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HEAVY METAL CONTAMINATION IN SOIL AND THEIR TOXIC EFFECTS – A REVIEW

SRINIVAS J.[1*], PURUSHOTHAM A.V.[2] and POTSANGBAM KUMAR SINGH[3]
[1*]*Department of Environmental Science, Manipur International University, Imphal, -795 140, Manipur, India*
[2]*Department of Botany, MSN Degree College, Kakinada-533016, Andhra Pradesh, India.*
[3]*Department of Botany, Manipur International University, Imphal, -795 140, Manipur, India.*

ABSTRACT
Now-a-days synthetic products such as industrial waste, pesticides, batteries, paints, and industrial or domestic sludge widely applied, as well as and manufacturing can adversely result in heavy metal contamination of urban and agricultural soils. These heavy metal pollutants are widely distributed in the environment through water, soil and also into the atmosphere. It occurs when the pollutants causing the pollution reduce the quality of the soil and convert the soil inhabitable for microorganisms and macro-organisms living in the soil. However, mostly it is due to human activities. The soil contamination can occur due to the presence of chemicals in the soil. It is also affecting to agricultural farm land to growth, and yield of crop. There are few soil prevention and control measures are recommended.

Keywords: *Contamination, Environmental Pollution, Heavy metal contamination, Pollution and Soil Pollution.*

INTRODUCTION

Soil pollution is defined as the build-up in soils of persistent toxic compounds, chemicals, salts, radioactive materials, or disease-causing agents, which have adverse effects on plant growth and animal health (Okrent 1999. Soil is the thin layer of organic and inorganic materials that covers the Earth's rocky surface. The organic portion, which is derived from the decayed remains of plants and animal, is concentrated in the dark uppermost topsoil. The inorganic portion made up of rock fragments, was formed over thousands of years by physical and chemical weathering of bedrock. Productive soils are necessary for agriculture to supply the world with sufficient food (Belluck et al. 2003).

Soil is a non-sustainable asset, created at a pace of a couple of centimetres every thousand years. It assumes a basic part in supporting biological systems and human culture by giving a living space to most of the species present on Earth and as the vehicle by filling in for crop production (Kabata-Pendias and Pendias 2020). However, soil degradation is increasing at an alarming rate due to several anthropogenic activities (Abedin et al. 2002). Even the eighth goal out of 17 Sustainable Development Goals set by the United Nations are based on soil environment (Aguilera et al. 2021) (Fig. 1), however, due to the degradation of soil these goals are at greater risk and a major challenge also to be achieved by 2030 because the loss of agricultural soil put the major population at greater risk of poverty and malnutrition (Al-Lami et al. 2020).

MATERIALS AND METHODS

The research concerning heavy metal contamination is highly specific in this context, and therefore many research papers have not really investigated various dimension of heavy metal contamination. Since this review is the role of heavy

metal and affects the environment, livelihood improvement, all scientific publication that addresses these issues are highlighted. Materials and methodologies were collected from the published literatures of the following: Plants in Phytoremediation of Heavy Metal-Contaminated in soil and natural organic amendments for improved phytoremediation of polluted (Azab and Hegazy 2020, Wiszniewska et al. 2016). Removal of heavy metal from contaminated soil with chelating agents (Wei et al. 2011). Soil heavy metal bioremediation of soils contaminated with polycyclic aromatic hydrocarbons, petroleum, pesticides, chlorophenols and heavy metals by composting (Chen et al. 2015). Heavy metal accumulation by roadside vegetation and implications for pollution control (Altaf et al. 2021) and effects of heavy metals pollution on human health, pollution from mines (Li et al. 2014, Al-Lami et al. 2020, Aguilera et al. 2021). Heavy metal contamination in industrial areas, phyto-accumulation process, uptake mechanism by plants and groundwater their toxic effects on human health and environment (Srinivas et al. a,b,c). The findings of the above papers are reviewed and reported in the results and discussion section.

