JUATIKA
JURNAL AGRONOMI TANAMAN TROPIKA
VOL. 8 No. 1 January 2026

DOI :https://doi.org/10.36378/juatika.v8i1.5126
eissn 2656-1727
pissn 2684-785X
pages : 231 – 239

RESEARCH ARTICLE Open Access

Assessment of Water Quality in MARDI (Malaysian Agricultural Research and Development Institute) for Sustainable Farming

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Abstract

This study aims to assess the water quality at MARDI Serdang, Selangor, Malaysia, which is utilized to support MARDI's efforts in maintaining the availability and quality of water for research purposes and sustainable agricultural activities. This study was conducted to assess the water quality at several selected locations within the Malaysian Agricultural Research and Development Institute (MARDI). Several key physico-chemical parameters such as dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), pH, and the presence of certain heavy metals were analyzed. Water samples were collected from identified sampling points and analyzed according to the standard procedures established by the American Public Health Assiciation (APHA, 2017). The analytical results were compared with the Water Quality Index (WQI) standards used by the Department of Environment (DOE) Malaysia. The findings of the study showed significant variations in water quality among the sampling locations, with some areas exceeding the Class II limits specified in the Malaysian National Water Quality Standars. This study emphasizes the need for continuous monitoring and recommends measures to maintain and improve water quality within MARDI facilities. Overall, this study provides important insights into the water quality conditions at MARDI Serdang. Through regular monitoring and the implementation of approriate water treatment technologies, MARDI can maintain water quality while supporting the implementation of sustainable agriculture in the future.

Keywords: Agroecosystem, DOE, Environmental Pollition, Parameter Physico-Chemical, Water Resources Management

1. Introduction

Rivers are large-scale natural waterways that flow into the sea, lakes, or other bodies of water, and are reinforced by tributaries along their course. Although they contain only about 0.0001% of the world's total water, rivers play an important role in distributing water and nutrients to various ecosystems. River water quality is a crucial aspect because it affects human utilization and the sustainability of the surrounding environment. Generally, water quality is assessed by comparing measurement results with local normative standards, but this method does not fully describe the spatial and temporal variations in water quality (Ering et al., 2024).

At the national level, rivers play a significant role in providing raw water in Malaysia. In Malaysia, rivers contribute more than 90% of the raw water supply for the domestic, agricultural, industrial, and construction sectors. Rapid population and industrial growth has increased water demand by 63% between 2000 and 2050. In addition, river water abstraction increased by 23.9% between 2005 and 2009 and continues to increase every year. Historically, the development of early settlements in Malaysia was concentrated around river basin areas (watersheds), which later evolved into urban regions after independence, accompanied by rapid changes in land use due to increased human activities. In the context of agriculture, water quality plays a crucial role in the productivity and sustainability of agroecosystem, as the water used directly affects plant growth, soil fertility, and ecological balance. For research institutions such as MARDI, water quality assessment is a

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critical aspect in supporting research activities, agricultural production, and the implementation of sustainable practices. Lack of awareness regarding the quality of water used can lead to various problems, such as the accumulation of heavy metals, salts, and harmful chemicals that cause yield reduction, soil degradation, and disturbances to aquatic ecosystem. Furthermore, water pollution can pose contamination risks to agricultural products, impacting human health and food safety, therefore, water quality monitoring and management are essential steps in ensuring the sustainability of the agricultural sector. Although various studies have assessed water quality in Malaysia, studies on water source conditions in the MARDI region are still limited, especially in the context of continuous monitoring based on physical and chemical parameters (Mardi et al., 2025).

Globally, water quality assessment is generally conducted using physical and chemical parameters such as dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), adn pH. In Malaysia, the Department of Environment (DOE) uses the Water Quality Index (WQI) as the primary standard for evaluating the condition of water bodies. Previous studies, sush as research conducted on the Masai River in Johor, have shown that the water quality in the area falls under Class III or slightly polluted, influenced by land-use activities (Wqi *et al*., 2025). In Indonesia, research on the Pilang River, East Java, applied the WQI alongside a pollution index and found that most obsevation points ranged from lightly to heavily polluted. Unlike these studies, the present research focuses on assessing water quality from several selected water sources within the MARDI area using the DOE WQI to support sustainable water resource management in the context of agriculture. Thus, this study provides novelty in the application of the WQI as a basis for water management in agricultural research institutions, an area that has not been widely explored in Malaysia. order to support sustainable water resource management. This study aims to determine the water quality status of several sources in the MARDI area by comparing the measurement results with DOE standards, thereby supporting more effective environmental monitoring and water resource management (Xu et al., 2024).

Based on the background description above, the problem formulation is whether the water quality in the MARDI area meets the standards set by the Malaysian Department of Environment (DOE) based on the Water Quality Index (WQI). This study aims to determine the water quality at MARDI Serdang, Selangor, Malaysia, which is used to support MARDI's efforts in maintaining water availability and quality for research and sustainable agricultural activities.

2. Material and Methods

2.1. Research location and time

This research was conducted over a period of approximately 21 days, from September 21 to October 11, 2025, at MARDI, Serdang, Selangor, Malaysia. Samples were collected on Wednesday, October 1, 2025, at the MARDI lake located in the MARDI Serdang area, Selangor, Malaysia (3.0012° N, 101.7051° E) with an elevation of approximately 38 meters above sea level (m.a.s.l.).

