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Application of STORET Method to Determine Lake Sentani Water Quality Status in Papua Province

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ABSTRACT

Lake coastal communities utilize Lake Sentani's water to meet clean and other needs such as industry, irrigation, plantations, fisheries, and water transportation facilities. In addition to the lake mentioned above, they use it as a garbage dump and family waste; even human and animal feces are thrown into Lake Sentani. This study aims to determine the quality and quality status using the STORET method based on PP 22 of 2021 concerning the Implementation, Protection, and Management of the Environment annex vi-2 class 1 by applying ten parameters. The study used three stations: Ifale, Asei, and Jaifuri coast. Each station was sampled four times: January, April, July, and October 2023. The results showed that seven parameters did not meet the quality standards, namely TSS, BOD, COD, Pb, Oil and Fat, Total Ditergen, and Total coliform, and only three parameters met the quality shoulder, namely temperature, TDS, and pH. Water quality status based on the application of the STORET method was obtained that station 1 obtained a score of -26 based on US_EPA, including class C (moderately polluted), station 2 obtained a score of -64, including class D (heavily polluted), and station 3 obtained a score of -116 including class D (heavily polluted) and the average STORET score of the three stations was obtained -68.67 including class D (heavily polluted).

Introduction

Lake Sentani is the largest lake in Papua, located on the slopes of the Cyclops Nature Reserve Mountains at an altitude of 85 meters above sea level, with water depths reaching 75 m (Suhartawan, Alfons, & Daawia, 2022). This lake was formed due to tectonic activity in the form of landslide dams and has an area of approximately 9,360 hectares with a length of 28 km and a width of 19 km. There are 12 rivers supporting Lake Sentani (inlet) and one discharge river (outlet). Apart from being the primary source of clean water and raw drinking water for coastal communities, Lake Sentani water is also used for industrial purposes, irrigation of plantation land, capture fisheries for fishermen,

aquaculture with cages, and even as a means of water transportation (Asocadewi, Oktiawan, & Hadiwidodo, 2015).

In addition to the lake mentioned above, they use it as a garbage dump, and family waste, including human and animal feces, is thrown into Lake Sentani. So that Lake Sentani becomes the center of all community activities. Conditions like this certainly cause a decrease in lake water quality and are very dangerous to the health and sustainability of the lake water environment (Ashok Lumb, Halliwell, & Tribeni Sharma, 2006).

Water is a very important part of supporting the sustainability of life because life will not occur without water. The water needed for life, both flora and fauna, must be by its designation because if it is not appropriate, life will be disturbed (Akhtar et al., 2021). Likewise, the increasing population of residents who live on the shore of the lake and settlements that dispose of domestic waste that empties into Lake Sentani certainly negatively impact the environmental sustainability of Lake Sentani's waters. In addition, population growth also impacts the increasing need for clean water, conditions of which are increasingly scarce. In addition, (Yacub et al., 2022), the problem of poor urban sanitation management systems, industrial development, and the use of pesticides and chemical fertilizers are also causes of declining water quality. This condition is very concerning and requires serious attention from various parties, especially the Jayapura district/city government.

Evaluating water quality can be done in a conventional way, where laboratory test results are compared with the water quality standards applied, whether drinking water, clean water, or wastewater, but sequential and routine sampling is the main obstacle. Therefore, a quantitative method has been developed for calculating a single index, which is a combination of several values of water quality parameters (Saraswati, Sunyoto, Kironoto, & Hadisusanto, 2014) and is a popular method developed in Indonesia (State Minister of the Environment, 2003), namely the STORET method. The STORET method can be adjusted to the desired quality standards and applicable in each region. The use of the STORET method is also adjusted to the allocation of the water being tested; one of the requirements of the STORET method is to have quality data that describes the time series (Reza, 2021).