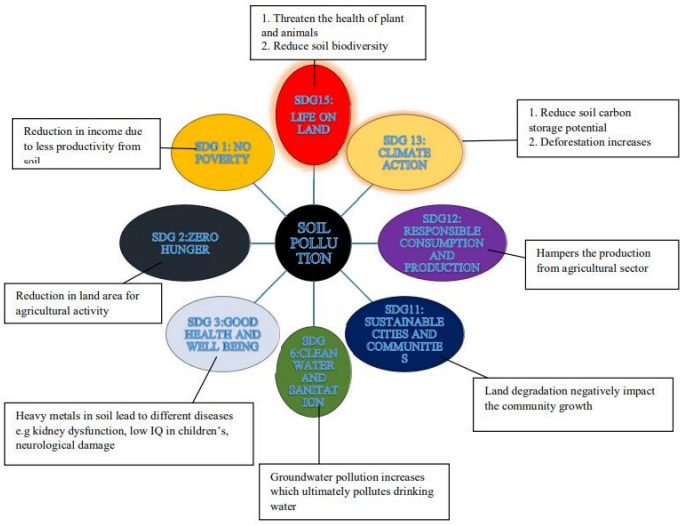
RESULTS AND DISCUSSION

These metals have exceptional properties such as low radioactivity, high density, polyvalent in their chemical nature and the most problematic property is non degradability in the soil. The heavy metals persist for longer period in the soil (Altaf et al. 2021). There are different sources of heavy metals in urban areas Due to high population density and intense and various types of anthropogenic activities, the source of heavy metal in urban areas are more (Azab and Hegazy 2020).

Causes of Soil Pollution

The before World War II, the chemical nicotine chemical present in the tobacco plants was used as the pest controlling substance in agricultural practices. However, DDT was found to be extremely useful for malaria control and as pest control of many insects during World War II. Therefore, it was used for controlling many diseases. Hence, post-war, people started using it as pest control in agriculture for killing rodents, weeds, insects, etc and avoiding the damages due to these pests. However, everyone gradually the adverse effects of this chemical which led to the ban of this chemical in many parts of the world including India.

Figure 1: Interrelationship between Sustainable Development Goals and Soil health.



There are many different ways that soil can become polluted, such as: Seepage from a landfill, discharge of industrial waste into the soil, percolation of contaminated water into the soil, rupture of underground storage tanks, excess application of pesticides, herbicides or fertilizer and solid waste seepage.

The most common chemicals involved in causing soil pollution are: Petroleum hydrocarbons, heavy metals, pesticides and solvents etc.

Types of soil pollution: A. Agricultural Soil Pollution: i) pollution of surface soil, ii) pollution of underground soil. **B.** Soil pollution by industrial effluents and solid wastes: i) pollution of surface soil, ii) disturbances in soil profile. **C.** Pollution due to urban activities: i) pollution of surface soil and ii) pollution of underground soil.

Sources of soil pollution

The sources which pollute the soil are twofold: Agricultural sources and non-agricultural sources. Figure 1 shows the different sources for the soil pollution. a. Agricultural sources Soil pollution comes from different sources including agriculture and animal husbandry. Some of the agricultural practices lead to soil pollution. They are animal wastes, use of long-lived pesticides, herbicides, fungicides, nematicides, etc. fertilizers and some agricultural practices. b. Non-agricultural sources Soil pollution by non-agricultural sources is usually the direct result of urban sprawl caused by rapidly increasing population and a rapidly per capita output of waste related to our modem way of life. Its materials that find their entry into the soil system have long persistence and accumulate in toxic concentration and thus become sources of pollution. Some of those most important soil pollutants are inorganic toxic compounds.

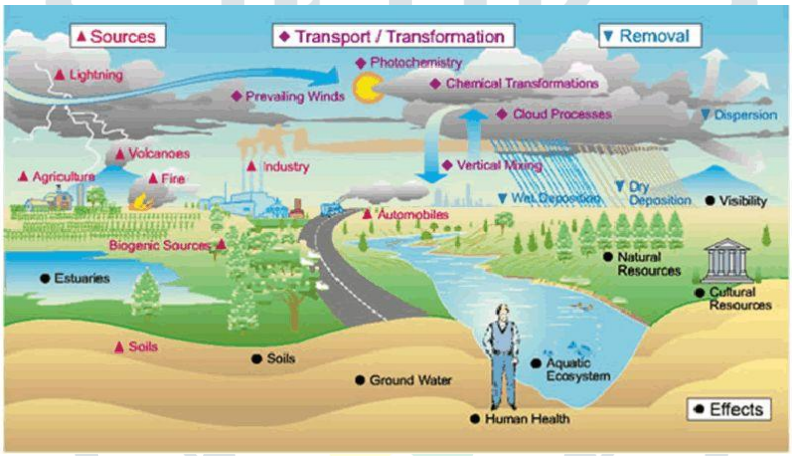


Figure 2. Sources of Soil Pollution (Swartjes 1999)

