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Water Quality Study at the Downstream of Gunung Belumut

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Abstract: Sungai Dengar is located at the downstream of Gunung Belumut. The surrounding at the downstream was mainly used for agriculture purpose. A study was taken at this river to analysis the water quality of the downstream that is located at Sungai Dengar, based on the parameter of water quality which are DO, BOD, COD, pH, TSS and AN, in order to classify the river water based on WOI-DOE. The objective of this study is to determine the water quality at the downstream of Gunung Belumut and to identify the relationship of the downstream of Gunung Belumut with its surrounding land use. There was 3 sampling station of different location that have been selected to obtain the water sample along Sungai Dengar. In order to control variables that might affect the result, all the parameters was analyzed in laboratory which produce the average from three stations are, value of DO is 7.91, BOD is 4.82, COD is 28.31, pH is 6.92, TSS is 115.3 and AN is 1.72. In that case, that the water has been classified as class II where it is in a clean condition. The surrounding land used is a major factor that influencing the current water quality at the downstream of Gunung Belumut. By completing this study, the current water quality at the downstream of Gunung Belumut has been analyzed and all the precautions can be taken, in order to prevent the river from continuously being polluted in the future.

Keywords: Sungai Dengar, Water Quality, Surrounding Land

1. Introduction

Water is undeniably one of the most important element or resources which covers more than 70% of surface on the earth. Even though it looks like a lot of them, but in reality, only 1% from them which can be found at lakes, river, reservoirs and underground sources, can be used by humans, and the other 99% of the water is either too salty for human consumption or frozen at the north and south pole [1]. Water is essential to all including animal, plants, and human who are mostly filled up with water. Many more areas expected to experience water shortage in the near future as the water demand already exceeds supply [2]. Throughout the history, the total number of water that are available for human

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development and welfare remains the same, the only difference is that the quality of the water is getting much more worse and distributed differently [2].Rivers and streams are very important element to all the living things on earth. There are few of the functions and beneficial uses of river such as agriculture. Modern agriculture in some area is still depend on natural rivers. As the demand for food increases, the need for agriculture also increases. In that case, more and more water are needed. In Asian countries such as China which is the largest rice producer in the world uses 82% of its countries water source in agriculture [3]. Other than that, river is a key component in recreational activities. Activities such as rafting, boating, kayaking, located at rivers, streams and some other sources of natural water. However, clean water is required to ensure the safety of humans involving in these type of activities [1]. The major focus of this study was to assess the water quality at the downstream of Gunung Belumut and to investigate the relation between water quality at the downstream of Gunung Belumut and the surrounding land, which is agricultural area. Large amounts of agrochemicals, organic waste, drug residues, sediments, and salty drainage are discharged into water bodies by farms. [4]. The objective of this study is to determine the water quality at the downstream of Gunung Belumut and to identify the relationship of the downstream of Gunung Belumut with its surrounding land use. Dissolved oxygen (DO), Biological oxygen demand (BOD), Chemical oxygen demand (COD), pH, Total suspended solid (TSS), and Ammonia Nitrogen (AN) will be used in this study to classify the water quality using the Water Quality Index (WQI).

2. Source of Water Pollution

In this study, the location of the downstream of Gunung Belumut is located at Sungai Dengar. The surrounding land at the downstream of Gunung Belumut, is mainly used for agriculture purpose. A big part of the downstream flows through the agricultural land. There are several sources of water pollution such as, nutrient enrichment and acid rain. Animal farming, urban and agriculture runoff, industrial waste, and sewage effluents are the major anthropogenic source causing freshwater nutrient enrichment. As a result, concentration of nutrients such as nitrogen, phosphorus has increase significantly and the abundance of primary producers such as phytoplankton, benthic algae, macrophytes have occurred in many freshwater system [5]. Based on a study which is located at Sungai Sembrong where this river is connected to Sungai Dengar, agricultural' use of pesticides and fertilizers adds an excessive amount of nutrients to water and sediment According to a study, nutrient enrichment and productivity increase cause imbalances such as disturbances in photosynthesis and respiration, which result in chemical and biological alterations, resulting in pollution. This will enhance the growth of plants in water systems, as well as the need for oxygen [6]. The nutrient content in ordinary water flow is most likely from household wastewater, while in high water flow, the nutrient concentration is far more diluted. Nitrates are regarded better indicators in ordinary water flow due to their comparatively strong solubility and non-reactive nature, while phosphate is strongly connected in the surface soil layers and to sediment and therefore detected in higher concentration during high water flow [6].

