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Analysis of Sayang-Sayang Spring Water Quality Using the Water Quality Index for Evaluation of the Suitability of Clean Water Sources

Hismi Susane[1], Mulhidin[2], Nurhidayah[3], Hijriati Sholehah[4]
[1,2,3,4] Environmental Engineering Study Program, Mataram College of Environmental Engineering, Mataram

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Corresponding Author:

Mulhidin,
Environmental Engineering Study Program, Mataram College of Environmental Engineering

Email: mulhidin.088@gmail.com

ABSTRACT

Clean water plays a crucial role in public health and environmental sustainability, particularly in urban and peri-urban areas that still rely on springs as a water source. The Sayang-Sayang Spring in Mataram City is utilized by the community, but its water quality is potentially affected by anthropogenic activities in the surrounding area. This study aimed to comprehensively evaluate the water quality of Sayang-Sayang Spring using the Water Quality Index (WQI) approach and determine its suitability as a clean water source. Water samples were collected in August 2025 and analyzed for physical, chemical, and biological parameters in accordance with Minister of Health Regulation No. 32 of 2017. The Weighted Water Quality Index (WQI) was calculated by determining parameter weights using the Delphi method. The analysis results showed that most physical and chemical parameters, such as temperature, TSS, TDS, pH, BOD, DO, nitrate, and ammonia, met clean water quality standards. However, COD and total phosphate values exceeded the established threshold, and microbiological parameters showed a total coliform content of 240 MPN/100 mL. A WQI of 90.20 indicates excellent water quality. However, the presence of organic matter, nutrients, and coliforms limits the use of this spring as untreated drinking water. This study confirms the effectiveness of the WQI as a water quality assessment tool and supports the sustainable management of the spring from anthropogenic pressures.

Keyword: Sayang-Sayang Spring, WQI, Water quality

1. INTRODUCTION

Clean water is essential for life, public health, and environmental sustainability. Springs provide a key source of drinking water, especially in rural and peri-urban regions. Springs occur when groundwater rises to the surface through cracks in rocks or soil. As a result, their water is usually of good quality and often does not need intensive treatment (Dos Santos et. al, 2025). Springs serve as drinking water sources for household use and for local activities. However, spring water quality can fluctuate.

Anthropogenic activities such as dense settlements, intensive agriculture, tourism, and land-use changes can degrade spring water quality. These activities generate pollutant runoff, domestic wastewater, and other liquid wastes that enter the catchment zone and spring flow channels, polluting the water. This pollution alters physical, chemical, and biological parameters, threatening the suitability of springs as clean water sources (Sururi & Hardika, 2024).

Water quality evaluation typically involves measuring specific physicochemical or microbiological parameters and comparing them to quality standards. This single-parameter or partial assessment has limitations; it provides only a partial view of water quality, making it less useful for comprehensive management decisions. Single-parameter assessments often cannot capture the complexity of water pollution, which involves many factors and interactions among water characteristics. To address this, the Water Quality Index (WQI) was developed as a comprehensive method that combines various water quality parameters into a single, representative value. The WQI simplifies the interpretation of water quality data, enabling efficient monitoring and comparison across locations or over time. In practice, WQI aids decision-makers by providing a clear overall assessment that supports effective water resource management, pollution identification, and policy development. The use of intelligent monitoring technology to calculate the WQI in real time is a growing trend in recent years (Silmi, 2017).

Several recent studies demonstrate the use of WQI to monitor groundwater and springs used directly by communities. For example, research on the Water Quality Index in Bauro, Timor-Leste, showed some springs failed to meet clean water standards despite being the main water source. However, an adequate study of the Water Quality Index for the Sayang-Sayang Spring has never been conducted. Existing research generally targets only specific chemical or physical parameters or uses basic pollution indices rather than comprehensive indices that assess overall water quality. Therefore, this study aims to (1) use the WQI to thoroughly assess and quantify the water quality of Sayang-Sayang Spring, (2) determine whether Sayang-Sayang Spring meets clean water standards. The research is also expected to provide a comprehensive, scientific evaluation of water quality and serve as a reference for effective, sustainable management and protection strategies to address anthropogenic pressures in spring catchment areas.

