Surface Water Management for Large-Scale Quarry Mining Activities in Kuala Kurun, Gunung Mas Regency

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ABSTRACT

Mining is the extraction of valuable and economically valuable mineral deposits from the earth's crust, either mechanically or manually, on the surface, below the earth's surface, or below the water surface. Wastewater from large quarry mining activities generally contains suspended solids (*mud/sediment*), heavy metals, pH changes, and possibly certain chemicals used in the processing. Data analysis was conducted using the Pollution Index (PI) to develop a Surface Water Management. The results of the Pollution Index (PI) analysis showed that all monitoring points were polluted and did not meet water quality standards. The upstream point has an IP of 4.23 (slightly polluted), while the other three points-the reservoir (5.81), middle (6.66), and downstream (5.36)-are classified as moderately polluted. The increase in IP values from upstream to downstream indicates an increase in human activity along the river.

Keywords: Quarry mining wastewater, Surface water quality (rivers), Pollution Index (PI),

INTRODUCTION

Mining is the extraction of valuable and economically valuable mineral deposits from the earth's crust, either mechanically or manually, on the surface, below the earth's surface, or below the water surface. This activity is an important sector in economic development because it provides raw materials for various industries and human needs, such as energy, infrastructure, and construction. In Government Regulation No. 96 of 2021 concerning the Implementation of Mineral and Coal Mining Business Activities, mineral and coal mining is classified into 5 categories: radioactive minerals, metal minerals, non-metal minerals, rocks, and coal.

Wastewater from large quarry mining activities generally contains suspended solids (mud/sediment), heavy metals, pH changes, and possibly certain chemicals used in the processing. If not managed properly, this wastewater can have various negative impacts on the environment. River water pollution can occur through changes in water color and turbidity, increased concentrations of suspended solids, and the emergence of unpleasant odors. This has a negative impact on aquatic organisms, disrupts aquatic ecosystems, and reduces the quality of water that may have previously been used by the

community for daily needs, irrigation, and fishing.

In the context of mining large quarry mountain rock commodities in Kuala Kurun, Gunung Mas Regency, the quality of river water around the mining area is an important issue. These rivers have the potential to receive polluting loads from mining activities, while on the other hand they are still used by the community for various needs (Ouma, *et al.,* 2022). Therefore, a comprehensive study is needed to assess the condition of river water quality based on physical and chemical parameters, and determine the level of pollution that occurs due to mountain rock mining activities.

In addition to mining activities for large quarry mountain rock commodities, the Kuala Kurun area, Gunung Mas Regency, is also an area that develops as a community settlement. Around the research location there are domestic (household) activities, service activities, trade, and possible other activities such as agriculture, fisheries, and small and medium businesses. These activities have the potential to produce liquid and solid waste, such as household waste (grey water and black water), waste that is not properly managed, and fertilizer and pesticide residues from agricultural land. Pollution indications from these sources can complicate the condition of river water quality, because the pollutant load that enters the water body comes not only from mining activities, but also from non-mining activities in the vicinity. Therefore, in analyzing water quality and pollution levels in this area, it is necessary to consider that rivers receive pollutant inputs from various sources.

Water Quality Conditions and Surface Water Management Strategies In the Mining Activities of the Gunung Kuari Besar Commodity in Kuala Kurun, Gunung Mas Regency it is important to study the quality of river water around mountain rock mining activities, analyze the level of pollution that occurs due to mining activities, and formulate an effective, sustainable, and potentially beneficial wastewater control and management strategy for the environment and the community in the around the mine site.

