UNIT 4 SOIL POLLUTION

Structure

4.0 INTRODUCTION

Soil is the unconsolidated outer layer of the earth's crust consisting of a mixture of minerals, organic material, living organisms, air and water that together support the growth of life. The process of soil formation is complex and involves a number of physical, chemical and biological transformations. Several factors contribute to the formation of soil. The factors include mechanical weathering of rocks due to temperature changes and abrasion, wind, moving water, glaciers, chemical weathering activities and lichens. Climate and time are also important determinants in the development of soils. Extremely dry or cold climates develop soils very slowly while humid and warm climates develop them more rapidly. The topmost layer of the soil richer in nutrients and supports maximum bioforms composed of minerals of varying sizes and organic matter along with pore space filled with air and water. There are different classes of soil types based on the particle size distribution patterns. The soil ecosystem includes inorganic and organic constituents, and microbial groups. The soil biota can be categorized as bacteria, algae, fungi, actinomycetes, protozoans, nematodes and microarthropods. The biota helps in decomposition of soil, organic materials and in nutrient cycling. Soil microbes are the active agents in the decomposition of plant and animal wastes and are referred to as nature's garbage disposal system. These soil microbes keep the earth free of toxins and help in biogeochemical cycling of elements i.e. C, N, and P. However, soil gets contaminated through a number ways which is referred to as soil pollution/land pollution. Soil can be contaminated with pollutants from different sources like industries and agricultural practices. Heavy metal contaminations of soil through anthropogenic activities such

as chemical and metallurgical industries have degraded the soil quality. These substances change the quality of soil and make it less fertile to support life.

4.1 OBJECTIVES

After reading this unit, you should be able to:

- define soil pollution;
- describe the sources of soil pollution and types of soil pollutants;
- explain the effects soil pollution; and
- discuss some prevention measures to reduce soil pollution.

4.2 CAUSES OF SOIL POLLUTION

Soil pollution can be defined as an undesirable change in the soil physico-chemical properties, which can result in adverse effects on human beings, plant life and animals. Soil pollution occurs when the presence of some toxic chemicals or contaminants in the soil is in reasonably higher concentrations that can pose a risk to plant life, animals and humans. Global warming, unsustainable practices, agricultural fertilizers and pesticides are responsible for converting arable land to non-arable lands finally leading to the process known as desertification. Soils are often contaminated with persistent toxic organic compounds, chemicals, salts, radioactive materials and biological disease causing agents. Pollution of the soil makes soil less suitable for crop cultivation causing severe ecological disturbances. Biological contaminants like bacteria, viruses, fungi, algae, nematodes and vectors like mosquitoes multiply in numbers in polluted soils that pose severe health threats. Some of the pollutants biomagnify in the food chain giving rise to undesirable and disastrous effects. The United Nations Food and Agricultural Organization estimate that annually 75 billion tons of soil, is lost to erosion, water-logging and salination. A healthy soil has several physical, chemical and biological properties. A healthy soil, (1) needs to incorporate adequate organic matter, (2) have a good structure, and (3) be home to a diverse mix of organisms. These properties allow the soil to carry out important functions, and this may be achieved in a natural setting by a soil reaching equilibrium with its surroundings, or in managed settings by human intervention to improve the overall soil's health. Agricultural soil health is linked to human health, as poor soils yield fewer crops with decreased nutritional value. Healthy soils also limit erosion, and help improve air and water quality (Brevik et al. 2013).

The European Commission has proposed the following definition of 'contaminated site': a site where there is a confirmed presence, caused by human activities, of hazardous substances to such a degree that they pose a significant risk to human health or the environment, taking into account land use (Commission Proposal COM (2006) 232). The major causes of soil pollution occur from industrial activities, oil spills, domestic activities, agricultural activities and acid rain. Local soil contamination occurs in places where intensive industrial activities, inadequate waste disposal, mining, military activities or accidents have introduced excessive amounts of contaminants. Soils have a limited ability to process these contaminants through filtering or transformation. Once this ability is exceeded, problems such as water pollution, plants taking up contaminants etc. become more significant (EEA, 2007).