2. RESEARCH METHOD

Spring water was collected from Sayang-Sayang Village, Cakranegara District, Mataram City, on August 25, 2025, and tested at the Mataram City Environmental Service Laboratory.

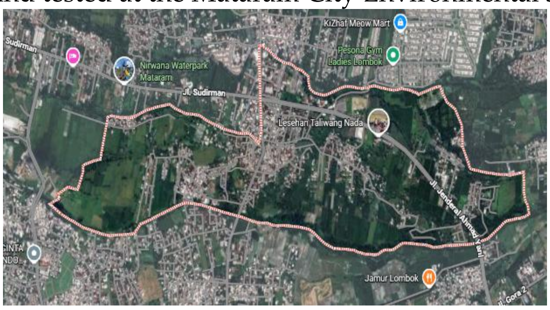

Figure 1.1. GPS map showing the locations of spring water sampling points in Sayang-Sayang Village, Cakranegara District, Mataram City. Coordinates: 08°34'6.678"S, 116°08'07.506"E.

Physical, chemical, and biological parameters were tested. Results were compared with the quality standards set out in Minister of Health Regulation No. 32 of 2017.

WQI Calculation: To calculate the Weighted Water Quality Index (WWQI), parameter weights are determined using the Delphi method. The following formula is then used:

$Si = 100 \text{ x} \frac{Li}{Ci}$ eq. (1)
Where Li = quality standard, Ci = measured concentration, and is limited to a maximum of 100.
For dissolved oxygen (DO), a higher value indicates better quality, as reflected in a score of 100.

$$SDO = 100 \text{ x} \frac{DCO}{LDO} \text{reaches } 100 \quad \text{eq. (2)}$$

Wi is the weight of parameter i, and n is the total number of parameters. To determine the quality value, divide the variable concentration by the established parameter standard, then multiply the result by 100, as shown in the equation (2) (Azhari et. al., 2023).
For pH: If the value falls within the standard range (6.5–8.5), set SpH = 100. If it falls outside this range, reduce SpH accordingly (Dewi, et. al., 2016).

Next, assess the water classification criteria using the WQI to determine the ranking using the following equation:

$WQI = Si\ x\ Wi$ eq. (3) (Gusri, et. al., 2025)

3. RESULTS AND ANALYSIS

Table 1.1 presents the results of water-quality testing at Sayang-Sayang Spring, showing that both local hydrogeological conditions and nearby anthropogenic activities influence the water composition. The findings focus on physical, chemical, and microbiological parameters to assess the suitability of the spring as a clean water source.

Table 1.1 Results of Spring Water Quality Tests in Sayang- Sayang with a Comparison of Water Quality Standards

No	Parameter	Results	Unit	Permenkes No.32 Th. 2017	Information
A	**PHYSICH**				
1.	Temperatus	27,40	C	Air temperatue ± 3	Passed
2.	Electrical conductivity	223,26	µS/cm	-	Passed
3.	TSS	34,00	mg/L	50	Passed
4.	TDS	124,26	mg/L	1000	Passed
5.	Turbidity	0,91	NTU	25	Passed
B	**CHEMISTRY**				
1.	pH	7.29	mg/L	6,5-8,5	Passed
2.	BOD	0.165	mg/L	3	Passed
3.	COD	<40.00	mg/L	25	Failed
4.	DO	4.48	mg/L	4	Passed
5.	Phosphate as P	0.532	mg/L	0,2	Failed: risk of eutrophication
6.	Sulfat	<1.00	mg/L	300	Passed
7.	Flourida	<1.40	mg/L	1,5	Passed
8.	Khlorida	8.70	mg/L	250	Passed
9.	Amonia (NH3-N)	0.107	mg/L	10	Passed
10.	Nitrit as N	<0.01	mg/L	0,06	Passed
11.	Total Hardness	48.00	mg/L	-	-
12.	Calcium hardness	9.60	mg/L	-	-
13.	Magnesium hardness	5.83	mg/L	-	-
14.	Nitrat (NO3)*	1.867	mg/L	20	Passed
15.	Detergent (MBAS)	0.046	mg/L	0,2	Passed
16.	Oils and Fats*	<1,00	mg/L	1	Passed
C	**BIOLOGY**				
1.	Total Coliform	240	MPN/100ml	5000	Passed: still need disinfectant

