Study of Water Quality of Way Umpu River, Way Kanan Regency, Lampung Province, Indonesia, Based on Differences of TSS, DO, BOD, COD, and Phosphate Levels in Mining Locations

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Abstract

Mining activities and community activities around the Way Umpu River have the potential to be the main source of the decline in the water quality of the Way Umpu River. Therefore, to determine the level of pollution in the Way Umpu River, it is necessary to test the quality of river water using several chemical and physical parameters such as TSS (Total Suspended Solid), DO (Dissolved Oxygen), BOD (Biological Oxygen Demand), COD (Chemical Oxygen Demand), and Phosphate. The study aims to study the differences in levels of TSS, DO, BOD, COD, and phosphate in river water before and after the mining location. The research is an observational study. Samples were taken from two points, namely the upstream (before the mining location) and the downstream (after the mining location). The average result after the analysis test is then compared with the river water quality standard in accordance with the provisions of Government Regulation no. 11 of 2012 concerning class III river water quality standards. There is no significant difference before and after mining location for the average levels of TSS, DO, BOD, and Phosphate parameters (p-value > 0.05). In the COD parameter, there is a significant difference (p-value < 0.05). Overall, the average yields of TSS, DO, BOD, COD, and Phosphate after the mining location have met the quality standards set out in accordance with Government Regulation. Therefore, it can be concluded that mining activities and community activities around the Way Umpu River have not completely decreased the water quality of the Way Umpu River in the last four years.

Key words: TSS, DO, BOD, COD, Phosphate, and Way Umpu River (Water Quality, Mining Location)

Introduction

One of the water sources that is widely used to meet the needs of human life and other living things is river [1]. As a source of water supply, rivers play an important role in influencing groundwater quality and the surrounding environment. River water that comes out of springs is usually of very good quality. However, in the flow process, the water will receive various kinds of pollutants [2]. In recent years, the quality of river water in Indonesia has been mostly polluted, especially after passing through residential, industrial, and agricultural areas [3].

Mining activities are one of the activities to utilize natural resources. The mining activity can have a negative impact on the environment around the mine area in the form of a decrease in the quality of ground water and land as indicated by a decrease in the physical, chemical, and biological qualities of the soil [4]. The Way Umpu River is one of the rivers that is a mining location, including Manganese (Mn) mining and Gold (Au) mining. Gold mining activities are found in the vicinity of the Way Umpu River which is managed by the community. The mining activity has been going on for quite a long time. As a result, the environment in the mining area is getting worse and worse. Mining which is very extensive has turned the landscape into large pits formerly excavated. The mining activity has been suspected of being one of the causes of the decline in the water quality of the Way Umpu River.

The behaviors of the community around the watershed, such as littering directly into the river, carrying out fishing, mining, industry, and other domestic needs have an impact on the quality of river water. Along with the rate of development and population growth, rivers have become a place for accumulated waste disposal from all human activities. It causes pollutants to enter the river flow before finally being channeled into the sea or lake, and at a certain point when the river's capacity for the pollution load reaches its limit, river pollution will occur and will cause new problems. The main problem faced with regard to water resources is that the quantity of water is no longer able to meet the increasing demand and the quality of water for domestic use has decreased from year to year [5,6,7]. Various land use activities in the area around the Way Umpu River such as settlement, agriculture, fishery, mining, and industrial activities are thought to have affected the water quality of the Way Umpu River. Water quality is related to TSS (Total Suspended Solid), DO (Dissolved Oxygen), BOD (Biological Oxygen Demand), COD (Chemical Oxygen Demand), and Phosphate. The decline in the water quality of the Way Umpu River deserves the attention of all parties because the river is used for many purposes by the community. Water contamination parameters can be analyzed physically, chemically, and biologically [8]. Therefore, the main objective of the research is to study the differences in levels of TSS, DO, BOD, COD, and Phosphate in the upstream and downstream of the Way Umpu River before and after the mining location.

