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UNVEILING THE HIDDEN IMPACTS: HOW ANTHROPOGENIC ACTIVITIES SHAPE THE WATER QUALITY OF PAYA BUNGUR LAKE, GAMBANG, PAHANG

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Abstract:

Water quality is essential for sustainable development and public health. This study investigates the water quality of Paya Bungur Lake in Gambang, Pahang, Malaysia, a vital resource for the local community. The lake's ecosystem is significantly degraded by anthropogenic activities, including agriculture, aquaculture, mining, and construction, which contribute to pollution through nutrient runoff, organic waste,

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heavy metal contamination, and habitat destruction. The study assessed six sampling points for key water quality parameters, including temperature, turbidity, pH, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), salinity, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), and heavy metals. Results indicated a temperature range of 31.4 to 33°C, turbidity levels of Class III (88.55 to 95.85 NTU) at most points, and Class IV (101 to 102.55 NTU) at two points. BOD ranged from 3.94 to 4.27 mg/L (Class III), while DO (5.75 to 5.96 mg/L) and pH (6.0–6.4) met Class IIB standards. Salinity (0.03%) and TDS (42 to 45 mg/L) were classified as Class I, while TSS ranged from 54.5 to 121.5 mg/L, with two points in Class IV. Heavy metal analysis revealed aluminium (1.51 mg/L), calcium (6.05 mg/L), and magnesium (1.43 mg/L) at Class IV levels. Iron (0.72 mg/L) was Class III, manganese, lead, and zinc were within Class I, and copper was in Class IIB. Elevated nutrient and heavy metal levels, primarily originating from oil palm plantations, aquaculture, and the East Coast Rail Link (ECRL) construction project, have led to eutrophication, algal blooms, and ecological stress. Mitigation strategies, including precision agriculture, eco-friendly aquaculture, advanced water treatment technologies, and regular monitoring, are crucial for restoring the lake's environmental health. Collaborative efforts among policymakers, local authorities, and stakeholders are crucial for enforcing environmental regulations, promoting sustainable land-use practices, and ensuring the lake's sustainability for future generations.

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Anthropogenic Activities, Heavy Metals, National Water Quality Standards, Water Quality

Introduction

Water is a vital component of the environment, playing a crucial role in the survival of all living organisms. Water pollution has become a pressing issue, affecting not only aquatic ecosystems but also the livelihoods of communities that rely on freshwater sources for their survival. Lakes are essential water bodies for local fisheries, agriculture, and recreational activities. However, rapid urbanisation and anthropogenic activities have significantly degraded the lake's water quality (Camara et al., 2019). One significant concern in water quality assessment is the presence of heavy metals, which accumulate over time and pose severe risks to aquatic life and human health (Yusoff et al., 2024). Discharging untreated wastewater, excessive use of fertilisers, and land development projects contribute to the deterioration of water quality (Wisnu et al., 2019). High nutrient levels, particularly nitrogen and phosphorus, promote algal blooms that deplete oxygen levels, leading to eutrophication and the decline of aquatic species

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(Sayara et al., 2020). This study aims to evaluate the key water quality parameters of Paya Bungur Lake and identify the primary sources of pollution contributing to its degradation.

Literature Review

Multiple physical, chemical, and biological parameters influence water quality (Shah et al., 2023). Pollution arising from anthropogenic activities has led to significant degradation of freshwater ecosystems. Heavy metal accumulation, nutrient overload, and organic waste are key factors affecting water quality. Studies have shown that various human activities contribute to the decline in water quality in freshwater ecosystems, making them unsuitable for consumption and aquatic life (Prakasha & Veeresha, 2020).

