Lead Concentration in Soils of Roadside Farmland in Lubuk Pakam, Deli Serdang

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Abstract

Infrastructure development is one of the development priorities for the current government. This economic improvement certainly requires a variety of supporting infrastructure. One of them is road infrastructure. Adequate road infrastructure will certainly increase traffic activity. Traffic activity is one of the sources of heavy metal pollution in soil. The contents of motor vehicle emission gases is lead. Lead (Pb) is one of the metal elements that can cause poisoning in humans. This research is important to determine the concentration of soil which is an area of agricultural land that is overgrown with rice. This research was conducted to investigate lead concentration in roadside farmland soils according to roadside distance in the street of Lubuk Pakam – Medan km 32. A total of 13 topsoils samples were collected with a distance of 0 m, 5 m, 20 m, 40 m, 50 m, 60 m, 80 m, 100 m, 120 m, 150 m, 200 m, 250 m, and 300 m from the roadside. The study found that the concentration of lead in the soil was in the range of 2.33-11.40 mg/kg. There is no correlation of lead concentration in soil with distance from highway with r =0.093 and p=0,762. There is no pattern of constant decrease in the distribution of lead content based on the distance to the roadside. Suggestions for further research to examine other factors that cause lead pollution in the soil, and also the lead content in paddy plants around the roadside Lubuk Pakam-Medan Km 32.

Keyword:* *Lead concentration, Traffic activity, Pollution

INTRODUCTION

Infrastructure development is one of the development priorities for the current government. This economic improvement certainly requires a variety of supporting infrastructure. According to Naziarto in Budi (2022), road infrastructure has a role as the lifeblood of the economy that affects human movement or mobilization and affects the distribution and logistics process. It is noted that the process of road infrastructure development or toll road construction in Indonesia has reached 2,042 km (Kominfo, 2022). Adequate road infrastructure will certainly increase traffic activity. This makes the relationship between health and economic development inversely proportional. High economic development is the cause of the decline in health status in Indonesia. According to research by Siregar et al., (2022) one of the causes of environmental pollution in Kotanopan is vehicle fumes from traffic activities.

Traffic activity is one of the sources of heavy metal pollution in soil. According to Abidin et al., (2019), exhaust gases from motorized vehicles can directly enter the road environment. Thus, people who live or have activities around roads with heavy traffic have a high probability of being exposed to pollutants. Although motor vehicle exhaust gases are not harmful, they contain other compounds that in large quantities can endanger health and the environment (Sudarwanto et al., 2020). One of the contents of motor vehicle emission gases is lead. Lead (Pb) is one of the metal elements that can cause poisoning in humans (Sembel, 2015). Pollution of heavy metal waste such as lead to the soil if it exceeds the ability of the soil can cause soil pollution. Lead contamination in the soil is absorbed by roots, straw, and rice (Hidayah et al., 2018).

Deli Serdang Regency is one of the rice-contributing districts for North Sumatra Province with a rice field area of 40,716 ha (Anonim, 2018). However, many rice fields are located very close to the highway. Such paddy fields are at high risk of exposure to metal Pb from heavy traffic activities traversed by vehicle activities, both large and small vehicles. According to data, the number of motorized vehicles in Lubuk Pakam Subdistrict shows an increase every year, including freight cars, passenger cars, and motorcycles (BPS, 2020).

According to research conducted by Hamid et al., (2020) showed that Pb and Cd metal contents were found in guava plantation soil in Perawang Barat Village, Siak Regency, which is located on the edge of the highway. Another study also stated that in cabbage plants in Tomohon, which is 6 meters from the highway, lead concentrations were also found even though they were still below the metal contamination standard (Rurut et al., 2019), In addition, according to Fitrianah et al., (2019) stated that the high traffic activity in Waru and Wonoayu Sub-districts of Sidoarjo Regency caused the average lead (Pb) concentration to be high in the area.