Research Method

In the study, four stations are determined from the Way Kanan regency which is likely to be able to provide the greatest amount of information. The code and name of the river from the station are: WU 1 (Way Umpu 1 is located in the Kasui Pasar area), WU 2 (Way Umpu 2 is located in the Ojolali area), WU 3 (Way Umpu 3 is located in the Negeri Baru area), and WU 4 (Way Umpu 4 is located in the Blambangan Umpu area). The determination of the point of taking river water quality is based on the ease of access, cost, and time in the research. Determination of water sampling points using the sample survey method, namely the sampling method carried out by dividing the research area into segments or points which are expected to represent the research population.

In the study, the method used is observational using descriptive analysis because the writing is based on a complete description of the conditions that occur in the environment around the Way Umpu River. Five representative water quality parameters are chosen to be measured, including TSS (Total Suspended Solid), DO (Dissolved Oxygen), BOD (Biological Oxygen Demand), COD (Chemical Oxygen Demand), and Phosphate. DO values are determined on the spot using a multi-parameter water quality monitoring instrument. Sensor calibration is performed prior to measurement. Pre-treatment and determination of other parameters in the laboratory follow the national standard method (SNI 6989.57 / 58/59: 2008). Sample analysis is carried out at the UPTD Environmental Laboratory DLH Lampung Province. The data obtained is then compared with the quality standard criteria of PP. 22 of 2021 for class II water which is designated as water for water recreation infrastructure / facilities, freshwater fish farming, animal husbandry, irrigating crops, and / or other designations requiring the same water quality as the said use.

Data Analysis Technique

The data is first processed using the Kolmogorov Smirnov test to determine whether the data is normally distributed or not. Paired sample t test is used when the data scale is a ratio and is normally distributed to determine whether there is a significant difference in decreases between TSS, DO, BOD, COD, and Phosphate levels before and after the mining location. Furthermore, the results from the outlets are compared with the quality standards that have been set.

Discussion

TSS, DO, BOD, COD, and Phosphate Levels Before and After Mining Location

TSS, DO, BOD, COD, and Phosphate Levels Before Mining Location

The results of checking TSS levels in the Way Umpu River water before the mining location showed an average value of 33 mg/L. For DO levels, the average value is 4.25 mg/L. The BOD level from the results of the analysis the average value was 3.5 mg/L. The average COD level was 12 mg/L, while for Phosphate the analysis results the average value was 0.175 mg/L. Complete results can be seen in Table 1.

Table 1. Results of Analysis of TSS, DO, BOD, COD, and Phosphate Levels of Way Umpu River Water Before the Mining Location (Kasui Pasar District)

No.	Years	Lampung Regional Regulation Quality Standards No. 11 of 2012 Class III				
		TSS (400 mg/L)	**DO (3 mg/L)**	**BOD (6 mg/L)**	**COD (50 mg/L)**	**Phosphate (1 mg/L)**
1	2021	16	5	6	24	0.1
2	2020	16	4	1	3	0.3
3	2019	32	4	3	14	0.2
4	2018	68	4	4	7	0.1
Average		33	4.25	3.5	12	0.175

TSS, DO, BOD, COD, and Phosphate Levels After Mining Location

From the results of laboratory tests, the average TSS level is 89.5 mg/L. For DO levels, the average value is 3.75 mg/L, BOD 4 mg/L, COD 13.75 mg/L, and phosphate 0.1375 mg/L. Complete results can be seen in Table 2.

Table 2. Results of Analysis of TSS, DO, BOD, COD, Phosphate Levels of Way Umpu River Water After the Mining Location (Blambangan Umpu District)

No.	Years	Lampung Regional Regulation Quality Standards No. 11 of 2012 Class III				
		TSS (400 mg/L)	**DO (3 mg/L)**	**BOD (6 mg/L)**	**COD (50 mg/L)**	**Phosphate (1 mg/L)**
1	2021	92	4	7	25	0.05
2	2020	28	4	2	5	0.2
3	2019	42	3	3	17	0.2
4	2018	196	4	4	8	0.1
Average		89.5	3.75	4	13.75	0.1375

Analysis of Differences in TSS, DO, BOD, COD, and Phosphate Levels Before and After the Mining Location Along the Way Umpu River Flow

