

Water quality characteristics in the waters of Pangempang, Muara Badak, East Kalimantan

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ABSTRACT

The Pangempang waters, located within the estuarine area of Muara Badak, have experienced continuous coastline changes due to annual erosion. Monitoring water conditions in this region is essential to evaluate environmental suitability and detect potential threats. This study examined the physical and chemical properties of the water, following the guidelines of Government Regulation No. 22 of 2021. Observations were conducted at five selected sites: a shrimp pond, a river area adjacent to the pond, the river mouth near mining activities, a tourist area on Pangempang Island, and the outer section of the island near the dock, representing the Pangempang waters. Overall, the results indicate that water quality remains within acceptable limits for marine biota. However, certain parameters, such as temperature, salinity, and nitrate levels, deviated from the established standards. These variations are influenced by weather conditions, location, and potential organic waste input from activities along the study area.

INTRODUCTION

Muara Badak is a district located in Kutai Kartanegara Regency, East Kalimantan Province, with a total area of 930.09 km². The waters of Pangempang are part of the coastal region of Muara Badak, where mangrove forests grow optimally in Pangempang Bay. Currently, the mangrove ecosystem in Pangempang Bay is utilized as an educational tourism area and is frequently visited by tourists, especially during holidays. The Pangempang Bay area is also used for residential settlements, industries, fishing activities, and marine transportation (Bappeda, 2005).

Water is an essential environmental indicator, as its quality determines the overall health of an aquatic ecosystem. This applies to coastal ecosystems, including mangroves, seagrasses, and coral reefs.

The degradation of the mangrove ecosystem in Pangempang Bay has been evident over the years, with a decrease in mangrove area from 2014 to 2017. Furthermore, in 2023, the waters of Muara Badak experienced degradation due to land clearing and industrialization. At Kurma Indah Beach in Pangempang Bay, the beach slope was recorded at 1° in 2017, but by 2019, it had increased to 6°, indicating a 5° change within two years. Previous research data suggest that annual coastal erosion occurs in the area (Viridanto, 2024). Therefore, an updated study is needed to assess the current condition of the waters in Pangempang Bay, covering both riverine and coastal waters.

This research aims to analyze the water quality characteristics in the waters of Pangempang Bay, Muara Badak. The study is based on the assessment of water quality availability and refers to water quality

evaluation standards set by Government Regulation of the Republic of Indonesia No. 22 of 2021 on Environmental Protection and Management.

METHODOLOGY

This study was conducted in the waters of Pangempang Bay, Muara Badak, Kutai Kartanegara Regency, over a period of five months. The research was divided into five purposively selected sampling points, representing different activities in the surrounding area. The research locations are detailed in Table 1, with an illustration of the study site provided in Figure 1.

Table 1. Coordinates of research locations

Research Point	Coordinates	Description
1	0° 11' 36.0852" S, 117° 25' 30.88" E	Inner Bay Side
2	0° 12' 4.4820" S, 117° 26' 20.8212" E	Inner Bay Side
3	0° 12' 35.5867" S, 117° 25' 58.0066" E	Inner Bay Side
4	0° 13' 16.6764" S, 117° 25' 20.2944" E	Inside the Bay
5	0° 13' 38.9424" S, 117° 25' 26.4828" E	Inside the Bay

