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(Research Article)

Post-normalization Water Quality Assessment of the Karang Mumus River Based on Physicochemical, Microbiological Parameters, and the STORET Index

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Abstract

River normalization has been widely implemented as a structural approach to restore urban rivers; however, its effectiveness in improving water quality remains uncertain. This study assessed post-normalization water quality of the Karang Mumus River (KMR), an urban river in Samarinda, Indonesia, based on physicochemical parameters (TSS, TDS, pH, DO, BOD, COD, nitrate, nitrite, and Pb) and microbiological indicators (Fecal Coliform). Water quality status was determined using the STORET index in accordance with Indonesian Government Regulation No. 22/2021 for Class II surface waters. Water samples were collected purposively at six stations representing upstream, midstream, and downstream segments. The results showed significant improvements in physical and microbiological parameters, as indicated by a reduction in TSS from 40–251 mg/L to 14–83 mg/L, an increase in DO from 1.3–4.0 mg/L to 3.6–4.2 mg/L, and a marked decrease in Fecal Coliform from 1.5×10^6 to 150–230 MPN/100 mL. In contrast, nitrite and Pb concentrations consistently exceeded regulatory limits. STORET scores classified the river as slightly to moderately polluted, indicating an improvement compared to pre-normalization conditions. These findings demonstrate that river normalization effectively enhances physical and microbiological water quality but remains insufficient to control dominant chemical pollutants derived from urban activities.

Keywords: River Normalization; Water Quality Assessment; STORET Index; Urban River; Heavy Metals

1. Introduction

Urban rivers frequently experience water quality degradation due to rapid population growth, uncontrolled land-use change, and direct discharge of domestic wastewater. The Karang Mumus River (KMR) is a major urban river in Samarinda City, Indonesia, functioning as a natural drainage system and an ecological buffer. Prior to normalization, the river was characterized by high total suspended solids (TSS), low dissolved oxygen (DO), elevated organic loading, and extreme microbiological contamination caused by untreated domestic effluents.

River normalization of the KMR was conducted through sediment dredging, riverbank restructuring, and relocation of settlements along the riparian zone to improve hydraulic capacity and reduce flood risk. Although normalization has been shown to improve river morphology and flow dynamics, evaluations of its effectiveness in improving water quality, particularly chemical pollutants and heavy metals, remain limited. Therefore, this study aims to (1) evaluate post-normalization water quality of the Karang Mumus River based on physicochemical and microbiological parameters, (2) determine water quality status using the STORET index, and (3) compare pre- and post-normalization conditions to assess the effectiveness of urban river restoration measures.