MATERIALS & METHODS

This research was carried out in Kuala Kurun Village, Kurun District, Gunung Mas Regency, Central Kalimantan Province. The sampling location in this study can be seen in the following image
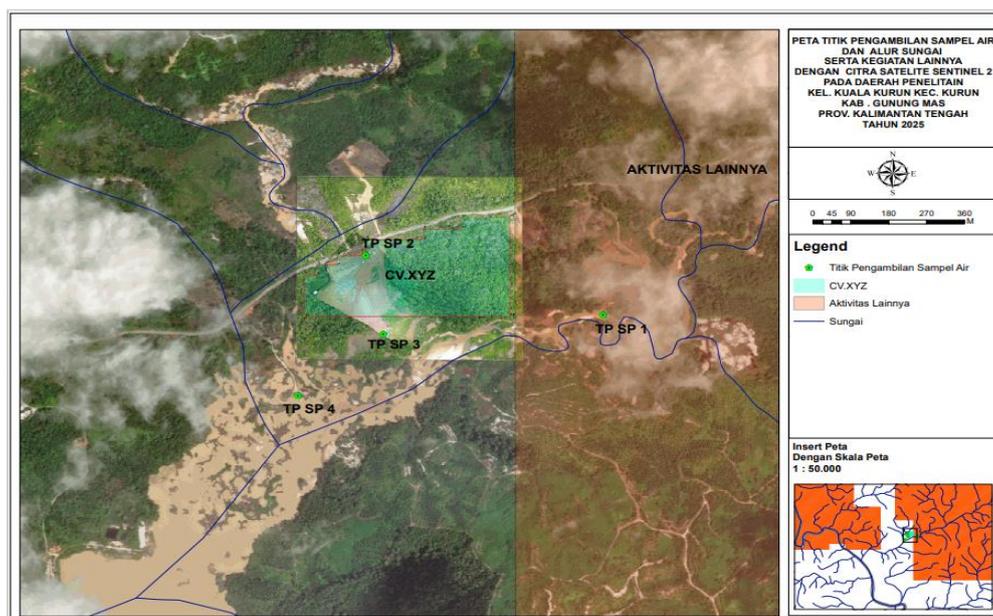

Figure 1. Map of sampling locations

Data analysis uses the Pollution Index and SWOT Analysis methods. The measurement of pollution levels will be used the IP (Pollution Index) method regulated in the Decree of the Minister of Environment Number 115 of 2003 concerning Guidelines for Determining Water Quality Status. If the maximum value of Ci/Lij and/or the average value of Ci/Lij is larger, then the level of pollution of a water body will also be greater. So the length of the line from the point of origin to the point of Pij is proposed as a factor that has meaning to express the level of pollution.

$$PIj = m \sqrt{(Ci/Lij)_M^2 + (Ci/Lij)_R^2}$$

Description:
PIj = Pollution index for allocation j
Ci = concentration of water quality parameters i
Lij = concentration of water quality parameters i
M = maximum
R = average
(Ci /Lij)R = average index
(Ci /Lij)M = maximum index
Where m = the balancing factor The critical state is used to calculate the value of m PIj = 1.0 if the maximum value of Ci/Lij = 1.0 and the mean value of Ci/Lij = 1.0 then

$$1.0 = m \sqrt{(1)^2 + (1)^2}$$
$$M = 1 / \sqrt{2}$$
$$PIj = \sqrt{\frac{(Ci/Lij)_M^2 + (Ci/Lij)_R^2}{2}}$$

This method can directly link the level of pollution to whether or not the river can be used for a specific use and with the value of certain parameters. Evaluation of PI values is presented in Table 1.

Table 1. Pollution Index

Value	Pollution index
0 ≤ PId ≤ 1.0	Meet quality standards (good condition)
1.0 < D≤ 5.0	Light contamination
5.0 < PId ≤ 10	Moderate pollution
FIGj > 10	Heavy contamination

Source: Ministry of Agriculture and Forestry 115 Water Quality Status (2003)

RESULTS
The results of water quality measurements of physical and chemical parameters during the research in Kuala Kurun Village, Kurun District, Gunung Mas Regency, Central Kalimantan Province with four (4) sampling locations can be seen in Table 1. Next

Table 1. Water Quality Results

PARAMETERS	Units	BM Class II	TP1-SP1	TP2-SP2	TP3-SP3	TP4-SP4
PHYSICS						
Temperature	°C		26.2	28.1	26.9	29.9
TDS	mg/L	1000	51.1	115.1	20.7	9.7
TSS	mg/L	50	107*	12	148*	41
CHEMISTRY						
pH		6-9	7.56	4.16	6.63	5.42
BOD	mg/L	3	24.32*	9.91*	12.61*	10.81*
COD	mg/L	25	85.79*	81.28*	93.69*	94.82*
DO	mg/L	Min 4	6	6.8	6.3	5.9
Stuttgart	mg/L	10	<0.3	2.9	<0.3	0.7
Ammonia	mg/L	0.2	<0.15	<0.15	<0.15	<0.15
Iron	mg/L	-	4.32	1.21	2.98	1.86
Eat	mg/L	-	0.9	3.4	1.5	1.8
Copper	mg/L	0.02	0.07*	0.42*	0.78*	0.33*

(Source: Primary Data, 2025)
Remarks
* : Not in accordance with quality standards
TP1-SP1 : Hulu Sungai Kahayan
TP2-SP2 : *Settling pond*
TP3-SP3 : Middle of the Kahayan River
TP4-SP4 : Downstream of Kahayan River

The results of laboratory tests obtained several test parameters that exceeded the standard threshold for river water quality, in accordance with research conducted by Yulis (2018) that the standard for using Kahayan river water is in class II.

