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A Case Study on Assessment and Rehabilitation of IIUM Pusu River for Water Quality Improvement

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Abstract: Pusu river (or Sungai Pusu/Sg. Pusu) is one of the most severely polluted rivers in Malaysia. Pusu river is a tributary of River Gombak in the Klang River Basin, and the IIUM Gombak campus is located at the downstream part of Pusu river. This study was conducted in response to the recent cloudy river flow on the IIUM Gombak campus. Due to the lack of current data for water quality parameters in Pusu river, it is hard to identify the sources that contributed to the river's pollution. Hence, this study was to determine the sources of river water pollution by analysing the parameters for water quality. The analysis of river water quality showed that the average values of pH, conductivity, TDS, TSS, and turbidity were 7.09, 67.6 µs/cm, 46.5 mg/L, 131.8 mg/L, and 717.6 NTU, respectively. It can be seen that Pusu river has a severe sedimentation issue, as turbidity and TSS showed values beyond the allowable limit according to the National Water Quality Standards for Malaysia. As such, several river methods were suggested to rehabilitate Pusu river, which flows through the IIUM Gombak campus.

Keywords: *Water quality assessment, water treatment, reviver rehabilitation, water turbidity*

1. INTRODUCTION

97% of the water supply in Malaysia comes from rivers, lakes, and groundwater. According to the Department of Environment, 43% of Malaysia's rivers were slightly polluted and 11% were severely polluted in 2017. High concentrations of ammoniac nitrogen and suspended solids degrade the overall water quality index by 26% and 57%, respectively [1]. According to the Malaysia Environment Quality Report for 2017, sewage treatment plants (54%), manufacturing sectors (38%), animal farms (5%), and agro-based industry (3%), accounted for the majority of the 17,991 point-sources of water pollution in 2017.

DOE reported in 2012 that the Klang River Basin has the highest BOD loading (142 tonnes per day), followed by the Perak River Basin (114 tonnes per day), the Sarawak River Basin (30 tonnes per day), the Jawi River Basin (26 tonnes per day), and the Muar River Basin (24 tonnes per day). In addition, the Klang River Basin has the highest levels of suspended solids (360 tonnes per day) and NH3-N (37 tonnes per day). On the contrary, palm oil mill waste was shown to account for the greatest percentage of annual industrial solid waste discharge in Malaysia [2]. Urbanization, industry, agricultural and mining activities have degraded the water quality of Semenyih River, Selangor. Several studies [3-4] found elevated levels of heavy metals such as lead, mercury, and carbon monoxide in the surface water of the Tunggak River. Other studies [5-6] also revealed that bauxite mining in the region

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surrounding Kuantan has moderately polluted the Kuantan.

River Basin in recent years, as opposed to urbanisation and industrialization. In the Klang River Basin, Pusu river is a tributary of river Gombak and located at the upstream of river Gombak. The river flows through the International Islamic University of Malaysia (IIUM), Gombak campus, that located at the downstream part of river Pusu. Pusu river is one of Malaysia's most highly polluted rivers.

This study focuses on the assessment and rehabilitation of a river in Pusu river, Gombak, Malaysia, in an effort to improve its water quality. This study is also a part of a comprehensive effort, as the parameter data will be utilised to propose certain river rehabilitation techniques. River Pusu is chosen for the pilot scale of this project because to its size, location, and suitability for catchment activities, which encompass rural, urban, and forest settings.

2. MATERIALS AND METHODS

The river water samples were collected from river Pusu tributaries around the IIUM Gombak campus. The water samples were collected from five different stations. The stations are listed as Station 1 through Station 5, respectively, as shown in **Table 1**.

Table 1: List of stations

Stations	SamplingCode	Location
S1	S1BS	At the back of Mahallah Maryam
S1	S1BU	
S2	S2BS, S2AS	In between Mahallah Maryam and Female Sports Complex (FSC)
S2	S2BU, S2AU	
S3	S3BS, S3AS	Beside Female Sports Complex (FSC)
S3	S3BU, S3AU	
S4	S4BS, S4AS	In between Human Science (HS) and Education Department

The water sampling was carried out on November 2020 during rainy season (RS). Two water samples were collected from each station; one on the surface of the water and the other one is underwater with the depth less than 2 ft as the water depth of the river was very shallow.

