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Soil Pollution

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Abstract

Soil is the complex mixture of minerals, water, air, organic matter and countless organisms. It formed at the surface of land and it is called the skin of the earth. Soil is capable of supporting plant life and is vital to life on earth. With the increasing population and rapid urbanisation the health status of the soil is decline. They increase the contamination concentration in the soil and gave birth to the problem of soil pollution. Soil pollution is the situation in which the level of toxic substances enhanced in the soil which creates hazardous risk to soil organism and plants life cycle. The untreated flow of drainage and dumping of waste in the soil, leakage during storage and transportation, and excess use of chemical and pesticides in the agriculture are the principal sources of soil pollution. These pollutants not only affect the fertility status of soil but also develop many serious health problems to human beings such as tooth decay, blue baby syndrome, etc. Not only humans, water ecosystem also affected which results in the shifting of aquatic bodies from one area to others. Many plant and animal species are now at the course of extinction because of industrialization now. Soil pollution needs to be controlled now. Special strategies should be adopted to decrease the soil pollution. There are several chemical, physical and biological to prevent and control pollution. Strict laws should be implemented in the society by the government against industries to control environment. There is a need to continuous monitoring of prevention and amelioration options. Soil is crucial for substance life on earth. Therefore, it should be utilized optimally keeping environment in mind.

Keywords: Soil pollution, contaminants, hazardous risk, industrialization, environment

Introduction

Soil is one of the most wonderful gifts provided by nature to humans. Soil is formed the weathering of rocks and minerals by different weathering agents. Weathering process is important for maintaining the fertility status of the soil. It is a very slow process so it takes

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thousands of years in the formation of soil which we see today. Soil which is called Soil Of Infinite Life is the large pool in which a numerous lives survives. Presence of microorganism, plants and animals give life to it. Soil plays an important role in the existence of life on earth. It provides all the necessary products which are crucial for survive on earth. Soil is a medium for the growth of plant. It provides support and essential nutrients to plants. But with the increasing population, man put more pressure on soil to feed this increasing population. Increase in anthropogenic activities in the last past years, results in decreasing the fertility and health status of the soil. Rapid industrialisation results in generation of huge amount of soil and liquid waste materials, which is the principal cause of soil pollution. This chapter defines the soil pollution, sources of soil pollution, relationship between the pollution and productivity of crops and the mitigation technologies to control the soil pollution.

Soil Pollution

Soil pollution is the presence of harmful toxic substance in the soil which makes it unfit for any use and cause serious health hazards to us. It can also be defined as the undesirable change in the physical, chemical and biological characteristics of soil that can harmfully affect life and human being and other living system. In simple words, soil pollution is the introduction of contaminants in the soil that cause adverse change. The term pollution and contaminants are sometimes used synonymously. However, there is some difference between them. Contamination is the presence of a substance that should not be present naturally. Pollution is when contaminant cause harm to organism or infrastructure. Therefore, it can be said that you can have a contaminated environment without being it polluted but you cannot have a polluted environment without it being contaminated.

Sources Of Soil Pollution

Soil pollution is mainly caused by industrial activities, agricultural chemicals and improper disposal of waste. The major sources of soil pollution are the disposal of untreated industrial waste, use of fertilizer and pesticides in intensive agriculture, leakage loss of oil and other chemical during storage and transportation, dumping of nuclear and radioactive waste in soil, drainage of polluted water, deforestation and constructions. Radioactive waste is a result of many activities, including nuclear medicine, nuclear power generation and nuclear weapons reprocessing.

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Depending on the nature of chemical, soil pollutants are of two type; organic and inorganic. The major organic soil pollutants are petroleum hydrocarbons, polynuclear aromatic hydrocarbon, pesticide and solvents. Inorganic soil pollutants include heavy metals, nitrate, phosphate and inorganic acids. Many agricultural activities are also responsible for soil pollution. The chemical fertilizer added to soil has low solubility and are slowly degradable persist for long time in the soil. These chemical get accumulated in the soil over time and decrease the fertility status of soil. Pesticides also have harmful effect on soil flora and fauna because of its residual effect. Similarly, large amount of untreated industrial waste when dumped in soil releases heavy metal in the soil. These heavy metals entered in the food chain of human and cause deadly problems. Even if the waste is away from residential area, the fumes released from the industrial waste pollute the air which causes breathing problems. These fumes cause acid rain and pollute the soil. Many day to day activities also directly and indirectly cause soil pollution. The use of non-biodegradable plastic, glass and construction activities is the reasons of deposition of contaminants in soil.

Types of Soil Pollution

There are generally five types of soil pollution namely (a) Pesticides pollution (b) Inorganic pollutants (c) Organic waste (d) Fertilizer and (e) Radioactive material.