Physico-Chemical Parameters

The physicochemical parameters assessed in this study include both physical and chemical properties. Temperature plays a crucial role in aquatic ecosystems, affecting the survival of organisms, the growth of vegetation, and treatment efficiency, with freshwater typically ranging between 27°C and 30°C (Al Rasyid et al., 2021). pH measures water's acidity or alkalinity, with freshwater usually ranging from 5.0 to 10.0 and saltwater between 5.0 and 8.3 (Akhter et al., 2021). Turbidity refers to the clarity of water and is influenced by suspended particles, which affect light penetration, dissolved oxygen levels, and the health of aquatic life (Kale, 2016). Salinity is determined by the concentration of dissolved ions, such as sodium and chloride. Total Suspended Solids (TSS) include particles that influence sedimentation and the transport of pollutants. Dissolved Oxygen (DO) is essential for aquatic life; levels above 6.5-8 mg/L indicate good water quality, while lower levels indicate pollution (Abu Bakar et al., 2020). Biochemical Oxygen Demand (BOD) measures organic contamination; high values indicate pollution. Total Dissolved Solids (TDS) encompass dissolved inorganic and organic substances, affecting conductivity, hardness, and overall water quality (Kothari et al., 2021).

Anthropogenic Activities and Water Pollution

Anthropogenic activities significantly impact water quality. Agricultural practices such as oil palm plantations, fruit and vegetable farming, and livestock rearing introduce pollutants like nitrogen, phosphorus, pesticides, and antibiotics into water bodies, contributing to eutrophication and ecosystem imbalances (Lan et al., 2024). Similarly, aquaculture, particularly the farming of Pangasius hypophthalmus and Barbonymus schwanenfeldii, leads to nutrient accumulation, organic waste, and antibiotic contamination, further degrading water quality (Karim et al., 2021). Hence, industrial and construction activities also threaten water quality significantly (Kumar et al., 2023). The resulting runoff introduces pollutants into nearby water systems, altering natural hydrology and contaminating water (Siddiqua et al., 2022).

Methodology

The methodology of this study comprised two primary components: fieldwork for data collection and laboratory analysis. The laboratory analysis was further categorised into in situ and laboratory-based testing to ensure a comprehensive water quality assessment.

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Sampling Points

This research was conducted at Paya Bungur Lake, Gambang, Pahang, Malaysia. The lake is a manufactured water body with an approximate length of 4.8 km. Water sampling was conducted at six designated points, with distances between sampling points ranging from 50 to 100 meters. Figure 1 shows the sampling points' location of Paya Bungur Lake, and all six points' coordinates were recorded as shown in Table 1. The physical parameters analysed included temperature, turbidity, TSS, and TDS, which influence water clarity, stability, and overall composition. The chemical parameters comprised pH, salinity, DO, BOD, and the presence of heavy metals. These factors are critical in determining water quality, as pH and salinity affect chemical balance, while DO and BOD are essential indicators of aquatic life sustainability and organic matter decomposition.

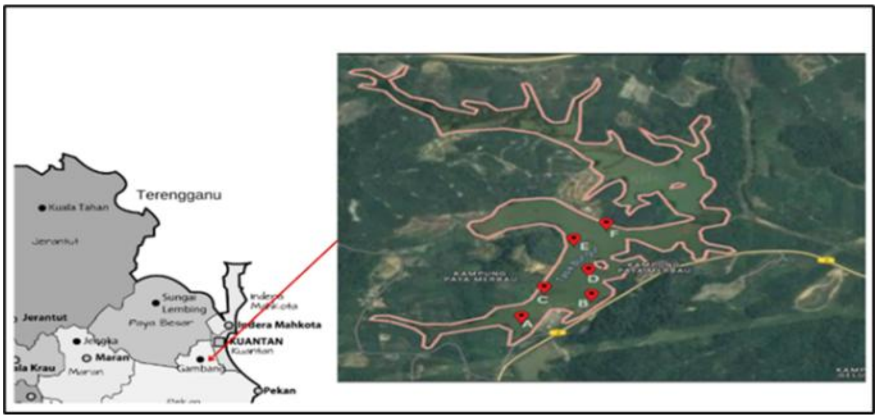

Figure 1: Sampling Points Location of Paya Bungur Lake, Gambang, Pahang

Table 1: Coordinates And Remarks for Each Sampling Point

Point	Latitude (N)	Longitude (E)	Remarks
A	3.701892°N	102.934600°E	Fish farming, a nearby plantation
B	3.702138°N	102.934687°E	Fish farming, nearby plantation, and the use of lake water for cleaning utensils
C	3.702317°N	102.934745°E	Fishing, nearby plantation, bird nest farm
D	3.709409°N	102.934572°E	Fish farming, a nearby plantation, and a resting place
E	3.704633°N	102.935754°E	Fish farming, a nearby plantation
F	3.807557°N	102.084057°E	Fishing, nearby plantation, bird nest farm

