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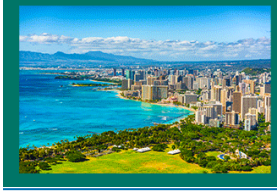

Quality Control Assessment in the River of Kajang, Selangor, Malaysia

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Abstract. This paper investigates the biochemical oxygen demand (BOD) and the pH level along Jelok River, Kajang, Selangor, Malaysia. The BOD and pH level are of major interest as microbial activity. Five water sampling locations along the river have been selected. To test the pH level of each water sample, a pH meter was used. To test the BOD of each water sample, the 5-days BOD test was conducted. Using the collected data, the Pearson's correlation coefficient between the pH and BOD was calculated. The computed Pearson correlation coefficient is -0.67988, indicating that pH does affect BOD of the water, specifically for this river. In addition, it demonstrates that when pH value increases, BOD of the water will decrease. The results show that water pH was quite stable, range between 7.05 to 7.65, while BOD fluctuates wildly, range between 1.4 to 4.3 mg/L. According to the BOD value, the high BOD value was found along the bridge at Changkat Road with 4.3 mg/L, and the lowest was found to be the one at Shell Petrol Station along Semenyih Road with BOD value of 1.4 mg/L. From the findings, public and authority shall be alert of the water performance and actions are necessary to preserve the water quality along this river. In addition, it is recommended to compare the water quality parameters among few rivers in future studies.

1. Introduction

Being one of the human's basic needs, water is the key for human survival, necessary for the human body's biological processes, as well as in manufacturing and other industries. However, as of now, the mass industrial activities are one of the contributing factors to water pollution, especially in urban areas like Kajang, Selangor, Malaysia. One of the reasons of water pollution is bacterial activity, which indirectly affects the water quality. The biochemical oxygen demand (BOD) and pH are the most commonly used parameters in determining the existence of the bacteria in the water. The water quality has been widely studied by [1-3], to name a few.

Oram [4] stated that the pH is one of the most common tests for the rate of bacteria activity. It measures the potential proton activity in the water sample. An ideal value of the water pH is at 7.5 [5]. Meanwhile, Fondriest Environmental Inc. [5] identified the importance of water pH to aquatic life, due to the fact that most aquatic organisms have a unique ideal pH to survive in the water. This has been further affirmed by the USGS (U.S. Geological Survey's) [6], which stated that large changes and deviations in pH values of samples taken from a common water source are indicators of increasing pollution, as well as other environmental factors.

BOD is a major indicator of the water pollution level [7]. BOD is a measure of how much oxygen needed by microorganisms to decompose organic materials in the water. BOD is usually proportional to the amount of organic matter present in the water. Hence, a high BOD value is an indicator of a polluted water, while a low BOD value indicates a good water quality. Most water sources have low dissolved oxygen levels. Thus, when BOD is heightened, the aerobic organism will compete for oxygen due to the low amount of dissolved oxygen in the water [8]. The researches related to pH and BOD of the water have been studied by [9-12].

Jelok River is one of the rivers located in Kajang, Selangor, Malaysia surrounded by industrial activities. According to Bahrum and Malek [13], Jelok River is a main tributary of the Langat River. It is about 9 km long. It appears more like a drain, due to the tall embankments which have been built on its sides at several points along the river. In addition, the river itself does not vary much in width at different points along the river. As an example, it is only 7 meters wide at the bridge of Jelok 7 Road, and at Metro Kajang, roughly 550 metres away, it only becomes 7.5 meters wide, a small increase of only 0.5 meters.

In this paper, our research aim was to investigate the two parameters in the water quality analysis, i.e. BOD and pH values of the Jelok River. In addition, the correlation between water pH and BOD will be revealed, specifically for the Jelok River. The correlation coefficient is important to determine the association between two variables [14]. Findings of this study could alert the responsible parties on the contaminated water due to activity of bacteria, which indirectly affect the water quality.

This paper is organized into several sections as follows: The methodology to measure the water pH and BOD value is discussed in the next section. Section 3 presents the findings and related discussion. Finally, Section 4 provides some concluding remarks.

2. Materials and Methods

2.1. Sampling areas

This study investigates pH and BOD along Jelok River. In view of this, a total of 5 sampling points have been selected. Figure 1 shows the Jelok River where the river is marked as a line and sampling areas are marked in circle. Table 1 lists the sampling locations and the corresponding reasons. At each sampling location, 2 water samples, each around 600 millilitres of water were collected using polyurethane bottles.

2.2. Apparatus and Materials

To measure BOD, the 5-days BOD test was conducted in a laboratory, Centre of Water Research and Analysis (ALIR), Universiti Kebangsaan Malaysia (UKM). The total amount of collected water samples for one sampling area must be at least 500 millilitres. The water samples were wrapped in aluminium foil during collection to minimize algae growth, as it may cause errors during the test and were sent to the laboratory as soon as sample collections were completed.