4.3 SOURCES OF SOIL POLLUTION

Over 200 years of industrialization have caused soil contamination to be a widespread problem in the world. Decision makers, scientists, businesses and individual citizens generally accept and understand that pollution can have negative impacts on human health, but the impacts of soil pollution on our health are not so well understood. The major sources of soil pollution include: mining and quarrying, household waste, construction industry wastes, biomedical wastes, agricultural wastes etc. These wastes reach the soil and infiltrate eventually entering the ground waters, rivers, lakes, streams through rainfall, irrigation, drainage thus polluting and disturbing the natural balance of the ecosystems. Soil gets polluted in a number of ways and some important sources are discussed below.

4.3.1 Agricultural Sources

a) Pesticides

In modern agriculture the use of various agrochemicals is a common practice. A wide range of pesticides have been developed, almost more than 450 compounds. The most commonly used include herbicides, insecticides, fungicides while others include nematicides, miticides, rodenticides and molluscicides. Pesticides applied on seed or foliage act in a number of ways depending on their application and ultimately reach the soil. Accumulation of pesticide residues in the biosphere creates ecological stress causing contamination of soil, water, and food. After the Second World War, many countries suffered from food shortage and this introduced chemical fertilizers and other agricultural chemicals. Pesticides such as DDT i.e. dichlorodiphenyltrichloroethane a chemical pesticide, was introduced which is a potent nerve poison in insects. DDT was found to bioaccumulate in the food chains. Persistent pesticides may accumulate in the bodies of animals and over a period of time increase in concentration if the animal is unable to flush out the toxins leading to bioaccumulation. When an affected animal is eaten by a carnivore, the pesticide is further concentrated in the carnivore. This phenomenon of increasing in the concentration of a nondegradable substance along the food chain is called 'Biomagnification'. DDT prevents the shelling of bird eggs. The war of Vietnam in 1970's introduced another chemical, dioxin. Dioxin is a toxic chemical and was used as a defoliant by the American army. After the war, it was found that the chemical caused congenital deformities and mental aberrations to the children born to the American soldiers. Insecticides such as, lead arsenate, calcium arsenate, and Paris green are used extensively and can penetrate soil and ground water.

b) Fertilizers

Farmers started using artificial fertilizers at the end of the 19th century that enabled more land to be brought under cultivation. The production of these man-made fertilizers requires large amounts of energy and depletes the world's resources of phosphate ores. In recent decades the use of inorganic fertilizers has increased dramatically. Between 1952 and 1985, the global consumption of these fertilizers increased from 14 million tonnes to 125 million tones which is a tremendous increase. Inorganic fertilizers are used in preference to organic fertilizers as the nutrients are in a more readily available form and are released quickly after their application to the soil. The agricultural production depends on chemical fertilizer application, as most

of our high yielding varieties are fertilizer responsive. Continuous application of chemical fertilizers lead to deterioration of soil properties and cultivated soils lose their natural characteristics. Fertilizers like ammonium sulphate, ammonium chloride and urea reduce the soil pH. Many crops, for example like potato, grapes, citrus, beans are sensitive to chloride toxicity. Excessive use of inorganic nitrogen fertilizers in agricultural practices has been associated with soil acidification, partly through the process of nitrification. If the levels of NO_3^- ions in soil are in excess of plant requirements, they will behave as mobile anions, thus increasing the leaching process. The acidifying effect of nitrogen fertilizers is mobilized in the form of organo-metallic complexes. If mineral acids predominate then aluminium is mobilized in its ionic form Al^{3+}. This form of aluminium is very toxic to fish and many freshwater organisms. The excess use of nitrate containing fertilizers leads to nitrates discharged in the soil and ground waters. When human beings consume nitrate rich waters, the nitrates are converted to nitrites by the action of intestinal flora. The nitrites have an affinity to hemoglobin and combine with it to form methaemoglobin that interferes with the oxygen carrying capacity of blood. This phenomenon is called 'methaemoglobinaemia'. It is common in infants and often called the 'blue baby syndrome' as the symptoms include blue colouration of the skin, vascular and respiratory problems, headache, giddiness, and ocular tensions. Serious nitrate poisoning is reported in Rajasthan and Punjab. Integrated nutrient management helps to sustain the productivity of soils. The use of organic manures and bio fertilizers are recommended as supplements to chemical fertilizers.

