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The effect of agricultural activities on water quality at Kuala Krau River, Temerloh, Pahang, Malaysia

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ABSTRACT

Kuala Krau in Temerloh, Pahang, is a significant region for aquacultural and agricultural activities such as fish farming, plantations, and animal husbandry. Although the availability of water supplies, favourable climate, and scenic views encourage these activities, they also negatively impact the water quality of the Kuala Krau River. Three sampling points were selected along the river to assess the parameters of the physico-chemical and heavy metals. In this study, nine physico-chemical parameters were analysed to evaluate the water quality of the Kuala Krau River. Five parameters were measured in situ, while the other four were analysed through laboratory testing. The results indicated this river is in Class I for pH and Salinity, Class II for Biochemical Oxygen Demand and Dissolved Oxygen, and Class III for Total Suspended Solids and Turbidity. Only Ferum and Aluminium for heavy metals exceeded the National Water Quality Standards For Malaysia. These findings indicate that the Kuala Krau River is suitable for fisheries, agricultural activities, and livestock drinking. However, regular monitoring is crucial to protect water quality and preserve the habitats for future planning.

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1. INTRODUCTION

The agricultural sector in Malaysia is a significant contributor to the economy, and among the activities are palm oil plantations, animal husbandry, and fish aquaculture [1]. Fish aquaculture is the commercial breeding of fish in controlled environments such as aquariums or fish cages in artificial enclosures like ponds and rivers. The primary freshwater aquaculture species cultivated in Malaysia are Silver catfish (*Pangasius hypophthalmus*) and African catfish (*Clarias gariepinus*). Temerloh, Pahang, is a specialised region known for producing Silver Catfish, which has become the local community's primary revenue source. In 1990, Temerloh was famous for its delicious traditional meal called 'Ikan Patin Masak Tempoyak', considered a speciality of the residents [2]. It is crucial to preserve and avoid the deterioration of the river's water quality to ensure the quality and flavour of this fish species. The loss of exclusivity will decrease the price and demand for Silver Catfish, impacting farmers and fishermen's economic income. Water quality can be described as a condition of water in chemical, physical, and biological attributes tailored to its specific intended use for drinking, domestic usage, or recreational activities. Many biological, physical, and chemical elements, particularly in excessive amounts, are dangerous to aquatic environments. While there are studies on the impact of agriculture on river water quality in Malaysia, there may be limited localised studies explicitly focused on the Kuala Krau River in Temerloh, Pahang. This site needs research to understand the unique agricultural practices and their direct impacts on the river ecosystem. A detailed assessment of specific farm activities in the Kuala Krau area, e.g., oil palm plantations, rubber farming, and aquaculture, and their contribution to water pollution could fill this gap. This study focuses on identifying the concentration of physico-chemical parameters and heavy metals in Kuala Krau River and classifying the water quality of each parameter based on National Water Quality Standards. Furthermore, the factors contributing to each parameter's concentration must be determined.

2. LITERATURE REVIEW

According to the Environmental Quality Report (EQR), of the 672 rivers in Malaysia, 66%, or 443 rivers, were observed to be clean, 29%, which is equivalent to 195 rivers, were mildly contaminated, and 5%, or 34 rivers, were identified as polluted (DOE, 2021). Based on the report, most of the rivers in Pahang State are classified as Class II (DOE, 2021). Furthermore, it is crucial to conserve the specific niche area within the Pahang River that serves as a suitable habitat for freshwater species, including the economically and culturally important Patin fish. This conservation effort is essential for maintaining the distinctive qualities of the ikan Patin and other species originating from the Pahang River. Agricultural activities can significantly impact water quality, introducing pollutants such as pesticides, fertilisers, and sediment into water bodies, thereby affecting aquatic ecosystems and human health [3]. Water environment research emphasises the importance of understanding the factors that influence water quality, particularly concerning pollutants [4]. The investigation of these effects in specific regions, such as the Kuala Krau River in Temerloh, Pahang, Malaysia, is essential for developing targeted strategies for sustainable agricultural practices and effective water resource management. Understanding the balance between agricultural production and environmental preservation is crucial for the long-term health of both ecosystems and human populations [5-6]. The Kuala Krau River, located in Temerloh, Pahang, Malaysia, is susceptible to the impacts of agricultural activities in its surrounding areas. Agriculture, while vital for food production and economic stability, can introduce numerous pollutants into water systems [7].

