LAKE SENTANI WATER QUALITY INDEX BASED ON NSF-WQI AS RAW WATER FOR DRINKING WATER FOR LAKE SENTANI COASTAL COMMUNITIES, JAYAPURA REGENCY

Bambang Suhartawan, Jusuf Haurissa, Sarah Agustina Rumawak
Universitas Sains dan Teknologi Jayapura
Email: basuhpapua@gmail.com, jhaurissa@gmail.com, alenbiakbiak@gmail.com

ARTICLE INFO	ABSTRAK
	Lake Sentani has an area of about 9,630 ha and is located at an altitude of 72 m above sea level. Residents who live on the shores and shores of the lake, use the lake water for bathing, washing and latrine purposes. They also use it as raw water for drinking water and also as a means of transportation and even throw household waste into the lake water. There are 5 (five) rivers as the inlet, namely the Hawaii, Yamolo, Klandeli, Dofroko and Hobay rivers and there is one estuary, the Djaifuri River which is located in the east (Puay area). This study aims to determine the index of each water quality parameter and the total index of water quality. The water quality index parameters studied were; DO, Fecal coliform, pH, BOD, Temperature, Total Sulfate, Nitrate-N, Turbidity and Total Dissolved Solid (TDS). Sampling was carried out at 3 (three) sample points (stations) namely the mouth of the Haway River (Ifale Sentani), the middle of the lake (Ayapo Sentani) and the Upper Jaifuri River (Puay Yoka). Determination of the Total Water Quality Index is calculated using the National Sanitation Foundation's Water Quality Index (NSF-WQI) method for both Lake Sentani water and the total standard water quality index. The test results of each parameter are compared with the Class 1 Water Quality Standards Government Regulation of the Republic of Indonesia Number 22 of 2021 concerning the Implementation of Environmental Protection and Management. The results obtained from the research at 3 (three) research stations turned out that station 1 obtained an index of 44.24 and station 3 obtained an index of 46.60 both classified as Bad (bad), station 2 obtained an index of 51.42 classified as Medium (medium), while the standard water quality class 1 obtained a quality index of 47.24 classified as Bad (poor) too. Thus, when compared with the standard water quality index of class 1, what meets the requirements as raw water for drinking water is lake water at station 2 (Ayapu Sentani) where the index value is greater than the quality standard.

Bambang Suhartawan, Jusuf Haurissa, Sarah Agustina Rumawak

Introduction

Lake Sentani is located in Papua Province and most of its territory is located in Jayapura Regency, namely East Sentani District, Sentani District and West Sentani District, and a small part of its area is in Abepura District, Jayapura City (Burhanuddin et al., 2018, pp. VIII–56). Geographically, Lake Sentani is located in Jayapura Regency at coordinates 140º23'-140º50' East Longitude and 2º31'-2º41' South Latitude (Syariz, 2015, p. 2). This lake has an area of about 9,630 ha and is located at an altitude of 72 m above sea level (Burhanuddin et al., 2018) with 5 (five) rivers as its inlet, namely the Hawaii, Yamolo, Klandeli, Dofroko and Hobay rivers and there is one estuary, namely the Djaifuri River which is located in the east (Puay area) (Syariz, 2015).

Lake Sentani is surrounded by villages where most of the people's livelihoods are from aquaculture and agriculture (Syariz, 2015) as well as a place of recreation, while also using it to meet their raw water needs for drinking water. Almost all major rivers, lakes, and reservoirs on the island of Java have been used as raw water sources for drinking water (Badan Pengembangan Sumber Daya Manusia Kementerian Pekerjaan Umum dan Perumahan Rakyat, 2015, p. 3)

Water is one component of the environment that is very important for development and growth not only for humans, but also for other living things (Alihar, 2018, p. 68). Especially for humans, in everyday life, water is used for drinking, cooking, bathing, washing and for other needs such as farming and raising fish for farmers or other activities (Ashar et al., 2020). The water referred to here is water commonly used for drinking and cooking, which is taken daily from the lake by rural communities in the interior (Sentani, n.d., p. 44)

Overall, the amount of water on the planet Earth is relatively constant from time to time (Sari et al., 2012) meaning that it does not experience addition or subtraction because water undergoes a hydrological cycle and only undergoes changes in shape. Although the amount of water on earth is always constant, the quality of water changes along with the growth of the human population and the activities that accompany it (Rohmawati & Kustomo, 2020). High population growth has resulted in not all components of society being able to enjoy clean water (Utomo et al., 2020).

Water quality is the condition of water quality that is measured and or tested based on certain parameters and certain methods based on the applicable laws and regulations (Keputusan Menteri Negara Lingkungan Hidup No. 115, 2003:8) While the status of water quality is the level of water quality conditions that indicate polluted conditions or good conditions in a water source within a certain time by comparing it with the water quality standards set (Keputusan Menteri Negara Lingkungan Hidup No. 115, 2003:8).

The purpose of this study is to determine the parameters of the water quality index of Lake Sentani and compare it with the quality standard and to determine the Water Quality Index (NSF-WQI) of Lake Sentani and the Class 1 Water Quality Standard.

