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HEAVY METALS LANDFILL EFFECT ON PEOPLE AND ORGANISM HEALTH RISK: ATOMIC ABSORPTION SPECTROSCOPY APPROACH

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ABSTRACT

Some urban city faced to soils around landfill. This study investigates the heavy metals contamination around the Tamangapa Antang Final Disposal Site (FDS). The samples were divided into 4 points consisting of 2 points that align with the groundwater flow (Point A and Point C), and 2 points that are vertical to the groundwater flow (Point B and Point D) in the Antang landfill. Atomic Absorption Spectroscopy (AAS) was used to examine heavy metal around sample observation. The results of the analysis show that the soils of landfill have spread across the topsoil vertically with the highest concentration, reflecting the vast amount of trash dumped to the FDS. The second highest heavy metal concentration was at its highest at Point A and Point D exceeding the limit, but remaining under the limit recommended by the Indonesian Food and Drug Authority at Point B and Point C. Meanwhile, Point A, B, and C heavy metal concentrations were lower. The findings showed that in general, FDS has been contaminated, hence there is a need to concern for regional disaster management, specifically for people which live around the Antang landfill. The construction of regional centres for recycling and reuse activities, and consolidated sanitary landfills for the disposal of municipal solid waste are the main strategic priorities.

Keywords: landfill, soils, vertical, AAS, heavy metals.

AIMS AND BACKGROUND

The main issue in developing countries is how to select a suitable area for a final disposal site (FDS). Because of the rapid population growth and urbanization, the

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demand for disposal products has increased by a factor of two[1–3]. It caused a greater need for landfill space. Hence, an integration approach for waste disposal and waste management plays an important role in reducing the impact of solid waste and heavy meal on the environment and the people who live in and around landfill areas. People who reside nearby landfills are exposed to a number of harmful chemicals that are created during the landfilling process[4,5]. Litter, dust, excessive rodents, unforeseen landfill fires are some additional contaminants linked to the deposition of trash on landfills. The type and quantity of garbage placed, the age of the landfill, and the climatic conditions of the landfill sites are all factors that affect the by-product or emissions from landfills. Heavy metals, particulate debris, and a number of gaseous contaminants (including dioxins and polycyclic aromatic hydrocarbons) are regularly formed in the landfill as a result of intricate chemical and microbiological processes[6,7].

Urbanization is a key issue in developing nations like Indonesia, which has faced various environmental challenges, including the percentage of solid waste, due to social issues including socioeconomic, economic, and population inequality. Traditional solid waste management methods used in Indonesian towns have not been designed to advance environmental protection, public health, or renewable energy sources[8,9]. These methods of managing solid waste are now widely recognised as the primary contributors to contamination of surface and groundwater as well as a degradation in the cleanliness of cities and towns[10,11]. Makassar is one of the places, and it deals with concerns including how to manage heavy metal problems in final disposal sites and poorly managed solid waste operations (FDS). Makassar City has been undergoing a significantly rapid development which unfortunately contributes to the increasing amount of waste produced. Waste is an undeniably serious issue which grows with the population in Makassar City.

The Final Disposal Site (FDS) is a vital necessity to create a convenient environment for the community in big cities. If waste from all areas of Big City is not transferred to the FDS even for one day, the city will be full of waste, and it annoys the convenience of the community. It is an undeniable truth that the current conditions of FDS in some big cities have not met the standards of environmental safety. In fact, some FDSs are shut down because they are located too close to people residence and the resulting air pollution from waste deterioration has aggravated the community[12]. Poorly managed FDS is critically harmful to human health and potentially damaging the environment. The human activities have caused serious damage to the environment, and significantly increased biological toxicity of heavy metals in soils. Some heavy metals in excessive concentration may harm the organisms around landfill. The heavy metal contamination also damages soils and animals[13,14].

Soils may be contaminated with heavy metals that are typically without colour or odour, thus are difficult to be controlled. Heavy metal contamination may not instantly be damaging to environment; however, it has been reported[15,16] that when the concentration of heavy metals has exceeded the tolerance level of the environment, they will be activated and trigger ecological damage. Previous researchers have investigated heavy metal concentration in the soils landfill in Slovakia[17]. Similarly, heavy metals in landfill may be removed by modified membrane[18].

