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Distribution of Cu Metal on the Soil around the Landfills of Antang, Makassar City

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Abstract. The waste processing technique in the landfill of Antang, Makassar City, South Sulawesi, Indonesia, uses the Open Dumping system that potentially pollute the surrounding soil. The contamination of heavy metals in the soils is the center of attention from an ecological point of view. Research has been done on the distribution of heavy metal Cu on the soil around Antang landfill. This study aims to analyze the heavy metals potential distribution to the soil around Antang TPA. The sample point was divided into 4 Lines, 2 Lines are in the direction of the groundwater flow (Line A and Line C) while the other 2 Lines are perpendicular to the groundwater flow (Line B and Line D). At the point of 0 m with a depth of 0 to 10 cm, 10 to 20 cm and 20 to 30 cm. The total soil samples whose heavy metal elements analyzed by using ICP-OES method are twelve samples. The heavy metal Cu on Antang Landfill soil has spread over the soil surface (Top Soil) vertically. The results show that the soil around Antang Landfill is contaminated with the heavy metal elements that exceed the value of Indonesian Intervention as a soil contaminant. The Cu metal concentrations for Line D at the depth of 0 to 10 cm and 10 to 20 cm are 105 ppm and 103 ppm which were already above the average. Meanwhile, for Line A, Line B and Line C are still below the average allowed by the Government of the Republic of Indonesia and the General Control of Drugs and Food as a soil contaminant. The pH soil varies from 4.82 to 6 (acidic). Therefore, it requires proper remediation or preventive measures to prevent the risks on the humans and the environment.

Keywords-Landfill, Soil, Top Soil, Metal Cu, Makassar.

1. Introduction

Landfill or TPA for the citizens of Makassar is an essential need to create comfortable environment in a big city. If the waste of Makassar city is not transferred to the landfill in one day, then the city will be full of waste so it disturbs the public convenience. Uncontrolled landfill is very harmful to health and can damage the environment [11], [23]. Tamangapa Antang landfill's operation performs Open Dumping in which the waste is dumped and left open daily with the soil [3]. Since its opening, Tamangapa landfill of Antang is estimated to have 1,240,000 tons of disposed organic waste [16]. If the landfill does not have proper management, it will produce solid waste which contains many toxic compounds such as heavy metals [8].

The increase of human activity both industrial and household causes the increase of waste volume produced from time to time. Most of the waste is disposed directly to the environment without going through any process. The consequence is the occurrence of pollution that causes a lot of harm to humans and the environment. One of the pollution that can occur is soil pollution in which the chemicals enter and change the natural soil environment. Soil is one of the important supporting factors in beings' life on this earth. As the basis of the existence of beings including humans, soil has

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an important role for the material or ecological cycle. Therefore, maintaining the soil sustainability in order to be able performing its functions properly and continuously is an important obligation for every living creature. However, it is the same as water and air pollution that soil pollution is also caused by natural factors and human activities which is very difficult to avoid. One of the pollutants that become an indicator to detect the occurrence of soil contamination is heavy metal contamination therein. Factors which cause heavy metals to be included in the pollutant group are due to the non-degradable and easily absorbed characteristics of the heavy metals. One of the heavy metals that could potentially be toxic if contained in soil with excess concentration is Copper (Cu).

Copper is an IB type transition metal which has an atomic number of 29 and an atomic weight of 63.55 g/mol. Copper in the form of metal has a reddish color, but more often found in the form of binding with other ions such as sulfate so that it has a different color than pure copper metal [1]. The widespread use of Cu will increase the Cu levels in the environment. The production processes such as coloring, plating, and rinsing using Cu metal will produce waste containing high level of Cu. High level of Cu can have a negative impact on biotic and abiotic environments. This is because Cu is included in heavy metal group. Heavy metal is a stable and uneasily damaged element, so that Cu which is absorbed by the soil tend to accumulate and its content will increase continuously. The excessive high level of Cu can give a negative impact on animals and humans because of its carcinogenic nature and accumulated in body. These environmental changes will have a real impact on plants because plants are the organisms that have the most rapid response to the environmental changes compared to humans and animals.