Causes of soil pollution

Soil pollution is caused by the presence of man-made chemicals or other alteration in the natural soil environment. This type of contamination typically arises from the rupture of underground storage links, application of pesticides, and percolation of contaminated surface water to subsurface strata, oil and fuel dumping, leaching of wastes from landfills or direct discharge of industrial wastes to the soil. The most common chemicals involved are petroleum hydrocarbons, solvents, pesticides, lead and other heavy metals. This occurrence of this phenomenon is correlated with the degree of industrialization and intensities of chemical usage. A soil pollutant is any factor which deteriorates the quality, texture and mineral content of the soil or which disturbs the biological balance of the organisms in the soil. Pollution in soil has adverse effect on plant growth.

Pollution in soil is associated with • Indiscriminate use of fertilizers, • Indiscriminate use of pesticides, insecticides and herbicides, • Dumping of large quantities of solid waste, • Deforestation and soil erosion.

The Sources of soil contamination are of the following:

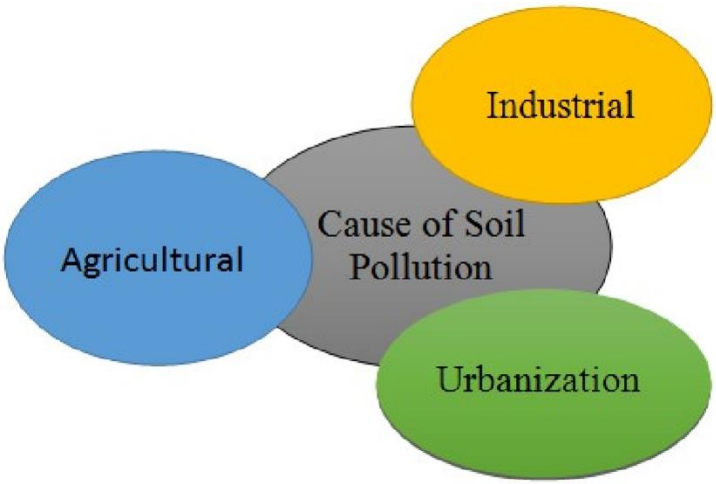


Figure 3. Causes of Soil pollution

Artificial contamination

Which is contamination made by artificially in order to get good homogeneity in terms of consistent heavy metals concentration and speciation, soil composition, contamination process and contamination period. This would minimize ambiguity in the extraction results arising from sample heterogeneity (Gothwal and Shashidhar 2015).

Naturally contaminated soil

The natural contamination of heavy metals was occurred due to many activities such as Fertilizers, Pesticides, Bio solids and Manures, Wastewater, Metal Mining and Milling Processes and Industrial Wastes and AirBorne Sources use of all these, can unknowingly occurs heavy metals such as Pb, Cd, Hg, Ni and Zn etc., in the soil and cause effects on the environment. Many contaminants that enter the soil will increase to certain levels that present serious threats to plants and animal health (Li 2014). The indiscriminate land use of waste soil as the disposal of nature can also lead to problems with pollution (Wiszniewska 2016).

Effects of Soil Pollution

This is largely due to the involvement of anthropocentric behaviors in soil degradation. Such waste products are produced from chemicals which originally do not exist in nature and thus pollute the soil. Usually soil contamination arises from industrial production, agricultural chemical products and inadequate waste disposal. Relation of soil direct and indirect with polluted soil contributes to health risks. Ecological balance soil contamination creates tremendous disruptions and organism health is at risk. There are some very disturbing effects of pollution on soil that can lead to major changes to the ecological equilibrium and wellbeing of living beings on the planet (Kefeni et al. 2017).

Effects of soil pollution are of the following:

Agricultural: Reduced soil fertility, reduced nitrogen fixation, increased erodibility, larger loss of soil and nutrients, deposition of silt in tanks and reservoirs, reduced crop yield, imbalance in soil fauna and flora, etc.

Industrial: Dangerous chemicals entering underground water and ecological imbalance, release of pollutant gases, release of radioactive rays causing health problems, increased salinity, reduced vegetation, etc.

