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Physicochemical water quality and basic soil parameters of Embung B, Institut Teknologi Sumatera: a preliminary assessment

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ABSTRACT

Monitoring physicochemical parameters is essential for establishing baseline information on the ecological condition and water safety of small reservoirs. This study provides a preliminary assessment of the water quality of Embung B based on selected physicochemical parameters and iron (Fe) concentration. Water samples were collected from three spatially representative locations and analyzed for pH, electrical conductivity, total dissolved solids (TDS), and Fe(III). TDS was determined using both gravimetric and in situ meter-based methods, while Fe(III) concentration was measured colorimetrically through the formation of the $Fe(SCN)^{2+}$ complex at 480 nm. Meter-based TDS measurements indicated relatively low dissolved solids, whereas gravimetric results showed notable variability, highlighting method-dependent differences. Water pH values ranged from 8.31 to 8.83 and remained within the permissible range (6–9). Electrical conductivity values suggested low ionic strength, and Fe(III) concentrations (0.178–0.241 mg/L) were below the national drinking water limit of 0.3 mg/L. Overall, the results indicate that the water quality of Embung B, based on the measured physicochemical parameters, complies with applicable regulatory standards at the time of sampling. These findings provide baseline information to support environmental monitoring and educational activities, while emphasizing the need for extended spatial, temporal, and methodological assessment in future studies.

Keywords: Environmental monitoring, Fe(III) concentration, iron contamination, total dissolved solids, water quality assessment

PLAIN LANGUAGE SUMMARY

We assessed the water and soil quality of Embung B, one of campus reservoir at Institut Teknologi Sumatera. Water samples collected from three locations showed pH, dissolved oxygen, total dissolved solids, and electrical conductivity values that met Indonesian national standards. Iron (Fe) concentrations were below the permitted drinking water threshold of 0.3 mg/L. Soil conditions around the reservoir showed stable pH, moisture, and temperature consistent with tropical environments. Overall, our findings suggest that Embung B maintains acceptable environmental quality at the time of sampling. We recommend continued seasonal monitoring to better understand long-term changes in water and soil conditions.

their ability to neutralize free radicals, both the avocado peel extract and the nanoparticles showed moderate antioxidant activity. This work demonstrates that avocado peel waste can be repurposed as a sustainable resource for producing functional nanoparticles.

Introduction

Water is an essential resource that supports various aspects of human life, including domestic activities, industrial processes, irrigation, and drinking water supply. Different types of water, such as swimming pool water, drinking water, bathing water, and clean water—serve specific purposes according to their characteristics [1,2]. However, not all water sources are safe for direct consumption due to potential contamination that may pose risks to human health. One of the common pollutants found in aquatic environments is iron (Fe) [3].

Iron naturally occurs in surface and groundwater systems at relatively low concentrations. However, anthropogenic activities such as industrial operations, domestic waste disposal, and land-use changes can significantly increase iron levels beyond safe limits. Iron contamination may also originate from the dissolution of Fe-bearing minerals, such as pyrite (FeS_2), through natural geochemical processes [4]. Water quality assessment generally involves three categories of parameters: physical, chemical, and biological. Physical parameters include turbidity, color, total dissolved solids (TDS), temperature, taste, and odor. Chemical parameters include pH, iron content, fluoride, hardness, manganese, nitrite, nitrate, cyanide, detergents, and total pesticides, while biological parameters encompass total coliforms and *Escherichia coli*.

Among chemical parameters, iron concentration is an important indicator of water quality. According to the Indonesian Ministry of Health Regulation No. 32 of 2017, iron (Fe) is regulated as a parameter in water intended for hygiene and sanitation purposes [5]. Chronic exposure to excessive iron can lead to various adverse health effects, including liver cirrhosis, hemochromatosis, gastrointestinal irritation, diarrhea, coma, and abdominal pain. Furthermore, iron accumulation in the alveoli may impair lung function and can be fatal if left untreated [6].