Method

This type of research is experimental research with tests in the laboratory and at the research location on water based on the test parameters or parameters studied. While the type of data obtained is primary data that is quantitative in terms of water quality parameters.

The location in this study is Lake Sentani which is an area of the City and Regency of Jayapura with its geographical location limited by:

a. To the north it is bordered by the Cycloops Mountains, Depapre District;

b. To the east it is bordered by the Abepura valley;

c. To the south, it is bordered by the Kemtukgresi and Arso Hills;

d. To the west, it is bordered by the hills of the Nimboran District

There are 3 (three) location points / sampling stations in the implementation of this research, namely:

1) Stasiun I   :   the estuary of the Haway Ifale Sentani river is ordinate : (2o 35' 53" S, 140o 31'00" E)

2) Stasiun II   :   in the middle of Lake Sentani, Ayapo Sentani District with the ordinate location : (2o 36' 31" S, 140o 35'06" E)

3) Stasiun III :   the headwaters of the Jaifuri Yoka river (the outlet of Lake Sentani) with the ordinat : (2o 41' 24" S, 140o 35'04" E).

1. Data Collection Method

The water sample that has been taken is then tested on water quality parameters with a predetermined method. The data collection method in question is as follows:

Table 1. Types of Water Quality Parameters According to NSF-WQI

No	Parameter	Testing Method	Test Place
1	DO	Electrochemistry	Laboratory
2	Fecal coliform	MPN	Laboratory
3	pH	Electrometric	Research sites
4	BOD	Titrimetry	Laboratory
5	Temperature	Thermometry	Research sites
6	Total Phosphate	Spectrophotometry	Laboratory
7	Nitrat	Spectrophotometry	Laboratory
8	Turbidity	Turbidimeter	Laboratory
9	TDS	Gravimetry	Laboratory

2. Data Processing and Analysis Method

The Water Quality Index is determined by comparing the water quality data with the sub-index curve. Determination of the water quality index (NSF-WQI) only uses 9 water quality parameters which better describe the relatively good water conditions that are not polluted by heavy metals. This is because heavy metal parameters are not included in the calculation of this index. It is feared that if the water quality index is applied to waters that are categorized as relatively polluted with metals and persistent organic pollutants (POPs), then it is possible to under estimate, because it only includes conservative water quality

parameters which only tend to describe waters contaminated with organic matter (Effendi, 2015, p. 2).

The National Sanitation Foundation's Water Quality Index (NSF-WQI) is determined to assess the level of water quality of a water body. This water quality index is based on 9 parameters which include: DO, Fecal coliform, pH, BOD, Temperature, Total Phosphate, Nitrate, Turbidity and TDS (Effendi, 2015).

To determine the Water Quality Standard Quality Index (NSF-WQI) class 1 according to Government Regulation Number 22 of 2021 using 7 water quality parameters, namely: DO, Fecal coliform, pH, BOD, Temperature, Total Phosphate and TDS, while the Nitrate-N parameter and Turbidity are not taken into account in determining the NSF-WQI Water Quality Index because they are not required in the Government Regulation. Thus, the weighting of each parameter needs to be changed first without taking into account the Nitrate-N and TDS parameters. The total weight of all parameters of both Lake Sentani water and the Water Quality Standard is equal to 1. How to calculate the weight results for each parameter with the help of the NSF-WQI online calculator (Hoya et al., 2020, p. 51). The results of the weighting of each parameter can be seen in table 2 below:

Table 2. Weight Modification (Wi) of Water Quality Parameters According to NSF-WQI

No	Parameter	Normal Weight (Lake Sentani Water)	Modified Weight (Water Quality Standard) PP 22/2021
1	Dissolved Oxygen (DO)	0,17	0,21
2	Fecal coliform	0,16	0,13
3	Acidity (pH)	0,11	0,13
4	Biological Oxygen Demand (BOD)	0,11	0,13
5	Temperature	0,10	0,12
6	Total phosphate	0,10	0,12
7	Nitrat	0,10	-
8	Turbidity	0,08	-
9	Total Dissolved Solid (TDS)	0,07	0,21
	Total Score	1	1

Results and Discussion

1. Lake Sentani Water Quality

In accordance with the research objectives that have been stated and the number of test parameters to determine the amount of the Water Quality Index (NSF-WQI), the following will present the test results of 9 (nine) water quality parameters for the 3 research stations and their quality standards in table 3 below.

Table 3. Results of Sentani Lake Water Quality Test

No	Parameter	Research Station			Grade 1 Quality Standard
		I (Ifale)	II (Ayapo)	III (Jaifuri)	
1	DO	4,84	6,62	5,40	6,00
2	Fecal coliform	245	26	210	100
3	pH	7,90	7,81	7,60	7,50
4	BOD	2,62	1,02	1,83	2,00
5	Temperatur	30,6	31,4	32,1	30,00
6	Total Pospat	1,0	2,1	1,2	0,010
7	Nitrat	0,002	0,014	0,007	-
8	Kekeruhan	208	98	189	-
9	TDS	121	90	98	1.000

From the table above shows the research data in the form of index parameter test results at each station, namely:

a. Station I is located on Lake Sentani, near the inlet of the Haway River, Ifale Village, Sentani District.
b. Station II is located in the middle of Lake Sentani in Ayapo Village, Sentani District.
c. Station III is located on Lake Sentani near the Jaifuri Yoka . river outlet.