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In Situ and Laboratory Tests

A YSI-556 MPS (Multiprobe System) was used for in-situ DO, pH, temperature, salinity and TDS measurements, as shown in Figure 2 (a). The Hach 2100Q Turbidity Meter was employed to determine turbidity. BOD was measured using the YSI Pro-BOD Probe and incubated at 20°C for five days (Walsh & Garrett, 2019). TSS was analysed using a Buchner funnel and vacuum filtration, as shown in Figure 2(b), followed by drying at 110°C (Ajeel et al., 2020). Heavy metals were analysed using ICP-OES, as shown in Figure 2 (c), after acidification and filtration of water samples.

(a) (b) (c)

Figure 2: (A) The In-Situ Test, (B) Laboratory Analysis for The Physicochemical And (C) Heavy Metals Parameters

Field Observation and Photographic Documentation of Anthropogenic Factors

A systematic field observation and photographic documentation approach was employed to identify potential pollution sources. As illustrated in Figure 3, key anthropogenic activities impacting water quality included agricultural practices, such as the application of pesticides and fertilisers, as well as irrigation and fish farming systems, which contributed to sediment runoff and heavy metal discharge. Photographs were taken to document visible signs of pollution. These were annotated with dates, times, and locations for contextual analysis.

(a) (b) (c)

Figure 3: Documented Anthropogenic Activities at Paya Bungur Lake, Gambang, Pahang (A) Oil Palm Plantation, (B) Fish Aquaculture, (C) Bird's Nest Farm.

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Result And Discussion

Table 2 presents the concentration values for in-situ and laboratory analysis of water quality parameters at six sampling points classified according to the National Water Quality Standards (NWQS), as shown in Tables 3 and 4. Thus, Table 5 presents the classification of water-quality parameter classes measured according to the NWQS. The DO levels in this study ranged from 5.67 to 5.96 mg/L, classifying the lake as Class IIB, indicating moderately good water quality. This finding aligns with Ngatia et al. (2023), who reported DO depletion in the Ngong River due to human activities, rendering the water unsuitable for aquatic life. Similarly, Loaiza et al. (2021) observed significant reductions in DO and increased BOD in Mexican water bodies affected by agricultural runoff, a pattern also evident in Paya Bungur Lake. Thus, turbidity levels in this study ranged from 88.55 to 102.55 NTU, while TSS ranged from 54.5 to 121.5 mg/L, placing the lake in Class III-IV. Similar results were reported by Bayas (2022) in Powai Lake and Ulhas River. Anthropogenic pollution, including urban development and agricultural runoff, significantly increased turbidity and suspended solids. The pH values recorded in this study ranged from 6.00 to 6.41, indicating slightly acidic conditions that remained within acceptable limits. This finding is comparable to those reported by Yunita et al., (2021), which showed that pH values in Kurapan Lake ranged from 6.05 to 6.28, indicating that moderate variations in acidity are common in freshwater systems influenced by anthropogenic inputs. Heavy metal analysis in this study revealed concerns about aluminium (Al) levels, with concentrations peaking at 3.01 mg/L, exceeding Class IV standards.

Table 2: In-Situ and Laboratory Water Quality Parameters of Paya Bungur Lake

Points	In-Situ Parameters				Laboratory Parameters			
	Temperature (°C)	DO (mg/L)	Salinity (%)	pH	Turbidity (NTU)	TSS (mg/L)	TDS (mg/L)	BOD (mg/L)
A	33	5.96	0.03	6.17	88.55	90.5	43	4.27
B	32	5.76	0.03	6.1	89.15	82.5	44	4.05
C	32	5.75	0.03	6.0	89.85	120.5	45	3.83
D	32.2	5.89	0.03	6.11	102.55	121.5	44	4.3
E	32.5	5.78	0.03	6.14	101	71.5	44	3.94