2.1 Effect of agricultural activities on water quality

This study is categorised into three key aspects based on distinct agricultural activities: fish aquaculture, animal husbandry, and oil palm plantations. Each aspect represents a unique sector within agriculture,

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allowing for a structured and detailed analysis. These activities are frequently linked to ecological imbalances, particularly in freshwater ecosystems. Malaysia's water pollution primarily arises from manufacturing, agro-based industries, domestic waste, livestock, mining, and surface runoff [8-9]. Fish aquaculture involves breeding and harvesting fish in controlled environments, while animal husbandry focuses on livestock management for food production. Meanwhile, oil palm plantations are large-scale agricultural operations for palm oil extraction. The expansion of agricultural activities, including aquaculture, animal farming, and oil palm plantations, has been noted to contribute significantly to this pollution [10-11]. By dividing the study into these three categories, their specific impacts, challenges, and contributions to the agricultural sector can be assessed in a more systematic and comprehensive manner.

Fish aquaculture

Aquaculture, or fish aquaculture, can affect water quality positively and negatively, depending on various parameters, including the farming methods. This involves nutrient loading due to fish excrement and uneaten feed being used in fish aquaculture, and they contribute organic matter and nutrients to the water [2]. Improper management can result in nutrient loading and water quality problems, such as reduced oxygen levels and algae blooms. Besides, waste accumulation, such as Ammonia and other contaminants, may leak into the water from the build-up of uneaten food and fish waste at the bottom of the ocean or pond enclosure. Waste management is essential in closed or intensive farming systems to prevent the deterioration of the water quality.

Furthermore, the medications and chemicals used to treat fish infections in aquaculture may impact the water quality. These compounds' by-products may enter the water and harm aquatic ecosystems. In addition, fish that escape from fisheries carry the risk of bringing non-native species into natural waterways. Local ecosystems may be disrupted, and biodiversity and water quality may shift. Moreover, the physical buildings used in fish aquaculture, such as cages and pens, may change local habitats. Water clarity and benthic communities may be impacted by sedimentation surrounding these structures. Indeed, water quality can benefit from well-managed aquaculture systems, especially those that use integrated multi-trophic aquaculture (IMTA) or recirculating aquaculture systems (RAS). For instance, growing several species close to one another can aid in the more effective use of nutrients in IMTA. Adopting sustainable aquaculture techniques, implementing appropriate waste management, routinely checking the cleanliness of the water, and abiding by the law are all part of the mitigation efforts. Sustainable certification schemes like the Aquaculture Stewardship Council (ASC) aim to advance ecologically conscious aquaculture.

Animal husbandry

Raising animals, or animal husbandry, can affect water quality. The scale of the operation, waste management, and land use practices mainly determine these effects. Nutrients consisting of phosphorus and nitrogen can be found in livestock waste, which comprises urine and manure. Water bodies may become overloaded with nutrients due to improper disposal or runoff from places with a high concentration of animals. Algal blooms, a drop in oxygen levels, and general deterioration of the water quality may result from this [12]. Human-harming microorganisms, including infections, can be found in livestock manure. Bacterial contamination can result from improperly managed runoff or direct waste deposition into water bodies, endangering aquatic ecosystems and human health. Soil erosion can be caused by overgrazing or poor land management techniques in livestock-populated areas. By affecting aquatic habitats and causing turbidity to rise, sediment runoff into water bodies can lower water quality. Runoff from using hormones, veterinary medications, and other chemicals in animal husbandry may end up in water bodies. Water quality and aquatic life may be affected by this. Access for livestock to water sources may cause streambank deterioration. Water quality and aquatic habitats can be impacted by sedimentation, which can be caused by erosion and trampling along waterways. Riparian buffer zones, waste management programmes, and well-managed rotational grazing can reduce adverse effects. These methods aid in maintaining water quality, reducing fertiliser runoff, and controlling erosion. Using sustainable agricultural techniques,

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enforcing laws, and adopting best management practices can help reduce the environmental impact of animal husbandry on water quality. In addition, outreach and education initiatives are essential for advancing responsible cattle management techniques.