The location of Tamangapa Antang Landfill located in Bangkala Sub-District, Manggala District, Makassar City, South Sulawesi Province, has been used since 1995 until now with the area of 18.8 hectare. According to the planing, Tamangapa Landfill that was originally designed for the needs of 10 years, but in fact, until now the Landfill is still in use, it means that the age of the Landfill is 21 years, and cannot accommodate the volume of waste that is in Makassar City is reaching 800 tons or about 4,000 cubic per day. Based on the records of the Department of Hygiene and Environment, Makassar with an approximate total population of 1.3 million people, is producing about 3,800 m³ or equal to 300 tons of public waste every day. Whereas the maximum capacity of Tamangapa Landfill is only about 2,800 m³ for accommodate public waste every day. Additional landfill is needed for the disposal of 1000 m³ of the over waste. About 87% of waste in Makassar City is organic waste and about 13% is inorganic waste, such as plastic and paper.

Considering this fact, it can be assumed that there has been pollution in Antang landfill of Makassar, such as environmental pollution, soil pollution, and groundwater pollution which can cause the effects to the environmental sanitation and air pollution. The movement of pollutants has spread to the northwest of the Southeast Sea, where the pollution is around 300-450 m away from Antang landfill [9]. The groundwater in Antang landfill has the same flow with the slope of rock layer in West Southeast-Sea [4]. This greatly impacts on shallow groundwater quality. Pollution of the shallow groundwater caused by liquid waste leak (*Leachate*) from the landfill also can contaminate the wells nearby the residents. This pollution has been felt by the residents around the landfill, especially by those who use free ground water as a source of drinking water [4].

This research is motivated by the amount of pressure received by the soil due to piles of waste from domestic activities. Such pressure produces soil contamination. When a harmful or toxic substance pollutes the soil surface, it can evaporate, swept away by the rainwater and/or absorbed by the soil which then settled as a toxic chemical in the soil. Toxic substances in the soil can have a direct impact on humans when it is touched or can contaminate the groundwater and air above it. This study aims to analyze the potential and the chances of the distribution of the heavy metals Cu in the soil around Antang landfill. The study focuses on how the impact of heavy metals could spread in the surrounding soil of Tamangapa Antang Landfill of Makassar City towards the life of the people around the landfill at 0 m with a depth of 0 to 10 cm, 10 to 20 cm [21] and 20 to 30 cm.

2. Methodology

2.1. Research Location

The location of this study is administratively included in the Bangkala Sub-District, Manggala District, and Makassar City, South Sulawesi Province, Indonesia. Geographically, Tamangapa Antang Landfill is situated 119°29'10" to 119°29'40" East Longitude and 5°10'20" to 5°10'40" South Latitude. The location of the study area is shown in Figure 1.

