 6 types.

- i. Food industries waste**
- ii. Paper and pulp industries waste**
- iii. Textile industries waste**
- iv. Petroleum industries waste**
- v. Organic chemical industries waste**
- vi. Inorganic chemical industries waste**

**i) Food industries waste: -**

During canning, processing and preservation of different kinds of foods like milk, vegetables, meat and cereals etc, the waste consisting of food materials is resulted.

**ii) Paper and pulp industries waste: -**

During the manufacture of paper and pulp from the raw material, waste material is resulted which contains wood chemicals and sugars like cellulose, hemicellulose, lignin, starch etc.

**iii) Textile industries waste: -**

During cotton finishing, wool weaving synthetic fibers, dyeing and painting etc, the cotton fibers, proteins, fatty acids, esters, rayon, acids, dyes are mixed with wastewater.

**iv) Petroleum industries waste: -**

During separation of petroleum products from crude material, waste oils, acids, phenols, hydrocarbons are resulted.

**v) Organic chemical industries waste: -**

Several industries are involved in organic component synthesis, hence number of waste products are resulted including acids, alcohols, amines and gases etc.

**vi) Inorganic chemical industries waste: -**

Several industries are involved in inorganic component synthesis like  $H_2SO_4$ , HCL,  $HNO_3$ , Cu, Fe, Zn, Hg, Ag, Mn, Au etc. Waste resulted from these industries contain acids and metals which are toxic.

### **3. Ground, Surface and Atmospheric waterborne wastes**

Different chemicals, waste matter secreted by human beings and animals, leaves and branches of trees, dead animal and plant bodies, organic and inorganic chemicals from the soil are mixed in water during raining and waste water resulted is mixed with running water bodies and in lakes, ponds etc.

#### **Health hazards of waste water pollution**

Feces and urine from both humans and animals carry many disease-causing organisms. Wastewater also may contain harmful chemicals and heavy metals known to cause a variety of environmental and health problems. Disease-causing organisms (pathogens) from humans can enter a community's wastewater from patients at hospitals, or from anyone who is sick or a carrier of disease. Carriers may not have symptoms or even know they have a disease. Animal wastes often enter from farms, meat packing and processing facilities, and from rats and other animals found in or around sewage or sewers.

Much of our wastewater, treated or untreated, eventually ends up in our rivers, streams, lakes, and oceans-sometimes via groundwater, the underground water source we tap for well water. We often assume that groundwater is pure-and it usually is-but unfortunately, well water contaminated by sewage is a common cause of outbreaks of wastewater-related diseases.

When untreated wastewater reaches water used as a drinking water source for the community, there can be significant health risks. The effectiveness of drinking water treatment can be reduced when water is heavily contaminated with waste. To ensure safe drinking water, communities need both effective water and wastewater treatment. In addition, communities need to make sure that untreated wastes are not disposed of improperly on land where people can come in direct contact with it or where it can attract disease-carrying insects or animals.

Bacteria, viruses, and parasites (including worms and protozoans), are the types of pathogens in wastewater that are hazardous to humans. Fungi that can cause skin, eye, and respiratory infections also grow in sewage and sewage sludge.

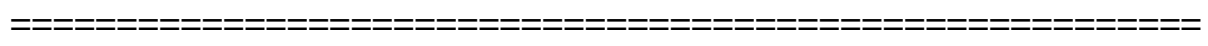
Scientists believe there may be hundreds of disease-causing organisms present in sewage and wastewater that have yet to be identified

Because of inadequate wastewater treatment, excessive amounts of the nutrients nitrogen and phosphorus sometimes invade water sources causing algae blooms. Algae blooms are dangerous to fish because they use a lot of the oxygen in the water. They can also have a strong, objectionable smell and can affect the taste of water.

Too much nitrogen in water can also be dangerous for humans. It is the cause of methemoglobinemia, or blue baby syndrome-a condition that prevents the normal uptake of oxygen in the blood of young babies. It is also suspected of causing miscarriages.Excess nutrients in coastal waters may also be related to certain "red tides," which kill fish and other aquatic life and can cause shellfish poisonings and certain respiratory illnesses in humans.

Metals, such as cadmium, copper, lead, nickel, and zinc, can also be found in wastewater. Some of these metals are needed in trace amounts by our bodies, but can be harmful in larger doses. Acute poisoning from heavy metals in water is rare in the U.S., but whether ingesting small amounts over an extended period of time has any accumulative effects is unknown. Other potentially toxic substances can enter wastewater from various sources, such as local business, industry, or storm water runoff. These substances can include pesticides and chemicals like chlorinated hydrocarbons, phenol, PCBs (polychlorinated biphenyls), and benzene.

Preventing potentially harmful substances from polluting water in the first place is always the best strategy for protecting health and the environment and preserving valuable water resources for community use and recreation. Communities can help through programs that ensure local businesses and industries properly pretreat and dispose of the wastewater they generate. Communities can also educate and encourage homeowners to properly dispose of hazardous household chemicals, such as paints, varnishes, photographic solutions, pesticides, and motor oil. Some communities set up special dates and locations for collecting these substances.



## **Soil pollution**

**Soil contamination** or **soil pollution** is caused by the presence of xenobiotic (human-made) chemicals or other alteration in the natural soil environment. It is typically caused by industrial activity, agricultural chemicals, or improper disposal of waste. The most common chemicals involved are petroleum hydrocarbons, polynuclear aromatic hydrocarbons, solvents, pesticides, lead, and other heavy metals. Contamination is correlated with the degree of industrialization and intensity of chemical usage.

### **Causes of Soil pollution**

- Accidental Spills
- Acid rain
- Intensive farming
- Deforestation
- Genetically modified plants
- Nuclear wastes
- Industrial Accidents
- Landfill and illegal dumping
- Agricultural practices, such as application of pesticides, herbicides and fertilizers
- Mining and other industries
- Oil and fuel dumping
- Buried wastes
- Disposal of coal ash
- Drainage of contaminated surface water into the soil
- Electronic waste

The most common chemicals involved are petroleum hydrocarbons, solvents, pesticides, lead, and other heavy metals.

## **Health hazards of soil pollution**

Contaminated or polluted soil directly affects human health through direct contact with soil or via inhalation of soil contaminants which have vaporized; potentially greater threats are posed by the infiltration of soil contamination into groundwater.

Health consequences from exposure to soil contamination vary greatly depending on pollutant type, pathway of attack and vulnerability of the exposed population. Chronic exposure to chromium, lead and other metals, petroleum, solvents, and many pesticide and herbicide formulations can be carcinogenic, can cause congenital disorders, or can cause other chronic health conditions. Industrial or man-made concentrations of naturally occurring substances, such as nitrate and ammonia associated with livestock manure from agricultural operations, have also been identified as health hazards in soil and groundwater.

Chronic exposure to benzene at sufficient concentrations is known to be associated with higher incidence of leukemia. Mercury and cyclodienes are known to induce higher incidences of kidney damage, some irreversible. PCBs and cyclodienes are linked to liver toxicity. Organophosphates and carbomates can induce a chain of responses leading to neuromuscular blockage. Many chlorinated solvents induce liver changes, kidney changes and depression of the central nervous system. There is an entire spectrum of further health effects such as headache, nausea, fatigue, eye irritation and skin rash for the above cited and other chemicals. At sufficient dosages a large number of soil contaminants can cause death by exposure via direct contact, inhalation or ingestion of contaminants in groundwater contaminated through soil.