Acid rain is a phrase used to describe a variety of methods in which acid is released into the atmosphere, including rain, fog, hail, and snow. The issue with acid rain is commonly assumed to be the washout of sulfur, nitrogen, and other elements presence in any environment. The primary sources of oxides are fossil power stations, smelters that produce SO_2, and exhaust fumes that produces CO_2. Sulfur dioxide (SO_2), nitrogen oxides, and ozone are the major source of acid rain to a certain extent. [7]. According to a study, the pH value that has been taken at the end of the year where more rainy days occur is lower, compared to the pH value taken around the middle of the year where it is has more dryer days [8]. Although there are obviously pollutant that originate from human activities that engage with chemical components in the environment and end up causing acid deposition, such as the emission of combustible wastes, biofuels in thermal power stations, and cars, there are also pollutant that originally come from human activities that contact with reactants in the surrounding, resulting in air pollutants. The effect of acid rain on aquatic ecosystem is also alarming and need serious attention. In Belgium, Denmark, West Germany, and The Netherland, acid lakes have been found, uncovering the fact that all component of aquatic ecosystem are affected by acid rain [7]. Another study shows that, the pH value that has been taken at the end of the year where more rainy days occur is lower, compared to the pH value taken around the middle of the year where it is has more dryer days [8].

3. Materials and Methods

A visual observation has already been taken in order to verify the analysis and the study's objective at the downstream of Gunung Belumut, which is located in Sungai Dengar. The water sample was taken from three different stations along the river, and then each sample container was labelled as soon as the water was collected to prevent confusion. Figure 1 shows the location of the sampling point.

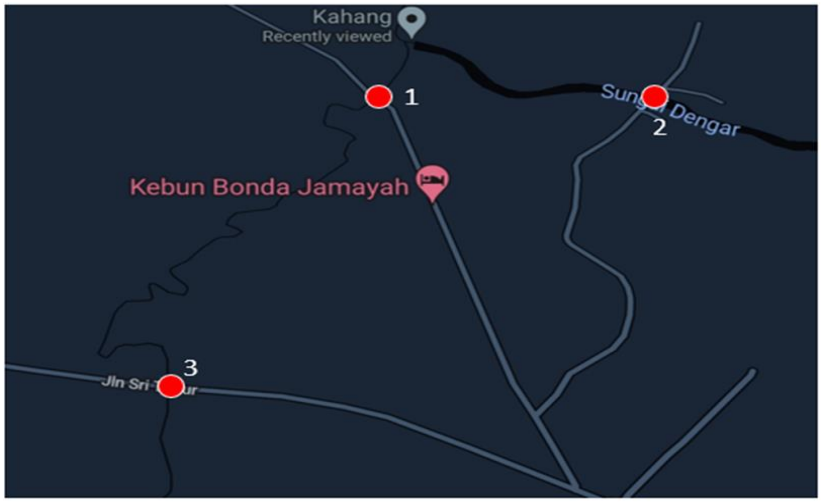

Figure 1: Flow Chart of Study Methodology

2.1 Materials

To complete this study, there are some equipment that have been used to measure the parameters that will be analyzed which is DO, BOD, COD, pH, TSS and AN. The equipment that have been used are as listed below:

- HQ440d multi
- DRB200-HACH
- DR6000- HACH

HQ440d was used in the process to analyze DO, pH, and BOD. DRB200-HACH was used to preheat the vials and DR6000-HACH was used to measure the value of COD and AN.

2.2 Methods

Figure 2 shows the methodology of this study. First and foremost, sampling station was located using Google Earth where it can be observed from figure 1. After the selection of study area where in this case, it contain three sampling location at the downstream of Gunung Belumut which is along Sungai Dengar. Water sample was collected from each location at the center of the stream. During transportation, especially at high ambient temperature, it is very important to cool down the water sample as a physical preservation because, it can cause an increase rate of biochemical processes [9]. In that case, to maintain the temperature, all the bottles of samples that were collected need to be placed inside an ice box. All the parameter was late measured in a laboratory.

