Preliminary Assessment of Teknologi Lake Quality Status at Universiti Tun Hussein Onn Malaysia (UTHM) Campus in Parit Raja, Johor, Malaysia

Muhammad Safwan Miswan¹, Radin Maya Saphira Radin Mohamed¹*, Adel Ali Saeed Al-Gheethi¹ and Amir Hashim Mohd Kassim¹

¹Micro Pollutant Research Centre (MPRC), Department of Water and Environmental Engineering, Faculty of Civil and Environmental Engineering, Universiti Tun Hussein Onn Malaysia, 86400 Parit Raja, Batu Pahat, Johor, Malaysia
*Corresponding author: maya@uthm.edu.my

Abstract. A study was carried out to determine the status of the water quality condition in UTHM campus area located in Teknologi Lake, Batu Pahat, Johor, Malaysia. Sampling was conducted in two different times; the first sampling was in 22 March 2018 and the second sampling in 13 September 2018. A total of ten water quality parameters was selected, analyzed in-situ and ex-situ, and classified based on NWQS Classifications. The status of lakes were determined by using Water Quality Index (WQI). Results for in-situ water quality parameters are: pH contents ranged from 6.42 to 6.61; DO from 9.0 to 9.8 mg/L; temperature from 28.7 to 28.9 °C. Ex-situ water quality parameters are; BOD was ranged from 105.2 to 106.0 mg/L, COD was ranged from 1 to 19 mg/L, TSS was ranged from 19 to 20 mg/L, turbidity was ranged from 12 to 13 NTU, ammoniacal nitrogen from was ranged 3.6 to 4.3 mg/L, nitrite was ranged from 0.13 to 0.11 mg/L and nitrate was ranged from 1.4 to 1.5 mg/L. The observed values for seven parameters in both sampling period of Teknologi Lake were classified as IIA/B. The results of the lake can be used for recreational purposes and suitable for sensitive aquatic species. However, based on WQI calculated value, the status of the lake during the study period was indicated as slightly polluted for Teknologi Lake. Overall, Teknologi Lake was classified as class IV due to agricultural activities and the water suitable for irrigation uses only.

1. Introduction

A lake is one of important water sources in Malaysia. A lake is enclosed body of water (usually freshwater) with considerable size, surrounded by land with no direct access to sea except with a river or stream that feeds or drains the lake [1]. Lake may occur anywhere within a river basin as natural or man-made lakes. Natural lakes consist of wetlands, marshes, estuarine lakes, or naturally occurring lakes whereas man-made lakes can be referred as reservoirs, retention pond, ex-mining pond, recreational lakes [2] or as urban landscape elements. In Malaysia, water quality of a lake can be influenced by external inputs entering the lake from the watershed as well as the inlake ecosystem, nutrients cycling and internal loading. External inputs can be organic and inorganic pollutants as well as nutrients which cause deterioration of water quality from point and non-point sources. Nutrient input from point sources is relatively easy to determine and well characterized because it is...
concentrated and sampling is easy [3]. Meanwhile, input from nonpoint sources is more difficult, but broad ranges of nutrient loss rates from different types of land uses are known [4]. Point sources include discharge from domestic and municipal wastewater, agricultural effluents including applied of fertilizers and industrial wastewaters whereas non-point sources include urban/ storm water runoff, agricultural runoff, septic tank overflow and construction sites runoff [5].

Excessive input of nutrients such as phosphorus and nitrogen into the lakes will lead to eutrophication. Agricultural and urban uses lead to the greatest degree of runoff, with human population density in a watershed demonstrating a significant positive correlation to nitrogen and phosphorus runoff [6]. Eutrophication is the process by which a water body becomes uncontrollably rich and abundance in aquatic plants such as algae and aquatic macrophytes (water weeds) due to plant nutrients enrichment, especially phosphorus and nitrogen as dissolved solutes and as compounds bound to organic and inorganic matters from natural and anthropogenic sources [1]. Huang et al., [1] stated that 56 lakes or 62% of the 90 lakes evaluated were eutrophic while 34 lakes or 38% were mesotrophic. These lakes were assessed based on the Tropic State Index (TSI) values, computed adopting the land use and TP relationships. Therefore, the steps are needed to deal with the deterioration of water quality.