The results of the calculation of the Pollution Index (IP) at four monitoring points (TP1–SP1, TP2–SP2, TP3–SP3, and TP4–SP4).

The IP value is calculated based on physical and chemical water quality parameters, then compared to the set quality standard. This graph provides an overview of the level of pollution at each monitoring point as well as the tendency to change in water quality along the monitoring stream can be seen in figure 2. Pollution Index Results
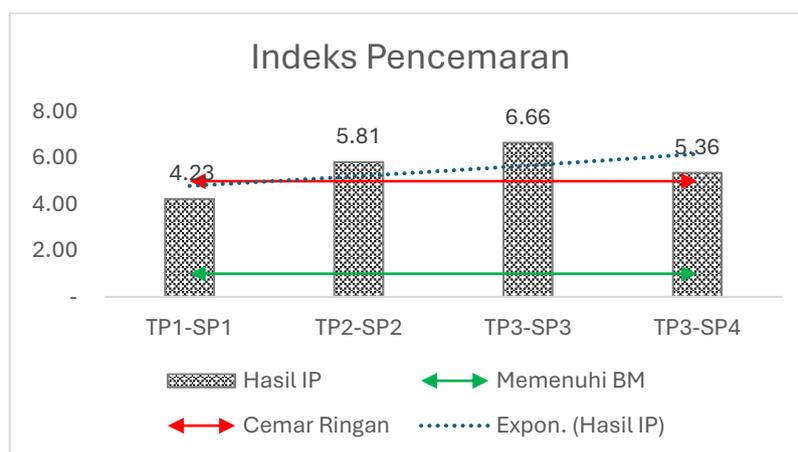
(Source: Primary Data, 2025)
Figure 2. Pollution Index Results

DISCUSSION

The Kahayan River is one of the main rivers in Kalimantan that has a strategic function for the community, both as a source of surface water, a transportation route, and a support for agricultural and fishing activities. As a river with a length of more than 600 km and passing through several areas, including Pulang Pisau Regency, the water quality of the Kahayan River is greatly influenced by environmental developments along the river basin and various human activities that utilize it. Changes in river water quality generally occur due to the interaction between natural factors and anthropogenic activities, such as land clearing, mining, agriculture, settlements, and domestic and industrial waste disposal. Therefore, water quality research is important to describe the status of water quality and the potential for pollution pressure.

This study evaluated the water quality of the Kahayan River based on 12 physical and chemical parameters measured at four sampling points, thereby providing a comprehensive picture of the water conditions. The measurement results show that several basic parameters, such as water

temperature, Total Dissolved Solids (TDS), Dissolved Oxygen (DO), nitrate, and ammonia, are still within the Class II water quality standards according to applicable regulations. This condition indicates that, in general, the waters of the Kahayan River still have the ability to support aquatic biota and water utilization for certain needs. The water temperature, which was within the normal range, was influenced by natural factors such as sunlight intensity, season, and river hydrological conditions, while the relatively low to moderate TDS value reflected a level of dissolved substances that was still tolerable for the aquatic ecosystem.

However, the results of the study also show indications of significant pollution pressure on several other parameters. The Total Suspended Solids (TSS) value shows high variation between locations, with concentrations exceeding quality standards in the upper and middle reaches of the river. This condition indicates high sediment input into the river body originating from cliff erosion, surface runoff during rainfall, land clearing, as well as mining activities and land use around the watershed. The decrease in TSS values in the settling pond and downstream indicates the process of particle sedimentation and flow dilution, but still emphasizes that sediment sources from the upper and middle reaches need special attention in watershed management.

In addition, the pH values of the water showed a fairly wide range, with a tendency for low pH at the water storage pond location. This condition indicates the potential for the formation of acid mine drainage due to the oxidation of sulfide minerals in exposed rocks, which can reduce water quality and increase the solubility of heavy metals. The Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) parameters at all sampling points were recorded as exceeding Class II water quality standards, indicating a high level of organic pollution in the Kahayan River. This organic load is suspected to originate from domestic waste, industrial activities, and organic residues from human activities around the river, which have the potential to reduce dissolved oxygen levels and disrupt the balance of the aquatic ecosystem.

Heavy metals, particularly iron (Fe), manganese (Mn), and copper (Cu), were also detected at relatively high concentrations at several observation sites. The presence of these metals is suspected to be related to runoff from agricultural activities, mining processes, and weathering of rocks and exposed soil around the river basin. High concentrations of heavy metals have the potential to cause negative impacts on aquatic biota, reduce water quality for domestic needs, and pose health risks to the community if river water is used directly without adequate treatment.

