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Comparative Analysis of Water Quality Using Pollution Index Method and BCWQI in Cisanggarung River

Naufal Firdaus Bimantara [1], Ferdinan Novrizal [2], Syahrul Ramdhani [3], Heri Pramawan [4]
Universitas Swadaya Gunung Jati, Indonesia
bimantara724721@gmail.com, ferdinannovriz@gmail.com, syahrulramdhani22@gmail.com

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ABSTRACT

Assessment of water quality status is crucial to carry out as part of the efforts to maintain water quality, ensuring its use in community life meets the established standards. This is in stark contrast to the numerous community activities that often pollute the water content in rivers, leading to a decline in water quality and adverse effects on the people who use that water. This research is crucial for determining the quality status of water in the Cisanggarung River, as well as for comparing the water quality status in the upstream section of the Cisanggarung River using the Pollution Index and the British Columbia Water Quality Index (BCWQI). The average Pollution Index value in the Cisanggarung River is 1.192, categorized as Slightly Polluted. At the same time, the water quality status in the Cisanggarung River has an average score of 26.24, indicating a level of Fair (slightly polluted). Based on the results of determining water quality status using two methods, it can be concluded that the British Columbia Water Quality Index is the most suitable method for use in the Cisanggarung River (BCWQI).

INTRODUCTION

Access to clean water is a growing global issue amidst rapid population growth, urban expansion, and industrialization (Izah et al., 2024; Rusprayunita et al., 2025; Saxena, 2025). The United Nations recognizes clean water and sanitation as a Sustainable Development Goal (SDG 6), yet many countries including Indonesia continue to face significant challenges in maintaining river water quality(Wang et al., 2023). Rivers, which serve as primary water sources for various domestic, agricultural, and industrial needs, are increasingly polluted due to untreated waste disposal, agricultural runoff, and industrial discharge.

Several contributing factors have been identified in the degradation of river water quality (Anh et al., 2023). These include the lack of wastewater treatment infrastructure, poor environmental awareness among communities, overuse of fertilizers and pesticides in agricultural practices, and insufficient environmental regulation enforcement. In

Indonesia, the accumulation of pollutants in rivers has reached alarming levels, threatening both human health and ecological sustainability (Ahmad et al., 2022).

Water is the fundamental basis for all biological and human activities (Djana, 2023). Water is a vital material for every living thing. Notes that water is needed by humans for consumption, household needs, and large-scale industrial purposes (Mulyanti, 2022). Water is a vital and most valuable natural resource in human life and for other living things, so it can be said that water is the source of life on Earth, where the need for water continues to increase over time (Kurniawan et al., 2017). Therefore, if it is available in small quantities and of poor quality, it will pose a problem for residents who intend to use it (Marlina et al., 2017).

According to the World Health Organization (WHO), in developed countries, each person requires between 60 and 120 liters of water per day. Meanwhile, in developing countries, including Indonesia, each person needs between 30 and 60 liters of water per day. Water has numerous benefits that are crucial for the survival of living things (Mayada, 2020).

The river water that emerges from the spring has excellent quality; however, during its passage through various areas, including agricultural land, settlements, and industrial sites, it picks up multiple pollutants (Juwono & Subagiyo, 2019; Suprayogi et al., 2024). Various community activities around the river have the potential to degrade the water quality in the river. As population growth increases, so does the daily demand for water. So that the use of primary water sources, such as rivers, is needed, considering the growing need for water (Putranto, 2022).

The level of public awareness is a problem, and every citizen should strive to improve this phenomenon to promote a clean and healthy lifestyle (Roos, 2021). Waste disposal activities in rivers by the community are currently challenging to prevent, as the community does not consider the consequences that will occur if waste accumulates in water bodies. As a result, the water in the river has decreased in quality, capacity, carrying capacity, usability, and productivity, which will reduce the wealth of natural resources. Consequently, these resources cannot be used directly and require special treatment to be reused (Aminulloh, 2022).

The lifestyle of people who ignore environmental aspects, such as throwing garbage out of place, and disposing of hazardous waste (Maliga, 2023; Sulistyorini et al., 2016; TIMUR, 2020). Various community activities around the river flow result in the river being polluted due to waste that is discharged directly into the water body (Naillah et al., 2021). The entry of pollutants into the river can lead to a decline in water quality, as evidenced by changes in key water quality parameters of the river. Mada et al., (2023) A river is considered polluted if the quality of its water no longer meets its designated standards (Pohan et al., 2016).