This research is important to determine the concentration of soil which is an area of agricultural land that is overgrown with rice. One of these studies were conducted in China, which are the highest rice-producing countries in the world. However, from these studies, traffic activity factors are not necessarily the cause of high Pb concentrations in agriculture soil because it may be attributed to the difference in metal uptake mechanisms among the plant species and metal bioabailability in soils (Huang et al., 2018). Therefore, this study investigates whether or not the soil in paddy fields, as measured by their distance from the roadside, has a corresponding trend. The study aimed to determine the concentration of lead in soil that is roadside agricultural land based on the distance from the highway on the Lubuk Pakam - Medan km 32 road.

METHODS

This study used a quantitative method with a cross-sectional study design to analyze whether the independent variable (distance) had a statistically significant effect on the concentration of lead metal in the roadside farmland soil. Sample of soil indicates how much there is lead concentration according to the distance. Distance is defined as the roadside distance perpendicular to the road edge. This study has 13 soil samples. A total of 13 topsoils samples were collected with a distance of 0 m, 5 m, 20 m, 40 m, 50 m, 60 m, 80 m, 100 m, 120 m, 150 m, 200 m, 250 m, and 300 m from the roadside. The variables in this study include the independent variable (distance) and the dependent variable (concentration of lead metal in soil). Soil samples were analyzed in the laboratory by the Atomic Absorption Spectroscopy (AAS) method. Atomic Absorption Spectrometry is an elemental analysis technique that provides quantitative information. Furthermore, laboratory results will be analyzed using the Spearman correlation statistical test with decision making if the p-value <0.05 indicates a correlation between distance and concentration of lead metal in the roadside farmland Lubuk Pakam.

Figure 1. Sampling site

RESULTS

Table 1. Descriptive Statistical Result of Lead Concentration in Soil Corresponding Distance

Distance (m)	Lead concentration in soil (mg/kg)
0	2,73
5	10,22
20	6,31
40	11,40
50	2,23
60	3,40
80	3,81
100	3,65
120	4,22
150	4,50
200	7,60
250	4,36
300	4,61

The statistical description of lead metal concentrations in soil corresponding distance is summarized in Table 1. It can be seen that the point with the highest lead content contained in the soil is at a distance of 40 m with a lead content of 11.40 mg/kg. The lowest lead content contained in the soil is at a distance of 50 m with a lead content of 2.23 mg/kg. The results of the analysis showed that there is no constant pattern of decrease in lead metal content when viewed from the distance of farmland to the highway. In addition, distance also does not show a consistent influence on lead concentration in soil.

Bivariat Analysis

The correlation of soil lead content based on distance is shown in Table 2. Below :

Table 2. Correlation Analysis of Lead Concentrations in Soil Corresponding Distance

	Correlation Coef. (n=13)	***P***
Distance	0.093	0.762

Table 2. summarizes the correlation analysis of lead concentrations in soil corresponding distance. The correlation pattern indicates that the heavy-metal concentrations of lead in roadside soil are not associated with traffic contamination in the Lubuk Pakam - Medan Km 32 highway (p-value 0,762).

DISCUSSION

The results of the analysis show that there is no constant pattern of decrease in lead metal content when viewed from the distance of farmland to the highway. Based on the correlation statistical test, result obtained where the p-value was 0,762 (>0.05), meaning that there is no correlation between the distance of roadside farmland and lead content in the Lubuk Pakam - Medan Km 32 highway. Lead content in soil that does not affect the distance from the roadside can be influenced by various factors. Soil collection during rainfall will bring lead into the soil carried by water (Laksana et al., 2019).

This study's phenomenon was probably caused by a number of factors. First off, regular farming practices like fertilization, plowing, and irrigation may mix the topsoil of farmland spatially and alter the pattern of heavy metal distance distribution along highways. Second, the crops in the farmland next to the road may have different capacities for assimilating heavy metal soil pollutants. Thirdly, the intricate local topography and ecosystems, including rain runoff and drainage, wind direction and speed, and other non-crop plants, may alter the distribution patterns of heavy metal contamination in terms of roadside distance. Therefore, the lead content of the soil is not affected by the distance from the roadside because lead absorption may be attributed to the difference in metal uptake mechanisms among the plant species and metal bioavailability in soils (Huang et al., 2018).