BOD measurement was the oxygen consumption in a water sample, after 5 days of incubation at 20^{o}C. In this study, two water samples were taken and dissolved oxygen (DO) level of one water sample was immediately measured using the digital meter. After five days of incubation, DO level was measured using the same digital meter. BOD value was determined by subtracting this DO level from the DO level found five days previously:

$$\text{BOD} = \text{DO in mg/L (measured before incubation)} - \text{DO in mg/L (measured after incubation)} \quad (1)$$

On the other hand, the pH of the water samples was measured using a pH meter. The water pH was obtained as soon as the water was put into polyurethane bottles. The pH value reading was taken twice for each water sampling. Next, the average water pH was calculated.

Figure 1. Map along the Jelok River.
(Source: Google Maps)

Table 1. Sampling locations and the corresponding reason.

Location	Sampling location (latitude and longitude)	Reason
A	Metro Plaza, Kajang (N 2° 59' 27.64", E101° 47' 20.93")	This location closes to a shopping mall, which making it a dumping ground for domestic waste
B	The T-Intersection at Tun Abdul Aziz road (N2° 59' 28.04", E101° 47' 20.93")	It is a back alley area, where the water might contain solid waste
C	The bridge at Changkat road (N2° 59' 27.84", E101° 47' 31.98")	This location is surrounded by housing areas and a commercial wet marketplace, making it prone to domestic waste
D	The bridge at Jelok 7 road (N2° 59' 26.92", E101° 47' 40.35")	This is the traffic area, where has gas emission from the passing vehicles
E	Shell Petrol Station along Semenyih road (N2° 59' 27.54", E101° 47' 48.66")	The water in this location is prone to petrol runoff from the nearby Shell Petrol Station

3. Results and Discussion

3.1. Biochemical Oxygen Demand (BOD) and pH Level

Table 2 displays the BOD and average pH values of the 5 sampling locations. BOD value was computed using Equation (1). From Table 2, water pH was noted to be only slightly alkaline, with low deviation from the average overall water pH value of 7.2. This means that chemical pollution levels, at least from an acid-base perspective, are low, as the mean pH value was close to the normal river pH level of 7.5. This also means that chemical pollution was evenly spread in the river, with no particular areas having extremely high or low levels of chemical pollution.

Table 2. The average pH and BOD values for the sampling locations along Jelok River.

Location	Sample number	pH values	Average pH	BOD value (mg/L)
Shell Petrol Station along Semenyih road	1	7.1	7.65	1.4
		7.7		
	2	8.5		
		7.3		
The bridge at Jelok 7 road	1	7.2	7.10	2.8
		7.3		
	2	6.9		
		7.0		
The bridge at Changkat road	1	7.0	7.05	4.3
		7.1		
	2	7.1		
		7.0		
The T-intersection at Tun Abdul Aziz road	1	7.3	7.10	3.1
		7.2		
	2	7.0		
		6.9		
Metro Plaza, Kajang	1	7.3	7.10	1.8
		7.2		
	2	7.0		
		6.9		

BOD is a measure of the amount of oxygen consumed by microorganism during the decomposition of organic materials. When BOD value is high, dissolved oxygen (DO) level declines because the available oxygen in the water is absorbed by the bacteria. This shows that the water is polluted. Unpolluted water typically has BOD value of no more than 2 mg/L [15]. From Table 2, the highest BOD value (4.3 mg/L) was found at the bridge of Changkat Road, while the lowest value (1.4 mg/L) was discovered at Shell Petrol Station along Semenyih Road. The high BOD value at the bridge of Changkat Road is due to the water bodies in this location receiving waste water from the surrounding areas, such as commercial wet marketplace. According to Huong et al. [16], a higher amount of dissolved organic carbon is associated with the appearance of certain bacterial species. Thus, conditions such as that near the bridge of Changkat Road would mean that the organic runoff is high, thus promoting bacterial growth. Likewise, the reading is the lowest at the Shell Petrol Station along Semenyih Road, as the chemical runoff, i.e., oil in particular would effectively impact on how soluble oxygen is in the river water, reducing the initial dissolved oxygen in the water. This in turn would negatively affect the bacterial growth rate, and thus, the total amount of BOD.

3.2. Relationship between water pH and BOD value

It is known that certain bacteria has specific optimal pH, which the bacteria can survive. The optimal pH is usually around the neutral pH range. Most bacteria do not function well at acidic or basic pH ranges. In view of this, the rate of bacteria activity is dependent on the water pH [17]. In a certain pH region, the activity of the bacteria is maximum. Thus, the pH will have some influence on the rate of BOD.