The research area covered several types of water bodies, including ponds, irrigation channels, and drainage systems. A total of 33 sampling points were selected based on usage patterns and accessibility levels. However, sampling points 31 and 32 were inaccessible, so only 31 sampling points were used. This research location is mainly used for agricultural irrigation and aquaculture research. Water samples were collected for physical-chemical and microbiological analysis using sterile polyethylene bottles, then stored at 4°C before being analyzed in the laboratory. This area has a tropical climate with an average annual temperature of around 27°C and rainfall exceeding 2000 mm.

Figure 1. Mardi Water Sample Map

Water samples were collected using polyethylene bottles that had been cleaned beforehand, preserved inaccordance with the guidelines of the American Public Health Association (APHA, 2017), stored at 4°C, and immediately taken to the laboratory for further analysis.

Figure 2. Mardi Lake Water Samples Equipment and Materials

The equipment used in this study included a water sampler, water sample bottles, a cool box, Pro DSS, name labels, tissues, writing instruments, a camera, as well as equipment used to measure the analyzed parameters and safety equipment used in the laboratory. The materials used in this study were water samples from Lake Mardi as the research object, as well as reagents used in the laboratory to measure the analyzed parameters.

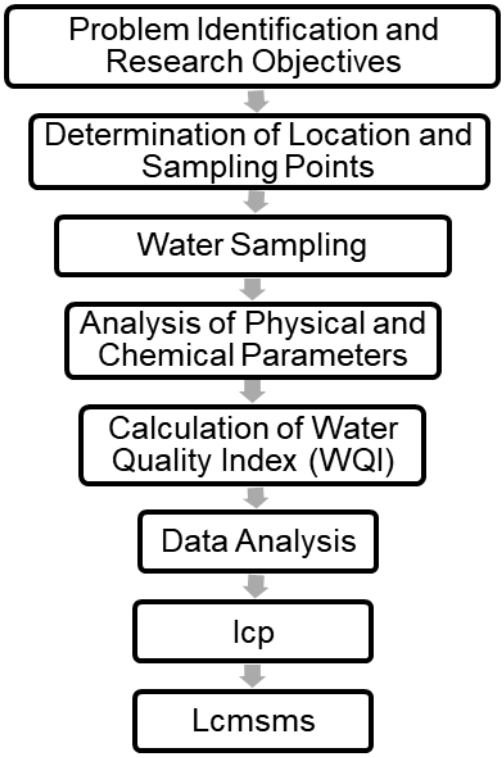


Figure 3. Research Flow Diagram

2.2. Data Analysis Method

In this study, the method used was quantitative data analysis. The types of data used consisted of data primary and secondary data. Secondary data was obtained from various scientific literature and references, including research journals, and water quality data was evaluated with reference to the Malaysian National Water Quality Standards (NWQS) and DOE-WQI classification.

Meanwhile, primary data was collected through direct observation in the field and water sampling for subsequent testing at the MARDI (Malaysian Agricultural Research and Development Institute) water quality laboratory. The parameters tested included pH, TSS, NH_3 -N, BOD, COD, DO, and Temperature.

The laboratory test results were then compared with the Malaysian national water quality standards and the Water Quality Index Classification (DOE Water Quality Index Classification) to determine the water quality level at each sampling point.

2.3. Analysis Parameters

The parameters analyzed were Ph, Total Suspended Solids (TSS), Ammonia Nitrogen (NH_3-N), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Dissolved Oxygen (DO), and Temperature.

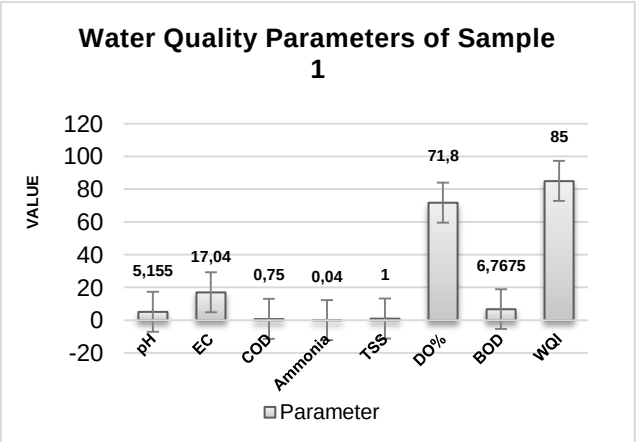
Tabel 1. Doe Water Quality Index Classification

Parameter	Unit	CLASS				
		I	II	III	IV	V
Ammoniacal Nitrogen	mg/l	< 0.1	0.1-0.3	0.3-0.9	0.9-2.7	>2.7
Biochemical Oxygen Demand	mg/l	< 1	1 - 3	3-6	6-12	>12
Chemical Oxygen Demand	mg/l	< 10	10-25	25-50	50-100	>100
Dissolved Oxygen	mg/l	> 7	5 – 7	3-5	1-3	<1
pH	mg/l	> 7.0	6.0-7.0	5.0-6.0	<5.0	>5.0
Total Suspended Solid	mg/l	< 25	25-50	50-150	150-300	>300
Water Quality Index (WQI)	mg/l	> 92.7	76.5-92.7	51.9-76.5	31.0-51.9	<31.0

