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E-WASTE POLLUTING SOIL: A REVIEW

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ABSTRACT

Soil is one of the most important constituent of earth's ecosystem as it is responsible for the growth of plants, regulates the atmosphere and acts as a habitat for a number of organisms. Soil pollution by hazardous materials such as heavy metals is a serious issue as these toxic materials will enter into the food chain and ground water through soil and ultimately into the human beings resulting in serious health problems among them. The major source of this hazardous material is electronic waste which contains toxic heavy metals. The present study revealed the fact that the hazardous waste is treated informally in most of the Asian and African countries including India and ending up in landfills from where it enters the soil and finally into the living organisms including human beings. The study includes the soil analysis for the presence of hazardous heavy metals and organic compounds in different regions of the world. The analysis is done mainly in the vicinities of the sites where e-waste is treated informally.

Keywords: E-Waste, Heavy Metals, Human Health, Informal Recycling, Soil.

1. INTRODUCTION

Soil is the major constituent of earth's ecosystem and it contains various minerals, organic matter, gases, liquids within it and serves as habitat for a number of microorganisms.[1] Minerals are the largest components in soil which constitutes about 46% to 49% of the soil volume followed by water which constitutes 2% to 50% of the soil volume depending on the type of soil. Organic matter constitutes 1% to 5% of the soil volume and microorganisms constitute less than 1% of the soil volume. Soil has a major role in the growth of plants which provides food to various living organisms including human beings and plays an important role in maintaining environmental balance. There are basically four types of soil that is sand, silt, clay and loam. Sand consists of small particles of weathered rocks and is very inefficient for vegetation and is good for drainage only whereas silt is fine sand having more capability to hold water as compare to sand. Clay finds its use in making pottery bowls and bricks as it can be molded into any shape. Loam is the soil in which all the above three types of soils are combined in different proportions so as to make it ideal for required piece of work and this type is used mainly for agricultural purposes.

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1.1 E-Waste as the major source of hazardous soil pollutants

Electronic waste is one of the major sources of hazardous soil pollutants such as heavy metals.[2] CRT screens contain a large amount of lead and also contain nickel. PCBs are the basic components of every electronic equipment and it constituents lead and copper. Fluorescent lamps have mercury as the major constituent. Floppy disks contain chromium and LEDs contain arsenic in the form of gallium arsenide. The incineration of plastic casings of electronic waste which contains polyvinyl chlorides leads to the formation of organic pollutants. The other source of soil pollutants is chemical industrial waste. Most of the e-waste generated is treated informally by illegal sectors. The informal ways includes treatment of waste with highly concentrated nitric and sulphuric acids and the other way is incineration of the generated e-waste. After treatment with both of these ways, the precious metals are collected and the rest of the waste finds its way into the open lands or landfills.[3] From landfills, this hazardous waste is leached into the soil thereby contaminating it. From soil these toxic materials enters the food chain by contaminating ground water and vegetation plants. Human beings and other living organisms intake these toxic materials through food and water causing serious health issues among them. A study was done by toxics link (an India based NGO) to study the effects of e-waste in two informal e-waste recycling areas Loni and Mandoli around Delhi. [4]They found that heavy metal concentration in soil as well as water in the surrounding areas of Loni and Mandoli was much more then the prescribed limits. According to an article published by "The Hindu", out of the generated e-waste all around the world, the most of this hazardous waste is exported mainly to Asia and in Asia mainly to Indian subcontinent as it is ten times cheaper for the European countries to process the waste in Asia as compare to their own countries and in India poor workers collect the valuable materials and dump the rest into landfills or nearby lands resulting in contamination of soil.[5]

1.2 Soil Pollutants affecting human health

Heavy metals are one of the most hazardous pollutants which has been contaminating the soil.[6] Among these heavy metals cadmium, mercury, chromium, lead, zinc and nickel are the most hazardous. These metals even in small amount are very dangerous for human health. Cadmium is very harmful for the kidneys of human beings and can even cause kidney failures. Mercury is very dangerous for lungs and nervous system. Arsenic exposure have a very bad impact on skin of human beings and can even lead to skin cancer. Lead exposures even in very small amount have very bad impact on human nervous system.[7] Organic pollutants in soil are chlorinated hydrocarbons (CHCs), polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs).They becomes more harmful due to the fact that their stability is very high and there decomposition is extremely slow. Organic pollutants also have a very bad impact on human health and their exposure to human body may lead to serious health issues.

It can be said that soil is very important component of earth's atmosphere for all types of living creatures but its pollution can have even more drastic consequences as it can cause serious health issues to all the living creatures including human beings. Hence considering it to be a serious issue, soil pollution should be taken care of and proper measures should be taken in order to control the soil pollution and to treat the generated e-waste in an efficient manner.

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II E-WASTE TREATMENT SCENARIO AND ITS IMPACTS ON SOIL

The section includes the study that is being done to analyze the soil for the contamination due to hazardous heavy metals and organic matter in the different regions of the world.