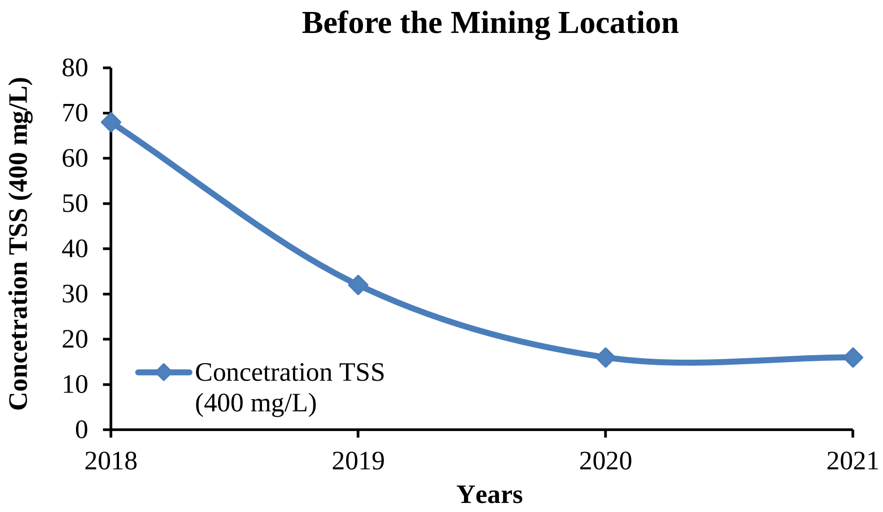
Analysis of Differences in TSS Levels Before and After the Mining Location

The measurement results show that there are variations in TSS levels and differences in TSS levels before and after the mining location. The differences seen show an increasing trend between before and after the mining location. The results of laboratory examinations of TSS levels for Way Umpu River water can be seen in Table 3.

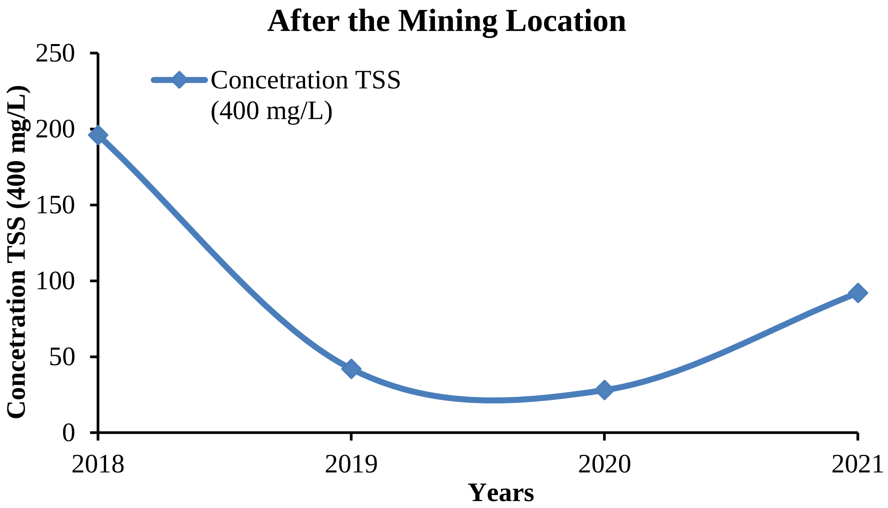
Table 3. The Differences in TSS Level of Way Umpu River Water Before and After the Mining Location Using the t Test

No.	Years	TSS (400 mg/L)	
		Before the Mining Location	**After the Mining Location**
1	2021	16	92
2	2020	16	28
3	2019	32	42

4	2018	68	196
Average		33	89.5
t-value = -1.99		df = 3	p = 0.140



Graph 1. Graph of TSS concentration at the site before mining



Graph 2. Graph of TSS concentration at the site after mining

High TSS can increase water temperature because solid materials absorb heat from sunlight [9]. A low TSS value indicates that the waters are in good condition, it is because organic and inorganic materials do not reduce the penetration of the sun into the water body [10]. The TSS value on the class III water quality standard is 400 mg / L, the Way Umpu River TSS value at two locations, namely before and after mining still meets the class III water quality standard (Table 3). It indicates that the Way Umpu River has not been polluted by particulates which can increase turbidity. Based on the results of the paired t test with df = 3, the obtained t-value = -1.99 and significance ($p = 0.140$). With $\alpha = 0.05$, the result is that $p > \alpha$. It means that there is an insignificant difference in TSS levels before and after the mining location.