Table 2. Water Classes and Uses

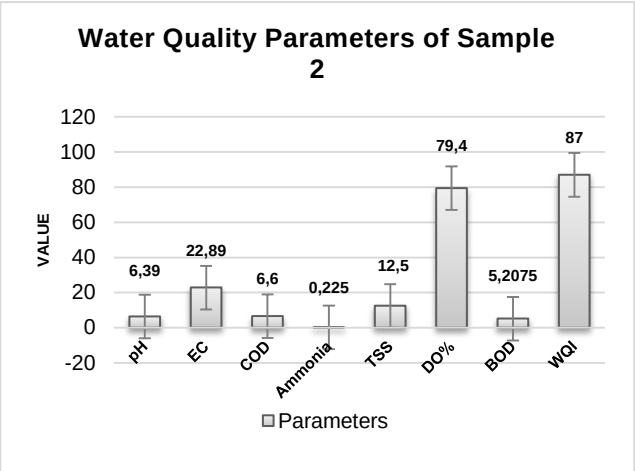
CLASS	USES
Class I	Conservation of natural environment. Water Supply I – Practically no treatment necessary. Fishery I – Very sensitive aquatic species.
Class IIA	Water Supply II – Conventional treatment required. Fishery II – Sensitive aquatic species.
Class IIB	Recreational use with body contact.
Class III	Water Supply III – Extensive treatment required. Fishery III – Common species of economic value and tolerant species; livestock drinking.
Class IV	Irrigation
Class V	None of the above

3. Results and Discussion



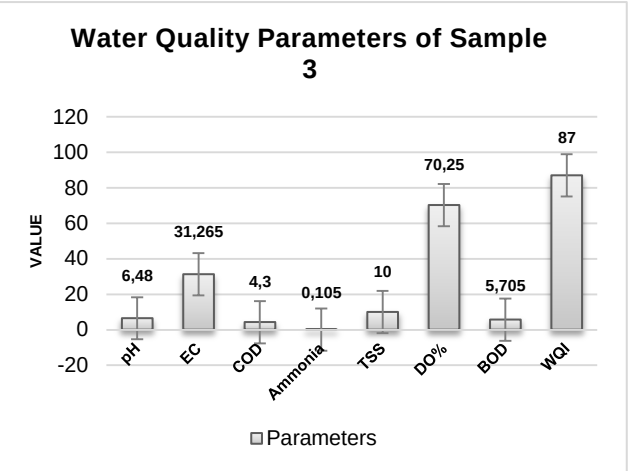
The results of water quality measurements in sample 1 show that the water conditions are still relatively good. The pH value of 5.15, which is slightly acidic, together with low EC, indicates that the dissolved ion content in the water is relatively small. The low COD, ammonia, and TSS values also indicate that the organic and inorganic pollutant load in the water is very minimal, while the high DO% reflects the availability of dissolved oxygen that is still

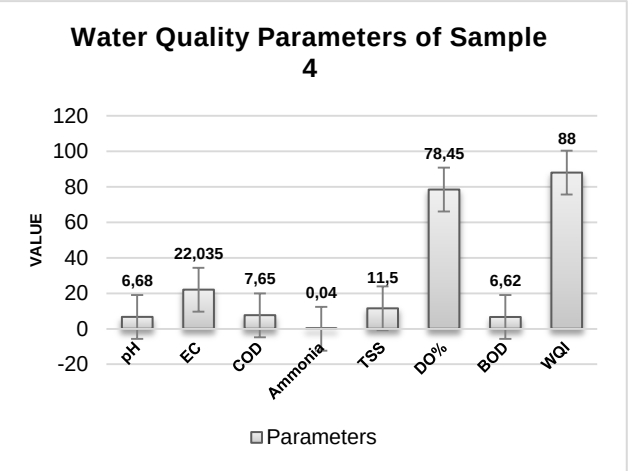
adequate for aquatic organisms. Although the BOD value indicates moderate biological activity, the overall parameters still produce a WQI value of 85, which places water quality in the good category. This interpretation is in line with research results in Malaysia which confirm that parameters such as pH, DO, BOD, COD, ammonia, and TSS are the main indicators in water quality analysis and can produce high WQI values in waters with minimal pollution. This is in accordance with the literature (Uning et al., 2021) showing that the combination of these physical-chemical parameters is effective in assessing water quality status and identifying low levels of pollution.



The results of water quality analysis on sample 2 show that the water conditions are relatively good. The pH value is close to neutral, electrical conductivity is very low, and COD and BOD are low, indicating that the organic pollutant load in the water is minimal. Low ammonia and TSS levels also indicate that there is no significant pollution pressure from natural or anthropogenic sources, while high dissolved oxygen (DO) levels support the stability of aquatic organisms. This is consistent with the water quality assessment, which resulted in a WQI of 87, which is in the "good" category. This conclusion is in line with research in the Setiu River Basin, which reported that the use of pH, DO, BOD, COD, ammonia, and TSS parameters indicated a clean river status with an average WQI of 84. This is consistent with the literature (Mohd Zain et al., 2025) in the Kelantan River Basin study, which states that the combination of these WQI parameters is effective in describing water conditions that are still in the good category.

