Report

Reviewer

REVIEW MANUSCRIPT OF INTERNATIONAL JOURNAL OF ECOLOGY

Number of ID : 2689879

Title of Manuscript: Evaluation of The Water Quality Status and Pollution Load Carrying Capacity of Way Umpu River, Way Kanan District, Lampung Province, Indonesia Based on Land Use

In general, the substance of this research is quite good. However, the writing of the manuscript still looks messy, such as:

• The use of legal basis guidelines to assess environmental conditions in river waters is stated to use class III. However, what legal basis was used was never stated (line 25)

We have clearly stated the legal basis of use class III in the introduction.

• Measure units do not use superscripts (line 76)

We have corrected.

• Some sentences may be unclear or hard to follow (lines 80-81, 84-86, etc.)

Yes, we have correct as requested.

• Preposition used may be incorrect (line 82, etc.)

Yes, we have correct as requested.

• There are some pronoun problems - for example, using “that was” instead of “which was” - Consider changing it (line 88)

Yes, we have correct as requested.

• The use of the incorrect article. (line 100, etc.)

Yes, we have correct as requested.

• Writing geographic positions should be standardized in degrees, minutes, and seconds (line 104)

Yes, we have correct as requested.

• The use of a singular verb (i.e., was) that does not agree with the plural compound subject. Consider changing the verb to the plural form (line 115)

Yes, they are corrected as required.

• The map image is less clear. The base color of the map is too dark. Consider creating a clearer map image for easier understanding (lines 123-126)

We have replaced with a better map.

Meters cubic per second is not equivalent to (L/sec). Meters cubic/second is higher than (L/sec). L/sec = dm3/sec. Consider changing it (line 141)

Yes we have correct it.

• There are still sentences in the local language that have not been translated into English (lines 163, 225, 216-217, etc.)

All have been revised and corrected.

- This means that the manuscript is not subject to final corrections before being submitted

We have corrected all the typoerrors to meet the standard for publication in the journal.

• Some of the same statements are written repeatedly. Consider making sentences effective so that they don't take up much space (266-271) The results of a more detailed review can be seen in the manuscript

Yes, we have deleted the repeated sentences and we have added more discussion to give a better explanation.

Report
Reviewer 2
The Review result :
Dear Authors, The manuscript is very interesting, it explained and evaluate the water quality status and pollution load-carrying capacity of Way Umpu River based on land use, but not well designed and written. In general, there are many mistakes in grammar and language, please use Grammarly or consult an expert to check the manuscript or use proofreading services.
There are some corrections in the manuscript as follows:
Abstract :
- Better explain briefly the importance of the research as an introduction, not directly write the objective of the research
The importance of the work is actually stated in the abstract already although is not mentioned straightforward.
- Please do not use the term that has not been explained before, such as DO, ST, TSS, etc.
Introduction :
We have added definition one by one in order to clarify what do they mean.
- Please write the state of the art of this research. Was there any other relevant research? What is important about this research?
We have mentioned it in the introduction.
- 47-48: It is better to describe the condition of Indonesia rather than Europe.
Yes, I have done the revision as requested by comparing with other developing countries.
- 49, 61, 69-70: give more explanation. - Describe the land use more to get correct information that may be used in the discussion.
Yes, we have described in details.

Materials and Methods
- 96, 98: Use the correct term
We have corrected and used the correct terminology.
- 99-114: write the information in a table so it is more clear.
We have created table in order to give clearer information about each station used.

- 117-118: redrawn the map, making it more informative and clear. Use a standard scientific map.
We have drawn a better map and describe correct position for each station
- 119: please describe when did the research take place?
We have provided the correct information.

- 123-131: Which parameter was measured in situ? Which was analyzed in the lab?
Yes, I have provided the details for all measurements undertaken.

- 126-131: it is not mentioned in the abstract.
We have corrected.

- 133 : M3/sec or L/sec?
We have corrected.
- 136: What plankton? Phyto or zoo-plankton?
All planktons are measured in this work.

- 140: For what parameter? Identification? Diversity? Density? Or what?

We have clarified.

- 157: What is load capacity? Have you explained this in the introduction?
It has been mentioned clearly.
- 157-160: The sentences were too long, and contained so much unclear information. Please re-write
We have revised it.
- 169-179: what plankton? what unit?
It is mentioned in the text.

- There are some confusing procedures, so better rewrite more clearly and be easy to understand (see the manuscript).
We have rewritten the procedure to make it clearer.

Results and Discussions
- 181-190: you could discuss directly why Station 4 gave a different result.
We have added the clear discussion.
- 196-199: re-write, please.
It is done.

- 202-204: Table 1: Water quality measurement results ◊when was it? You did not mention the time of research in the method as well as in the result.
We have added in the discussion.

- 212-215: The sentence was too long, please rewrite.
We have rewritten.

- 224-227: when was it? You did not mention the time of research in the method as well as in the result.
We have done and mentioned the time of research in the material and method section.

- The value in Tables 1, 2, and 3: were they average? Of what? Monthly data?
We have corrected.

- 230-231, 235-236, 245-246, 248-250, 253-255: Please re-write the paragraph with more effective sentences. - 228-255: Please discuss the result and mention the result
We have done the correction based on the reviewers request.
- 259-266, 267-277, 278-286, 287-295: Mention your result first, then discuss it
I have done it.
- 259-295: better put the same parameter in the order of explanation.
Okay, I will do for all tables.

