

Hazardous E-waste and its impact on soil structure

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Abstract. E-waste disposal has been a significant issue over the past few decades with the development of technology and the plethora of electronic products produced. The inclusive term E-Waste encapsulates various forms of electrical and electronic equipment which provides no value to the current owners and it is one among the fastest growing waste streams. E-Waste is a complex, non-biodegradable waste which is generally dumped in mountain like heaps. These wastes are said to have a large quantities of lead, cadmium, arsenic etc. it is mandatory to dispose such scrupulously since they have the ability to affect the soil and water parameters. Solid waste management is a blooming field which strives to reduce the accumulation of used electronic gadgets. Rainwater gets infiltrated through the e-waste landfill and it leaches through the soil which in turn reaches the groundwater directly thereby affecting the water intended for drinking and domestic purposes. This study focuses on the consequences of toxic waste by comparing the difference in properties of the soil structure prior to and after the e-waste landfill at various concentrations.

1. Introduction

Every year 2.7 million tonnes of e-waste are produced in India and disposal becomes a huge problem. India becomes the fifth largest producer of e-waste. Generally treating and processing e-waste is an expensive task and space becomes a huge challenge. The problem is convoluted by the toxicity of the waste that is being handled by workers and dumped unsafely in municipal yards. That informal sector has been handling such waste are out of capital and there is not much support from the government.

Lead and Mercury takes a long time to decay and the people who gets exposed to it will have long term irreversible health effects. Most of the e-waste is dumped in the landfill and metals like lead serve to harm the nature of soil. Due to the scarcity of lands there are limited chances of getting fresh dump yards hence the available yards are overflowing with such wastes. The chemicals produced are non-biodegradable and they persist in the environment for prolonged time periods thus increasing exposure risks.

Burning of e-waste on an open landfill for obtaining gold and other precious metals produce fine particulate matter from the smoke produced and cause cardio-vascular and pulmonary ailments for children in that specific area. The wind pattern of a particular area carry toxic particles and they enter the soil-crop-food pathway affecting both humans and animals as they enter the food chain. The mother boards have abnormal level of mercury and improper disposal may cause skin and respiratory diseases. Drinking water contaminated with lead affects the central and nervous system and causes poor brain growth, dwarfism, hearing disability and impaired formation and function of blood cells. The



exhaust produced as a result of combustion of mother circuit board causes lung cancer when inhaled. It was also responsible for dermatological diseases. [1] [4]

2. Experimental Investigation

Procedure adopted for soil: In order to identify the change in parameters for the variations in the concentration of lead, three pits of similar soil composition were dug with equal dimensions of 2 x 2 x 1.5 feet. Solder was melted and shredded into pieces for mixing with the soil.

- Pit -1 was mixed with 50g of un-shredded lead and 100g of PCB and the pit was closed and compacted.
- Pit -2 was mixed with 10g of shredded lead and was closed and compacted.
- Pit 3 was mixed with 150g of shredded lead and was closed and compacted.

An original soil sample i.e the sample without any mixture of lead was excavated and sent for testing its parameters. The parameters of the soil mixed with lead to that of the original soil is later analysed. Pits were watered with four litres of water, twice a day, continuously for a month to analyse the change in the soil parameters. Mustard seeds were sprinkled above all the three pits to check if they could grow on the ground containing toxic substances. Acknowledging the concept of ground water leachate, three pits parallel to the original pits with a distance of 1m were dug out to procure a soil sample at a depth of 2 feet. These samples were again sent for testing its parameters.

Table 1. Observation table for soil parameters

Parameters	Original Sample(kg/acre)	Pit 1 (50g of lead+ 100g of PCB) (kg/acre)	Pit 2 (100g of lead) (kg/acre)	Pit 3 (150 g of lead) (kg/acre)
Calcium carbonate	Medium	High	High	High
Phosphrous	255	155	100	155
Nitrogen	72.4	66	50	35.6
Potassium	245	60	115	75
pH	8.1	9.3	9.3	9.3
Electrical conductivity	0.21	1.2	1.4	0.3

Procedure adopted for water: To find the change in parameters of the water sample containing toxic substances such as lead, mercury, tin etc. a series of tests were conducted. A setup was made where a separate sample mixed with lead was placed in a bucket which was provided with multiple holes of 1cm diameter at the bottom. The soil was watered regularly for a month and the water was let to percolate through the soil and collected down below through the perforated holes. Thus the water obtained was sent for testing to compare the change in parameters to that of the parameters of the water which doesn't contain lead. Tests such as turbidity, chlorides test, total dissolve solids, pH were conducted on the samples obtained.

