Water quality monitoring of Polder Air Hitam Lake in Samarinda

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ABSTRACT

This study aimed to evaluate the water quality status of Polder Air Hitam Lake, Samarinda, through monitoring several key water quality parameters and comparing the results with the Indonesian water quality standard (PP RI No. 22 Tahun 2021, Class II). Sampling was conducted from September to November 2023 at five monitoring stations. The measured parameters included chlorophyll-a, Dissolved Oxygen (DO), pH, temperature, Total Dissolved Solids (TDS), turbidity, salinity, and electrical conductivity. The results showed that chlorophyll-a concentrations ranged from 20.67–148.00 µg/L, indicating relatively high phytoplankton productivity, with several observations exceeding the quality standard threshold. DO concentrations ranged from 3.36–10.45 mg/L, while pH values ranged from 7.49–9.61, indicating slightly alkaline conditions. Temperature (27.2–31.27°C), TDS (172–215 ppm), and salinity (0.01–0.02‰) generally remained within acceptable ranges for freshwater ecosystems. Turbidity values (40–121 NTU) indicated considerable suspended materials that may reduce light penetration and affect aquatic productivity. Overall, the water quality of Polder Air Hitam Lake was generally within acceptable standards for several parameters; however, elevated chlorophyll-a, pH, and turbidity values suggest potential anthropogenic influences and indicate the need for continued monitoring and management efforts.

INTRODUCTION

The City of Samarinda, the capital of East Kalimantan, continues to experience rapid development. This is reflected in the steadily increasing population each year. As of September 2020, the population reached 827,994 inhabitants, with an annual population growth rate of 1.26% between 2010 and 2020 and a population density of 1,147 people per square kilometer (BPS Samarinda City). The increasing population in Samarinda has led to changes in vegetation cover, which may reduce the area’s water storage capacity. As a result, flooding has become a recurring annual issue in Samarinda.

Water pollution is one of the major problems frequently encountered in various aquatic ecosystems, including polder lakes such as Air Hitam Polder Lake. This condition may potentially cause serious impacts on aquatic organisms and the overall lake ecosystem. Water pollution is generally caused by industrial waste discharges and surrounding community activities that contribute excessive nutrient inputs into the water body. According to Novita et al. (2023), one of the most important parameters for assessing water quality is dissolved oxygen, which reflects the suitability of aquatic environments as habitats for aquatic biota. In addition, information regarding chlorophyll-a concentration, temperature, salinity, turbidity, Total

Dissolved Solids (TDS), pH, and Electrical Conductivity (EC) are key parameters in determining water quality status.

The importance of information regarding the condition of these key water quality parameters forms the basis for conducting research to monitor various water quality parameters and compare them with nationally applicable water quality standards in Indonesia.

METHODOLOGY

This study was conducted from September to November 2023, with water sampling carried out at Air Hitam Polder Lake in Samarinda. Sample analyses were performed at the Water Quality Laboratory, Faculty of Fisheries and Marine Science, Mulawarman University.

Water quality parameters measured at the five sampling stations included key water quality indicators, namely chlorophyll-a, temperature, salinity, turbidity, Total Dissolved Solids (TDS), pH, Dissolved Oxygen (DO), and Electrical Conductivity (EC). Water sampling was conducted at five sampling stations in Air Hitam Polder Lake.

Chlorophyll-a concentration was determined through direct in situ measurement using a fluorometer. The working principle of the fluorometer involves the use of a specifically designed light source to illuminate the water volume being examined. The emitted light is detected by sensors capable of observing light reflections from algae or microalgae. The sensor captures light reflections that interact with algal cells, after which the fluorometer detects and determines the chlorophyll-a concentration. The chlorophyll-a data obtained represented the five sampling stations of Air Hitam Polder Lake, thereby providing information on chlorophyll-a levels within the lake waters (Hamdhani, 2021).

Descriptive analysis was conducted by comparing the measured water quality data with the water quality standards established under Government Regulation of the Republic of Indonesia (PP RI) No. 22 of 2021 for Class II water quality criteria.

RESULT AND DISCUSSION

Chlorophyll-a

The results of chlorophyll-a concentration measurements in Air Hitam Polder Lake are presented in Table 1.

