Water Quality Assessment – River Trail Project of Asasi, UiTM Dengkil

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Abstract Environmental sustainability is one of the important agendas in the development of the community and the country. In supporting the Sustainable Development Goals (SDGs) initiatives, the pilot project consists of environmental appreciation development activities involving the students and academicians that have been organized in the river tributary beside Pusat Asasi, UiTM Dengkil. The preliminary project consists of a water quality assessment for the river. The parameters of biochemical oxygen demand (BOD), chemical oxygen demand (COD), pH, temperature, and ammonia-nitrogen have been determined to evaluate the water quality index (WQI) of the river and wastewater treatment plant of Pusat Asasi, UiTM Dengkil. From the results obtained, the river downstream has been classified in Class III (extensive treatment required) as the WQI calculated is 52.49%. Therefore, rehabilitation works need to be considered to improve the water quality in the river. Moreover, extensive wastewater treatment is required to enhance the quality of the effluent discharge into the river. The outcome of this project is educating the students of Science, Technology, Engineering and Mathematics - STEM based on living lab concepts of sustainable management in environmental engineering. Furthermore, the students can be disclosed on SDGs 6 to achieve clean water and sanitation for all.

1. Introduction
Environmental management is one of the important agendas in the Sustainable Development Goals. The top priority in developing countries is to have sustainable technology for the long-term preservation of environmental issues. Under the United Nations, the SDGs are very significant; key elements on these goals need to be followed to safeguard the surrounding environment [15]. The seventeen (17) SDG goals need to have three important criteria: social balance, economic and environmental sustainability for long-term development.

Thus, to ensure the SDG initiatives' succession, environmental education needs to be vigorously introduced to the group of people consisting of students and the surrounding community. The importance of environmental education is essential to create awareness among the target groups. Then, single out the root cause of the problem will lead to the succession of best practices on environmental handling for
long-term sustainable management. Tackling this issue will further help support the decision-makers and stakeholders in implementing the environmental policy and law-making on this matter. Moreover, the appreciation of environmental awareness should be a core subject that needs to be implemented for the younger generation as too many environmental pollution issues arise nowadays. Therefore, it is essential to cultivate a positive attitude to the youngsters on the awareness and caring for the environmental surroundings.

The river trail project is very significant in the river quality and rehabilitation programme [17]. Therefore, this project seems vital and a wake-up call for the population to be caring for the environment. This research introduces a river water system comprising environmental pollution for lifelong learning and adaptation of citizen scientists among the Science, Technology, Engineering and Mathematics – STEM students. Thus, the river and effluent characteristics of the wastewater treatment plant in Pusat Asasi, UiTM Dengkil are evaluated in the research study. The SDG Goal 4, which is quality education by exposing the students to practical or on-site learning, will be achieved by implementing this investigation analysis. Hence, the environmental appreciation in introducing the best practices of Science, Technology, Engineering and Mathematics – STEM to achieve SDG Goals 6 (clean water and sanitation) will also be adopted and learned.

2. Materials and Methods

2.1 Location study
The case study focused on the targeted area of sampling in the wastewater treatment plant (WWTP) (2.866877, 101.667411) of UiTM Kampus Dengkil and Langat's tributary beside the UiTM campus (2.872174, 101.667950). This small river tributary flows to the mainstream of the Langat River catchment. This site is the upper stream of Langat River intake for Water Treatment Plant Bukit Tampoi, approximately ten (10) km from the UiTM Kampus Dengkil.

The water treatment plant Bukit Tampoi serves the clean water to the area of Putrajaya, Hulu Langat, Kuala Langat, Sepang and Petaling [19]. The wastewater treatment plant in UiTM Kampus Dengkil has processed the sewerage water from the residential college of Dahlia and Tualang, Anjung Dengkil, and all academic buildings in UiTM Dengkil [4]. The area of sampling is shown in Figure 1.