In addition, the table also displays class 1 water quality standards according to the Indonesian Government Regulation Number 22 of 2021. The results of the discussion of each parameter are:
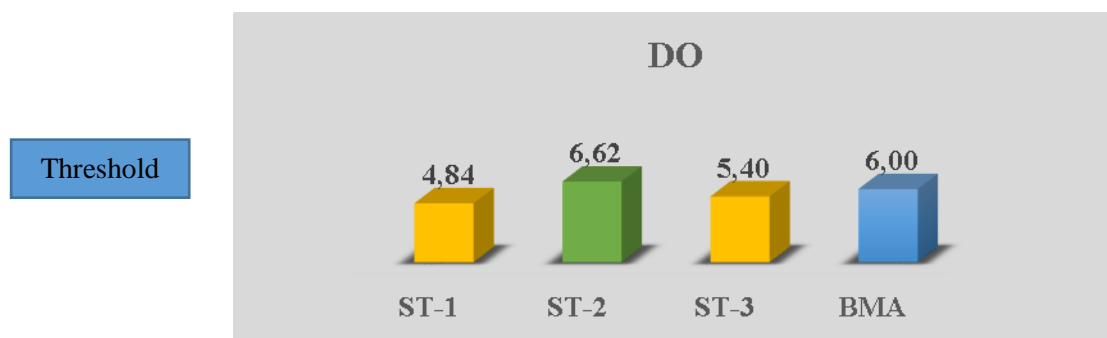

**Figure 1. Dissolved Oxygen (DO) Index Parameter Diagram
Sentani Lake Water and Water Quality Standards**

To fulfill its function, it is expected that the DO index parameter is greater than the quality standard, the bigger the better. The results showed that station 1 (Ifale) had DO levels below the minimum threshold of 6.00, as well as station III (upstream of the Jaifuri River) with DO levels of 5.40. At station II (middle of the lake in Ayapo) a DO level of 6.62 meets the requirements as a water quality standard.

The low oxygen content is influenced by temperature, salinity and atmospheric pressure. The concentration of dissolved oxygen is also influenced by the density of aquatic organisms, because the denser the aquatic organisms, the respiration rate will also increase. An increase in respiration will cause a decrease in dissolved oxygen in the water.
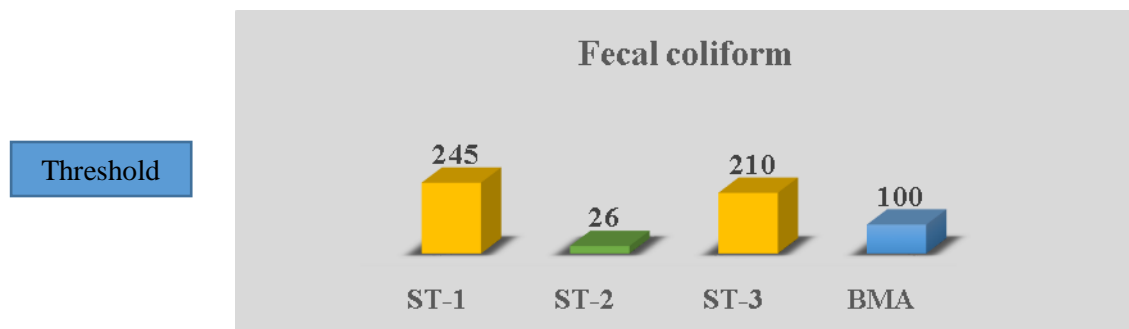
2. **Fecal coliform**

Figure 2. Parameter Diagram of Fecal coliform Index
Sentani Lake Water and Water Quality Standards

Fecal coliform is a rod-shaped bacterium found in the feces of warm-blooded animals, the presence of fecal coliform indicates the presence of harmful pathogenic bacteria in the waters of Lake Sentani. The high fecal coliform at Lake Sentani station 1 is due to the large amount of livestock and domestic waste that is discharged into Lake Sentani via Singai Haway, in addition, the coastal communities of the Lake dispose of feces directly into the waters of Lake Sentani. Meanwhile, the low fecal coliform at station 2 is because it is far from residential areas.
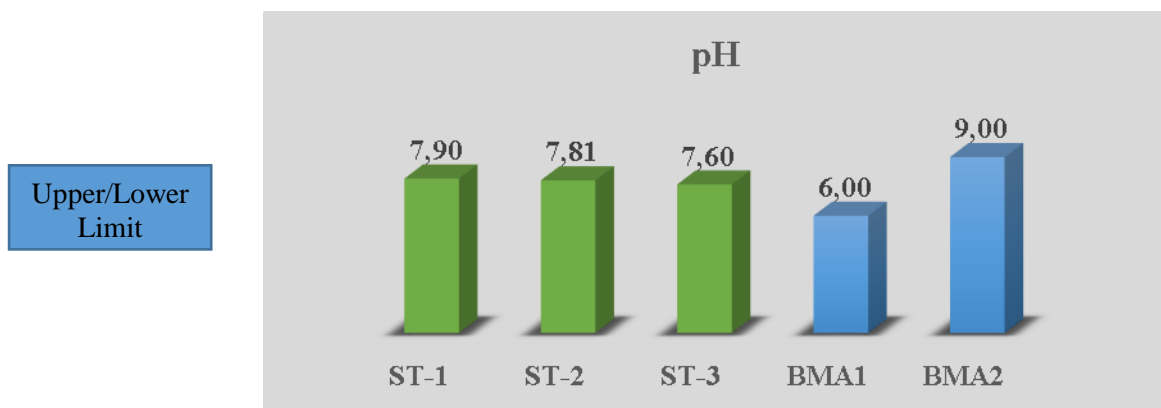
3. **Degree of Acidity (pH)**