A Teknologi Lake in UTHM campus area located in Parit Raja, Batu Pahat is a man-made lake surrounded by palm oil plantation. The lake flows is connected with Sembong Dam river. Parit Raja always occurs a flood when there are heavy rains. Thus, this lake reacts as a retention pond by slowing down the water flow. Lately, the lake serves the local people as an infrastructure for social activities such as fishing, jogging, fitness training (kayak) and for investigation process. Therefore, the study aims to characterize the pollutant in lake water either suitable for water activities or suitable for others purpose (irrigation).

2. Methodology

Twice sampling period were performed, the first sampling was in March 2018 and the second sampling in September 2018. Different sampling time was taken due to wet season and dry season. The samples were taken using polyethylene bottles, which had been soaked and cleaned before the sampling. After the collection, the samples were immediately placed into ice boxes and proceed for analysis in the laboratory. The water samples were collected on a range of time, from 8.00 to 10.00 am. Three replications of samples were taken randomly. The water quality analysis is divided into two measurements: In-situ measurement and in the lab measurement. Three water quality parameters (temperature, pH, dissolved oxygen) were measure in-situ using Eutech instruments DO 450. Seven other parameters are physico-chemical parameters such as the chemical oxygen demand (COD), biochemical oxygen demand (BOD), total suspended solids (TSS), ammoniacal nitrogen (AN), nitrite (NO2), nitrate (NO3) and turbidity were analysed in the laboratory. All the analyses were performed in accordance with the Standard Methods of Examination of Water and Wastewater [7] and HACH Water Quality Testing and Analytical Instruments procedure. The results were compared to USEPA water quality standards [8] and Interim National Water Quality Standard Malaysia [9]. The water quality index calculation [6] was used for the computation of observed data comprises six water quality parameters.

3. Results and Discussions

3.1. Lake water characteristics.

Lake water characteristics based on the geometry and environmental conditions of lakes is presented in Table 1. The Teknologi Lake which has a total area of 4067.18 m² consists of 343.77 m perimeter of the lake. The water level of lake is 1.136 m. The lake includes three different main land uses such as palm oil plantations, water bodies and industry. The range annual rainfall of the area is about 50 to 350 am and the average wind speed 5.56 m/s to 8.33m/s. According to [8], under water body survey and assessment, it is important to identify the several factors including physical factors that may be
examined to determine whether an aquatic life protection is attainable for a given water body. The physical factors listed including in lake characteristics.

**Table 1:** Geometry and environmental conditions of lake

| Parameter/ Geometry         | Value                          |
|-----------------------------|--------------------------------|
| Area                        | 4067.18 m² (observed data)     |
| Perimeter                   | 343.77 m (observed data)       |
| Water level                 | 1.136 m (observed data)        |
| Wind speed                  | 5.56 m/s to 8.33 m/s           |
| Mean Surface water temperature | 28.8 °C                        |
| Total precipitation         | 50-350 mm (Malaysian Meterological Station) |

3.2. Water Quality Assessment.

Lake water quality characteristics obtained from this study was compared to one of the recent previous studies on lake water [10] as same function with present study as retention lake and the National Water Quality Standards for Malaysia as shown in Table 2.

**Table 2:** Characteristics of Teknologi Lake water in campus area (Minimum, maximum and mean value) sampling was conducted on March 2018 and September 2018 (n=12).

| Parameter      | Present study | Previous study | National Water Quality Standards for Malaysia |
|----------------|---------------|----------------|-----------------------------------------------|
|                | Minimum | Maximum | Mean     | Gasim et al., 2015 | Class I | Class IIA |
| pH             | 6.42    | 6.61    | 6.51±0.095 | 6.9             | 6.5-8.5 | 6-9      |
| DO (mg/L)      | 9.0     | 9.8     | 9.4±0.4  | 3.2             | 7       | 5-7      |
| Temperature (°C) | 28.7   | 28.9    | 28.8±0.1 | 28.4            | 28      | 28       |
| BOD (mg/L)     | 105.2   | 106.0   | 105.7±0.42 | 0.97            | 1       | 3        |
| COD (mg/L)     | 1       | 19      | 10.3±9.02 | 22.17           | 10      | 25       |
| TSS (mg/L)     | 19      | 20      | 19.7±0.58 | 6.75±2.50       | 25      | 50       |
| Turbidity (NTU) | 12     | 13      | 12.3±0.58 | NR              | 5       | 50       |
| Ammoniacal nitrogen (mg/L) | 3.6 | 4.3 | 3.95±0.38 | 2.46±0.32       | 0.1     | 0.3      |
| Nitrite (mg/L) | 0.13    | 0.11    | 0.12±0.01 | 0.19±0.12       | 0.04    | 0.4      |
| Nitrate (mg/L) | 1.4     | 1.5     | 1.36±0.15 | 1.17±0.10       | 7       | 7        |

