

Analysis of the Seawater Quality Index in the Marine Waters of Bontang City, East Kalimantan

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ABSTRACT

Seawater quality is a key factor in determining the health of coastal ecosystems and the sustainability of marine resources. Anthropogenic activities such as the discharge of industrial and domestic waste, marine transportation, and intensive fishing practices can influence the physical, chemical, and biological parameters of seawater. Research on seawater quality in the marine waters of Bontang City has been conducted, but remains very limited in number. This study aims to analyze the Seawater Quality Index (IKAL) in the marine waters of Bontang City. The analytical method employed refers to the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia No. 27 of 2021. The results indicate that the average Seawater Quality Index (IKAL) in Bontang City during the second semester of 2023 was 72.69, which is categorized as good condition.

INTRODUCTION

Seawater quality is a fundamental factor determining the health of coastal ecosystems and the sustainability of marine resources (Napitupulu, 2024). High-quality waters support marine biodiversity, fisheries, marine tourism, and coastal community livelihoods. Conversely, a decline in water quality can trigger ecosystem degradation, reduce biodiversity, and pose risks to human health (Anatasyah, 2025). Bontang City, located on the eastern coast of East Kalimantan, possesses strategic marine waters rich in biological resources. However, this area also serves as a hub for industrial, port, and settlement activities, which exert considerable pressure on marine environmental quality (Ascha, 2025).

Anthropogenic activities such as industrial and domestic waste discharge, marine transportation, and intensive fishing practices can alter the physical, chemical, and biological parameters of seawater. If not properly managed, pollution may disrupt ecosystem balance and diminish the ecological functions of marine environments as providers of ecosystem services (Khairunnisa et al., 2024). Therefore, continuous monitoring and evaluation of seawater quality are essential, one of which can be carried out through the Seawater Quality Index (IKAL), which provides a comprehensive overview of marine environmental conditions.

Studies on seawater quality in the marine waters of Bontang City have been conducted but remain limited in number. Purbawati and Widyastuti (2014) reported that overall wastewater quality parameters complied with quality standards. In contrast, Wahyuningsih et al. (2021) found that seawater quality in Bontang was classified as lightly polluted, with phosphate ($\text{PO}_4\text{-P}$) and dissolved oxygen parameters failing to meet quality standards.

The analysis of the Seawater Quality Index in Bontang's marine waters is crucial, given the area's vital role in sustaining both regional economic activities and coastal ecological functions. The results of this analysis are expected to provide accurate scientific information as a basis for formulating sustainable marine environmental management policies. This study aims to calculate and evaluate the Seawater Quality Index (IKAL) in the marine waters of Bontang City, thereby determining its quality status and identifying appropriate management measures to ensure the preservation of local marine ecosystems.

METHODOLOGY

The data used in this study were obtained from routine seawater monitoring conducted by the Environmental Agency of East Kalimantan Province during the second semester of 2023, with sample collection carried out on August 10, 2023. Seawater samples were collected from four (4) observation stations, as shown in Figure 1.