Table 2. Observation table for water parameters

Description	Normal water	Lead water
pH	8.3	10.2
TDS(ppm)	300	1400
Hardness(ppm)	140	260
Chlorides(ppm)	187	195
Conductivity(μ S/cm)	1.2	4.7

3. Results and discussion

The results obtained from the water test are presented in Table 2. It can be understood that the parameters such as pH, TDS, hardness, chlorides and conductivity were stable in normal water and these parameters were observed to have undesirable values in lead water. If the pH value is less than 7 it indicates acidity and if it is greater than 7 indicates base. The presence of toxic metal has lead to the increase in alkalinity of the lead water when compared with normal water. High amount of dissolved solids reduces the quality of water thereby affecting people with health disorders. The desirable value of total dissolved solids in normal water is 500ppm whereas the amount of TDS in lead water is 1400ppm that makes it unsafe. Water hardness may cause serious effects in industries handling water especially boilers, cooling tower etc. The desirable value of hardness in normal water should be within 300ppm and the hardness of water containing lead is found to be 260 ppm. Excessive concentration of chloride ions makes the water unpleasant to drink. The desirable value of chloride is 250ppm and we can clearly see the increase in chloride content from normal water to lead water. The desirable values of electrical conductivity in drinking water is 0.5 – 3 μ S/cm. “Mineral taste” in water is a common problem due to the presence of higher dissolved solids and also causes problems with the boilers and other equipment. The conductivity value in lead water is beyond this value and hence it is undesirable.

The results obtained from the soil test conducted by National Rice Research Institute, Aadudurai are presented in table 1. Presence of both low and high Calcium contents may cause problems. Calcium is generally required for proper functioning of plant cell walls but it may harm the plant if the Calcium content increases which leads to increase in pH. According to the test results there is high amount of calcium carbonate in the test samples affected by E-waste which has lead to the depletion of nutrients essential for plant growth. When plants undergo the process of photosynthesis to drive its metabolism, Phosphorous helps in harnessing that energy. The deficiency of its nutrient can lead to impaired growth and have abnormal dark green colour. We can clearly see the depletion of phosphorus across the table in the soil subjected to landfill. Nitrogen is very vital since it forms a major component of chlorophyll, the compound by which the plants uses sunlight as energy to produce photosynthesis.. It is also the building blocks of proteins. In our case the presence of harmful elements has led to the depletion of nitrogen which is essential for plant growth. Potassium entrants nitrogen as the nutrient absorbed by plants. High levels of potassium indicate a healthy atmosphere for the wellbeing of plants. We can see the depletion of potassium in test sample subjected to landfill. The availability of plant nutrients is completely affected by soil PH. Soil acidity or alkalinity directly affects the plants growth. , they are unavailable to plants. It is for the nutrients to disperse through the soil under alkaline conditions. Although the optimum range of pH in soil is 5.5 to 7 some plants will grow in a more acid or in alkaline level. pH is not an indication of fertility but it does affect the availability of fertilizer nutrients. The pH levels of the landfill soil are being increased. The electrical conductivity of water is the measure of salinity. Excessively high salinity can affect plants in many ways. The EC values of lead affected soil are increased.

4. Conclusion

From the observed test results it can be inferred that the soil samples subjected to harmful landfills are infertile and are made unfit for vegetation permanently. The lead content depletes the soil of its natural

nutrients and makes it sterile. Flora and fauna of the area near the landfill gets affected since the landfill releases particulate matter causing air pollution. Electronics that are thrown in landfills, produce toxins that may leach into groundwater and affect local resources. The water which was made to react with lead is unsuitable for drinking due to the abnormal pH, turbidity, TDS, conductivity, chloride levels. E-waste leaches the groundwater and has its effect on the ground water table. It thereby affects the water intended for domestic and drinking purposes as even a small quantity of lead in drinking water can cause potential health hazards to children as well as adults. Improperly disposed e-waste has been responsible for water pollution, air pollution, soil pollution and a threat to humans and animals. Because of the alarming rates at which e-waste is being illegally and dangerously dealt with, the natural environment is being affected. Therefore E-waste has to properly processed, recycled and disposed for the safety of the environment.

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