- You have data on total Phosphate (P), Nitrate (NO3-N), Cadmium (Cd), total Chromium (Cr), Copper (Cu), Lead (Pb), Mercury (Hg), Nitrite (NO2-N), Cyanide (CN), why don't you discuss these result? If so, why did you measure these parameters?
- How about the carrying capacity of the river for pollutants as you mentioned in the title?

Conclusion : - Please rewrite and make a sharp pinpoint conclusion. Please revise the manuscript. Thank you
We have totally rewritten the conclusion.

Research Article

Evaluation of The Water Quality Status and Pollution Load Carrying Capacity of Way Umpu River, Way Kanan District, Lampung Province, Indonesia Based on Land Use

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Abstract

This research aims to evaluate the water quality status and pollution load-carrying capacity of Way Umpu River based on land use. This was carried out using the survey method by directly measuring the river water debit, pH, temperature, and dissolved oxygen (DO) on-site, taking the water sample to analyze the parameters of water quality such as total dissolved solid (TDS), total suspended solid (TSS), water color, turbidity, salinity, biochemical oxygen demand (BOD), chemical oxygen demand (COD), fecal coli, total coliform and plankton in the lab, and monitoring the land use. The results showed that the use of land for illegal mining and settlement of inhabitants station-4 (ST-4) caused water pollution. Furthermore, based on class III water use, the parameters in ST-4 exceeded the standards for TSS, color, and BOD, while other stations such as ST-1, ST-2, ST-3, ST-5, and ST-6 showed clean and good water quality statuses. It was also found that the pollution load-carrying capacity of Way Umpu River has not yet been exceeded for class III, and the quality of the water may be improved when the river water debit increases. Additionally, the plankton community structure on ST-1, ST-2, and ST-3 showed the number of species and individuals, and the diversity index was relatively high compared to ST-4, ST-5, and ST-6. It was concluded that the integrated evaluation was based on water quality status, plankton community structure, and pollution load analyses. The land use for illegal mining will decrease the water quality and the plankton community structure compared to other land use.

1. Introduction

Water is the most important component in life and as a result, people tend to reside around riverine areas. Most human civilizations are located near water streams, especially along big rivers. This is because they are important freshwater sources however it is the most susceptible to pollution. Moreover, good water quality is essential because it plays a major role in supporting life, food production, energy generation, industry, and environmental support capacities including domestic consumption, agriculture, transportation, tourism, and other required water activities [1, 2].

The river is a meeting point of water coming from various sources such as rainwater, and even liquid waste from human activities such as agriculture, transportation, industry, urban, and settlement areas. However, some people think that river is an ideal place to receive waste from most anthropogenic activities because of its continuous water flow [3]. The river in Indonesia, generally, the condition of water quality determined by the land use. As an example the source of pollution entering The Cikeas river (West Java) was dominated by housing complexes, The Celeungsi river (West Java) was dominated by Industrial Sector. While The Bekasi river (Wes Java) was dominated by shopping centers, hotels and restaurants [4]. This condition is also widespread in countries with low and middle incomes such Indonesia, Malaysia and Myanmar where rapid developments are followed with minimal environmental considerations [2]. Furthermore, the examples of dominant stressors in the lotic system (80% of all water bodies) include hydro morphology degradation, point resource pollution distribution, and water use [5]. They commonly affect the water quality in the downstream and upstream areas as a result of the waste that comes from local activities around their surroundings [6]. In addition, stressors found in the upstream areas due to the effects of anthropocentric activities such as dam building, urbanization, mining, forestry as well as chemical fertilizers and pesticides from agriculture [7, 8].

Water is considered polluted due to the presence of some substances or some conditions that prevent it from being used for a particular purpose [9]. Previous researches have shown that reduced water quality in some areas such as Celeungsi, Cikeas and Bekasi River in West Java, Indonesia has increased in the last century [4], and this is caused by rapid industrialization, urbanization, other developments/processes, and pollution. The level of water pollution is assessed based on physical and chemical parameters that influence the quality of the water body, aquatic habitats, phytoplankton community, and the health of fish [1, 10-12]. Furthermore, the water body is functioned as a habitat for organisms, and responses to the stressors may vary among the producers and consumers. These responses affect the nutritional status of the phytoplankton community and in the long run, it may affect the survival biodiversity [7].

The water quality assessment is a complex problem because it involves many factors such as physical, chemical and biological parameters and difficulties in identifying polluting components accurately, which are also influenced by many factors and processes. Therefore, the knowledge of various causes of pollutants such as sources and impacts of pollution on ecological status is a fundamental prerequisite for effective river management [5].

