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Impacts of Heavy Metals in Soil Profile of Surrounding Municipal Solid Waste Dump Site

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Abstract: ***An experimental study was performed to measure the concentration of heavy metals on soil profile (top soil, middle soil and bottom soil) around municipal solid waste dumpsite. Six samples were collected around municipal solid waste dump site within1.5 kilometre distance between 300 meter differences. Average values were measured in soil profile. The overall study indicated that the level of heavy metal almost same in top soil, middle soil and bottom soil. High concentration of Cadmium, Copper, Nickel, Chromium and Zinc were measured on near the dumpsite. But the lowest level of heavy metals was measured on the sixth site when compared to near the dumpsite. The level of heavy metals was decreased on increasing distance from the municipal solid waste dumpsite. The results indicated that the heavy metal contamination on Soil due to landfill.***

Keywords: Heavy metal, Municipal solid waste, landfill and soil profile

1. Introduction

Worldwide municipal solid waste management is the major problem because the quantity of municipal solid waste is increasing tremendously with improved lifestyle. Unorganized dumping of solid waste is predominant in developing countries and causes adverse impacts to the environment. Several countries are choosing landfilling as a primary solid waste disposal method. Similarly in India solid waste management are the most challenging issues due to rapid urbanisation and increasing population.

Municipal solid waste is major sources of toxic hazardous substances even house hold waste also contain numerous hazardous substances (Slack et al., 2004). One of the chief hazardous substances is heavy metals. Sources of heavy metals from municipal solid wastes are batteries, paint, wood polishing waste, thermometer, dental amalgam, stainless steel waste, etc. Landfill leachate is a product by the reaction of solid waste degradation. It is a major contamination problem. Recent researches described leachate can cause various health and environmental impacts represented by toxicity, soil, ground water and surface water contamination (Malyuba Abu Daabes et al., 2013). Metal contaminants strongly depend on the metals speciation, mobility and bioavailability in soil (Mohamed Rashad et al., 2011). Heavy metals are significant hazard for the human health and the environment and it usually form compounds that can be toxic, carcinogenic or mutagenic even at very low concentration (Krishna et al., 2012). Esakku et al., (2003) reported that about 70% of the heavy metals found in landfills come from electronic wastes. Similarly (Chen et al., 1999) mentioned "Soil pollution by heavy metals in both serious and widespread in china". And that the main sources of heavy metal pollution are irrigation, solid waste disposal, pesticide and fertilizer application and atmospheric deposition.(Mohamed rashadet al., 2011) reported that some heavymetals (Zn, Cu and Mn) are essential for plant growth and Co and Ni for animal. But high concentrations of metals become toxic to plants animals and human through their entry into food chain. Generally such activities like landfilling composting are tend to increase the elemental background levels in the surrounding. Compost preparation of MSW and application to soil is used to maintain and improve soil structure (Giusguiani *et al.,* 1995; Lillenberg et al., 2010). But controversially Ayari *et al.,* 2010 reported in their experiment they observed the concentration of Cd, Cr, Ni, Pb, Cu and Zn were increased in MSW Compost amended soil as compared to untreated control soils. AlsoEsakku *et al.,* 2003 reported that "when the compost from MSW is used as manure some heavy metals are being subject to bioaccumulation.

In this study heavy metal deposition studied on soilprofile, around municipal solid waste dump sit at vellakal Madurai. Madurai is the second largest city in Tamilnadu and also considered as the cultural capital. Landfilling is the main activities of vellakal dumpsite. Compost preparation is going on trial basis.

2. Materials and Methods

2.1. Site Description

Madurai is second largest city in Tamil Nadu, with total population of 1108755 persons 2004.The current solid waste generation from the city 600t/day. This waste is disposed by open dumping at the vellakal, Madurai. Total area of this site is about 110 acre.

2.2. Sample Collection

Samples were collected on during the month of April and May2015. Six sites in 300 m distance were selected and in each site duplicate samples were collected surrounding landfilling area. Three types of soil profiles were collected topsoil 0-20 cm depth, middle soil 40-60 cm and bottom soil 80-100 cm. The collected soil samples were air dried in a clean room and stored in cellophane bags Then taken to the laboratory for pre-treatment and analysis.