The water samples were collected in February 2021 from the upstream of the river beside UiTM Dengkil, effluent from the WWTP and downstream of the river near UiTM Dengkil (see Figure 2 until Figure 4). These three samples were analyzed using Standard Methods [18], and the assessment of water quality is made according to the Water Quality Index (WQI) from the Department of Environment (DOE) Malaysia [16]. Effluent samples from WWTP and the river water are stored in a bottle and kept cool in the refrigerator before being tested [18]. The testing was done in situ and in the laboratory. For laboratory testing, an experiment was conducted in the Environmental Laboratory in the School of Civil Engineering, College of Engineering, UiTM, Shah Alam, Selangor.

2.2 In-situ parameter
The in-situ testing was done on-site using HORIBA portable instruments [1]. These include physical parameters such as dissolved oxygen (DO), pH and temperature [18].

2.3 Sample laboratory testing
Laboratory assessments have been done in triplicate, and the average values are obtained for ammoniacal-nitrogen (NH₃-N), biochemical oxygen demand (BOD), chemical oxygen demand (COD) and total suspended solids (TSS) parameters using HACH spectrophotometer [18]. In addition, the microbiology testing of E-Coli is done using the Lovibond E-Coli test apparatus to measure the existence of E-coli bacteria in the samples [3].
2.4 Water Quality Index (WQI) Analysis
The results were then used to calculate various sub-index values to determine water quality classification on each sub-index [16]. Furthermore, the sample water quality status was decided based on the Interim National Water Quality Standards for Malaysia (INWQS), categorized from Class I until Class V [16].

Figure 1. Location of intake water samplings (yellow highlight).

Figure 2. Upper stream of the river beside UiTM Dengkil.

Figure 3. Downstream of the river beside UiTM Dengkil.
Figure 4. Wastewater Treatment Plant UiTM Dengkil.

3. Result and Discussion

3.1 Water Quality Parameters

Water quality parameters were identified in the three locations: the wastewater effluent and the upper and downstream river samples. The parameters need to be evaluated to assess the quality of the water samples. Table 1 shows the water quality parameters for the three locations, whereas Table 2 and 3 show the results of water samples according to [16]. The results of parameters were taken, both in-situ and laboratory tests.

3.1.1 pH. The pH values in wastewater effluent and river samples showed different values, which higher values of 7.0 was obtained at wastewater effluent, whereas the lower pH values of 5.95 are obtained upstream of the river. For downstream of the river, the pH value was 6.11. The pH in the range of 6.5 to 9 is mainly appropriate for aquatic life [5]. The downstream and wastewater effluent result was within the standard range and was classified under Class I and Class II, respectively, based on National Water Quality Standards (NWQS) for Malaysian rivers [8]. However, the pH result for the upstream sample showed that the water is in acidic condition, classified under Class III based on NWQS [8]. According to [7], pH is important as it generally signifies the degree of acidity or alkalinity of a water sample. Therefore, the identification of pH in water is needed to maintain the aquatic ecosystem of the river as unsuitable pH can disturb the living condition of the natural ecosystem [8,14].