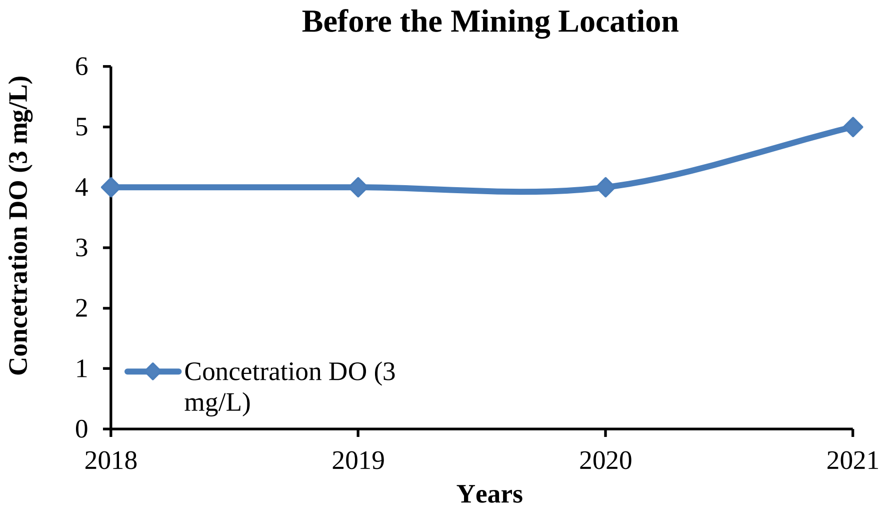
Based on the analysis of the data before and after the mining location, the result is p > 0.05, so it can be concluded that there is no significant difference in TSS levels between before and after the mining location. The average TSS level of Way Umpu River water from the results of laboratory examinations after the mining location was 89.5 mg / L. It shows that the TSS level in the Way Umpu River has met the quality standards that have been set, even for the TSS level, before the mining location, the levels were already low.

Differences in DO Levels Before and After the Mining Location

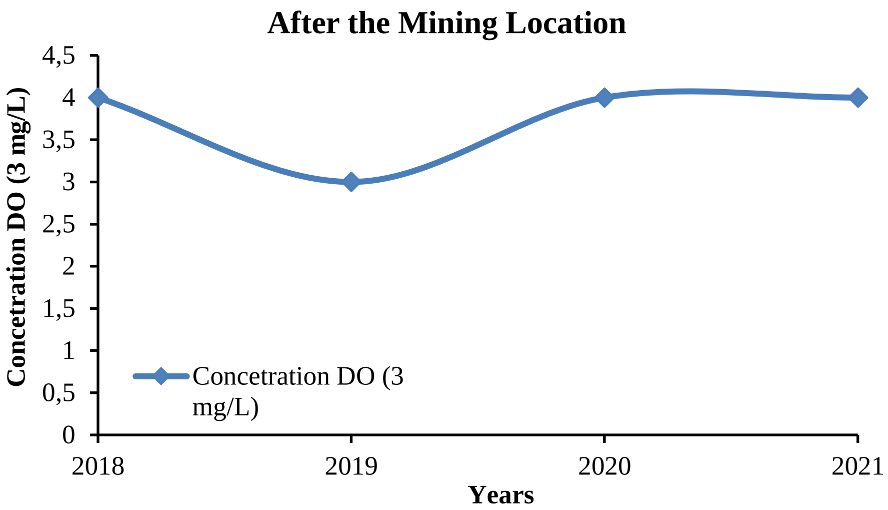
From the DO measurements between before and after the mining location, almost no significant differences are found. DO levels varied and there is a decrease in DO levels before and after the mining location in 2021 and 2019. Based on the results of the paired t-test with df = 3, the obtained t-value = 1.73 and significance ($p = 0.182$). With $\alpha = 0.05$, the result is that $p > \alpha$. It means that there is an insignificant difference between DO levels before and after the mining location. For more details, it can be seen in Table 4.