Oil palm plantation

Oil palm plantations may impact water quality in several ways, and these effects are frequently linked to land management and agricultural activities. Runoff and sedimentation: Increased soil erosion may result from clearing land for oil palm crops [13-14]. Rainfall from these cleared areas may bring sediments into nearby water bodies, causing turbidity and sedimentation, lowering water quality. Chemical runoff may arise from oil palm cultivation's usage of pesticides and fertilisers [14]. These compounds can be misused or applied excessively, contaminating water sources and lowering groundwater and surface water quality. Water sources may become nutrient overloaded due to oil palm plants' fertiliser usage. Fertiliser runoff containing nitrogen and phosphate can enhance water with nutrients, which might result in problems including oxygen deprivation and algae blooms [2]. The equilibrium of local ecosystems can be upset by the conversion of natural ecosystems, which frequently involves the deforestation for oil palm plantations. The hydrological cycle may be impacted by vegetation loss and land use changes, resulting in modified water flow patterns and heightened susceptibility to drought or flooding [15]. The effect on water quality and the decline in biodiversity are related. The natural buffer that various ecosystems provide can be diminished by land use changes, increasing aquatic bodies' vulnerability to pollution. Reforestation of riparian zones, adopting sustainable practices like Best Management Practices (BMPs) in agriculture, and establishing certifications like the Malaysian Sustainable Palm Oil (MSPO) that prioritise environmental stewardship are some measures implemented to lessen these effects. However, adopting sustainable techniques on a large scale remains a challenge.

3. METHODOLOGY

The methodology of this study was divided into two main components: fieldwork for data collection and laboratory analysis. The laboratory analysis was further categorised into in-situ testing and laboratory-based tests to obtain comprehensive water quality data. The collected data were subsequently analysed to assess the potential environmental impacts of agricultural activities along the Kuala Krau River, Temerloh, Malaysia.

3.1 Sampling points

Three sampling points were strategically selected along the Kuala Krau River in Temerloh, Malaysia, based on the presence of key agricultural activities, including catfish and tilapia aquaculture, a small oil palm plantation, and buffalo farming (Fig. 1 and Fig. 2). The average distance between each sampling point was approximately 1 km, ensuring adequate spatial distribution for comprehensive data collection. The river's depth at these locations was estimated to be 3 metres, while its width varied, measuring 250 m, 175 m, and 225 m at points A, B, and C, respectively. The precise coordinates of these sampling sites were recorded using the Global Positioning System (GPS), as detailed in Table 1.

The sampling was done twice per month from October to December due to the wet season, which may allow the flow of pollutants by the rivers to occur and significantly impact the nearby sampling points. This will also contribute to the surrounding conditions for points A, B, and C, where mud-covered soil affects the turbidity of the river.

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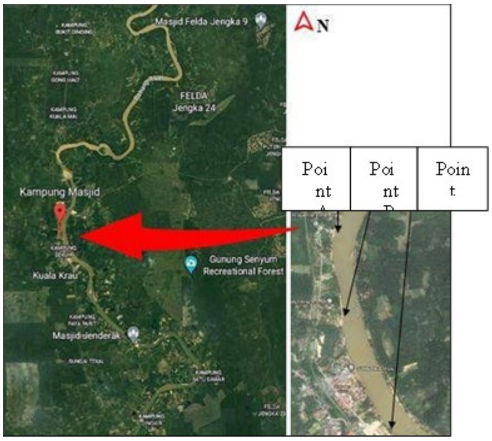

Fig. 1. Sampling points location along Kuala Krau River, Temerloh, Pahang.