Way Umpu River is one of the main rivers in Way Kanan District, Lampung Province, Indonesia. It has a watershed width of ± 1.179 km^2 area, a river length of 100 km, and an average width of 90 to 110 meters. the Way Umpu River watershed has several land uses, i.e. for forestry, plantation, agriculture, industry, mining, and inhabitant settlement. Besides its main function as macro drainage into the Java Sea, it serves as a water source for the public. In the dry season, people depend on it for bathing, washing, and fishing [13-15]. Moreover, a river is an open ecosystem that is susceptible to stressors coming from its surroundings. The chief of Environmental Service in Way Kanan District, Dwi Handoyo Retno, S.E., M.M., on

27 January 2021 stated that illegal mining in Way Kanan, especially gold, severely polluted Way Umpu River [14]. The color of the water became brown-yellowish, indicating that the water is not safe to use by the people for many purposes such as, washing and bathing. Subsequently, illegal mining also destroys river water flow and mining material waste disposal causes river silting. This illegal activity violates the regulation implemented by Indonesian government for Mineral and Coal Mining Number 4 in 2009 which has been amended to Law number 3 in 2020 concerning mineral mining [14, 15]. Therefore, environment parameter monitoring is the highest priority in water resource environmental status evaluation, environment protection and management, and policy implementation. Furthermore, polluted rivers are important challenges that require intervention from various stakeholders [1, 2].

Based on the information above, the objective of this research was to measure the level of pollution by analyzing the river water quality, calculating the pollution load capacity and plankton community structure in Way Umpu River based on land use.

2. Materials and Methods

2.1. Sampling Location and Sample Collection. Way Umpu River is geographically located between 04°28'41.4" south latitude and between 104°42'34.9" east longitude. The research location includes 7 (seven) stations for sample collection representing several land uses such as forestry, plantation, agriculture, mining, and inhabitant settlement. The sanpling location is presented in Table 1. Sampling locations to predict the water pollutant carrying load capacity are presented in Table 1 and Figure 1.

Table 1: Sampling location

No	Station	Location	Ordinat	Land Use
1	ST-1	Way Kasui Kiri River downstream	4°42'34.94"S 104°28'32.92"E	inhabitant settlement in Kasui Pasar Village of Kasui Sub-district plantation, and Bukit Punggur forests registered 24
2	ST-2	upstream of Way Umpu River before receiving water flow from Way Kasui Kiri River	4°42'36.55"S 104°28'35.44"E	inhabitant settlement in Kasui Pasar Village of Kasui Sub-district plantation, and Bukit Punggur forests registered 24
3	ST-3	Way Umpu River that received water flow from Way Kasui Kiri River	4°42'33.89"S 104°28'36.52"E	inhabitant settlement in Kasui Pasar Village of Kasui Sub-district plantation, and Bukit Punggur forests registered 24
4	ST-4	Ojolali River downstream	4°41'11,67"S 104°29'49.37"E	for gold and manganese mining and inhabitant settlement in Ojolali Village of Umpu Semenguk Sub-district
5	ST-5	Way Umpu River at Suspension bridge Ojolali Village	4°41'9.57"S 104°29'49.45"E	inhabitant settlement in Ojolali Village of Umpu Semenguk Sub-district
6	ST-6	Way Neki River downstream	4°38'45.87"S 104°30'22.44"E	plantation, mining, and inhabitant settlement in

				Gunung Katun Village of Baradatu Sub-district
7	ST-7	downstream of Way Umpu River received water flow from Way Neki River (ST-6) and other rivers above it (ST-1 to ST-5)	4°38’45.53”S 104°30’20.48” E	This was the area that was used to predict the water pollutant carrying load capacity

