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Research Article

HEAVY METAL POLLUTION IN SOIL AND WATER AROUND LANDFILL DUMPSITE

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ABSTRACT

Anthropogenic activity enhances the heavy metal contamination in surrounding environment. This research was designed to measure the metal pollution level from soil and ground water system around land fill dumpsite. The levels of pollution measured from 0 distances to 1200m distance of landfill. The overall study indicated that concentration of heavy metals Arsenic(As), Mercury(Hg), Lead(Pb), Cadmium(Cd), Chromium(Cr), Copper(Cu), Nickel(Ni) and Zinc(Zn) were witnessed in very near to dumpsite also the concentration was decreased when distance increased. The levels of As, Hg, Pb, Cd, Cr, Cu, Ni and Zn in soil were observed every 300m distance (90.75, 90, 77.3, 98.5, 92.3, 58, 95.9 and 94%) respectively. The above level was compared to 1200m distance; the concentration was gradually reduced to (36.8, 0, 51.7, 51.8, 50.4, 56, 51.3 and 46%) separately. Also the concentration of heavy metals in ground water samples at 300 m distance were (100, 96, 90.2, 93.91, 92, 95.5, 100, and 97.3%) the levels reduced to (24.2, 10.3, 30.7, 29.6, 52.5, 49.6, 21.1&57.5%) at 1200m distance. This indicated that the nearest area soil and ground water were highly polluted; however the heavy metals concentration was reduced gradually at far distance. To reduce th toxic compounds from the waste, create awareness for the people to limit the waste from every house. Sanitary landfilling and composting is an excellent and ecofriendly manner of waste mangement.

Keywords: Environmental pollution, Heavy metals, Municipal solid waste, Leachate, Ground water.

INTRODUCTION

Municipal solid waste (MSW) normally called “trash” or “garbage,” which are categorized as recyclables, biodegradables and toxic substances like heavy metals (HMs). Generally it contains solid or semisolid nature of waste, which is predominantly from house hold waste, commercial and industrial waste. Most of the developing countries, MSW are dumped in landfill in an unscientific manner. Decomposed landfill generate leachate develop due to physical, chemical and biological reaction inside the landfill and pollute surrounding (Bhalla *et al*., 2013). India is the second highest populated country and generation of waste is increasing at an alarming rate, due to urbanization and population explosion. In India roughly 70% of MSW is disposed on dump yard (Aswathi *et al*., 2013). Globally the occurrence of HMs in waste as a result of modernization of society is ever-growing concern. Accumulation of HMs above the threshold level is mainly due to anthropogenic activities, like ore refining, mining, metal working industries, combustion of fossil fuels, battery manufacturing, paints, preservatives, fertilizers, insecticides, health care and clinics waste and electronic waste etc. (Nies, 2000). Soil polluted with HMs can contaminate surface water and ground water in addition plant accumulates toxic compounds then enters in to food web (Wang *et al*., 2021).

Metal contamination can cause different types of health complication, affect central nervous system, reduce metabolic function, and damage to blood composition, affects heart, liver, lungs, kidney and other vital organs (Anjanapriya *et al*., 2021; Mohod & Dhote, 2013). Long term exposure of arsenic can cause different types of cancer, skin lesions and impairment of respiratory and central nervous system (Choong *et al*., 2007).Various

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countries were investigated arsenic contamination in ground water, also the chronic exposure through ingestion of arsenic contaminated food and water, polluted air, they found arsenic contamination is the source for keratosis, hyperpigmentation, vascular diseases and cancers (Argos *et al*., 2010; Gibb *et al*., 2011). Also, trace amount of lead may affect fetus development, brain damage in infants, behavioral changes, respiratory problems, intoxication and male infertility (Gol *et al*., 2018; Needleman *et al*., 2002; WHO, 2010). In humans, brain and other organs are highly affected by methyl mercury, at embryonic developmental stage of children get mercury thru the placenta; it affects children's mental growth. Cadmium contamination in soil, groundwater, plants (grow in contaminated soil) is documented by various studies. It increases cadmium accumulation in kidneys leading to kidney dysfunction (EC., 2002).Toxic effect of chromium causes cancer in urinary tract, allergic dermatitis as well as nasopharyngeal cancer (Gol *et al*., 2018; Martin & Griswold, 2009). Nickel and chromium used as a main component in stainless steel and electronics industry using. Copper, Nickel and Zinc are the essential elements for various metabolic reactions, but when increased consumption rate will cause some defects. For example, Zn is essential for the proper growth of sex organ and bone development, young men and unborn fetuses. When increase the level it becomes harmful to health (Kjærgaard *et al*., 2000).