(a) (b) (c)

Fig. 2. Agriculture activities along the Kuala Krau River: (a) catfish and tilapia fish aquaculture. (b) oil palm plantation; (c) buffalo farming

Table 1: GPS coordinates of river water sampling

Point	GPS	Remarks
A	3.72476°N 102.36793°E	Nearest to catfish and tilapia fish aquaculture, oil palm plantation, buffalo farming
B	3.71844°N 102.36837°E	1 km from point A
C	3.70609°N 102.37323°E	2 km from point A

3.2 In-situ and laboratory test

The physical parameters, namely the Dissolved Oxygen (DO), temperature, pH, and salinity, were measured in situ using the handheld YSI-556-Multiprobe System (Fig. 3(a)). 1.5 L water samples were

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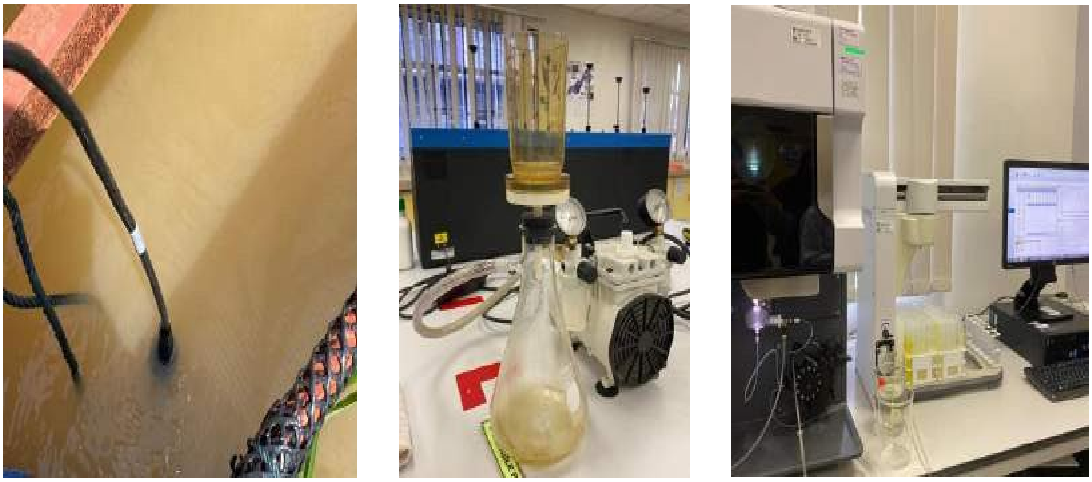
collected for analysis in the environmental laboratory, Civil Engineering Studies, Universiti Teknologi Mara Pahang Branch. Meanwhile, the parameters of water quality determined under laboratory tests are heavy metals, Turbidity, Total Suspended Solids (TSS), Total Dissolved Solids (TDS), and Biochemical Oxygen Demand (BOD) analysis. Tests were conducted according to the Standard Methods for Examining Water and Wastewater, National Water Quality Standard. The analysis of heavy metals was done in the laboratory using ICP-OES. The samples were filtered before being analysed for heavy metals that include aluminium (Al), calcium (Ca), iron (Fe), potassium (K), magnesium (Mg), manganese (Mn), sodium (Na), and zinc (Zn). Fig. 3 indicates the types of equipment used for the in-situ test and laboratory analysis for the concentration of physicochemical and heavy metals parameters.



(a) (b) (c)

Fig. 3. (a) In situ test; (bmiddle) laboratory test of Total Suspended Solids (TSS) and Total Dissolved Solids (TDS); (c) ICP-OES setup.

4. RESULT AND DISCUSSION

The results are categorised into physicochemical parameters and heavy metal parameters. Physicochemical parameters include in-situ measurements (pH, salinity, dissolved oxygen and temperature) and laboratory parameters (Turbidity, TSS, TDS, BOD).

