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The Impact of Flood on Water Quality in Muar River Along Jalan Panchor, Muar, Johor

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Abstract

This research investigates the relationship between floods and river water quality, focusing on the impact they pose to aquatic ecosystems. It uses hydrological, ecological, and environmental science perspectives to understand the effects of floods on aquatic ecosystems and communities. The approach are by using WQI parameters which are pH, Dissolved Oxygen, Biochemical Oxygen Demand, Chemical Oxygen Demand, Total Suspended Solid and Ammoniacal Nitrogen. . The study analyzed the post-flood situation of Muar River along Jalan Panchor, Johor, using the Malaysian Water Quality Index (WQI) to categorize it as clean, slightly polluted, or polluted. Results showed that the overall water quality of Muar River can be classified as Slightly Polluted or Class III, with WQI values ranging from 59.34 to 74.47. However, the impact of the flood on water quality increased from 65.01 pre-flood to 68.51 post-flood, suggesting a better water quality index after the flood.

1. Introduction

The survival of human populations and the environment relies on proper water management, particularly rivers. Floods, which are common but have gained attention, significantly impact river water quality. These events cause the formation of pollutants, sediments, and toxins, which can disrupt the delicate balance of aquatic ecosystems. Changes in water temperature, turbidity, sediment load, nutrient concentrations, and dissolved oxygen levels can lead to a loss of biodiversity and decreased ecosystem services. Changes in hydrology, geomorphology, nutrient cycling, and sediment dynamics have all had an impact on biodiversity and aquatic ecosystems [1].

The study focuses on the Muar River along Jalan Panchor, examining the impact of floods on water quality. Floods have caused significant damage to the river, introducing contaminants such as sewage, agricultural runoff, and industrial waste. These pollutants can harm the river's water quality, making it unsuitable for drinking, bathing, and fishing. The study is conducted along the Jalan Panchor Muar River, which is prone to flooding and provides significant water to the Muar district. Floods can introduce chemical contaminants, sediments, and nutrients, including heavy metals, petroleum products, pesticides, and medications. Understanding the complex connection between floods and water quality is crucial. Water quality is evaluated using physical qualities, chemical features, and biological characteristics. The DOE uses two basic methodologies to classify and assess the quality of Malaysian rivers [2]. These are the Water Quality Index (WQI) and the Malaysian National Water Quality Standards (NWQS). Using a Water Quality Index (WQI), the parameters are used to rate the overall quality of the water. Preventive interference and regular checks are necessary to prevent contamination of the water supply. This research is interested in determining the water quality index of Muar

River along Jalan Panchor, Johor and testing the quality of water, whether it is polluted or clean, using Water Quality Index to ensure the quality of water resources is safe for man and aquatic life.

2. Materials and method

The study was conducted at Muar River along Jalan Panchor, Muar Johor. This study was carried out to determine the impact of flood on water quality of Muar River. In this study, the parameters that were analysed to determine the biological and physio-chemical parameters are pH, Dissolved Oxygen (DO), Biologival Oxygen Demand (BOD), Total Suspended Solid (TSS), chemical oxygen demand (COD) and Ammoniacal Nitrogen (AN) were measured based on the Water Quality Index (WQI). The implementation method was carried out through sample analysis in 5 sampling stations which are at Muar River along Jalan Panchor as shown in Figure 1.

The sampling points chosen in such a way that they are representative of the various areas affected by the flood. This can be carried out by randomly selecting sampling locations from a flood-affected area [3]. These sampling locations are strategically placed along the river's flow, each providing a distinct perspective on the dynamic interplay of elements influencing water quality after flood events. The thesis attempts to provide a thorough understanding of how floods effect water quality in this crucial aquatic environment through strategic effected locations, as well as targeted areas near known pollution sources. Also, a point with a good water flow, water flow areas are less likely to be stagnant, which can contribute to the formation of algae and bacteria. The sampling point's positions is critical for ensuring that the sample is representative of the water body being sampled. When measuring for the impact of floods on water quality, it is critical to gather samples from flood-affected areas [4]. Sampling is generally recommended during the morning hours, ideally between 6 a.m. and 10 a.m. This is because water conditions tend to be more stable during this time, with minimal interference from activities like rainfall, photosynthesis, and temperature fluctuations [5]. At low tide, the water level is lower, and the water's surface area is exposed to the air.

To ensure no sample exchange, each bottle of the water samples storage was labelled first and then filled with water samples for all sampling stations. The water sample storage bottles were cleaned first to avoid contamination of the sample. The water sample bottles were placed in an ice box for transportation to the materials laboratory at UTHM Pagoh. Transporting water samples to the laboratory as soon possible is critical for preserving sample integrity and ensuring the dependability of water quality data. The data was also analyzed using Microsoft Excel for the biological and physio-chemical parameters of water samples based on the standard method of Water Quality Index (WQI).

