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Water Quality during Rainy and Droughty Seasons based on Water Quality Index

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Abstract: The water quality index (WQI) pattern is a prominent method for determining the quality of the water. Aggregation methods are used to reduce a large volume of water quality data to a single value or index. The WQI method has been used across the world to estimate water quality (surface and subsurface) using local water quality standards. Water pollution is a serious environmental issue in Malaysia because of many activities have been done by humans until the occurrence of pollution around the body of water, which affects the natural status of the lake may be in a dangerous zone of water pollution. This research was conducted to determine the sampling area in RMC lake for Water Quality Experiment, to investigate water quality parameters for five (5) water sampling location points in RMC lake during the rainy and droughty season and also to analyze water quality levels in the lake as a whole according to Water Quality Index (WQI). The best way to assess lake water quality uses the water quality index (WQI), which can determine the lake's condition during the rainy and droughty season. WQI classification needs to do the laboratory data from the parameters which are Biochemical Oxygen Demand(BOD), Chemical Oxygen Demand(COD), Total Suspended Solid(TSS), Ammoniacal Nitrogen(AN), pH, and Dissolved Oxygen(DO). As a result, the WQI of RMC Lake was higher during the drought than during the rainy season. The RMC lake's WQI rating during the drought was Slightly Polluted and Clean (Class II & III), with a range of 75.21 to 82.96. Many of the samples with WQI results are classified as Class II or III. During the drought, all stations were changed to Slightly Polluted status. According to the study's findings, the water quality in the RMC lake was better in droughty than rainy season..

Keywords: Water Quality Index (WQI), Water Pollution

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1. Introduction

The importance of water in the global economy cannot be overstated. Thus, the quality of water must be emphasized to ensure a continuous and safe supply for people, industries, and aquatic life. To assess the overall state of their rivers, many countries utilize the water quality indexing (WQI) method. Chemical, physical, and biological qualities are examples of water quality parameters that can be tested or monitored depending on the desired water parameters of concern [1]. The condition of the lake water is a matter that needs to be taken into consideration to ensure the quality of the water is in the best condition and not polluted. Lakes are internal water bodies that are not directly connected to the ocean. Lake ecosystems are made up of the physical, chemical, and biological characteristics of these bodies of water.. A lake can be found anywhere within a river basin, depending on its source. A headwater lake receives inflow from multiple tiny tributary streams, direct surface rainfall, and groundwater influx rather than a single river. Almost all of these lakes have a single river outlet [2].

Nowadays, many human activities did the pollution around the water body, which impacts the natural status of lakes and may come into the dangerous zone of water pollution [3]. Water quality testing is important to test the water before it is used for drinking, domestic users, industrial purposes, or agricultural [4]. Therefore, the best way to evaluate the quality of a lake's water is by using the water quality index (WQI) which can gain the status of the lake as either polluted or clean [5]. The lakes that contain too high temperatures and the lowest oxygen levels are unsafe and dangerous [6]. These seasonal changes may affect the water quality in both good and negative ways. Humidity and temperature are associated with different seasons. The temperature variations caused by climate change create churning in water reservoirs. The bulk of the water affects its quality. In terms of water quality in 2008, there are considerable changes in the metrics between the dry and wet seasons. The study's findings will aid in the protection of water quality and the management of water resources [7].

This research aimed to obtain the quality of water at the lake by using Water Quality Index. Thus, the objectives are to determine the sampling area in RMC lake for Water Quality Experiment, to investigate the water quality parameters for five (5) points at the location of sampling water in RMC lake during the rainy and droughty seasons and to analyze the level of water quality at the lake thoroughly according to the Water Quality Index (WQI). Furthermore, a new WQI based on weights to specific parameters was established by the Brown group in 1970, which was similar to Horton's index countries [8]. Various scientists and specialists have recently proposed different adjustments to the WQI concept. The formula of WQI is shown **Eq. 1** and the result can be used to identify the pollution status of the lake [9].

$$WQI = (0.22 * SIDO) + (0.19 * SIBOD) + (0.16 * SICOD) + (0.15 * SIAN) + (0.16 * SISS) + (0.12 * SIpH) \quad \textbf{Eq. 1}$$

where, SIDO is Subindex Disolved Oxygen, SIBOD is Subindex Biochemical Oxygen Demand, SICOD is Subindex Chemical Oxygen Demand, SIAN is Subindex Ammoniacal Nitrogen, SISS is Subindex Suspended Solid, and SIpH is Subindex pH [10].

2. Materials and Methods

For this research, water sampling is conducted at RMC Lake, UTHM Batu Pahat, Johor. This water sampling is done in different seasons, which is rainy and drought season. Five samples are taken every season for laboratory work. The first sampling is on 29 December 2021 on a rainy day and the second one on 13 April 2022 on a droughty day. Sampling locations should be in areas that are safe to reach, accessible under all flow and discharge circumstances, adequately mixed to ensure a homogeneous

sample is obtained, and easily identified for further sampling. Based on **Figure 1**, there are steps for taking the water sample at the sampling location.

A few laboratory works are used to identify and analyze the quality of water at the lakes which became polluted because of human activities. The laboratory work or experiment to be carried out is pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), ammoniacal nitrogen, total suspended solid (TSS). This laboratory work was done using samples that have been taken in different seasons which is drought season and the rainy season.

