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Water Quality Status of the Pangkajene River: A STORET-Based Assessment

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ABSTRACT

This study assessed the water quality status of the Pangkajene River using the STORET method based on physical, chemical, and biological parameters. The research employed a quantitative descriptive-evaluative approach using 11 water quality parameters measured at 12 sampling points representing the upstream, middle, and downstream sections of the river. The observed parameters were compared with Class II water quality standards established under Government Regulation No. 22 of 2021. Water quality status was determined using the STORET scoring system to identify pollution levels and dominant parameters contributing to water quality degradation. The results showed that the Pangkajene River was classified as lightly to moderately polluted, with STORET scores ranging from −8 to −20. No sampling points were categorized as having good water quality or heavy pollution. Chemical Oxygen Demand (COD) was the main parameter exceeding the quality standard across all sampling points, followed by Total Suspended Solids (TSS), turbidity, Biological Oxygen Demand (BOD), and Escherichia coli. In contrast, pH, Dissolved Oxygen (DO), nitrate, phosphate, and Total Dissolved Solids (TDS) generally remained within acceptable limits. Higher pollution levels were observed in the middle and downstream sections of the river, indicating the influence of human activities along the watershed. These findings highlight the need for improved watershed management and pollution control measures to support sustainable water resource management and contribute to the achievement of SDG 6 related to water quality improvement.

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1. INTRODUCTION

The Pangkajene River is an important water resource that supports domestic, agricultural, fisheries, and economic activities in Pangkajene Regency, South Sulawesi, Indonesia. In recent years, increasing population growth, settlement expansion, and land-use activities along the river basin have raised concerns regarding declining water quality (Lestari & Nugraheni, 2024; Nasrul, Amdah, et al., 2024; Nurlilasari et al., 2024; Permata et al., 2024). These activities may introduce pollutant loads into the river system, affecting its physical, chemical, and biological characteristics and reducing its suitability for various water uses (Nasrul, Erman, et al., 2026; Samputri, et al., 2026).

Despite its importance, information on the current water quality status of the Pangkajene River remains limited, particularly across different sections of the river (Nasrul, Qaiyimah, et al., 2024;

Zhang et al., 2025). A comprehensive assessment is needed to identify the level of pollution and determine the dominant parameters contributing to water quality degradation. Therefore, this study assesses the water quality status of the Pangkajene River using the STORET method based on physical, chemical, and biological parameters measured at upstream, middle, and downstream locations. The results provide baseline information for river pollution control and sustainable watershed management. In a broader context, improving river water quality contributes to the objectives of Sustainable Development Goal (SDG) 6 concerning water quality improvement and sustainable water resource management (Maru et al., 2025; Nasrul, Amal, et al., 2024; Qaiyimah et al., 2025; N. Tuan et al., 2023; Zhang et al., 2025).

In the Indonesian context, river water quality issues are becoming increasingly complex with population growth and the intensification of economic activity. Various studies have shown that river water quality in various regions has declined from its natural state to mild to moderate pollution, characterized by increases in parameters such as Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and a decrease in Dissolved Oxygen (DO) (Mohammadnezhad et al., 2023; Nasrul, Arfan, et al., 2024; Ruliana et al., 2025). This condition indicates a pollution load that exceeds the river's environmental carrying capacity. Furthermore, water quality is greatly influenced by regional conditions and the activities of surrounding communities, making spatial and geographic approaches crucial in understanding the distribution of pollution and its contributing factors (Fatihah et al., 2025; Nasrul et al., 2026; Pratama et al., 2020; Yang et al., 2021). Therefore, water quality analysis requires not only a laboratory approach, but also the integration of a geographical perspective to examine the relationship between human activities, regional characteristics, and environmental dynamics.

The Pangkajene River, one of the local river systems in South Sulawesi, plays a vital role in supporting the livelihoods of the local community. However, like other rivers in Indonesia, the Pangkajene River faces pressures from land use changes and anthropogenic activities in the surrounding area (Alimuddin et al., 2024; Thoha et al., 2021). A study by Rasyid et al., (2025) in the same area showed that the quality of river water in Pangkajene and Kepulauan Regency had decreased with indications of pollution measured through various physical and chemical parameters. This condition emphasizes the need for a more comprehensive study to understand the status of water quality spatially and ecologically. From a conservation geography perspective, water quality analysis focuses not only on pollution levels, but also on efforts to maintain ecosystem sustainability through area-based management and water resource conservation (Hidiya et al., 2025; Narendra et al., 2021; Nasrul, Nur, et al., 2025; Nasrul, Qaiyimah, et al., 2025).