Landfill waste are slowly decomposed and degraded, further the toxic compounds are percolating through the rain water to the environment. Heavy metal contamination in soil, due to dumping of waste at MSW is major thread to the ecosystem (Kanmani & Gandhimathi, 2013). Leaching property of HMs extremely contaminates the surrounding soil and ground water, and the people who live around landfill dumpsite are exposed to this toxicity. According to (EPTA, 2001), to evaluate the pollution level there is a need for regular analysis of the soils from decomposed solid waste and dumpsite, agriculture , industrial area. The study conducted by Cambra *et al*., (1999) proposed that irrigation of soil with leachate water is the source and accumulation of HMs (Cd,Cr,Pb,Zn,Ni)in surface soil. According to Beyene & Banerjee, (2011), investigation concentration of K, Cd, Cr, Pb, Mg, Co, Zn, Ni and Fe augmented in surrounding water system. This study was designed to measure the HM pollution in the soil and ground water around municipal solid waste dumpsite. This investigation is helpful to assess the pollution level and its impact on ecosystem.

MATERIALS AND METHODS

Sample location

Chennai is the capital of Tamil Nadu located on Bay of Bengal. The Chennai city waste is collected and dumped in two locations, Kodugaiyur and Perungudi. In this study Perungudi dumping site is chosen for the assessment of heavy metals pollution around neighbourhood area. The dump yard is located accurately at 12.97´N and 8.25´E at an elevation of 9metres above the sea level. The dump yard is active since 1992 and the height of waste reached the height of multi-storey building. Triplicate samples were collected at each location (from 0 to 1200m distance) for better results and samples were kept in laboratory for further analysis (Figure1)Shows the satellite view of sampling location.

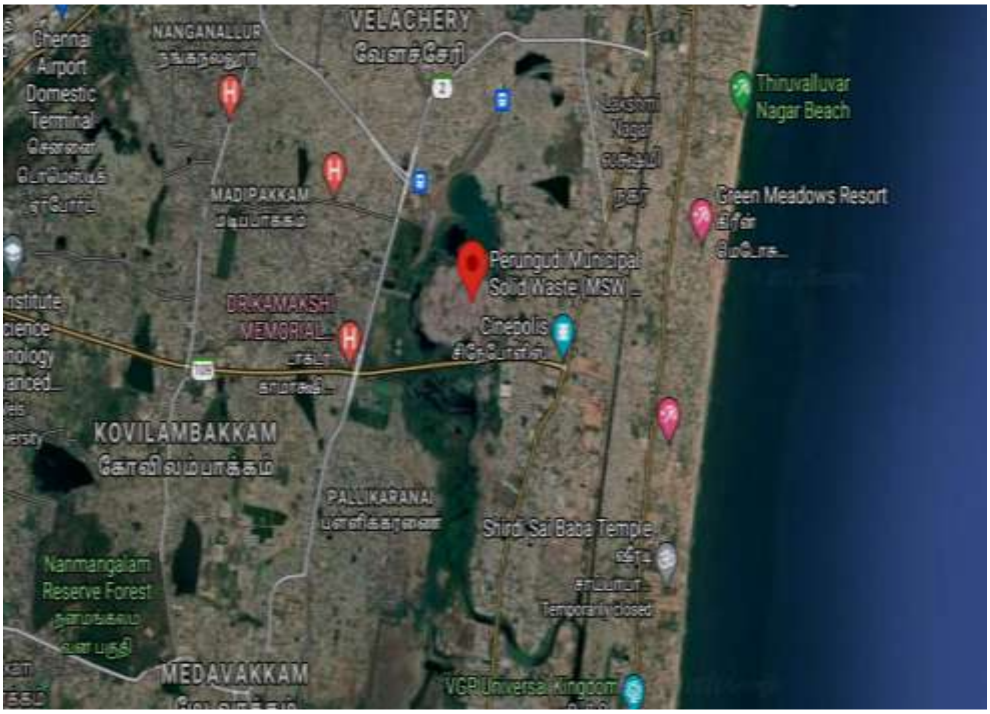

Figure1. Shows the satellite view of Perungudi dumping site.