4.1 Psychochemical parameters

The average in-situ and laboratory physicochemical parameter results for the three sampling points are presented in Table 2. The results are compared against the threshold limits established by Malaysia National Water Quality Standards (2021) as shown in Table 3.

Table 2. In-situ and laboratory water quality parameters of Kuala Krau River

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	27.24	6.71	0.03	7.26	69.64	200	41	1.24
B	27.24	6.88	0.02	7.45	46.5	100	24	1.04

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C	26.95	6.86	0.03	7.55	76.5	100	39	1.18

Table 3. Malaysia National Water Quality Standards (MNWQS)

Class	DO (mg/L)	Salinity (%)	pH	Turbidity (NTU)	TSS (mg/L)	TDS (mg/L)	BOD (mg/L)	Remarks
I	7	0.5	6.5 - 8.5	5	25	500	1	Water Supply I – Practically no treatment necessary
IIA	5 - 7	1	6 - 9	50	50	1000	3	Water Supply II – Conventional treatment required.
B	5 - 7	-	6 - 9	50	50	-	3	Recreational use with body contact.
III	3 - 5	-	5 - 9	-	150	-	6	Water Supply III – Extensive treatment required
IV	< 3	2	5 - 9	-	300	4000	12	Irrigation
V	< 1	-	-	-	300	-	> 12	None of the above

Table 4 shows the summary of classes for seven psycho-chemical characteristics. Point A exhibits values indicative of being more contaminated than Point B and C. Specifically, Point A demonstrates the highest BOD concentration of 1.24 mg/L, the lowest DO concentration of 6.71 mg/L, the lowest pH value of 7.26, and the highest TSS concentration of 200 mg/L. Furthermore, Point A exhibits a higher water temperature of 27.24 °C, the second-highest turbidity of 69.64 NTU, and the highest TDS concentration of 41 mg/L. This indicates that the proximity of agricultural activities to water bodies and sampling points characterises Point A. On Point A, agricultural activities include fish aquaculture, oil palm plantations, and buffalo farming. Previous research underscores that in tropical countries, alterations in land use, encompassing agricultural practices, industrial and mining activities, and the encroachment of population waste are primary contributors to river water pollution [16].

Table 4. The water quality classes of each physicochemical parameter for the 3 sampling points.

Parameters		BOD	DO	pH	TSS	Salinity	Turbidity	TDS
Point	A	II	II	I	IV	I	IIB	I
	B	II	II	I	III	I	IIA	I
	C	II	II	I	III	I	IIB	I

Dissolved Oxygen (DO) levels in the Kuala Krau River are closely linked to Biochemical Oxygen Demand (BOD). As the BOD levels increase, the DO decrease. A decreased concentration of DO in Point A results from the runoff of nitrogen and phosphorus nutrients into the river. This nutrient influx triggers an overproduction of algae, culminating in the phenomenon known as algae bloom [14]. Oxygen is essential for the decomposition of algae, thereby limiting the available DO in aquatic habitats. The predominant use of nitrogen and phosphorus compound fertilisers is observed in small-scale oil palm plantations [14]. Hence, this situation can be linked to an oil palm plantation in Point A. Phosphorus levels can also be associated with discharges from wastewater treatment and runoff from urban areas. Additionally, elevated temperatures can contribute to reduced DO levels, as the accelerated metabolism of fish in the river results in increased oxygen consumption [13].

The elevated BOD observed at Point A can be attributed to dead plants, animals, and manure. The presence of manure, stemming from animal husbandry activities involving five to ten buffaloes at Point A, contributes to the availability of manure. Farmers' use of a fertiliser mix containing chemicals and manure can also contribute to increased BOD levels through runoff into water bodies [17]. Additionally, improper manure disposal directly into the river exacerbates BOD levels by introducing aerobic organisms that disrupt

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oxygen consumption. Discharge of effluents from residential areas into river water bodies can further result in a heightened concentration of BOD.