EXPERIMENTAL

Research area. The administrative area of the research encompassed the regional Bangkala Sub-district at Manggala District, Makassar City, South Sulawesi Province (Fig. 1).

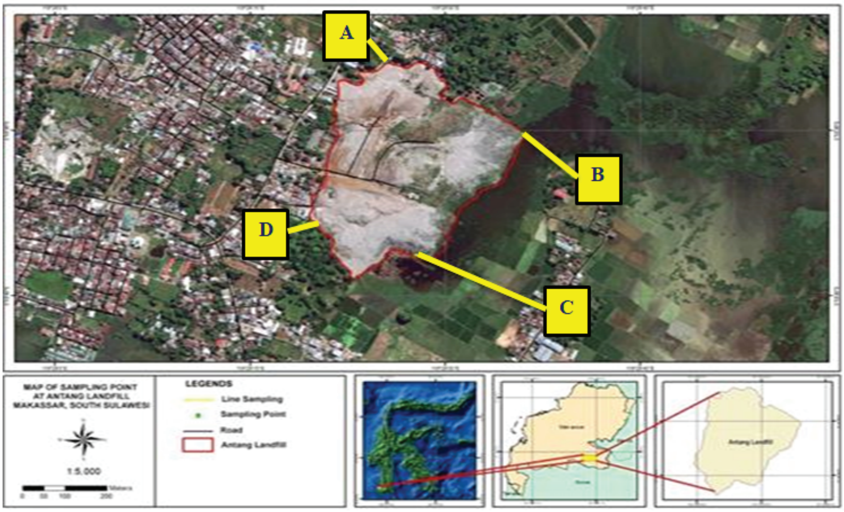


Fig. 1. Location map of Antang landfill, Makassar city, South Sulawesi, Indonesia

Sampling point. The samples used in this study were the topsoil collected from the area of Antang Final Disposal Site, Makassar City, South Sulawesi. There were four sampling areas: two areas (A and C) aligned with the groundwater flow, and areas B and D were vertical to the groundwater flow. All points were measured vertically at the depth of 0–10, 10–20, and 20–30 cm depth.

RESULTS AND DISCUSSION

The results of analysis of heavy metals concentrations of Cu, Pb, and Zn at area A at the depth of 0–10, 10–20, and 20–30 are presented in Fig. 2.

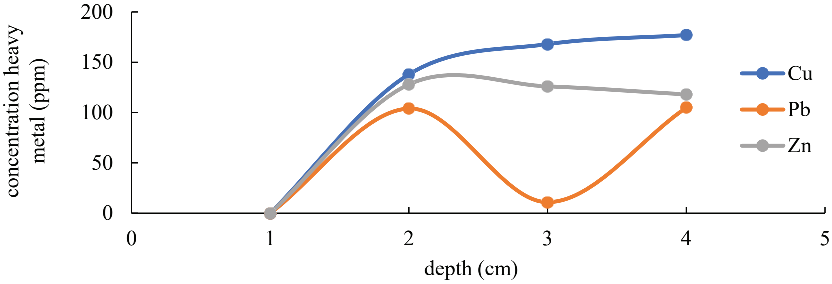


Fig. 2. Results of analysis of heavy metals concentrations of area A

Area A shows that the concentration of Cu at the depth of 0–10 cm is 138 ppm, then increases to 168 and 177 ppm at the depth of 10–20 and 20–30 cm, respectively. The concentration of Pb at 0–10 cm depth is around 104 ppm, then increases to 11 ppm at 10–20 cm depth, and to 105 ppm at 20–30 cm depth. Meanwhile, Zn concentration at 0–10 cm was 128 ppm which decreases to 126 and 118 ppm at the depth of 10–20 and 20–30 cm, respectively. The results of analysis of heavy metals concentrations of Cu, Pb, and Zn at area B at the depth of 0–10, 10–20, and 20–30 cm are presented in Fig. 3.