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2.3. Soil digestion for heavy metal analysis

After transportation, in the laboratory the bulk soil samples were spread on trays and were air dried at ambient conditions for two weeks. The samples were then grounded by mortar and pestle, sieved through a 2 mm mesh, and oven-dried at 50°C for about 48 hours and were stored at room temperature before analyses. Soils samples (1.00 ± 0.001g each) were placed into 100 ml beakers separately, to which 15 ml of tri-acid mixture (70% high purity HNO3, 65% HClO4 and 70% H2SO4 in 5:1:1 ratio) was added. The mixture was then digested at 80°C till the solution became transparent (Allen et al., 1986). The resulting solution was filtered and diluted to 50 ml using deionized water and was analysed for concentrations of heavy metals using an atomic absorption spectrophotometer (Modal-ELICO, SL173).

3. Results and Discussion

3.1Heavy metals concentration in topsoil

Soil samples collected from 6 sites around MSW dumpsite. The concentration of heavy metals in top soil were presented on table 1, figure 1, the results shows highest concentration of Cd, Cu, Ni, Cr and Zn were observed in area of close to the dumpsite 15.58, 210.9, 69.0, 185.67 and 404.5respectively. But the levels were reduced when distance increased from municipal solid waste dumpsite. The concentration of Cd, Cu, Ni, Cr and Zn were observed in sixth site at 1500 meter distance from the municipal solid waste dump site were 8.75, 137, 40.6, 135.6 and 280.55 respectively.

Table 1: Heavy metal concentration mg/kg in top soil(0-20 cm)around municipal solid waste dumpsite

Location	Cd	Cu	Ni	Cr	Zn
Close to the dump site	15.45	209	70.56	197.67	378.6
300 meter	14.67	189.5	67.00	196.78	370.0
600 meter	12.5	160.9	50.6	178.56	350.8
900 meter	10.45	149.5	45.5	150.4	320.4
1200 meter	9.3	140.0	42.4	143.3	303.5
1500 meter	8.75	137	40.6	135.6	280.55

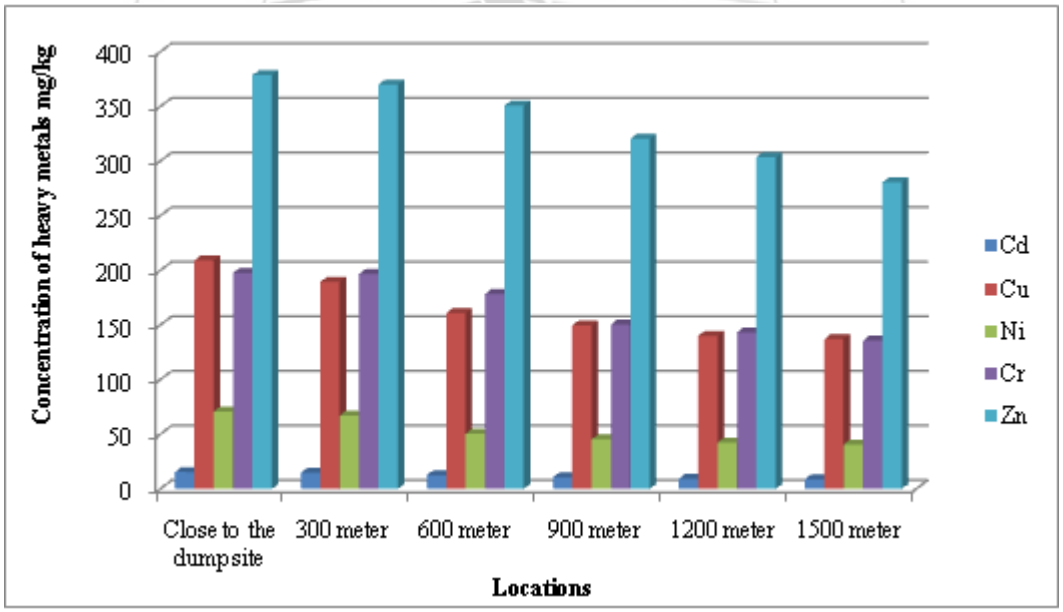

Figure 1: Heavy metal concentration mg/kg in top soil (0-20 cm) around municipal solid waste dumpsite