Water quality checker which is HQ440d multi was used to measure DO of water sample. Each sample was labeled, and the probe was rinsed before reading each samples. The DO reading of each samples was taken twice, in order to get more accurate result. BOD test was performed using the procedures outlined in APHA Standard Method 5210-B. By filling an airtight 350mL bottle to overflowing with sample and incubating it at 20°C for 5 days is the approach. BOD reduction can be avoided by evaluating the sample as soon as feasible or chilling it to near-freezing temperatures during storage, and it should be reheated to 20 3°C before analysis. The COD test is performed according to APHA 5220- C Standard Methods. In specific vials used for the HACH technique, samples are refluxed in a highly acid solution with a known amount of potassium dichromate (K2Cr2O7), sulfuric acid

(H2SO4), mercuric sulphate (HgSO4), and argentum sulphate (Ag2SO4). The samples are then refluxed for 2 hours at roughly 150°C in a COD reactor before being tested to determine the COD value. pH of the downstream water sample was measured using HQ440d multi while taking the measurement of DO because HQ440d multi is capable of conducting both experiment simultaneously. The pH reading of each samples was taken twice, in order to get more accurate result. The APHA 4500-NH3-BC Standard Method is used to determine the amount of AN. The HACH model DR6000, will produce AN values directly in the unit of mg/L, but the results must be adjusted for the dilution factor. Nessler Reagent, Mineral Stabilizer, and Polyvinyl Alcohol are the three reagents used to determine AN.

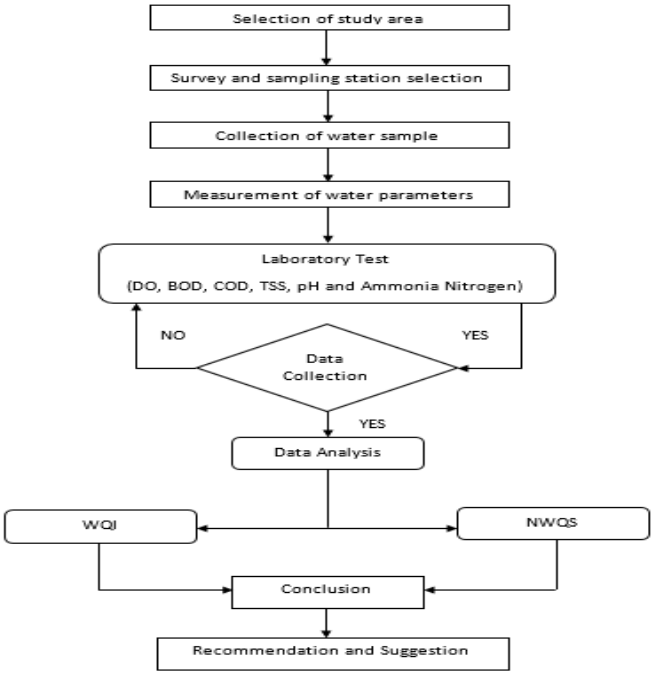

Figure 2: Flow Chart of Study Methodology

2.3 Equations

Eq.1 has been used is to determine the value of Water Quality Index (WQI) from all the sub-index that has been calculated.

$$\text{WQI} = \begin{bmatrix} (0.22\ \text{X SIDO}) + (0.19\ \text{X SIBOD}) + (0.16\ \text{X SICOD}) + \\ (0.15\ \text{X SIAN}) + (0.16\ \text{X SISS}) + (0.12\ \text{X SIpH}) \end{bmatrix} \quad Eq.1$$

Eq.2 has been used to determine the value of SIDO. Eq. 3 has been used to calculate the value of SIBOD for the value of BOD that is more than 5mg/L and Eq.4 was used for the value of BOD that is less than 5mg/L. To determine the SICOD for COD value which is more than 20mg/L, Eq. 5 was used and for the value of COD which is less than 20mg/L, Eq 6 was used.