Based on the above, the background for researching water quality in the Cisanggarung River is as follows. The importance of calculating the quality status of a water body is to simplify the number of values from the type of parameters into a number and level that can describe water quality so that it is easy to understand, as well as testing the status of water quality using the pollution index method, and BCWQI (British Columbia Water Quality Index), then testing based on physical, chemical, and biological parameters. Alternatively, TSS (Total Dissolved Solids) is used for physical parameters. In contrast, chemical parameters, including dissolved oxygen (DO), chemical oxygen demand (COD), biological oxygen demand (BOD), Nitrate, Phosphate, and Fecal Coliform, are used to determine biological parameters.

This study focuses on the analysis of water quality in the Cisanggarung River, located in West Java, Indonesia. Specifically, the study employs two widely recognized methods Pollution Index (PI) and British Columbia Water Quality Index (BCWQI) to evaluate and compare the water quality status. The Pollution Index method simplifies multiple parameters into a single score based on the worst-case scenario approach, while the BCWQI method integrates a broader range of parameters across a time-series, providing a more comprehensive assessment.

The novelty of this research lies in the comparative analysis between the Pollution Index and BCWQI methods in the specific context of the Cisanggarung River. Although both methods have been individually applied in previous studies, comparative application within the same watershed using synchronized sampling data is rare. This approach allows for a more nuanced evaluation of which method is more suitable for practical water monitoring in Indonesian rivers.

The purpose of this study is to determine the status of water quality in the upstream part of the Cisanggarung River using the Pollution Index method and *the British Columbia Water Quality Index* (BCWQI) method, as well as to find out the comparison of water quality status in the upstream Cisanggarung River using the Pollution Index method and *the British Columbia Water Quality Index* (BCWQI) method.

RESEARCH METHODS

This study uses a type of quantitative research with a comparative descriptive approach, which aims to describe and compare the water quality of the Cisanggarung River based on two analysis methods, namely the Pollution Index and the British Columbia Water Quality Index (BCWQI). The source of data in this study is secondary data obtained from the Cimanuk-Cisanggarung River Area Center (BBWS), in the form of the results of physical water quality parameter tests (temperature, TSS), chemistry (pH, DO, BOD, COD, Nitrate, Phosphate), and biology (Fecal Coliform). In addition, this study also conducts direct observations in the field to support the understanding of the actual conditions of the research site.

Data collection techniques are methods used to gather data for research purposes. According to Sugiyono (2017), there are at least four methods of data collection, including observation, questionnaires, interviews, and documents. This study employs a quantitative method. The research begins by conducting field observations to identify problems in the location and reviewing various literature, along with gathering the necessary data for this study.

1. Observation technique means systematically observing and recording the symptoms

that appear in the object of research.

2. This interview technique is carried out face-to-face through questions and answers between researchers or data collectors and respondents or resource persons.
3. The last data collection technique is documentation, in which the researcher takes research sources or objects.

Research Flowchart

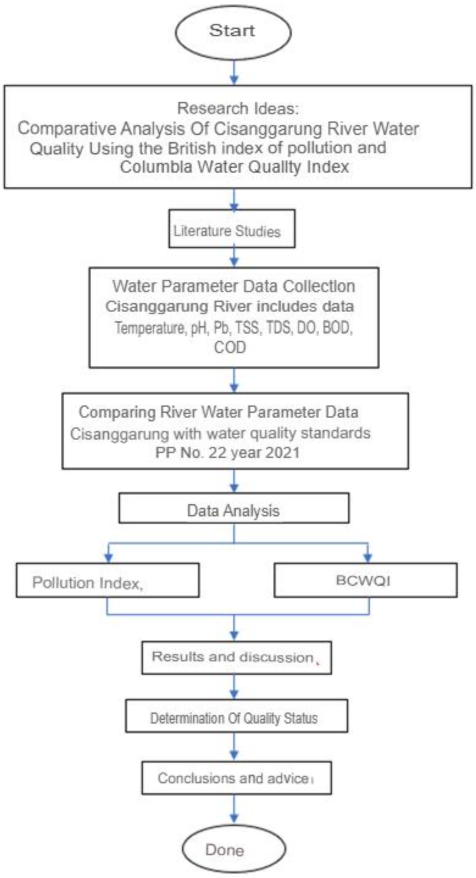

Figure 1. Flowchart

Data Collection

In this study, the following types of secondary data were used:

a. Literature studies in the form of journals, both national and international, final project reports in the form of theses, books, and regulations as research support
b. Chemical parameter data include pH, Dissolved Oxygen (DO), BOD (Biological Oxygen Demand), Nitrate ($NO3–N$), Phosphate ($PO4$), and Lead (Pb). Then, the parameters of Physics include TSS (Total Suspended Solids). As for the Biological parameters, namely the total coliform bacteria, data were obtained from the Cimanuk-Cisanggarung River Area Center (BBWS).

c. The standard for river water quality, as outlined in Government Regulation Number 22 of 2021 concerning the Implementation of Environmental Protection and Management, is found in Appendix VI. In addition to the three types of secondary data above, this study also conducts field observations to see the condition of the river.