3.2. Heavy metal concentration in Middle soil

The concentration of heavy metals in middle soil shows on table 2, figure 2, Highest concentration of Cd, Cu, Ni, Cr and Zn were observed (15.58, 210.9, 69.0, 185.67 and 404.5)on the area of close to the dumpsite like as top soil, And the low levels of metals were observed (8.86, 140.7, 42.8, 130.3 and 310.7)on sixth site at 1500 meter distance. Results shows the levels were decreased with the increasing distance from the municipal solid waste dumpsite.

Table 2: Heavy metal concentration mg/kg in middle soil (40- 60 cm) around municipal solid waste dumpsite

Location	Cd	Cu	Ni	Cr	Zn
Close to the dump site	15.58	210.9	69.0	185.67	404.5
300 meter	13.58	179.0	70.5	180.78	356.0
600 meter	11.70	167.5	65.6	175.9	355.3
900 meter	11.28	150.9	43.47	163.2	350.4
1200 meter	10.6	142.0	45.78	154.7	346.9
1500 meter	8.86	140.7	42.8	130.3	310.7

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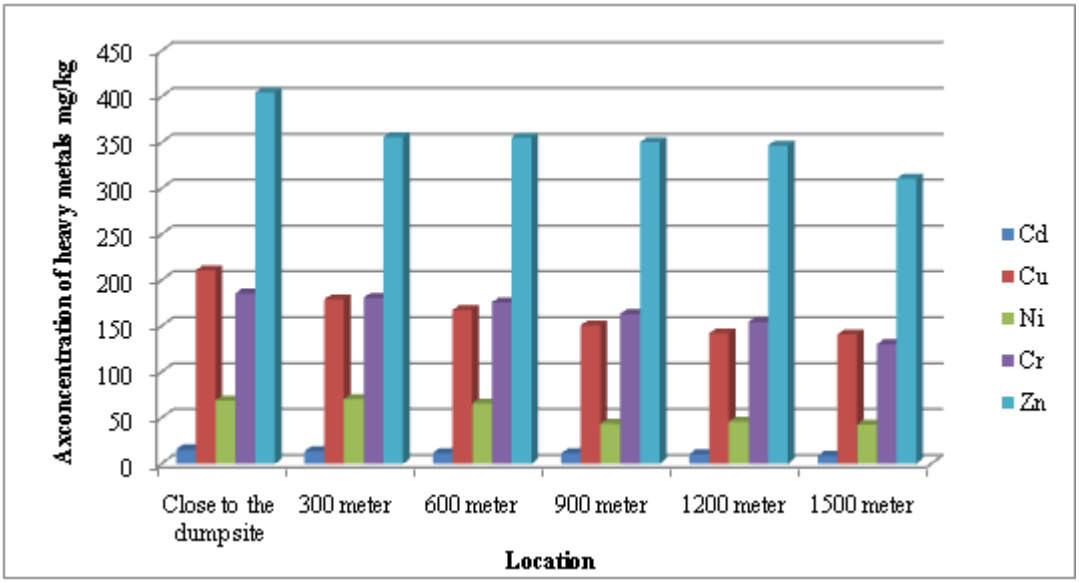

Figure 2: Heavy metal concentration mg/kg in middle soil (40- 60 cm) around municipal solid waste dumpsite

3.3 Heavy metal concentration in Bottom soil

The concentration of metals in bottom soil were represented on table 3, figure 3. The same results were observed like as top soil and middle soil. The level of Cd, Cu, Ni, Cr and Zn were high in close to the dump site and low in the sixth site of 1500 meter distance (14.30, 200.34, 65.03, 173.98 and 400.7) and (9.29, 130.5, 38.5, 111.20, and 300.23) respectively.