$$SIDO > 100 \quad Eq.2$$

$$SIBOD = 108e^{(-0.055x)} - 0.1x \quad Eq.3$$

$$SIBOD = 100.4 - 4.23x \quad Eq.4$$

$$SICOD = 103e^{(-0.0157x)} - 0.04x \quad Eq.5$$

$$SICOD = -1.33x + 99.1 \quad Eq.6$$

Eq.7 was used to calculate SIAN for the value of Ammonia Nitrogen between the range of 0.3mg/L to 4mg/L while Eq.8 was used to calculate SISS for the value of Total Suspended Solid

less than 100mg/L. Eq.9 was used to calculate the value the value of SIpH for the range between 5.5 to 7 and Eq 10 for the range of pH between 7 to 8.75.

$$SIAN = 94e^{(-0.573x)} - 5(x-2)\ Eq.7$$

$$SISS = 103e^{(-0.0157x)} - 0.04x\ Eq.8$$

$$SIpH = -242 + 95.5x - 6.67x^2\ Eq.9$$

$$SIpH = -181 + 82.4x - 6.05x^2\ Eq.10$$

All the calculation was done according to the guideline of the General Rating for the Water Quality Index (WQI) [10].

4. Results and Discussion

When the WQI value for a water body is low, it signifies that some factors are affecting the WQI value. As a consequence, it was possible to investigate the specific parameter that caused the WQI value to decrease. [11]. Water quality, on the other hand, is a not a constant characteristic of the liquid. It is very dynamic, changing throughout time in response to environmental and biological factors. [12].

3.1 Results

The water quality subindex parameters are computed using DOE-WQI equations for each parameter. The water quality index value is generated when the subindex parameters are gathered, and each station is classified into its corresponding classes using the DOE-WQI river classification. Table 1 shows the result of water quality subindex parameter that has be calculate.

Table 1: Result of Water Quality Subindex Parameter

Sampling Station	Water Quality Subindex						WQI	Class
	SIDO	SIBOD	SICOD	SIpH	SISS	SIAN		
1	100	79.98	76.72	98.91	97.43	32.61	81.82	II
2	100	79.33	58.94	98.83	97.44	38.27	79.69	II
3	100	82.51	59.05	99.24	97.43	38.53	80.36	II

3.2 Discussions

All the parameters which involved in this study has an influence towards the value of WQI because the surrounding area has affected the result [13]. Figure 3 shows the surrounding of the study area is utilized for agricultural purpose. In this study, dissolved oxygen is classified as class I and the value is high because the surrounding area, where the downstream is located is used for agriculture, in other words, the temperature around the station is low because there is no direct sunlight from the dense plantation The only variables between this three stations, that can influence the value of dissolved oxygen is the temperature of water itself. According to a study, during season with low temperature, reading of dissolved oxygen in water is significantly higher compared to season with high temperature [14]. Aside from that, depending on the flow speed and frequency, the circumstances of flowing water in the streams can also impact BOD readings. Despite the high DO, the BOD is likewise high and polluted in these areas. This is because when these streams run at a slower rate, the currents does not able to transport organic matter, allowing it to settle at the bottom. As a result, the slower current would promote microbial processes on degrading organic material. It's important to note that decomposition can only happen when organic matter settles to the bottom owing to a sluggish stream or stagnant water [11]. According to INWQS, it can be classified class III because the value of BOD at station 1, station 2 and station 3 ranges between 3 and 6. On the other hand the value of COD at station 2 is higher in comparison to station 1 and station 3. However the value of COD at station 2 and station 3 is almost

same. Station 1 can be classified as class IIA where the downstream water require conventional treatment while station 2 and station 3 can be classified as class III where the downstream water requires extensive treatment and can be used for livestock to drink [10].