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2. Materials and Methods

2.1. Study Area and Sampling Strategy

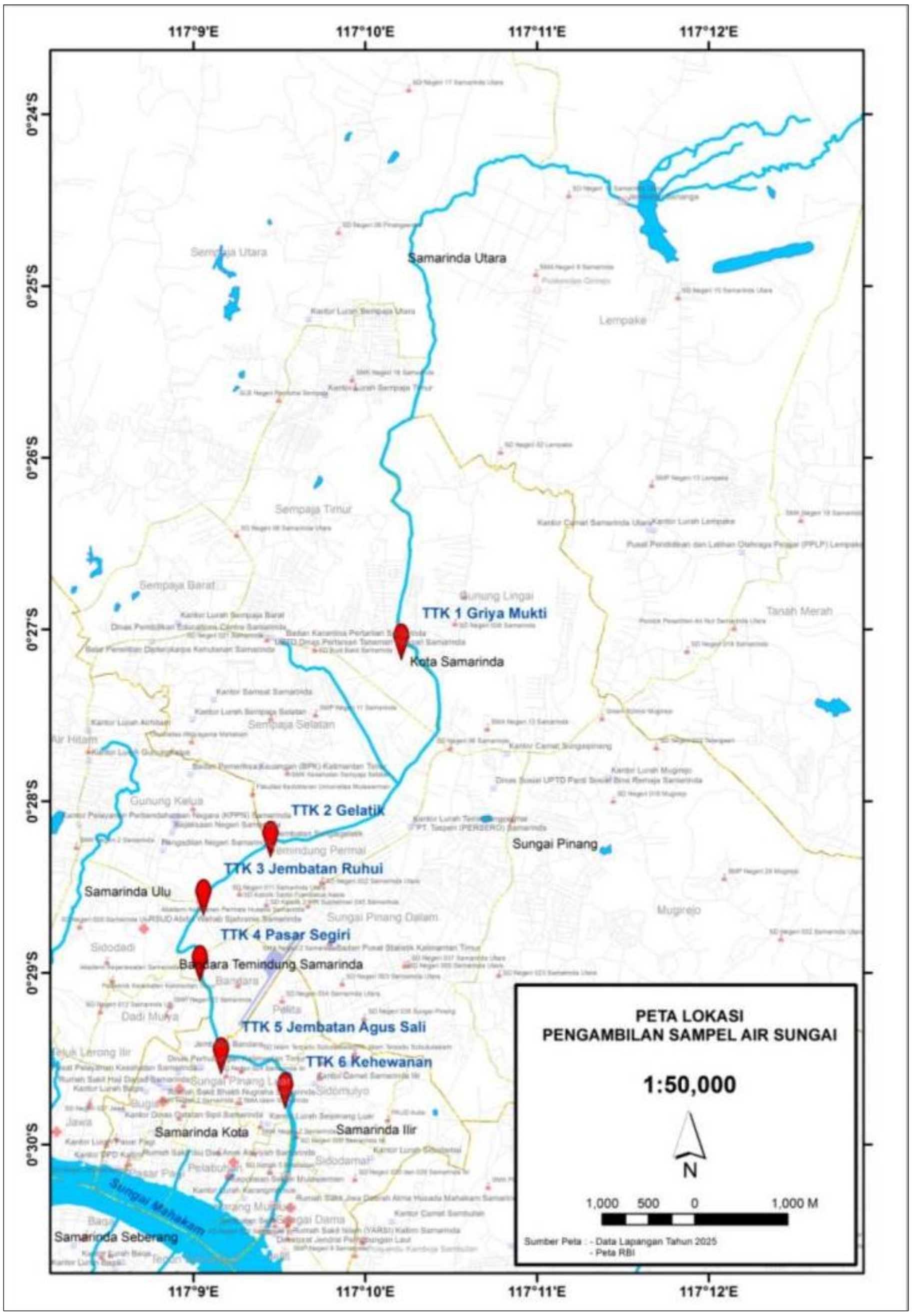


Figure 1 Placeholder

Water samples were collected from six monitoring stations representing upstream, midstream, and downstream segments of the Karang Mumus River, namely Griya Mukti, Gelatik, Ruhui Rahayu, Perniagaan, Agus Salim, and Kehewanan. Sampling locations were selected purposively based on anthropogenic pressure and potential pollution sources. Sampling was conducted under dry-weather conditions, with no rainfall occurring 24 h prior to sampling.

2.2. Water Quality Analysis

In situ measurements of pH, DO, and TDS were conducted using calibrated portable instruments. Laboratory analyses were performed following APHA (2017) standard methods. Parameters analyzed included TSS, BOD, COD, nitrate, nitrite, Pb, and Fecal Coliform.

2.3. Laboratory Analysis

- Physical: TSS, TDS
- Chemical: pH, DO, nitrate, nitrite, Pb, BOD, COD
- Microbiological: Fecal Coliform

2.4. Water Quality Status Assessment

Water quality status was determined using the STORET method by comparing measured values with Class II surface water quality standards stipulated in Indonesian Government Regulation No. 22/2021.

3. Results

Table 1 Physical Parameters Before and After Normalization

Parameter	Before Normalization	After Normalization	Water Quality Standard	Interpretation
TSS (mg/L)	40–251	14–83	50	Significant decrease
TDS (mg/L)	150–190	169–184	1000	Stable & safe

Post-normalization TSS values ranged from 14 to 83 mg/L, substantially lower than pre-normalization levels (40–251 mg/L). This reduction indicates decreased sediment loads due to channel dredging and increased flow velocity. TDS values remained relatively stable (169–184 mg/L) and well below regulatory limits, suggesting that dissolved solids were not a critical issue in the KMR. hanges in DO, BOD, and COD before and after normalization.

Table 2 Chemical Parameters

Parameter	Before Normalization	After Normalization	Water Quality Standard	Remarks
pH	6.8–7.2	6.89–7.62	6–9	Stable
DO (mg/L)	1.3–4.0	3.6–4.2	≥4	Increased
BOD (mg/L)	4.8–15.8	2.9–4.5	3	Decreased
COD (mg/L)	8–29	15–32	25	Slightly increased
Nitrat (mg/L)	0.09–1.8	0.7–0.9	10	Within safe limit
Nitrit (mg/L)	0.01–0.9	0.11–1.16	0.06	Exceeds standard
Pb (mg/L)	0.00–0.0078	0.09–0.15	0.03	Exceeds standard