Table 3: Heavy metal concentration mg/kg in bottom soil (80- 100 cm) around municipal solid waste dumpsite

Location	Cd	Cu	Ni	Cr	Zn
Close to the dump site	14.30	200.34	65.03	173.98	400.7
300 meter	12.88	167.5	68.45	175.50	347.45
600 meter	10.39	156.25	63.23	165.34	350.25
900 meter	11.28	150.9	42.5	157.38	345.63
1200 meter	9.35	132.0	40.34	123.5	334.32
1500 meter	9.29	130.5	38.5	111.20	300.23

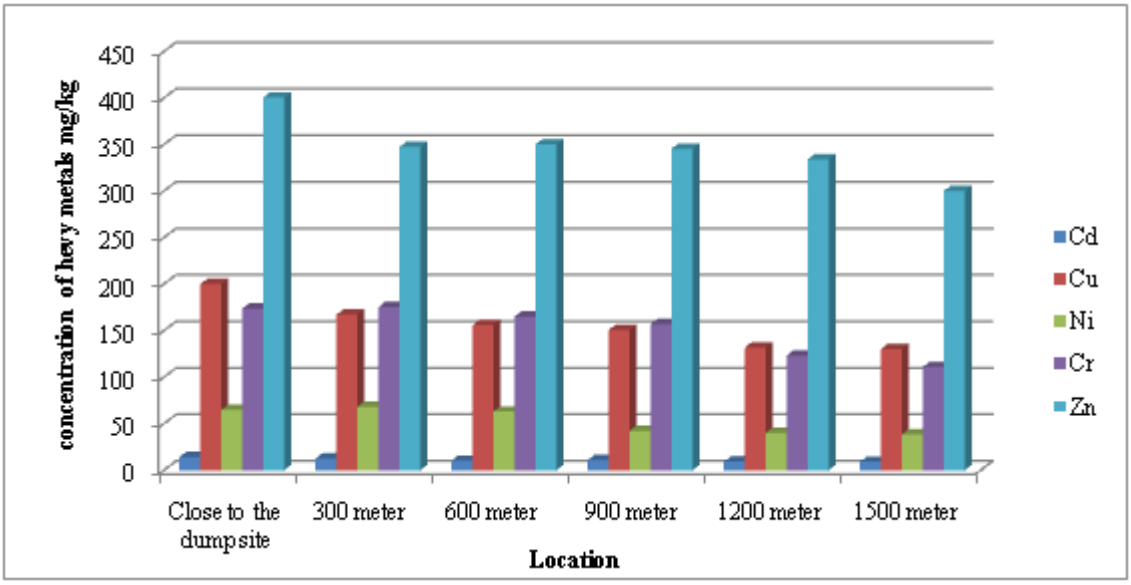

Figure 3:.Heavy metal concentration mg/kg in bottom soil (80- 100 cm) around municipal solid waste dumpsite

The overall results were indicated that the area is polluted by heavy metals. The concentrations of heavy metals were high in nearest area of MSW dumping. Lowest level of heavy metals measured in far distance from MSW dumpsite. The results shows decrease in heavy metal concentration with increasing distance from the dumpsite. Similarly Abul Kashim et al 1999 reported that the concentration of total heavy metals in soil decrease with increasing distance from distance from disposal sites of the tannery and textile industries in Dkaka city Bangladesh.

4. Conclusion

Unorganised dumping and burning of MSW pollute the ambient air in surrounding area. The heavy metal Dispersion in the ambient air then deposited in soil and the surrounding environment. Soil is one of the major resources for agriculture purpose that have to be protected from further heavy metal contamination. Because it will supply healthy food for the worlds increasing population (Mohmed Rashad *et al*,. 2012) The metal content was decreased in surrounding soil profile when increasing distance from the MSW

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dumpsite. To reduce the deposition of heavy metals, Should avoid burning of solid waste and incineration. Which are disperse the metal content in the ambient air then it will deposited on soil, plants, trees and water finally enter in to the food chain. Make awareness about the hazardous substances to the people. Should separate the waste as recyclable, hazardous substances, metals and bio degradable things that will reduce the level of metal content. Many researchers mentioned the composting is the best option for waste removal. But it will take time and need excess land for storage the waste. Generally microorganisms are involved and reduce the level of hazardous substances but not completely. So if we can use enhanced microbial composting is one of the best methods for reducing the level of heavy metal in solid waste.

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