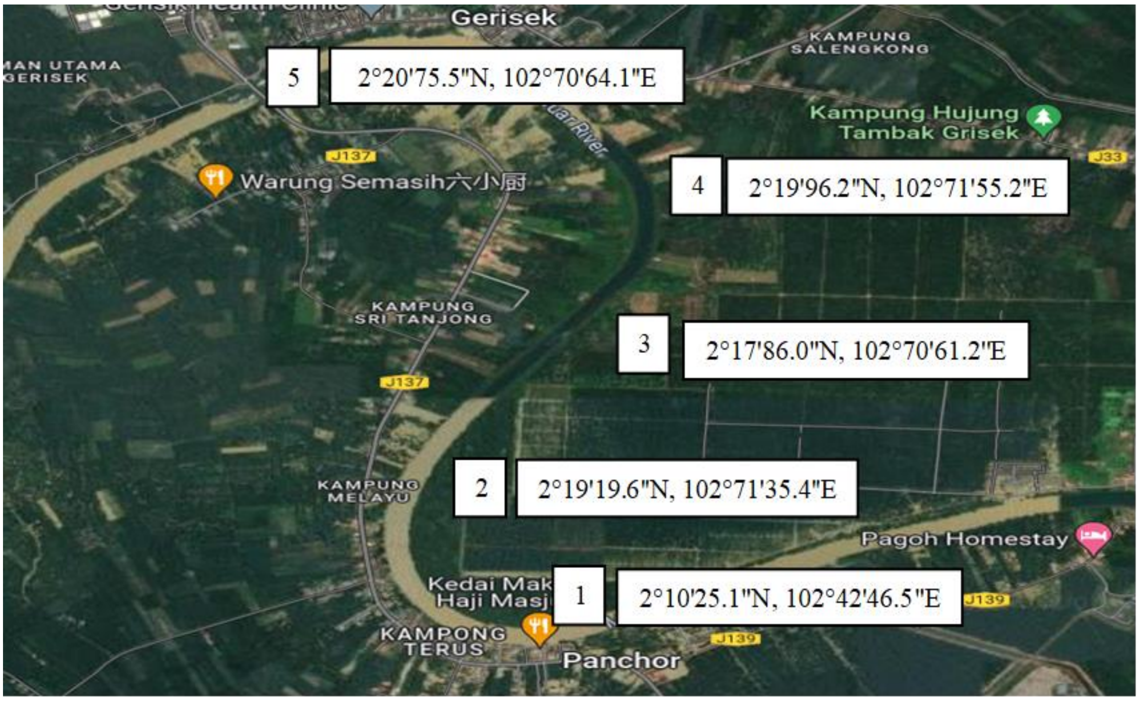

Fig. 1 *Area of study*

The experiment was carried out using the method mentioned in Table 1. Total 6 parameters were measured, which are pH, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Total Suspended Solids (TSS), Chemical Oxygen Demand (COD) and Ammoniacal Nitrogen (AN).

Table 1 *Equipment and Method* [6]

Characteristic	Equipment	Method	Unit
pH	Multiparameter	APHA 2012	-
DO	Multiparameter	APHA 2012	mg/L
TSS	Filtration Pump	Gravimetric Method Based on APHA 2550D	mg/L
COD	DR6000 Spectrophotometer	Reactor Digestion Method (Method 8000)	mg/L
BOD_5	Incubator	Method 5210B	mg/L
AN	Spectrophotometer	Nessler Method Based on APHA 4500 NH_3-N C (Method No. 8038)	mg/L

3. Result and discussion

Table 2 shows the pH levels of water samples collected from five different locations along the river were tested to determine if the water was acidic or alkaline. The pH scale, which goes over from 0 to 14, determines whether a solution is acidic or alkaline. A sample is classified as acidic if its pH is less than 7.0. Meanwhile, it is alkaline if the pH is greater than 7.0. The results found only slight variations between the stations. Based on the table below, the water sample values for the five sampling stations are found to be in the range between 6.69 to 6.81.

Table 2 *pH analysis of water sample for sampling stations*

Station	Result	Class
1	6.81	I
2	6.73	I
3	6.72	I
4	6.78	I
5	6.69	I
	Average: 6.75	**I**

River pH levels are crucial for determining water quality, and environmental conditions like floods can significantly impact them. The data from Figure 2 from five stations shows a narrow range of pH values, indicating stability. Factors contributing to these values include local geology, human activity, and buffering compounds. The pH values are within the accepted range for freshwater habitats, 6.5 to 8.5, which is ideal for the healthy growth and survival of most freshwater creatures. However, the immediate impact of floods on pH levels may be minimal, as they can introduce pollutants and change the composition of river water. Long-term monitoring is needed to understand the cumulative impacts of environmental stressors, as pH may not change dramatically immediately after flooding. The steady pH values observed in the current dataset suggest the need for a thorough analysis over a long period.