In groundwater systems, iron typically exists in the ferrous form (Fe^{2+}) due to low-oxygen conditions. High concentrations of dissolved carbon dioxide (CO_2) promote the reduction of ferric ions (Fe^{3+}) into the more soluble ferrous form. When groundwater is exposed to aeration or oxygenation, Fe^{2+} is oxidized to ferric oxyhydroxide ($Fe(OH)_3$), which readily precipitates and becomes insoluble at pH values between 6 and 8 [7]. One analytical method widely used to determine iron concentration in water is UV–Vis spectrophotometry, which operates in the ultraviolet and visible wavelength range of approximately 380–480 nm. This technique has been successfully applied for the analysis of iron, ammonium, and phosphate in water samples.

In addition to water quality, soil conditions surrounding a reservoir play a crucial role in shaping the overall environmental status of the area. Soil is a natural body that covers most of the Earth's surface and serves as a medium for plant growth. Its physical, chemical, and biological properties strongly influence soil fertility and plant productivity [8]. Key chemical properties of soil include pH, cation exchange capacity (CEC), base saturation, organic matter content, and the availability of macro- and micronutrients. Macronutrients include N, P, K, Ca, Mg, S, and C, H, and O, while micronutrients consist of Fe, Mn, Mo, B, Zn, Cu, Cl, Na, and Co, all of which are essential for plant metabolic processes and overall soil health [9]. Therefore, monitoring their concentrations is important.

The selected physicochemical parameters such as pH, dissolved oxygen, electrical conductivity, and turbidity were chosen due to their fundamental role in indicating water quality status and their influence on metal mobility and bioavailability. Iron (Fe) was selected as the target metal because it is commonly found in surface waters, can originate from both natural and anthropogenic sources, and may pose environmental and health concerns when present at elevated concentrations [10].

Despite the growing number of studies on water quality and metal contamination in rivers and large reservoirs [11,12], limited attention has been given to small artificial reservoirs, particularly campus-based retention ponds, in Indonesia. These water bodies play an important role in water storage, flood control, and daily campus activities, yet their physicochemical characteristics and potential metal contamination remain poorly documented. Embung B, located within a university campus environment, is exposed to surface runoff, anthropogenic activities, and natural weathering processes that may influence its water quality. However, to date, no systematic assessment of water quality and iron contamination has been reported for this reservoir.

Therefore, this study aims to evaluate the physicochemical characteristics and iron (Fe) contamination levels in Embung B, Institut Teknologi Sumatera (ITERA) and to assess the overall water quality status of this campus reservoir using appropriate water quality indices.

Methods

Water and soil sampling

Water and soil sampling were conducted using the grab sampling method. Water samples were collected from Embung B, located within the Institut Teknologi Sumatera campus. Sampling was performed at three representative points (n=3) selected to reflect spatial variation within the reservoir, namely Sample A (5°21′31″ S, 105°18′27″ E), Sample B (5°21′33″ S, 105°18′27″ E), and Sample C (5°21′34″ S, 105°18′27″ E). All samples were collected during a single sampling campaign under stable weather conditions to minimize temporal variability. Water samples were collected using pre-cleaned polyethylene bottles. Prior to sampling, bottles were rinsed three times with reservoir water. Samples for iron analysis were preserved by acidification to pH < 2 using concentrated nitric acid (HNO_3) and stored at 4 °C until analysis to prevent metal precipitation and