Pesticides

Pesticides include insecticides, fungicides, herbicides rodenticides and nematocides and many other chemical such as hormones, antibodies, etc. Many of these chemical are extremely poisonous not only to soil organism but also to animals and human. These chemical get accumulated in the lower organism and there concentration reached up to toxic level. When higher animal consume theses high concentration of pesticides they enter in their food chain and cause serious health problems. When these pesticides applied in soil, they undergo different reactions: lost to the environment through vaporization, adsorbed on the surface of the soil, leached downward with the percolating water or may be degraded by soil microorganism. But some of the pesticides such as DDT, Aldrin, etc. are not easily degradable in soil so may persist for long period of time in soil. They move to water bodies by soil erosion and enter into the food chain of aquatic animals.

Inorganic pollution

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Inorganic pollution includes trace elements which are usually the metals especially heavy metals. Among all the heavy metals (Hg, Cd, Pb, As, Ni, Cu, Zn, Mn, etc.) Cd and Ar are extremely poisonous. Hg, Pb and Ni are moderately poisonous and Cu, Zn and Mn are relatively lower in toxicity. Cu, Zn and Mn are considered essential for plants and their availability in soil depends on pH of the soil. These heavy metals added into the soil by the application of sewage water, and untreated disposal of paper mill and different industries. Soil reaction and symbiosis process in the soil are affected by the high concentration of heavy metal in soil. Along with their phytotoxic effect, they disturb the nutrient balance in soil. Pb is less toxic to plant as its solubility is highly depended on soil pH. It remains in insoluble form until the pH of the soil is not too acidic. The toxicity of the Pb can be minimised by the application of lime in the soil. Long term application of Ar pesticides in soil increases the concentration of Ar to toxic level in soil. Cd is extremely toxic to plant as well as human being. It accumulates in the plant tissue and affects the normal functioning of plant.

Organic waste

Organic waste or bio-degradable waste is the natural refuse that comes from plants and animals. It contains bio-degradable plastics, food waste, green waste, paper waste, human waste, animal and crop residue, etc. This organic waste now becomes a serious reason of soil pollution. It is the major source of virus and diseases. Organic waste is one of the rich sources for building fertility status of soil if it is recycled properly in field. But the main problem is its disposal because of its bulky nature. Also during composting, anaerobic decomposition of organic waste take place which release methane gas which is a major greenhouse gas.

Fertilizers

Fertilizer may be defined as the substances which are chemical in nature and are capable to supply plant nutrients in available form. Mostly fertilizers are inorganic in nature synthesized in industries except urea and amide. Fertilizers are used to enhance the growth of crop. But with the urbanisation and population growth, the consumption of fertilizer increased exponentially throughout the world to feed the ever increasing population. However, the excess use of fertilizer through direct application or through irrigation water, results in accumulation of salts in the soil which threatens the productivity of the crop. Increase in the concentration of salts in soil results in development of soil salinity and alkalinity problem. Nitrogen is universally deficient in our soil. Majority of the fertilizer

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added in to the soil is to supply nitrogen to the crop. Excess of use of these fertilizers results in a large number of environment problems because some of these fertilizer contains heavy metals. It affects the nutrients uptake by plants and nutrients supplying capacity of the soil.

Radioactive material

Radioactivity is a phenomenon in which unstable atomic nuclei of energy decompose and emit radiation energy in the form of electromagnetic waves. The major sources of radioactive material are nuclear weapon, generation of energy from nuclear material, nuclear reactor and waste from medical laboratories. Contamination of the soil with radioactive material is an important hazard for the environment and economy. The radioactive materials on decomposition emit radioactive rays which enter and affects the environment at all the stages of nuclear fuel cycle. The degree of the hazard is determined by the concentration of the contaminants, the energy of the radiation emitted and the type of energy.

Impact of Soil Pollution

The toxic substances that are deposited on the earth's surface harm our health and well-being and affect food, water and air quality. The industrial waste discharged on land and in to water bodies. These effluents have variable chemical characteristics which effects the soil environment. It causes soil degradation and environmental pollution. The untreated waste of industries contain huge amount of heavy metals which destroy the soil structure, fluctuate the pH, decrease the plant uptake by affecting the physical and metabolic activities of plants. Heavy metals causes serious problem to grower as well as consumer. Heavy metals not only decrease the crop yield by affecting seed germination and seedling growth, but it is a major cause of number of diseases in human being. Long term expose of such soil affects the genetic make-up of the body and cause congenital and chronic health diseases. High concentration of Hg affects the women and children brain functioning whereas high content of Ar is dangerous to nervous system. Also, the emission of foul and poisonous gases from the landfills pollutes the environment and cause serious problem in breathing.