Figure 3. Parameter Diagram of Acidity Degree Index (pH)

Sentani Lake Water and Water Quality Standards

The degree of acidity (pH) of the research results at all stations was respectively 7.90; 7.81 and 7.60 are still at the required pH for class 1 water quality standards, namely pH 6 – 9, so the water is still fit for consumption.

The Environmental Protection Agency (EPA) in the United States recommends that the pH level of drinking water that is safe for human consumption is in the range of 6.5 to 8.5. If the pH of drinking water is within the recommended level, the water will be safe for consumption.

4. Biological Oxygen Demand (BOD)

**Figure 4. Parameter Diagram of Biological Oxygen Demand (BOD) Index
Sentani Lake Water and Water Quality Standards**

In the picture above, it can be seen that the BOD index for station 1 (Ifale) is the highest at 2.62 or exceeds the threshold value for class 1 water quality standards, which is 2.00. This condition is caused by a large amount of domestic waste generated by residents who live in the Sentani City area. Meanwhile at station 3 (Jaifuri river outlet) the BOD index has improved to below the water quality standard threshold.

5. Temperature
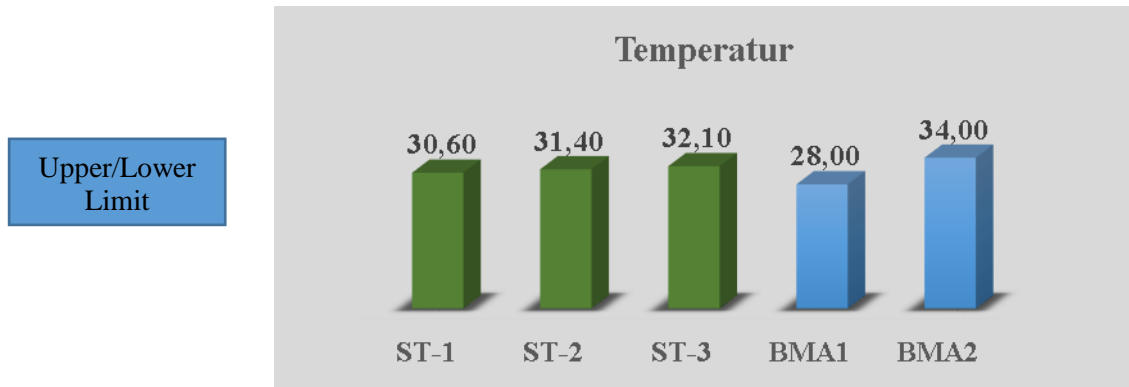
**Gambar 5. Diagram Parameter Indeks Temperatur
Air Danau Sentani dan Baku Mutu Air**

The air temperature above the lake water surface at the time of data collection was 31oC. In accordance with the provisions that the allowable water temperature is ± 3oC from the air temperature above the surface which means in the range of 28oC to 34oC. Thus, the water temperature index parameter of Lake Sentani still meets the requirements of class 1 . water quality standards.
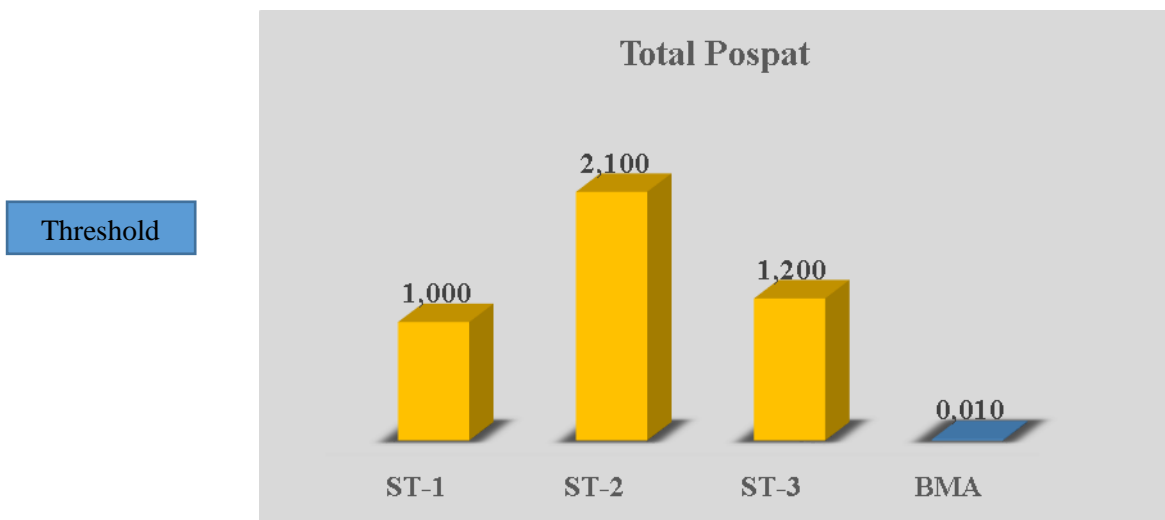
6. Total phosphate