Estimation of HMs in soil and ground water around landfill dumpsite

Present investigation, eight metals such as Ar, Hg, Cu, Cd, Pb, Cr, Zn and Ni were selected for the study of HM pollution around landfill dumpsite. Soil sample 1 gram was mixed with 15 ml of try acid mixture (HNO_3, $HClO_4$, H_2SO_4) in a beaker then digested at 80° C until transparent solution attained (Allen & Rae, 1986). Then solution was filtered and diluted with 50 ml of deionized water finally the HMs levels were analyzed using atomic absorption spectrophotometer (Modal-ELICO, SL173). Similarly estimation of HMs from ground water sample done with 50 ml of sample dissolved with 10 ml of concentrated HNO_3 at 80°C, for HMs analysis followed the procedure above mentioned (APHA, 2005). Mean standard deviation calculated for heavy metal concentration of all the samples.

RESULTS AND DISCUSSION

Globally, heavy metal pollution in the ecosystem due to numerous anthropogenic activities like industrial and municipal waste, is a major threat (Kanmani & Gandhimathi, 2013; Štofejová *et al*., 2021; Wang *et al*., 2021).Without proper leachate collection system, it will percolate to the soil compartments and cause soil pollution (Emenike *et al*., 2016). This research focused to measure the HMs pollution in soil around landfill. The highest concentration of Zn followed by Pb Cu, Ni and Cr were observed in 0 distance (closest to the dumpsite), 274.5, 166.4, 137.36, 128.19 and 55.84. However 40-50 percentages of heavy metals found at 1200m distance from dumpsite. Figure 2 shows the concentration of HMs in soil sample. When compared with 0 distance the levels were gradually decreased at every 300 m distance increased. The concentration of HMs at 1200 m Zn (46.05%, Pb (51.74%), Cu (56.09%), Ni (51.27%) and Cr (39.14%). At 300m distance, 93.8% of Zn (257.69mg/kg) observed but the levels rapidly decreased 59.8,55.8 and 46.5 % at the distance 600,900and 1200 m(164.41,53.4&126.42 mg/kg) respectively. Zn is a vital element and plays a major role in the physiological and metabolic process, for example, protein synthesis. The concentration of Zn from 0-1200m distance observed below or nearly the same with WHO permissible limits 300mg/kg. Similarly concentration of lead in soil sample in 0-1200 was 166.4, 129.6, 122.29, 120 and 86.11 mg/kg. The levels were reduced gradually at every 300m distance 77.9, 73.4, 72.1 and 51.7%. Which were found to be above the permissible limit of Pb in soil as recommended by WHO, 2001(50 mg/kg) and European Commission, 1986 (100mg/kg).The high amount of lead in the soils may be leached from dumpsite. This is because lead used in gasoline, paints, cosmetics and toy and X-ray shielding devices.

