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Research Article

MOBILIZATION AND DEPOSITION OF HEAVY METALS IN SOIL AROUND MUNICIPAL SOLID WASTE DUMPSITE

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ABSTRACT

Improper waste management and dumping of solid waste on land is responsible for the contamination of both surface and ground water resources. Leaching of heavy metals from the solid waste is highly polluting the surrounding environment and health hazards for the people living in nearby area.The present study was focused to measure the level of heavy metals in the soil around municipal solid waste dump site. The soil samples were collectedin Melur(MS),Thirumangalam(TS) and Usilampatti(US) municipal solid waste (MSW) open dumpsitearea in Madurai district. Totally six metals (Copper, Chromium, Cadmium, Zinc, Lead and Nickel) were analyzed and compared their level in soil around three dump site. The metals level in soil samples were high in 100 m distance than 1000 m.When the distance increased the metals level decreased. When compared with WHO permissible limits all the metals except lead and cadmium were beyond the limits in melur. Inthirumangalm dump site area lead only within the limit and in usilampatti dump site Nickel only within the limit. The results conclude that high metal contamination, due to leachate migration from an open dump siteis highly pollute the surrounding soil.

Keywords: Municipal solid waste; Heavy metal;Mobilization;Leachate; Pollution and Health hazard.

INTRODUCTION

Municipal solid waste management (MSW) is a leading problem in the world, Human existence on earth is almost impossible without chemicals. Population growth and economic development lead to enormous amounts of solid waste generation by the dwellers of the urban areas (Karishnamurtiand Naidu, 2003).Solid waste disposals like open dumps, landfills, sanitary landfills or incinerators are the source ofmetals released into the environment (Yarlagaddaet *al*.,1995; Waheedet *al*.,2010; Iwegbueet *al*.,2010; Bretzel andCalderisi2011; Rizoet *al*.,2012).Many dangerous chemical elements are released into the environment, accumulate in the soil and sediments of water bodies (Abida Begum *et al*., 2009). From which several chemicals have been reported to exhibit toxic effects on environment.(Ogundiran and Afolabiet *al*., 2008).MSW contain organic, inorganic and hazardous substances. Localmunicipalities collect the waste from various places like industries, commercial building, house, clinicsetc. The sources of hazardous substances are in the form of paint, vehicles maintenance products, pharmaceuticals, batteries mercury containing waste etc. (slacket *al*., 2004). Almost 70% of MSW is disposed of to landfill internationally (CECD, 2001, zacarias – Farah and geyer-Allaely, 2003) various hazardous waste dumped in the landfill are solvent in paint, paint thinner, plastics pesticides, wood preservatives, drugs, disinfectant, detergent plasticizers, battery , electrical appliances, ink/dye, agrochemicals and food additives etc. These wastes are degraded and metabolized by microorganism to produce hazardous byproduct. When it exceed the limit will dangerous to the environment and also affect the people who has been living around the dumping site. The concentration of hazardoussubstance varies in one place to another, when the distance increases the levels of hazardous substances decreased. Among the various hazardous substance heavy metals are the major pollutants in MSW dump site and surrounding environment. Heavy metaldeposition can affect soil ecosystem as a result in significant loses of soil quality(More 1976). Soil is an important compartment receiving a significantamount of pollutants from different sources every year. Generally,Soil not only serves as sink for the chemical pollutants it also acts as a natural buffer by controlling the transportof chemical elements and substances to the environment (Kabata and Pendias.,2001). The source of Heavy metals in MSW are from paints dyes batteries metal coating & electroplating industry paper rubber cosmetics toys, pencils, x-ray, shielding, thinners, dental amalgam light bulbs thermometers pesticides and fertilizers human are exposed to ect, these metals by ingestion or inhalations become toxic when they are not metabolized by the body and accumulate in the soft tissues. High and excessive accumulation of heavy metals in soil can contaminate both human and animal food chain (Ayarieet *al*., 2010) according to European community regulation (1975 and 1986) land application of bio waste materials consider high content of heavy metals as a limiting factor for reuse purposes. The aim of the study is to assess the level of dispersion and deposition of heavy metals in soil around MSW dumpsite.