**Figure 6. Parameter Diagram of Total Phosphate Index
Sentani Lake Water and Water Quality Standards**

The maximum limit of phosphate required in the class 1 water quality standard is 0.01 mg/L, while the research results at stations 1, 2 and 3 are much higher than the maximum limit. One of the factors causing the high levels of phosphate in the waters is the presence of domestic waste containing detergent. Detergents can increase phosphate levels because phosphate ions are one of the constituents of detergents (Wekabury & Tungka, 2016).
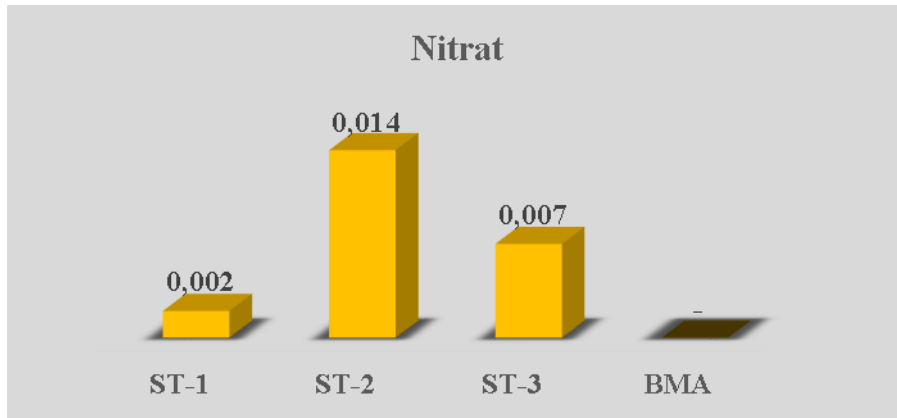
7. Nitrat – N

Figure 7. Parameter Diagram of the Nitrate Index – N Water of Lake Sentani

Nitrate content in lake water is not regulated in PP 22 of 2021, but is regulated in river water quality standards with a maximum limit of 10 mg/L. The Minister of Health of the Republic of Indonesia Number 32 of 2017 stipulates that the nitrate level in raw drinking water (sanitary hygiene water) is a maximum of 10 mg/L. Thus, the nitrate level in the waters of Lake Sentani for all research stations is still below the threshold, so it is still suitable for use as drinking water.
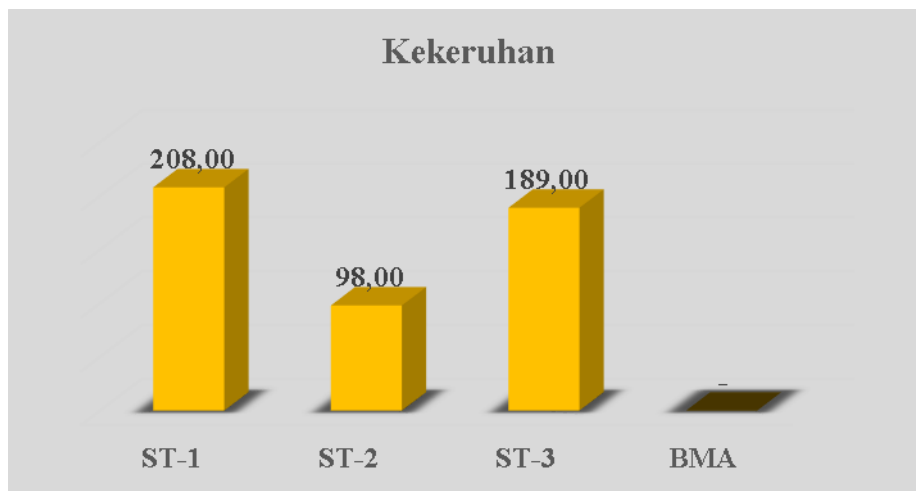
8. Turbidity

Figure 8. Turbidity Index Parameter Diagram
Sentani Lake Water and Water Quality Standards

The parameter of the turbidity index of Sentani lake water is quite high, respectively ST-1 = 208 NTU, ST-2 = 98 NTU and ST-3 = 189 NTU, but this parameter is not regulated in PP 22 of 2021. Referring to the Regulation of the Minister of Health Number 32 In 2017

that for water that is hygienic and sanitation (raw drinking water) the maximum level of turbidity index is 25 NTU, so that the turbidity index of Sentani lake water can be said to be far beyond the threshold. Thus, it does not meet the requirements as raw water for drinking water.