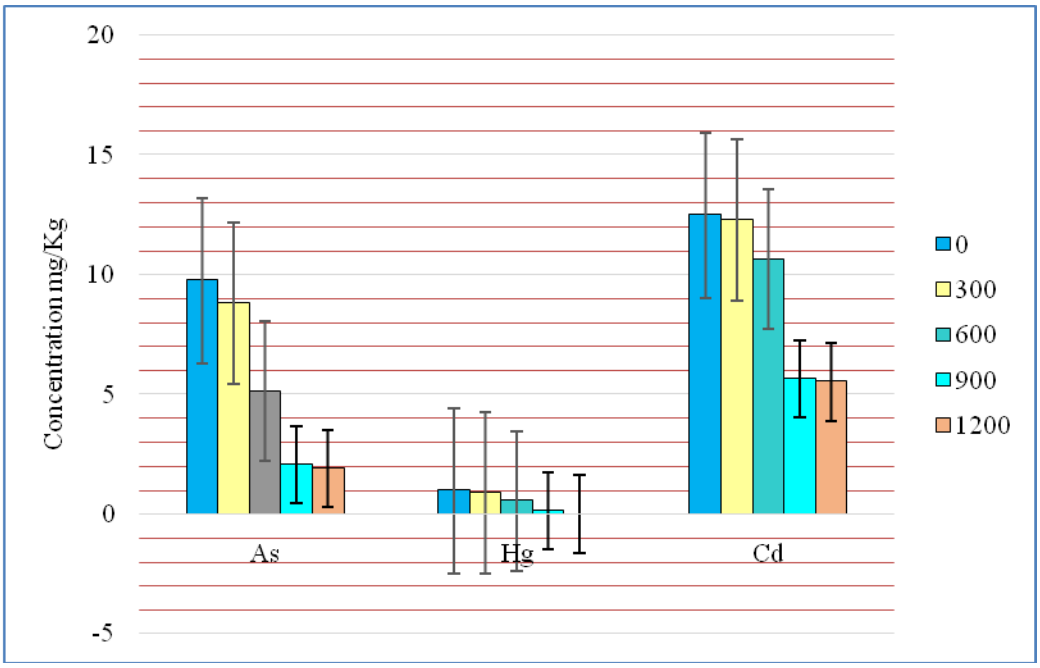

Figure 2. Concentration of HMs in soil from dumpsite to 1200m distance.

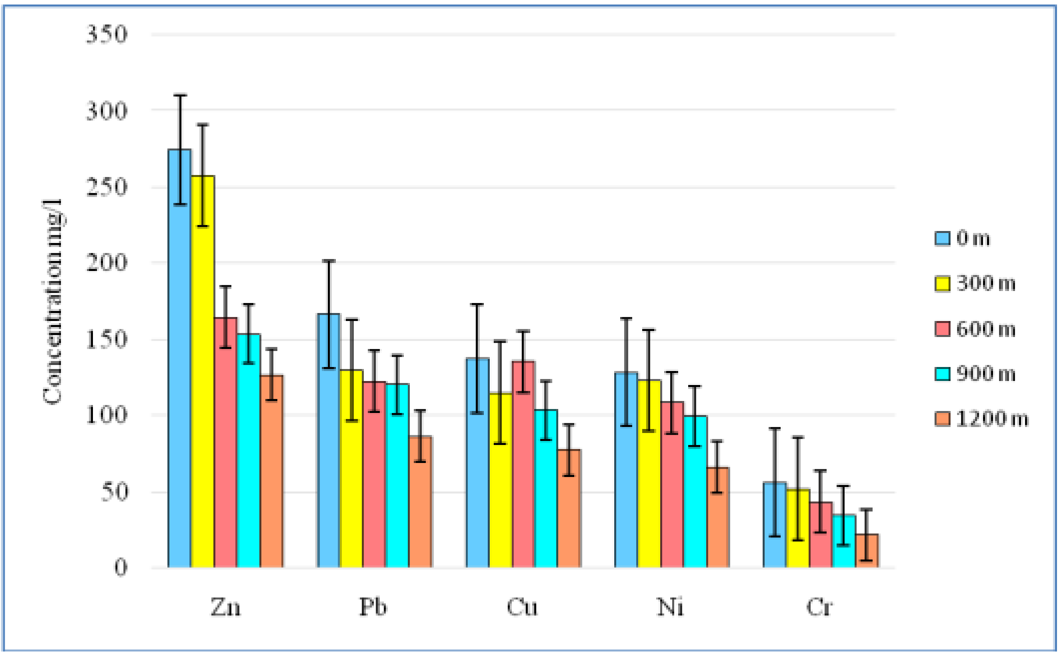

Figure 3. Concentration of HMs in soil from dumpsite to 1200m distance.