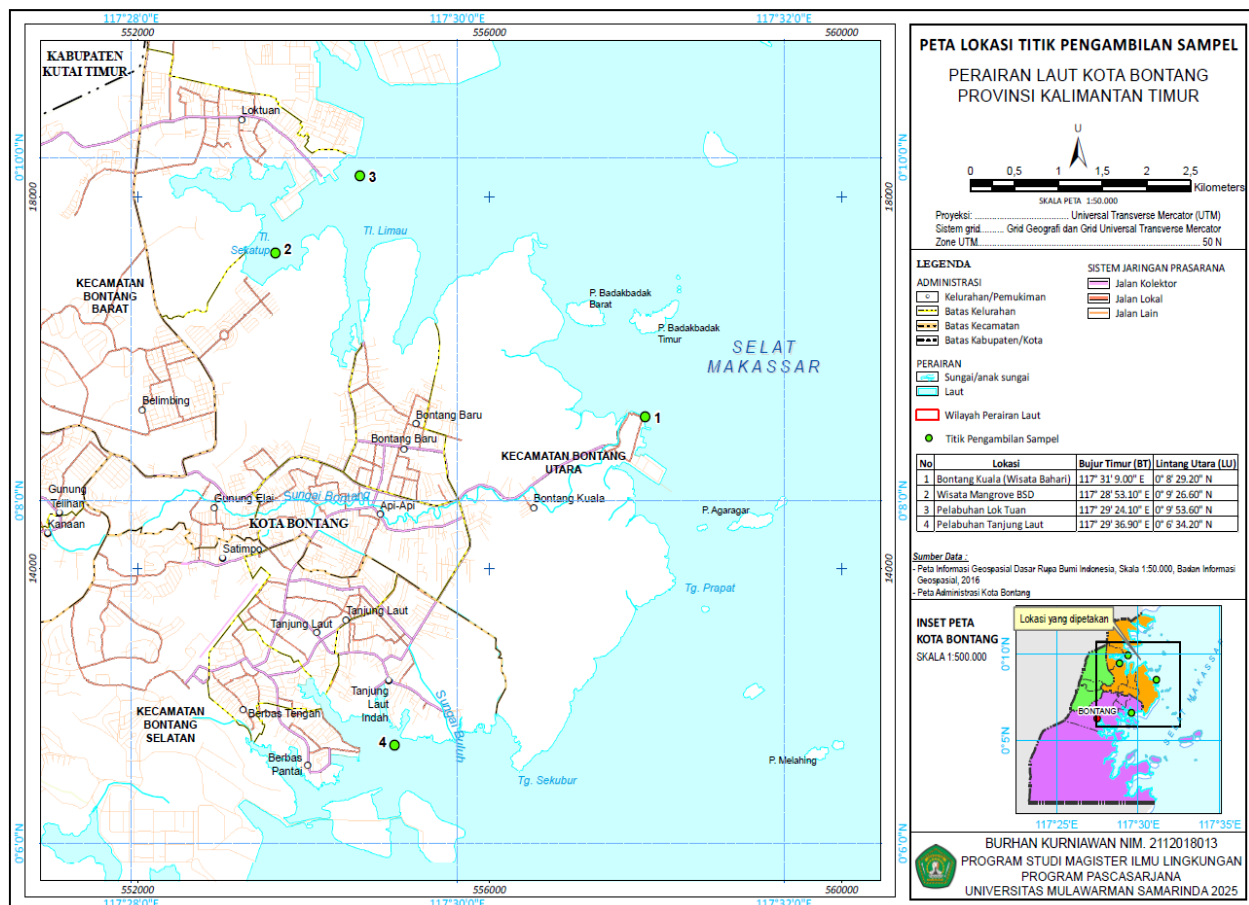


Figure 1. Sampling location

The calculation of the Seawater Quality Index (IKAL) refers to Annex III of the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number 27 of 2021 concerning the Environmental Quality Index. The IKAL is calculated using the following formula:

$$WQI = \sum_{i=1}^n Q_i W_i$$

Where:

Q_i = sub-index of the water quality parameter
 W_i = weight of the water quality parameter
 n = number of water quality parameters

Following the calculation, the water quality status at each sampling point was determined based on the classification presented in Table 1.

Table 1. Classification of Seawater Quality Index (IKAL) Values

Value Range	Classification
91 – 100	Excellent
71 – 90	Good
51 – 70	Moderate
26 – 50	Poor
0 – 25	Very Poor

Source: Regulation of the Minister of Environment and Forestry (PermenLHK) No. 27 of 2021

The results of the pollution load and seawater quality index calculations were analyzed using quantitative descriptive analysis by presenting the data in tables, graphs, and figures, followed by data interpretation.

RESULT AND DISCUSSION

Seawater Quality Index

The Seawater Quality Index (IKAL) is a composite value that reflects the condition of seawater quality, derived from multiple water quality parameters within a specific area at a given time. The calculation of IKAL follows the Water Quality Index approach—National Sanitation Foundation Water Quality Index (NSFWQI) as presented in Table 2.

Table 2. Calculation of Seawater Quality Index (IKAL) using the NSFWQI approach

No.	Parameter	Rationale for Selection
1	Total Suspended Solids (TSS)	Related to photosynthesis processes and water aesthetics
2	Dissolved Oxygen (DO)	Indicates organic pollution and potential risks to biota
3	Oil and Grease	—
4	Total Ammonia (NH ₃ -N)	Toxic in nature
5	Orthophosphate (PO ₄ -P)	Potential eutrophication

Source: Ministry of Environment and Forestry Regulation No. 27/2021

The analysis of the Seawater Quality Index, in accordance with Regulation No. 27/2021, is based on five parameters: Total Suspended Solids (TSS), Dissolved Oxygen (DO), Total Ammonia, Oil and Grease, and Orthophosphate (PO₄-P). The calculation of IKAL values for Bontang coastal waters was carried out using primary data obtained from routine seawater monitoring conducted by the Environmental Agency of East Kalimantan Province during the second semester of 2023. Sampling was performed on August 10, 2023, and laboratory test results are presented in Table 3.