Although numerous studies have examined river water quality, most have focused on assessing physicochemical characteristics and determining pollution status using water quality indices or descriptive approaches. Previous studies, including Nasrul, Amal, et al. (2024), have provided important information on water quality conditions; however, comprehensive assessments identifying pollution status and dominant pollutant parameters across different sections of the river remain limited in the Pangkajene River watershed. In addition, local-scale evidence on river water quality that can support watershed management and water resource planning is still insufficient.

This study addresses this gap by assessing the water quality status of the Pangkajene River using the STORET method based on physical, chemical, and biological parameters measured at upstream, middle, and downstream locations. The study also identifies the dominant parameters contributing to water quality degradation across the river system. The findings provide baseline scientific information for river pollution control, watershed management, and sustainable water resource planning. In a broader context, improving river water quality is relevant to the objectives of Sustainable Development Goal (SDG) 6, particularly efforts to enhance water quality and reduce pollution.

2. METHOD

2.1. Type and Research Location

This study employed a quantitative approach with a descriptive-evaluative design to assess the water quality status of the Pangkajene River. The quantitative approach was selected to objectively measure water quality parameters and compare the observed values with established water quality

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standards. The descriptive-evaluative design was used to describe existing water quality conditions and evaluate pollution levels based on regulatory criteria. Water quality assessment was conducted using the STORET method, which determines water quality status through a scoring system based on deviations of measured parameters from applicable water quality standards. The analysis included physical, chemical, and biological parameters collected from sampling locations representing the upstream, middle, and downstream sections of the river. STORET scores were then used to classify water quality conditions and identify the dominant parameters contributing to pollution. This approach provides a systematic evaluation of river water quality and enables comparisons among different sections of the river. The results serve as baseline information for identifying pollution conditions and supporting river management and water resource planning within the Pangkajene River watershed.

This research was conducted on the Pangkajene River, located in Pangkajene and Kepulauan Regency, bordered by the administrative area of Pangkajene District, South Sulawesi Province, Indonesia. This river is a vital water resource utilized by the community for various needs, such as agricultural irrigation, fisheries, and domestic activities.