RESULTS AND DISCUSSION

Physical Parameters

Table 1. Temperature Measurement

Suhu					
Semester	Titik Sampling				
	T1	T2	T3	Rata-rata	Buku Mutu
1	3,3	0,2	0,3	1,27	50
2	2,5	2,5	14	6,33	50

Source: BBWS Cimanuk-Cisanggarung, 2023

From table 1, it can be seen that the temperature measurement data for the Cisanggarung River in the 1st semester, on July 24, 2023, are as follows: sampling point 1, 18°C; sampling point 2, 19°C; and sampling point 3, 18°C. Meanwhile, the temperature parameter values as of December 21, 2023, for the 2nd semester are 17 °C for sampling point 1, 18 °C for sampling point 2, and 17 °C for sampling point 3. From the measurement of the temperature parameters, the following graph of temperature parameters was obtained.

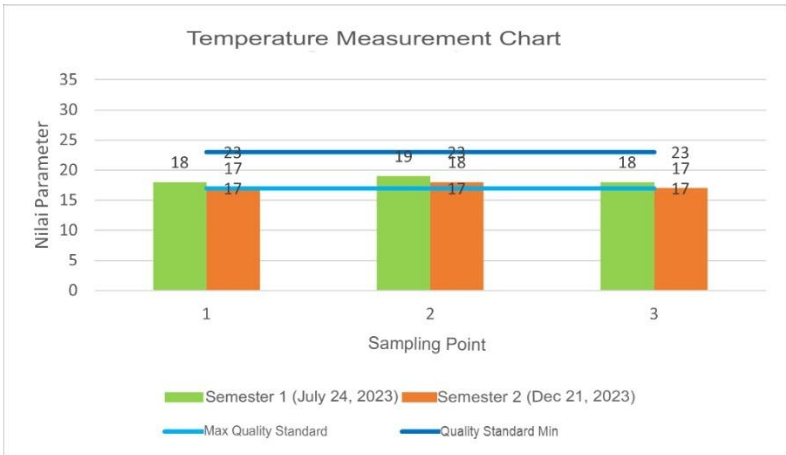

Figure 1. Temperature Measurement Chart

Total Suspended Solids (TSS)

Table 2. Total Suspended Solids *(*TSS*)* Measurement

Total Suspended Solids (TSS)					
Semester	Sampling Point				
	T1	T2	T3	Average	Quality Books
1	3,30	0,20	0,30	1.27	50
2	2.25	2.25	14.00	6.17	50

Source: BBWS Cimanuk-Cisanggarung, 2024

From table 2, it can be seen that the TSS measurement data for the Cisanggarung River in the 1st semester are as follows: sampling point 1, 3.3 Mg/L; sampling point 2, 0.2 Mg/L; and sampling point 3, 0.3 Mg/L. Meanwhile, the value of TSS parameters in the 2nd semester for sampling point 1 is 2.5 Mg/L, and for sampling point 2, it is also 2.5 Mg/L. and for sampling point 3 with a value of 14 Mg/L. From the measurement of the TSS parameters, the following graph was obtained.

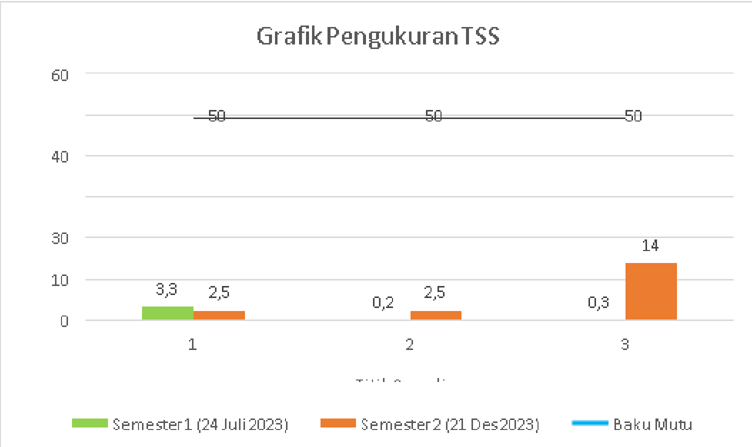

Figure 2. TS Measurement Graph

Parameter Kimia

Ph

Table 3. pH Measurement

pH					
Semester	Titik Sampling				
	T1	T2	T3	Rata-rata	Buku Mutu
1	7	8,14	7,28	7,47	6-9
2	7,2	7,7	6,6	7,17	6-9

Source: BBWS Cimanuk-Cisanggarung, 2024

From Table 3, it can be seen that the pH parameter data for the Cisanggarung River in the 1st semester are as follows: sampling point 1, 7.0; sampling point 2, 8.14; and sampling point 3, 7.28. Meanwhile, the pH parameter values in the 2nd semester for sampling point 1 are 7.2, for sampling point 2, 7.7, and for sampling point 3, 6.6. Based on the measurement of pH parameters, the following graph was obtained.