Table 3: National Water Quality Standard for Malaysia classification

Parameter	Unit	Class I	Class IIA	Class IIB	Class III	Class IV	Class V
BOD	mg/L	1	3	3	6	12	>12
DO	mg/L	7	5-7	5-7	3-5	<3	<1
pH	-	6.5-8.5	6-9	6-9	5-9	5-9	-
Salinity	%	0.5	1	-	-	2	-
TDS	mg/L	500	1000	-	-	4000	-
TSS	mg/L	25	50	50	150	300	300
Turbidity	NTU	5	50	50	-	-	-
Temperature	°C	-	Normal +2°C	-	Normal +2°C	-	-

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Table 4: National Water Quality Standard for Malaysia Classification for Heavy Metals

Parameter	Unit	Class I	Class IIA/IIB	Class III*	Class IV	Class V
Al	mg/L	Natural levels / absent	-	0.06	0.5	Levels above IV
Ca	mg/L		-	-	-	
Cu	mg/L		0.02	-	0.2	
Fe	mg/L		1	1	1 (leaf) 5 (others)	
mg	mg/L		-	-	-	
Mn	mg/L		0.1	0.1	0.2	
Pb	mg/L		0.05	0.02*(0.1)	5	
Zn	mg/L		5	0.4*	2	

Notes: *= At hardness 50 mg/L CaCO3

Table 5: The Water Quality Classes of Each Physicochemical Parameter for Six Sampling Points

Points	DO (mg/L)	Salinity (%)	pH	Turbidity (NTU)	TSS (mg/L)	TDS (mg/L)	BOD (mg/L)
A	IIB	I	IIB	III	III	I	III
B	IIB	I	IIB	III	III	I	III
C	IIB	I	IIB	III	IV	I	III
D	IIB	I	IIB	IV	IV	I	III
E	IIB	I	IIB	IV	III	I	III
F	IIB	I	IIB	III	III	I	III

Physico-Chemical Parameters Analysis

Water temperature regulates the lake ecosystem by influencing physical, chemical, and biological processes (Li et al., 2024). The findings indicate that the temperature ranged from 31.4°C (Point F) to 33°C (Point A). Higher temperatures were recorded in open areas with direct sunlight, whereas shaded locations had lower temperatures. Elevated temperatures may accelerate eutrophication, increasing the risk of pollution and disease outbreaks.

Turbidity is a measure of water clarity influenced by suspended particles, including sediments, organic matter, and microorganisms. The turbidity values ranged from 88.55 NTU (Point A) to 102.55 NTU (Point D). The highest turbidity was recorded near fish-farming areas, where sediment disturbance is common. Elevated turbidity reduces light penetration, inhibits photosynthesis, and negatively impacts aquatic organisms (Kjelland et al., 2015). According to NWQS, turbidity values classified as Class III or IV indicate moderate to high levels of pollution.

BOD measures the amount of oxygen required by microorganisms to decompose organic matter. The results showed BOD values ranging from 3.83 mg/L (Point C) to 4.3 mg/L (Point D), all of which fell within Class III, requiring extensive treatment. High BOD levels indicate organic pollution from nearby human activities, such as fish farming, waste discharge, and agricultural runoff (Jouanneau et al., 2014).

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DO is essential for aquatic life and is influenced by temperature, biological activity, and water flow. The recorded DO levels ranged from 5.67 mg/L (Point F) to 5.96 mg/L (Point A), all classified as Class IIB, which is suitable for recreational use and fisheries. Lower DO levels may be linked to organic pollution, high temperatures, and decomposition of organic matter (Yang, 2023). The pH values ranged from 6.0 (Point C) to 6.41 (Point F), indicating mildly acidic conditions. While within the permissible range for aquatic life, acidic conditions may leach heavy metals into the water, further degrading the quality (Dewangan et al., 2023). The pH levels were classified under Class IIA-IIB, suggesting suitability for aquatic ecosystems and irrigation.

Salinity remained constant across all sampling points at 0.03%, which is classified as Class I (clean water). TDS values ranged from 42 mg/L (Point F) to 45 mg/L (Point C), also categorised as Class I, indicating good water quality. Low TDS and salinity levels suggest minimal dissolved mineral content, making the water suitable for aquatic organisms and domestic use (Hijji et al., 2023).