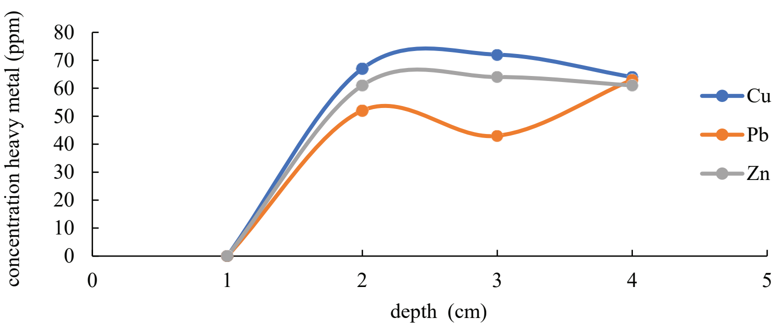
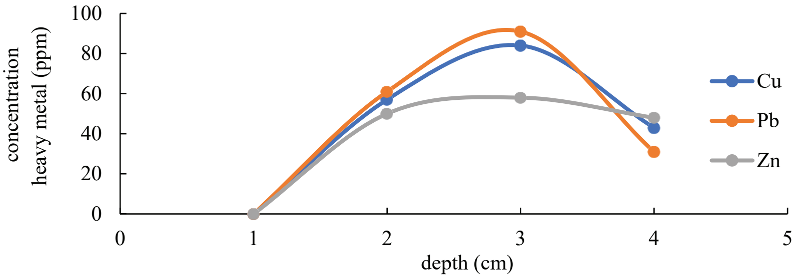


Fig. 3. Results of analysis of heavy metals concentrations of area B

Area B shows that the concentration of Cu at the depth of 0–10 cm is 67 ppm, then increases to 72 ppm (10–20 cm) and decreases to 64 ppm (20–30 cm). Pb concentration at 0–10 cm depth is around 52 ppm, then decreases to 43 ppm (10–20 cm) and increases to 63 ppm (20–30 cm). Meanwhile, Zn concentration at 0–10 cm was 61 ppm, then increases to 64 ppm (10–20 cm), and decreases back to 61 ppm (20–30 cm). The results of analysis of heavy metals concentrations of Cu, Pb, and Zn at area C at the depth of 0–10, 10–20, and 20–30 cm are presented in Fig. 4.



Fig, 4. Results of analysis of heavy metals concentrations of area C

Area C shows that the concentration of Cu at the depth of 0–10 cm is 65 ppm, then increases to 84 ppm (10–20 cm) and decreases to 43 ppm (20–30 cm). Pb concentration at 0–10 cm depth is around 61 ppm, then increases to 91 ppm (10–20 cm) and decreases to 31 ppm (20–30 cm). Meanwhile, Zn concentration at 0–10 cm was 50 ppm, then increases to 58 ppm (10–20 cm), and decreases to 4 ppm (20–30 cm). The results of analysis of heavy metals concentrations of Cu, Pb, and Zn at area D at the depth of 0–10, 10–20, and 20–30 cm are presented in Fig. 5.

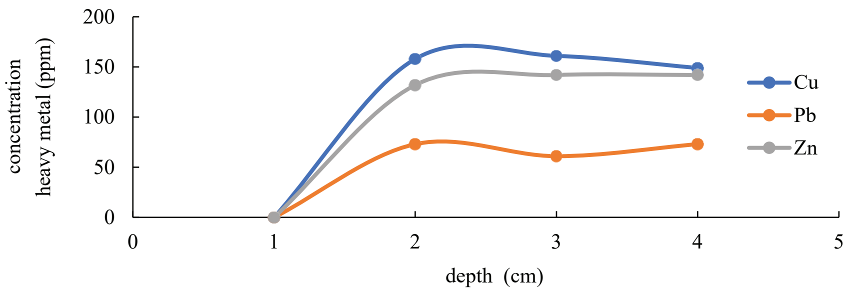


Fig. 5. Results of analysis of heavy metals concentrations of area D

Area D shows that the concentration of Cu at the depth of 0–10 cm is 158 ppm, then increases to 161 ppm (10–20 cm) and decreases to 149 ppm (20–30 cm). Pb concentration at 0–10 cm depth is around 73 ppm, then decreases to 61 ppm (10–20 cm) and back up again to 73 ppm (20–30 cm). Meanwhile, Zn concentrations at 0–10, 10–20, and 20–30 cm are around 132, 142 and 142 ppm, respectively.