In light of this, the scatter diagram of the average water pH and the BOD values are shown in Figure 2. It shows that there is a negative relationship between water pH and BOD value, i.e., as pH of the river water increases, BOD of the water decreases. To further investigate the relationship between these two variables, calculation of the Pearson correlation coefficient gives a value of -0.67988, i.e. moderately negative correlation between these two variables. This indicates that as water pH increases, the bacteria cannot thrive in the said environment. The lack of bacteria will in turn lower overall BOD, as BOD depends on the bacterial growth. Kumar Panda et al. [18] conducted a study in River Salandi, Bhadrak, Odisha, India. From the findings, the correlation coefficient between pH and BOD as -0.05533, which is also negative correlation between pH and BOD.

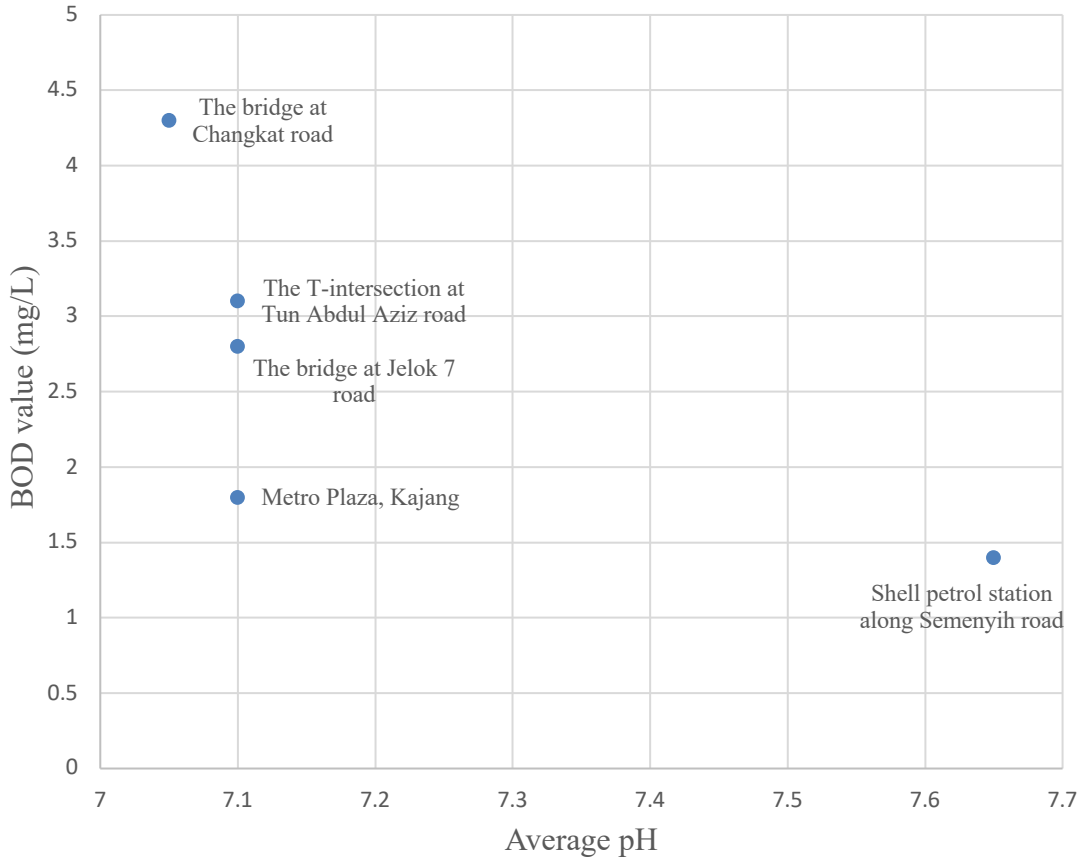

Figure 2. Scatter diagram of the average water pH and BOD.

4. Conclusion

The aim of this research is to study the performance of water along Jelok River, based on water pH and BOD levels. The results show that the correlation between these two variables is moderate negative linear correlation, indicating that when the water pH is increased, the BOD value is decreased. The increasing water pH is negatively affect the bacterial growth, which will reduce the BOD level. In addition, pH is quite stable along the river, while BOD values fluctuate wildly based on location. From the BOD value, the polluted water is found along the bridge of Changkat Road, the T-intersection of the Abdul Aziz Road and the bridge of Jelok 7 Road, with the bridge of Changkat Road

appeared to have more pollutant in water. The findings from this research provides substantial evidence that the water quality along Jelok River needs immediate attention. Thus, this should raise an awareness to the public and authority to take action to preserve the water performance along this river. This research can be further improved by monitoring the water pH and BOD values along Jelok River throughout a certain time frame.

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