This study aims to examine the use of the STORET method to determine the status of Lake Sentani water quality by applying ten water quality parameters, namely: 1) temperature; 2) total dissolved solids (TDS); 3) total suspended solids (TSS); 4) degree of acidity (pH); 5) biochemical oxygen demand (BOD); 6) chemical oxygen demand (COD); 7) lead (Pb); 8) oils and fats; 9) total detergent; and 10) total coliform as a reference for comparison in conducting water quality analysis guided by PP Number 22 of 2021 concerning Environmental Management, annex VI part 2 concerning Lake Water Quality Standards and the like, annex VI part 2 concerning Lake Water Quality Standards and the like. With the knowledge of the status of Lake Sentani water quality, the Regency / City Government of Jayapura or Papua Province control strategy can be known so that the lake water functions optimally (Sumaji, 2017).

Research Methods

Location and Time of Research

This study determined three research points (stations), namely the upstream, middle, and downstream of Lake Sentani, namely:

a. Station 1: The waters of Lake Sentani in Ifale Sentani with ordinate location : (2o 35' 53" S, 140o 31'00" E).
b. Station 2: The waters of Lake Sentani in Asei with ordinate location: (2o 36' 01" S, 140o 34'17" E).
c. Station 3: The waters of Lake Sentani in Jaifuri Yoka (outlet of Lake Sentani) with ordinate location : (2o 41' 24" S, 140o 35'04" E).

Data Collection

Data collection was carried out in-situ (on-site tests) and ex-situ (laboratory tests) on water samples at three research stations based on procedures by the Indonesian National Standard (SNI) for appropriate water quality parameters. Three parameters are tested initially. Namely, temperature, TDS, pH, and seven parameters are tested in the laboratory: TSS, BOD, COD, Pb, oils and fats, total detergents, and total coliforms (Nemerow, 1971).

Data Processing and Analysis

Method STORET

Step-rare calculation of STORET index:

1. Collect data based on time series.
2. The data obtained are determined by their maximum, average, and minimum values.
3. The above results are confirmed with class 1 water quality standards PP 22 of 2021 water attachment for appropriate parameters. If the score meets it, it is given a score of 0, and if it is not appropriate or outside the quality standard, it is scored according to the STORET score table (Tanjung et al., 2021).

Results and Discussion

Result

No	Parameter	Baku Mutu	Stasiun 1				Stasiun 2				Stasiun 3			
			Feb	Mei	Agt	Nop	Feb	Mei	Agt	Nop	Feb	Mei	Agt	Nop
1	Suhu	Dev3	29,40	30,20	30,20	32,00	31,80	32,10	32,40	30,70	29,60	28,60	31,50	30,10
2	TDS	1.000	65	55	52	90	98	98	87	101	465	782	465	771
3	TSS	25	23	21	43	33	18	19	34	38	176	190	52	98
4	pH	6-9	7,40	7,70	8,00	8,10	7,60	7,60	7,90	8,40	7,60	7,60	7,90	8,40
5	BOD	2,00	1,20	2,20	2,30	1,60	1,67	1,83	1,22	2,40	1,67	1,83	1,22	4,30
6	COD	10,00	12,2	21,1	13,4	16,2	15,7	19,6	15,4	17,2	15,70	24,00	21,00	11,00
7	Pb	0,03	0,01	0,01	0,02	0,02	0,06	0,05	0,02	0,02	0,01	0,02	0,02	0,02
8	M&L	1,00	0,90	1,60	2,10	2,20	2,10	1,50	3,20	1,30	33,00	89,00	45,00	13,00
9	DT	0,20	0,24	0,16	0,22	0,18	0,18	0,16	0,42	0,36	34,00	45,00	8,00	13,00
10	Tc	1.000	86	120	130	341	87	210	112	235	1.120	1.412	1.350	1.345

a. Lake Sentani water quality

Water quality is discussed on parameters that do not meet quality standards, namely TSS, BOD, COD, Pb, Oil and Fat, Total Ditergen, and Total coliform.