Heavy metals, such as Cu, Pb, and Zn in Antang Final Disposal Site, Makassar City, South Sulawesi have vertically distribution across the topsoil with a variety of concentrations at each depth which has exceeded the limit of contaminant in soil environment, which is acidic. The recommended limit of heavy metal concentrations by the Government of the Republic of Indonesia and Food and Drug Authority is 100 ppm of Cu, 100 ppm of Pb, and 70 ppm of Zn.

Heavy metal Cu is strongly associated with organic matters, iron and manganese oxidation, silica clay and a slight amount of mineral. Cu is particularly absorbed and is slightly mobile in the soils. Organic matter is the dominant factor that controls the retention of Cu. Most Cu is soluble in the soil surface in a complex form of Cu^{2+}. It means that, if Pb heavy metal in the soils functions as Pb^{2+} oxidiser. If pH increases, the Pb^{2+} ion becomes less soluble oxidiser. A higher pH will form a complex form which allows the organic matters settle as carbonate, hydroxide, and phosphate. Lead is one of heavy metals that poses significant harms to living organisms because it is carcinogenic. The recent study found varying levels of Zn and the average pH was indicative of acidity. The oxidation of Zn in the soils shows Zn^{2+} under oxidised acid conditions. Zn^{2+} is one of the heavy metals that is the most soluble and mobile in the soil, hydrocarbon oxide, and organic matters. Zn solubility in the soils is highly potential at acidic pH (Ref. 19).

The concentrations of heavy metals in this study which also have surpassed the limit are tolerance. High levels of Cu in Final Disposal Site reflect the high quantity of waste dumped to the FDS (Ref. 20). The enrichment of heavy metal in the Antang landfill has been highly accumulated because of the anthropogenic activities or human activities, leachate, and soil characteristics and supported by a very acidic pH, the mobility of acid in heavy metals in the soils is relatively high[21]. Heavy metals will be carried by leachate and deposited in the soils, and as a result, heavy metals like Cu, Pb, and Zn will remain deposited in the soils.

Relatively acid soils have an increasing solubility and mobility of nutrients, thus increasing the concentration of heavy metals in the soils[22]. If the soil solution is too acidic, plants can not utilise and other nutrients they need to grow. Meanwhile, acidic soils (low pH) are dominated by ion Al, Fe, and Mn which will bind the nutrients vital for the plants, especially P, K S, and Mg. As a result, plants can not absorb their food well despite the richness of nutrients in the soil. In addition, acidic soils contain high level of micro nutrients, which are very dangerous to people's health[23], particularly those living around the landfill because it causes cancer and lung damage in addition to IQ drop among children, and potential death to human in general.

CONCLUSIONS

The increased manufacturing and widespread availability of different consumer items have an impact on the continuous rise in garbage output. Municipal waste management and the effects of heavy metals on the environment and community health in Indonesia and developing countries can be significantly improved by even just coordinated work and integrated activities of experts, researchers, government and municipal officials, as well as citizens and other stakeholders. The expansion of the municipal trash collection system, the construction of regional centres for recycling and reuse activities, and finding practical and affordable alternatives to locate consolidated sanitary landfills for the disposal of municipal solid waste are the main strategic priorities. In addition to keeping people and the environment safe, this can offer financial payback and the chance to partially recoup maintenance costs for waste management systems. As it gathers useful informational bases required for the development of environmental protection strategies, city development strategies, and information for spatial planning in the Indonesia region, this research can be applied by the city's official agencies for environmental management and protection as well as spatial planning.

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