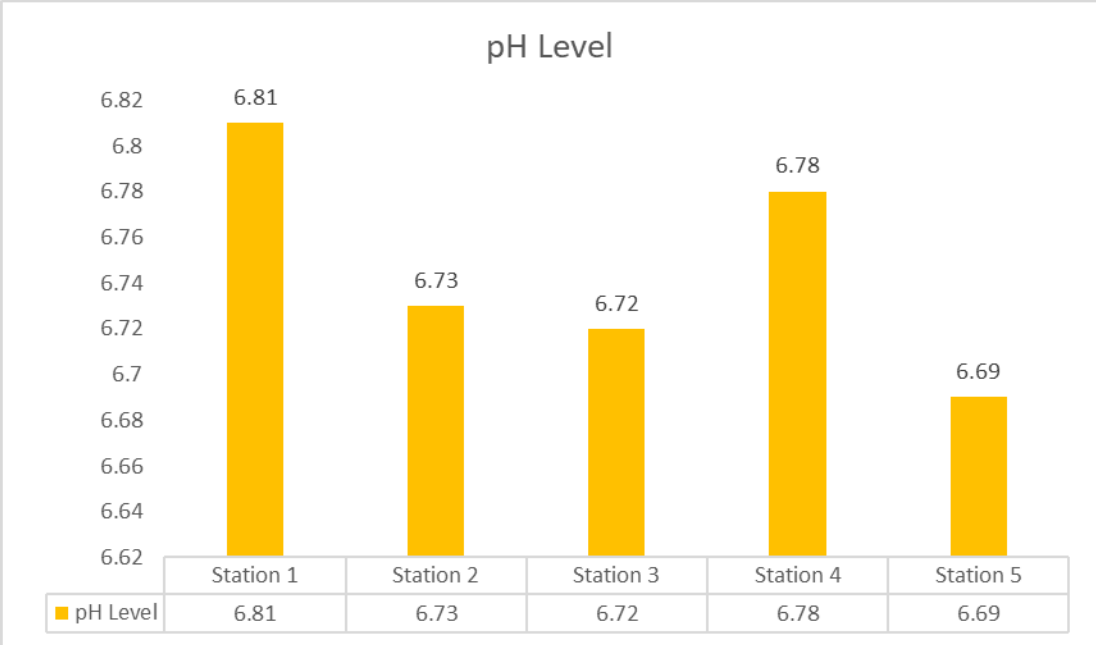

Figure 2 *pH analysis of water sample for sampling stations*

3.1 Dissolved Oxygen (DO)

The amount of oxygen dissolved in water is measured by dissolved oxygen. Dissolved oxygen concentrations in healthy water should be greater than 6.5-8 mg/l and between 80% and 120%. Concentrations higher than this can be harm to aquatic life. Proper dissolved oxygen levels in water are required for optimum water quality and the support of aerobic living forms. The lower the dissolved oxygen concentration, the higher the stress on aquatic life. Based on the Table 3, the water sample values for the five sampling stations are found to be in the range between 6.26 mg/L to 6.54 mg/L.

Table 3 *Dissolved Oxygen (DO) analysis of water sample for sampling stations*

Station	Result	Class
1	6.61	II
2	6.26	II
3	6.52	II
4	6.54	II
5	6.29	II
	Average: 6.44	**II**

The change in the aquatic environment can be observed from Table 3, the dissolved oxygen (DO) levels in water samples from five sites along the river. Station 1 had a DO level of 6.61, while Station 2 had a lower level of 6.26. Station 3 had the highest DO level of 6.52, followed by Stations 4 and 5, which had values of 6.54 and 6.29, respectively. These data indicate a significant variance in DO concentrations across the stations. Stations 1, 4, and 5 had reasonably close DO levels, indicating a comparable degree of oxygenation in the water. Stations 2 and 3, on the other hand, show lower and higher DO values, indicating potential localised factors impacting oxygen availability. Floods can significantly impact dissolved oxygen levels, with stations 2 and 5 showing lower levels due to pollution sources like fertiliser runoff. Floods can introduce contaminants, organic debris, and sediments, reducing oxygen levels. However, stations 1 and 4 show higher levels, indicating potential mitigation mechanisms. Flooding can cause increased turbidity and sedimentation, limiting light penetration and slowing oxygen exchange. The arrival of organic materials during floods can also reduce oxygen levels through biological processes. Bacteria dissolve organic waste, consuming dissolved oxygen, causing stress on aquatic creatures, leading to reduced reproductive success, poor growth, and even death. Understanding the link between water temperature and dissolved oxygen levels during floods is crucial for managing and mitigating flood-related consequences on aquatic ecosystems.

