Heavy Metal Pollution in River Sediments on Tin Mining Location at Pakil River, Bangka, Indonesia

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ABSTRACT

Tin mining will produce tailings waste which has the potential to be a source of pollution environment, especially in watersheds. This research was conducted in Paya Benua Village, Mendo Barat District, Bangka Regency, Bangka Belitung Islands Province. This study aims to determine the level of spread of heavy metals Cu, Cd, Pb, and Zn in river sediments in the waters of the Pakil River, Paya Benua Village using the geoaccumulation index (I-geo) and analyze the factors that cause the spread of heavy metals in river sediments at the research site. Samples of river sediment were taken at as many as 16 points along with the river flow from upstream to downstream. Laboratory analysis was performed using the ICP-AES (Inductively Coupled Plasma-Atomic Emission Spectroscopy) method. The results of the laboratory analysis of heavy metals Cu, Cd, Pb, and Zn showed that most of the heavy metals were found varies with the difference in the upstream to downstream region, where there is a higher value of heavy metal content in the tin mining area and the lowest is in a location far from mining. This shows that The varying values are due to natural sediment enrichment factors through geological weathering and other factors anthropogenic or caused by human activities such as mining. Based on the index geoaccumulation (I-geo) the location of the research area is in the category of unpolluted to moderately polluted.

Keywords: *Tin, ICP-AES, Heavy metal, River sediments, I-geo*

1. INTRODUCTIONS

Tin is one of the mineral deposits found underground. The demand for the supply of tin ore is currently getting higher. So, a large-scale exploration is conducted in areas that are suspected of containing tin ore, for example, Bangka Island [1].

Pakil River located in Paya Benua Village, Mendo Barat District, Bangka. The Pakil River is widely used by the surrounding community to catch fish. Also, there are various kinds of human activities in that river, including tin mining activities. Tin mining will produce tailings waste which could be a source of environmental pollution. A study in the Pakil River showed that tin mining activities resulted in high sedimentation in the river waters [2].

Pollution caused by tin miners is heavy metal pollution. Heavy metal pollution occurs due to natural factors (geogenic) and human activities, including mining (anthropogenic), geogenic controlling factors (such as lithology, geological structure, geomorphology), and anthropogenic controlling factors (such as the distance of the sampling location from the mining site and processing) also influence heavy metal content on river sediments.

Mine waste is usually directly discharged into the river so that it might be deposited and pollute the river water. The heavy metals content of cadmium (Cd) and lead (Pb) is most found in river sediments in locations where many tin mining activities and near tin discharge pipe holes [4].

Based on the background, it needs a study to determine the level of spread of heavy metals Cd, Cu, Pb, and Zn using the geoaccumulation index (I-geo) and analyze the factors that cause the spread of heavy metals in river sediments in the study area. The results of the study may use as a reference for prevention and remediation.

2. METHOD

A sampling of river sediment was taken in the waters of the Pakil River, Paya Benua Village, with as many as 16 samples (figure 1), 15 sediment samples, and one control sample. Sediment sampling was carried out

A. D. Saputro et al. (Eds.): ICOSEAT 2022, ABSR 26, pp. 674–677, 2023.
https://doi.org/10.2991/978-94-6463-086-2_89

simply, namely by using a plastic container to avoid heavy metal contamination, a sample weighing ± 100 grams was taken using a plastic spoon, and then the water was removed and separated from gravel, animal pieces, plant. then put in a plastic clip to prevent contamination with substances. Samples that have been put in plastic are then given a specific code. The control sample was taken in an area with no mining so that this sample can be used as a reference for the natural state of the research area. Samples that were taken in the laboratory were analyzed using ICP-AES (Inductively Coupled Plasma-Atomic Emission Spectroscopy), and to determine the level of distribution of heavy metals Cu, Cd, Pb, and Zn in river sediments in the waters of the Pakil River, Paya Benua Village using a geoaccumulation index. (I-geo). A geoaccumulation index (I-geo) analysis was carried out by calculating the laboratory analysis results of river sediment samples. These calculations will classify pollution levels in river sediments in the study area [5]. The geoaccumulation index was used to assess the level of contamination. Geoaccumulation index can be calculated by the formula:

$$I_{geo}=\log_2\left(\frac{Cn}{1.5\ Bn}\right) \quad (1)$$

Information :