MATERIALS AND METHODS

Study area:

For this study three municipal solid waste dumping site were selected around Madurai district. Madurai district is one of the oldest districts of the State and culturally Tamilnadu.Such as Melur represented MS,Thirumangalam represented TS and Usilampatti US.The District lies between 10^0 25' and 9^0 65' north latitude and 77^0 48' and 78^0 35' eastLongitude. Major mineral resources available in Madurai district, such as lime stone found in melur and thirumangalam .Melurhave large amount of granite,which are excavated and exported.Sustancial amount of graphite present in melur,thirumangalam and usilampattitaluk. Other than the natural resources major level of industrial activity is taking part in and around Madurai,melur ,thirumangalam and usilampatti (MSME-2010-2013).Table 1.Shows number of non -food small scale industry (SSI) units in2009.

S.NO	Name of Industry	No of industry
1	Textiles	775
2	Hosiery and Garments	6948
3	wooden products	1034
4	Paper Products and Printing	1965
5	Leather Products	455
6	Rubber Products	1411
7	Chemical & Chemical Products	1254
8	Non- Metallic Mineral Products	730
9	Basic Metal Products	406
10	Metal Products	2421
11	Machinery except Electrical Products	2022
12	Electrical Machinery	861
13	Transport Machinery	670
14	Misc. Manufactering Parts	5121

Table 1: Number of Non-Food registered SSI units 2009

Source: DIC Madurai.

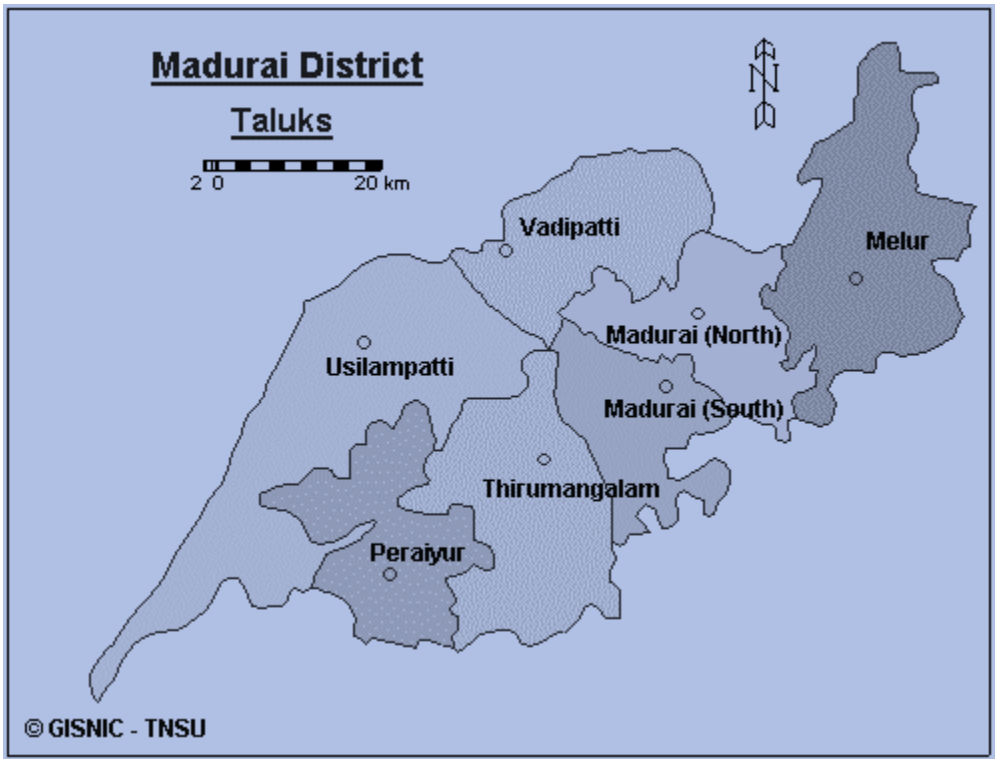

Figure 1: Madurai district map

Melur:

Melur is located10°03′Nlatitude and 78°20′E longitudeThe present system of solid waste management in Melur Municipality is not well structured and properly organized to meet the total requirement and does not satisfy the local population as per Pollution Control Board norms. Estimated Quantity of Waste Generated perday7.0 tones Existing Municipal compost yard extended to 3.74 acres situtated at Pudusukkampatti 3 kms away from the town.

Thirumangalam:

Thirumangalamis located 9°91' N latitude and 77°98'E longitude.The town generates 17.00 MT of Solid Waste per day at a rate of 325 gm per capita per day collected, transported and dumped at Karisalpatti Village which occupy an area of 5.20 acres.

Usilampatti:

Usilampattiis located 10° 37' N latitude and 77° 20' E longitude.Which generates 9.00 MT of Solid

Waste per day at a rate of 281 gms per capita per day.transported and disposed in the Theni main roadarea, 1 KM away from the town centre, which occupy an area of 1.54 acres.which works to per capita generation of At present, there is no full-fledged compost yard facility is available for solid waste dumping and the waste is generally disposed.

Sample collection:

Ten locations selected for sample collection around municipal solid waste dump site, 100g of triplicate soil samples were collected at each location. The distance of each sampling point is 100 meter (100-1000 m).Samples were kept in polyethylene bags, labeled as MS, TS, US and transported to the laboratory for further analysis.

Heavy metal Analysis:

After transportation, in the laboratory the bulk soil samples were spread on trays and air dried at ambient conditions for two weeks. The samples were then grounded by mortar and pestle, sieved through 2 mm mesh, and oven-dried at 50◦C for about 48 hours and were stored at room temperature before analysis. 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.The resulting transparent solution was filtered and diluted to 50 ml using deionized water (Allen *et al.,* 1986).Then it was analyzed for concentrations of Copper (Cu), Chromium (Cr), Cadmium (Cd), Zinc (Zn), Lead (Pb) and Nickel (Ni) using an atomic absorption spectrophotometer (Modal-ELICO,SL173).

RESULT AND DISCUSSION

Municipal solid waste landfill leachate causes pollution of the soil, Which is an important component where polluted materials aredeposited and transported to other media like air, ground and surface water by evaporation, erosion and infiltration, this component is a natural source which is needed to carefully monitor (Banar*et al*,. 2009).Three municipal solid waste dump site of Melur(MS),Thirumangalam(TS) and Uailampatti(US) were selected for analyze the metals level in surrounding soil. Samples collected at every 100 m distance from dumpsite (100 m-1000m).Metals like Copper (Cu), Chromium (Cr), Cadmium (Cd), Zinc (Zn), Lead (Pb) and Nickel (Ni) were measured in soil sample. In this study, the concentrations of heavy metal present in the collected soil sample were reported in Table 2, 3 & 4 and the levels compared with WHO permissible limits.Overall study reported that there was significant difference observed in the heavy metal concentration between the sampling point(100m-1000m).The concentration of metals were high in 100 m

distance and the levels were gradually decreased when distance increased.