Blue baby or methemoglobinemia

Nitrates can enter the ground water from chemical fertilizers used in agricultural areas. Excessive nitrate concentrations in drinking water pose an immediate and serious health threat to infants less than 3 months of age. The nitrate ions react with blood hemoglobin, reducing the blood's ability to carry oxygen and this produces a disease called blue baby or methemoglobinemia. In this illness the infant's blood is unable to carry enough oxygen to the body cells and tissues. An infant with moderate to serious 'blue baby syndrome' may have a brownish-blue skin tone due to the lack of oxygen. The symptoms observed include: fatigue, diarrhea, vomiting, headache, respiratory disorders and in severe cases it can cause death.

c) Excess Salts and Water

Salinization refers to the impregnation of soils by various salts most importantly, calcium sulphate (gypsum: $CaSO_4.2H_2O$) and sodium sulphate (thenardite Na_2SO_4) and in some cases various salts of magnesium sulphate (epsomite) and sodium chloride (halite). They precipitate from the ground water by percolating vertically through capillary under the influence of evapotranspiration during spells of drought, and not from the evaporation of stagnant water on impermeable soils. They dissolve again and seep downwards when rain occurs; hence an alternate vertical motion of salts occurs with time. Salinization usually occurs *per ascensum* when capillary water brings up phreatic water and when supersaturation of dissolved salts occurs through evaporation. Hence, excess irrigation which shifts the groundwater level is a significant cause of soil salinization. The irrigation water helps to produce more yield than rainfed land. Irrigation water contains dissolved salts and in the dry seasons, water

is in the form of saline solution which evaporates leaving its salts such as sodium chloride (NaCl) in the top soil. This saline soil causes stunted plant growth, lower yield and productivity. Flushing out salts reduces the salinity but makes downstream irrigation water saltier.

4.3.2 Industrial Sources

Indiscriminate dumping of untreated or inadequately treated industrial wastes is an important source of soil pollution. Fall out of gaseous and particulate air pollutants from mining and smelting operations, smoke stacks etc. are some of the major source of industrial soil pollutants. They can be wastes from textile, tannery, chemical, electroplating, glass, distilleries, paper, petroleum, cement industries, pharmaceutical etc. These wastes contain inorganic and organic materials that alter and change the natural composition of our soils. Toxic chemicals leached into the soil are potential threats to large numbers of birth defects, cancers, respiratory, nervous and kidney diseases.

Heavy metal pollution

Metalliferous wastes which include heavy metals like: mercury, lead, zinc, cadmium, copper, nickel are commonly found in soils where ore extraction and smelting processes have occurred. Further metal contamination can also occur on land/soil used for scrap metal dealing and ammunition factories. The heavy metals include all metals with atomic numbers greater than 23 (with a few exceptions). The metals are classified as "heavy metals" if in their standard state they have a specific gravity of more than 5 g/cm^3. There are sixty known heavy metals. Heavy metals get accumulated in time in soils and plants and could have a negative influence on physiological activities of plants (e.g. photosynthesis, gaseous exchange, and nutrient absorption), determining the reductions in plant growth, dry matter accumulation and yield (Devkota et al. 2000, Baker 1981). In small concentrations, the traces of the heavy metals in plants or animals are not toxic (De Vries et al. 2008). Lead, cadmium and mercury are exceptions; they are toxic even in very low concentrations (Galas-Gorchev 1991). Heavy metals are hazardous and toxic to man and other life forms. Most of them are slow poisons as they accumulate in the body and cause serious disorders. Another description often used interchangeably with heavy metals is 'trace elements'. These elements occur naturally in rocks and in variable amounts in soils, depending on their location and the rocks that have broken down to make the soil's components. The group 'heavy metals' for the purpose of discussing health risks or impacts generally includes: Arsenic (As), Lead (Pb), Cadmium (Cd), Chromium (Cr) (although only the form Cr(VI) is toxic), Copper (Cu), Mercury (Hg), Nickel (Ni), Zinc (Zn). Several of these elements are necessary for human health, and are beneficial when taken in to the body in foods or as supplements at appropriate, low levels. Conversely, cadmium, lead and mercury have no known biological function and are toxic to humans. Heavy metals are widely used in industrial processes and as biocides. These can be discharged into the environment by improper treatment, resulting in their accumulation causing public health hazards. Toxic metals can exist in soil in a number of forms including adsorbed cations, attached to clay and humus colloids and organometallic chelates. Their availability to plants depends on a number of soil metals. In soils with low cation exchange capacity (CEC), the metals are not retained effectively and will be leached from the soil. But in the case of soils with high cation exchange capacity they are fixed in the soil through adsorption. Hence the mobility and availability of heavy metals is important and is greater in acidic soils (pH<5.5) than in near neutral and alkaline soils. The heavy metals once

mobilized can enter the food chain through water supplies, aquatic organisms, arable produce and grazing animals.