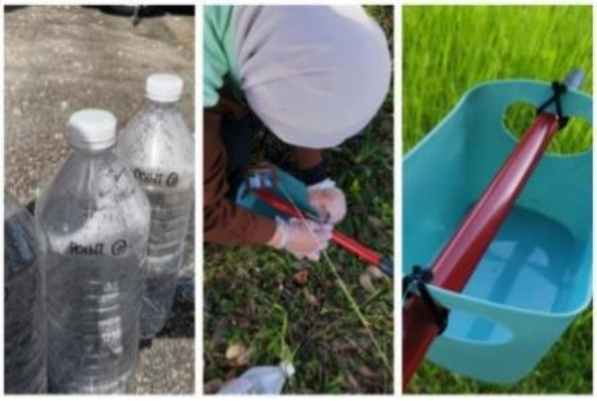

Figure 1: Steps for taking water samples

The result of WQI in rainy and drought season are shown in **Table 2** and **Table 3**.

Table 2: Result of Water Quality Index (WQI) in the rainy season

Result Water Quality Index							
Sample	**COD(mg/L)**	**BOD (mg/L)**	**TSS (mg/L)**	**AN (mg/L NH_3-N)**	**DO (mg/L)**	**pH**	**Temperature**
1	37.5	5.4	2000	0.19	8.3	6.46	30
2	27	5.4	4000	0.08	8.45	6.58	30
3	63.5	72	6000	0.1	8.55	6.76	30
4	33.5	29.7	4000	0.2	7.56	6.77	30
5	97	65.7	4000	0.26	6.18	6.88	30

Table 3: Result of Water Quality Index (WQI) in droughty season

Result Water Quality Index							
Sample	**COD(mg/L)**	**BOD (mg/L)**	**TSS (mg/L)**	**AN (mg/L NH_3-N)**	**DO (mg/L)**	**pH**	**Temperature**
1	18	7.89	100	0.16	7.72	6.52	26.9
2	12.5	9.5	60	0.12	7.92	6.58	26.4
3	21	6.17	280	0.14	8.18	6.75	26.2
4	17	8.83	120	0.18	8.04	6.82	26
5	12.5	19.08	80	0.22	7.4	6.77	27.2

3. Results and Discussion

The RMC Lake water quality index was calculated using the WQI values for each station and season. The WQI value was estimated at each sample using Formula in appendix A and compared to the DOE Water Quality Classification based on WQI, which includes range indices for Clean (81-100), Slightly Polluted (60-80), and Polluted (0-59) status. These range indices were created based on six parameters used criteria. According to **Table 4** and **Figure 2**, during the rainy season, the WQI in the RMC lake ranged from 56.35 to 69.61 (Class III), indicating polluted and Slightly Polluted conditions. Meanwhile, Polluted was ascribed to samples 1 and 5. Referring to Pollution Status Based on DOE, the results is shown as **Table 4**.

Table 4: DOE Water Quality Classification Based on Water Quality Index in rainy season

Sample	WQI	Index Range	Water Class & Uses	DOE WQI Classification
1	57.77	Polluted	Water supply III -extensive treatment required Fishery III-lifestock drinking	III
2	62.91	Slightly Polluted	Water supply III -extensive treatment required Fishery III-lifestock drinking	III
3	69.61	Slightly Polluted	Water supply III -extensive treatment required Fishery III-lifestock drinking	III
4	60.97	Slightly Polluted	Water supply III -extensive treatment required Fishery III-lifestock drinking	III
5	56.35	Polluted	Water supply III -extensive treatment required Fishery III-lifestock drinking	III

Figure 2 : Index Range of Water Quality Index for each point in rainy season

Table 5: DOE Water Quality Classification Based on Water Quality Index in droughty season

Sample	WQI	Index Range	Water Class & Uses	DOE WQI Classification
1	77.8	Slightly polluted	Water supply II -Conventional treatment Fishery II-sensetive aquatic species	II
2	82.96	Clean	Water supply II -Conventional treatment Fishery II-sensetive aquatic species	II
3	75.66	Slightly Polluted	Water supply III -extensive treatment required Fishery III-lifestock drinking	III
4	76.58	Slightly Polluted	Water supply II -Conventional treatment Fishery II-sensetive aquatic species	II
5	75.21	Slighty Polluted	Water supply III -extensive treatment required Fishery III-lifestock drinking	III

The WQI value was estimated at each sample and compared to the DOE Water Quality Classification based on WQI. According to **Table 5** and **Figure 3**, during the drought season, the WQI in the RMC lake ranged from 75.66 to 82.96 (Class II) and (Class III), indicating Clean and Slightly Polluted conditions.

Figure 3 : Index Range of Water Quality Index for each point in droughty season

The RMC lake's WQI was higher during the drought season than during the rainy season. Based on Figure 3, during the drought season, the WQI rating of the RMC lake was classed as Slightly Polluted and Clean (Class II & III) with a range between 75.21 to 82.96. Many of the samples that recorded WQI readings were in Class II or III. During the drought season, however, all stations were classified as Slightly Polluted and improved. The study's findings suggest that the RMC lake's water quality was better during the drought than during the rainy season.

4. Conclusion

The Water Quality Index, a useful tool for evaluating the quality of surface water, is used to determine the lake's water quality. To ensure its scalability, the Surface Water Quality Index will be used in a variety of urban and rural settings. This study provided a low-cost surface water quality monitoring system that authorities might use to the advantage of communities, especially those in aquatic situations. To cover the inflows, outflows, and midpoints, a water body should have more monitoring stations installed. It would be advantageous to use cameras to visually analyze and monitor surface water bodies.

To ensure that a larger range of contamination sources is identified, it is advised that additional studies be conducted using more advanced water sampling techniques. The results of a more organized sample technique that can access the water's top, middle, and bottom will be more accurate indicators of the level of water pollution. Additionally, there is room for improvement in terms of sampling safety. In order to decrease contamination in water bodies as soon as possible, stakeholders should create a foul-proof plan that will make crucial knowledge and techniques accessible.

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