This farmland is planted with a variety of crops, such as rice, corn, and beans which are planted alternately. The planting process which consists of several layers makes agricultural land mixed, thus changing the pattern of distribution of heavy metals with distance. The farmland located on the edge of the Lubuk Pakam - Medan Km 32 highway is known to have an alternating planting system between one type of plant and another, such as rice, corn, and beans. When the farmland is not planted with rice, it is transformed into a corn plantation. The planting process that consists of various types of crops makes the agricultural land become mixed, so that it can change the distribution pattern of heavy metal lead with distance.

The correlation pattern indicates that the heavy-metal concentrations of lead in roadside soil are not associated with traffic contamination. The results of this study are not in accordance with research conducted by Ulini (2021) which states that the highest lead content in water spinach is 0.747 mg/kg. The study also explained that the distance of water spinach plants from the highway affects the lead levels in water spinach. Another study conducted by Diana (2019) found that lead levels in vegetables sold around the highway had a lead content of 0.34 mg/kg. The study also stated that the closer the location of vegetables sold to the highway, the greater the possibility of lead exposure.

Several factors cause differences in soil lead content that make the results of this study different from previous studies. The difference in the results of this study with previous studies can be caused by differences in the mechanism of absorption of lead levels in soil and influenced by the bioavailability of metals in the soil (Huang et al., 2018). Other studies have also suggested that Besides soil, there are factors that affect the lead content in the soil, namely soil coverage, relative altitude, and soil properties (Dong et al., 2021).

The nature of heavy metals that can not be eliminated and difficult to decompose into other substances and can accumulate in the soil for a relatively long period can make the lead content in the soil exceed the existing quality standard. This is consistent with the results of an examination of lead content in the soil which was in the range of 2.33-11.40 mg/kg. Soil samples taken in this study are topsoil. The surface layer of the soil is the recipient of various kinds of pollutants, especially heavy metals. Lead is a soil pollutant and tends to be in the soil for a long time (Sukarjo et al., 2019). Lead contamination in the soil is absorbed by roots, straw, and rice (Hidayah et al., 2018). Soil transfer to plants is a key process for human exposure to toxic heavy metals in the food chain (Rudzi et al., 2018). Intake of heavy metals through rice is an important chain of exposure to heavy metals (Sukarjo et al., 2019).

High lead accumulation in plants that have been contaminated by lead will have a harmful impact on human health if consumed by humans through the food chain. Lead when it enters the human body will accumulate in the body and can cause damage to organ systems in the body (Adhani et al., 2017). In children, lead will cause neurobehavioural disorders (Salsabilla et al., 2020). Another impact of lead exposure on children is that it affects children's intelligence and can reduce IQ by 7.4 times (Arianty et al., 2020). Lead exposure can also have an impact on reducing hemoglobin levels in the blood due to inhibition of biosynthesis through the enzymes coproporphyrinogen, delta-ALAD (Aminolevunilic acid dehydratse), and also inhibition of ferrocelatase (Mulyadi et al., 2015; Sinatra et al., 2020).

High levels of lead also has a damaging effect on the environment. Lead can effectively inhibit plant growth and development. Based on research shows that lead (Pb) in *Muntingia calabura* leaves can affect leaf morphology due to necrosis and shrinkage in leaf area (Rifai & Puspitawati, 2022). In addition, lead also significantly affects the width of stomatal openings of tamarind plants (Siregar et al., 2020). Lead must be properly controlled so that it does not interfere with human health and damage the environment.

CONCLUSIONS

There is no pattern of constant decrease in the distribution of lead content based on the distance to the roadside which was in the range of 2.33-11.40 mg/kg. Based on the correlation statistical test, there is no correlation between the distance of roadside farmland and lead content in the Lubuk Pakam - Medan Km 32. It was presumably due to several reasons. The land farm that is lead-contaminated if used to grow crops that will be consumed is at risk of lead-contaminated. Hence, suggestions for further research to examine other factors that cause lead pollution in the soil, and also the lead content in paddy plants around the roadside Lubuk Pakam-Medan Km 32.

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