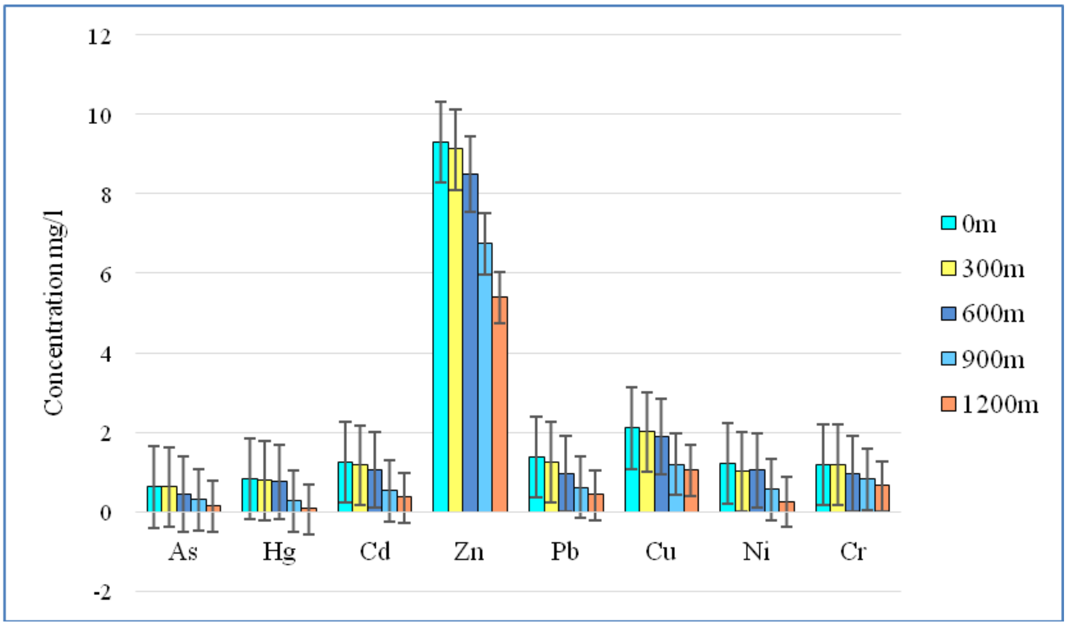

Figure 4. Concentration of HMs in water from 0 -1200 meter distance.

In this research high concentration of Cd witnessed at each sampling location 0 – 1200m (12.48, 12.29, 10.65, 5.63 & 5.52mg/kg) (also it exceeds the WHO permissible limits (3mg/kg) (figure 3).Likewise As concentration were (9.75, 8.8, 5.13,2, 1.89 mg/kg) observed, levels were below the WHO permissible limits (20 mg/kg) Hg observed only at 0, 300 and 600 m only (0.97, 0.87, 0.53& 0.15mg/kg). The concentration of copper and nickel were similar but the levels decreased at every distance. Like Zn, copper and nickel have some biological role and Work done by (Kanmani & Gandhimathi, 2013), reported that copper is a moderately immobile element in soil and the highest amounts of adsorbed copper have continually found for Fe and Mn-oxides. This study found 137.3, 114.6, 135.09, 103.4 and 77.05 mg/kg of Cu and 128.1, 123, 108.4, 99.5 and 65.73 mg/kg of Ni were witnessed in 0-1200m distance of soil sample. The Cu levels declined, from 100% at 0 distance to 83.4% (300m), 75.28% (900m) and 56 % (1200m) but increased levels observed at 600m 98.3%. The levels of Ni 95.9, 84.5, 77.60 and 51.2% at the distance from 300-1200m. Observed concentration of Cu and Ni were beyond the WHO permissible limits (Cu 100 mg/kg, Ni 50mg/kg) (WHO, 2010). Chromium concentration at 0 distance 55.8 mg/kg (100%) gradually it decline at every 300m distance 51.5(92.2), 43.32(77.5) 34.14(61.1) and 21.8 mg/kg (39.14%) respectively. When compare with Pb, Cu and Ni, Cr was found below the WHO permissible level (100mg/kg).(Figure 4) Sources of Cr in the soils could be due to automobiles, discarded plastic materials, colored polythene bags, waste paint containers and electronic waste (Jung & Han, 2006).

CONCLUSION

The study indicates, every day huge amount of heavy metal containing substances collected through municipality and dumped as a landfill, unscientific disposal causes adverse impact to the surrounding environment. The metal pollution due to the leaching of HMs from the landfill and pollutes soil, groundwater finally enter in to food web. Consequently, the area around dumping site was highly polluted than the far distance; this indicates leaching of toxic compounds occurs due to various chemical reactions. Peoples who are living very near to the landfill are continuously exposed to heavy metal this leads various health defects to that people. This concludes that municipality services must follow screening and separation of metal sourced products from dumping, and enhance the sanitary landfilling.

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