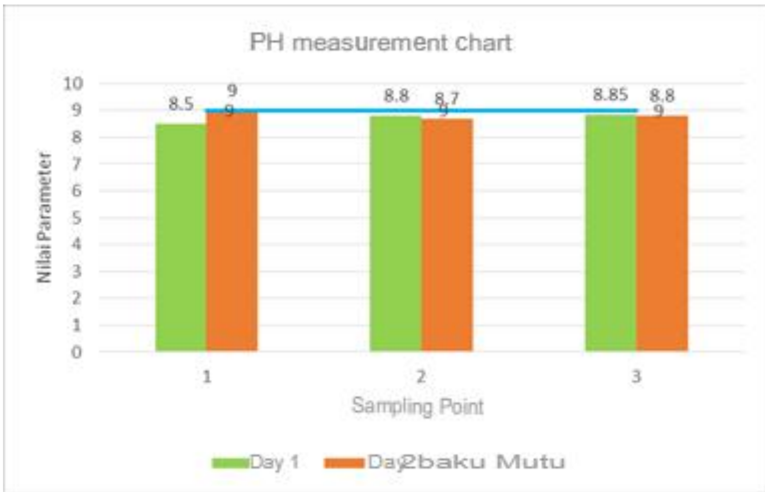

Figure 3. pH Measurement Graph

Biochemical Oxygen Demand (BOD)

Table 4. Pengukuran *Biochemical Oxygen Demand* (BOD

Biochemical Oxygen Demand (BOD)					
Semester	Sampling Point				
	T1	T2	T3	Average	Quality Books
1	2,1	2,22	3,3	2,54	3
2	2,13	2,07	3,21	2,47	3

Source: BBWS Cimanuk-Cisanggarung, 2024

From table 4 it can be seen that the BOD parameter data for the Cisanggarung River in the 1st semester are as follows: sampling point 1, 2.1 Mg/L; sampling point 2, 2.22 Mg/L; and sampling point 3, 3.3 Mg/L. Meanwhile, the values of BOD parameters in the 2nd semester for sampling point 1 are 2.13 Mg/L, and for sampling point 2, they are 2.07 Mg/L. and for sampling point 3 with a value of 3.21 Mg/L. From the measurement of the BOD parameters, the following graph was obtained.

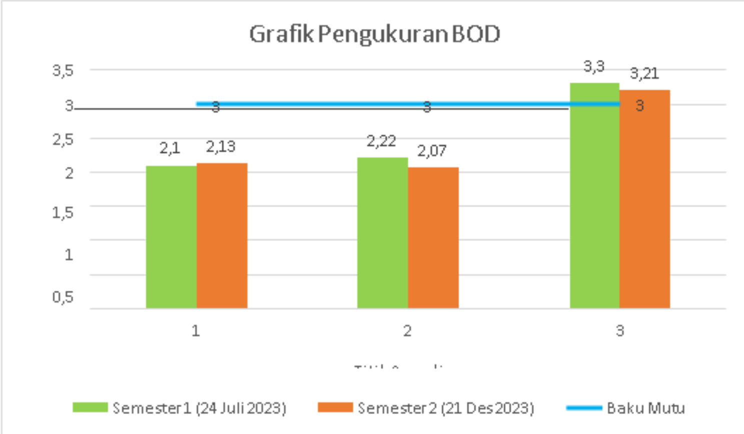

Figure 4. BOD Measurement Chart

Chemical Oxygen Demand (COD)

Table 5. Pengukuran *Chemical Oxygen Demand* (COD)

Chemical Oxygen Demand (COD)					
Semester	Titik Sampling				
	T1	T2	T3	Rata-rata	Buku Mutu
1	7	7,4	11	8,47	25
2	7,1	6,9	10,7	8,23	25

Source: BBWS Cimanuk-Cisanggarung, 2024

From Table 5, it can be seen that the COD parameter data for the Cisanggarung River in the 1st semester are as follows: sampling point 1, 7 Mg/L; sampling point 2, 7.4 Mg/L; and sampling point 3, 11 Mg/L. Meanwhile, the COD parameter value in the 2nd semester for sampling point 1 is 7.1 Mg/L, and for sampling point 2, it is 6.9 mg/L. and for sampling point 3 with a value of 10.7 Mg/L. From the measurement of the COD parameters, the following graph was obtained.