Table 3. Seawater Quality Index (IKAL) in Bontang Coastal Waters

Location	TSS (mg/L)	DO (mg/L)	Total Ammonia (mg/L)	PO ₄ -P (mg/L)	Oil & Grease (mg/L)	IKAL Value	Rating
Tanjung Laut	19.9	5.0	0.013	0.01	1.10	73.42	Good
Lok Tuan	20.2	4.4	0.210	0.05	0.95	63.97	Moderate
Bontang Kuala	16.1	5.5	0.013	0.01	0.86	76.49	Good
Mangrove BSD	18.1	6.1	0.013	0.01	0.97	76.88	Good

Average IKAL: 72.69 (Good)

Source: Environmental Agency of East Kalimantan Province, 2023

The IKAL assessment results (Table 3) indicate that seawater quality in Tanjung Laut, Bontang Kuala, and Mangrove BSD was categorized as *Good*, while Lok Tuan was classified as *Moderate*. On average, the overall seawater quality in Bontang was rated *Good*.

The lower quality at Lok Tuan was primarily due to higher Total Ammonia concentrations compared to the other three sites, although still below the seawater quality standard for port designation as stipulated in Annex VIII of Government Regulation No. 22/2021. The elevated ammonia levels may be attributed to the site's proximity to residential areas, ports, and industrial zones that discharge ammonia-containing wastes.

Ammonium (NH₄⁺) is a dissolved form of ammonia (NH₃) that occurs under low pH conditions. In aquatic environments, ammonium is typically derived from urine and feces, as well as from the decomposition of organic matter originating from natural waters or industrial/domestic effluents. Ammonium concentrations are influenced by its sources, the presence of aquatic plants that absorb ammonium, dissolved oxygen levels, and water temperature. Elevated ammonia levels are generally indicative of organic pollution from domestic sewage, industrial effluents, or agricultural fertilizer runoff (Juliasih et al., 2017).

The Seawater Quality Index (IKAL) is a composite indicator derived from multiple parameters such as temperature, pH, dissolved oxygen, salinity, nitrate, phosphate, and others. When some parameters yield poor results but others perform well, the composite index may still fall into the "Good" category. Sampling locations situated farther from pollution sources often produce better quality scores, although contamination may persist in nearby areas. Seasonal variation also influences seawater quality. For instance, high rainfall during certain seasons may dilute pollutant concentrations.

Seawater quality monitoring is essential to assess environmental conditions and detect potential issues, which can then inform mitigation measures. In this study, IKAL assessment was based on samples collected along the shoreline without considering tidal cycles. As tidal fluctuations alter water conditions, the timing and location of sampling inevitably affect results. This finding is consistent with Ascha (2025), who reported that tidal conditions influence IKAL values, with high tide generally associated with better seawater quality compared to low tide due to enhanced water mixing and dilution effects. During high tide, the influx of seawater facilitates more effective mixing with coastal waters, reducing pollutant concentrations through dilution. Future studies relevant to this research are recommended to account for tidal phases (high and low tide) during sampling to obtain more representative assessments of seawater quality.

CONCLUSION

Based on the analysis of the Seawater Quality Index (IKAL) using the National Sanitation Foundation Water Quality Index (NSFWQI) approach, in accordance with the Regulation of the Minister of Environment and Forestry No. 27 of 2021, the seawater condition in Bontang during the second semester of 2023 was classified as Good, with an average IKAL value of 72.69. The highest IKAL value was recorded at the Mangrove BSD site (76.88), while the lowest was observed at Lok Tuan (63.97).

The assessed parameters included Total Suspended Solids (TSS), Dissolved Oxygen (DO), Total Ammonia, Orthophosphate, and Oil & Grease. Results indicated that, overall, the parameters remained within the established quality standards. However, at certain sites such as Lok Tuan, reduced DO levels and elevated ammonia concentrations suggested potential signs of water quality decline.

In general, the seawater condition in Bontang remains supportive of ecosystem sustainability as well as fisheries and tourism activities. Nevertheless, continuous monitoring is essential to anticipate increasing pollution loads, particularly from domestic and industrial sources, in order to ensure that water quality is maintained and does not deteriorate in the future.

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