Biochemical Oxygen Demand (BOD) quantifies the oxygen microorganisms require to decompose organic matter (OM) in water. Elevated BOD levels in the Kuala Krau River can be attributed to various agricultural activities. Fish farming, for instance, generates significant amounts of organic waste, including uneaten feed and fish excreta. As this OM enters the river, microorganisms decompose it, consuming oxygen and increasing BOD levels. Furthermore, nutrient runoff from nearby oil palm plantations may contribute to eutrophication, resulting in excessive algal growth. When the algae die and decompose, microorganisms consume additional oxygen, further elevating the BOD. Similarly, livestock farming introduces large quantities of OM, particularly manure, into the river. Microorganisms' breakdown of this manure also increases oxygen consumption, raising the BOD.

The observations at Point A reveal the lowest pH compared to Point B and C, almost reaching acidic levels. Acidic conditions, indicated by lower pH levels in rivers, lead to higher hydrogen ion concentrations. This increase in ion enhances the solubility of toxic elements, such as heavy metals, making them more accessible and potentially harmful to aquatic ecosystems. A lower pH can be related to vegetation, where decaying plant material in the water and decomposition processes may contribute to a slight decrease in pH. [16]. Indeed, when plant material decomposes, it releases carbon dioxide (CO_2) into the water. As the CO2 dissolves in water and forms carbonic acid (H2CO3) thereby, it dissociates into hydrogen ions (H+) and bicarbonate ions (HCO3-). This increase in hydrogen ions leads to decreased pH, making the river water more acidic. The decomposition of organic matter can come from dead plants and animals. It can be related to the high number of living organisms in or near Point A. Further, pH is also influenced by the higher temperatures (sunny weather) recorded during in-situ tests by accelerating the decomposition of organic matter and increasing microbial activity, which further contributes to CO2 production and pH reduction. Sunny weather, leading to higher water temperatures, can enhance these processes. Furthermore, a diminished pH in water can be related to agricultural runoff, where applying fertilisers and pesticides in agriculture can result in nutrient runoff, consequently influencing the pH of rivers [14].

A high concentration of TSS may decrease the river's natural DO while increasing the temperature due to the absorption of light by Suspended Solids. Elevated TSS levels can threaten aquatic habitats, particularly fish, as they may obstruct their gills, ultimately resulting in habitat destruction [13]. Fish aquaculture practices, including feeding fish with pellets and discharging waste particles into the river, can contribute to increased TSS in water bodies [17]. Point A also recorded a significant level of turbidity. Turbidity levels correlate with the concentration of TSS, wherein higher TSS concentrations lead to increased turbidity. TSS and turbidity are associated with the erosion and sedimentation of soil, silt, or clay carried by water runoff into surface water. Alterations in land use, particularly the rise in illegal mining activities and mining within agricultural fields driven by the demand for riverbed materials, play a substantial role in the elevated levels of TSS and turbidity [18]. Additionally, fishing activities and water transportation, such as boats, can influence turbidity by causing turbulence in the water.

4.2 Heavy metal parameters

Fig. 5 and Table 3 show the average heavy metal concentrations in the Kuala Krau River using Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES). The elements that were detected with notable concentrations are Aluminium (Al), Calcium (Ca), Iron (Fe), Potassium (K), Magnesium (Mg), Manganese (Mn), Natrium (Na), and Zinc (Zn).