Table 1. Chlorophyll-a Concentration Measurements in Air Hitam Polder Lake Waters

Date	St.1	St.2	St.3	St.4	St.5
13-Sep-23	30.33	24	24.67	33.33	20.67
27-Sep-23	47.67	39.33	34.33	35	42.67
11-Oct-23	146.67	41	33.67	102.33	44.33
25-Oct-23	148	27.33	41.33	42.67	66
8-Nov-23	63.33	60	94.33	43.33	43

Chlorophyll-a in aquatic environments serves as an important indicator of primary productivity and functions as a major component in the photosynthesis process (Rahman et al., 2015). Based on Table 1, chlorophyll-a concentrations in Air Hitam Polder Lake ranged from 20.67 µg/L to 148.00 µg/L. The lowest concentration was recorded during the first sampling at Station 5 (20.67 µg/L), while the highest concentration was observed during the fourth sampling at Station 1 (148.00 µg/L). These results exceeded the water quality standard established under Government Regulation of the Republic of Indonesia (PP RI) No. 22 of 2021 for Class II waters, which sets a threshold value of 50 µg/L. According to Effendi et al.

(2012), chlorophyll-a concentration in aquatic ecosystems is strongly influenced by nutrient availability and sunlight intensity. When nutrient availability and sunlight intensity are sufficient, chlorophyll-a concentrations tend to increase, and vice versa.

Dissolved Oxygen (DO)

The results of Dissolved Oxygen (DO) measurements in Air Hitam Polder Lake are presented in Table 2.

Table 2. Dissolved Oxygen (DO) Measurements in Air Hitam Polder Lake Waters

Date	St.1	St.2	St.3	St.4	St.5
13-Sep-23	9.32	6.8	9.76	9.69	9.77
27-Sep-23	5.68	5.95	5.75	4.53	5.33
11-Oct-23	6.17	8.24	8.53	10.45	7.94
25-Oct-23	5.57	8.41	8.57	8.21	6.34
8-Nov-23	3.36	4.88	4.79	4.75	4.16

Dissolved Oxygen (DO) refers to the amount of oxygen dissolved in water, most of which is produced through photosynthesis by aquatic plants and algae (Noor and Ngabito, 2018). The DO concentrations measured in Air Hitam Polder Lake ranged from 3.36 mg/L to 10.45 mg/L. These results indicate that dissolved oxygen levels in the lake generally exceeded the minimum water quality standard established by PP RI No. 22 of 2021 for Class II waters, which is 4 mg/L. According to Garini et al. (2021), poor dissolved oxygen conditions in aquatic ecosystems can negatively affect nearly all living organisms within the aquatic environment.

pH (Degree of Acidity)

The results of pH measurements in Air Hitam Polder Lake are presented in Table 3.

Table 3. pH Measurements in Air Hitam Polder Lake Waters

Date	St.1	St.2	St.3	St.4	St.5
13-Sep-23	9.45	9.5	9.45	9.5	9.47
27-Sep-23	8.89	8.95	8.93	8.58	8.58
11-Oct-23	9.55	9.61	9.6	9.74	9.33
25-Oct-23	8.33	9.57	9.56	9.6	9.16
8-Nov-23	7.49	8.47	8.56	8.25	7.79

Based on Table 3, the pH values in Air Hitam Polder Lake ranged from 7.49 to 9.74. Referring to the water quality standards of PP RI No. 22 of 2021 for Class II waters, the acceptable pH range is 6–9. Therefore, the pH values in Air Hitam Polder Lake tended to be slightly above the standard range, indicating alkaline conditions. According to Pratiwi et al. (2015), pH values in aquatic environments are influenced by several factors, including photosynthesis and respiration, temperature, and ion concentrations in the water. Under normal pH conditions, photosynthesis can occur optimally. The elevated pH values observed in the lake were likely caused by household waste entering the water body. Syawal et al. (2016) stated that increased pH levels may result from high concentrations of OH^- ions originating from domestic detergent waste.

Temperature

The results of temperature measurements in Air Hitam Polder Lake are presented in Table 4.

Table 4. Temperature Measurements in Air Hitam Polder Lake Waters

Date	St.1	St.2	St.3	St.4	St.5
13-Sep-23	30.2	30.3	31	31	31.27
27-Sep-23	27.2	28.9	28.8	28.3	27.7

11-Oct-23	28.7	31.3	30.3	30.1	29.2
25-Oct-23	27.4	30.4	29.5	29.6	28.1
8-Nov-23	27.3	28.8	28.8	28.3	27.6

The temperature measurements in Air Hitam Polder Lake ranged from 27.2°C to 31.27°C. Based on the water quality standards established under PP RI No. 22 of 2021 for Class II waters, the temperature values in the lake remained within the acceptable standard range of 27°C–33°C. Variations in temperature were likely influenced by weather conditions and the intensity of sunlight penetrating the water surface. This finding is consistent with Maniagasi et al. (2013), who stated that temperature variations in aquatic ecosystems are influenced by altitude, rainfall intensity, and solar radiation reaching the water surface. In general, the observed temperature range during the study remained suitable for phytoplankton growth and development. According to Irawati (2014), the ideal temperature range for phytoplankton growth is between 20°C and 30°C.