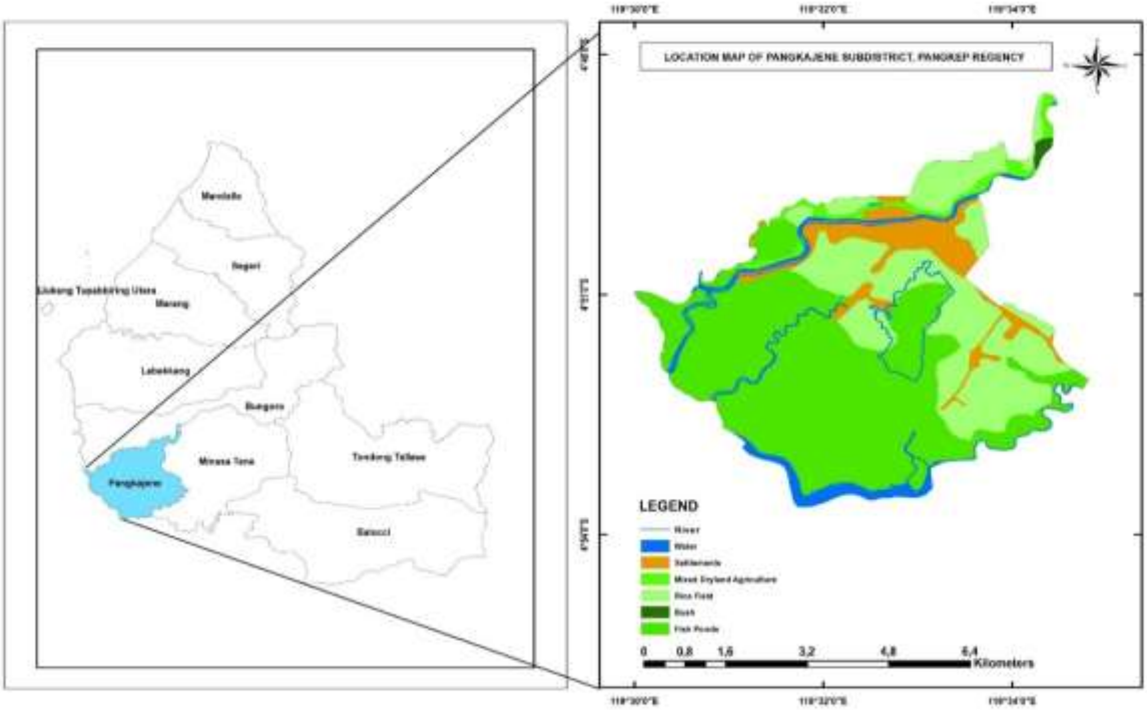

Figure 1. Administrative Location Map of Pangkajene Subdistrict

2.2. Population and Sample

The population in this study was located along the Pangkajene River, which is bordered by the administrative area of Pangkajene District, Pangkep Regency. Sampling points that would represent the entire population were determined purposively, taking into account the characteristics of the study area. In this study, samples were taken from 12 sampling points along the Pangkajene River, which is bordered by the administrative area of Pangkajene District. The number of sampling points was determined by considering the representation of each river segment (upstream, middle, and downstream), so that variations in water quality conditions could be identified comprehensively.

Thus, the use of purposive sampling with 12 sampling points was not only based on practical considerations but also on scientific considerations to obtain representative and reliable data that comprehensively reflect the water quality conditions of the Pangkajene River. Water sampling was conducted during November–December, corresponding to the rainy season in the study area. Sampling activities were carried out under hydrological conditions characterized by a transition from low tide to rising tide (flood tide), which may influence the distribution and mixing of water quality parameters, particularly in downstream sections affected by tidal processes. All sampling locations were selected to represent the upstream, middle, and downstream segments of the river. The spatial distribution of the sampling points is presented in Figure 2.