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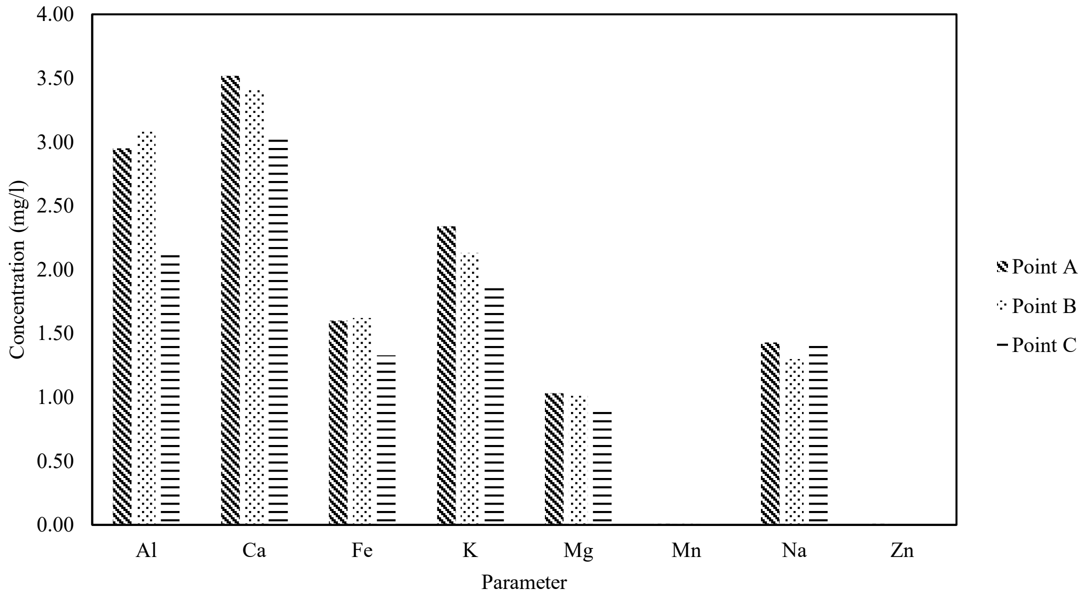

Fig. 5. The comparison of the concentration of heavy metal parameters for the 3 sampling points.

Table 3. The water quality classes of each heavy metal parameter for the 3 sampling points.

Parameters		Al	Ca	Fe	K	Mg	Mn	Na	Zn
Point	A	V	-	V	-	-	II	-	I
	B	V	-	V	-	-	II	-	I
	C	V	-	IV	-	-	II	-	I

The analysis indicates that a few concentrations of heavy metal assessed exceed the permissible limits outlined by the World Health Organization (WHO) on standard concentrations for drinking water. The presence of metal elements in water can expose a person to health conditions, but risks become more severe if they exceed the guidelines [21]. The Al and Fe are found to exceed the concentration limit for National Water Quality Standards For Malaysia. Four elements analysed are categorised as taste threshold values: K, Na, Mg, and Ca. The observed concentration of elements present is similar to data recorded by a previous study on heavy metal downstream of the river by [22]. Both Zn and Mn parameters were in Class I and II, respectively, indicating that they have not exceeded the permissible limit.

The concentration of Al present in all three points can be observed to exceed the standard set by the World Health Organization (WHO) on the permissible limit for drinking water. The limit concentration of Al set by WHO was 0.2 mg/L, whereas the highest concentration of Al present in the sample at Point B was 3.08 mg/L. The lowest concentration was recorded at Point C at 2.12 mg/L. The presence of Al in water bodies can occur naturally but in deficient concentrations. This can also be linked to the dissolution of minerals in the soils due to acid rain and mining waste from ore processing [23]. Therefore, the high concentration of Al can be related to the rainy weather during sampling.

The concentration of Fe present in all three samples exceeds the standard that the WHO outlined on the permissible limit for drinking water. The standard set by the WHO is 0.30 mg/L or less, but the highest concentration observed was at Point B, with a value of 1.62 mg/L. The minimum concentration observed was at Point C at 1.33 mg/L, which still exceeded the guideline value. The presence of Fe in the water body

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can be linked to the plumbing materials and the staining of clothes [23]. The graph shows that the highest concentration was recorded at Point B. This can be related to the materials used to build the fishpond cage and the plumbing system used by the owner, as the fish cage was still under continuous construction.