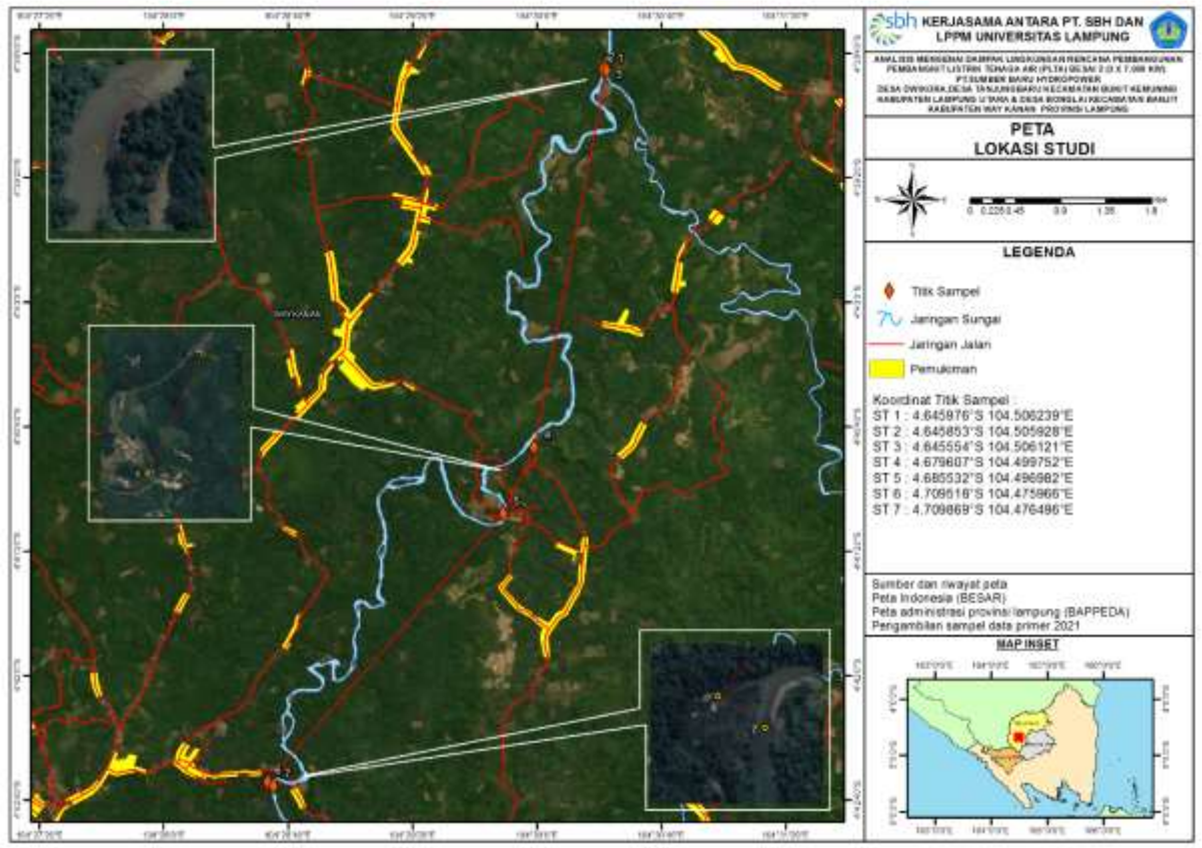


Figure 1: Map sampling location.

The water samples were taken during the wet season (October-April) with the monthly average rainfall data for the last 5 years are 376.83 mm, the data are obtained from the Meteorology, Climatology and Geophysics Agency of Kota Bumi Lampung, Indonesia. Furthermore, they were collected from 7 stations selected based on the land use in watershed areas. Samples were taken from the right and left banks at each station. The water parameter was measured directly in situ (pH, temperature, DO) and the other parameters were analyzed in Seameo Biotrop Service Department Environment Laboratory, in Bogor, Indonesia, which is LP-221-IDN nationally accredited. The physical and microbiology parameters include temperature, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), water color and turbidity, and Fecal and Total Coliforms. Furthermore, the chemical parameters include pH, salinity, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Dissolved Oxygen (DO), total Phosphate (P), Nitrate (NO_3-N), Cadmium (Cd), total Chromium (Cr), Copper (Cu), Lead (Pb), Mercury (Hg), Nitrite (NO_2-N), Cyanide (CN).

Water debit is the volume of water that flows per time unit through a river cross-section, and it is expressed in meters cubic per second (m^3/sec). The data was obtained by multiplying the speed measurement using the current meter and river width and a trapezoidal width approach. the width of the river cross-section was also measured with a tape meter [3].

The 50L water of the plankton sample was taken quantitatively and compositely using a bucket, and filtered with a 50µm plankton net. Plankton samples were taken from the right and left banks at each station. Furthermore, the collected sample was poured into a 30mL plastic container and fixated with 5 drops of 4% formalin solution [16]. The sample was then observed in an Ecological Laboratory in the Biology Department of the Faculty of Mathematics and Natural Sciences at the University of Lampung, Indonesia.

2.2. Data analysis The Nemerow index (PI) was used to evaluate water quality with the maximum and average scores of a single factor index affecting the composite index [17]. PI has been used widely to evaluate water bodies and is determined based on the ratio of environment standard parameters for specific purposes with parameter scores from various measurement results [18]. Subsequently, the standard scores for this research were purposed for Class III, which makes up the categories of water used for freshwater fish culture, animal husbandry, crop irrigation, and for other purposes based on Local Regulation of Lampung Province (2012) [19]. The PI equation is presented below (Equation 1) [17].

$$PI = \frac{\sqrt{\left(\frac{Ci}{Sij}\right)max^2 + \left(\frac{Ci}{Sij}\right)ever^2}}{2} \quad (1)$$

PI= Nemerow Index, Ci= measured concentration from evaluation factor class *i*, and Sij= standard concentration of evaluation factor for water purpose class *j*.

The correlation between PI value and water classification includes $PI < 1.0$: clean, $1<PI<2$: mild pollution, $2<PI<3$: moderate pollution, $3<PI<5$: polluted, and $PI > 5$: extremely pollution categories [17, 20] . The differences between each station were evaluated with the method of analysis of variance (ANOVA), Values were considered significant at $p < 0.05$ level.

The analysis for load capacity based on Minister Environment Decree of Indonesia Number 110 years 2003 [21] was carried out in Station 7, in the downstream area of Way Umpu River which receives water flow from some tributaries, namely, the Way Kasui Kiri River where its water flowed through the registered 24 forests of Bukit Punggur and plantation (ST-1) and ST-2 Up stream Way Umpu, Way Ojolali River (ST- 4), where the water flowed through inhabitant settlement, manganese and gold mining, and Way Neki River (ST-6) where its water flowed through gold mining and inhabitant settlement.