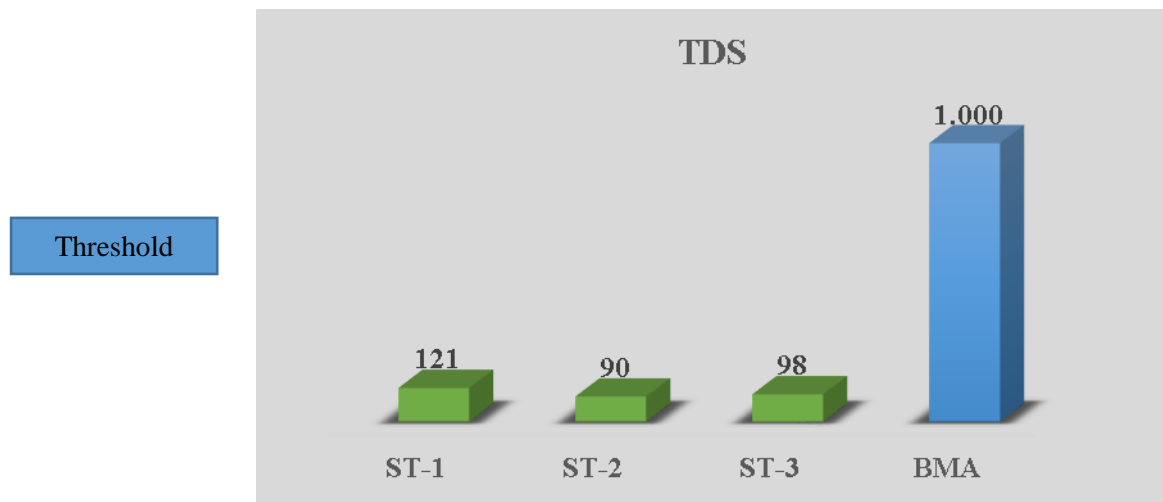## 9. Total Dissolved Solid (TDS)

**Figure 9. Parameter Diagram of Total Dissolved Solid Index (TDS)
Sentani Lake Water and Water Quality Standards**

Sentani lake water TDS index parameter for the three stations is still very low, this index is still far below the threshold line in accordance with PP 22 of 2021, which is 1,000 mg/L. Thus, for the TDS parameter, Sentani lake water is still suitable for use as raw water for drinking water.

10. Water Quality Index Based on NSF-WQI

The following will describe the results of the analysis of water quality data at Sentani Lake with 3 research stations with 9 parameters (DO, pH, BOD, Temperature, Total Phosphate, nitrate, turbidity, TDS and Fecal coliform) and water quality standards for classes 1, 2 and 3 according to attachment vi part ii Government Regulation Number 22 of 2021 concerning the Implementation of Environmental Protection and Management as many as 7 parameters (DO, pH, BOD, Temperature, Total Phosphate, TDS and Fecal coliform) Data analysis was carried out to determine the water quality index based on the National Sanitation Foundation Water Quality Index (NSF-WQI).

a. NSF-WQI Danau Sentani Station I (Ifale)

Table 4. Calculation of Water Quality Index (NSF-WQI)
Lake Sentani at Station I (Ifale)

No	Parameter	Unit	Test results	Weight (Wi)	Curve Value (Li)	NSF-WQI
1	DO	mg/L	4,84	0,17	4	0,68
2	Fecal coliform	mg/L	245	0,16	35	5,6
3	pH	-	7,90	0,11	87	9,57
4	BOD	mg/L	2,62	0,11	69	7,59
5	Temperatur	ºC	30,60	0,10	10	1
6	Total Pospat	mg/L	1	0,10	40	4
7	Nitrat	mg/L	0,002	0,10	97	9,7
8	Kekeruhan	NTU	208	0,08	5	0,4
9	TDS	mg/L	121	0,07	82	5,74
	Jumlah NSF-WQI					44,24

From the calculation results obtained a water quality index of 44.24. This index
according to (NSF-WQI) includes the criteria Bad (poor).

b. NSF-WQI Danau Sentani Station II (Ayapo)

Table 5. Calculation of Water Quality Index (NSF-WQI)
Lake Sentani at Station II (Ayapo)

No	Parameter	Unit	Test results	Weight (Wi)	Curve Value (Li)	NSF-WQI
1	DO	mg/L	6,62	0,17	5	0,85
2	Fecal coliform	mg/L	26	0,16	60	9,60
No	Parameter	Unit	Test results	Weight (Wi)	Curve Value (Li)	NSF-WQI
3	pH	-	7,81	0,11	90	9,90
4	BOD	mg/L	1,02	0,11	95	10,45
5	Temperature	ºC	31,40	0,10	10	1
6	Total Pospat	mg/L	2,1	0,10	26	2,6
7	Nitrat	mg/L	0,014	0,10	97	9,7
8	Turbidity	NTU	98	0,08	18	1,44
9	TDS	mg/L	90	0,07	84	5,88
	Total NSF-WQI					51,42

From the calculation results obtained water quality index of 51.42. This index
according to (NSF-WQI) includes the criteria of medium (medium).

c. NSF-WQI Danau Sentani Station III (Jaifuri)

Table 6. Calculation of Water Quality Index (NSF-WQI)
Lake Sentani at Station III (Jaifuri)