Taste thresholds in distilled water for the significant cations of drinking water Ca, Mg, Na, and K have been reported to be approximately 125 mg/L, 100 mg/L, 30–140 mg/L and 340–680 mg/L, respectively. For K, the highest concentration was present at Point A, with a concentration of 2.43 mg/L and the lowest at Point C, with a value of 1.87 mg/L. The excessive amount present in consumption may result in hypertension, heart disease, diabetes, and coronary artery disease [22]. For Na, the highest concentration recorded was 1.43 mg/L at Points A and C, and the lowest concentration was at Point B with a 1.30 mg/L value. A human does need an acceptable amount of Na to ensure the continuity of the body system. However, the extreme amount of Na can lead to health issues like high blood pressure [23]. Next, for Mg, the highest concentration observed was 1.03 mg/L on Point A, and the lowest was recorded on Point C with a value of 0.90 mg/L. This element is considered to have no health-based value, but it can increase the hardness of water, which will reduce its usability if present at excessive concentrations [22]. Lastly, the concentration of Ca was the highest at Point A, with a value of 3.52 mg/L, and the lowest was observed at Point C, with a value of 3.02 mg/L. Ca may affect the hardness of water when it exists excessively in the body. By drinking and using hard water for daily activities, humans may experience dry skin and hair, which can also lead to itchy scalps due to dryness.

5. CONCLUSION AND RECOMMENDATIONS

In Kuala Krau River, the water flows from Point A to Point B. However, water quality at Point A indicates cause for concern due to the agricultural activities and natural processes in or near Point A, while Points B and C experience slightly better water quality due to dilution, sediment settling, and natural filtration processes [19]. However, it is essential to note that downstream water quality can also be influenced by inputs from upstream sources, particularly in cases where pollution persists or accumulates along the river course. These activities, including catfish and tilapia aquaculture, oil palm plantations, and buffalo farming, harm the water quality. Land conversion for plantations has repercussions for communities dependent on ecosystem services like pristine rivers, forest goods, and small-scale agriculture, leading to the loss of access to these vital resources [20].

Furthermore, applying chemical fertilisers and pesticides in extensive plantations can contaminate freshwater sources essential for indigenous and rural communities. Therefore, farmers must actively contribute to preserving water quality in their cultivated ponds by adopting sustainable farming practices and effective waste management. Maintaining good water quality has environmental benefits and plays a crucial role in preserving the quality of ikan Patin, a speciality of Temerloh, Pahang. This, in turn, meets consumer demand and provides economic benefits to the farmers. In conclusion, agricultural activities such as catfish and tilapia farming, animal husbandry, and oil palm plantations impact the water quality in the Kuala Krau River, Temerloh, Pahang.

The physicochemical and heavy metal parameters for Kuala Krau River, Temerloh, Pahang, were assessed according to the standards outlined in the National Water Quality Standards for Malaysia. It can be concluded that the river was in Class I for pH and Salinity, Class II for Biochemical Oxygen Demand and Dissolved Oxygen, and Class III and IV for Total Suspended Solids and Turbidity. For heavy metals, only Ferum and Aluminium exceeded the permissible limit. This finding indicates that the Kuala Krau River can be a water supply point. However, it still requires conventional treatment. Furthermore, it is suitable for fisheries involving sensitive aquatic species and recreational use with body contact. However, regular monitoring is highly needed to preserve the water quality. Local authorities must ensure that all local businesses in the agricultural sector abide by the laws set, adopt sustainable practices, and practice

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proper waste and land management. It is recommended that this study be conducted during the dry season, from May to September, and a comparison be made between these two seasons.

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7. CONFLICT OF INTEREST STATEMENT

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare the absence of conflicting interests with the funders.

8. AUTHORS' CONTRIBUTIONS

Duratul Ain Tholibon: Conceptualisation, methodology, formal analysis, investigation and writing-original draft; **Wan Ameera Amalin Wan Mohd Asri**: Conceptualisation, methodology, and formal analysis; **Engku Azlin Rahayu Engku Ariff**: Conceptualisation, formal analysis, and validation; **Masyitah Md Nujid**: Conceptualisation, supervision; **Jamilah Abd Rahim:** writing- review and editing; **Nurul Faiizin Abdul Aziz:** validation.

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