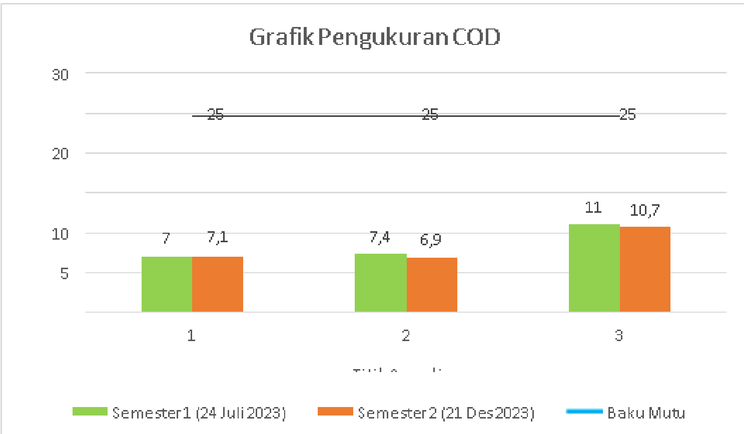

Figure 5. COD Measurement Chart

Dissolved Oxygen (DO)

Table 6. Dissolved Oxygen (DO) Measurements

Dissolved Oxygen (DO)					
Semester	Sampling Point				
	T1	T2	T3	Average	Quality Books
1	3.60	4.30	3.70	3.87	4
2	2.10	2.30	3.80	2.73	4

Source: BBWS Cimanuk-Cisanggarung, 2024

From table 6, it can be seen that the DO parameter data for the Cisanggarung River in the 1st semester are as follows: sampling point 1, 3.6 Mg/L; sampling point 2, 4.3 Mg/L; and sampling point 3, 3.7 Mg/L. While the value of the DO parameter in the 2nd semester for sampling point 1 is 2.1 Mg/L, for sampling point 2, it is 2.3 Mg/L. and for sampling point 3 with a value of 3.8 Mg/L. From the measurement of the DO parameters, the following graph was obtained.

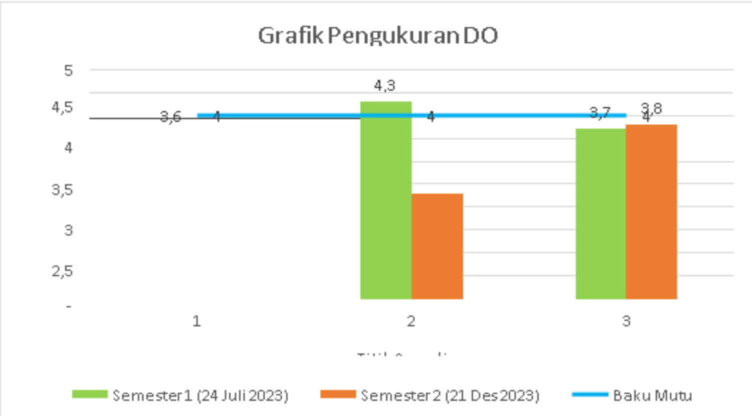

Figure 8. DO Measurement Graph

Total Phosphate

Table 7. Total Phosphate Measurements

Fosfat Total (Mg/L)					
Semester	Sampling Point				
	T1	T2	T3	Average	Quality Books
1	3.6	4.3	3.7	0,92	0,2
2	2.1	2.3	3.8	0,15	0,2

Source: BBWS Cimanuk-Cisanggarung, 2024

From table 7, it can be seen that the Total Phosphate parameter data for the Cisanggarung River in the 1st semester are as follows: sampling point 1, 0.97 Mg/L; sampling point 2, 0.99 Mg/L; and sampling point 3, 0.81 mg/L. Meanwhile, the Total Phosphate parameter value for sampling point 1 in the 2nd semester is 0.14 mg/L. For sampling point 2, the value is 0.15 Mg/L, and for sampling point 3, the value is 0.17 mg/L.

From the measurement of the Total Phosphate parameters, the following graph is obtained.