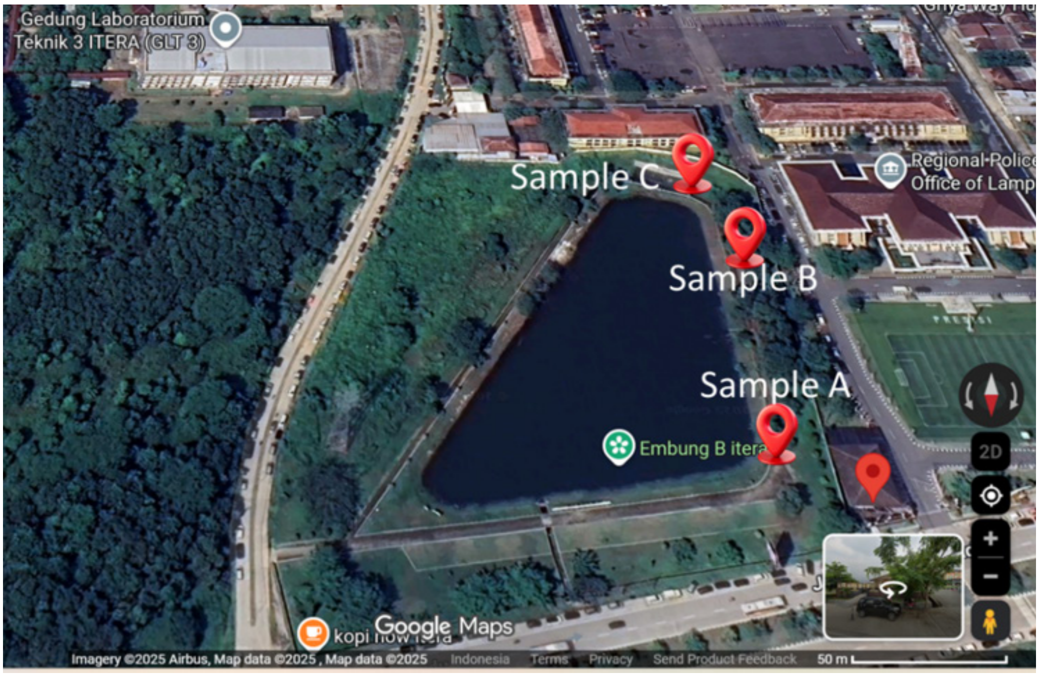

Figure 1. Map of Embung B ITERA showing the water and soil sampling locations at three designated points. (base map: Google Maps, accessed December 2025).

adsorption. Water pH, TDS, dissolved oxygen (DO), and electrical conductivity (EC) were measured using a portable water multimeter (Lutron WA-2017SD, Lutron Electronic Enterprise Co., Ltd., Taiwan). The instrument was calibrated according to the manufacturer's instructions before measurement.

Soil sampling was conducted at representative points around Embung B at a depth of 0–15 cm using a hand hoe. Collected samples were placed in clean plastic bags and labeled accordingly. Soil parameters, including pH, moisture, temperature, soil fertility index, light intensity, and air humidity, were measured in situ at each sampling location using a portable soil multimeter. Measurements were performed directly in the field to reflect actual environmental conditions. The soil fertility index represents an integrated field indicator based on soil pH, moisture, and temperature, while light intensity and air humidity were measured to characterize the local microclimatic conditions influencing soil processes. Figure 1 presents the location map of Embung B at Institut Teknologi Sumatera along with the water and soil sampling points used in this study.

Gravimetric determination of TDS

The analysis of TDS was also carried out using the gravimetric method. The water sample was first filtered using filter paper to separate suspended solids. The resulting filtrate was transferred into a pre-weighed and oven-dried beaker. The filtrate was then evaporated to dryness, after which the beaker was placed in an oven at 103–105°C for approximately one hour. The beaker was subsequently cooled in a desiccator and reweighed. The difference in mass before and after evaporation represents the amount of TDS in the water, which is then calculated as the TDS value.

Determination of Fe(III) by UV-Vis spectrophotometry

The determination of Fe concentration was carried out using UV-Vis spectrophotometry based on the formation of a colored complex between Fe^{3+} and thiocyanate ions (SC^{N}–). A 100 mg/L Fe stock solution was prepared by dissolving 0.04833 g of $FeCl_3{\cdot}H_2O$ in distilled water, followed by the addition of several drops of hydrochloric acid to stabilize the Fe^{3+} ions. The solution was then diluted to 100 mL in a volumetric flask.

Standard solution preparation. A series of standard solutions were prepared using five 25-mL volumetric flasks. Aliquots of the 100 mg/L Fe stock solution were pipetted to obtain final concentrations of 0.2, 0.4, 0.6, 0.8, and 1.0 mg/L,

Table 1. Soil quality parameters at Embung B sampling points

Parameter	Sample A	Sample B	Sample C
Soil pH	6.0	6.0	6.0
Soil moisture	55%	52%	54%
Soil temperature	30.4 °C	30.0 °C	30.0 °C
Soil fertility index	58	150	151
Microclimatic conditions (light intensity)	8,647 lux	8,370 lux	9,607 lux
Air humidity	75%	72%	70%

corresponding to 200, 400, 600, 800, and 1000 µL of the stock solution. To each flask, 3 mL of 4 N HNO_3 and 5 mL of 2 M KSCN were added. The solutions were then diluted to the mark with distilled water and homogenized thoroughly.