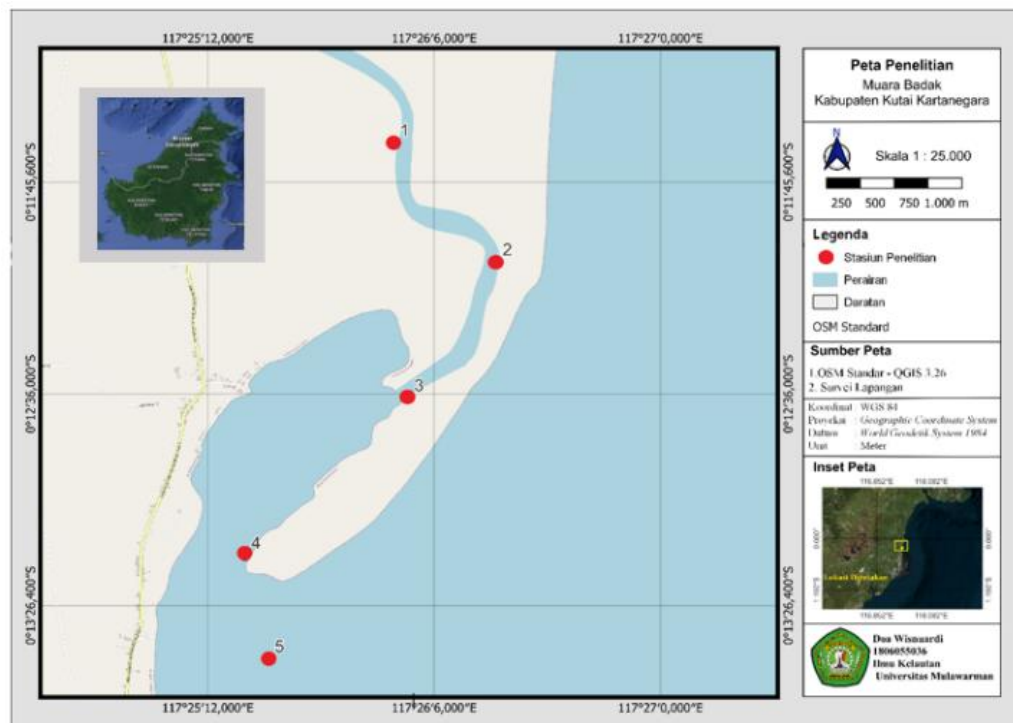


Figure 1. Research location map

Research points 1, 2, and 3 represent the river area from the innermost to the outermost part, located on the inner side of the bay. Research points 4 and 5 represent the estuarine waters of Pangempang, which are within the bay area.

Equipment and Materials

The equipment and materials used in this study include a 5L jerry can, glass bottles, a thermometer, a refractometer, a plankton net, a sediment grab, a pH meter, a pipette, a Winkler bottle, measuring glasses, Erlenmeyer flasks, test tubes, beakers, Whatman filter paper, a vacuum pump, an oven, a microscope, a digital scale, a spectrometer, a styrofoam storage box, and Lugol's solution.

Sample Collection

Sample collection at each research point was conducted using the purposive sampling method. Water samples were collected during high tide to facilitate sampling at the designated stations. The study employed a descriptive data analysis approach to illustrate the condition of Pangempang Bay, Muara Badak District, and compare water quality parameter values with legal standards.

Water samples were collected at each designated research point for both field and laboratory analysis. The procedure for seawater quality sampling involved using a 5L jerry can, collecting water in the direction of the current flow. The samples were then stored in a cool box filled with ice to maintain their composition and prevent changes.

Data Analysis

Data analysis for each seawater quality parameter was conducted as follows:

1. Total Suspended Solids (TSS) – SNI 6989.3:2019
2. Dissolved Oxygen (DO) – SNI 06.6989.14:2004
3. Biochemical Oxygen Demand (BOD₅) – SNI 6989.72:2009
4. Ammonia (NH₃) – SNI 19-6964.3-2003
5. Nitrate (NO₃-N) – SNI 19-6964.7-2003
6. Orthophosphate (PO₄-P) – SNI 6989-31:2021
7. Comparison between points – Simple linear regression

RESULT AND DISCUSSION

Pangempang Bay, located in Muara Badak, is a subdistrict in Kutai Kartanegara Regency, East Kalimantan Province, with a travel time of approximately 1–2 hours by land (BPS, 2020). Based on visual observations, the study site conditions are as follows: Point 1: Located in an aquaculture pond area with an ecosystem consisting of shrubs and mangrove vegetation. Point 2: Situated on the inner side of the bay, featuring mangrove vegetation and mining activities. Point 3: Located on the outer bay, with mangrove vegetation forming part of the river estuary and a floating net cage (KJA) near the Mutiara Beach tourist attraction. Point 4: Positioned in an active beach tourism area. Point 5: Located at a pier in the outer bay area.