Table 4.1: Some sources of heavy metals in soil

Heavy metal	Sources
Lead	Plumbing, petrol, paint, battery, refinery,
Arsenic	sm elter, plumbing pipes
Mercury	Wood preservative, pesticides,
Zinc	uranium mining, glass/copper
Cadmium	smeltersPesticides, mining, refinery,
Chromium	photography, scientific instruments
Nickel	Electroplating, textile industry
	Fertilizers, tannery, smelter, battery,
	electroplating, paint pigments
	Dyeing industry
	Electroplating industry

4.3.3 Urban Sources

Annually tonnes of untreated urban waste are produced. This cause serious health hazards to humans, pollute the soil and decreases its fertility and productivity. Plastics constitute a major portion of global domestic and industrial waste. Plastics are non-biodegradable so they remain in the environment for a number of years. Municipal wastes mainly include domestic and kitchen wastes, market wastes, hospital wastes, livestock and poultry wastes, slaughterhouse wastes etc. Wastes from the residences are usually found dumped on soil and is a serious cause of concern. These wastes include garbage, organic wastes, paper, glass, plastics, clothes, metal containers etc. These do not degrade easily and cause toxicity to the soils. Hospital wastes contain organic materials, chemicals, metal needles, plastic and glass bottles, vials, etc. Dumping of domestic and hospital wastes contaminate the environment with a variety of pathogens that can seriously affect human health. Plastics form a major part of global domestic and industrial waste. They are nonbiodegradable and remain in the soil adding to pollution. Using photodegradable plastic or biodegradable plastic are solutions to the problem. Photodegradable plastic contains an element sensitive to UV rays. Under the effect of solar rays the element is activated and breaks the polymeric chain of the photodegradable plastic. It results in small fragments that are easily digested by microbes.

4.3.4 Nuclear waste sources

Radioactive materials

They are often released into the soil from nuclear explosions, atmospheric fallout from nuclear dust, discharges from radioactive laboratories etc. Uranium, Thorium, Radium, and Cesium are commonly found in the environment that keep emitting radiations and persist for a long time. They are known to bioaccumulate in plants. Radiations can enter human beings when plants and food containing them are ingested resulting in mutations and genetic disorders.

Activity 1

- *Identify some activities in your residence/ offices that are responsible for soil pollution.*
- *Identify the soil pollution generating sources in your neighborhood.*
- *Classify them based on the sources and type*

Check Your Progress 1

Note : a) Write your answer in about 50 words.
b) Check your progress with possible answer given at the end of the unit.

1. What is soil pollution?

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2. Describe the sources of soil pollution.

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4.4 EFFECTS OF SOIL POLLUTION

Soil pollutants may be responsible for health effects costing millions of Euros, but studies to quantify them are in still in the preliminary stages. Health problems from cancers (arsenic, asbestos, dioxins), to neurological damage (lead, arsenic), kidney disease (lead, mercury, cadmium), skeletal and bone diseases (lead, fluoride, cadmium) are serious issues, that needs to be addressed. Some countries have detailed soil monitoring networks to measure soil quality, however, these may reflect national or regional priorities and standards, and so comparing results between countries is extremely difficult. Recent improvements in data collection mean that the number of reported contaminated sites could increase by as much as 50% by 2025 (EEA, 2007).

4.4.1 Effects on Agriculture

The major effects of soil pollution on agriculture are: loss of nutrients in the soil, soil erosion, less fertile land for vegetation, reduction in crop yield and reduction in nitrogen fixation. Many of the chemicals used in pesticides are persistent soil contaminants, whose impact may endure for decades and adversely affect soil conservation. The use of pesticides decreases the general biodiversity in the soil. Pesticides can hinder nitrogen fixation in legumes. DDT was one of the first synthetic organic insecticides to be used. DDT, methyl parathion, and pentachlorophenol have been shown to interfere with legume rhizobium chemical signaling resulting in reduced nitrogen fixation and thus reduced crop yields. DDT also interferes with the production of normal eggshells in birds making them weak and thin shells. Pesticides

lead to poor root hair development, shoot yellowing and reduced plant growth. Pesticide surface runoff into rivers and streams can be highly lethal to aquatic life. 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. 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.

4.4.2 Effects on Ecosystem

Soil pollution can affect the ecosystem in the following ways: ecological imbalance, permanent change in the chemical properties of soil, alteration in the metabolism of endemic microorganisms resulting in eradication of the primary food chain, adverse health effects on all organisms**.** 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.