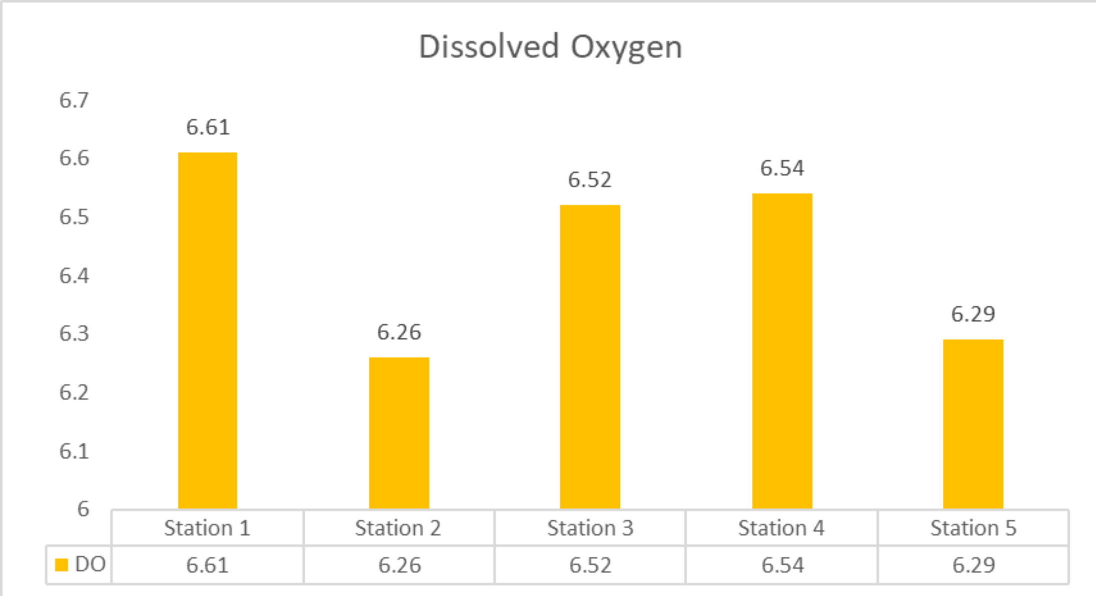

Fig. 3 *Dissolved Oxygen (DO) analysis of water sample for sampling stations*

3.2 Chemical Oxygen Demand (COD)

Chemical Oxygen Demand (COD) assesses the amount of oxygen required to chemically oxidise organic and inorganic contaminants in water. COD levels can reduce oxygen levels in the water, causing fish and other aquatic species to suffer. Furthermore, the presence of contaminants can alter the flavour, smell, and overall quality of the water, rendering it unfit for ingestion or other uses. As a result, it is critical to monitor and control COD levels in order to preserve the health and sustainability of the aquatic ecosystem as well as the safety of humans and wildlife. As shown in the Table 4, the water sample readings for the five sampling stations range from 29 mg/L to 48 mg/L.

Table 4 *Chemical Oxygen Demand (COD) analysis of water sample for sampling stations*

Station	Result	Class
1	31	III
2	48	III
3	43	III
4	29	III
5	33	III
	Average: 36.8	**III**

Floods significantly impact river water quality, specifically the Chemical Oxygen Demand (COD) levels at five sites. As shown in Figure 4, Station 1 had a COD reading of 31, Station 2 had a reading of 48, Station 3 had a reading of 43, Station 4 had a reading of 29, and Station 5 had a reading of 33. Stations 2 and 3 received higher COD levels, indicating more severe flooding. Station 4 had a significantly lower COD level, indicating a smaller influence of flooding. Understanding these trends is crucial for determining flood-related environmental damage severity. High COD levels at Stations 2 and 3 may endanger aquatic life and the environment's health. Studies highlight the negative impacts of high COD on aquatic organisms and emphasize the need for COD control for long-term water quality. Water quality can be preserved through regulatory regulations, best management practices, and community involvement. Flooding can introduce pollutants like agricultural runoff and sewage overflow, causing elevated COD levels.

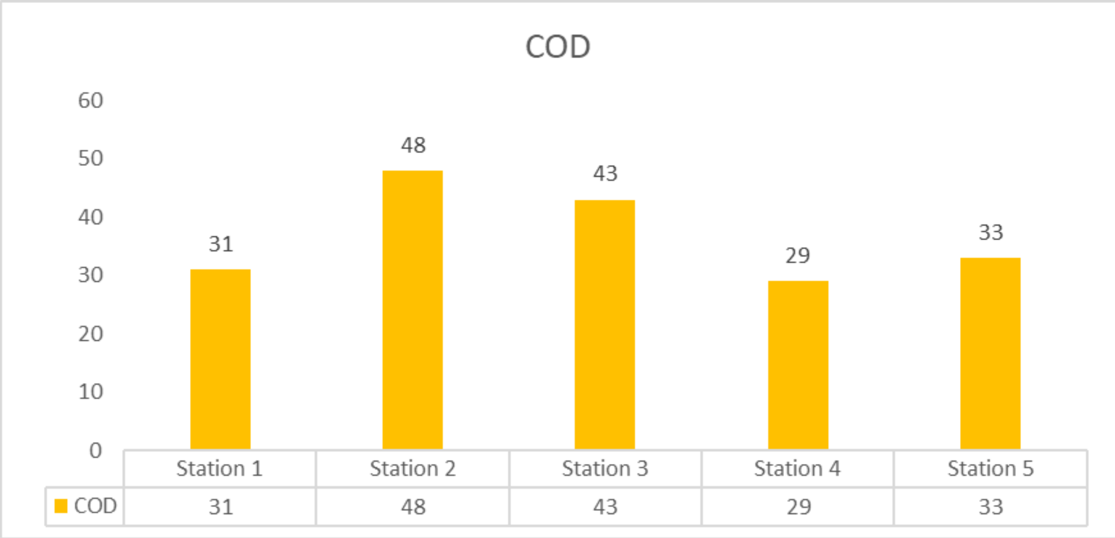

Fig. 4 *Chemical Oxygen Demand (COD) analysis of water sample for sampling stations*

3.3 Biological Oxygen Demand (BOD)

High BOD readings (more than 5 mg/L) indicate a polluted water source, which is frequently connected with excessive sewage, agricultural runoff, or industrial waste. Such levels have the potential to deplete dissolved oxygen, resulting in fish fatalities and ecosystem disruption. BOD readings less than 1 mg/L, on the other hand, indicate clean water with little organic matter. A concentration of 1-5 mg/L indicates moderate water quality, requiring monitoring and maybe intervention to prevent future deterioration. Based on the Table 5, the water sample values for the five sampling stations are found to be in the range between 4 mg/L to 7 mg/L.