Urban: Clogging of drains, inundation of areas, public health problems, pollution of drinking water sources, foul smell and release of gases, waste management problems, etc.

Environmental: Soil becomes unavailable to grow food, if contaminated soil is used to grow food, the land will usually produce lower yields, can cause even more harm because a lack of plants on the soil will cause more erosion, the pollutants will change the makeup of the soil and the types of microorganisms that will live in it, etc.

Prevention of Soil Pollution

Soil contamination leads to hazardous chemicals, salts, radioactive, poisonous contaminants and other waste. These influence the health of plants and animals. All organic and inorganic content are found in soil. Because plants and animals' decay, organic material is created. This also constitutes the highest soil layer. Over thousands of years, organic soil like rocks has been formed. The top layer consists of organic soil and the layers below are inorganic soil (Kefeni et al. 2017).

Inorganic layers have also been slowly affected by emissions. There are various sources of soil pollution, including soil pollution from agriculture, soil pollution from industrial waste, and soil pollution from urbanization. The fertility of the soil reduces and its mineral content is depleted by these various forms of emissions. Steps to avoid soil contamination therefore have to be taken. Many farmers used chemical fertilizers to increase their farm yield. The yield improved, but lost its fertility at the expense of the soil. It will take a long time to restore soil fertility to what it was, but one must begin at a certain time. For the same, drastic steps are required. The use of bio fertilizer is to be promoted for farmers.

The fertility of soil is boosted by the microorganisms in those fertilizers. It is critical that farmers, along with fertilizers, migrate to bio-pesticides and fungicides, also known as herbicides, in order to avoid soil contamination. Such products take some time to react, but have no negative effect on the soil (Chen et al. 2015, Wei et al. 2011).

CONCLUSION

1. Phytoaccumulation and plant uptake studies are more recommended to know the soil contaminated sites in the contaminated sites.
2. Phytoremediation, as it takes advantage of natural plant processes, is the most effective instrument to counter industrial emissions.
3. Phytoremediation has been performed successfully in many countries and is used at a variety of locations. Phytoremediation has many different approaches and is an interdisciplinary technique. Also, studies have shown that some plants can be effective in the remediation of toxic metals.
4. The quick growth and high biomass production and deep roots of the ideal plant for plant remediation are expected to be easy to collect, allow different metals to be tolerated and collected in shots and/or plant components. Phytoremediation is still in its development and testing process with many technological challenges to be addressed.

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Conflict of interest: Authors declare no conflict of interest

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Author's Biography:

Dr. J. Srinivas

First Author: Dr. J. Srinivas is a post-doctoral research student in Manipur international University, India, took Doctor of philosophy from JNTUK Kakinada in 2018, received dual Master's degree from Andhra University and Acharya Nagarjuna Universities, Andhra university, India, published 26 research papers in various international journals, research of interest in Phyto-remediation, Plant uptake and Bio remediation methods, also interesting in Taxonomy and plant physiology subjects in Botany, participated, attended & presented 12 research papers in various national, international conferences and seminars, 15 years of research experience and also having 13 years of Oil and Gas, Mining, Pharmaceutical and Chemical industrial experience.

Second Author: Prof. A.V. Purushotham (Retired) was a principal in M.S.N. Degree College, Kakinada, Andhra Pradesh, India, had Doctor of philosophy from Andhra University, Visakhapatnam, Andhra Pradesh on 2005, received Master of Science in Botany (Specialization in Plant Taxonomy) from South Gujarat University, Suat, Gujarat, India, took B.Ed., from Andhra University, published 26 research papers in various international journals, research of interest in Phyto-remediation, Plant uptake and Bio remediation methods, also interesting in Taxonomy and subject in Botany, participated, attended & presented 12 research papers in various national, international conferences and seminars, also having 34 years of teaching experience in Botany and Environmental Science departments.

Third Author: Senior Prof. Potsangbam Kumar Singh, Former Professor, Centre of Advanced Study in Life Sciences, Ethnobotany and Plant Physiology Laboratory, Department of Botany, Manipur University, Imphal, Manipur, India. At present he is working as a Senior Professor cum Research Officer, Department of Botany, Manipur International University, Imphal, -795 140, Manipur, India. He received Doctor of Science from International Open University, Colombo, having well experience in teaching, research pursuits and published 167 research papers in various international Journals.

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