Table 4. The Differences in DO Levels in Way Umpu River Water Before and After the Mining Location Using the t Test

No.	Years	DO (3 mg/L)	
		Before the Mining Location	**After the Mining Location**
1	2021	5	4
2	2020	4	4
3	2019	4	3
4	2018	4	4
Average		4.25	3.75
t-value = 1.73		df = 3	p = 0.182



Graph 3. Graph of DO concentration at the site before mining



Graph 4. Graph of DO concentration at the site after mining

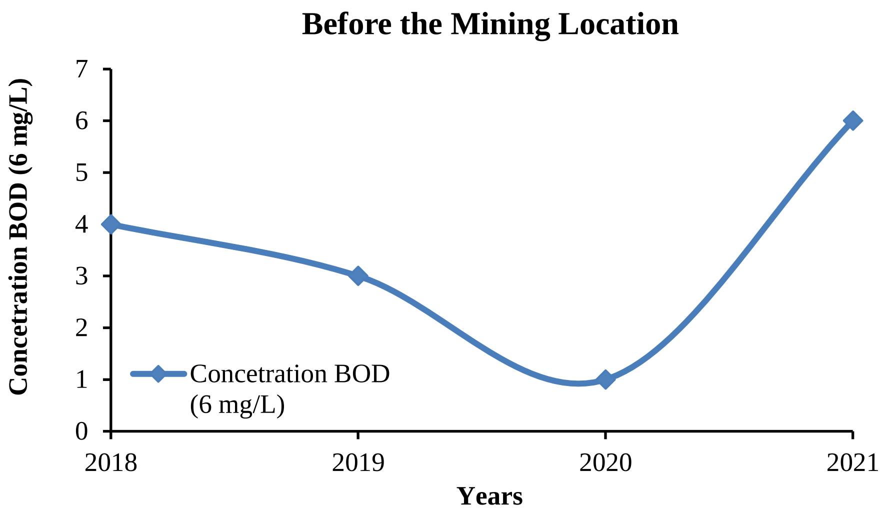
Based on Table 4, the DO levels in the Way Umpu River water from 2018 to 2021 meet the quality standard threshold, which is more than 3 mg/L. The more DO (Dissolved Oxygen), the better the water quality. If the dissolved oxygen level is too low, an unpleasant odor as a result of the anaerobic degradation may occur. Based on the analysis of the data before and after the mining location, the result is $p > 0.05$, so it can be concluded that there is no difference between before and after the mining location. The average DO level value of Way Umpu River from the results of laboratory examinations after the mining location is 3.75 mg/L. It shows that the DO level in the Way Umpu River has met the quality standards that have been set, even for the DO level, before the mining location, the level had exceeded 3 mg /L.

Differences in BOD Levels Before and After the Mining Location

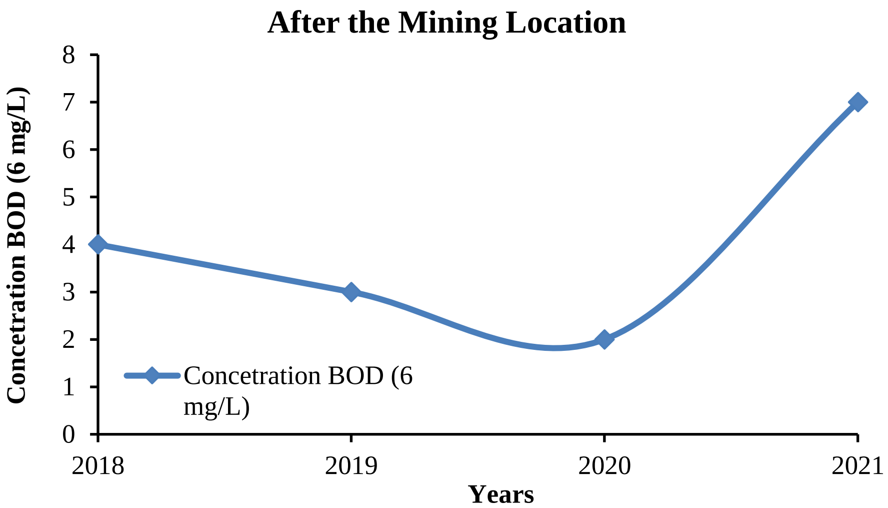
From the measurement results of BOD levels, various levels of BOD are obtained and there was an increase in BOD levels before and after the mining location in 2021 and 2020. Based on the results of the paired t-test with df = 3, obtained t-value = -1.73 and significance ($p = 0.182$). With $\alpha = 0.05$, the result is that $p > \alpha$. It means that there is an insignificant difference between the BOD levels before and after the mining location. For more details, it can be seen in Table 5.