Comparative assessment of heavy metals in three dump site:

The highest copper level was reported in usilampatti than inmelur&thirumangalam dumpsite area with164,121.24&118.36mg/kg respectively(Figure).When compared with WHO permissible limits the concentration of copper was beyond the limits in all sampling point of US site,in MS1 -3 sample beyond the limits but in MS5-10sample copper was within the limits and in TS1&2 sample only exceed the level other sites within the limit. Nearest area of municipal solid waste dump site was highly polluted,when the distance increased the copper level were decreased.In MS site chromium was beyond the limit in sample MS1,2,3&5(124.8,108.37&109.31mg/kg), in TS1,2 & 4 beyond the limit(105.04,112.23&110.36 mg/kg) highest level occur in TS 4&2 than other places. And in US site concentration of chromium was beyond the limitin sample US1-5 (132.68,132.16,126.86,122.25&112.57 mg/kg).The cadmium concentration beyond the limits in TS1(3.19mg/kg) and inUS1-3(3.2,3.44&3.2 mg/kg) respectively the highest level observed in TS2 than TS1. But in MS site the level within the limits in all sample.The concentration of Zinc higher in MS1-7 (431.9,413.6,409.8,398.06,395.3,358.8&350.1) than US and TS site in. In TS site the levels were higher in sample TS1-4 (355.34,332.4,315.38310.61) and in US site the levels higher in sampleUS1-9 (417.43,404.94,400.23,393.07,383.74,390.32,365.91&356.85).The concentration of lead was within the limit in MS and US site. But in TS site the levels were higher than WHO permissible limits in sample TS 1 – 10(155.7,153.91,155.12,153.58,138.74,145.28,141.92,138.26,135.6 and 132.55). Finally the concentration of Nickel were high in TS 1 -3 (67.19,64.88,61.74mg/kg) than MS & US sites.

CONCLUTION

The overall study concluded that the heavy metal concentrations present in the solid waste depends on site conditions ,season,age of landfill,composition of solid wasteect., Similarly the concentration of metals in soil also varies in sampling sites, leaching property and location. The results conclude the high metal contamination, due to leachate migration from an open dump site of Melur,Thirumangalam and Usilampatti sits were highly pollute the surrounding soil. Because the major industrial activity taking part in melur,thirumangalam and usilampattitaluk.But the metals levels were decrees when the distanceincrease.

Sample Name	Distance in Meter	Cu	Cr	Cd	Zn	Pb	Ni
MS1	100	121.24±5.29	124.8±6.7	2.34±0.15	431.9±5.21	93.01±8.45	55.06±3.84
MS2	200	111.48±3.44	122.03±5.78	2.31±0.15	413.6±12.38	104.79±9.17	49.8±1.31
MS3	300	119±5.9	108.37±7.05	2.12±0.07	409.8±8.09	106±8.05	51.74±1.73
MS4	400	102.78±2.61	102.5±5.31	2.09±0.03	398.06±7.71	101. 15±2.88	50±0.72
MS5	500	104.75±9.21	109.31±7.74	1.98±0.1	395.3±8.29	97.5±1.65	49.26±0.7
MS6	600	99.85±5.1	98.09±2.4	1.57±0.11	358.8±8.53	94.95±3.15	46.56±1.12
MS7	700	104.7±9.29	94.58±4.59	1.41±0.2	350.1±8.53	89.13±2.32	42.97±2.1
MS8	800	90.66±4.8	91.51±2.37	1.34±0.09	307.39±16.44	87.4±2.45	42.98±3
MS9	900	88.85±8.79	83.84±3.3	1.15±0.07	290.03±6.84	85.16±3.17	44.02±1.59
MS10	1000	90.76±3.93	82.11±3.06	1.09±0.05	275.6±11.1	82.8±1.67	41.55±0.95
WHO*mg/l		100	100	3	300	100	50

Table 2: Heavy metal concentration(Mean ± SD) mg/kg in soil around Melur municipal solid waste dump site

*WHO Maximum permissible limit in soil.