No	Parameter	Unit	Test results	Weight (Wi)	Curve Value (Li)	NSF-WQI
1	DO	mg/L	5,40	0,17	5	0,85
2	Fecal coliform	mg/L	210	0,16	37	5,92
3	pH	-	7,60	0,11	92	10,12
4	BOD	mg/L	1,83	0,11	83	9,13
5	Temperature	ºC	32,10	0,10	10	1
6	Total Pospat	mg/L	1,2	0,10	36	3,6
7	Nitrat	mg/L	0,007	0,10	97	9,7
8	Turbidity	NTU	189	0,08	5	0,4
9	TDS	mg/L	98	0,07	84	5,88
	Total NSF-WQI					46,60

From the calculation results obtained a water quality index of 46.60. This index according to (NSF-WQI) includes the criteria Bad (poor).

d. NSF-WQI Water Quality Standard Class 1 (PP 22/2021)

Table 7. Calculation of Water Quality Index (NSF-WQI)
Lake Water Quality Standard Class 1 PP 22 Year 2021

No	Parameter	Unit	Quality standards	Weight (Wi)	Curve Value (Li)	NSF-WQI
1	DO	mg/L	6	0,21	5	1,05
2	pH	-	7,5	0,13	93	12,09
3	BOD	mg/L	2	0,13	80	10,40
4	Temperature	ºC	30	0,12	10	1,20
5	Total Pospat	mg/L	0,01	0,12	100	12,00
6	TDS	mg/L	1.000	0,09	20	1,80
7	Fecal coliform	MPN/100 mL	100	0,20	44	8,80
	Total NSF-WQI					47,34

From the calculation results obtained a water quality index of 47.34. This index according to (NSF-WQI) includes Bad criteria (bad).

From the description of the determination of the water quality index based on the National Sanitation Foundation's Water Quality Index (NSF-WQI) on the test results index parameters and water quality standards, it can be described as follows:
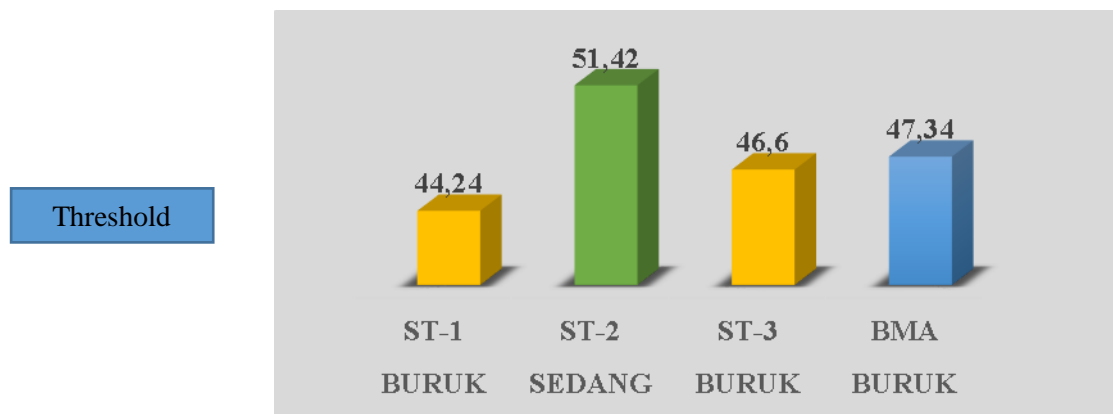
Figure 10. Diagram of Water Quality Index (NSF-WQI)
Lake Sentani and Water Quality Standards

From the picture, it can be informed that the water quality index (NSF_WQI) of Lake Sentani at Station I is 44.24 and Station III is 46.6 including the Bad (Bad) criteria, water quality index (NSF-WQI) class 1 water quality standards Government Regulation Number 22 of 2021 obtained a value of 47.34 which also includes the Bad (Bad) criteria, even the Lake Sentani water quality index at Stations I and III is lower than the water quality index (NSF-WQI) of the class 1 water quality standard. The low water quality index (NSF-WQI) at Station I and Station III is due to the large number of domestic pollutant loads entering the lake. Meanwhile, Lake Sentani's water quality index (NSF-WQI) at Station II was 51.42, slightly improved compared to Stations I and III. The improvement in the water quality index is because Station II is located in the middle of the lake and far from residential areas, so that the pollutant load is relatively reduced.

11. Lake Sentani Water as Raw Water for Drinking Water

To determine whether the water of Lake Sentani meets the requirements as raw water and according to its designation, it is necessary to do a comparison test of the water quality index. The water quality of Lake Sentani is determined by laboratory tests while the raw water in question is water that meets the requirements as a lake water quality standard and the like which is annex vi part ii of the Government of Indonesia Regulation Number 22 of 2021. To determine the Water Quality Index based on the National Sanitation Foundation Water method Quality Index (NSF-WQI). The summary of Lake Sentani's water quality index and its quality standards are as follows:

Table 8. Lake Sentani Water Quality Index
And Lake Water Quality Standard Index

No	Jenis Air	NSF-WQI	Kriteria
1	Sentani Lake Water Station 1 (Ifale)	44,24	Bad
2	Sentani Lake Water Station 2 (Ayapo)	51,42	Medium

3	Sentani Lake Water Station 3 (Jaifuri)	46,60	Bad
4	Water Quality Standards according to PP 22/2021 (Class 1)	47,34	Bad

The table above provides information that 3 (three) Lake Sentani water test stations obtained different water quality index criteria, stations 1 and 3 obtained medium (moderate) criteria, while at station 2 obtained bad (bad) criteria. While the water quality standard quality index according to Government Regulation No. 22 of 2021, both classes 1, 2 and 3 all get bad (bad) criteria.