The load capacity was estimated using the mass balance method (Equation 2) based on the Regulation of the Indonesian Ministry of Environment Decree No 110 for the year 2003 [21].

$$CR = \frac{\sum CiQi}{\sum Qi} = \frac{\sum Mi}{\sum Qi} \quad (2)$$

With CR= average concentration of composite flow (mg/L or ^oC), Ci= Constituent concentration of flow i (mg/L or ^oC), Qi= Debit of flow-i (m^3/s), and Mi= Constituent mass of flow-i (kg^3/s)

Plankton community structure was determined based on plankton density and expressed as the numbers of individual plankton per liter. Abundance Index (individual per Liter or dm^3). Plankton abundance estimation is based on the following Equation 3:

$$N = \frac{(ax1000)b}{L} \quad (3)$$

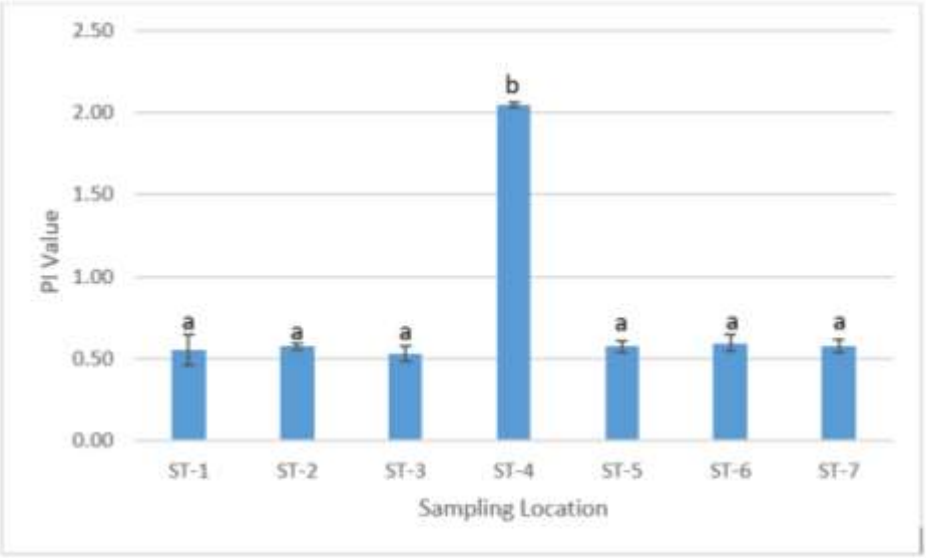
With N= number of plankter per Liter of river water, a= average of plankter number counted from 1 cc of filtered water, b= volume of filtered sample water (mL), and L= volume of filtered river water (L) [16].

The diversity (H) and evenness of plankton were determined based on the Shannon-Wiener diversity and evenness index [22]. Furthermore, based on the H score, the water condition was evaluated as follows $H < 1.0$: heavy pollution, $1<H<3$: moderate pollution, and $H > 3$: clean according to Mason [23].

3. Results and Discussion

The results of the physical, chemical, and biological parameter analysis are presented in Table 1. the measurement results for all water quality parameters at all stations were below the quality standard for class III, except for Station 4 where its TSS, color, and BOD exceed the standard. The estimation result of the water PI score for all stations showed the water quality status was clean and in good condition ($PI < 1$). However, ST-4 showed moderate water polluted quality status ($PI = 2.05$) which exceeded the standard for Class III water use. The PI scores are presented in Figure 2. Based on the results of the analysis of variance (Anova) at Station 4 the PI value was significantly different with a p-value <0.05 compared to the other 6 stations (ST-1, ST-2, ST-3, ST-5, ST-6 and ST-7), while between the 6 stations each PI value was not significantly different $p > 0.05$.

The results from the analysis of the pollution load capacity of Way Umpu River using the mass balance method for all parameters are shown in ST-7. These results were compared with the standards for Class III water use according to Local Regulation of Lampung Province [19], shown in Table 2.



Note: PI < 1.0: clean, 1<PI<2: mild pollution, 2<PI<3: moderate pollution,3<PI<5: polluted, and PI > 5: extremely pollution categories [17] .The results obtained are based on the calculation of the pollution load capacity according to KepmenLH no. 110 of 2003 [21].

Figure 2: Evaluation of river water quality based on PI score.