Wavelength selection. The absorbance of the Fe–SCN complex was scanned in the wavelength range of 400–800 nm. The maximum absorbance (λmax) typically appears around 450–480 nm, depending on solution conditions such as acidity and reagent concentration. This λmax is used as the operational wavelength for constructing the calibration curve and analyzing the samples.

Calibration and sample measurement. Each standard solution was transferred into a cuvette previously rinsed with 96% ethanol to avoid contamination. The absorbance was measured at λmax using a UV-Vis spectrophotometer. The resulting absorbance values were plotted against Fe concentration to obtain the calibration curve, which is used to calculate Fe concentration in unknown samples.

Sample analysis. Water samples were treated using the same procedure as the standard solutions to ensure identical chemical conditions. Each sample was added with 3 mL of 4 N HNO_3 and 5 mL of 2 M KSCN, diluted to volume, homogenized, and measured at λmax. The Fe concentration in the samples was determined by interpolating the absorbance values onto the calibration curve.

Results

Soil parameters

The soil analyses conducted at three different points around Embung B, Institut Teknologi Sumatera, indicate that the overall soil condition in the area is within acceptable quality ranges when compared with the standards established by the Food and Agriculture Organization (FAO). Table 1 summarizes the analytical results obtained from the collected soil samples.

Soil quality parameters measured in the Embung B area included soil pH, soil moisture, soil temperature, and a soil fertility index, which represent intrinsic soil properties (Table 1). The soil fertility index reported in this study is a qualitative, unitless indicator obtained directly from a portable soil multimeter and is derived from the combined response of soil pH, moisture, and temperature. In addition, light intensity and air humidity were measured to characterize the microclimatic conditions at the soil surface during sampling. These parameters are not intrinsic soil properties but were included to provide an environmental context that may influence soil moisture dynamics and biological activity in the surrounding area.

Based on the physical and chemical measurements conducted at three soil sampling points around Embung B, Institut Teknologi Sumatera, the overall soil condition falls within a range generally considered suitable to support biological processes. The soil pH, recorded consistently at 6.0 across all sampling points, lies within the ideal range recommended by the FAO (5.5–7.5). This pH range indicates favorable conditions for nutrient availability, particularly nitrogen and phosphorus and supports microbial activity. The uniformity of pH values also suggests a relatively stable soil environment across the study area.

Soil moisture levels ranged from 52% to 55%, indicating relatively high moisture conditions typical of soils in humid tropical environments and reflecting the soil's capacity to retain water during the sampling period. This moisture range is essential for maintaining root respiration, enzymatic processes,

Table 2. Water quality parameters at Embung B sampling points

Parameter	Sample A	Sample B	Sample C	Quality standard*
Water pH	8.31	8.73	8.83	6–9
Total dissolved solids (TDS)	63 mg/L	65 mg/L	63 mg/L	1000 mg/L
Dissolved oxygen (DO)	8.3 mg/L	6.2 mg/L	6.5 mg/L	Minimum 6 mg/L
Electrical conductivity (EC)	130 µS/cm	130 µS/cm	126 µS/cm	–

** (KLHK PP 22/2021)*

microbial populations, and preventing soil erosion or degradation. Soil temperature measurements, ranging from 30 to 31.5 °C, fall within the acceptable FAO range for tropical soils (25–35 °C), indicating conditions that continue to support biological and microbial metabolic activity.

Soil fertility values showed considerable variation among the sampling points, with a value of 58 at the first point and 150–151 at the second and third points. These differences are likely influenced by spatial variations in organic matter content or soil aeration. Nevertheless, all values remain within functional and acceptable limits. Light intensity measurements ranged from 8,370 to 9,607 lux, categorized as moderate to high exposure for open areas and consistent with typical tropical light intensity ranges (5,000–10,000 lux). Variations between points may be attributed to cloud cover or the position of the sun during sampling. Air humidity values ranged from 70% to 75%, which is considered high but normal for tropical environments. Overall, these parameters indicate that the soil conditions around Embung B are stable and align with tropical soil quality standards. The observed physicochemical conditions are generally consistent with soils capable of supporting basic biological activity. However, definitive conclusions regarding vegetation suitability or land-use potential would require additional biological and ecological assessments beyond the scope of this preliminary study. These findings also provide a foundation for further ecological assessment, particularly regarding soil and water quality control around the reservoir. Regular monitoring and proper management are recommended to ensure long-term environmental sustainability and maintain the ecological, hydrological, and biological functions of Embung B within the ITERA campus landscape.