Conclusion

When compared with the water quality standard for class 1 PP 22 of 2021, the water quality index parameters of Sentani Lake are generally still good and not much different. The results of the determination of the water quality index (NSF-WQI) of Lake Sentani are as follows:

1. Station I (Estuary of the Haway River, Ifale Sentani), NSF-WQI = 44.24 Bad (Poor) water quality criteria.
2. Station II (Central Lake Sentani, Ayapo Sentani), NSF-WQI = 51.42 water quality criteria Medium (Medium).
3. Station III (Upstream of the Jaifuri River, Yoka), NSF-WQI = 46.60 Bad (Bad) water quality criteria.
4. Water Quality Standard Class 1 PP 22 Year 2021, NSF-WQI = 47.34 Bad (Bad) water quality criteria.

BIBLIOGRAFI

Alihar, F. (2018). Penduduk dan Akses Air Bersih di Kota Semarang. *Jurnal Kependudukan Indonesia*, *13*(Juni), 67–76. Google Scholar

Ashar, Y. K., Susilawati, S., & Agustina, D. (2020). *Analisis Kualitas (BOD, COD, DO) Air Sungai Pesanggrahan Desa Rawadenok Kelurahan Rangkepan Jaya Baru Kecamatan Mas Kota Depok*. Fakultas Kesehatan Masyarakat UINSU Medan. Google Scholar

Badan Pengembangan Sumber Daya Manusia Kementerian Pekerjaan Umum dan Perumahan Rakyat. (2015). *Modul 2 : Sistem Air Baku*. 1–14. Google Scholar

Burhanuddin, I. I., Setyobudiarso, H., & Sudiro. (2018). Kajian Biomonitor Makroinvertebrata Dan Status Mutu. *Seminar Nasional Infrastruktur Berkelanjutan Era Revolusi Industri 4.0*, 55–64. Google Scholar

Effendi, H. (2015). Simulasi Penentuan Indeks Pencemaran dan Indeks Kualitas Air (NSF-WQI). *Puslitbang Kualitas Dan Laboratorium Lingkungan Kementerian Lingkungan Hidup Dan Kehutanan*, 8. Google Scholar

Hoya, A. L., Yuliastuti, N., Sudarno, S., Magister, P., Lingkungan, I., Sarjana, S. P., Diponegoro, U., & Diponegoro, U. (2020). Kajian Karakteristik Indeks Kualitas Air Menggunakan Metode IP , Storet Dan NSF WQI. *Komoditas Sumber Pangan Untuk Meningkatkan Kualitas Kesehatan Di Era Pandemi Covid -19*, 47–53. Google Scholar

Keputusan Menteri Negara Lingkungan Hidup. (2003). Keputusan Menteri Negara Lingkungan Hidup Nomor 115 Tentang Pedoman Penentuan Status Mutu Air. *Jakarta : Menteri Negara Lingkungan Hidup*, 1–15. Google Scholar

Rohmawati, Y., & Kustomo, K. (2020). Analisis kualitas air pada reservoir PDAM kota semarang menggunakan uji parameter fisika, kimia, dan mikrobiologi, serta dikombinasikan dengan analisis kemometri. *Walisongo Journal of Chemistry*, *3*(2), 100–107. Google Scholar

Sari, I. K., Limantara, L. M., & Priyantoro, D. (2012). Analisa Ketersediaan dan Kebutuhan Air pada DAS Sampean. *Jurnal Teknik Pengairan*, *2*(1), 29–41. Google Scholar

Sentani, D. (n.d.). *Babrongko*.

Syariz, M. A. (2015). *Analisis Perubahan Kualitas Air dan Tutupan Lahan Sempadan Danau dengan Menggunakan Citra Medium Resolution Imaging Spectrometer (MERIS) (Studi Kasus : Danau Sentani , Jayapura)*. Google Scholar

Utomo, B., Siregar, S. M., & Tanjung, K. (2020). Pembuatan Pompa Sumur Dalam (Deep Well) Untuk Menyediakan Air Bersih Bagi Masyarakat. *Prosiding Konferensi Nasional Pengabdian Kepada Masyarakat Dan Corporate Social Responsibility (PKM-CSR)*, *3*, 173–178. https://doi.org/10.37695/pkmcsr.v3i0.891. Google Scholar

Bambang Suhartawan, Jusuf Haurissa, Sarah Agustina Rumawak

Wekabury, A. P., & Tungka, A. E. (2016). *Fasilitas Rekreasi Pantai Di Pulau Mansinam (Arsitektur Neo Vernakular)*. Sam Ratulangi University. Google Scholar

---