4.4.3 Effects on Humans

We are also affected by soil pollution as crops and plants grown on polluted soil absorb much of the toxic contaminants. Long term exposure to polluted soil can affect the genetic make-up of the body, causing congenital illnesses and chronic health problems that cannot be cured easily. These include: pollution in drinking water, contamination in vegetation due to presence of chemicals, problems of waste management, polluted environment with harmful gases to breathe in and foul smells and health issues. Exposure to pesticides by consumption of food can result in skin irritation, birth defects, tumors, genetic changes, blood and nerve disorders, endocrine disruption, and even coma or death. Soil can enter our bodies via three main routes: eating, inhalation and through the skin. (a) Ingestion: Eating soil or geophagia is common among children under the age of three. Children are particularly sensitive to contaminants and at highest risk from contaminated soils. Accidental ingestion may occur in adults (i.e. by eating fruits or vegetables with some soil contamination). When consumed, some chemicals are absorbed in the oral cavity while others are swallowed and move into the digestive system. From here, they may be absorbed into the body and transported to the liver. In the liver, some chemicals are largely returned to the digestive system via bile, but others will enter the bloodstream. Some chemicals are broken down in the liver before they reach the blood. Some chemicals are not absorbed, and remain in the gut and may cause toxicity to the gut lining. (b) Inhalation: Working with soil releases particulate matter into the air that may be inhaled by workers. These particles may enter the lungs and may be absorbed into the bloodstream. Compared to ingestion, this is a far less significant source of exposure, but may be relevant to those exposed repeatedly over a long time period. (c) Skin contact: Volatile, organic compounds are absorption through the skin. Absorption of a chemical through the skin is known as 'dermal absorption', 'cutaneous absorption' or 'transcutaneous absorption'. (d) Indirect contact: Soil contaminants may move from soils into ground or surface water, leading to contaminated drinking

water. They may also be taken up by plants which are subsequently consumed, either by humans or by agricultural livestock, causing contaminants to enter the human food chain. Some of these effects may be quite significant, as in the case of dioxins accumulating up the food chain, or large quantities of cadmium in crops grown in contaminated soils. High levels of arsenic in drinking water supplies are often another significant indirect result of soil contamination. Arsenic may also be naturally present in groundwater. A contaminant becomes toxic in the human body once the system is unable to detoxify. The body starts to be exposed to excess amounts of the chemical or the metabolite produced when the body's normal metabolic pathways are saturated. If a chemical accumulates in tissues, reaching critical toxicity long-term accumulation and toxicity occurs. Factors that are relevant in this case are the body's rate of elimination (by metabolism or excretion), and the overall 'body burden' – the quantity of chemicals stored in body tissues (Environment Agency, 2009).

Check Your Progress 2

Note : a) Write your answer in about 50 words.

b) Check your progress with possible answer given at the end of the unit.

1. Explain the various routes through which soil can enter the human body?

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2. Describe some important effects of soil pollution?

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4.5 PREVENTION OF SOIL POLLUTION

The different types of wastes namely agricultural, industrial and urbanization have decreased the soil fertility and made it highly contaminated. Some ways in which soil pollution can be controlled are discussed below:

(i) ***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.

(ii) ***Use of bio-pesticides and biofertilizers*:** Bio-pesticides should be used in place of toxic chemical pesticides. Organic fertilizers should be used in place of synthesized chemical fertilizers. To increase agricultural yield, most farmers use chemical fertilizers. The microorganisms in these fertilizers will help in increasing the fertility of the soil. Ex: Organic wastes in animal dung may be used to prepare compost manure instead of disposing them into soil. The concept of Integrated Plant Nutrient System (IPNS) can also be used.

(iii) ***Proper Hygienic Condition*:** People should be trained regarding sanitary habits. Ex: lavatories should be equipped with quick and effective disposal methods.

(iv) ***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.

(v) ***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. Therefore, people should consider shifting to reusable containers like glass, cotton bags, etc. Although paper does disintegrate faster, a lot of trees are cut for producing paper bags. Therefore, it is best to opt for cloth bags. Similarly, instead of using tissue papers in the kitchen, etc., one should use cloth napkins, handkerchief, etc. This will go a long way in reducing land-fills.

(vi) ***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.