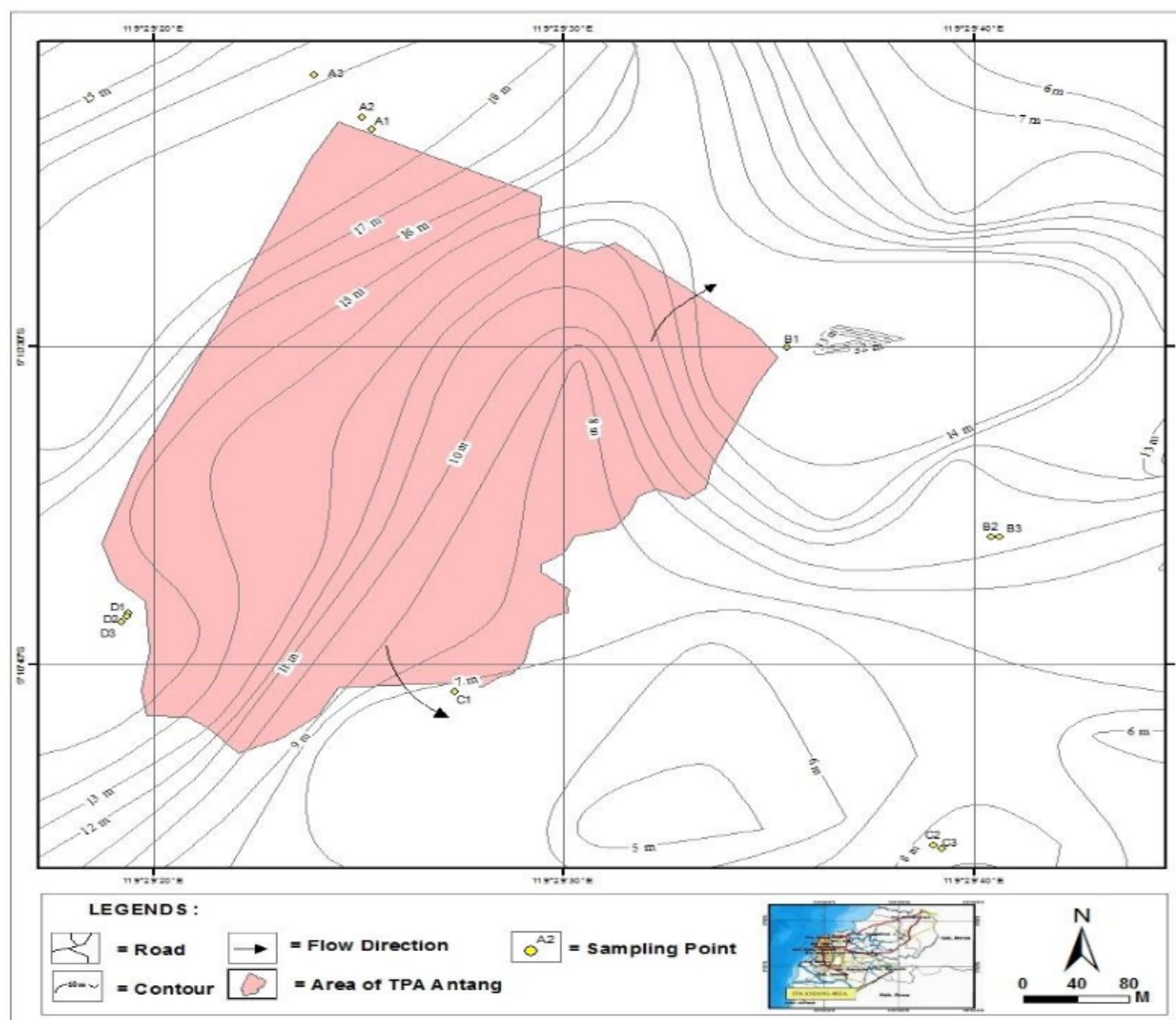


Figure 1. Map and location of sampling point Line A, line B, Line C and Line D at point 0 m at the depth of 0 to10 cm, 10 to 20 cm and 20 to 30 cm on land TPA Tamangapa Antang Makassar, South Sulawesi Province, Indonesia.

2.2. Sampling point

The sample used in this research is top soil collected from Tamangapa Antang Landfill area of Makassar City. The determination of soil sampling point is by dividing it into 4 Lines, 2 Lines in the direction of groundwater flow which are Line A and Line C and 2 lines are perpendicular to the groundwater flow which are Line B and Line D. At the point of 0m with the depth of 0 to 10 cm, 10 to 20 cm, and 20 to 30 cm. Thus, the total soil samples whose heavy metal elements analyzed using ICP-OES method is as many as twelve samples.

A total of 0.5 kg of each soil sample was collected using a stainless steel shovel. Samples were stored in containers and labeled according the location, date of collection and depth of soil. Then, it is transferred to a laboratory, stored at room temperature for physic-chemical determination. When it was collected, the soil sampling is recorded based on its type, color, condition, temperature and pH.

2.3. Soil Samples Testing

The soil before being tested was saved in the oven for 48 hours at 106°C [18], [15], [2], first to ease the filtering process so that the grains are not attached to each other. It was then crushed with a wooden or ceramic hammer [18], sieved using stainless steel of 2 mm sieves [12], [2]. Further, it was stored in Desiccator before being analyzed [2]. The soil sample that had been repaired was then brought to the laboratory for analysis.

3. Result and Discussion

3.1. Result

The measurement of total Cu concentration using ICP-OES method for Line A, Line B, Line C and Line D at the point of 0 m at the depth of 0 to 10 cm, 10 to 20 cm and 20 to 30 cm, can be seen in Figure 2.