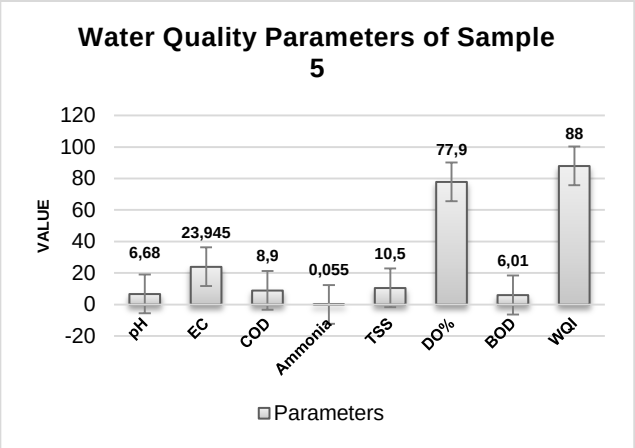
The results of the water quality analysis of sample 3 show that the water conditions are still classified as good based on the evaluation of physical-chemical parameters. The variation in physico chemical parameters such as pH, BOD, COD, Ammonia, and TSS has been proven to be a major factor in determining the water quality status. This indicates that the increase in anthropogenic activities, particularly from the agricultural and urbanization sectors, contributes significantly to the decline in water quality in several aquatic areas in Malaysia. This finding is consistent with research conducted in the MARDI area, Serdang, where a WQI value of 87 indicates that the water body is still in good condition with a low level of pollution. The near-neutural pH value (6.48) and the low levels of BOD, COD, and ammonia suggest that human activities around the MARDI area have a relatively minimal impact. This is in accordance with the literature (Ahmed et al., 2022) showing that the combination of these physical-chemical parameters are effective in assessing the status of the aquatic environment and determining the level of pollution comprehensively.





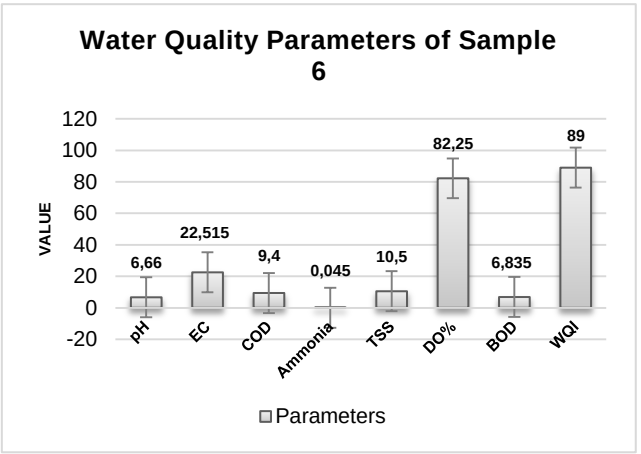
The analysis results of sample 4 indicate that the water quality is classified as good with a WQI value of 88, a nearly neutral pH of 6.68, a COD concentration of 7.65 mg/L, a BOD of 6.62 mg/L, very low ammonia levels, and low TSS, reflecting relatively clean water conditions with minimal pollution stress. Quantitatively, this value is slightly higher compared to the findings from the Setiu Basin River in Terengganu, which recorded an average WQI of 84.0 and demonstrated variations in water quality due to environmental influences and changes in surrounding land use. In comparison with studies on the Kelantan River, which experienced a decline in quality from class II to class III-IV as a result of anthropogenic

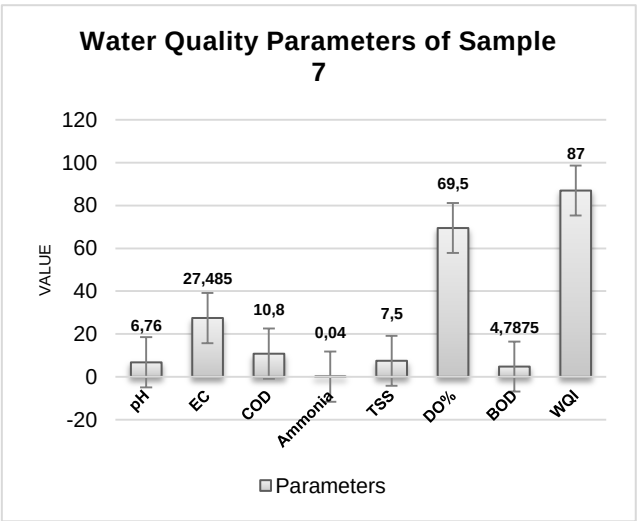
activities and watershed development, the water conditions at this study site appear more stable and do not show significant quality degradation. Overall, the combination of these parameters indicates that the aquatic environment remains relatively clean and is not under significant pollution pressure. This is in accordance with the literature (Aswad H. Aswad et al., 2025), which states that this study is consistent with research in Malaysia which reports that water bodies with high DO levels and low organic loads generally have good water quality.