Water quality parameters

The analysis of water samples collected from three different points around Embung B at Institut Teknologi Sumatera shows that the physical and chemical conditions are generally within acceptable ranges. The measured parameters included pH, TDS, DO, and EC using water quality meter instrument. All results were evaluated with reference to the Indonesian national water quality standards established by the Ministry of Environment and Forestry (KLHK) under Government Regulation No. 22 of 2021 on Water Quality Standards and Criteria. This regulation provides the benchmark for assessing the quality of surface water, groundwater, and wastewater in Indonesia. The following section presents the detailed results of the water sample analysis.

Water pH measurements

The pH measurements of the water samples showed values of 8.31 for Sample A, 8.73 for Sample B, and 8.83 for Sample C. According to the KLHK Regulation PP No. 22/2021, the acceptable pH range for surface water is 6–9, indicating that all samples fall within the permissible limits. The pH conditions suggest that the water in Embung B remains within a safe range, although the values observed at Sampling Points B and C approach the upper threshold. This slight increase may be associated with microalgal activity, which can elevate pH through photosynthetic uptake of dissolved CO_2.

Total dissolved solids

The TDS values measured at the three sampling points were 63 mg/L for Sample A, 65 mg/L for Sample B, and 63 mg/L for Sample C. According to KLHK Government Regulation No. 22/2021, the maximum permissible TDS concentration for surface water is 1000 mg/L. These results indicate

Table 3. Results of total dissolved solids (TDS) analysis using the gravimetric method

Sample	Mass before (g)	Mass after (g)	TDS (mg/L)
A	33.8085	34.8046	-[a]
B	35.3724	35.3788	256
C	29.3230	29.3291	244

[a] The gravimetric TDS value of Sample A was excluded from interpretation due to an abnormal deviation compared to in situ measurements and other samples, likely caused by particulate interference during the gravimetric procedure.

that the water in Embung B contains relatively low levels of TDS and remains well within the acceptable limit. The low TDS values suggest that the water is still clean and exhibits minimal dissolved particulate matter, a condition that supports aquatic life by reducing the risk of pollution from dissolved contaminants.

Dissolved oxygen

The dissolved oxygen (DO) measurements showed values of 8.3 mg/L for sample A, 6.2 mg/L for sample B, and 6.5 mg/L for sample C. All values meet the minimum DO standard of 6 mg/L set by KLHK PP 22/2021. The variation among sampling points is likely influenced by differences in light intensity and water temperature, with the first point showing the highest DO presumably receiving greater light exposure.

Conductivity

The EC measurements obtained for sampling points A, B, and C were 130 μS/cm, 130 μS/cm, and 126 μS/cm, respectively. These consistently low conductivity values indicate a low abundance of dissolved ionic species in the Embung B water. Such conditions suggest that the water body has not experienced significant ionic contamination. Moreover, low conductivity is generally associated with higher water purity, which is favorable for maintaining a healthy aquatic environment.

Gravimetric TDS analysis

The determination of TDS in the water samples was also performed using the gravimetric method. For TDS analysis, 25 mL of water sample was filtered, and the resulting filtrate was transferred into a pre-weighed beaker. The filtrate was then evaporated to dryness and dried in an oven at 103–105 °C for approximately 1 hour. After cooling in a desiccator, the beaker was reweighed, and the increase in mass was used to calculate TDS.

TDS concentrations in Embung B varied among the sampling locations (Table 3). In situ measurements using a portable TDS meter showed relatively low and comparable TDS values across all sampling points. Gravimetric TDS analysis yielded consistent results for Samples B and C; however, the gravimetric TDS value for Sample A was excluded from further interpretation due to an abnormal deviation from both the meter-based measurement and the other gravimetric samples. This discrepancy is likely associated with particulate interference during the gravimetric procedure. Therefore, discussion of TDS levels is based on meter measurements and gravimetric data from Samples B and C.

