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The Seawater Heavy Metal Content of the Mining Port Close to the Residential Area in the Morowali District

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Abstract. Mining port operations are complex and can cause various forms of pollution. Analysis of seawater pollution from mining ports is required and complicated because of the various types of pollution, sources, effects, and different characteristics. This study examines the content of heavy metals in seawater in residential areas very close to mining ports. The method used sampling in three different places, examining seawater's heavy metal properties. Secondary data of the quality of seawater was obtained from the results of data monitoring carried out by the company periodically since the port was built as a comparison material from the results of sample inspection. The results of this study indicate that the waters around the settlements contain heavy metals. The composition of Cd was 10%, Pb was125%, Cu was 625%, Ni was 760%, and Zn was 300% above the standard of seawater quality for the Port Area set by the Indonesian government, which did not match the yearly reports (secondary data). On the other hand, community activities also have a minor role as a source of pollution. Therefore, it is essential to do further research with a focus on finding sources of pollution.

1. Introduction

Large-scale commercial mineral mining has contributed significantly to driving economic growth and regional development [1]. On the other side, mining activities have various impacts on the environment. The practice of disposing of mining waste by dumping tailings directly into rivers, lakes, and the sea is detrimental to fishers [2].

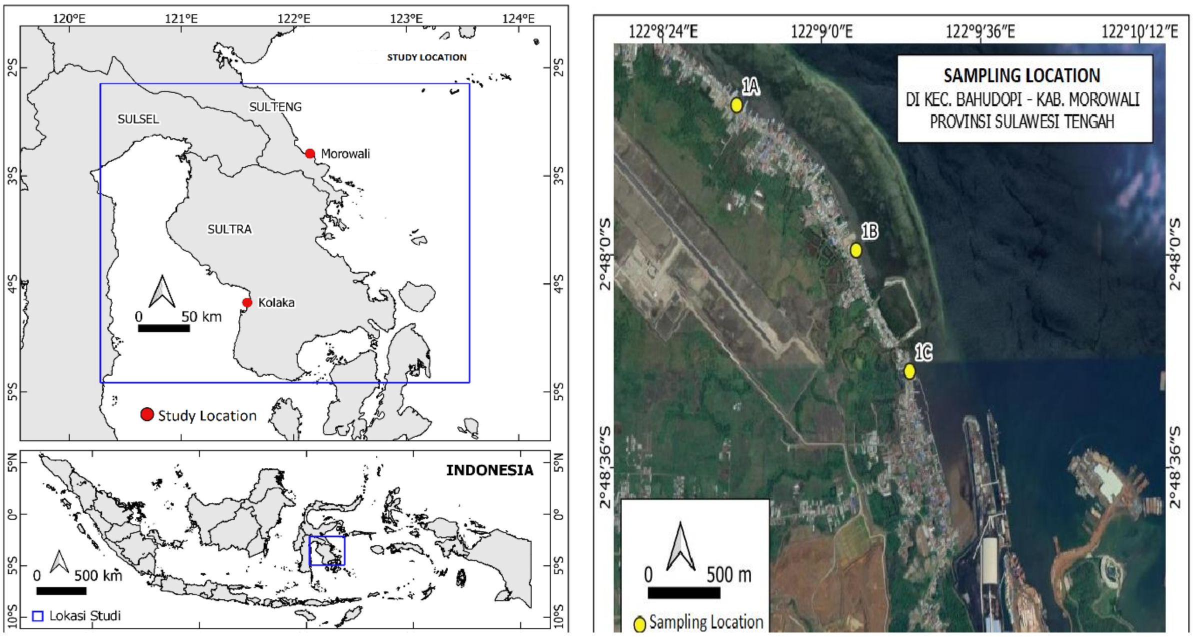
Several mining activities are located near the sea. Hence, they are connected to ports and piers. Environmental pollution from ports and docks cannot be avoided by carrying out activities at the port. Contamination in the port area may include activities from the crossing, ships, trade, industry, shipbuilding, and supporting services [3]. The high level of commercial traffic in seaports and pollution from ships directly affect coastal areas [4].