Table 2: Water quality measurement results

No	Parameters	Unit	Standard Class III	Sampling Location						
				ST-1	ST-2	ST-3	ST-4	ST-5	ST-6	ST-7*
1	Air Temp	^oC	-	27±0	29±0	27±0	29±0	29±0	27±0	28.5±0
2	Water Temp	^oC	-	27.9±0.1	27.6±0.1	27.9±0.3	29.2±0.3	28.1±0.1	27.9±0.1	27.7±0.1
3	TDS	mg/L	1,000	28±1.4	24.5±1.1	28.6±1.2	42.1±1.2	24±2.8	31.2±0.2	26.0±0.6
4	TSS	mg/L	100	7.4±0.4	12±1.0	11.2±0.8	235±2.8	11.2±1.6	0.8±0.4	1 2.0±0.7
5	Calour	Pt-Co	100	38.7±2.8	40.5±1.7	56.7±1.5	181±7.1	36.9±2.1	42.3±2.8	41.0±1.3
6	Turbidity	NTU	-	4.9±0.6	5.8±0.1	6.8±0	70.6±6.4	6.3±0.1	9.4±0.4	6.4±0.2
7	pH	-	6 – 9	7.8±0.1	7.4±0.1	7.8±0.08	6.7±0.3	7.5±0.2	7.7±0.2	7.6±0.1
8	Salinity	$^o/_{oo}$	-	0	0	0	0	0	0	0±0
9	BOD	mg/L	6	2±0.3	2.2±0.3	3.6±0.07	9.7±0,2	2.4±0.3	2.0±0.1	2.2±0.2
10	COD	mg/L	40	1.9±0.1	4.4±0.4	7.9±0.3	22.4±1.6	5.0±0.1	4.1±0.2	4.0±0.4
11	DO	mg/L	3	3.9±0.6	3.8±0.1	4.1±0.003	3.9±0.6	3.8±0.2	3.7±0.3	3.8±0.2
12	P (PO_4^-)	mg/L	1	0.4±0.01	0.5±0.04	0.6±0.003	0.3±0.02	0.4±006	0.4±0.04	0.4±0.1
13	N(NO_3^-)	mg/L	20	0.5±0.01	0.7±0.06	0.7±0.0004	1.7±0.04	0.8±0.03	1.5±0.4	0.7±0.01
14	Cd	mg/L	0.01	0.0002±0	0.0002±0	0.0002±0	0.0002±0	0.0002±0	0.0002±0	0.0002±0
15	Cr	mg/L	0.05	0.0003±0	0.0003±0	0.0003±0	0.0003±0	0.0003±0	0.0003±0	0.0003±0
16	Cu	mg/L	0.02	0.002±0.001	0.003±0.001	0.004±0.0001	0.002±0.0003	0.001±0.0004	0.002±0.001	0.003±0.0009
17	Pb	mg/L	0.03	0.001±0.001	0.001±0.0001	0.0009±0.00004	0.001±0.0001	0.0007±0.0001	0.0008±0.001	0.001±0.0002
18	Hg	mg/L	0.002	0.0002±0	0.0002±0	0.0002±0	0.0002±0	0.0002±0	0.0002±0	0.0002±0
19	N (NO_2^-)	mg/L	0.06	0.002±0.002	0.003±0.001	0.002±0.0001	0.008±0.001	0.002±0.001	0.007±0.003	0.003±0.0003
20	Cn	mg/L	0.02	0.01±0	0.01±0	0.01±0	0.01±0	0.01±0	0.01±0	0.01±0
22	Fecal Coliform	MPN/ 100 mL	2,000	7.2±0.3	9.4±1.0	7.2±0.1	11±1.4	7.4±1.4	7.2±0.3	8.8±0.6
23	Total Coliform	MPN/100 mL	10,000	7.2±0.3	9.4±1.0	11±1.4	11±1.4	7.4±1.4	7.2±0.2	8.8±0.7

Standard: water body for Class III purposes according to Local Regulation of Lampung Province [19]
ST7*: The results obtained are based on the calculation of the pollution load capacity according to KepmenLH no. 110 of 2003 [21].

Table 3 shows that the load capacity of Way Umpu River at ST-7 for all parameters did not exceed the standard for Class III water purpose according to this Local Regulation of Lampung Province [19]. This means that at ST-7 the pollution load capacity for all designation parameters for class III has not exceeded the quality standard, so Way Umpu still has a capacity for all parameters [21].

Furthermore, the analysis of the plankton community structure consisting of the values of density, diversity, dominance, and evenness of plankton is presented in Table 4. Based on Table 4, it was found that the structure of the plankton community n land use in the form of forests, plantations, and settlements (ST-1, ST-2, and ST-3) which shows the number of species, individuals and the diversity index were relatively high compared to the areas that were in the form of mining, and settlements (ST-4, ST-5, ST-6 and ST-7). The plankton diversity index indicated that all locations belong to moderate community stability or moderate polluted water quality (1<H<3) [21]. In addition, the structure of the plankton community based on the evenness index showed that planktons were evenly distributed (0.41<E<0.60 and 0.61<E<0.80) with low dominance (0 <D ≤0.5) at each station [22]. There are several species of plankton used as indicators of pollution, namely *Anabaena* sp, *Closterium* sp, *Euglena* sp, *Microsystis* sp, *Nitzchia* sp [7]. The existence of *Euglena* sp, *Nitzchia* sp, *Navicula* and *Synedra* is an indication of pollution by organic matter originating from organic waste, agricultural runoffs and anthropogenic inputs [7].

Table 3: Analysis of load capacity of Way Umpu downstream.