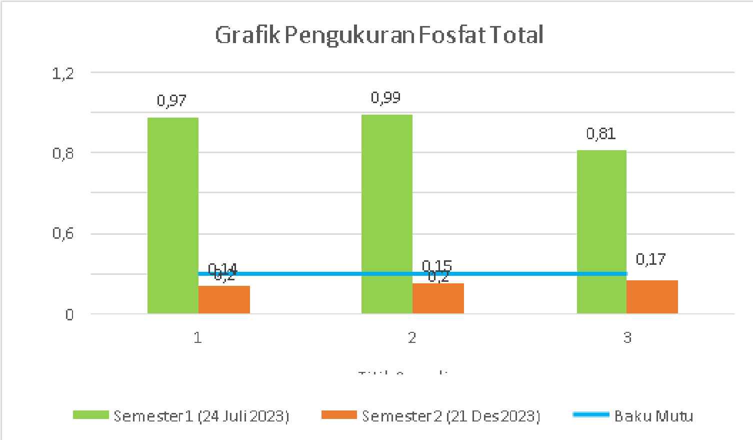

Figure 7. Total Phosphate Measurement Graph

Nitrate

Table 8. Nitrate Measurements

Nitrat (Mg/L)					
Semester	Sampling Point				
	T1	T2	T3	Average	Quality Books
1	3,55	1,48	0,89	1,97	10
2	0,14	0,06	1,07	0,42	10

Source: BBWS Cimanuk-Cisanggarung, 2024

From table 8, it can be seen that the data on Nitrate parameters in the Cisanggarung River for the 1st semester, at sampling point 1, is 3.55 Mg/L, at sampling point 2, 1.48 Mg/L, and at sampling point 3, 0.89 mg/L. Meanwhile, the values of the Nitrate parameters in the 2nd semester for sampling point 1 are 0.14 Mg/L, for sampling point 2 are 0.06 Mg/L, and for sampling point 3, the value is 1.07 Mg/L. So that from the measurement of the Nitrate parameters, a graph was obtained as a result of

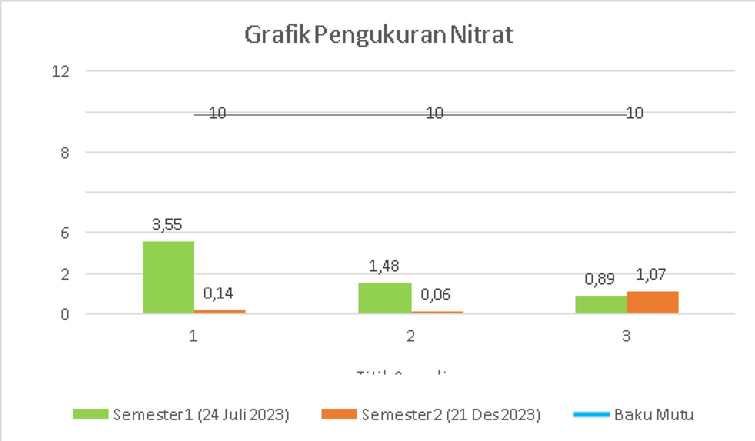

Figure 8. Nitrate Measurement Graph

Parameter Biologi

Fecal Coliform

Table 9. Fecal Coliform Measurements

Fecal Coliform (MPN/1000mL)					
Semester	Sampling Point				
	T1	T2	T3	Average	Quality Books
1	0	0	10	3,33	1000
2	16	46	58	40	1000

Source: BBWS Cimanuk-Cisanggarung, 2024

From table 9, it can be seen that the *Fecal Coliform* parameter data for the Cisanggarung River in the 1st semester, for sampling point 1, is 0 MPN/100 mL, for sampling point 2, is 0 MPN/100 mL, and for sampling point 3, is 10 MPN/100 mL. Meanwhile, *the Fecal Coliform parameter values in the 2nd semester are as follows: for sampling point 1, 16 MPN/100 mL; for sampling point 2, 46 MPN/100 mL; and for sampling point 3, 58 MPN/100 mL*. From the measurement of Fecal Coliform parameters, the following graph was obtained.