The fertilizer and pesticides contains water soluble salts which dissolve in water and leached down from the soil and contaminates the underground water. Excessive use of chemical also affect the water bodies at earth surface through drainage and make water unsafe for domestic and drinking purpose. Excess use of nitrogenous fertilizer results in high concentration of NO_3^- in drinking water which causes methemoglobinemia, also known as

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blue baby syndrome. Excess use of phosphatic fertilizer in soil results in eutrophication of PO_4^{3-} in water bodies which results in algal bloom on the surface of water bodies. This algal bloom consumed the oxygen dissolved in water bodies and affects the aquatic life. When nitrogenous fertiliser applied in soil in excess amount, it release nitrogen and sulphur oxides gases in the environment. In calcareous soil, application of ammoniacal fertilizer release ammonia gas in the environment. These gases accumulate in the atmosphere and oxidised in presence of water and cause acid rain which decrease the pH of the soil. The decrease in pH affects the soil biodiversity which results in decrease in the amount and quality of harvest. The use of pesticides not only kills the pathogens but also kills the beneficial microorganism in the soil. It results in the complete extinction of the microbial as well as animal species in the soil and minor pests become the major pests in crop. The population of fungi and bacteria decreases which create an additional problem of soil erosion. The death of microorganism leads to alteration in soil structure. Apart from that, it also leads to the movement of other predators in search of food.

Irrigation with polluted water increases the salt content in the root zone of the plants and makes it unsuitable for consumption. Soil erosion leads to the depletion of nutrients which affects the fertility and thus reduces the agriculture production. Exposure of very high level of radiation, such as being close to an atomic blast, can cause health diseases such as skin burns and acute radiation syndrome. It can also results in long-term health effects such as cancer and cardiovascular diseases. Radioactive waste also leads to genetic mutation, which leads to changes in the DNA composition of the humans. When the radiation absorbed in the body of an organism, it will stay active once it is inside the body because energy can't be destroyed. The resulting mutation will make the person or the organism highly susceptible to different forms of cancer. Other dangerous diseases that might be due to exposure to radioactive waste include anaemia, leukaemia, haemorrhages and cardiovascular diseases. Soil pollution also affects the economic status of the farmer as well as nation. Extra efforts have to be put on the land to get a good crop. Addition of amendments to decrease the effect of pollutants increases the economic input of the farmer in the field which affects its economic status. Also a huge investment of the nation is utilized in decreasing the level of soil pollutants to make the environment healthy. Large plants for the treatment of waste water consume a huge capital investment which affects the overall economy of the nation.

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Remediation of Soil Pollution

Remediation of soil pollution includes use of physical, chemical and biological methods to reduce the soil pollution. These methods are categories unto two categories (a) In-situ (b) Ex-situ. In-situ methods include the treatment of soil on its original place whereas in Ex-situ the treatment of soil is done after removing from its original site. The best In-situ method is the degradation of soil pollutants with the help of microorganism. It depends on many factors includes pH, temperature, moisture content and microorganism species present in soil. Whereas in Ex-situ, soil and the waste material which pollute the soil is collected and decontaminated away from the pollution site in landfills and sewage treatment plants. The various process involved in the Ex-situ are oxidation, reduction, ion exchange, photolysis, washing and flushing. Methods of remediation depend on the type of pollutants and severity of the pollution. Following steps should be followed to ameliorate the soil pollution related problems:

- During storage and transportation, oil and other liquid material should be handled with care.
- The use of chemical fertilizer and pesticides in agriculture should be reduced. However, it should be replaced by Integrated Nutrient Management and Integrated Pests Management practices.
- Recycling and reuse of biodegradable and non-biodegradable waste material should be adopted.
- The nuclear waste should be safely disposed far away from residential area after reducing its radiation energy.
- Industrial waste should be properly treated to low level before discharging.
- Afforestation should be practised to improve the fertility of soil and to reduce soil erosion.
- Soil polluted with heavy metals, organic and inorganic substances, and pesticides should be ameliorated through phtyo-remediation and bioremediation and growing resistant crops.
- Addition of organic matter in the form of green manure, organic manure, crop residue, etc. improves the soil organic carbon and microbial population which degrade the soil pollutant.

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- Social awareness programs about soil pollution should be organised to provide guidance to the people about soil conservation.

Conclusion

Indiscriminate use of soil for fulfils of our needs leads to soil pollution. It results in the decreased in the fertility soil. Because of rapid industrialisation and excess use of chemical in agriculture degrades the status of soil. It affects the physical, chemical and biological properties of soil and make the soil unfit for ant use. Increase in the concentration of pollutants and heavy metal in the soil gave rise to many incurable health problems. Also producing enough food for the rising population along with the pollution is a big challenge for Indian agriculture. There are some methods which reduce the soil pollution. Along with these methods, social awareness about soil pollution should be done. Strict laws should be implemented against industries for the discharge of waste in to the soil. Soil is a non-renewable resource; it should be use appropriately. It is the duty of every citizen to conserve this resource for our future generation.