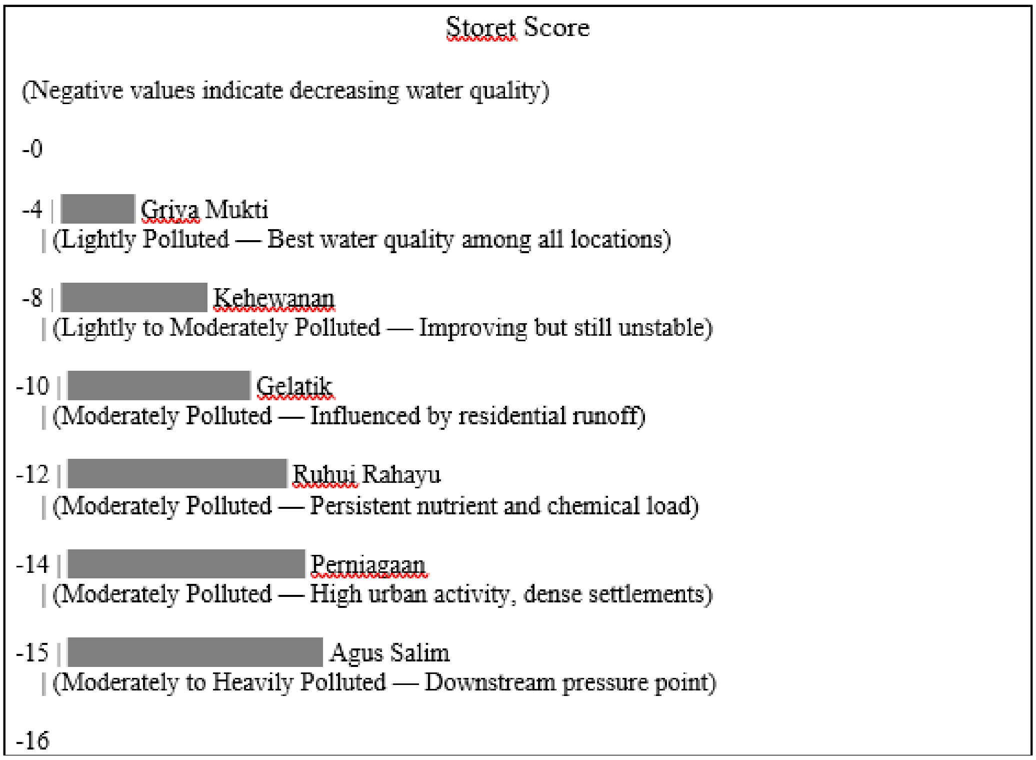
Post-normalization pH values remained within neutral range (6.89–7.62), complying with regulatory standards. DO concentrations increased significantly, reflecting improved natural aeration resulting from enhanced flow conditions. BOD values decreased compared to pre-normalization conditions, indicating reduced organic pollution. However, COD showed an increasing trend at several stations, suggesting persistent inputs of non-biodegradable chemical substances.

Nutrient analysis revealed contrasting patterns, with nitrate concentrations remaining within acceptable limits, while nitrite concentrations (0.11–1.16 mg/L) exceeded standards at all stations. Furthermore, Pb concentrations (0.09–0.15 mg/L) surpassed Class II limits, likely originating from urban runoff and remobilization of contaminated sediments during normalization activities.

Table 3 Microbiological Parameters

Parameter	Before Normalization	After Normalization	Water Quality Standard	Interpretation
Fecal Coliform (MPN/100 mL)	$1.5×10^6$	150–230	5000	Significant decrease

Fecal Coliform concentrations declined dramatically from 1.5×10^6 to 150-230 MPN/100 mL. This reduction reflects decreased direct discharge of domestic wastewater and improved hydraulic flushing, reducing stagnant conditions conducive to microbial proliferation.



Notes: Locations with lower STORET values represent poorer water quality.
Upstream areas (e.g., Griya Mukti) show improvement post-normalization.
Downstream segments (Agus Salim, Perniagaan) remain the most degraded due to urban discharge and high anthropogenic stress.

Figure 1 STORET Scores of Karang Mumus River (2025)

STORET assessment classified post-normalization water quality as slightly to moderately polluted. Upstream segments exhibited better water quality status, while midstream and downstream segments remained under higher pollution pressure, primarily driven by nitrite and Pb exceedances.

Table 4 STORET Score per Location

Location	STORET Score	Water Quality Status
Griya Mukti	−4	Lightly Polluted
Gelatik	−10	Moderately Polluted
Ruhui Rahayu	−12	Moderately Polluted
Perniagaan	−13	Moderately Polluted
Agus Salim	−15	Moderately to Heavily Pollutedt
Kehewanan	−8	Lightly to Moderately Polluted

4 illustrates the spatial variation of water quality along the Karang Mumus River based on the STORET index. The upstream location, Griya Mukti (−4), is categorized as lightly polluted, indicating relatively good water quality following normalization. Midstream locations such as Gelatik (−10), Ruhui Rahayu (−12), and Perniagaan (−13) fall within the moderately polluted category, reflecting the influence of residential runoff and moderate anthropogenic pressure. The lowest score is recorded at Agus Salim (−15), classified as moderately to heavily polluted, which suggests intense urban activities and continuous wastewater discharge in the downstream area. Kehewanan (−8) shows a transition between lightly and moderately polluted conditions. Overall, the STORET assessment reveals a clear gradient in water quality, with degradation increasing toward the downstream reaches of the river.

4. Conclusion

River normalization of the Karang Mumus River has resulted in measurable improvements in physical and microbiological water quality, as evidenced by reduced TSS, increased DO, and substantially lower Fecal Coliform concentrations. However, persistent exceedances of nitrite and Pb indicate that structural normalization alone is insufficient to mitigate chemical pollution originating from urban anthropogenic activities. Sustainable improvement of river water quality therefore requires integrated pollution source control, enhanced domestic wastewater management, and routine water quality monitoring to complement physical restoration measures.

Compliance with ethical standards

This research involved environmental field observations and laboratory analyses of river water quality and did not include human participants or animal subjects. Therefore, ethical approval was not required. All research procedures were carried out in compliance with applicable environmental regulations and scientific ethical standards.

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