Physical Parameters

The designation of spring water must comply with the government's quality standards. In this study, the quality standard used is the Minister of Health Regulation No. 32 of 2017, which regulates clean water quality (Menteri Kesehatan Republik Indonesia, 2017). Based on the applicable standards, the Sayang-Sayang spring's physical parameters have met the established clean water quality standards. The measured water temperature of 27.4°C is still within the standard temperature range (Permenkes RI, 2010), so it does not have the potential to disrupt oxygen solubility, chemical reaction rates, or biological processes in the water (Wiratno, et. al., 2024). The electrical conductivity (EC) value of 233.26 μS/cm indicates that the dissolved ion content is within the general range of shallow groundwater and drinking water, which is still safe and suitable for consumption (Khairunnas & M. Gusman, 2024). The suspended solids (TSS) concentration of 34 mg/L is below the quality standard of 50 mg/L, indicating that water clarity is quite good and that there are minimal suspended solids that could affect human health and aquatic ecosystems (Asnawi, 2023). The dissolved residual (TDS) value of 124.26 mg/L is below the threshold of 1000 mg/L, indicating low mineral and dissolved substance content that could potentially degrade water quality (Menteri Kesehatan Republik Indonesia, 2017). In addition, the turbidity level of 0.91 NTU is below the quality standard of 25 NTU, indicating clear water with good light penetration and minimal indications of pollution (Menteri Kesehatan Republik Indonesia, 2017). Overall, the results of the physical parameter analysis indicate that the Sayang-Sayang spring has very good physical quality and is suitable for use as a source of clean water.

Chemical Parameters

Analysis of the chemical parameters of the Sayang-Sayang spring water indicates that most parameters fall within the clean water quality standards set by Minister of Health Regulation No. 32 of 2017. The pH of 7.29 is within the neutral range (6.5–8.5), indicating chemically stable water and safety for consumption (Menteri Kesehatan Republik Indonesia, 2017).. The dissolved oxygen (DO) level of 4.48 mg/L meets the minimum limit, supporting natural oxidation processes and the sustainability of aquatic biota. Therefore, Sayang-Sayang Spring water is suitable for use in accordance with established standards ecosystems (Asnawi, 2023).

The very low BOD value (0.165 mg/L) shows minimal organic pollution. Ammonia (0.107 mg/L), nitrate, and nitrite are all well below thresholds, indicating no significant pollution from domestic waste or heavy agriculture (Menteri Kesehatan Republik Indonesia, 2017). These results show that the nitrification process is working well and that the water system is relatively healthy. However, COD at 40 mg/L and phosphate (P) at 0.532 mg/L exceed quality standards, signaling a chemical oxidation load and excess nutrients. High phosphate levels likely originate from agricultural activities near the spring and could reduce dissolved oxygen and degrade water quality if not managed (Legasari, et. al., 2023). Sulfate (1 mg/L), fluoride (<1.4 mg/L), chloride (<250 mg/L), and total hardness (48 mg/L) are low and within safe limits, showing natural geological effects and little seawater intrusion or industrial pollution (Maželienė, et. al., 2025). Detergent (MBAS) at 0.046 mg/L and oil and grease below 1.00 mg/L show very low domestic wastewater impact. While most chemical parameters meet quality standards, the excess COD and phosphate require ongoing attention to maintain long-term water quality (Güven & Ç. Çetin, 2025).