Table 5. The Differences in BOD Levels in Way Umpu River Water Before and After the Mining Location Using the t Test

No.	Years	BOD (6 mg/L)	
		Before the Mining Location	**After the Mining Location**
1	2021	6	7
2	2020	1	2
3	2019	3	3
4	2018	4	4
Average		3.5	4
t-value = -1.73		df = 3	p = 0.182



Graph 5. Graph of BOD concentration at the site before mining



Graph 6. Graph of BOD concentration at the site afer mining

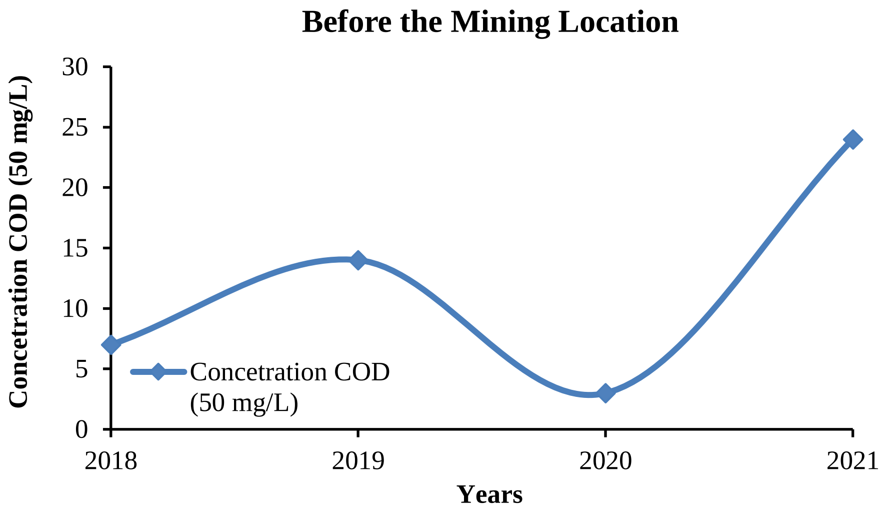
Based on Table 5, the BOD level in 2021 at the location after mining has passed the quality standard threshold. It indicates that at that location, the Way Umpu River water may have been lightly polluted. Waters with high BOD values indicate that the water is polluted by organic matter. The lower the BOD content indicates that the organic pollutant content in the river is low [11]. The greater the BOD value of a water, the higher the concentration of organic matter in the water. After statistical analysis is carried out on the data before and after the mining location, it is found that the data is not significant with $p > 0.05$, so it could be concluded that there is no difference between the BOD levels before and after the mining location. From the description above, although there is no difference between before and after the mining location, the average BOD value after mining location is 4 mg/L that has met the stipulated quality standard for class III river water quality.