A notable discrepancy was observed between the TDS values obtained using the water quality meter and those determined through the gravimetric method. The water quality meter consistently measured TDS at 63 mg/L for all sampling points, indicating relatively low dissolved solid content. In contrast, the gravimetric analysis produced higher and more variable TDS values across samples. This difference may be attributed to the fundamental principles of each method. Water quality meters estimate TDS indirectly from electrical conductivity, assuming a proportional relationship between ionic strength and TDS. Consequently, the measurement reflects primarily ionic species. Conversely, the gravimetric method quantifies all dissolved residues remaining after evaporation, including both ionic and non-ionic dissolved substances such as organic matter, silica, or fine colloids that do not strongly influence conductivity. Variations in sample composition, evaporation efficiency, or slight losses during filtration and drying may also

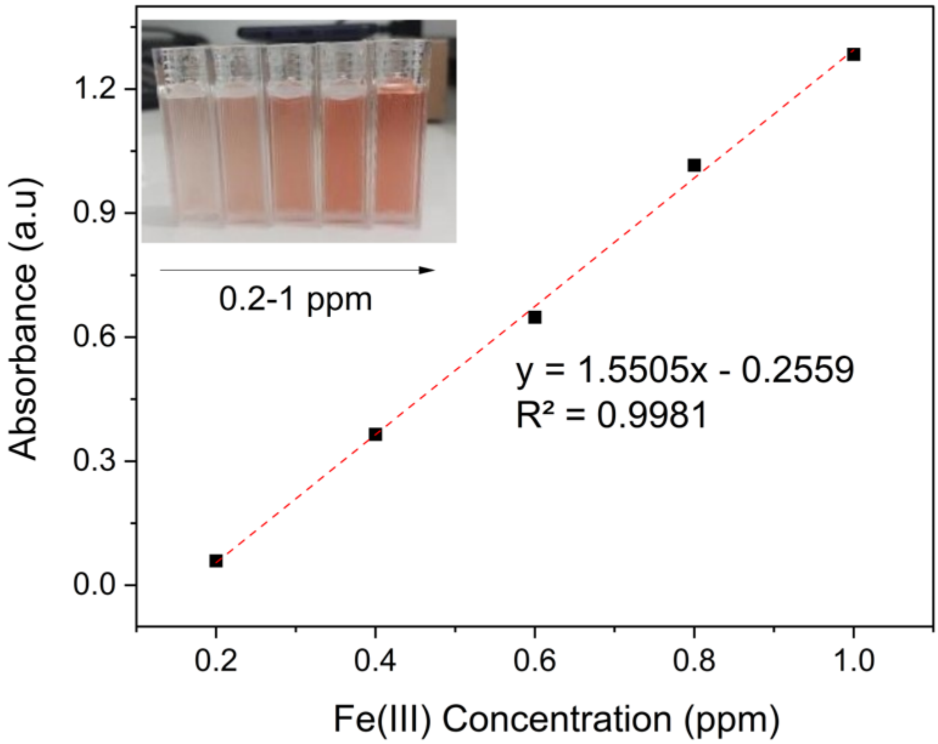

Figure 2. Standard calibration curve for Fe(III) obtained using UV–Vis spectrophotometry.

contribute to the observed differences. Therefore, gravimetric TDS values tend to be higher and more representative of total dissolved residues, whereas meter-based TDS values provide a rapid but indirect approximation dominated by ionic content.

Fe(III) concentration

The Fe(III) content in water samples from Embung B, ITERA, was analyzed using UV–Vis spectrophotometry based on the formation of a colored complex. A calibration curve was first established to determine Fe(III) concentrations in the samples, using a maximum absorbance wavelength of 480 nm. The spectrophotometric measurements obtained for various standard concentrations used to construct the calibration curve are presented in Table 4, while the corresponding calibration plot is shown in Figure 2.

Table 4. Absorbance values for Fe(III) standard solutions measured at 480 nm.

Fe(III) concentrations (mg/L)	Absorbance (a.u)
0.2	0.059
0.4	0.365
0.6	0.648
0.8	1.016
1	1.284

Based on Table 4 and Figure 2, the calibration curve produced a linear equation of $y = 1.5505x - 0.2559$ with a correlation coefficient (r) of 0.9981. This value demonstrates high linearity, as the minimum accepted correlation coefficient for method linearity is r ≥ 0.995 [13]. However, a complete linearity assessment including residual plot analysis is recommended in future studies to conform with current validation guidelines. The absorbance values for each water sample are presented in Table 5.