(vii) ***Reduce Toxic Waste*:** Toxic waste is a significant aspect of soil pollution. Hence, industrial toxic waste should be treated to reduce its toxicity before it is disposed of. At the same time, responsible methods should be used for disposing off the waste. The best however, is to avoid the use of harmful chemicals unless they are of extreme importance.

(viii) ***Deforestation*:** To prevent soil pollution, deforestation measures have to be undertaken at rapid pace. Soil erosion is caused, when there are no trees to prevent the top layer of the soil from being transported by different agents of nature like water and air. At the same time, measures should be taken to avoid over cropping and over grazing, as it leads to flood and soil erosion and further deterioration of the soil layer.

(ix) ***Reforesting*:** Control of land loss and soil erosion can be attempted through restoring forest and grass cover to check wastelands, soil erosion and floods. Crop rotation or mixed cropping can improve the fertility of the land.

(x) ***Solid Waste Treatment*:** 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. Further, storage of hazardous waste should be investigated such as deep well injection and more secure landfills. Composting 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.

(xi) ***Soil Conservation*:** Soil conservation is the protection of soil against excessive loss of fertility by natural, chemical, or artificial means. It encompasses all management and land-use methods protecting soil against degradation, focusing on damage by erosion and chemicals. Soil conservation techniques can be achieved through crop selection and rotation, fertilizer and lime application, residue management, contouring and strip cropping, and mechanical methods (e.g., terracing).

4.6 LET US SUM UP

Dear learners, in this unit we have learnt that soil serves as a natural sink for pollutants by concentrating contaminants which end up in the soil from various sources. Modern cities have enormous impacts on soils. Here, the city's soils are covered with asphalt, cement, stone, waste piles, pollutants and the soils have lost their natural cover of vegetation. The natural exchange of gases between the soil and air is greatly reduced. Such soils lose their organic matter and are likely to be waterlogged, compacted and impervious to water flow. Pollutants decrease soil quality, disturb the soil's natural balance and may also lead to wear and erosion. Different types of soil pollution can be distinguished by their source, as well as the effects each has on the ecosystem. Anthropogenic or human activities that pollute the soil include: agricultural practices that use excessive pesticides, industrial wastes, radioactive emissions that contaminate the soil with various toxic substances etc. Soil pollution affects plants, animals and humans. Soil pollution may cause a variety of health problems in human beings, starting with headaches, nausea, fatigue, skin rash, eye irritation and potentially resulting in more serious conditions like neuromuscular blockage, kidney and liver damage and various forms of cancer. Some prevention measures for soil pollution are also discussed.

4.7 KEY WORDS

Methemoglobinemia: The nitrate ions react with blood hemoglobin, reducing the blood's ability to carry oxygen and this produces a disease called blue baby or methemoglobinemia.

Soil conservation: Soil conservation is the protection of soil against excessive loss of fertility by natural, chemical, or artificial means.

Land Farming: It is a bioremediation treatment process that is carried out in the upper soil zone.

Reforestation: It involves replanting areas of forest which have previously been damaged or destroyed, using native tree species.

Deforestation: It refers to the removal of a forest or trees where the land is thereafter converted to a non-forest use.

4.8 REFERENCES AND SUGGESTED FURTHER READINGS

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4.9 ANSWERS TO CHECK YOUR PROGRESS

Answers to Check Your Progress 1

1. Your answer must include the following points:

   Soil pollution can be defined as an undesirable change in the soil physico-chemical properties, which can result in adverse effects on human beings, plant life and animals. Soil pollution occurs when the presence of some toxic chemicals or contaminants in the soil is in reasonably higher concentrations that can pose a risk to plant life, animals and humans.

2. Your answer must include the following points:

   Agricultural sources

   Industrial sources

   Urban sources

   Nuclear waste sources

Answers to Check Your Progress 2

1. Your answer must include the following points:

   Soil can enter our bodies via three main routes: eating, inhalation and through the skin.

Ingestion

Inhalation

Skin contact

Indirect contact

2. Your answer must include the following points:

Soil pollutants may be responsible for health effects costing millions of Euros, but studies to quantify them are in still in the preliminary stages. Health problems from cancers (arsenic, asbestos, dioxins), to neurological damage (lead, arsenic), kidney disease (lead, mercury, cadmium), skeletal and bone diseases (lead, fluoride, cadmium) are serious issues, that needs to be addressed.

Effects on Agriculture

Effects on Ecosystem

Effects on Humans

Effect on growth of plants and soil fertility