The results of water quality analysis on sample 5 show that the water condition is still in the good category with a Water Quality Index (WQI) value of 88. A pH value of 6.68 indicates a condition that is close to neutral, supporting biological stability for aquatic organisms. The EC value of 23.945 µS/cm indicates a low level of dissolved ions, reflecting water with a low level of mineralization. The COD (8.9 mg/L) and BOD (6.01 mg/L) parameters indicate natural biological activity, but do not indicate significant organic pollution. Meanwhile, very low ammonia (0.055 mg/L) and TSS of 10.5 mg/L indicate minimal pollutants and suspended particles in the water. The DO content of 77.9% also confirms the availability of sufficient dissolved oxygen to support aquatic life. Overall, these results indicate that the water is in a healthy condition and is not experiencing severe ecological pressure. This is consistent with the literature (Halmi & Abdul Rahman, 2021), which explains that waters with high DO levels and low BOD, COD, and ammonia levels generally have high WQI values and good environmental quality.

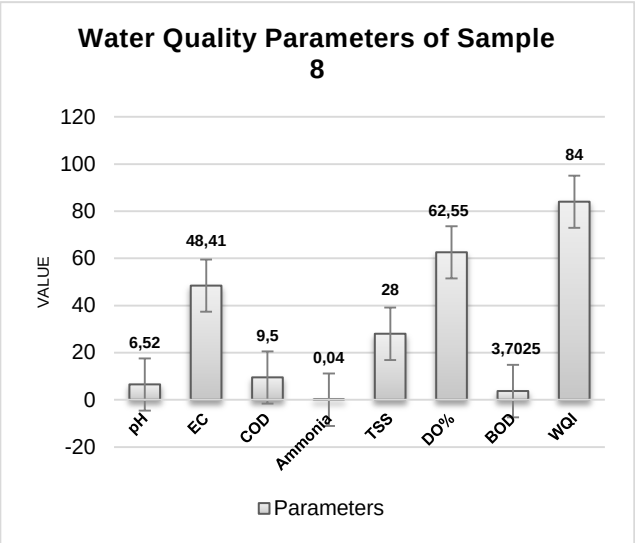
Based on the analysis of sample 6, a WQI value of 89 was obtained, indicating that the water quality falls within the good category, with clean aquatic conditions that support the life of aquatic organisme. The pH value of 6.66 reflects near-neutral chemical stability, while the EC value of 22.52 µS/cm indicates a low concentration of sissolved ions. The COD 9.4 mg/L and BOD 6.835 mg/L parameters suggest moderate biological activity without signs of severe organic pollution, accompanied by low ammonia 0.045 mg/L and TSS 10.5 mg/L levels, demonstrating a minimal pollutant load. This condition differs from studies on the Skudai River in Johor, which reported WQI values of 76-83 due to industrial and domestic activites, and the Langat Rivers in Selangor, which recorded an average WQI of 80.2 influenced by agricultural and urban runoff. Compared to those results, the gigher WQI value in this study indicates that the water conditions in the MARDI area more stable and relatively free from anthropogenic pressures. Overall, these conditions indicate that the water body remains in a stable ecological state and is not significantly polluted. This study is in line with the literature (Kurniawan et al., 2024), which emphasizes that the combination of high DO, moderate BOD, and near-neutral pH values reflects good water quality in tropical aquatic environments.





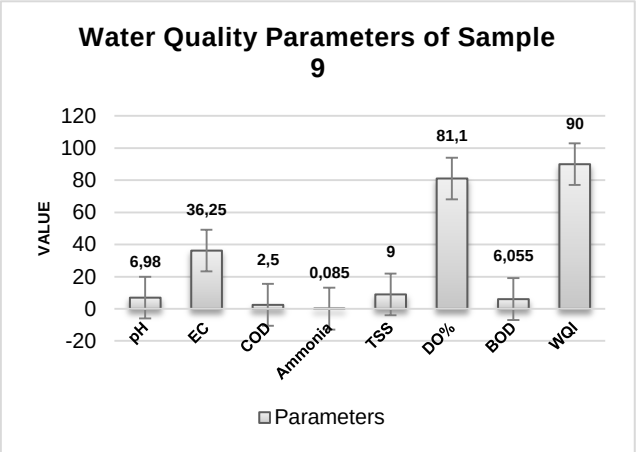
The results of sample 7 testing, with a pH value of 6.76, indicate neutral to slightly acidic water conditions, which are still suitable for aquatic organisms. The electrical conductivity (EC) value of 27.485 µS/cm indicates a low content of dissolved ions, which indicates that the water is not heavily polluted. The chemical oxygen demand (COD) of 10.8 mg/L and biochemical oxygen demand (BOD) of 4.7875 mg/L indicate a level of organic matter that can still be broken down naturally by microorganisms. meanwhile, the WQI value of 7,5 mg/L and a DO level of 69.5%