There are variety of parameters to measure the water quality. In reality, physical, chemical, and biological parameters influence quality parameters. Physical parameters consist of turbidity, temperature, color, taste, odour, suspended solids, dissolved solids, and conductivity. Chemical parameters consist of pH, acidity, alkalinity, salts, heavy metals, hardness, dissolved oxygen (DO), biological oxygen demand (BOD), and chemical oxygen demand (COD). Biological water quality parameters are measurements of the presence of living organisms such bacteria, algae, viruses, and protozoa [7].

Total dissolved solids (TDS), conductivity and salinity were measured using HACH Sension 5 conductivity meter. The samples were tested within 48 hours after collection. The values obtained were recorded in table and plotted in graph. pH was measured using pH meter. The samples were tested within 48 hours after collection. The values obtained were recorded in table and plotted in graph. Turbidity was measured using portable turbidity meter. The samples were tested within 48 hours after collection. The values obtained were recorded in table and plotted in graph. Total suspended solids (TSS) are the number of filterable solids dried at 103– 105°C using oven. Then, the filters were weighed to determine the amount of TSS in mg/l of sample.

3. RESULTS AND DISCUSSION

3.1. Study area

Pusu river flows into Sg. Gombak inside the Klang River Basin. Before reaching Sg. Gombak, the river flows from the highland forest through Kampung river Pusu and the International Islamic University Malaysia (IIUM) campus in the downstream section. The approximate overall catchment area of Pusu river (on the IIUM Gombak campus) is 12.6 km^2 [4]. The overall length of Sg. Pusu covered by this project on the IIUM Gombak campus is anticipated to secondary forest slopes. The central half of the watershed, however, is undergoing extensive land removal. The section of Pusu river downstream is narrow and shallow. Sg. Pusu meets Sg. Gombak at about 2.1 kilometres downstream from the campus border.

The catchment regions were chosen in accordance with the positions of the aeration system throughout the river on the be 1.60 kilometres. The upper catchment consists of steep IIUM campus, which begins at the construction site in the rear of Mahallah Maryam and extends downstream. **Table 2** shows the descriptions contain exact locations, the sources, and the number of drains leading to the stations before and after. The total length of the river covered in this project is estimated to be 1.6 km.

Table 2: Description for each selected station

Stations	Locations	Sources	Drains
S1	At the back of Mahallah Maryam	• Construction sites • Mahallah Salahuddin	3
S2 [0.51 km from S1]	In between Mahallah Maryam and Female Sports Complex (FSC)	• Mahallah Maryam • Mahallah Halimatussa'diah • Mahallah Asma' • Female Sports Complex (FSC)	12
S3 [1.02 km from S1	Beside Female Sports Complex (FSC)	• Female Sports Complex (FSC) • Mahallah Hafsa	2
S4 [1.12 km from S1	In between Human Science (HS) and Education Department	• Kuliyyah of Human Science (HS) • Kuliyyah of Education (KOED) • HS Cafeteria • KOED Cafeteria • Student Mall • Bank Area • Cultural Activity Centre (CAC) • Rectory Building	21
S5 [1.6 km from S!	In between Main Auditorium and Cultural Activity Centre (CAC)	• Main Auditorium	1

3.2. Point source pollution

The point-sources of the catchment area were identified. Wastewater from sewage treatment plants and sullage from the campus were determined to be the main point-sources. The measurement of pollution loading from these five point-sources was done during the rainy season.

Each station's river water quality was compared to the Malaysian Department of Environment's (DOE) prescribed water quality standards. This report presents the data from these five locations to provide a basic picture of the situation. It is reasonable to assume that these five stations adequately represent the overall condition. Thus, the data from these stations will represent the entire spectrum of effluent water quality in Pusu river on the IIUM campus.