Igeo = Geoaccumulated Index

Cn = Concentration in sediment

Bn = Reference concentration

Reference concentration values (Bn) were obtained from control samples in unpolluted areas. In this study, samples were taken in areas with no tin mining activities.

2.1 Area of Study

The research location and river sediment sample points can be seen in (figure 1), the research location is a watershed area where tin mining is located.

2.2 Geology of Research Area

The regional stratigraphy of the Bangka Belitung Islands is generally divided into old and young granite. The younger granite is mostly lead-bearing granite and has typically been eroded further [6]. The research area is a type of secondary tin formed due to weathering, erosion, and transportation processes from the primary tin. Based on the regional geological map, the study area is composed of Alluvial. Alluvial in the form of lumps, krakal, gravel, clay and peat sand, swamp deposits consisting of silt and sand [7]. The texture of the sediment, mostly comainlyd in the waters of the Pakil River is more influenced by the sand fraction [4].

3. RESULTS AND DISCUSSION

Figure 2 shows the distribution pattern of Cu, Cd, Pb, and Zn elements in river sediments. In general, the distribution value of heavy metals varies widely because there is an increase and decrease, this is because the location of the Pakil River contains mining, former mining, and places far from the mining location. The distribution of heavy metals Cu and Pb is highest at the sampling location S4 where the location is located at the mining site. While the lowest value of Cu is at the sample point S11 where the location is far from mining activities and the lowest Pb element is at the sample point S13 where the location is also a location far from mining activities. The distribution pattern of Cd and Zn elements in the highest river sediment is found at the sampling point location S5 where the location is a tin mining location. While the lowest element of Cd is found at the sampling point S11 and the lowest Zn element is found at the sampling point S10 where the location is far from the mining site. The distribution of heavy metals Cu, Cd, Pb, and Zn as a whole for the highest value is at sampling points S4 to S5 located at tin mining locations and the lowest values are at locations far from mining. This is because heavy metal pollution is caused by sediment enrichment naturally through geological weathering and human activity (anthropogenic) factors such as tin mining. Unconventional floating tin (TI) mining in the study area produces tailings waste. Tin tailings are the residual portion of the target mineral produced after the separation and concentration of tin from the rock and ore mass. Fine-grained tailings produce dusty pollution in dry environments while sulfides produce acid runoff [8]. Heavy metals are not only naturally contained in soil and rock but also from anthropogenic sources, namely industry [9][10]. The residue from tin mining (tailings) contains heavy metals which cause higher heavy metal values at tin mining sites.

3.1 Geoaccumulation Index

Table 1. Geoaccumulation Index of heavy metals concentration in sediment [3]

I-geo	I-geo Class	Pollution Intensity
I-geo < 0	0	Unpolluted
0 < I-geo < 1	1	Unpolluted to Moderately
1 < I-geo < 2	2	Moderately polluted
2 < I-geo < 3	3	Moderately polluted to Highly polluted
3 < I-geo < 4	4	Highly polluted
4 < I-geo < 5	5	Highly polluted to very highly polluted
5 < I-geo	6	Very highly polluted

The complete results of the calculation of the geoaccumulation index (I-geo) of all samples are calculated by entering the value of each element obtained from laboratory tests into formula (1), then according to the results of existing calculations, a class classification of geoaccumulation index can be carried out to determine the quality of river sediment in the study area. Based on the value of the geoaccumulation index (I-geo) (figure 3) for the content of Cd, Cu, Pb, and Zn, it can be seen that

the level of heavy metal pollution at each sample location in the study area is categorized as unpolluted to moderately polluted based on the Igeo class table which is in class 1 (Table 1).