Table 5 *Biological Oxygen Demand (BOD) analysis of water sample for sampling stations*

Station	Result	Class
1	4	II
2	4	II
3	7	III
4	6	III
5	5	II
	Average: 5.2	**II**

The study examines the impact of floods on biochemical oxygen demand (BOD) levels in rivers by analyzing data from five sites along a river as shown in Figure 5. The data shows that the impact of floods on water quality is not uniform across the river, suggesting localized contamination sources. Stations 1 and 2 had BOD readings of 4, indicating a baseline level of organic contamination. Station 3 had a significantly higher BOD reading of 7, indicating a greater influence of pollutants from urban and agricultural areas into rivers. The increased BOD levels at stations 3 and 4 may indicate a greater influence of these pollutants, emphasizing the need for appropriate land-use management and pollution control strategies. High BOD levels can decrease dissolved oxygen in water, causing fish and other aquatic species to suffer. This highlights the importance of implementing sustainable practices and flood risk reduction approaches to preserve water quality and ecosystem health. Supports the idea that flood events might contribute to poor water quality [7] and [8]. These investigations provide important insights into the complex interactions between floods and river ecosystems, providing a scientific foundation for the observed changes in BOD levels at the specified sites [9].

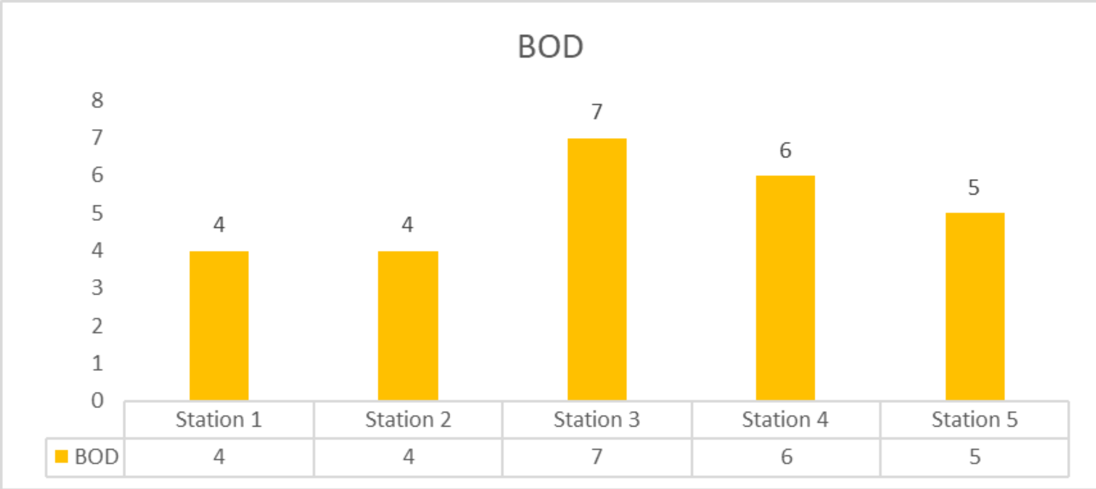

Fig. 5 *Biological Oxygen Demand (BOD) analysis of water sample for sampling stations*

3.4 Total Suspended Solid (TSS)

The number of solid particles suspended in water is measured by Total Suspended Solids (TSS), a critical indicator for evaluating water quality. These particles, which range in size from sand grains to microscopic clay, can come from a variety of sources, including erosion and agricultural runoff. TSS levels in water samples can be used to detect pollution sources and assess the overall quality of a body of water. TSS levels beyond a certain threshold indicate poor water quality and can contribute to environmental degradation because suspended particles can block sunlight, lower oxygen levels, and suffocate aquatic plants and animals. Based on the Table 6, the water sample values for the five sampling stations are found to be in the range between 52 mg/L to 79 mg/L.

Table 6 *Total Suspended Solid (TSS) analysis of water sample for sampling stations*

Station	Result	CLASS
1	79	III
2	61	III
3	66	III
4	52	III
5	55	III
	Average: 62.6	**III**

Flooding events significantly impact Total Suspended Solids (TSS) levels in five river stations as shown in Figure 6. The highest TSS level was recorded at Station 5, with a reading of 79. The initial surge of sediments and debris from floodwaters may have contributed to higher TSS levels at Station 1. This result is consistent with other research, which emphasises the link between floods and water quality degradation [10],. As the water moves downstream, sedimentation and settling may occur, resulting in a steady decline in TSS levels. Station 5 shows a modest rise, possibly due to downstream river buildup or input. Floods can add suspended materials into the water column, affecting aquatic ecosystems and limiting light penetration. The movement of pollutants linked with sediments endangers water quality, potentially causing negative consequences on aquatic life and human health. This is consistent with research highlighting the link between floods and water quality degradation. Understanding sediment dynamics in river ecosystems is crucial for addressing these issues.