Sample Name	Distance M	Cu	Cr	Cd	Zn	Pd	Ni
TS1	100	118.36±2.64	105.04±6.4	3.19±0.25	355.34±9.65	85.71±0.64	67.19±2.04
TS2	200	115.1±6.32	112.23±9.44	2.88±0.036	332.4±7.08	94.31±4	64.88±1.45
TS3	300	103.93±3.31	98.76±2.51	2.9±0.092	315.38±5.04	89. 36±1.68	61.74±1.49
TS4	400	34.75±1.52	110.36±11	2.64±0.14	310.61±1.55	85±1.77	58.25±1.41
TS5	500	106.77±4.89	101.28±3.72	2.72±0.16	282.09±7.73	77.16±2.15	54.95±1.04
TS6	600	98.62±1.51	97.26±0.88	2.45±0.27	275.08±5.55	75.67±0.79	52.42±1
TS7	700	102.97±9.17	93.75±2.97	2.39±0.05	269.31±1.26	70.8±0.87	52.13±0.59
TS8	800	98.89±3.34	91.56±2.48	2.03±0.13	258.4±1.9	70.71±0.757	48.46±2.01
TS9	900	100.98±3.68	87.13±2.61	1.7±0.15	253.07±5.44	66.72±2.72	43.01±2.01
TS10	1000	94.57±1.83	82.78±3.29	1.38±0.11	236.89±5.53	65.2±2.04	41.4±0.77
WHO*mg/l		100	100	3	300	100	50

Table 3: Heavy metal concentration (Mean ± SD) mg/kg in soil around Thirumangalammunicipal solid waste dump site

Sample Name	Distance M	Cu	Cr	Cd	Zn	Pd	Ni
US1	100	164±3.92	132.68±2.13	3.21±0.058	417.43±6	155.7±5.05	45.94±2.99
US2	200	163.08±2.48	132.16±3.51	3.44±0.18	404.94±4.34	153.91±2.08	45.08±1.39
US3	300	159.91±4.04	126.86±1.93	3.2±0.04	400.25±2.05	155.12±2.86	41.54±0.96
US4	400	149.25±2.98	122.25±3.38	2.88±0.08	393.07±2.5	153.58±0.58	39.5±1.09
US5	500	142.05±1.31	112.57±2.72	2.78±0.08	383.74±2.99	138.74±8.4	36.83±1.53
US6	600	136.77±2.42	103.83±3.24	2.37±0.04	372.75±3.39	145.28±3.9	42.12±0.58
US7	700	133.54±2.03	97.23±1.62	2.28±0.06	390.32±4.16	141.92±1.07	36.61±0.98
US8	800	131±1.31	91.16±0.64	2.29±0.02	365.71±1.53	138.26±2.04	35.78±0.41
US9	900	125. 57±5.06	89.19±1.34	2.08±0.08	356.85±1.43	135.6±0.81	35.2±1.09
US10	1000	120.02±6.64	84.68±1.95	1.93±0.04	315.74±5.42	132.55±2.52	31.89±1.35
WHO*mg/l		100	100	3	300	100	50

Table 4: Heavy metal concentration (Mean ± SD) mg/kg in soil around Usilampatti municipal solid waste dump site