Table 2. Water quality parameters in Pangempang Bay

Parameter	Unit	Research Points					Average (Σ)	Marine Biota Quality Standard*	Remarks
		1	2	3	4	5			
Temperature	°C	26	26	26	28	28	26.8	28-30	Compliant
Salinity	‰	16	16	19	18	19	17.5	34	Compliant
pH	-	7.025	7.635	7.505	7.975	7.475	7.523	7-8.5	Compliant
Turbidity	NTU	0.04	0.68	0.41	0.03	0.04	0.24	5	Compliant
Total Suspended Solids (TSS)	mg/L	6.9	7.1	5.4	5.3	4.5	5.84	80	Compliant
Orthophosphate	mg/L	0.002	0.002	0.005	0.003	0.002	0.0028	0.015	Compliant
Ammonia	mg/L	0.071	0.063	0.046	0.058	0.072	0.062	0.3	Compliant

Parameter	Unit	Research Points						Average (Σ)	Marine Biota Quality Standard*	Remarks
Nitrate	mg/L	0.084	0.103	0.121	0.127	0.122	0.1114	0.06		Non-compliant
Dissolved Oxygen (DO)	mg/L	5.84	6.08	6.00	5.92	6.00	5.968	>5		Compliant
Biochemical Oxygen Demand (BOD ₅)	mg/L	1.12	1.04	1.20	1.02	1.12	1.1	20		Compliant
Odor	-	Natural	Natural	Natural	Natural	Natural	Natural	Natural		Compliant

Source: Appendix VII of Government Regulation of the Republic of Indonesia No. 22 of 2021 on Environmental Protection and Management. Marine Water Quality Standards for Marine Biota.

From the table above, the characteristics of water quality based on the quality standards can be observed. The temperature has an average value of 26.8°C. This indicates that, based on the quality standard range in Government Regulation No. 22 of 2021, this value falls below the suitability range for aquatic life. This may be due to weather conditions at the time of sampling, where rain occurred at sampling points 1 to 3. A temperature lower than the quality standard can affect the presence of organisms and influence the metabolic rate of aquatic organisms. However, since the temperature remains within the epilimnion layer range (20°C), photosynthesis can still take place optimally.

Salinity has an average value of 17.5‰, indicating estuarine water characteristics, while the referenced quality standard applies to marine waters. Based on the geographical location of Pangempang waters, this salinity value aligns with the criteria for transitional (estuarine) waters. Additionally, as described in the location description, the presence of mangrove vegetation characterizes the Pangempang water area.

A parameter that does not meet the quality standard is nitrate, observed at all sampling points with an average value of 0.111 mg/L. High nitrate levels in the water can result from the complete oxidation of nitrogen in the water. Nitrification is the process of oxidizing ammonia into nitrite and nitrate, facilitated by microorganisms in the nitrogen cycle (Effendi, 2003). Nitrate is the primary form of nitrogen in natural waters and serves as a nutrient source for plant and algae growth. Nitrate nitrogen is highly soluble and stable in water, forming as a result of the complete oxidation of nitrogen. The oxidation of ammonia into nitrite is facilitated by *Nitrosomonas* bacteria, while the oxidation of nitrite into nitrate is aided by *Nitrobacter* bacteria (Schaduw et al., 2013). Elevated nitrate levels in the water can be caused by the input of organic matter or nutrients entering the water. Land restoration and freshwater inflows also contribute to increased nitrate levels. Activities along the observation points, such as aquaculture ponds releasing excess feed and excretions into the water (Goddard, 1996; Djumanto, 2018), increased abrasion factors (Viridanto, 2024), tourism activities, freshwater inputs, other domestic discharges, and domestic waste disposal, are suspected sources of pollution.

CONCLUSION

Pangempang waters in Muara Badak are transitional (estuarine) waters that have experienced abrasion, as evidenced by documented shoreline changes. The water quality characteristics of Pangempang waters along Pangempang Bay show discrepancies with Government Regulation No. 22 of 2021, particularly regarding temperature, which is lower at around 26°C due to weather conditions during sampling. The lower salinity compared to marine water quality standards confirms the estuarine nature of Pangempang waters. Meanwhile, nitrate concentrations are relatively high, indicating potential organic waste input into the water, suspected to originate from activities along Pangempang Bay.