Environmental contamination analysis from ports and docks is challenging [5]. On the other hand, reports of environmental pollution and conditions can be misleading, either due to the influence of the government or mining companies. Therefore, the potential hazards of mining ports close to the residential area need to be studied. This study examines the heavy metal content of seawater in residential areas very close to the mining port in the Morowali district. It compares the results with routine environmental management reports by the company. Kinds of literature are lack in the case of heavy metal content examination in the mining port case.

2. Method

2.1. Sampling location, method, and analysis

Data collection was carried out in two ways, namely the collection of secondary data and primary data. For primary data, samples were taken at three different locations near community settlements around the mining port area (Morowali), as shown in Figure 1.



Source: Google Earth

Figure 1. Left: Morowali area. Right: Points of Sampling locations (in yellow)

The seawater sampling method was carried out using a plastic bottle with a sampling volume of 330 ml. The bottles were tightly closed. The method for heavy metal analysis followed the Guidelines for Determining the Status of Water Quality (Decree of the State Minister of the Environment, 2003). The seawater quality was analyzed using Atomic absorption spectroscopy (AAS) in UPTD *Laboratorium Lingkungan, Dinas Lingkungan Hidup (*Environmental Laboratory, Environmental Office) of Southeast Sulawesi Province.

2.2. Secondary data

The previous seawater composition data were taken from reports on environmental conditions monitoring issued by companies managing mining port activities from 2017 to 2019.

3. Results and Discussion

Secondary data is obtained from the environmental management and monitoring implementation report made by the company, the Government through the Morowali Regency Environment Agency to supervise the implementation of the environmental management and monitoring plan through the document (Table 1).

Table 1. The concentration of Heavy Metals in the Mining Port area Based on Reports and Analysis Results and Seawater Quality Standards for Port Areas.

Heavy Metals	Standard [mg/L]	Secondary data [mg/L]			Sampling Results [mg/L]
		2017*	2018*	2019*	
Mercury (Hg)	0.001	0.0003	0.0003	0.0003	0.001
Cromium heksavalen (Cr(VI))	0.005	0.0049	0.0341	0.0033	0.003
Arsenic (Ar)	0.012	0.0020	0.0020	0.0022	0.002
Cadmium (Cd)	0.001	0.1029	0.0005	0.0005	0.01
Copper (Cu)	0.008	0.0212	0.0058	0.001	0.05
Lead (Pb)	0.008	0.1499	0.0716	0.002	0.01
Zink (Zn)	0.050	0.0220	0.0020	0.002	1.5
Nickel (Ni)	0.050	0.0848	0.0330	0.033	0.38

Source: The secondary data is calculated from the Environmental Monitoring Result Report by the Company, which is submitted to the Morowali Regency Environmental Service. Environmental Management and Monitoring Report

Table 1 shows that the seawater was highly polluted by several heavy metal substances in 2017 (one year since the port was built). The highest heavy metal content is Lead (Pb) of 0.1499 mg/l and Cadmium (Cd) of 0.1029 mg/l. In 2018 some heavy metals were reduced (Mercury, Chromium hexavalent, and Cadmium) and followed the Indonesian government's seawater quality standards for the Port area. Nevertheless, some heavy metals are still above the set standards (Arsenic, Copper, Lead, Zinc, and Nickel). Meanwhile, in 2019 only Nickel content was still above the value set by the Indonesian government. We also tried to compare the results of the secondary data with the sample examination results that we did.

Measurement of seawater quality standard inspection shows a fairly high level of seawater pollution in the waters around community settlements close to mining ports. The concentration of dissolved zinc was 1.06 milligrams/liter (mg/l), copper was 0.05 mg/l, cadmium concentration was 0.01 mg/l and nickel was 0.38 mg/l. These values are typical of moderately polluted seas, and most surpass the quality standards set by the Indonesian Ministry of Environment in seawater quality standards in port areas (Table 2). In addition, some heavy metals have values 100 times above the standard values that have been set (lead, nickel, copper, and cadmium).