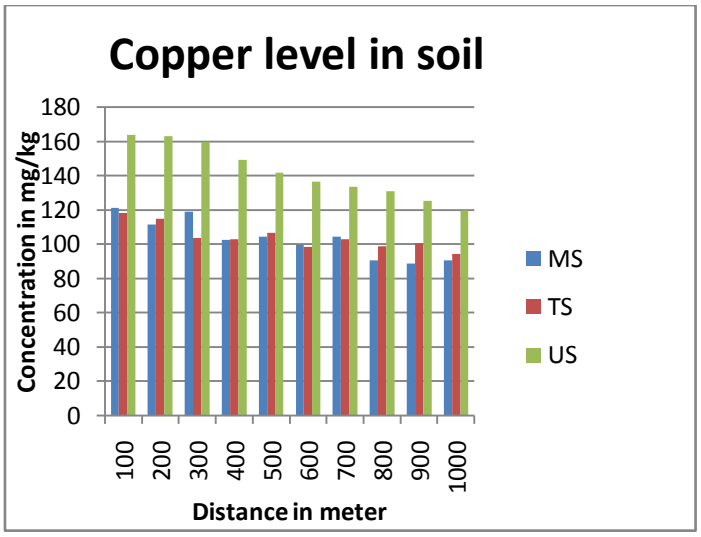

Figure 2: Copper level in soil around three MSW site

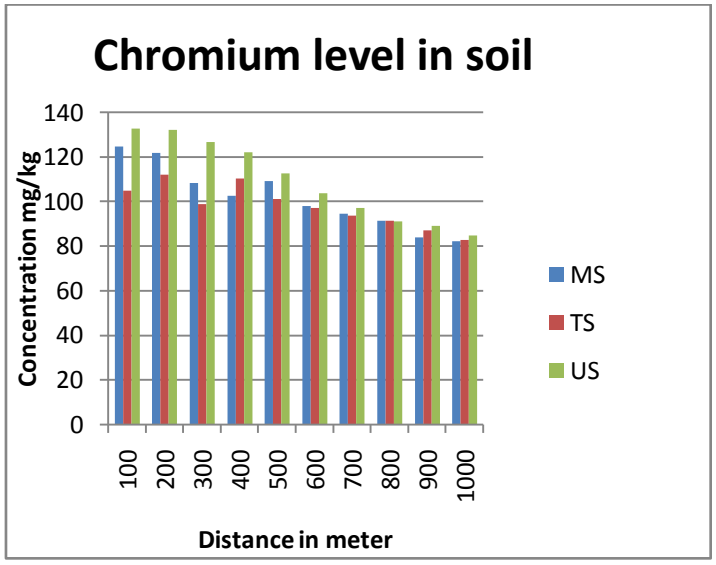

Figure 3: Chromium level in soil around three MSW site

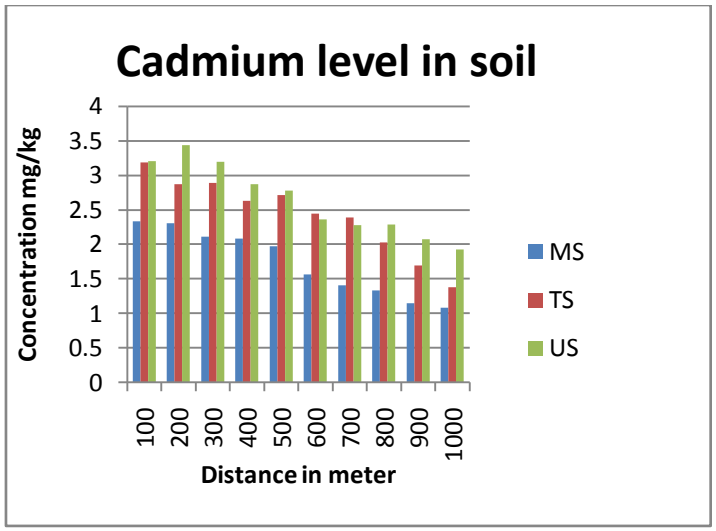

Figure 4: Cadmium level in soil around three MSW site

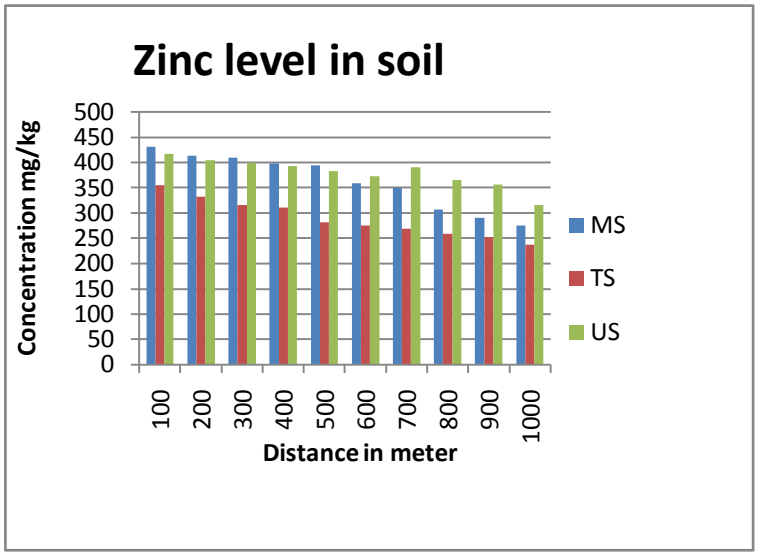