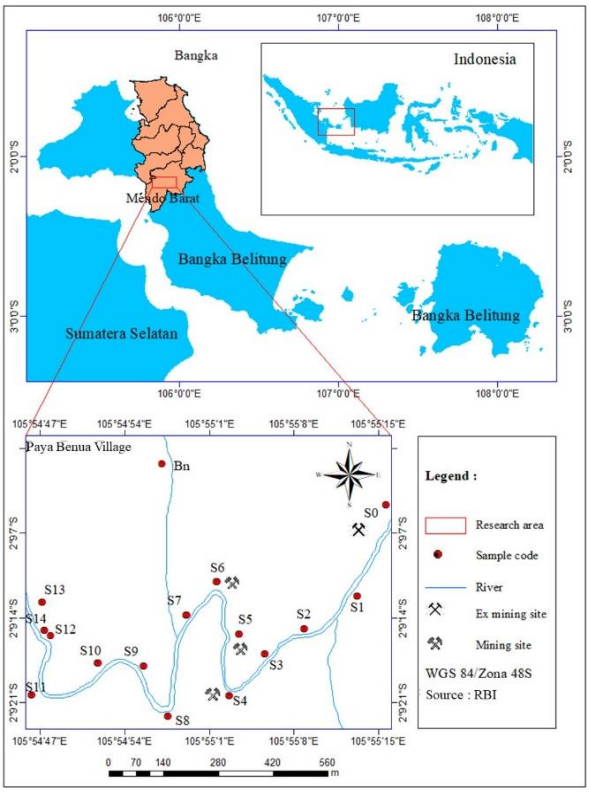

Figure 1. Research location

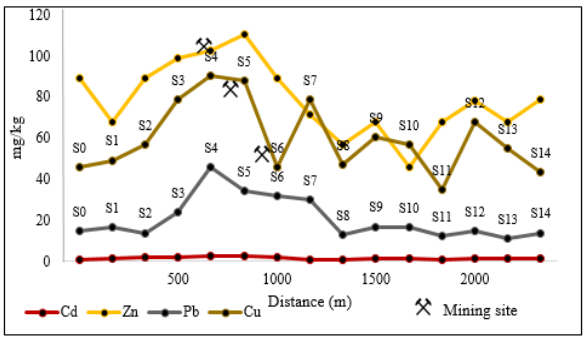

Figure 2. Graph of the distribution of Cu, Cd, Pb, and Zn content from upstream to downstream

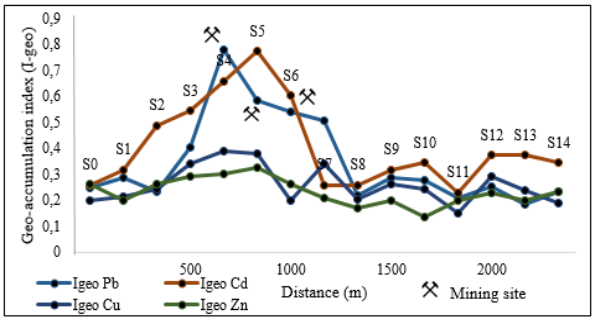

Figure 3. Geoaccumulation Index value from upstream to downstream

4. CONCLUSION

The highest content of Cd, Cu, Pb, and Zn is found at the sample points close to the tin mining location, and the lowest is at points far from the mining location. this shows that the distribution of the content of Cd, Cu, Pb, and Zn in river sediments at the study site is influenced by natural factors (geogenic) and human activities (anthropogenic). Natural factors such as sediment enrichment naturally through geological weathering and anthropogenic factors are the distance of the sampling location from locations close to mining. Based on the value of the geoaccumulation index, the level of heavy metals at the research site is in the category of uncontaminated to moderately polluted based on I-geo class.

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