Water at the downstream of Gunung Belumut from station 1 has the highest pH value followed by station 3 and station 2. Station 1, station 2 and station 3 is located around an agriculture land, and the factors that might have influence the pH value is acid rain. However, the value that has been acquired from laboratory test shows that the all the station, according to INWQS, can be classified as class IIA, where the downstream water just require conventional treatment. Changes in land use, such as transitioning from forest to agricultural land, or substantial disturbances, such as clear cutting, can significantly affect the character of particulate and dissolved material inputs to headwater streams [15]. Station 1 has the highest value of TSS followed by station 3 and station 2. However, it is noticeable that the value of TSS in station 1 and station 3 is almost the same. This is because the sides of the river at station 1 and station 3 is not been hold by plants to prevent from soil erosion towards the river compared to station 2. According to the INWQS, the value of TSS in all station can be classified as class III because it ranges between 50 -150. In this case, the water requires extensive treatment and can be used as livestock drink. In this case, it is highly possible that the content of AN, at each station has been influenced by the surrounding land. It is because the surrounding land of each station around the downstream of Gunung Belumut has been significantly used and utilized for agricultural purpose. The discharge of fertilizers from the agriculture land may be the potential reason of the water condition, at the downstream of Gunung Belumut, has high content of ammonia nitrogen. Based on figure 4.7, station 1 has the highest value of ammonia nitrogen, followed by station 2 and station 3. However, the difference between the value of AN, at station 2 and station 3 is considerably low. This is because water source at station 1 flows between an oil palm plantation, which means that it is the nearest to the source of pollution compared to station 2 and station 3. Based on the analysis of this case, according to INWQS, water at the downstream of Gunung Belumut at each station can be classified as class IV where the water is only acceptable to be used for irrigation only [10].

Figure 3: Location of study area

3.3 Tables

Table 2 shows the result of laboratory testing of all water quality parameters at the downstream of Gunung Belumut which is located at Sungai Dengar The findings of the water quality index, which is required to classify the river, are shown below. Except for pH, all water quality index measures are measured in the unit of mg/L.

Table 2: Result of Water Quality Parameter

Sampling Station	Water Quality Parameters (mg/L)					
	DO	BOD	COD	pH	TSS	AN
1	7.84	5.34	16.83	7.14	122	1.88
2	7.99	4.89	34.10	6.77	104	1.65
3	7.91	4.23	33.99	6.86	120	1.64

3.4 Figures

Figure 4 shows the value of WQI at Station 1, Station 2 and Station 3. The water Quality Index is almost the same at each station, and station 2 has the highest Water Quality Index value. The WQI value is high because land used around the downstream is vastly for agriculture purpose mainly surrounded by Palm Oil Plantations.

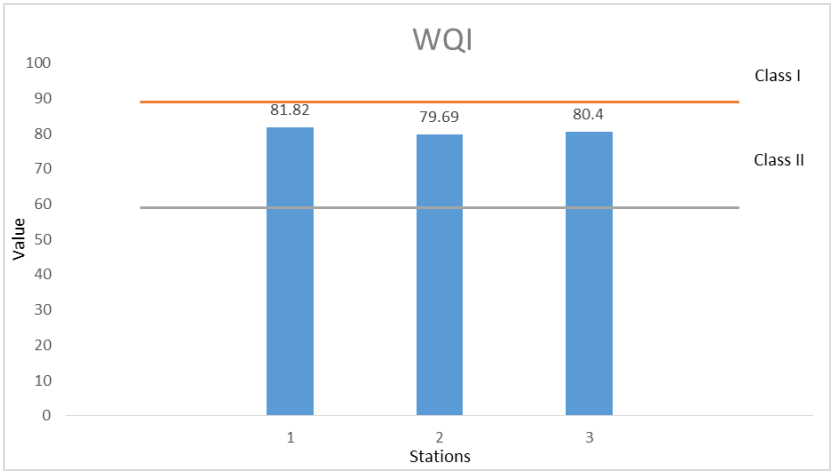

Figure 4: Water Quality Index (WQI) at the downstream of Gunung Belumut

The residential area is not as dense as the residential around urban areas where most water pollution detected. As stated above, according to DOE-WQI, it is clear that water at the downstream of Gunung Belumut, generally can be conclude that the water is clean and classified as class II.

5. Conclusion

The objectives of the study at water quality downstream of Gunung Belumut have been met. The water quality profile may be determined along each point utilising DOE-WQI analysis. The water quality downstream of Gunung Belumut has been discovered to be influenced by surrounding land used. In this case, the surrounding land has been used mainly for agricultural purpose and there is no other major use of land that can be seen as a source of pollution. Based on the WQI value at station 1, station 2 and station 3, the water has been classified as class III, which means all the parameter that influence the value of WQI in these station is responsible towards the outcome. All the parameters has been classified according to INWQS. Dissolved oxygen at each station has been classified as class I, while BOD and TSS has been classified as class III respectively. COD at station 1 falls under class IIA while station 2 and station 3 falls under class III. Ammonia Nitrogen at all three station has been classified as class IV.

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