Figure 5: Zinc level in soil around three MSW site

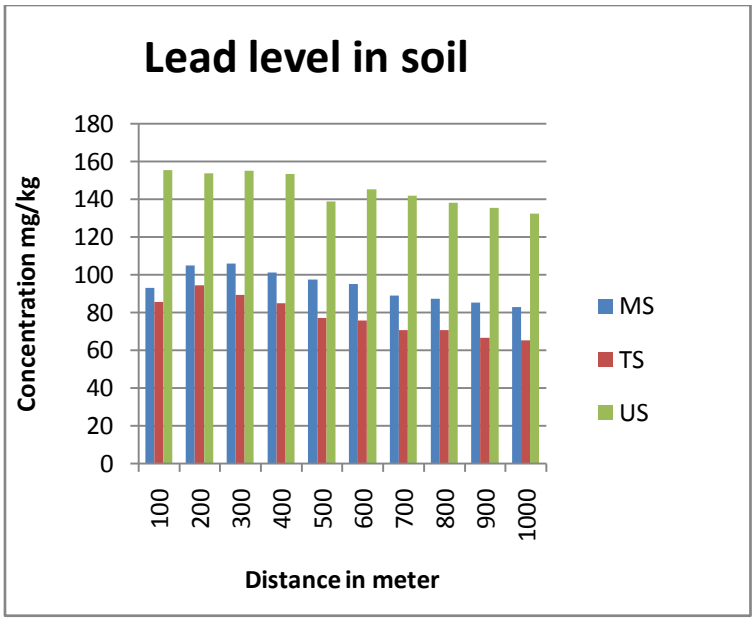

Figure 6: Lead level in soil around three MSW site

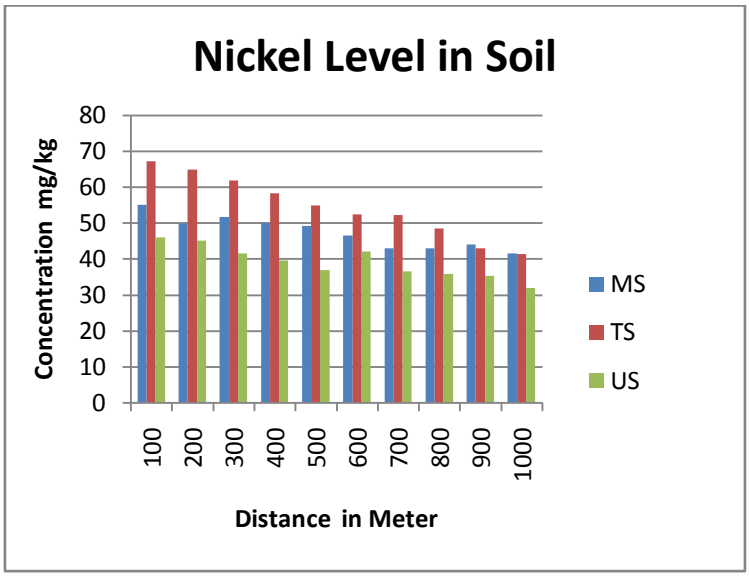

Figure 7: Nickel level in soil around three MSW site

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