TSS values ranged between 54.5 mg/L (Point F) and 121.5 mg/L (Point D). Points D and C recorded the highest TSS levels due to sediment runoff from plantations and aquaculture activities. High TSS reduces water clarity and impacts aquatic habitats by increasing sedimentation and facilitating the transport of pollutants (Adjovu et al., 2023).

Heavy Metals Analysis

The concentration of heavy metals was analysed using ICP-OES. Table 3 presents the average concentrations of heavy metals at six sampling points. The heavy metals identified in this study by ICP-OES are aluminium (Al), calcium (Ca), copper (Cu), iron (Fe), magnesium (Mg), manganese (Mn), lead (Pb), and zinc (Zn). Figure 4 visually represents the combined concentration readings for all six points.

Table 6: The Average Concentration of Heavy Metals at Six Sampling Points

Point	Al (mg/L)	Ca (mg/L)	Cu (mg/L)	Fe (mg/L)	Mg (mg/L)	Pb (mg/L)	Zn (mg/L)
A	0.21	6.12 o	0.01	0.32	1.40	0.04	0.01
B	3.01	6.53 o	0.01	0.32	1.51	0.09	0.01
C	1.21	5.59 o	0.00	1.15	1.42	0.11	0.00
D	0.72	5.84 o	0.00	0.49	1.50	0.09	0.00
E	1.36	6.01 u	0.00	0.86	1.35	0.11	0.00
F	2.53	6.21 o	0.01	1.18	1.41	0.12	0.00
Mean	1.51	6.05	0.005	0.72	1.43	0.09	0.003
Class of NWQS	IV	IV	IIB	III	IV	I	I

Notes:
Overrange concentrations (o)
Underrange concentrations (u)

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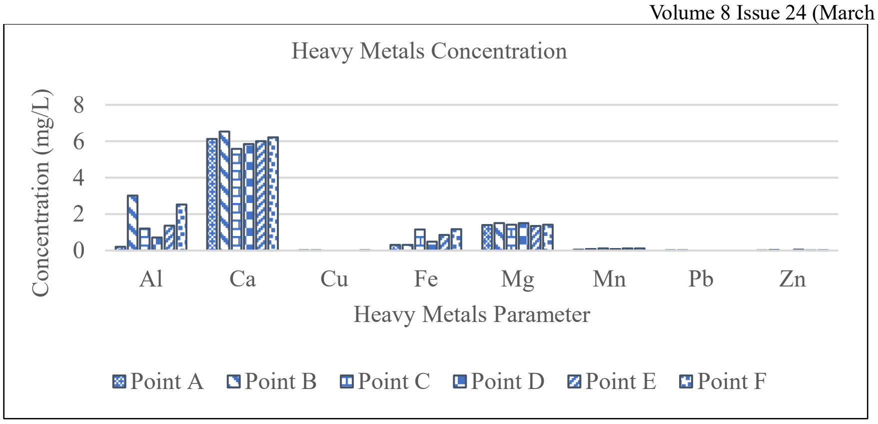

Figure 4: Heavy Metal Concentration Values for Six Sampling Points

Al concentrations varied from 0.21 mg/L (Point A) to 3.01 mg/L (Point B). The highest concentration was found near plantations and aquaculture sites, indicating runoff contamination. Elevated aluminium levels in a water supply resulting from low pH are attributed to geogenic and anthropogenic sources, followed by Al transfer from soil to natural water sources (Hızlı et al., 2023). According to NWQS, Al falls under Class IV (polluted) and requires extensive treatment. Thus, Cu is an essential metal that occurs naturally in water bodies, but excessive levels can be toxic (Gaetke et al., 2014). This study found Cu concentrations ranging from 0.00 mg/L (points C and D) to 0.01 mg/L (points A, B, and F), with a mean of 0.005 mg/L, which falls within Class IIB and is considered safe for most uses, including aquatic life. The water's chemical composition, natural attenuation processes, and analytical detection limits all contributed to the low Cu levels observed.

Mg is a critical chemical element involved in various biological and environmental processes. It significantly contributes to water hardness, working in conjunction with Ca ions (Tiwari & Bajpai, 2012). Ca concentrations ranged from 5.59 mg/L (Point C) to 6.53 mg/L (Point B), while Mg levels varied between 1.35 mg/L (Point E) and 1.51 mg/L (Point B). Both metals are classified under Class IV, indicating hard water that may cause scaling issues in water treatment systems.