In this investigation, the following water quality parameters were measured: pH, turbidity, conductivity, total dissolved solids (TDS), and total suspended solids (TSS) (TSS). During the investigation of water quality, salinity is also assessed; however, all stations indicated negligible values, which means the values are too small. The majority of the characteristics in **Table 3** indicates that Pusu river is still classified as Class I, with the exception of turbidity and total suspended solids (TSS), which reflect Classes IIB and III, respectively [8].

Table 3: Overall point source pollutants

Stations	**S1**		**S2**			**S3**			**S4**			**S5**		
Code	**S1 BS**	**S1 BU**	**S2 BS**	**S2 BU**	**S2 AS**	**S3 BS**	**S3 BU**	**S3 AS**	**S4 BS**	**S4 BU**	**S4 AS**	**S5 BS**	**S5 BU**	**S5 AS**
pH	6.04	5.95	7.28	7.28	7.45	6.97	6.97	7.10	7.02	7.34	7.02	7.42	7.30	7.40
TDS (mg/L)	51.4	37.6	43.3	43.3	35.0	42.5	42.5	42.7	38.4	38.4	51.6	38.3	36.4	37.1
TSS (mg/L)	116.8	122.4	116.5	116.5	116.5	116.8	116.8	117.5	117.8	117.0	115.4	116.4	117.6	116.7
Turbidity (NTU)	1390	1100	513	513	582	655	655	675	292	270	935	401	455	477
Conductivity, µs/cm	78.3	57.0	66.5	66.5	56.4	64.1	64.1	64.5	41.1	36.0	75.0	56.8	54.1	55.0

BU (Before Under) = Samples are taken below the surface with depth > 2 ft before aeration system; **BS** (Before Surface) = Samples are taken at the surface with depth = 0 ft before aeration system; **AS** (After Surface) = Samples are taken at the surface with depth = 0 ft after aeration

There are variety of parameters to measure the water quality. In reality, physical, chemical, and biological parameters influence quality parameters. Physical parameters consist of turbidity, temperature, color, taste, odour, suspended solids, dissolved solids, and conductivity. Chemical parameters consist of pH, acidity, alkalinity, salts, heavy metals, hardness, dissolved oxygen (DO), biological oxygen demand (BOD), and chemical oxygen demand (COD). Biological water quality parameters are measurements of the presence of living organisms such bacteria, algae, viruses, and protozoa[5] (Hassan Omer, 2020).

Total dissolved solids (TDS), conductivity and salinity were measured using HACH Sension 5 conductivity meter. The samples were tested within 48 hours after collection. The values obtained were recorded in table and plotted in graph. pH was measured using pH meter. The samples were tested within 48 hours after collection. The values obtained were recorded in table and plotted in graph. Turbidity was measured using portable turbidity meter. The samples were tested within 48 hours after collection. The values obtained were recorded in table and plotted in graph. Total suspended solids (TSS) are the number of filterable solids dried at 103– 105°C using oven. Then, the filters were weighed to determine the amount of TSS in mg/l of sample.

3.3. Total Suspended Solids (TSS)

In this investigation, the total suspended solids (TSS) values of river water samples ranged from a low of 115.4 mg/L at S4 for surface water after the aeration system to a maximum of 122.4 mg/L for under water. As seen in **Figure 1**, there were no statistically significant differences in TSS between the stations, as the values were nearly identical. The threshold level for TSS in rivers in Malaysia that support aquatic life is 150 mg/L. The average value for all sites is 131.8 mg/L, classifying the TSS values in this study as Class III. In this study, the primary source of pollution (S1) was located upstream, where residential and highway construction was taking place. Therefore, TSS had a somewhat greater value than other stations. Variations in the river's draining sources resulted in a small fluctuation in the TSS content.

3.4. Turbidity

In this study, the average value for all stations is 717.6 NTU, which exceeds the Class IIB standard. According to the Department of Energy, Class IIB water requires considerable treatment as excessive turbidity implies a low intensity of light scattered to the river and causes a lower oxygen concentration to permeate, hence reducing the photosynthetic activity of aquatic species.