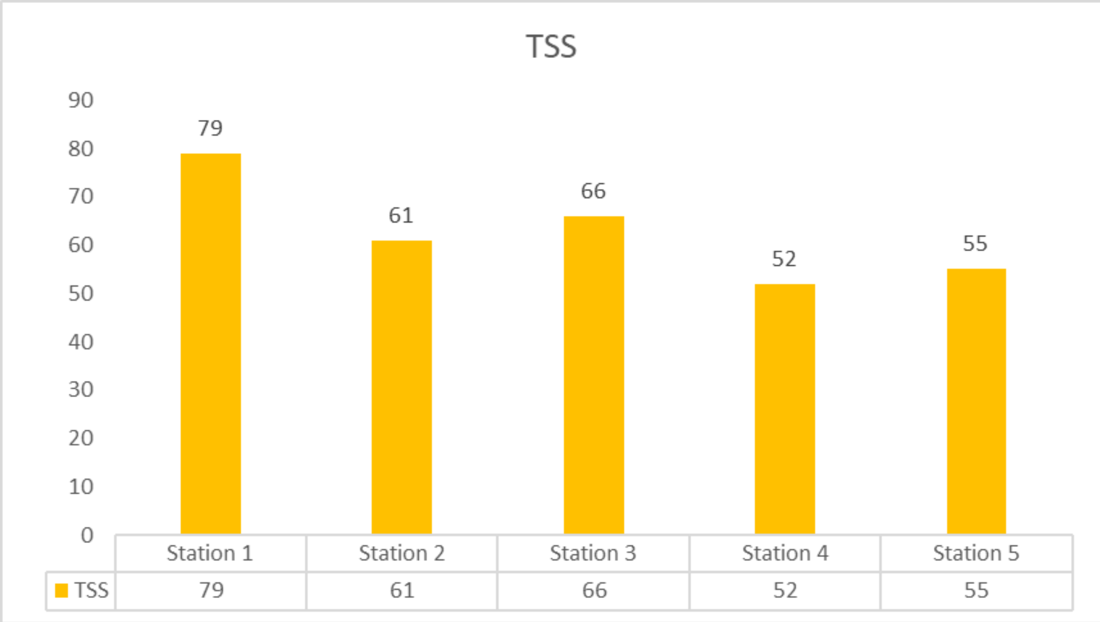

Fig. 6 *Total Suspended Solid (TSS) analysis of water sample for sampling stations*

3.5 Ammoniacal Nitrogen (AN)

The result of Ammoniacal Nitrogen (AN) gives light on a different threat: dissolved nutrients. This critical test determines the concentration of ammonia (NH^3), a type of nitrogen that is easily available to aquatic plants and microorganisms. While ammonia is necessary for some growth, it can be a double-edged sword in terms of water quality. Excess ammonia levels can produce eutrophication, a process in which an excess of nutrients promotes the growth of algae and other aquatic plants. Reduced oxygen levels in the water can affect fish and other aquatic species. Monitoring and managing ammonia levels is therefore critical in maintaining a healthy and balanced aquatic habitat. Based on the Table 7, the water sample values for the five sampling stations are found to be in the range between 1.53 mg/L to 1.78 mg/L.

Table 7 *Ammoniacal Nitrogen (AN) analysis of water sample for sampling stations*

Stations	Result	CLASS
1	1.53	IV
2	1.78	IV
3	1.68	IV
4	1.63	IV
5	1.65	IV
	Average: 1.65	**IV**

The data on Ammonia Nitrogen (AN) levels in five river sites during a flood event shown in Figure 7 shows a significant variability. Station 1 had a reading of 1.53, while Station 2 had a higher rating of 1.78. Stations 3, 4, and 5 measured 1.68, 1.63, and 1.65 mg/L, respectively. The greater AN level in Station 2 may indicate a localized source of pollution or higher runoff carrying nitrogenous chemicals. The differing degrees of influence at various locations highlight the complicated connection between flooding occurrences and AN concentration. Agricultural runoff and urban pollution could all play a role in the reported changes. Floods can accelerate the movement of pollutants into bodies of water, resulting in higher nutrient concentrations. The impact of floods on AN level in river ecosystems is complex, with both localized and systemic factors influencing nutrient concentrations. Extensive watershed management techniques are required to limit the negative effects of floods on river water quality.