3.1.2 Dissolved Oxygen. The water samples for dissolved oxygen (DO) were analyzed as 9.37 mg/L for wastewater effluent, 9.71 mg/L for the upstream of the river sample, and 8.63 mg/L downstream. The DO for all conditions was similar and categorized as Class I based on NWQS [8]. These results were within the standard acceptable levels of NWQS for the Malaysian river, which is more than seven (7) mg/L [8]. According to Karpinska and Kotowska [9], DO is very important to aquatic organisms for the respiration and degradation of organic matter in the water. Therefore, the DO analyzed the amount of oxygen gaseous (O₂) dissolved in an aqueous solution. Oxygen is dissolved into the water by diffusion from the surrounding air, by aeration (rapid movement), and photosynthesis's byproduct [18]. However, it is important to maintain the total dissolved solids of gaseous below 13 to 14 mg/L and should not exceed 110%. If the situation persists and surpassing more than the level stated, this can harm aquatic life. Thus, it is necessary to have an adequate amount of dissolved oxygen in the water for a sustainable environment [11].
3.1.3 Ammonia-nitrogen. The ammonia-nitrogen (NH₃-N) concentrations of water samples were 4.5 mg/L for the upstream river sample and 5.5 mg/L downstream of the river. However, the NH₃-N level was not detected in the wastewater effluent. The maximum threshold level of NH₃-N for Malaysian rivers is limited to 0.9 mg/L, based on the NWQS [8]. The intensity of NH₃-N, which is higher than this level of concentration, is classified as Class V and will reduce the mortality of aquatic life. On the other hand, excessive concentrations of NH₃-N can serve as nutrients for algae growth and lead to eutrophication. Moreover, the high NH₃-N values can be toxic to a living organism and decrease the performance of biological treatment systems [21].

3.1.4 Biochemical Oxygen Demand. These three locations' biochemical oxygen demand (BOD) was two (2) mg/L in the wastewater effluent, 12.04 mg/L in the upstream, and 5.33 mg/L in the downstream river. The BOD value of an upper stream of the river is categorized as Class V and can be considered high compared to other water quality studies [10]. However, the downstream of the river is classified in Class III as the water coming from the effluent of WWTP UiTM Dengkil. Here, it can be observed that the BOD level of wastewater effluent was better and classified in Class II and within the acceptable limit. According to Bora and Goswami [7], the higher values of BOD showed the presence of major organic pollutants near the sampling sites. In addition, the natural decaying process of the plant, fertilizer, and inefficient septic system contributed to the increased of total nutrients in the water. Thus, it caused the rise of BOD concentration above the allowable limits [20].

3.1.5 Chemical Oxygen Demand. The chemical oxygen demand (COD) concentrations were high for the wastewater effluent and upstream river samples. The COD level in the upstream river was 66 mg/L. The standard allowable limit of NWQS, which is 50 mg/L or less and classified as Class III. The COD level of the upstream river is higher than 50 mg/L and is classified as Class IV [8]. However, it contrasted with COD concentration wastewater effluent and downstream of the river, which was within the allowable limit at six (6) mg/L and 15 mg/L, respectively, classified as Class I. According to Waziri and Ogugbuaja [13], the lower concentration of COD indicates a low level of pollution, while the high intensity of COD signifies the excessive level of pollution in water bodies. It is supported by Eisakhani and Malakahmad [12], which indicated that high COD levels in the water would reduce its quality. It is crucial to identify the COD concentration as it is one of the most significant indicators to verify the efficiency of wastewater treatment facilities, affecting the quality of the effluent [6].

3.1.6 Total Suspended Solids. The values of total suspended solids (TSS) for wastewater effluent were four (4) mg/L, ten (10) mg/L for the upper stream's river sample and five (5) mg/L for the downstream river sample. Based on the NWQS, the maximum standard limit of TSS for Malaysian rivers is 150 mg/L [8]. However, the TSS values in this study were lower than this limit and were categorized as Class I. Thus, these TSS values for the study area are acceptable.

3.2 Water Quality Index (WQI)
The water quality index (WQI) based on National Water Quality Standards (NWQS) for Malaysian rivers is calculated based on six parameters which are pH, BOD, COD, suspended solids, dissolved oxygen and ammoniacal nitrogen [8]. From the results obtained, WQI was found for the effluent of wastewater treatment plant of 62.97%, the upstream river (41.84%) and 52.49% downstream of the river. The WQI for the upstream were classified as Class IV based on [8], which indicated as polluted. However, WQI for the wastewater effluent and downstream were classified as Class III. There is no significant contribution for the samples taken in the upper stream of the river with the effluent from the WWTP. However, the downstream has improved as effluent from WWTP is treated before being discharged to the water bodies.
The results have been obtained and shared with the pre-university student, Science, Technology, Engineering and Mathematics – STEM. From the evaluation of this research study, the introduction to the sustainable development of engineering practices of WWTP can promote the early concept of engineering education among this student. Moreover, from the practical approach and the results attained for the water quality assessment of this river, the awareness in preserving the water quality can further be improved for the target group.