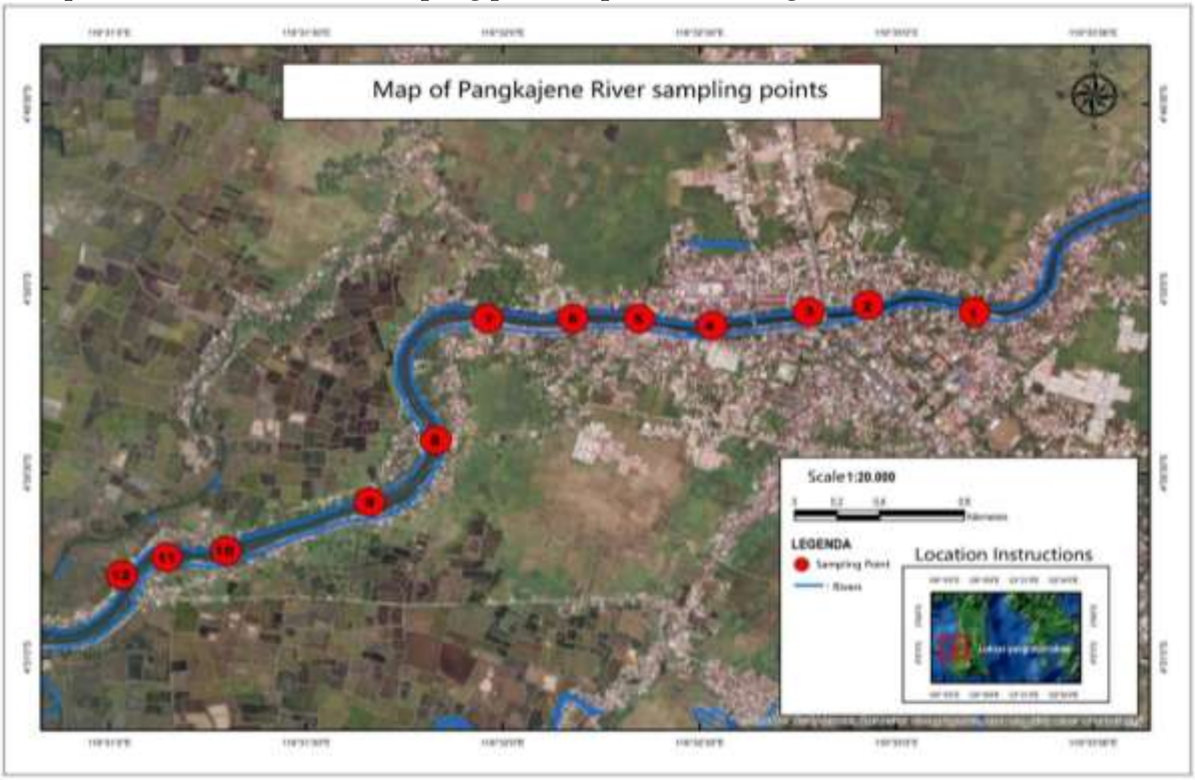

Figure 2. Sampling Point Locations of Pangkajene Rivers

2.3. Data Analysis

This study employed the STORET (Storage and Retrieval) method to evaluate water quality status by comparing measured water quality parameters with the Class II water quality standards established in Government Regulation No. 22 of 2021. The STORET method was selected because it provides a systematic framework for assessing water quality conditions based on the degree of deviation of observed parameters from the applicable standards and allows the identification of dominant pollutants affecting river water quality.

In this method, each parameter that complies with the water quality standard is assigned a score of 0, whereas parameters exceeding the standard receive negative scores according to the STORET scoring criteria. The penalty scores are determined based on the type of parameter (physical, chemical, or biological) and the statistical characteristics of the observed data, including maximum, minimum, and average values. For datasets containing fewer than ten observations, deviations from the quality standard are assigned penalty scores ranging from −1 to −3 for physical parameters, −2 to −6 for chemical parameters, and −3 to −9 for biological parameters. The individual parameter scores are then summed to obtain the overall STORET score, which is subsequently used to classify water quality status into good condition (score = 0), lightly polluted (−1 to −10), moderately polluted (−11 to −30), and heavily polluted (< −30). The detailed STORET scoring matrix used in this study is presented in Table X (Ramadhawati et al., 2021.

The analysis stage begins with measuring water quality parameters, including physical parameters (temperature, total suspended solids, total dissolved solids, turbidity), chemical parameters (pH, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, nitrate, and phosphate), and biological parameters (total coliform). The measurement data is then compared with water quality standards based on their intended use, as stipulated in applicable national regulations. The established standards refer to Government Regulation Number 22 of 2021, Class II. Class II classification was chosen because it aligns with the water's intended use for aquatic recreation, freshwater fish farming, livestock, and irrigation. The standards are as follows.

Table 1. Class II Water Quality Standards

Parameters	Unit	Class II Quality Standard	Description	Sampling Methods
Temperature	°C	Deviation of ±3	Natural temperature variation	Insitu
pH	–	6 – 9	Degree of acidity	Insitu
Dissolved Oxygen (DO)	mg/L	≥ 4	Dissolved oxygen level	Titrimetric
Biochemical Oxygen Demand (BOD)	mg/L	≤ 3	Organic load	Titrimetric
Chemical Oxygen Demand (COD)	mg/L	≤ 25	Chemical oxygen demand	Titrimetric
Total Suspended Solids (TSS)	mg/L	≤ 50	Suspended solids	Gravimetry
Total Dissolved Solids (TDS)	mg/L	≤ 1000*	Dissolved solids	Gravimetry
Turbidity	NTU	≤ 25*	Water turbidity level	Turbidimeter
Nitrate (NO_3)	mg/L	≤ 10	Nutrient	Spektrophotometry
Phosphate (PO_4)	mg/L	≤ 0.2	Nutrient	Spektrophotometry
E.coli	MPN/100 mL	≤ 5000	Biological indicator	MPN

Next, each parameter is assigned a score based on its level of compliance with the quality standard. Parameters that meet the quality standard are given a score of 0, while parameters that exceed the quality standard are given a negative score according to the level of violation. The greater the deviation from the quality standard, the greater the negative score assigned. This scoring system allows for identification of the dominant parameters contributing to pollution.

The total STORET score is calculated by adding up all the scores for each water quality parameter, as formulated as follows:

$$S = \sum_{i=1}^{n} S_1 \quad (1)$$

where S is the total STORET score, s_i is the score for each parameter, and n is the number of parameters analyzed.

Based on the total score, water quality status is classified into four categories: (1) a score of 0 indicates good condition or meets quality standards; (2) a score between -1 and -10 is categorized as lightly polluted; (3) a score between -11 and -30 is categorized as moderately polluted; and (4) a score below -30 is categorized as heavily polluted.