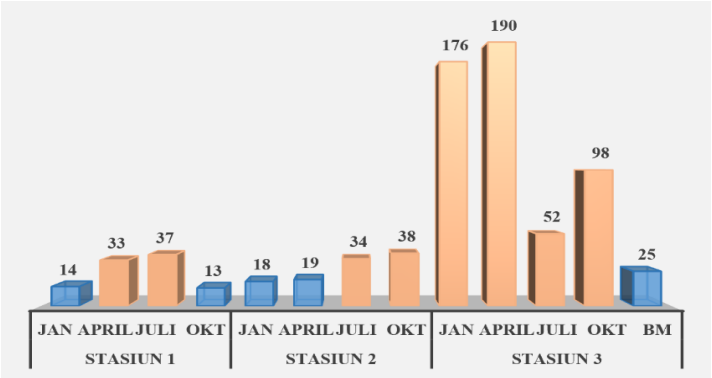


Figure 1 Total Suspended Solid (TSS)

Erosion from the Cycloops mountains that empty into Lake Sentani caused high TSS, especially at station 3, which is the only outlet of Lake Sentani water; in addition to the heavy flow, it also carried fine particles suspended in the water. High TSS also impacts water turbidity and inhibits the entry of sunlight into the water, disrupting the photosynthesis of aquatic plants (Burhanuddin & Setyobudiarso, 2019).

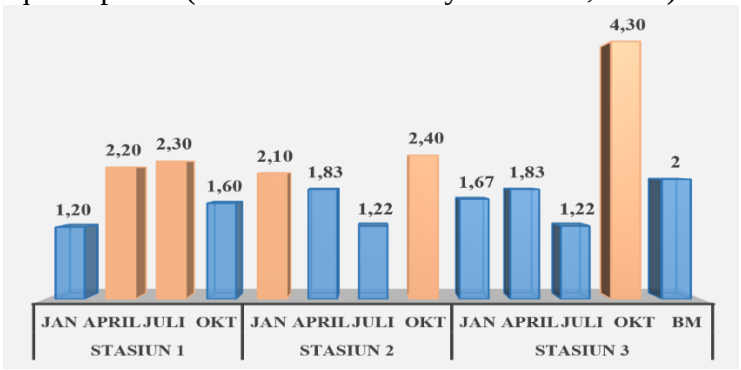


Figure 2 Biological Oxygen Demand (BOD)

The increase in organic matter will cause a high BOD. This is also due to the increasing number of bacteria in water bodies that require oxygen. There was no significant difference in the height of BOD at the three study stations (Karliansyah, 2016).

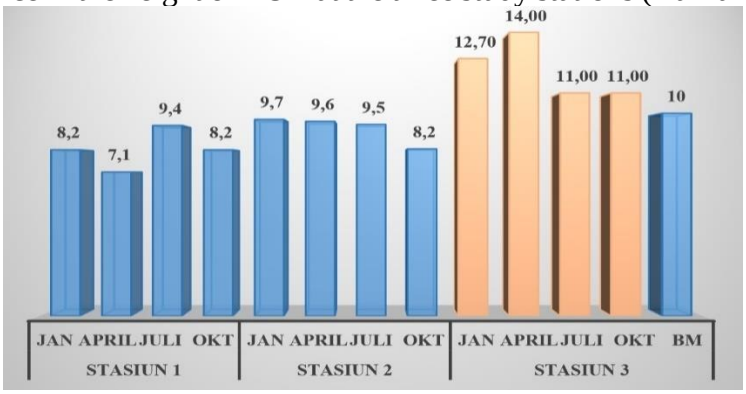


Figure 3 Chemical Oxygen Demand (COD)

Household waste containing organic matter and a large enough amount that empties into Lake Sentani is the cause of the high organic matter in the waste and is the leading cause of the high concentration of COD in Lake Sentani (Amin, 2014).