Measurements from seawater samples show that seawater quality in the residential area is quite damaging to the natural quality of most of the seawater. From the samples examined, Copper, Lead, Zinc, and Nickel concentrations were clearly above average. The seawater quality can be caused by activities in mining ports, mining activities, and waste from households. The concentration of these heavy metals in seawater is above the range of values according to the seawater quality standards for port areas set by the Indonesian government. Cadmium and Lead are two elements in seawater whose values exceed the limit. The significant difference between the seawater quality levels indicates that the seawater is quite polluted. The results of laboratory tests, the measurement of seawater heavy metal pollution is almost dependent on pollution caused by mining port activities and can threaten human health. Several epidemiological studies have reported an association between cadmium exposure and effects on the kidney. The Cadmium may stay for a long time, i.e., 6 to 38 years for the human kidney and 4 to 19 years for the human liver [6]. Cadmium causes many metabolic and histological changes, membrane damage, changes in gene expression [7], and apoptosis Neurodevelopment and cognitive development of children are affected by low levels of lead exposure [8].

Table 2. Environmental Research Issue, at Various Ports.

Port and Location	Environmental Issue	References
Pilbara, Perth, Australia	Compliance with ballast water management. according to IMO law	[9]
Onne, Nigeria	The effects of dumping pollutants into the marine environment damage ecosystems, ships, and human health.	[5]
Ribadeo, Spain	The expansion of ports located in estuaries can have a profound impact on estuary morphodynamics	[10]
Croatian Seaports	"Green Port", also known as ecological port, represents a model of sustainable port development,	[11]
Laem Chabang, Thailand	environmental performance indicators (EPI) are essential for evaluating environmental criteria	[12]
Port of Gävle, Sweden	A sustainable approach removes the contaminated material from the marine environment and renders it harmless through the s/s process.	[13]

Source: Various journals as listed in the table

According to [5], marine pollution comes from ships' discharge of oily water from the hull of ships, organisms from the ballast, accidental discharge of oil due to operational activities, and et cetera. Industry around the harbor or docks can also have a role in seawater pollution by dumping hazardous chemicals into the sea [5]. Have a detrimental impact on ecosystems, ships, and human health. Measures to trip supervisor and preventative have set action, including compliance and implementation of stated operating standards in ANNEX I-VI of the IMO conventions.

Persistent contamination of butyltin (BT) compounds in harbors, especially in sediments, due to past use or recent illegal applications. Observational analysis proves that BT contamination is associated with high sediment re-suspension processes occurring at the port due to high sea traffic and dredging operations [14]. The water quality measures include total suspended solids, turbidity, phosphate, total phosphorus, and chlorophyll-a transition. Dissolved oxygen, oxygen saturation, biological oxygen demand, and nitrate-nitrogen that exceed the threshold value indicate that seawater quality is inadequate for the ecosystem [15].

By comparing the findings of the two approaches, it can be concluded that the impact of mining port activities on seawater quality is relatively high. The results showed that samples for heavy metal pollution from seawater showed typical values of the quite polluted sea around community settlements closest to the mining port.

Dogaru [16] show that residents may prefer mining port activities over environmental protection under pressure from the economic situation. Those indicate that some level of pollution is acceptable to society for better income. This is an indication of contextual policymakers about the public's view about the effects of mining on the environment and the port of social and economic existence, which can support to take the following steps needed (communication, environmental protection, public participation). However, our research shows that environmental protection and supportive policies are needed to reduce environmental risks. Further studies on sources of pollution such as loading and unloading activities, stockpiling of mining materials, waste from ship cargo, ship engine oil waste, ballast water, and waste from community housing around the port. These attributes are not measured in this analysis but deserve to be investigated in future research.

4. Conclusion

This study indicates that the waters around the settlements contain heavy metals exceeding the seawater quality standard for the Port Area set by the Indonesian government. This study differs significantly from the data obtained from the report on the results of environmental quality monitoring by the company. Sources of pollution can come from mining port activities. The existence of community activities can also have a role as a source of pollution. Therefore, it is necessary to do further research focusing on finding the sources and burdens of each pollution.

The results of this study are helpful for local communities, government, and company, to determine appropriate steps to deal with seawater pollution due to mining port activities. This case study in Morowali District can also reference other analyses in other mining ports related to pollution and environmental risks and their socio-economic implications.

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