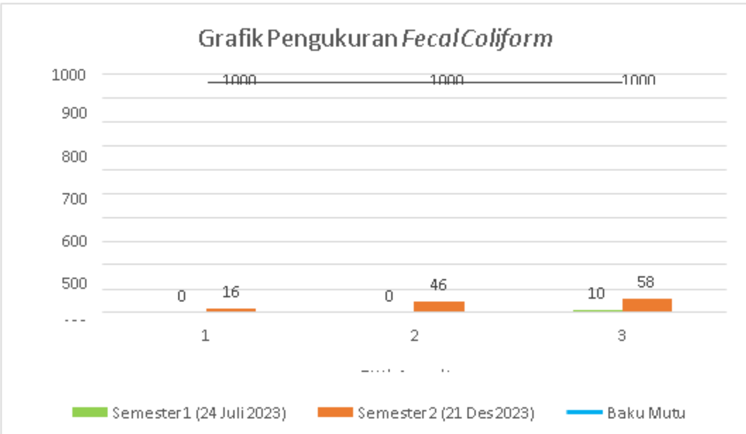

Figure 9. Coliform Total *Measurement Graph*

Cisanggarung River Water Quality Based On Quality Standards

Table 10. Measurement Results

Semester 1 Results						
No	**Parameter**	**Unit**	**Quality Standards**	**Titik**		
				T1	**T2**	**T3**
1	Temperature	-	19 -25	19	20	19
2	TSS	mg/L	50	3.30	0.20	0.30
3	Phosphate	mg/L	0.03	0.97	0.99	0.81
4	pH	-	6 – 9	7.00	8.14	7.28
5	DO	mg/L	4	3.60	4.30	3.70
6	BOD	mg/L	3	2.10	2.22	3.30
7	COD	mg/L	25	7.00	7.40	11.00
8	NITRATE	mg/L	10	3.55	1.48	0.89
9	FECAL COLIFORM	MPN/1000 MI	1000	0.00	0.00	10.00

*: PP No. 22 of 2021

Source: BBWS Cimanuk-Cisanggarung, 2023

Based on table 10, it is generally acknowledged that all parameters meet quality standards. The parameters that exceed the quality standard, specifically the 1st semester on July 24, 2023, include the Total Phosphate parameter with a value of 0.97 mg/L.

Table 11. Measurement Results

Semester 2 Results						
No	**Parameter**	**Unit**	**Quality Standards**	**Titik**		
				T1	**T2**	**T3**
1	Temperature	-	17 -23	17	18	17
2	TSS	mg/L	50	2.25	2.25	14
3	Phosphate	mg/L	0.03	0.14	0.15	0.17
4	pH	-	6 – 9	7.2	7.7	6.6
5	DO	mg/L	4	2.1	2.3	3.8
6	BOD	mg/L	3	2.13	2.07	3.21
7	COD	mg/L	25	7.1	6.9	10.7
8	NITRATE	mg/L	10	0.14	0.06	1.07
9	FECAL COLIFORM	MPN/1000 MI	1000	16	46	58

*: PP No. 22 of 2021

Source: BBWS Cimanuk-Cisanggarung, 2024

Based on the two tables of measurement results above, according to the quality standards of PP No. 22 of 2021, Class II, concerning the Implementation of Environmental Protection and Management, the Cisanggarung River meets its intended use, as all parameters comply with the quality standards outlined in PP No. 22 of 2021, Class II.

The above shows that the quality of the water is safe to use for the surrounding community and can even be used for raw water with little treatment because many parameters are below quality standards such as TSS, pH, BOD, COD, NITRATES, and *Fecal Coliform* so that it is still limited to safe or sound. The parameters that do not meet quality standards, such as Total Phosphate and DO, are caused by agricultural waste. Specifically, the use of fertilizers increases phosphate levels in waters through rainwater runoff and domestic waste containing phosphate, which can also contribute to an increase in phosphate levels in water bodies.

Pollution Index Method

Table 12. Results of Water Quality Status Analysis of Pollution Index Method

No	Location	Formula	Semester 1 Results	Quality Status	Semester 2 Results	Quality Status
1	Sampling Point 1	(Ci/Lij) Maks	3.55	Polluted Light	1.00	Good
		(Ci/Lij) Rate-Rate	0.80		0.24	
		PIj	1.818		0.727	
2	Sampling Point 2	(Ci/Lij) Maks	3.59	Polluted Light	0.69	Good
		(Ci/Lij) Rate-Rate	0.78		0.21	
		PIj	1.838		0.511	
3	Sampling Point 3	(Ci/Lij) Maks	3.16	Polluted Light	1.15	Good
		(Ci/Lij) Rate-Rate	0.78		0.47	
		PIj	1.625		0.876	
	Rata-Rata Pidge		1.761	Lightly Polluted	0.705	Good

Source: Data processed

From Table 12 above, it is observed that the most considerable Pollution Index value occurred at sampling point 2 in the 1st semester, with a value of 1.84, which was categorized as "Lightly Polluted." The smallest value occurred at sampling point 2 in the 2nd semester, with a value of 0.501, which was classified as "Good." The average Pollution Index value in the Cisanggarung River is 1.192, categorized as Lightly Polluted.