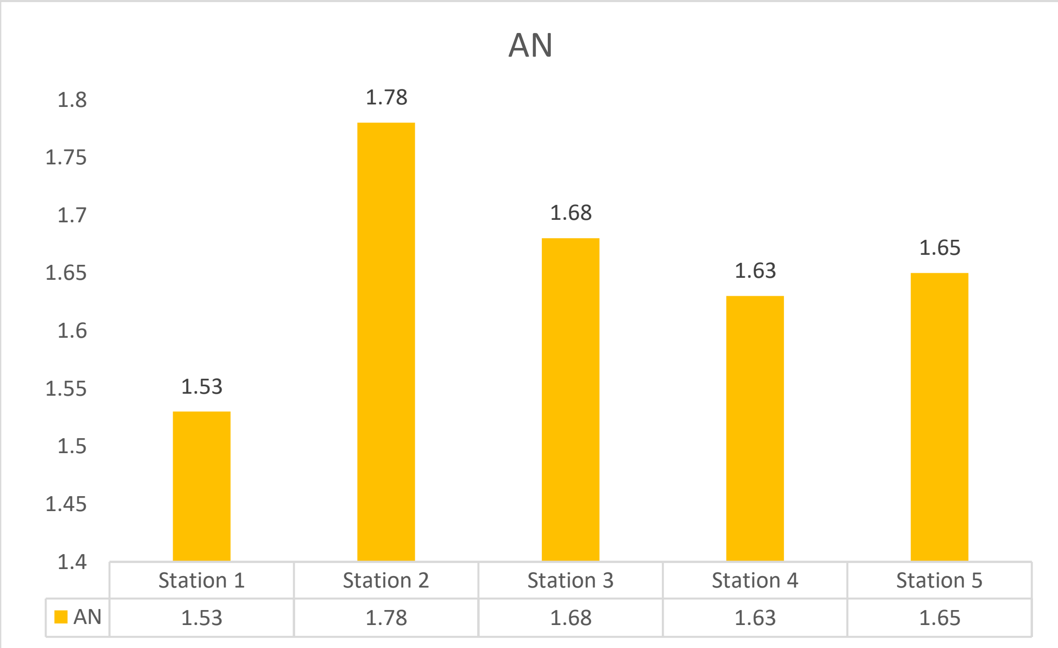

Fig. 7 *Ammoniacal Nitrogen (AN) analysis of water sample for sampling stations*

3.6 WQI parameters of pre- flood and post flood

Water quality assessment before and after a flood event is critical to understanding the dynamic influence of such natural events on river ecosystems. This research investigates the Water Quality Index (WQI) characteristics to determine the differences in water quality between pre-flood and post-flood situations. Flood events, which are defined by a rise of water and the potential introduction of contaminants, have the potential to dramatically change the physio-chemical features of rivers and water bodies. Table 8 shows the change in each parameter in determining the WQI.

Table 8 *WQI Parameters of pre- flood and post flood*

	pH	DO	BOD	COD	TSS	AN
Pre-flood	6.81	7.13	5.7	11	66.67	1.57
Post-flood	6.75	6.44	5.2	36.8	62.6	1.65

The data shown in Figure 8 comparing pre-flood and post-flood river conditions reveals considerable changes in several water quality parameters. The pH before the flood was 6.81, and it dropped to 6.75 after the flood. Dissolved Oxygen (DO) levels dropped more dramatically, falling from 7.13 to 6.44. Similarly, the Biochemical Oxygen Demand (BOD) decreased from 5.7 to 5.2, indicating a possible effect on organic matter breakdown. The Chemical Oxygen Demand (COD) increased significantly from 11 to 36.8, indicating an influx of organic and inorganic contaminants into the river. Total Suspended Solids (TSS) fell from 66.67 to 62.67, presumably due to post-flood sediment settling. Ammoniacal Nitrogen (AN) levels increased significantly from 1.57 to 1.65, indicating an increase in nitrogenous substances in the water. The decrease in pH, DO, and BOD after floods indicates a potential impairment of water quality. The increase in COD indicates the presence of more contaminants, possibly from urban runoff or industrial discharges. Sediment settling after floodwater recedation may have decreased TSS levels, and an increase in ammoniacal nitrogen levels suggests a possible fertiliser intake from agricultural runoff or other pollution sources. Reduced pH levels can cause an acidic environment, oxygen shortage, and depletion of oxygen as microbes digest waste. High COD levels can have serious consequences for human health, as they indicate contamination with pollutants like pesticides and industrial chemicals. Sediment settling is crucial in reducing total suspended solids levels and preserving water purity and quality. Analyzing ammoniacal nitrogen levels before and after floods can provide insights into the impact of agricultural runoff on water contamination and the efficiency of mitigation methods. This knowledge is critical for establishing sustainable farming techniques that reduce the flow of dangerous contaminants into water bodies, preserving the long-term health and safety of both ecosystems and human populations. Floods can bring contaminants, alter sediment dynamics, and disturb river ecosystems. Increased COD and ammoniacal nitrogen could be attributed to increased urban runoff, agricultural-related nutrient loading, or faulty wastewater treatment facilities. The drop in DO could be due to decreased oxygen exchange caused by sedimentation and increased demand from decomposing organic waste.