No	Parameter /river	Unit	Sampling Location					Standard
			ST-1	ST-2	ST-4	ST-6	ST-7*	Class III
1	River discharge	(m3/sec)	12.4	61.2	0.3	10.7	84.5	
2	Water Temp	^oC	27.9±0.1	27.6±0.1	29.2±0.3	27.9±0.1	27.7±0.1	-
3	TDS	mg/L	28±1.4	24.5±1.1	42.1±1.2	31.2±0.2	26.0±0.6	1,000
4	TSS	mg/L	7.4±0.4	12±1.0	235±2.8	1 0.8±0.4	1 2.0±0.7	100
5	Color	Pt-Co	38.7±2.8	40.5±1.7	181±7.1	42.3±2.8	41.0±1.3	100
6	Turbidity	NTU	4.9±0.6	5.8±0.1	70.6±6.4	9.4±0.4	6.4±0.2	-
7	pH	-	7.8±0.1	7.4±0.1	6.7±0.3	7.7±0.2	7.6±0.1	6 - 9
8	Salinity	$^o/_{oo}$	0	0	0	0	0±0	-
9	BOD	mg/L	2±0.3	2.2±0.3	9.7±0,2	2.0±0.1	2.2±0.2	6
10	COD	mg/L	1.9±0.1	4.4±0.4	22.4±1.6	4.1±0.2	4.0±0.4	40
11	DO	mg/L	3.9±0.6	3.8±0.1	3.9±0.6	3.7±0.3	3.8±0.2	3
12	P ($PO4^-$)	mg/L	0.4±0.01	0.5±0.04	0.3±0.02	0.4±0.04	0.4±0.1	1
13	N ($NO3^-$)	mg/L	0.5±0.01	0.7±0.06	1.7±0.04	1.5±0.4	0.7±0.01	20
14	Cd	mg/L	0.0002±0	0.0002±0	0.0002±0	0.0002±0	0.0002±0	0.01
15	Cr	mg/L	0.0003±0	0.0003±0	0.0003±0	0.0003±0	0.0003±0	0.01
16	Cu	mg/L	0.002±0.001	0.003±0.001	0.002±0.0003	0.002±0.001	0.003±0.0009	0.02
17	Pb	mg/L	0.001±0.001	0.001±0.0001	0.001±0.0001	0.0008±0.001	0.001±0.0002	0.03
18	Hg	mg/L	0.0002±0	0.0002±0	0.0002±0	0.0002±0	0.0002±0	0.002
19	N ($NO2^-$)	mg/L	0.002±0.002	0.003±0.001	0.008±0.001	0.007±0.003	0.003±0.0003	0.06
20	Cn	mg/L	0.01±0	0.01±0	0.01±0	0.01±0	0.01±0	0.02
21	Fecal Coliform	MPN/ 100 mL	7.2±0.3	9.4±1.0	11±1.4	7.2±0.3	8.8±0.6	2,000
22	Total	MPN/100	7.2±0.3	9.4±1.0	11±1.4	7.2±0.2	8.8±0.7	10,000

No	Parameter /river	Unit	ST-1	ST-2	ST-4	ST-6	ST-7*	Standard Class III
			Sampling Location					
	Coliform	mL						

Note:
Standard according to reference Local Regulation of Lampung Province [**19]**
ST-7*= Prediction result of pollution carrying load capacity of each water quality parameter [21]

The Ojolali River flow at ST-4, receives waste from illegal gold mining activities that resulted in polluted water conditions, especially in TSS, BOD, and color parameters which are 235 ± 2.8 mg/L, 9.7 ± 0.2 mg/L, 181 ± 7.1 Pt-Co, respectively. Gold mining is performed by striping soil using a diesel machine-driven soil suction with a big-size hose to suck and dispose of soil in big capacity. Furthermore, this method requires thousands of liters of water and disposes of thousands of cubic of soil daily (Figure 3), which blocks the water flow of rivers surrounding the mining area [24]. Besides that, illegal gold mining affects the quality of the river by turning it into brown-yellowish muddy water. This condition prevents people from relying on the Way Umpu River as a fresh water source, washing, bathing, and fishing, especially during the dry season [14, 15].

TSS consists of organic materials such as the debris part of an organism and inorganic materials in the form of fine sands and mud. Previous researches show that a high level of TSS in Semporo Strait (Papua, Indonesia) is caused by factors such as erosion, land use, shifting, agriculture, inhabitant settlement, and sand mining [25].

Table 4: Plankton community structure analysis.

No	Species	Sampling Location (individual/L)						
		ST-1	ST-2	ST-3	ST-4	ST-5	ST-6	ST-7
1	*Amoeba* sp.	7,800±848	600±848	3,000±848	38,400±4,242	12,600±3,394	1,200±0	1,200±848
2	*Anabaena* sp*	6,600±1697	600±0	13,800±3,394	600±0	0	600±0	600±0
3	*Arcella* sp.	0	0	0	4,200±1,697	0	0	0
4	*Asterionella* sp.	0	0	600±0	0	0	0	0
5	*Bacillaria* sp.	0	0	600±0	0	0	0	0
6	*Botryococcus* sp.	600±0	0	600±848	600±848	33,000±3,394	33,600±2,545	33,600±3,394
7	*Closterium* sp*	37,200±2,546	0	10,800±1,697	0	600±0	600±848	600±0
8	*Eudorina* sp.	0	0	1,200±	0	0	0	0
9	*Euglena* sp*	0	16,800±1,697	2,400±1,697	38,400±3,394	19,800±1,697	6,600±1,697	6,600±1,697
10	*Frontania* sp.	0	600±0	0	0	0	0	0
11	*Gomphosphaeria* sp.	0	3,600±848	1,200±0	0	0	600±0	600±848
12	*Gyrosigma* sp.	600±0	0	0	0	0	0	0
13	*Heteronema* sp	0	0	6	0	0	0	0
14	*Lyngbya* sp.	0	600±848	0	0	0	0	0
15	*Microsystis* sp.*	15,600±3,394	10,200±848	2,400±848	10,800±2,545	12,600±1,697	4,800±848	4,800±1,697
16	*Netrium* sp.	600±0	0	0	0	0	0	0
17	*Nitzchia* sp.*	21,000±3,394	4,800±0	0	6,600±1,697	1,800±848	600±0	600±0
18	*Oocyatis* sp.	600±0	0	0	0	0	0	0
19	*Phacus* sp.	600±848	0	0	0	0	0	0
20	*Rhabdonella* sp.	0	0	0	0	0	0	0
21	*Stauroneis* sp.	0	0	0	0	0	0	0
22	*Thallasiothrix* sp.	1200±0	0	0	0	0	0	0
	No of species	11±0.7	8±1.4	11±0.7	7±0.7	6±0	8±0.7	8±0.7
	No of Individual/L	92,411±4,243	37,808±3,394	37,211±2,545	99,607±12,727	80,406±4,242	48,608±2,545	48,600±5,091
	Diversity Index (H)	1.6±0.7	1.5±0.2	1.8±0.3	1.4±0.05	1.4±0.01	1.1±0.04	1.0±0.07
	Dominance Index (D)	0.3±0.03	0.3±0.01	0.2±0.07	0.3±0.02	0.3±0.02	0.4±0	0.5±0.004
	Evennes Index (E)	0.7±0.3	0.7±0.01	0.7±0.07	0.7±0.1	0.8±0.004	0.5±0.003	0.5±0.01