3. RESULTS AND DISCUSSION

3.1. Results

Based on laboratory analysis, the Pangkajene River's water quality was evaluated at twelve sampling points using physical, chemical, and biological parameters. Physical parameters included temperature, TSS, TDS, and turbidity; chemical parameters included pH, DO, BOD, COD, nitrate, and phosphate; the biological parameter was E. coli presence. Results showed variations among sampling points, especially in TSS, turbidity, COD, and E. coli, providing a basis for assessing pollution and environmental quality of the Pangkajene River.

Table 2. Laboratory test results data

Point	Temperature	TSS	TDS	Turbidity	pH	DO	BOD	COD	NO3	PO4	E.coli
1	20.8	44.0	89.3	35.1	7.36	7.68	2.88	392.5	0.0195	0.0232	1565.0
2	20.4	29.0	93	38.7	7.61	6.40	3.84	340.5	0.0172	0.0252	2755.0
3	20.2	56.0	93.7	68.8	7.78	6.40	3.84	395.5	0.0179	0.0252	2755.0
4	20.6	38.0	93.6	59.3	7.9	7.04	1.60	381.0	0.0195	0.0229	2489.0
5	21	42.0	98	61.9	7.8	7.04	2.24	363.5	0.0172	0.0256	2809.0
6	20.1	6960.0	98.8	68.9	8.05	6.72	3.20	469.0	0.0202	0.0269	1722.0
7	20.6	4288.0	95.8	71.5	7.94	7.68	2.88	410.0	0.0210	0.0238	2603.0
8	20.4	3239.0	102.6	67.6	7.92	8.64	5.44	410.5	0.0141	0.0266	1670.0
9	20.6	4058.0	115.9	74.9	7.93	6.08	1.28	508.5	0.0164	0.0222	3441.0
10	20.1	880.0	122.5	20.1	7.94	6.40	2.56	269.5	0.0102	0.0247	4106.0
11	20	1032.0	127.3	20	7.99	7.36	3.84	345.0	0.0149	0.0259	4611.0
12	20.2	876.0	126.4	20.2	7.95	7.68	3.52	350.5	0.0133	0.0235	3654.0

The water quality analysis of the Pangkajene River was conducted by comparing measurement data at 12 sampling points with class II water quality standards based on Government Regulation Number 22 of 2021. The parameters analyzed included physical, chemical, and biological aspects, then evaluated using the STORET method to determine the water quality status. The STORET score results at each point are presented in the following table.

Table 3. STORET Scoring Results for All Sampling Points

Sampling Point	(A1)	(A2)	(A3)	(A4)	(A5)	(A6)	(A7)	(A8)	(A9)	(A10)	(A11)	Total Score	Water Quality Status
1	0	0	0	-3	0	0	0	-5	0	0	0	-8	Lightly polluted
2	0	0	0	-3	0	0	-3	-5	0	0	0	-11	Moderately polluted
3	0	-3	0	-5	0	0	-3	-5	0	0	0	-16	Moderately polluted
4	0	0	0	-3	0	0	0	-5	0	0	0	-8	Lightly polluted
5	0	0	0	-3	0	0	0	-5	0	0	0	-8	Lightly polluted
6	0	-5	0	-5	0	0	-3	-5	0	0	0	-18	Moderately polluted
7	0	-5	0	-5	0	0	0	-5	0	0	0	-15	Moderately polluted
8	0	-5	0	-5	0	0	-5	-5	0	0	0	-20	Moderately polluted
9	0	-5	0	-5	0	0	0	-5	0	0	0	-15	Moderately polluted
10	0	-5	0	0	0	0	0	-5	0	0	-3	-13	Moderately polluted
11	0	-5	0	0	0	0	-3	-5	0	0	-3	-16	Moderately polluted
12	0	-5	0	0	0	0	-3	-5	0	0	0	-13	Moderately polluted

The water quality parameters analyzed in this study consist of physical, chemical, and biological parameters, which are coded from A1 to A11; (A1) Temperature, (A2) TSS, (A3) TDS, (A4) Turbidity, (A5) pH, (A6) DO, (A7) BOD, (A8) COD, (A9) NO3, (A10) PO4, (A11) E.Coli.