The mitigation measures for enhancing water quality need to be implemented, and the reduction of pollution in the river should be addressed. Exposing the pre-university student to this extracurricular learning will intrigue their interest in the subject, mainly Science, Technology, Engineering and Mathematics – STEM. This research study can be a practical approach on-site using the living lab concept consisting of bridging the knowledge on water quality assessment regarding the pollution issues scenario nowadays.

### Table 1. Water Quality Parameters.

| Parameters                        | River (upstream) | Wastewater Effluent | River (downstream) |
|-----------------------------------|------------------|---------------------|--------------------|
| pH                                | 5.95             | 7.0                 | 6.11               |
| Dissolved Oxygen (DO)             | 9.71             | 9.37                | 8.63               |
| Ammoniacal-nitrogen (NH₃)         | 4.5              | Not detected (<1.00)| 5.5                |
| Biochemical Oxygen Demand (BOD)   | 12.04            | 2                   | 5.33               |
| Chemical Oxygen Demand (COD)      | 66               | 6                   | 15                 |
| Suspended Solid (SS)              | 10               | 4                   | 5                  |

### Table 2. Results of water sample for Pusat Asasi, UiTM Dengkil according to National Water Quality Standards for Malaysia.

| PARAMETER                    | UNIT     | CLASS | River (upstream) | The effluent of Wastewater Treatment Plant | River (downstream) |
|-----------------------------|----------|-------|------------------|------------------------------------------|-------------------|
| Ammoniacal Nitrogen         | mg/l     | V     | I                |                                          | V                 |
| Biochemical Oxygen Demand   | mg/l     | V     | II               | III                                      |                   |
| Chemical Oxygen Demand      | mg/l     | IV    | I                | I                                        |                   |
| Dissolved Oxygen            | mg/l     | I     | I                | I                                        |                   |
| pH                          |          | III   | II               | I                                        |                   |
| Total Dissolved Solids      | mg/l     | I     | I                | I                                        |                   |
| Total Suspended Solid       | mg/l     | I     | I                | I                                        |                   |
| E-coli                      | Count/100ml| Detected | Not Detected | Detected                                 |                   |
Table 3. Water Class for Water Quality Index (WQI).

| Parameter               | Unit | Water Classes |
|-------------------------|------|---------------|
|                         |      | River (upstream) | The effluent of Water Treatment Plant | River (downstream) |
| Water Quality Index (WQI) | -    | Class IV         | Class III                 | Class III         |

4. Conclusion
The quality of the water samples taken for this study varies based on the locations, which are wastewater effluent of the WWTP and the upper and lower stream beside Pusat Asasi, UiTM Dengkil. However, it can be deduced that the wastewater effluent sample for NH$_3$-N, DO, TSS and COD were classified as Class I, while BOD and pH were categorized in Class II, according to the NWQS for Malaysian rivers [8]. It is because these parameters were within the allowable limits of [8]. For the upstream river sample, the results obtained are similar to the wastewater effluent sample. Therefore, it can be denoted that the DO and TSS were classified as Class I. In addition, the pH is classified as Class III, which these parameters were within the allowable limits. However, COD concentration has fallen to Class IV, and for NH$_3$-N and BOD, these parameters have exceeded the allowable levels, which were categorized as Class V. In the downstream of the river, the results are more improved as most of the parameters were in Class I except for ammoniacal nitrogen that is in Class V and the BOD which is in Class III. Thus, several mitigation measures need to be done to improve the quality of the river by reducing the pollutants and increase the efficiency of the wastewater treatment plant before the effluent is released into the water environment.

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