Differences in COD Levels Before and After the Mining Location

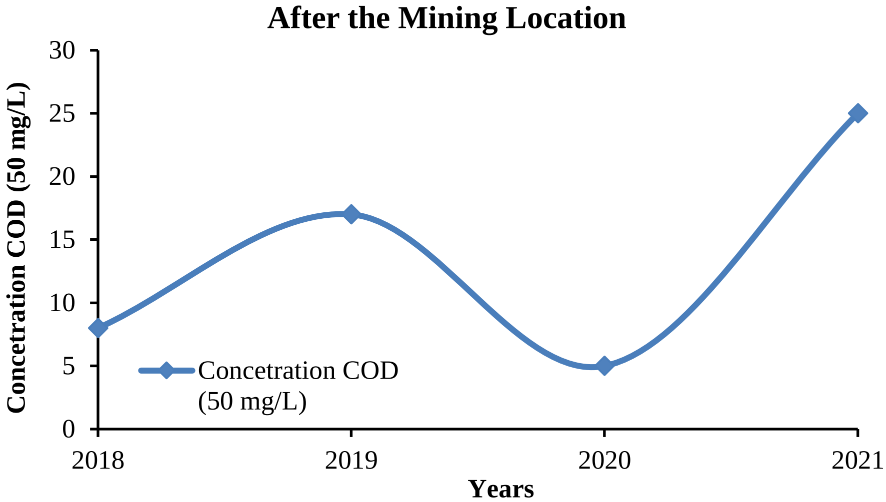
From the measurement of COD levels, various COD levels are obtained and there is an increase in COD levels before and after the mining location. Based on the results of the paired t test with df = 3, the obtained t-value = -3.66 and significance ($p = 0.035$). With $\alpha = 0.05$, the result is that $p < \alpha$. It means that there is a significant difference between COD levels before and after the mining location. For more details, see Table 6.

Table 6. The Differences in COD Levels in Way Umpu River Water Before and After the Mining Location Using the t Test

No.	**Years**	**COD (50 mg/L)**	
		Before the Mining Location	**After the Mining Location**
1	2021	24	25
2	2020	3	5
3	2019	14	17
4	2018	7	8
Average		12	13.75
t-value = -3.66		df = 3	p = 0.035



Graph 7. Graph of COD concentration at the site before mining



Graph 8. Graph of COD concentration at the site after mining

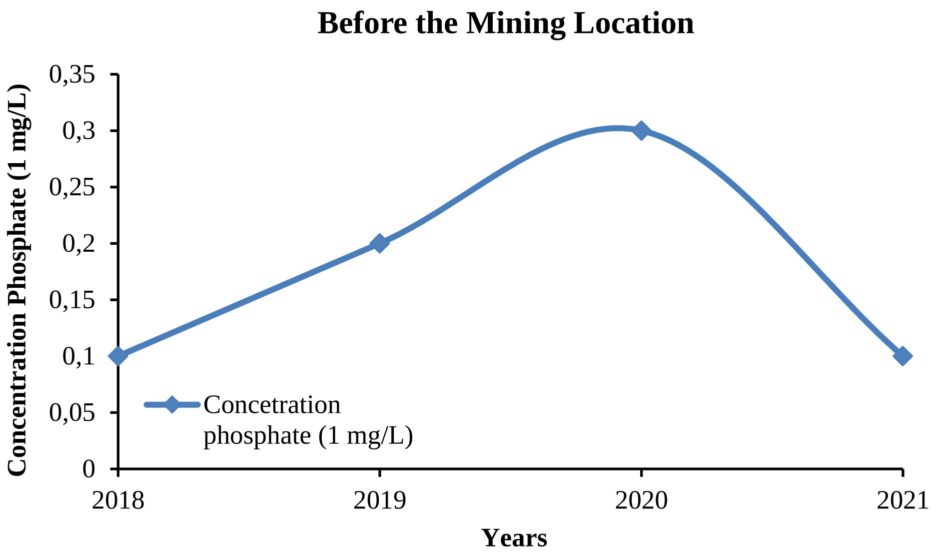
Based on Table 6, the COD levels obtained from the Way Umpu River water samples show that all the values of the analysis results do not exceed the quality standard threshold. It means that the water conditions of the Way Umpu River are of good quality. The COD parameter states the amount of oxygen needed to oxidize organic substances to CO_2 and H_2O. COD levels in water decrease along with the decrease in the concentration of organic matter in the wastewater. Based on the analyzed data, it is found that there is a significant difference between before and after the mining location with $p < 0.05$. Similar to TSS and BOD, COD levels increases at the site after mining. The average COD level after the mining location is 13.75 mg/L has met the predetermined quality standards.