The STORET-based assessment of water quality across the 12 sampling points indicates a clear spatial variation in compliance with Class II water quality standards. The calculated STORET scores range from -8 to -20, demonstrating that none of the sampling locations meet the “good” (unpolluted) category. Instead, all sampling points fall within the lightly to moderately polluted classifications based on the applied STORET criteria. Specifically, three sampling points (Points 1, 4, and 5) are classified as lightly polluted, each with a total STORET score of -8. In contrast, the majority of the sampling points (Points 2, 3, 6, 7, 8, 9, 10, 11, and 12) are categorized as moderately polluted, with scores ranging from -11 to -20. The lowest water quality conditions were recorded at Points 8, 3, and 11, with scores reaching -20 and -16, indicating higher cumulative deviations from the Class II standards.

A parameter-level evaluation revealed that Chemical Oxygen Demand (COD) consistently exceeded the permissible threshold (≤ 25 mg/L) across all sampling points, resulting in the highest penalty scores and identifying COD as the dominant parameter contributing to water quality degradation. In addition, turbidity exceeded the water quality standard at several sampling locations, particularly in the middle and downstream sections of the river, contributing negative STORET scores across multiple sites. Total Suspended Solids (TSS) also exhibited spatial variation, with lower concentrations generally observed in upstream areas and higher concentrations recorded at several middle and downstream sampling points, where additional penalty scores were assigned. These results indicate differences in water quality conditions among river sections. The Biochemical Oxygen Demand (BOD) parameter exceeded the quality standard at several sampling points, particularly in the middle and downstream sections, contributing further negative scores to the overall STORET assessment. Furthermore, E. coli concentrations exceeded the permissible limit at downstream sampling points (Points 10–12), indicating microbial contamination at these locations and contributing to the deterioration of overall water quality status.

In contrast, several parameters remained consistently within acceptable limits across all sampling points. These include temperature, pH, dissolved oxygen (DO), nitrate (NO_3), phosphate (PO_4), and total dissolved solids (TDS), all of which recorded compliant values and did not contribute to STORET scoring. This indicates that not all physicochemical and biological parameters are equally affected within the study area. Overall, the cumulative negative scores generated from COD, turbidity, TSS, BOD, and E. coli result in a consistent classification of lightly to moderately polluted conditions across the river system. The observed variation in STORET scores reflects differences in the magnitude and combination of parameter exceedances along the spatial gradient, rather than isolated extreme pollution events at specific points.

Specifically, the occurrence of pollution in the calculation results in Table 4 above is caused by the presence of certain parameters that are most dominant in influencing the high concentration of pollution load at each sampling point. These are as follows.

Table 4. STORET Score Results and Water Quality Status

Sampling Point	Dominant Parameters Exceeding Standards	STORET Score	Water Quality Status
1	COD, Turbidity	-8	Lightly polluted
2	COD, BOD, Turbidity	-11	Moderately polluted
3	COD, TSS, BOD, Turbidity	-16	Moderately polluted
4	COD, Turbidity	-8	Lightly polluted
5	COD, Turbidity	-8	Lightly polluted
6	COD, TSS, Turbidity, BOD	-18	Moderately polluted
7	COD, TSS, Turbidity	-15	Moderately polluted
8	COD, TSS, BOD, Turbidity	-20	Moderately polluted
9	COD, TSS, Turbidity	-15	Moderately polluted
10	COD, TSS, E. coli	-13	Moderately polluted
11	COD, TSS, BOD, E. coli	-16	Moderately polluted
12	COD, TSS, BOD	-13	Moderately polluted

3.2. Discussion

3.2.1. Water Quality Status of the Pangkajene River

The STORET assessment revealed that the water quality of the Pangkajene River falls within the lightly to moderately polluted classification, with STORET scores ranging from -8 to -20. None of the monitoring stations were categorized as either good quality or heavily polluted, suggesting that although the river ecosystem has been subjected to considerable environmental pressure, it has not yet reached a critical level of degradation. These findings indicate that the river is currently experiencing a moderate level of ecological disturbance, where essential ecosystem processes remain functional but the river's ability to naturally assimilate and dilute pollutant inputs has begun to decline.