Table 5. Fe(III) concentrations in water samples from Embung B, ITERA

Water Sample (Location)	Absorbance (a.u.)	Fe(III) concentration (mg/L)	Remarks
Sample A (5°21'31"S, 105°18'27"E)	0.117	0.241	Within Standard
Sample B (5°21'33"S, 105°18'27"E)	0.101	0.230	Within Standard
Sample C (5°21'34"S, 105°18'27"E)	0.020	0.178	Within Standard

The determination of iron (Fe) as a trace metal in water samples is an essential analytical procedure for assessing environmental water quality and identifying environmental factors that may influence it. The quantification of Fe(III) is commonly performed using UV–Vis spectrophotometry. In this method, the formation of the red-colored Fe–thiocyanate complex is an equilibrium process, in which Fe^{3+} reacts with thiocyanate ions (SCN^-) to form the predominant $[FeSCN]^{2+}$ species under acidic conditions and excess SCN^-. Which exhibits a maximum absorbance at 480 nm. The reaction between Fe(III) and potassium thiocyanate can be expressed as follows:

$$Fe^3+ + SCN^- \rightleftharpoons [FeSCN]^2+ \tag{1}$$

Based on the measurements obtained from Embung B ITERA, the Fe(III) concentrations at the three sampling points were 0.241 mg/L, 0.230 mg/L, and 0.178 mg/L for Samples A, B, and C, respectively. These values fall within the permissible limits established by the Indonesian Ministry of Health Regulation No. 2 of 2023, which sets a maximum Fe concentration of 0.3 mg/L for drinking water and 1.0 mg/L for environmental water [14].

Discussion

The overall characterization of soil and water quality around Embung B ITERA indicates that the environmental conditions remain within acceptable ecological and regulatory thresholds. Soil parameters including pH, moisture content, temperature, fertility, light intensity, and ambient humidity show relatively stable values across all sampling points. The uniform soil pH of 6.0 suggests slightly acidic conditions that are generally compatible with various terrestrial plant species commonly found in the surrounding landscape. Variations in fertility values likely reflect differences in organic matter accumulation or localized plant activity, yet all values remain indicative of adequate soil productivity. These findings collectively demonstrate that the terrestrial environment around the reservoir remains suitable for sustaining vegetation and natural ecological processes.

Water quality analysis further supports the conclusion that Embung B maintains good environmental status. The pH values of 8.31 to 8.83 fall within the acceptable range of 6–9, as specified in PP 22/2021, indicating that the water body is slightly alkaline but still within safe limits [15]. Elevated pH values at sampling points B and C may be associated with localized microalgal activity, which can increase alkalinity through photosynthetic CO_2 uptake. Dissolved oxygen concentrations across all samples exceed the minimum regulatory requirement of 6 mg/L, demonstrating sufficient aeration to support aquatic biota and indicating that the reservoir is not experiencing hypoxic stress. Variations in DO appear to correlate with differences in light exposure and water temperature, with the highest DO observed at the sampling point likely receiving greater sunlight.

Electrical conductivity (EC) values are consistently low, reflecting minimal dissolved ionic content in the reservoir water. This condition suggests that Embung B has not undergone significant mineralization or contamination from anthropogenic runoff, and the water remains relatively clean in terms of dissolved electrolytes. The comparison between TDS values obtained using a water quality meter and those determined gravimetrically highlights expected methodological differences. The meter measures ionic and conductive species, whereas the gravimetric method quantifies total dissolved residues, including non-ionic or weakly conductive solids after evaporation. Despite numerical differences, both methods indicate low TDS levels, confirming that the reservoir water is not burdened by dissolved solids that could impair ecological function [16]. These values suggest minimal particulate loading, limited sediment resuspension, and an absence of significant erosion or anthropogenic disturbance in the surrounding area. Low TDS levels are also consistent with the high DO and low conductivity observed, together depicting a clear, low-turbidity water body with favorable conditions for photosynthetic and microbial activity.