2.1 Indian Review

K.N. Beena and D.S. Jaya in 2016 evaluated the soil in the vicinity of KMMD (Kerala Minerals and Metals Limited) industrial area in Kollam district in Kerala, India. KMML spreads in about 210 acres and is a leading producer of titanium dioxide in India.[8] A total of eleven samples of soil from the nearby locations of KMML were collected for the analysis from three different distances that is half kilometer, one and a half kilometer and three kilometers from KMML. The collected samples were then undergone examination of physical and chemical properties of soil and percentage of different metals in the soil samples. The chemical properties of the soil samples proved the soil to be more acidic and organic matter content was found to be lesser. The percentage of heavy metals such as chromium, cadmium, lead, manganese, iron and zinc was found to be much more in the samples which were collected from nearest points that were at a distance of half kilometer as compare to that in the samples which were at a distance of three kilometers from KMML. Also it was found that metal content of iron was greatest and that of cadmium was least in all the soil samples as compared to other heavy metals. The study concluded that the soil in the nearby areas of this industry have got polluted with heavy metals to such an extent to cause serious health issues to the nearby residents. The pollution of soil to such an extent should be taken care of as it can create the environmental imbalance and can affect the lives of different living beings. Abhishek Kumar Awasthi et al. in 2016 gave a review about how the informal e-waste recycling in India is polluting the basic components that is soil, water and air of our ecosystem and affecting the health of the human beings in a very bad manner leading to different type of kidney, lung, neurological, chronicle diseases and different type of cancers.[9] Out of the total e-waste generated in India, a large amount is treated by illegal sector and a very small amount is treated by formal sector. Due to lack of awareness among the people, very lesser population knows about the consequences of e-waste and treat it simply like any other type of municipal solid waste. Most of the e-waste which contains hazardous heavy metals such as copper, zinc, lead, mercury, cadmium and manganese etc. undergoes the process of incineration and the waste which is left after the incineration process is dumped into the landfills from where hazardous materials enters the soil and enters the human bodies through this polluted soil, ash and also through the food being grown in the nearby sites. New Delhi, Ghaziabad, Kolkata, Chennai, Bangalore and Gwalior are the hubs for illegal recycling of e-waste in India.

2.2 Global Review

Chunling Luo et al. in 2011 analyzed the contamination of soil and vegetables with heavy metals in the vicinity of an electronic waste processing site in South China.[10] They found that in e-waste processing regions in South China, leaching of e-waste with vigorous acids and incineration of dismantled components are the commonly used processes for the extraction of high valued metals. Such type of processes leads to release of hazardous materials such as heavy metals and organic matter into the nearby areas due to which air, water and

soil got adulterated by heavy metals such as cadmium ,copper, lead etc. and by organic matter such as polychlorinated biphenyls(PCBs) and polybrominated diphenyl ethers (PBDEs).They analyze the soil from agricultural land, pond areas and gardens and vegetables being grown in these areas and found that the concentration of metals specifically cadmium and lead is too large to cause health risks to the local residents and workers. The concentration of cadmium exceeded 4.7 times and that of lead exceeded 2.6 times of their maximum acceptable limits being defined for food in China. The incineration sites were found to have the highest concentration of heavy metals as compare to other sites. From this study it can be concluded that the people living nearby these sites are more prone to serious health issues as they are in
taking these hazardous substances along with vegetables and water.

Tue Nguyen Minh et al. in 2016 studied about the concentrations of toxic compounds in soil in nearby areas of e-waste open burning site in Agbogbloshie in Accra, Ghana.[11]Soil samples were mainly tested for the presence of chlorinated, brominated and mixed halogenated dioxin-related compounds in it. The generation of these hazardous compounds takes place due to incineration of chlorinated polyvinyl materials for example polyvinyl chlorides, BFRs etc. being present in e-waste. The toxicity of such compounds can be justified by the fact that they have been enlisted in World Health Organization recommendations to add them in their Toxicity Equivalence Factor concept. A total of fourteen samples of soil were collected, ten samples were collected from e-waste site out of which five samples were from burning areas of e-waste and the other five samples from non-burning areas of e-waste and the remaining four samples were collected from non e-waste areas. The collected samples were then tested for toxic compounds. E-waste burning areas were found to have highest concentration and non e-waste areas had the least concentration of these compounds. The concentration in e-waste burning areas was found to be two times more than those in non e-waste areas and one to two times more in non burning e-waste areas. The concentrations detected were large enough to cause serious health issues and informal recycling ways should be replaced by proper techniques so as to save our ecosystem and future generations.

Adesokan Michael D. et al. in 2016 analyzed the soil in the nearby locations of e-waste recycling sites in Ibadan, Nigeria by collecting forty eight samples of soil from three types of locations based on the distance from the e-waste recycling site Ogunpa market and classify them into low, medium and high operational areas.[12]
Ogunpa market is a place in Ibadan where e-waste recycling is done using informal techniques such as treatment of waste with acids, incineration of e-waste in order to extract precious metals from the waste. Physical methods such as hammering etc. are also used to extract valuable material and the rest waste which is of no value to the recyclers is burnt in open or dumped in landfills. The collected samples of soil were then tested for chemical properties and concentration of heavy metals. It was found that the concentration of heavy metals specifically copper and lead in soil samples was much larger and was exceeding the limits which are defined by most of the countries whereas chromium, nickel and cadmium were found to be in prescribed limits. The concentrations were found enough to cause serious health issues in the residents and workers and the area needs to be taken care.

III CONCLUSION

In India and in most of the Asian and African countries hazardous e-waste is treated illegally by the informal sector due to lack of awareness, poverty and illiteracy. After informal treatment and collection of precious metals from the waste, the remaining toxic waste including heavy metals ends up in landfills from where it enters the soil and leads to soil pollution. From soil it enters the food chain and human beings intake these toxic materials which leads to different types of health issues among them. Hence proper techniques should be developed and proper steps should be taken to treat such hazardous waste by the formal sector and that too in a sophisticated manner so as to save our environment for the future generations.

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