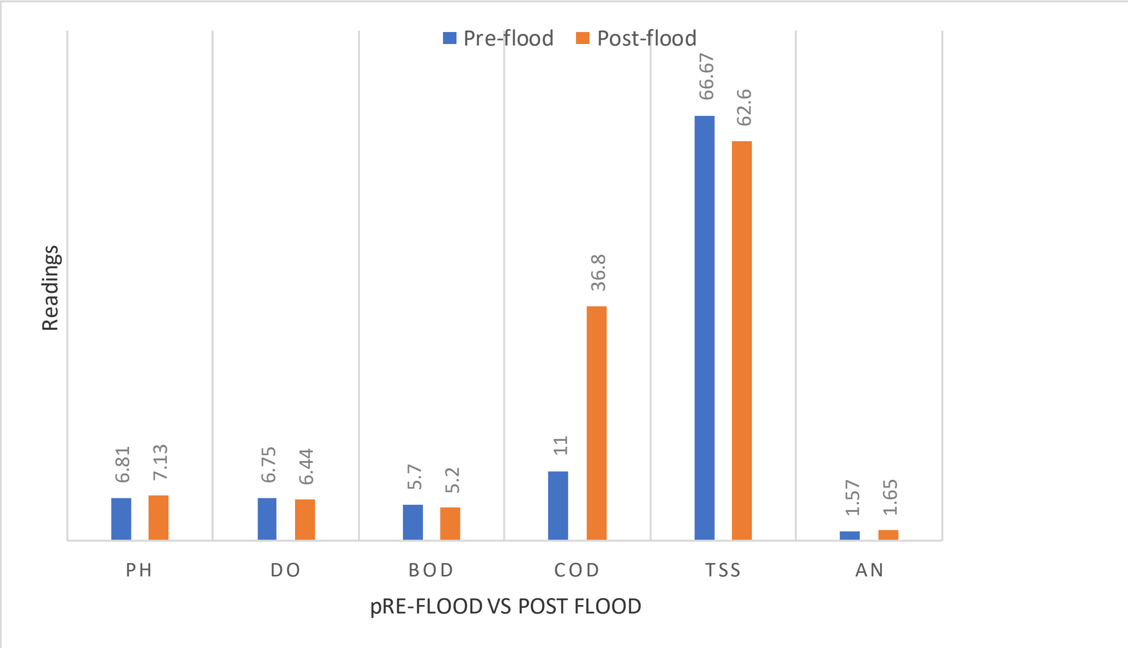

Fig. 8 *WQI parameters of pre- flood and post flood*

3.7 Water Quality Index (WQI)

In order to determine the current condition of good water quality throughout the study area, the Malaysian DOE WQI was utilised to classify four different forms of land use. WQI readings ranging from 81 to 100 indicate clean water, 60 to 80 suggest moderately contaminated water, and 0 to 59 indicate contaminated water [2]. The WQI values for three different sites were calculated by substituting sub-index values for each parameter in the WQI analysis.

The Water Quality Index (WQI) data before and after a flood event reveals a significant shift in river quality, with the WQI increasing from 65.01 before the flood to 68.51 post-flood as shown in Figure 9. This suggests that the flood event may have affected the river's overall water quality. The increase in WQI post-flood suggests an improvement in water quality, contrary to expectations of a fall due to flooding incidents. This could be due to factors like pollutant dilution, sediment settling, or contaminant flushing. The relationship between floods and water quality is dynamic and multifaceted, challenging traditional wisdom. It is crucial to evaluate individual parameters and how the flood may have affected them.

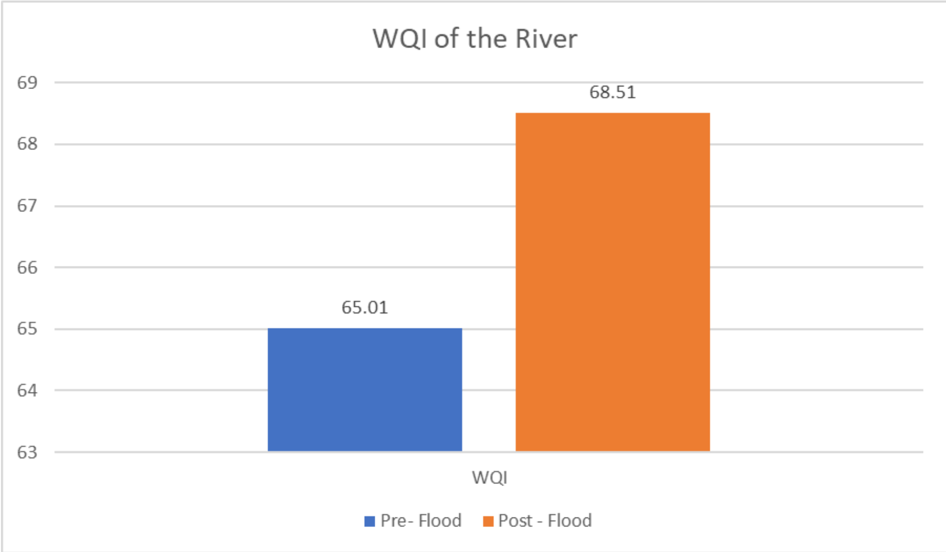

Fig. 9 *Difference of WQI*

4 Conclusion

The study aimed to evaluate the biological and physio-chemical characteristics of water quality in the Muar River along Jalan Panchor. All parameters, including pH, dissolved oxygen, Chemical Oxygen Demand, Biological Oxygen Demand, Total Suspended Solids (TSS), and Ammoniacal Nitrogen, were tested in the laboratory. All stations had dissolved oxygen concentrations below 6.6 mg/L, making them unfit for aquatic life. BOD levels were not uniform, with the exception of stations 1 and 2, which had a BOD value of 4mg/L and were classified as Class III. Station 2 had a higher COD level than other stations. All stations indicated an acidic pH, with pH ranges between 6.69 and 6.81. AN levels were in the Class IV range, not acceptable for freshwater farming and of moderate quality. All TSS levels were less than the 150 mg/L minimum criteria imposed by the Malaysian DOE WQI for Class IV water. Alternatively, the flood may have carried pollutants away, resulting in a temporary improvement in overall water quality. In support of this approach conducted research on the diverse effects of floods on water quality, demonstrating situations when floods can both decrease and improve water quality depending on local conditions [12].

The water quality after laboratory testing was compared to pre-flood data to investigate the impact of flood on the Muar River's water quality. The results showed a slightly improved water quality index after the flood, possibly due to better water circulation, dilution, and mixing. This could be a potential area for future research to establish long-term water quality monitoring in cooperation with Sungai Muar local authorities, research institutes, or environmental agencies along Jalan Panchor. Regular monitoring will aid in the detection of changes in water quality over time as well as the identification of any emergent issues or trends.

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This guide contains examples of common types of APA Style references. Section numbers indicate where to find the examples in the Publication Manual of the American Psychological Association (7th ed.).

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