Biological Parameters

Biological water quality parameters measure the presence and activity of microorganisms (bacteria, viruses, plankton) and other biota (invertebrates, fish), reflecting the health of aquatic ecosystems or the safety of water for consumption. Key indicators include fecal coliform (an indication of fecal contamination) and total coliform. Based on test results, a total coliform value of 240 MPN/100 mL indicates microbiological contamination likely originating from human or animal waste. This value is still above the drinking water quality standard stipulated in Indonesian Minister of Health Regulation No. 2 of 2023 (0 MPN/100 mL for total coliform) (Kementerian Kesehatan, 2023).Therefore, water with a coliform count of 240 MPN/100 mL is suitable as raw water but must be disinfected before it is safe for drinking or direct consumption (Maželienė, et. al., 2025).

Table 2. Results of Water Quality Index (WQI) Analysis

No	Parameter	Results	PERMENKES NO 32 Tahun 2017	Sub-Indeks (Si)		Wi	Wi × Si
1	TSS	34	50	147	100	0,074	7,40
2	TDS	124,26	1000	805	100	0,053	5,30
3	pH	7,29	6.5–8.5	100	100	0,117	11,70
4	BOD	0,165	3	1818	100	0,113	11,30
5	COD	40	25	62,5	62,5	0,120	7,50
6	DO	4,48	4	112,0	100	0,143	14,30
7	Total P	0,532	0,2	37,6	37,6	0,085	3,20
8	NH3-N	0,107	10	9346	100	0,092	9,20
9	NO3-N	1,867	20	1071	100	0,069	6,90
10	Total Coliform	240	5000	2083	100	0,134	13,40
				Total WQI			90,20

Based on the evaluation results, several parameters did not meet quality standards. COD (Cosmetic Value) was measured at 40 mg/L, exceeding the 25 mg/L threshold, and total phosphate (Total P) was 0.532 mg/L, above the 0.2 mg/L limit. These results indicate a significant organic and nutrient pollution load. The likely sources of this pollution include domestic wastewater from household activities, detergent use that introduces phosphates, runoff, and soil erosion from the surrounding land. Meanwhile, microbiological parameters showed a coliform count of 240 MPN/100 mL, which meets criteria for raw water but not for drinking water, and thus requires disinfection before direct consumption.

Although some parameters exceeded the quality standard, the WQI value of 90.20 indicated very good water quality. This means the Sayang-Sayang spring water is of high quality and suitable as a clean water source. The water can be used for bathing, washing, and sanitation with a low health risk. However, to serve as raw water for the Regional Water Company (PDAM), standard treatment is required to address the exceeded parameters and ensure safe distribution.

However, the Sayang-Sayang spring is not yet recommended for direct drinking water use due to relatively high COD and phosphate levels, as well as the presence of coliforms exceeding drinking water requirements (maximum allowed: 0 MPN/100 mL). These contaminant levels could pose health risks if consumed untreated. Therefore, sustainable water quality management, particularly control of organic and nutrient pollutant sources, is necessary to maintain and improve the spring's long-term water quality.

4. CONCLUSION

The Water Quality Index (WQI) assessment of Sayang-Sayang Spring yielded a score of 90.20, classifying the water as excellent and generally compliant with Indonesian clean water standards (Permenkes No. 32/2017). Most physicochemical parameters (temperature, TSS, TDS, pH, BOD, and DO) met the prescribed limits and strongly supported the high WQI value. Nevertheless, elevated COD and total phosphate concentrations, along with the presence of total coliform, indicate localized anthropogenic pressures and limit its suitability for direct consumption without treatment. These findings highlight the need to protect recharge areas, control organic and nutrient inputs, and implement routine monitoring. Overall, this study confirms the robustness of WQI as an effective decision-support tool for water quality management, while emphasizing the importance of integrated long-term and spatially informed assessments to ensure the sustainable use of Sayang-Sayang Spring.

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