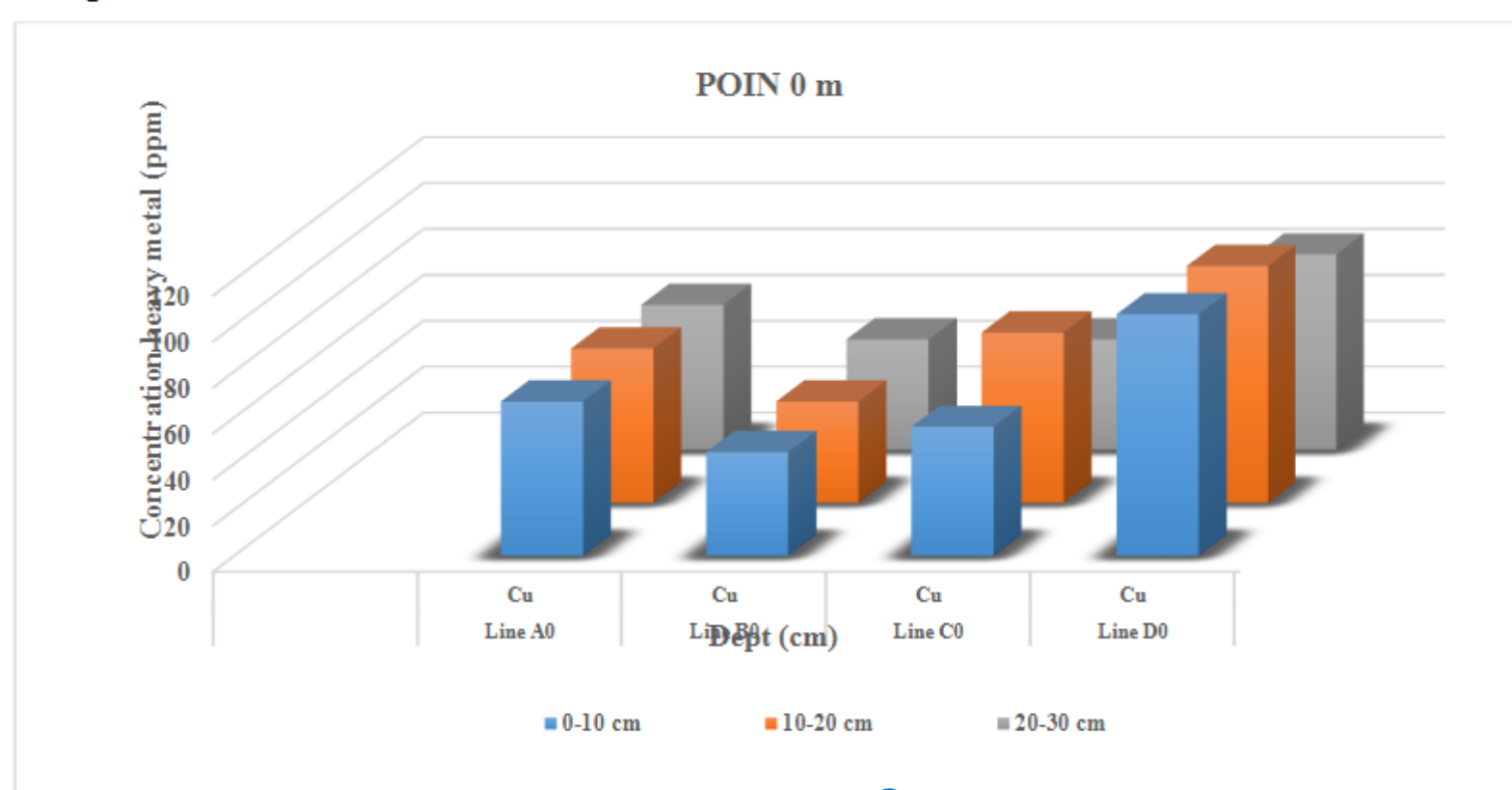


Figure 2. Analysis Result Graph of Cu heavy metal for Line A, Line B, Line C and Line D, at the point of 0 m with the depth of 0 to 10 cm, 10 to 20 cm and 20 to 30 cm.

Line A shows that the highest concentration of Cu metals at 0 to 10 cm and 20 to 30 cm depth ranged from 67 ppm. Meanwhile at the depth of 20 to 30 cm, the concentration begins to decrease to 63 ppm. Line B shows the result that the highest concentration of Cu metal is at the depth of 20 to 30 cm which is about 48 ppm. Meanwhile at the depth of 0 to 10 cm and 10 to 20 cm, the concentration begins to decrease to 45 ppm and 44 ppm. Line C shows the results that the highest concentration of Cu metal is at the depth of 10 to 20 cm in the range of 74 ppm. Meanwhile at the depth of 0 to 10 cm and 20 to 30 cm, the concentration begins to decrease to 56 ppm and 48 ppm. Line D shows that the highest concentration of Cu metal is at the depth of 0 to 10 cm and 10 to 20 cm in the range of 105 ppm and 102 ppm. Meanwhile at the depth of 20 to 30 cm, the concentration begins to decrease drastically to around 85 ppm.