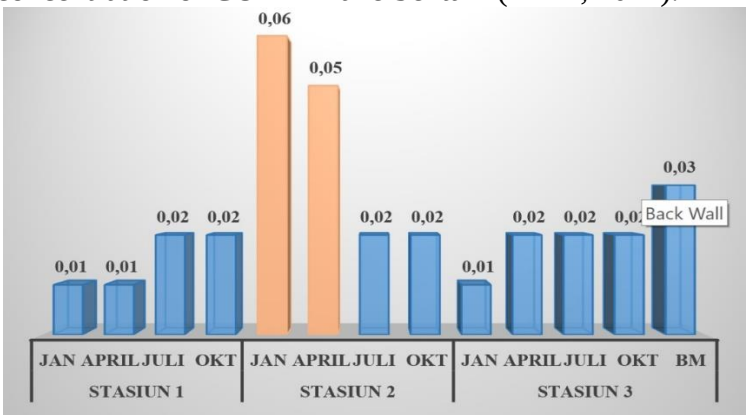


Figure 4 Lead (Pb)

Figure 4 shows that the Pb parameter at station 2 (Asei) in January and April was very high and exceeded the quality standard. This is due to the dense water transportation that operates. Dense transportation because Asei is a tourist area close to Kalkota Pier, the center of water transportation facilities on Lake Sentani. Waste use of transportation fuel resulted in high Pb content in Lake Sentani water in the Asei area (station 2) (Maufilda, 2015).

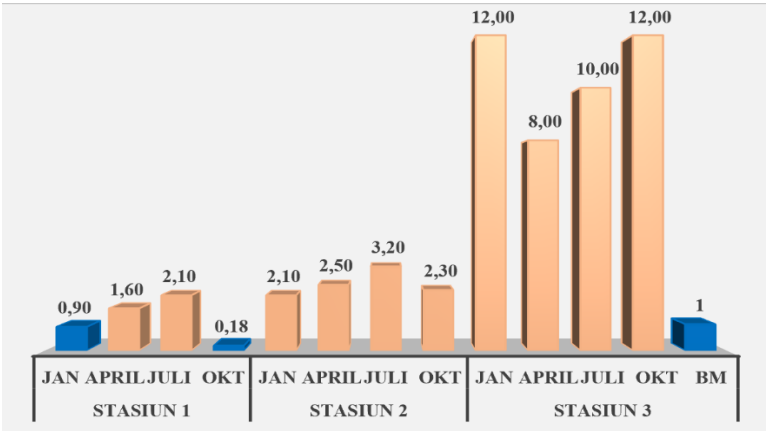


Figure 5 Oils and Fats

Oil and fats are classified as domestic waste that is difficult to destroy and decompose by microorganisms. This waste has a smaller density than water, so its existence floats above the water's surface and forms a small layer, and a small part dissolves in water (999). The picture above shows that at station 3 (outlet), the highest oil and fat content is caused by the smaller surface area of the water, causing the oil and fat layer on the surface of the water to get thicker and more soluble in water (Burhanuddin & Setyobudiarso, 2019).

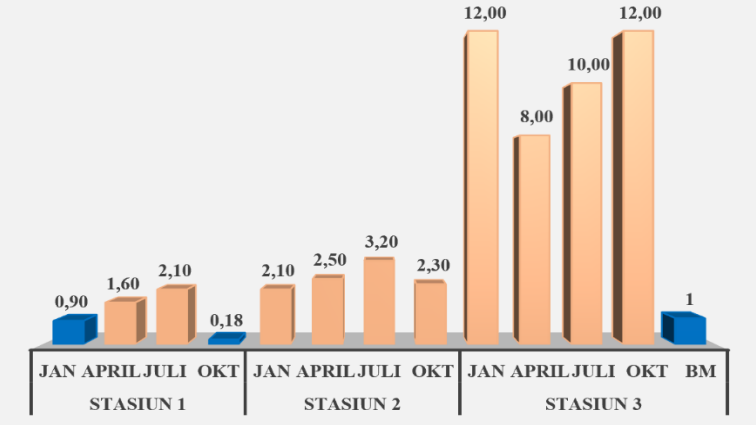
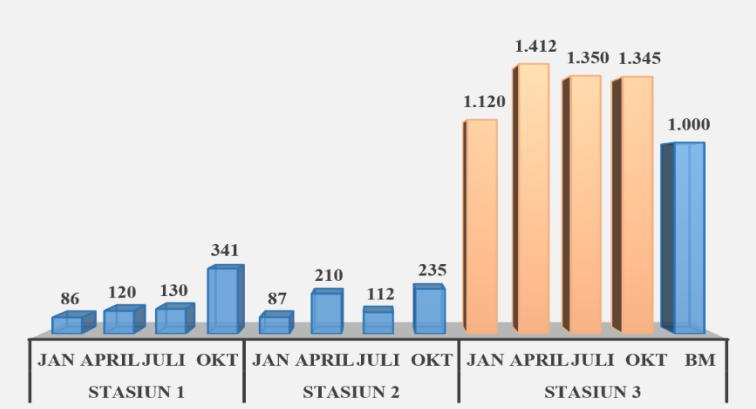