The dominance of moderately polluted status at most points (Points 2–12) indicates the spatial accumulation of pollutant loads along the river course. This finding aligns with various studies in Indonesia showing that rivers in urban and peri-urban areas tend to be moderately polluted due to a combination of domestic, agricultural, and small-scale industrial activities. Research on the Brantas, Citarum, and Bengawan Solo Rivers shows that the STORET method consistently classifies these rivers as moderately to heavily polluted, primarily due to high organic and suspended solid loads (Afifah et al., 2025; Brantas & Bumiaji, 2019). Another study also confirmed that water quality degradation in Indonesian watersheds is greatly influenced by the combination of COD, TSS, and BOD as the main parameters determining water quality status (Carrolina et al., 2025; Swandani et al., 2023).

In the context of the Pangkajene River, Chemical Oxygen Demand (COD) emerged as the most dominant parameter causing a decline in STORET scores across all observation points. COD values consistently exceeding quality standards indicate a high and persistent load of organic and chemical materials. This condition indicates that the river receives input from domestic waste and possibly anthropogenic runoff that has not been optimally processed (Anawar & Chowdhury, 2020; Bonisławska et al., 2024; Razif, 2022). Recent studies by Rizqi et al., (2021) shows that COD is the most sensitive indicator in detecting river water quality degradation because it represents the total oxidative load of organic and inorganic pollutants.

In addition to COD, increases in Total Suspended Solids (TSS) and turbidity at several points, particularly in the middle to downstream areas, indicate a significant contribution from suspended material. This is generally related to land erosion, construction activities, and surface runoff from built-up areas. Research in tropical watersheds shows that increases in TSS are significantly correlated with changes in land cover and intensification of land use around rivers (Zong et al., 2021). This condition is also reinforced by studies Nasrul, Arfan, et al., (2024) which states that turbidity and TSS are early indicators of hydrological degradation due to anthropogenic disturbances in river systems.

Overall, these results indicate that the Pangkajene River is in an ecological transition phase from a relatively stable state to a stressed state, where the river's self-purification capacity begins to decline due to the accumulation of pollutant loads. Hydrological studies show that when COD and TSS loads increase simultaneously, the river's ability to carry out natural decomposition will decrease significantly, ultimately accelerating the process of water quality degradation (Postigo et al., 2021).

3.2.2. Water Quality of the Pangkajene River in a Conservation Geography Perspective

From a conservation geography perspective, the water quality of the Pangkajene River reflects a complex interaction between the physical system of the watershed (DAS) and anthropogenic activities within spatial units of land use. The observed spatial pattern of water quality degradation from upstream to downstream indicates a clear environmental pressure gradient, which is strongly associated with increasing land-use intensity and human settlement expansion along the river corridor.

The increase in Total Suspended Solids (TSS) and turbidity in the midstream and downstream sections indicates a strong contribution from surface runoff processes, soil erosion, and domestic discharge inputs. This pattern is consistent with studies showing that land-use change—particularly the conversion of vegetated areas into settlements and agricultural land—significantly increases sediment load and reduces river water quality through enhanced erosion and nutrient transport processes (Clark et al., 2022; Wang et al., 2018). Similar findings in tropical watershed systems demonstrate that impervious surface expansion is positively correlated with increased TSS and decreased ecological integrity of river systems (Clark et al., 2022).

These findings also align with the river continuum concept and river degradation framework, which suggests that rivers function as longitudinal systems that progressively accumulate ecological pressures along their flow path. In the case of the Pangkajene River, the observed deterioration pattern indicates that the river is experiencing cumulative stress accumulation, where pollutants from upstream and local inputs in midstream areas are transported and intensified toward downstream sections. Recent hydrological studies emphasize that river systems in developing regions often exhibit such cumulative degradation patterns due to insufficient waste management and weak spatial planning integration (Brose et al., 2013).

Furthermore, the dominance of parameters such as COD, TSS, BOD, and nutrients (NO_3 and PO_4) reflects a typical signature of anthropogenically influenced river systems in rapidly developing regions. COD, in particular, indicates a high organic and chemical load derived from domestic wastewater and small-scale economic activities. Studies have consistently shown that COD is one of the most sensitive indicators of anthropogenic pollution in river ecosystems due to its direct relationship with organic waste decomposition and oxygen demand processes (Clark et al., 2022; Luo et al., 2021; Hamad et al., 2025).