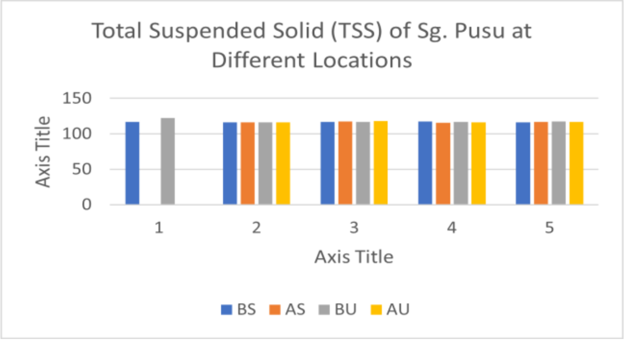

Fig.1. TSS variation of Sg. Pusu at five different stations

Figure 2 demonstrates that the turbidity values for S1 ranged between 1110 NTU and 1390 NTU. S2 turbidity findings ranged from 422 NTU to 582 NTU, but S3 turbidity levels varied slightly between 655 NTU and 675 NTU. In S4, the turbidity readings were extremely variable, ranging from 292 NTU to 1035 NTU. Last but not least, S5 displayed turbidity readings ranging from 401 to 477 NTU. In contrast to other stations, S4 has the greatest number of drains entering the river, as seen by its relatively large range. Meanwhile, S1 has the greatest turbidity rating, indicating that development activities in the upstream areas of Pusu river have impacted water quality [9].

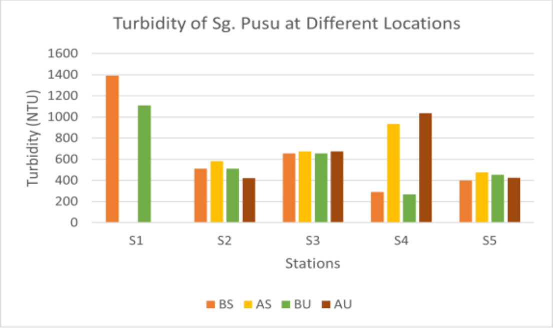

Fig.2. Turbidity variation of Sg. Pusu at five different stations

4. SUGGESTIONS FOR REHABILITATION OF SG. PUSU

The university administration must take immediate measures to address the sedimentation issue that has caused the river flow to decrease. It is necessary to remove the sediments from the lakes and ponds in order to restore the storage capacity of the facilities, which will help to reduce the peak flow in the rivers that flow through the IIUM campus. However, the lakes are rapidly polluted following heavy rainfall if the development works in the upstream section lack the sediment traps mandated by the Malaysian government.

Clearly, the TSS concentrations in the effluent from the drains exceeded the norms and necessitated considerable water treatment. Simultaneously, turbidity was influenced, and in several sites, readings were also elevated. In order to attain Class I or Class II water quality in rivers, it is necessary to lower the TSS and turbidity concentrations in river water from point-sources. In this part, therefore, methods for reducing the contaminants in drain effluent are briefly reviewed.

5. CONCLUSIONS

According to the acquired results, the pollution of the Pusu river originated from multiple point-sources on the IIUM Gombak campus. The average values for pH, conductivity, TDS, TSS, and turbidity were 7.09, 67.6 s/cm, 46.5 mg/L, 131.8 mg/L, and 717.6 NTU, respectively, according to the river water quality analysis. According to the Malaysian National Water Quality Standards, Pusu river has a serious sedimentation problem as both turbidity and TSS levels above the permissible limit. Therefore, this study was undertaken for river Pusu's rehabilitation, and it was determined that constructing a steady channel was the best way for his rehabilitation. In future investigations, it is suggested that other factors be used to establish the Pusu river's water quality. In fact, a model of water quality may be created to monitor the river water quality in river Pusu. In order to ameliorate river Pusu's condition, thus, more advanced technologies or techniques can be considered.

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