Note: Species with asterisks are pollution indicator based on references [1, 7]

The Ojolali River flow at ST-4 receives waste from illegal gold mining activities that resulted in polluted water conditions, especially in TSS, BOD, and color parameters where the values are higher the the standard, thus also much higher compared to other stations. Gold mining is performed by striping soil using a diesel machine-driven soil suction with a big-size hose to suck and dispose of soil in big capacity. Furthermore, this method, Furthermore, this method requires thousands of litres of water and disposes of thousands of cubic of soil daily (Figure 3), which blocks the water flow of rivers surrounding the mining area. Besides that, illegal gold mining affects the quality of the river by turning it into brown-yellowish muddy water. This condition prevents people from relying on the Way Umpu River for fresh water sources, washing, bathing, and fishing, especially during the dry season

Figure 3: (A) illegal gold mining activity, (B) brown-yellowish water river color after receiving mining waste

Subsequently, water bodies are said to be polluted when the TSS level is more than 50 mg/L [26] and our result indicated that the TSS in ST-4 is 235 ± 2.8 mg/L. The same result was found in the Brantas River of Samaan distric (East Java, Indonesia), Batang Kuranji River (Padang of West Sumatra, Indonesia) with TSS levels of 70 mL/L [3] and 165 mg/L to 734 mg/L [27]. The high TSS levels are also reportedly caused by land erosion, surface water flow from agriculture area, and industrial waste [28] as well as sand and stone mining [27]. Although TSS is a non-toxic pollutant material, its excessive level prevents sun ray penetration, affecting phytoplankton or covers water plants [29, 30]. Furthermore, it obstructs the gills of fishes and other aquatic habitats, thereby causing asphyxiation [29].

BOD describes the organic matter that may be decomposed biologically (biodegradable) and the decomposition result of dead plants and animals from industrial waste or domestic waste disposal. Moreover, water bodies are believed to be polluted when the BOD level is more than 2 mg/L. The high BOD level in Station 4 was due to domestic waste flow from the inhabitant settlements in Ojolali Village and the degradation of leaves along the river sides. Furthermore, the following results on BOD levels were obtained by some researchers, namely, 1.60 to 18.36 mg/L, 5.7 to 53mg/L, and 8.46 to18.48mg/L BOD levels in Batang Kuranji in Padang of West Sumatra, Indonesia [27]. The same condition was also found in developed countries such as the Tobol River and basin in Chelyabinsk, Russia, where there is continuous waste disposal from the city, industrial factories, agribusiness, and flood water [31].

TSS comes from suspended materials such as mud, sand, organic and inorganic materials, plankton, and other microscopic organisms that cause water pollution and muddiness [30]. It was also found that the TSS from soil particle deposits into the sediment and dissolves when river water debit increases. This was proved by the reduced concentration and color in the river downstream of ST-5. The analysis of pollutant carrying load capacity in ST-7 (Table 2) for TSS and color parameters showed that they were below the standard of Class III water use.

Furthermore, the BOD levels in downstream river areas in ST-5 and ST-7 were low due to decomposed organic materials, changes in the physical and chemical water quality parameters, and the plankton community structure. This was indicated by increased numbers of species and individuals, and the plankton diversity index in ST-5 and ST-7. This is in line with the research by Ma [32], which states that human activities play important roles in catchment area disturbance worldwide in terms of the physical and chemical parameters of rivers. Therefore, most aquatic species are under big threat because of human influences.

4. Conclusions

The results of this work clearly indicate that anthropogenic activities in aquatic ecosystems can be evaluated using water quality parameters and plankton community structure. The finding for ST-4 area, which is used for illegal mining and residential areas, indicates that this specific location moderately polluted conditions as demonstrated by TSS, color, and BOD which exceed Class III water use standards. On the other hand, the river in the area of plantation and forestry was found to meet the water quality standard. The pollution load carrying capacity of the downstream Way Umpu River (ST-7) is still in the ragne of standard for class III water use. The condition of the plankton community structure in each study location was found to evenly distributed ($0.41<E<0.60$ and $0.61<E<0.80$) with low dominance ($0 <D \leq 0.5$), and a moderate diversity index ($1 <H<3$). It should be noted that several species of plankton as an indicator of organic pollution was observed.

5. Data Availability

The data are available from the corresponding author upon request and are included in the manuscript.

6. Conflict of Interest

The author(s) declare(s) that there is no conflict of interest regarding the publication of this paper.

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