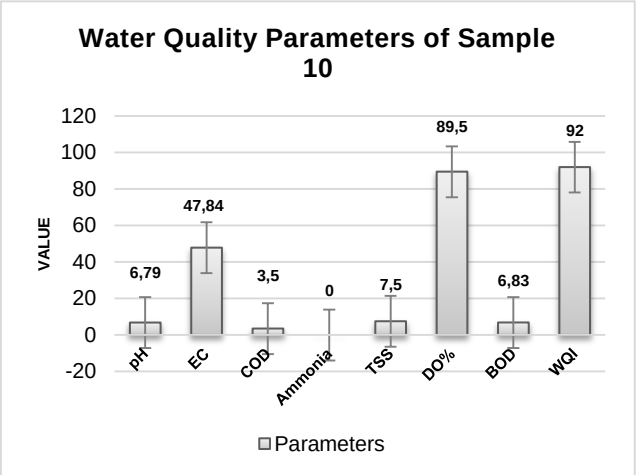
suggesting that the water is relatively clear and provides sufficient dissolved oxygen to support aquatic life. Quantitatively, this result is higher compared to the study conducted on the Langat River in Selangor, which reported an average WQI of 80.2 due to the influence of agricultural and urban activities. This finding is consistent with the literature (Madzalan et al., 2022) which states that waters with low TSS values and stable pH tend to have higher WQI scores and support the balance of aquatic ecosystem in Malaysian river basins. Such conditions are also sustaible for fishereies and recreational activities, in accordance with the Malaysian WQI classification, where values above 80 are considered good.



The analysis results for sample 8 indicate that the water quality is good and still capable of supporting aquatic life, with a pH values of 6.52 that is close to neutral and an EC value of 48.41 µS/cm, reflecting a low concentration of dossolved ions, the COD 9.5mg/L, BOD 3.70mg/L, and ammonia 0.04mg/L values indicate low levels of organic and nitrogen pollution. Quantitatively, these results are better compared to previous studies that reported BOD values of 6.2mg/L and COD values of 17.8mg/L in the Klang River, where domestic activities and agricultural runoff contributed to the decline in water quality. Meanwhile, the TSS of 28 mg/L shows that turbidity is still within safe limits, and the DO% of 62.55% indicates sufficient oxygen availability for aquatic organisms. Overall, a WQI of 84 places this sample in the good category, indicating stable water conditions and minimal pollution. This is in line with the literature (Norlida et al., 2023), which states that a combination of neutral pH, high dissolved oxygen, and low COD and BOD values are the main indicators of good water quality.

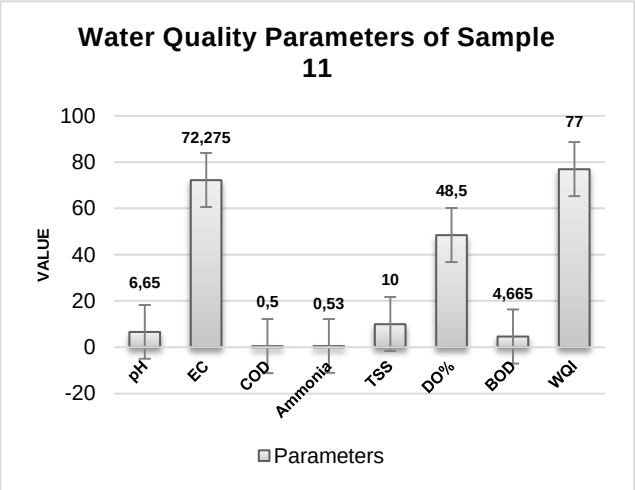
The analysis results for sample 9 show that the water quality is in the good to very good category. The pH value of 6.98 is close to neutral, reflecting the stability of the water's chemical conditions that support biota life. The EC value of 36.25 µS/cm indicates a low level of dissolved ions, signifying few inorganic contaminants. Quantitatively, the results of this study indicate better water quality compared to previous studies in Malaysia, which reported COD values of 6.8mg/L, BOD of 8.4mg/L, and TSS of 18mg/L in agricultural areas of Selangor, suggesting pollution stress caused bt human activities. Meanwhile, when compared ti findings from the MARDI area, which recorded COD of 2.5mg.L, BOD of 6.06mg/L, and TSS of 9mg/L. The results demonstrate a much lower pollutant load, along with a DO lebel of 81.1%, indicating optimal oxygenation conditions. Overall, a WQI value of 90 places the water in the very good category, indicating healthy, stable, and minimally polluted water conditions. This is in line with the literature (Zainurin et al., 2022), which states that neutral pH, high DO levels, and low COD and TSS values are indicators of high-quality water.





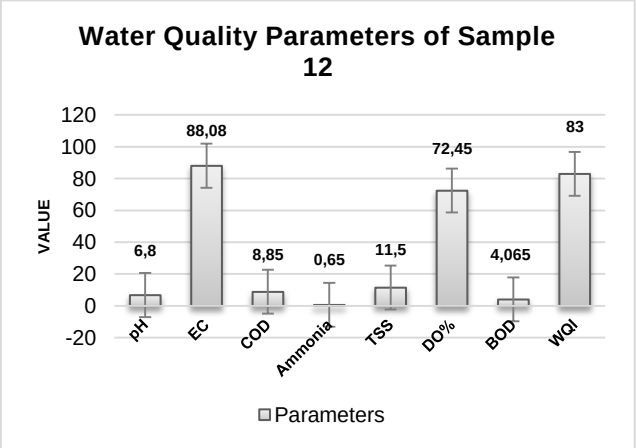
The analysis result of sample 10 indicate that the water quality ranges from good to very good, with a WQI value of 92, pH of 6.79. COD of 3.5mg/L, BOD of 6.105mg/L, low TSS 7.5mg/L, and high DO 89.5%, reflecting clean water conditions that support aquatic life. Quantitatively, when compared with previous studies in Malaysia such as that water quality mapping of the Klang River using the water quality indix (WQI), which reported classifications ranging from class II to class IV due to urban and industrial