Differences in Phosphate Levels Before and After the Mining Location

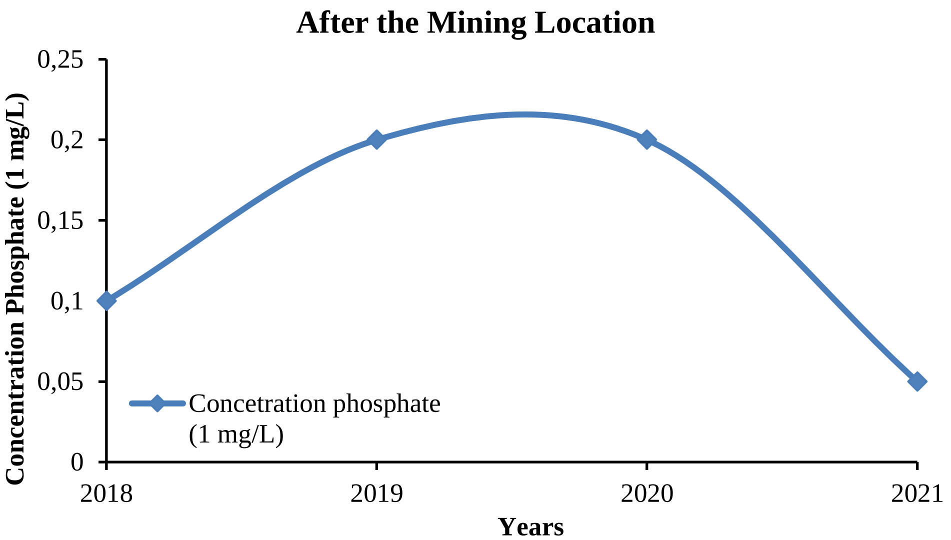
From the results of Phosphate measurements, it is obtained that the levels of Phosphate vary and there is a decrease in phosphate levels between before and after the mining location. For more details, it can be seen in Table 7.

Table 7. The Differences in Phosphate Levels in Way Umpu River Water Before and After the Mining Location Using the t Test

No.	Years	Phosphate (1 mg/L)	
		Before the Mining Location	After the Mining Location
1	2021	0.1	0.05
2	2020	0.3	0.2
3	2019	0.2	0.2
4	2018	0.1	0.1
Average		0.175	0.1375
t-value = 1.57		df = 3	p = 0.215



Graph 9. Graph of phosphate concentration at the site before mining



Graph 10. Graph of phosphate concentration at the site after mining

Based on the two graphs above, it can be seen that at the pre-mining location, the highest phosphate concentration was in 2020, which was 0.3 mg/L, meanwhile, the lowest phosphate concentration was in 2018 and 2021. At the location after mining, the highest phosphate concentration was in 2019 and 2020, which was 0.2 mg/L, while the lowest phosphate concentration was in 2021 at 0.05 mg/L.

Based on the results of the paired t test with df = 3, the obtained t-value = 1.57 and a significance of 0.215. With $\alpha = 0.05$, the result is that $p > \alpha$. It shows that there is no significant difference in Phosphate levels before and after the mining location. Table 7 shows that the Phosphate content in the Way Umpu River water from 2018 to 2021 has not exceed the quality standard threshold. It indicates that the waters of the Way Umpu River are in good condition which meets class III quality standards. From the results of data analysis, the results obtained $p > 0.05$, which means there is no significant difference between before and after the mining location. Laboratory examination shows that the average Phosphate level after the mining location is 0.1375, which means that the Phosphate content has met the predetermined quality standard of 1mg/L river water.

CONCLUSIONS

1. The main source of water pollution in the Way Umpu River comes from all community activities around the river and mining activities.
2. Judging from the average value of TSS, DO, BOD, COD, and phosphate levels in the Way Umpu River water before and after the mining location, it shows that these values do not exceed the predetermined river water quality standards.
3. There is a significant difference in COD levels in the Way Umpu River water before and after the mining location as evidenced by a p-value < 0.05, while for TSS, DO, BOD, and Phosphate levels, there is no significant difference where the value p-value > 0.05.

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