Mn is an essential heavy metal involved in biochemical processes but can become toxic at high concentrations. This study found Mn concentrations ranging from 0.04 mg/L (Point A) to 0.12 mg/L (Point F), with a mean concentration of 0.09 mg/L. The minimal variation among samples suggests stable Mn levels within Class I, indicating no significant water quality concerns. The geographical characteristics of the sampling sites influenced Mn distribution, with Point A, located near fish farms and solid waste disposal sites, recording the lowest levels due to minimal Mn inputs (Wu et al., 2022).

In contrast, Point F, located near bird nest farms, fishing areas, and construction sites, showed the highest Mn concentration, likely due to sediment deposition and the introduction of pollutants. Fe concentrations ranged from 0.32 mg/L (Point A) to 1.18 mg/L (Point F), with Class III classification signifying moderate pollution. Moreover, the outfall of raw sewage and fish aquaculture increased the Fe concentration at point E to 0.86 mg/L (Kosemani et al., 2024).

The measured Pb concentrations across the sampling points range from 0.04 mg/L (Point A) to 0.12 mg/L (Point F), with a mean of 0.09 mg/L, indicating that the water is Class I. However, the slightly higher concentrations at Points C, E, and F (0.11 to 0.12 mg/L) may indicate localised contamination sources linked to anthropogenic activities such as fish farming, agricultural runoff, or soil erosion from nearby plantations. Long-term exposure, even at low concentrations, can have toxic effects on aquatic ecosystems, leading to bioaccumulation in fish and potential risks to human health if consumed (Mustafa et al., 2024). The measured Zn concentrations in the lake were notably low, ranging from 0.00 mg/L to 0.01 mg/L, with a mean value of 0.003 mg/L. Zn is classified under Class I, indicating minimal contamination and no immediate environmental concern. Zinc is an essential micronutrient for aquatic organisms; however, excessive levels can cause toxic effects, including gill damage in fish, enzyme inhibition, and disruptions to aquatic biodiversity.

Correlation Analysis of Water Quality Parameters

A Pearson correlation analysis was conducted to assess relationships between key water quality parameters, as presented in Table 7. A positive correlation indicates a direct proportional relationship, whereas a negative one represents an inverse proportional relationship. A strong inverse correlation (r = -0.86) between DO and temperature indicates that as temperature increases, oxygen solubility decreases. This relationship is well-documented in aquatic ecosystems: warmer water holds less dissolved oxygen, which can negatively impact aquatic life and biochemical processes. Reduced oxygen availability can also exacerbate stress in fish populations, altering species composition and potentially disrupting ecosystems (Mariu et al., 2023). Similarly, a strong negative correlation (r = -0.96) between pH and TDS suggests that higher dissolved solids are associated with greater acidity. Studies have shown that acidification can occur when sulphate and nitrate ions accumulate from anthropogenic sources. In contrast, carbonate-rich environments can increase alkalinity, impacting aquatic species sensitive to pH variations (Middelburg et al., 2020).

A strong positive correlation (r = 0.73) exists between TDS and TSS, indicating that higher TSS levels are associated with increased dissolved solids. Elevated TSS levels can also reduce light penetration, affect photosynthesis and decrease primary productivity in aquatic ecosystems (Guenouche et al., 2024). The strong negative correlation between pH and TDS suggests that dissolved solids may influence the lake's buffering capacity. High TDS levels often indicate the presence of dissolved minerals that can alter the water's acid-base balance. Overall, the correlation analysis provides essential insights into how temperature, dissolved oxygen, organic matter, and sediment dynamics interact to influence water quality. The strong associations among parameters suggest that industrial effluents, agricultural runoff, and wastewater discharge significantly impact lake conditions.