Analysis of Fe(III) concentrations indicates that iron levels in Embung B remain below the regulatory thresholds established by the Indonesian Ministry of Health, namely <0.3 mg/L for drinking water and <1.0 mg/L for ambient water [20]. The measured Fe(III) concentrations of 0.241, 0.230, and 0.178 mg/L for samples A, B, and C, respectively, suggest no indication of excessive iron input at the time of sampling. Quantification was performed using UV–Vis spectrophotometry based on the formation of the red $Fe(SCN)^{2+}$ complex measured at 480 nm. The calibration curve exhibited strong linearity (r = 0.9981), supporting the reliability of the analytical results. These findings imply that major sources of iron contamination, such as intensive metallic runoff, pipe corrosion, or industrial discharges, are unlikely to be significant contributors in the study area during the sampling period [17].

Overall, the observed physicochemical characteristics of water and soil in Embung B indicate conditions that are generally within acceptable environmental limits under current regulatory standards. Low iron concentrations, together with moderate levels of dissolved solids and favorable pH and dissolved oxygen values, reflect relatively stable water quality at the time of observation. Nevertheless, given the limited spatial and temporal scope of this study, continued and seasonally resolved monitoring is recommended to evaluate potential long-term changes associated with hydrological dynamics, land-use activities, and watershed processes.

This study has several limitations that should be considered when interpreting the results. First, sampling was conducted during a single observation period at three spatially representative locations around Embung B, which limits the ability to capture temporal and seasonal variability that is known to significantly influence water quality in small reservoirs. Second, the absence of replicate measurements and inferential statistical analyses restricts the quantitative evaluation of variability and the significance of differences among sampling points; therefore, the findings should be regarded as exploratory. Third, methodological constraints particularly in the gravimetric determination of TDS may have introduced uncertainty, as indicated by the anomalous value observed in one sample, which was consequently excluded from interpretation. In addition, comprehensive water quality indices and ecological indicators were not calculated in this study. Accordingly, the results provide an initial physicochemical characterization of soil and water conditions in Embung B and serve as baseline data for future investigations with improved statistical rigor and seasonal resolution.

Despite these limitations, the present study offers a valuable snapshot of current environmental conditions in the reservoir. Future research should incorporate seasonal and multi-temporal monitoring to assess the effects of rainfall, surface runoff, and temperature fluctuations on physicochemical parameters and metal concentrations. Additional analyses of nutrients, such as nitrate, phosphate, and ammonia, are recommended to better evaluate the risk of eutrophication. Furthermore, biological assessments including plankton diversity and microbial community structure would provide deeper insight into the ecological health of the reservoir. The integration of remote sensing techniques and hydrological modeling could also support the assessment of spatial variability and prediction of future changes. Continuous and integrated monitoring is essential to ensure the long-term protection and sustainable management of Embung B for both environmental conservation and educational purposes.

Conclusion

The assessment of soil and water quality around Embung B, ITERA, indicates that the measured physicochemical parameters generally comply with applicable national regulatory standards. Soil properties exhibited relatively stable conditions that are supportive of basic biological processes, while key water quality parameters, including pH, EC, DO, and TDS, were within the permissible limits established by KLHK Regulation PP No. 22/2021. The measured iron (Fe) concentrations were below the threshold specified by the Indonesian Ministry of Health Regulation No. 2/2023, suggesting no indication of iron contamination at the time of sampling. Overall, the results provide a preliminary indication that Embung B maintains acceptable environmental quality under the conditions observed during the study period. However, as the assessment was based on single-time sampling at limited spatial points and without statistical analysis, the findings should be interpreted as baseline information rather than a comprehensive evaluation of long-term ecological status. Continuous and seasonally resolved monitoring, combined with expanded physicochemical, biological, and statistical analyses, is recommended to support sustainable management and future utilization of Embung B as a campus water resource.

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Declaration of interest

Competing interests: No relevant disclosures

Author contributions

Conceptualization: MAS, CMCLA, and RPP; Methodology, FF, SAS; Investigation and data analysis, SRP, YFCP, and NMP; Writing – original draft: MAS; Writing – review & editing: MAS, SAS, ES; Supervision and project administration: MAS and CMCLA. All authors have read and agreed to the published version of the manuscript.

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