Metode British Columbia Water Quality Index (BCWQI)

Table 13. Results of Water Quality Status Analysis of BCWQI Method Semester 1

Titik Sampling	Variabel Gagal	Uji Gagal	F1	F2	F3	Skor	Status Mutu Air
1	2	2	11.11	11.11	0.580	13.12	Good
2	1	1	11.11	11.11	0.697	15.17	Good
3	3	3	22.22	22.22	1.458	26.24	Fair
Rata-rata Nilai						18.36	Fair

Source: BBWS Cimanuk-Cisanggarung, 2023

Based on Table 13, the determination of quality status was obtained using the BCWQI method. Sampling point 1 received a score of 13.12, indicating Good quality status, while sampling point 2 scored 15.71, also achieving Good quality status. Sampling point 3 achieved a score of 26.24, corresponding to a Fair quality status. If the values of the three locations are averaged, the average score for the quality status in the Cisanggarung River is 18.36, indicating fair information.

Table 14. Results of Water Quality Status Analysis of BCWQI Method

Titik Sampling	Variabel Gagal	Uji Gagal	F1	F2	F3	Skor	Status Mutu Air
1	2	2	22.22	22.22	-0.905	26.24	Fair
2	2	2	11.11	11.11	-0.739	13.12	Good
3	3	3	33.33	33.33	0.013	39.35	Fair
Rata-rata Nilai						26.24	Fair

Source: BBWS Cimanuk-Cisanggarung, 2023

Based on table 13, the determination of quality status was obtained using the BCWQI method. Sampling point 1 received a score of 26.24, indicating a Fair quality status, while sampling point 2 scored 13.12, achieving a Good quality status, and sampling point 3 scored 39.35, also earning a Fair quality status. If the values of the three locations are averaged, the average score for the quality status in the Cisanggarung River is 26.24, indicating fair information.

Comparison Of IP And Bcwqi Water Quality Status

Table 15. Results of Water Quality Status Analysis for Each Semester 1 Method

No	Sampling Point	Water Quality Status Method	
		Pollution Index	BCWQI
1	1	Lightly Polluted	Good
2	2	Lightly Polluted	Good

No	Sampling Point	Water Quality Status Method	
		Pollution Index	BCWQI
3	3	Lightly Polluted	Fair
Average		Lightly Polluted	Fair

Source: BBWS Cimanuk-Cisanggarung, 2023

Table 16. Results of Water Quality Status Analysis for Each Semester

No	Sampling Point	Water Quality Status Method	
		Pollution Index	BCWQI
1	1	Good	Fair
2	2	Good	Good
3	3	Good	Fair
Average		Good	Fair

Source: BBWS Cimanuk-Cisanggarung, 2023

From tables 15 and 16, average results were obtained, showing that the two methods had different quality statuses. The Pollution Index method indicates that the water quality status in the Cisanggarung River in Semester 1 is "Lightly Polluted" and in Semester 2 is "Good". The BCWQI method shows that the status of water quality in the Cisanggarung river in semester 1 is "Fair" and in semester 2 is "Fair"

In the pollutant index method, the necessary parameter for determining the value is the one with the maximum (Ci/Lij) compared to the average of all parameters. Measurements with single data and different times in the exact location often result in different quality status values. This causes confusion or differences in interpretation for ordinary people (Aristawidya et al., 2020).

The BCWQI method utilizes time series data, whereas the Pollution Index Method employs single data points. The quality status calculated using time series data can describe the quality of river water over a certain period. Based on the description above related to the discussion of each method for determining water quality status, if you are seeking real-time water quality status data, you can utilize the Pollution Index Method. However, if you are looking for water quality status using periodic data, you can use the BCWQI Method. If you are looking for a method with high sensitivity and that does not depend on the weighting of each parameter, then the appropriate method to use is the BCWQI Method (Reza, 2021).

CONCLUSION

The results of the average value analysis using the Pollution Index method in Semester 1 yielded an average score of 1.761, indicating that the water quality status was "Lightly Polluted". In Semester 2, the average value was 0.705, indicating a "Good" water quality status. In contrast, the results of the average analysis using the BCWQI method in Semester 1 yielded an average score of 18.36, indicating a water quality status of "Fair." In Semester 2, the average score was 26.24, also indicating a water quality status of "Fair." Based on the results of the analysis to determine the water quality status using the two methods, it can be concluded that the appropriate method is the BCWQI method because it has a high sensitivity value because the average value results in each sampling semesters 1 and 2 get a water quality status **of "Fair"** while in the Pollution Index method, the average value results in each sampling semester 1 get the water quality status **of "Light Polluted"** and in semester 2 got the water quality status **"Good"** and because the data in this study uses periodic data so that the most appropriate method to determine the water quality status is the BCWQI method.

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