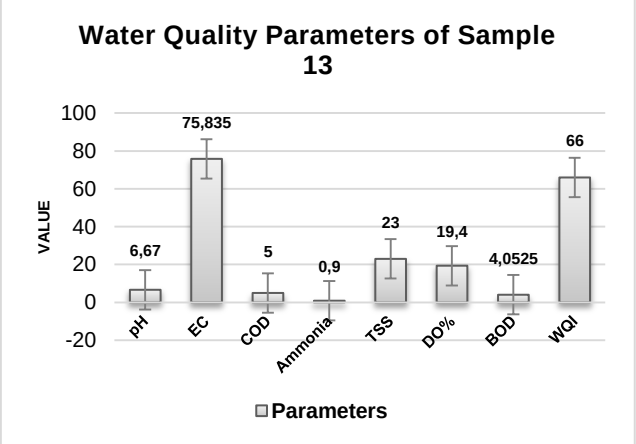
runoff, along with higher COD and BOD levels in certain parts of the river, this study demonstrates a lower pollutant load and more ecologically stable conditions. Furthermore, other studies conducted in urban areas have shown that parameters such as COD, BOD, and TSS tens to increase alongside urban development around rivers, leading to lower WQI classifications compared to the WQI value of 92 obtained in this sample. This comparison reinforces that the water quality in the MARDI area is superior in numerical terms, with physicochemical parameters remaining wuthin safe limits, indicating that the aquatic environment is relatively unaffected by anthropogenic pressures and continues to support the sustainability of aquatic ecosystem. This is consistent with the literature (Mohamed Hamim et al., 2025), which states that neutral pH, high DO, and low COD are indicators of good water quality.



The analysis results for sample 11 show a pH value of 6.65, which is still within the normal range for natural waters, but close to slightly acidic. The EC value of 72.275 µS/cm indicates a fairly high dissolved ion content compared to the previous sample, indicating increased anthropogenic activity around the water body. COD of 0.5 mg/L and BOD of 4.665 mg/L indicate a relatively low organic load, while an ammonia concentration of 0.53 mg/L indicates slight nitrogen contamination from domestic or agricultural waste. TSS of 10 mg/L indicates a slight level of turbidity, and a DO value of 48.5% indicates suboptimal dissolved oxygen conditions for aquatic life. With a WQI value of 77, the water quality is classified as fairly good to moderate, indicating the influence of human activity but not yet reaching a level of severe pollution. This is in line with research (Muhtadi et al., 2023) which states that a decrease in DO and an increase in EC often reflect a degradation in water quality due to light organic pollution.

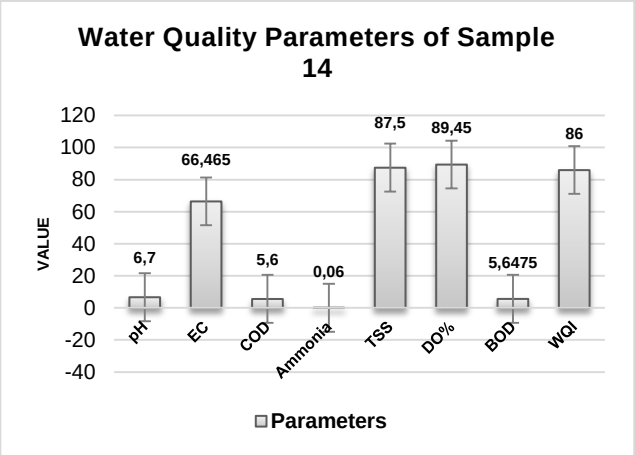
The analysis results for sample 12 show that the water quality is good based on a Water Quality Index (WQI) value of 83, which is generally categorized as clean water. The pH value of 6.8 is still within the neutral range (6.5–8.5), in accordance with the class II water quality standards according to Indonesian Government Regulation No. 22 of 2021. The EC value of 88.08 µS/cm indicates a low level of dissolved minerals, suggesting that the water has not been significantly contaminated by metal ions. COD , and BOD of 8.85 mg/L and 4.065 mg/L, respectively, indicate a relatively low organic content, suggesting that biological activity and organic pollution are still under control. The ammonia content of 0.65 mg/L is still within safe limits for aquatic life, while the DO of 72.45% indicates that dissolved oxygen is high enough to support aquatic organisms. Overall, these values indicate good water quality suitable for fishing and recreational activities, as supported by research conducted by (Onifade et al., 2023) which states that DO, BOD, and pH parameters are important indicators in determining the suitability of aquatic ecosystems.