REFERENCES

- Bappeda. (2005). Kutai Kartanegara. Diakses dari http://bappeda.kutaiartanegara.kab.go.id/info/wpcontent/uploads/EbookbappedaNonSave1/pdrb_mabadak2013/files/search/searcht ext.xml.
- BPS. (2020). Muara Badak. Diakses dari https://id.wikipedia.org/wiki/Muara_Badak,_Kutai_Kartanegara
- Djumanto, U., Ustadi, R., Triyatmo, B. (2018). Utilization of wastewater from vannamei shrimp pond for rearing milkfish in Keburuhan Coast Purworejo Sub-district. *Aquacultura Indonesiana*, 19(1), 38-46. <https://doi.org/10.21534/ai.v19i1.48>
- Effendi, H. (2000). *Telaah Kualitas Air Bagi Pengelolaan Sumber Daya dan Lingkungan Perairan*. Kanisius. Yogyakarta
- Effendi, H. (2003). *Telaah Kualitas Air Bagi Pengelolaan Sumber Daya dan Lingkungan Perairan*. Kanisius. Yogyakarta
- Goddard, S. (1996). *Feed Management in Intensive Aquaculture*. New York, US: Chapman & Hall.
- Hafizi, R., Dewiyanti, I., & Octavina, C. (2017). Produksi Serasah Hutan Mangrove di Kuala Langsa, Provinsi Aceh. *Jurnal Ilmiah Mahasiswa Kelautan dan Perikanan Unsyiah*, 2(4), 556-561.
- Hamuna, B., Tanjung, R. H., Maury, H. K., & Alianto. (2018). Kajian Kualitas Air Laut dan Indeks Pencemaran Berdasarkan Parameter Fisika-Kimia di Perairan Distrik Depapre, Jayapura. *Jurnal Ilmu Kelautan dan Perikanan*, 16, 35-43. <https://doi.org/10.14710/Jil.16.135-43>
- Harianka, M., & Yuyun, S. (2002). Studi Ekologi Populasi Mangrove Jenis *Rhizophora stylosa* di Pulau Tengah, Gugus Pulau Pari Kepulauan Seribu, Jakarta Utara. *Jurnal Ilmu Kelautan*, Fakultas Perikanan dan Ilmu Kelautan, Institut Pertanian Bogor.
- Krebs, C. J. (2014). *Ecological Methodology* (3rd ed.). New York.
- Magurran, A. E. (1988). *Ecological Diversity and Its Measurements*. Princeton University Press.
- MNLH. (2004). Keputusan Menteri Negara Lingkungan Hidup Nomor 51 Tahun 2004 tentang Baku Mutu Air Laut. Jakarta: Kementerian Negara Lingkungan Hidup.
- MRV Naufal. (2024). Analisis Struktur Komunitas Mangrove di Kecamatan Muara Badak, Kutai Kartanegara, Kalimantan Timur. *Jurnal Laot Ilmu Kelautan*, 6(1). <https://doi.org/10.35308/jlik.v6i1.9031>
- Virdianto. (2024). Analisis Struktur Komunitas Mangrove di Kecamatan Muara Badak, Kutai Kartanegara, Kalimantan Timur. *Jurnal Laot Ilmu Kelautan*, 6(1). <https://doi.org/10.35308/jlik.v6i1.9031>
- Onrizal. (2002). Evaluasi Kerusakan Kawasan Mangrove dan Alternatif Rehabilitasinya di Jawa Barat dan Banten. Fakultas Pertanian, Universitas Sumatera Utara, Medan.
- Kementerian Negara Lingkungan Hidup. (2021). Peraturan Pemerintah Republik Indonesia Nomor 22 Tahun 2021 tentang Penyelenggaraan Perlindungan dan Pengelolaan Lingkungan Hidup.
- Sachlan, M. (1972). *Planktonologi I*. Direktorat Jenderal Perikanan, Departemen Pertanian, Jakarta.
- SNI 6989.3:2019. Air dan Air Limbah - Bagian 3: Cara Uji Padatan Tersuspensi Total (Total Suspended Solid, TSS) Secara Gravimetri.
- SNI 6989.14:2004. Air dan Air Limbah - Bagian 14: Cara Uji Oksigen Terlarut Secara Yodometri (Modifikasi Azida).
- SNI 6989.72:2009. Air dan Air Limbah - Bagian 72: Cara Uji Kebutuhan Oksigen Biokimia (Biochemical

Oxygen Demand/BOD).

SNI 19-6964.3-2003. Kualitas Air Laut - Bagian 3: Cara Uji Amonia ($\text{NH}_3\text{-N}$) Dengan Biru Indofenol Secara Spektrofotometrik.

SNI 19-6964.7-2003. Air dan Air Limbah - Bagian 79: Cara Uji Nitrat ($\text{NO}_3\text{-N}$) Dengan Spektrofotometrik UV-Visibel Secara Reduksi Kadmium.

SNI 6989-31:2021. Air dan Air Limbah - Bagian 31: Cara Uji Kadar Ortofosfat dan Total Fosfor Menggunakan Spektrofotometer dengan Reduksi Asam Askorbat.