Figure 6 Total Detergent

Unlike oils and fats, total detergents are readily soluble in water. Total detergent is domestic waste due to the use of detergent for households to clean household appliances and wash clothes. High detergent content in waters can decrease the diversity of aquatic biota and the death of fish species in the aquatic ecosystem. In addition, it will result in silting the lake for a long time (Karliansyah, 2016).



As with detergents, oils, and fats, the total coliform content at station 3 is so high that it exceeds the maximum quality standards limit. The high total coliform is caused by the disposal of human and animal fecal waste into the water of Lake Sentani. In addition, station 3 is the estuary of Lake Sentani, where people quite densely inhabit the coast, so activities at the mouth of the lake are getting denser (Irma Lusi & Annisa Salsabilla, 2020).

Table 2
STRORET Score Calculation (station 1)

No	Parameter	Unit	BM	Moon				Valuation		Score
				Feb	From	And	Nop	Criterion	Value	
1	Temperatu re	(oC)	Dev 3	29,40	30,20	30,20	32,00	Max	32,00	0
								Min	29,40	0
								Average	30,45	0
2	TDS	(mg/L)	1.00 0	65	55	52	90	Max	90	0
								Min	52	0

								Average	66	0
3	TSS	(mg/L)	25	14	33	37	13	Max	37	-2
								Min	13	0
								Average	24	0
4	pH	-	6-9	7,40	7,70	8,00	8,10	Max	8,10	0
								Min	7,40	0
								Average	7,80	0
5	BE	(mg/L)	2,00	1,20	2,20	2,30	1,60	Max	2,30	-4
								Min	1,20	0
								Average	1,83	0
6	COD	(mg/L)	10,00	8,2	7,1	9,4	8,2	Max	9,40	0
								Min	7,10	0
								Average	8,23	0
7	Pb	(mg/L)	0,03	0,01	0,01	0,02	0,02	Max	0,02	0
								Min	0,01	0
								Average	0,02	0
8	M&L	(mg/L)	1,00	0,90	1,60	2,10	0,18	Max	2,10	-4
								Min	0,18	0
								Average	1,20	-12
9	DT	(mg/L)	0,20	0,14	0,26	0,22	0,18	Max	0,26	-4
								Min	0,14	0
								Average	0,20	0
10	Fc	(MPN/ 100 mL)	1.000	86	120	130	341	Max	341	0
								Min	86	0
								Average	169	0
								Number of Scores		-26

In the same way, station 2 and station 3 are obtained :
Skor STORET (st2) = - 64
Skor STORET (st3) = - 116(Sari & Wijaya, 2019)

Table 3 Lake water quality status based on the STORET method

No	Station	Score	Class	Category	Information
1	1	-26	C	Keep	Contaminated is
2	2	-64	D	Bad	Heavy contaminated
3	3	-116	D	Bad	Heavy contaminated
Average		-68,67	D	Bad	Heavy contaminated

Conclusion

Lake Sentani, located on the slopes of the Cyclops Nature Reserve Mountains with an area of about 9,360 hectares and a depth of 75 meters, has a vital role as a source of clean water, raw water, as well as for industrial, irrigation, and fisheries purposes, but faces water quality problems such as high Total Suspended Solids (TSS) especially at station 3 which is the outlet of the lake, indicating the need for further management and monitoring actions to maintain the sustainability of the lake ecosystem.

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