From a conservation geography standpoint, the degradation of water quality in the Pangkajene River is not merely a physicochemical phenomenon but represents a failure of spatial ecological governance within the watershed system. The increasing dominance of built-up areas and reduced riparian buffer zones have weakened the river's ecological resilience and its ability to perform self-purification functions. Similar conditions have been reported in other Indonesian watersheds, where land-use fragmentation significantly reduces ecosystem services provided by river systems (Allan, 2004).

3.2.3. Implications for Sustainable Development Goal 6 (Clean Water and Sanitation)

The findings of this study are relevant to water quality monitoring efforts associated with Sustainable Development Goal (SDG) 6, particularly Target 6.3, which emphasizes improving water quality through pollution reduction and better wastewater management. The STORET-based assessment classified the Pangkajene River as lightly to moderately polluted, indicating that several measured parameters exceeded the applicable water quality standards. These results provide baseline information on current river conditions and can support future monitoring programs aimed at tracking changes in water quality over time.

The observed exceedances of Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), turbidity, and other parameters highlight aspects of water quality that may require management attention. Similar water quality issues have been reported in many river systems in developing regions, where elevated concentrations of organic matter, suspended solids, and other pollutants are frequently observed (Hendro, 2022). However, the present study did not directly assess pollution sources or the specific factors contributing to the observed water quality conditions. Therefore, further investigations incorporating land-use, hydrological, and pollution source analyses are needed to better understand the drivers of water quality degradation within the Pangkajene River watershed.

From a management perspective, the findings contribute baseline data that may assist local stakeholders in evaluating water quality conditions and prioritizing future monitoring and pollution control efforts. Although this study does not directly assess SDG 6 indicators, the results provide information that is relevant for supporting long-term water quality management initiatives aligned with SDG 6 objectives. (Hendro, 2022). Similar patterns have been documented in Southeast Asian river systems, where rapid urban expansion without adequate wastewater infrastructure leads to continuous deterioration of surface water quality (Chen et al., 2022; Trinh et al., 2024; A. Tuan & Sharp, 2022).

The presence of Escherichia coli (E. coli) in downstream sampling points further strengthens the public health dimension of river pollution in the study area. This finding is particularly relevant to SDG Target 6.1, which focuses on universal and equitable access to safe and affordable drinking water. The detection of microbial contamination indicates the potential infiltration of untreated domestic sewage into the river system, which poses a direct risk to downstream water users. Studies have shown that elevated E. coli concentrations in river systems are strongly correlated with inadequate sanitation infrastructure and ineffective wastewater management in peri-urban and rural-urban interface zones (Kim et al., 2025; Widmer et al., 2013).

From a watershed governance perspective, the results highlight that fragmented and non-integrated river basin management significantly constrains progress toward SDG 6. The absence of effective spatial control over pollution sources along the river continuum leads to cumulative environmental loading from upstream to downstream sections. Recent studies emphasize that integrated water resources management (IWRM) is a critical governance framework required to achieve SDG 6, particularly in regions where land-use change and population growth are rapid and unregulated (Ramadhawati et al., 2021).

Overall, the results of this study demonstrate that the achievement of SDG 6 in the Pangkajene River basin remains constrained by structural environmental management challenges, particularly in the control of domestic wastewater discharge, sediment management, and organic pollution. Without integrated watershed-based interventions, the river is likely to remain in a persistent state of moderate ecological stress, thereby limiting progress toward sustainable water quality targets.

4. CONCLUSIONS

This study assessed the water quality status of the Pangkajene River using the STORET method based on physical, chemical, and biological parameters measured at 12 sampling points. The results showed that the river was classified as lightly to moderately polluted, with STORET scores ranging from −8 to −20. No sampling locations were categorized as having good water quality or heavy pollution. Chemical Oxygen Demand (COD) was identified as the dominant parameter exceeding the applicable water quality standard across all sampling points, followed by Total Suspended Solids (TSS), turbidity, Biochemical Oxygen Demand (BOD), and Escherichia coli at several locations. In contrast, temperature, pH, dissolved oxygen, nitrate, phosphate, and total dissolved solids generally remained within the established standards. These findings provide baseline information on the current water quality condition of the Pangkajene River and may support future water quality monitoring, pollution control, and watershed management efforts. Future studies should incorporate long-term monitoring and additional environmental variables, such as land use, hydrological conditions, and spatial analysis, to better understand factors associated with variations in river water quality and to support more comprehensive watershed management planning.

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