Table 7: Pearson Correlation Analysis Between Water Quality Parameters

	TEMP	TURBIDITY	BOD	DO	pH	TDS	TSS
TEMP	1.00						
TURBIDITY	-0.11	1.00					
BOD	0.29	0.20	1.00				
DO	0.86	-0.03	0.65	1.00			

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pH	-0.42	0.19	0.34	-0.34	1.00		
TDS	0.20	-0.04	-0.52	0.10	-0.96	1.00	
TSS	0.26	-0.02	0.05	0.48	-0.79	0.73	1.00

The Pearson correlation analysis of heavy metal concentrations is shown in Table 8. The strong positive correlation between Ca and Cu (0.805) suggests that both metals originate from industrial runoff, agricultural inputs, or natural mineral weathering, and that they subsequently accumulate in lake sediments through precipitation and adsorption processes. Similarly, the positive correlation between Zn and Cu (0.707) implies that both metals may be introduced via industrial discharge or agricultural fertilisers, where they bind to fine suspended sediments before settling in the lakebed (Bao et al., 2023). The strong association between Pb and Fe ($r = 0.791$) suggests that these metals are likely released from construction activities, mining operations, or vehicular emissions, and eventually bind to organic matter or clay particles, accumulating in the bottom sediments.

Table 8: Pearson Correlation Analysis Between Water Quality Parameters of Heavy Metals

	Al	**Ca**	**Cu**	**Fe**	**Mg**	**Pb**	**Zn**
Al	1.000						
Ca	0.640	1.000					
Cu	0.420	0.805	1.000				
Fe	0.198	-0.472	-0.313	1.000			
Mg	0.298	0.263	0.148	-0.495	1.000		
Pb	0.564	-0.188	-0.381	0.791	-0.105	1.000	
Zn	0.075	0.662	0.707	-0.780	0.293	-0.763	1.000

The Influence of Anthropogenic Activities on the Water Quality

The water quality of Paya Bungur Lake has been severely impacted by human activities, as evidenced by key parameters including turbidity, suspended solids, and heavy metal concentrations. Turbidity levels ranged from 88.55 to 102.55 NTU, placing most sites in Class III and IV under the NWQS. The highest readings were recorded near fish-farming zones, indicating sediment disturbance and poor water clarity resulting from aquaculture and plantation runoff. Total Suspended Solids (TSS) mirrored this trend, peaking at 121.5 mg/L, again in areas adjacent to agricultural and aquaculture operations. Heavy metal analysis further revealed alarming contamination: aluminium levels soared up to 3.01 mg/L, categorising it under Class IV, while calcium and magnesium were also detected in high concentrations (mean values of 6.05 mg/L and 1.43 mg/L, respectively), suggesting challenging water conditions and strong anthropogenic influence, especially from agrochemical use and construction runoff, notably the ECRL project. Although copper, manganese, lead, and zinc remained within Class I and IIB limits, their bioaccumulation still poses long-term ecological risks. Elevated BOD levels (3.83–4.3 mg/L, Class III) and relatively low DO values (5.67–5.96 mg/L, Class IIB) further confirmed organic pollution and stress on aquatic life, linked to nutrient loading from fertilisers, fish waste, and detergent usage. Together, these findings underscore how unchecked agricultural expansion, aquaculture, and development projects are accelerating the lake's degradation and compromising its ecological integrity.

Conclusions

This study comprehensively assessed the water quality of Paya Bungur Lake, Gambang, Pahang, by analysing key physicochemical parameters, heavy metal concentrations, and the influence of anthropogenic activities. The findings indicate that human activities, including agriculture, aquaculture, construction, and industrial waste disposal, significantly impact the lake's water quality. High turbidity, BOD, TSS, and heavy metal concentrations at specific sampling points highlight the extent of pollution and ecological stress in the lake. Agricultural runoff from oil palm plantations and fruit farms has elevated nutrient levels, leading to eutrophication and harmful algal blooms. Fish farming activities have further exacerbated water pollution by accumulating organic waste and releasing chemical residues. Construction projects, particularly the ECRL, have also increased sedimentation, impacting aquatic ecosystems. The presence of heavy metals such as Al, Ca, and Mg in Class IV levels emphasises the urgent need for regulatory intervention. Despite the observed pollution levels, some water quality parameters, such as DO and pH, remain within acceptable limits for aquatic life. However, continuous monitoring, improved waste management practices, and sustainable land-use policies are essential to mitigate further degradation.

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