Total Dissolved Solids (TDS)

The results of TDS measurements in Air Hitam Polder Lake are presented in Table 5.

Table 5. Total Dissolved Solids (TDS) Measurements in Air Hitam Polder Lake Waters

Date	St.1	St.2	St.3	St.4	St.5
13-Sep-23	177	179	178	182	176
27-Sep-23	180	173	176	179	178
11-Oct-23	177	176	194	185	179
25-Oct-23	201	206	215	199	208
8-Nov-23	172	200	209	213	200

Total Dissolved Solids (TDS) represent all dissolved substances present in water. Dissolved solids consist of colloids, ions, and compounds that may influence water quality (Addzikri and Rosariawari, 2023). Based on Table 5, TDS values in Air Hitam Polder Lake ranged from 172 ppm to 215 ppm. According to PP RI No. 22 of 2021 for Class II waters, the measured TDS values were still within the acceptable water quality standards. Effendi (2003) reported a strong correlation between conductivity and TDS values. The higher the concentration of dissolved substances in water, the greater the water's ability to conduct electrical current.

Turbidity

The results of turbidity measurements in Air Hitam Polder Lake are presented in Table 6.

Table 6. Turbidity Measurements in Air Hitam Polder Lake Waters

Date	St.1	St.2	St.3	St.4	St.5
13-Sep-23	45.52	44.25	43.33	43.62	40
27-Sep-23	45.15	41.44	45.14	45.23	40.93
11-Oct-23	75	65	96	69	60
25-Oct-23	121	85	100	81	67
8-Nov-23	106	57	78	47.22	63

Based on the measurement results obtained from Air Hitam Polder Lake, turbidity levels ranged from 40 NTU to 121 NTU. These values were relatively similar to turbidity levels reported in Lake Toba, which ranged from 0.8 NTU to 584.1 NTU due to the presence of high sediment and mud content that increased turbidity levels (Damayanti et al., 2022). High turbidity in Air Hitam Polder Lake reduced sunlight penetration into the water column, thereby inhibiting photosynthesis by aquatic plants and reducing oxygen production from photosynthetic processes. This finding is consistent with Nugraheni et al. (2022), who stated that turbidity in aquatic ecosystems can reduce light penetration and negatively affect photosynthesis.

Salinity

The results of salinity measurements in Air Hitam Polder Lake are presented in Table 7.

Table 7. Salinity Measurements in Air Hitam Polder Lake Waters

Date	St.1	St.2	St.3	St.4	St.5
13-Sep-23	0.01	0.01	0.01	0.01	0.01
27-Sep-23	0.01	0.01	0.01	0.01	0.01
11-Oct-23	0.01	0.01	0.01	0.01	0.01
25-Oct-23	0.02	0.02	0.02	0.01	0.02
8-Nov-23	0.01	0.02	0.02	0.02	0.01

Based on the measurements conducted in Air Hitam Polder Lake, salinity levels ranged from 0.01‰ to 0.02‰. Salinity refers to the total amount of dissolved salts in a given volume of water or solution (Annisa, 2023). The survival of aquatic organisms is highly dependent on salinity levels in aquatic ecosystems (Setiawati et al., 2022). In comparison, salinity levels in a lake located in Aceh Regency ranged from 0.02‰ to 0.03‰. In general, freshwater ecosystems typically have salinity levels ranging from 0 ppt to 35 ppt.

CONCLUSION

The monitoring results demonstrated that the water quality condition of Polder Air Hitam Lake varied across observation periods and stations. Several measured parameters, including temperature, TDS, and salinity, generally remained within the Indonesian water quality standards (PP RI No. 22 Tahun 2021 Class II), indicating that the lake still maintains basic physicochemical characteristics suitable for freshwater ecosystems. Dissolved oxygen concentrations were mostly within acceptable levels, although several measurements approached or fell below the minimum standard.

Several parameters showed indications of environmental pressure within the aquatic system. Chlorophyll-a concentrations reached relatively high values and, in several observations, exceeded the recommended threshold, suggesting elevated nutrient availability and increased phytoplankton productivity. The slightly alkaline pH condition and relatively high turbidity values further suggest possible influences from domestic waste discharge, suspended sediments, and surrounding anthropogenic activities.

Overall, the findings indicate that Polder Air Hitam Lake experiences moderate water quality fluctuations influenced by both natural environmental factors and human activities around the lake area. Therefore, continuous monitoring of key water quality parameters and improved management strategies are necessary to maintain ecosystem sustainability and reduce the risk of further water quality degradation in Polder Air Hitam Lake, Samarinda.

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