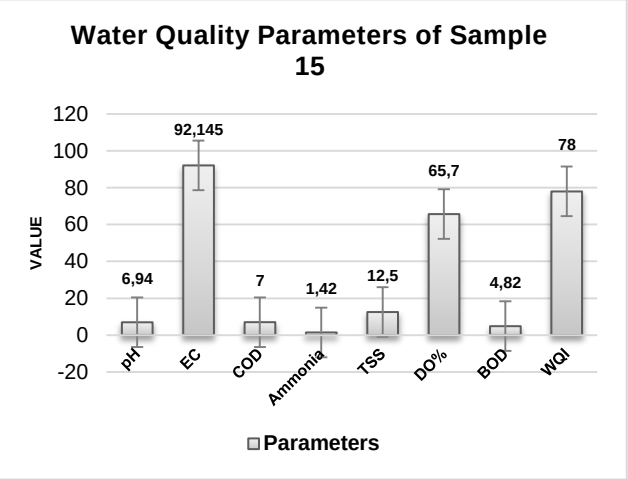


The analysis results show that the water quality in sample 13 is moderate with a WQI value of 66. The pH value of 6.67 is still within the neutral range, indicating water conditions suitable for aquatic ecosystems. The EC value of 75.835 µS/cm indicates a low dissolved ion content, while the COD value of 5 mg/L and BOD value of 4.0525 mg/L indicate a moderate level of organic pollution. The ammonia content of 0.9 mg/L and TSS of 23 mg/L

indicate the presence of suspended solids and nitrogen compounds that can affect water clarity. The low DO% value (19.4%) indicates limited oxygen levels, necessitating monitoring to maintain aquatic ecosystem balance. Overall, the water still meets quality standards but shows signs of declining quality. This is consistent with the literature (Brontowiyono et al., 2022) which states that BOD, COD, and DO parameters are the main indicators in determining river water quality status.



The analysis results show that sample 14 has good water quality with a Water Quality Index (WQI) value of 86, indicating that the water conditions are still suitable for aquatic life. The pH value of 6.7 and EC of 66.465 µS/cm indicate neutral conditions with a low concentration of dissolved ions, while COD 5.6mg/L, BOD 5.6475mg/L, and ammonia 0.06mg/L values reflect minimal organic pollution. The high DO leevel of 89.45% indicates sufficient oxygen availability for aquatic organisms, although the relatively high TSS values of 87.5mg/L may affect water clarity. Quantitatively, thee results demonstrate better water quality compared to previous research (Phelia *et al*., 2020), indicating that overall, the water quality is classified as good with stable biological activity. This is consistent with the literature (Syeed *et al*., 2023) which states that a WQI value above 80 indicates healthy water conditions with low pollution levels.



The analysis of sample 15 shows a pH of 6.94, which is still neutral and within the clean water standard, while the EC values of 92.145 µS/cm indicates a relatively high concentration of dissolved ions. The COD value of 7mg/L and BOD of 4.82mg/L suggest a moderate level of organic pollution , while the ammonia concentration of 1.42mg/L indicates potential influence from domestic and agricultural activiies. The TSS value of 12.5mg/L reflects relatively good water clarity, and the DO level of 65.7% remains adequate to support aquatic life. Quatitatively, the WQI value of 78 categorizes the water as being in good condition and is comparable to the finfings experiencing moderate anthropogenic pressure. Overall, these results indicate that the water quality at the study site is relatively good but shows early signs of moderate organic pollution, highlighting the need for regular monitoring and the implementation of more sustainable environmental management practices to prevent future deterioration of water quality. This is in line with the literature (Monica *et al*., 2023), which states that a WQI value above 70 indicates water quality that is safe for general use.

4. Conclusion

The study indicates that the water quality in MARDI is generally good, with most observation points classified as Class II, making it suitable for clean water treatment. However, several ponits that fall into Class III show a decline in water quality that requires further attention. Overall, this study reflects the increase in COD and TSS values at several locations suggests pollution pressure from agricultural activities. Therefore, regular water quality monitoring and the implementation of sustainable agricultural practices are strongly recommended to maintain water quality within acceptable standards and to support long-term agricultural productivity.

Acknowledgements

The author would like to express his deepest gratitude to the Malaysia Agricultural Research and Development Institute (MARDI) for the permission,

research facilities, and technical support provided during the implementation of water quality research at Mardi. Sincere thanks are also extended to my supervisor Mohd Nordin Abdul Rahman and Mohammad Shahid B. Shahrun as Senior Research Officer, as well as Nabila Ashad and all SF1 Mardi staff for their excellent assistance and cooperation in the sampling and data analysis process in the field and laboratory.

Thanks are also extended to the Faculty of Agriculture, University of Muhammadiyah Sumatera Utara (UMSU) as the affiliated institution that has provided academic support, scientific guidance, and motivation during the research process and preparation of this manuscript. Last but not least, the author would like to thank his parents for their moral and material support, as well as the supervising lecturers, accompanying lecturers during the research, a special thank-you goes to Mas F, who has been by my side for the past four years. Thank you for your unwavering support, patience, and encouragement. Your presence has made this journey much more meaningful and memorable and colleagues who provided suggestions, criticism, and moral support in completing this research and writing this scientific article.

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