Overall, the summary of this study shows that the Kahayan River still functions as a very important water resource and some of its water quality parameters still meet the established quality standards. However, the existence of parameters that exceed the threshold indicates that this river has experienced pollution pressure due to human activities along the river basin. Therefore, integrated and sustainable river management efforts are needed, including control of pollution sources, improvement of land use, supervision of mining and settlement activities, and regular water quality monitoring, in order to maintain the ecological function of the Kahayan River and ensure its use for future generations.

Environmental pollution, especially river water pollution, is a very crucial problem and must receive special attention to be overcome immediately. In order to maintain the existence and preservation of the environment and natural resources, as well as the sustainability of living things in it (Abigani, *et al.,* 2023). The Pollution Index (IP) is an index used to determine the level of pollution relative to the permissible water quality parameters. This index has a different concept from the Water Quality Index. The Pollution Index is determined for a designation, then it can be developed for

several designations for all parts of a body of water or a part of a body of water.

Based on the results of the calculation of the Pollution Index (IP) at the four location points shown in Figure 1, it can be seen that the water quality at all monitoring locations has not met the required water quality standards. The IP value at each monitoring point shows a variation in pollution levels which indicates a difference in activity pressure around the business location. At the upstream point, the IP value is 4.23, which indicates that the water conditions are in the category of light pollution ($1 < IP \leq 5$). Although the pollution level at this point is the lowest compared to other points, this condition still indicates that the quality of the waters has decreased and does not meet the applicable water quality standards. This location is arguably still relatively better, likely due to the lower activity pressure than other points.

The point of location of the storage pond, the IP value increased to 5.81, exceeding the light pollution limit, so it was in the category of moderate pollution. This increase indicates a stronger pollution pressure, which can come from runoff from mountain rock mining activities. An IP value above 5 indicates that some water quality parameters have significant deviations from the quality standard values. The most critical condition is seen at the central location point where the IP value reaches 6.66, which is the highest value among all monitoring points. This value indicates the moderate pollution category with the heaviest level of pollution. Downstream location points, the IP value reached 5.36, which is also in the moderate polluting category although slightly lower than the middle location point. This small decrease can indicate a natural dilution process or a difference in the source of pollution pressure. However, the IP value still indicates the condition of the waters that have experienced quality damage and require handling. Overall, the IP value pattern shows an increasing trend of pollution from the Upstream to the Middle, as depicted in the exponential trend line on the graph. This confirms that the quality of the waters is declining in areas with higher activity intensity. In addition, the entire IP value is above 1 which means that no point meets the water quality standard. A similar study related to mining by Susila (2015) the activities of the mining industry and unlicensed people's gold mining in areas adjacent to the river have the potential to affect the water quality of the Kahayan river.

CONCLUSION

The results of the Pollution Index (IP) analysis showed that all monitoring points were in a polluted condition and did not meet water quality standards. The Upstream Point has an IP of 4.23 (light pollution), while the other three points, Pond Reservoir (5.81), Central (6.66), and Downstream (5.36) are in the category of medium pollution. The increased IP value from Upstream to Downstream indicates an increase in the pressure of human activities along the river flow.

REFERENCES

1. Abigani, R., Wartono, S., Indrajaya, F., & Kristiawan, J. (2023). Analisis Pengaruh Pertambangan Emas Tanpa Izin Berdasarkan Data Mutu Air Sungai Kahayan Pada Dinas Lingkungan Hidup Provinsi Kalimantan Tengah. Jurnal Teknologi Mineral FT UNMUL, 11(2), 1-10.
2. Decree of the Minister of State for the Environment No. 115 of 2003 concerning Guidelines for Determining Water Quality Status.
3. Government Regulation (PP) Number 96 of 2021 concerning the Implementation of Mineral and Coal Mining Business Activities.
4. Ouma, K. O., Shane, A., & Syampungani, S. (2022). Aquatic

ecological risk of heavy-metal pollution associated with degraded mining landscapes of the Southern Africa River Basins: a review. Minerals, 12(2), 225.

5. Susila, N. (2015). Dampak pencemaran air sungai Kahayan pada usaha budidaya ikan karamba di Kelurahan Pahandut Seberang Kota Palangka Raya. Jurnal Ilmu Hewani Tropika (Journal of Tropical Animal Science), 4(2), 71-74.

6. Yulis, P. A. R. (2018). Analisis kadar logam merkuri (Hg) dan (Ph) air Sungai Kuantan terdampak penambangan emas tanpa izin (PETI). Orbital: jurnal pendidikan kimia, 2(1), 28-36

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