3.2. Discussion

The four location of Tamangapa Antang landfill sites which are Line A, Line B, Line C and Line D contains copper (Cu) metal elements. The results show that the concentration of Cu (copper) metal at the site of Antang Tamangapa landfill of Kelurahan Bangkala, Kecamatan Manggala, Makassar Municipality of South Sulawesi Province, has spread vertically with highly varying number of points and depths, above ground level (Top Soil) with the enrichment rate which already exceeds the threshold expected by the soil environment. Therefore, it can cause concern especially for the people living around Antang landfill of Makassar, South Sulawesi where the landfill is located in the middle of the residence (Figure 2). Cu metal mobility in soil and plants tends to be slow with its normal levels. The normal level of Cu in plants ranges from 5-20 ppm. Meanwhile, according to [1], the critical limits of Cu in the soil ranges from 2- 100 ppm. Cu metal is potentially toxic to plants and harmful to humans because it is carcinogenic [14]. The content of Cu metal in plant tissue grows normally around 5-20 mg/kg, while in critical condition in media is 60-120 mg/kg and in plant tissue is 5-60 mg/kg. In its critical conditions, the plant growth begins to be inhibited as a result of Cu poisoning [1], and according to [10], a concentration greater than 10 ppm can be toxic to plants. Therefore, knowledge about the nature and characteristics and toxicity potential of Cu metal to plants is needed.

Cu metal can accumulate in the medium and rapidly absorbed by plants, although it can be toxic at very low concentrations. Its high concentrations in the medium can enter the food chain and adversely affect organisms, meanwhile on the ground, copper will be bound to organic and mineral materials. Figure 2 shows that the concentration of Cu metal above the surface of the soil (decomposed waste) shows that it still accumulates high Cu heavy metal content and if there is a high and continuous rainfall, it can result in seepage to the bottom. The location of Tamangapa Antang landfill of Makassar has many wells and residents. The presence of Tamangapa Antang landfill of Makassar, in addition to water seepage that empties into the river will affect the quality of the environment. Antang landfill includes Utisol soil (reddish soil contains clay layer). The color of the soil is due to the metal content, especially the oxidized Iron and Aluminum (Weathered Soil). The average of soil pH at Antang landfill of Makassar analyzed ranges from 4.82-6, with average value of 4.84 and average temperature ranges between 25°C-31°C. Therefore, it is categorized as acid, poor nutrient of N, P, K and poor organic matter. pH plays an important role in the bioavailability of metals and toxicity of soil to adjacent areas [5].

The presence of metal in the soil is very complex with organic material, so it can affect its mobility in soil, metal soluble in acidic pH. If the soil solution is too acidic then the plant cannot take absorbed N, P, K and other nutrients they need. In acid soil (low pH), the soil is dominated by Al, Fe and Mn ions. These ions will bind the nutrients needed by plants especially P, K, S, Mg, thus the plants cannot absorb food well although the nutrient content in the soil is a lot. In the soil, the acids' micro content such as Zn, Cu, and Co is also high so it poisons the plants. Cu metal is very harmful to the health of the residence, because it can cause cancer and lung damage and the children can have low IQ or the level of intelligence. Such disease is a threat to humans that can cause death [19], [22], [7], [20], [14].

4. Conclusion

Cu metal concentrations for Line D at the depth of 0 to 10 cm and 10 to 20 cm are 105 ppm and 103 ppm which are above the average threshold. Meanwhile, the Cu metal concentrations for Line A, Line B and Line are still below the average threshold allowed by the Government of Indonesia and General of Drug and Food Control as a pollutant in the soil. The content of Cu metal in Tamangapa Antang landfill of Makassar is influenced by the content of organic matter, temperature, texture and pH. Cu metal accumulated is still high and if there is a continuous high rainfall, it can result in permeate to the bottom of the landfill area.

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