*All parameters are expressed as mg L⁻¹ except for pH and turbidity (NTU), NR= Not Reported

3.2.1. In-Situ Analysis

Three water quality parameters; pH, DO and temperature were measured in-situ (during sampling) to gain best appropriate result in this study. The range of pH value during the sampling period was 6.42 to 6.61, with a mean of 6.51±0.095. The mean pH value of the Teknologi Lake is indicated as slightly acidic. The low acidity of the lake could also be due to the free carbon dioxide as well as the various acids and alkalis which can penetrate the water bodies that came along with the industrial wastewater. Low pH was probably due to the rainfall and runoffs from the nearby agricultural area (Palm oil plantation) and surrounding areas and attributed to the presence of high organic matter resulting from the discharge of organic matter into the lake. The pH value was ideal when compared to the NWQS and classified as class I. The pH values of the lake in this study are non different compared to the values that have been studied by [10] of Cempaka Lake, Bangi, Selangor, which was 6.9. Next, the range of dissolved oxygen value during the samplings was from 9.0 to 9.8 mg/L, with a mean of 9.4±0.4 mg/L. The DO value was higher during the first sampling period because due to raining. Sharma et al., (2010) reported lower values of dissolved oxygen in summer months due to a higher rate of decomposition of organic matter and limited flow of water in the low oxygen holding.
environment due to the high temperature [11]. Hence, higher temperature in surface water lower its oxygen content. Another factors increases of DO probably due to frequently of raining and occur high natural aeration. The DO values of the lake in present study are higher compared to the DO values at Cempaka Lake which was from 3.76 to 4.94 mg/L. According to NWQS, Teknologi Lake placed under class I. At that moment, The range of temperature values during samplings time was from 28.7 to 28.9 °C, with a mean of 28.8±0.1 °C. This reading may result from the high level of exposure of the sun and heat evaporation after raining. Several factors which are affected by weather variations and may influence the water temperature; sampling time and location were taken considerably. The temperature value was recorded at the Teknologi Lake was classified as normal based on the NWQS and classified as class I.

![Figure 1](image1.png)

**Figure 1.** Observed data of a) pH, b) temperature and c) DO for Teknologi Lake compared to INWQS and USEPA standards.

### 3.2.2. Physico-Chemical Laboratory Analysis

The range of Chemical Oxygen Demand during the sampling period was from 1 to 19 mg/L, with a mean of 10.3±9.02 mg/L. In this study the value of COD take from lake in all samples was low. Increases of the COD level in the waters are due to the increase of organic matter and inorganic chemicals [10] runoff from the restaurant food waste and wastewater from areas around the lake. Based on the NWQS, the level of COD measured in this study in the lake was classified as class I. The COD values in this lake are not different compared to the COD values at Cempaka Lake in Bangi.
which was 14.25 mg/L. After that, The range value of biochemical oxygen demand during the sampling time was from 105.2 to 106.0 mg/L, with a mean of 105.7±0.42 mg/L. It is an empirical test to measure the amount of oxygen used by the microorganisms in the aerobic oxidation, or breakdown of organic matter in the lake, the higher BOD, the more organic matters in the water. According on the NWQS, the BOD value Teknologi Lake was classified as class IV. However, when comparing with a study which was done by [12] at Engineering Lake, UPM, the value of BOD was not much different, 78.33 mg/L. Then, the range of total suspended solids during the sampling time was from 10 to 20 mg/L, with a mean of 19.7±0.58 mg/L. The result of TSS values is high during the sampling, because there was raining and generated a strong rate of soil erosion and contributing more suspended solids in the area of flat land. According to [13], the solids may in fact consist of algal growths and hence be indicate be of severely eutrophic conditions. Based on the NWQS, level of TSS in the study area is classified as class I. However, the result was slightly lower compared to the TSS values at Sembrong Lake [14], which was 54.33 mg/L. At that time, The range of turbidity for the sampling was from 12 to 13 NTU and a mean of 12.3±0.58 NTU. The effect of raining increases the turbidity in water. However, referring to the NWQS it can be classified in class I which is suitable conversation of natural environment, water supply and fishery. Moreover, the comparison values with previous studies by [12] showed that the lakes turbidity still below the previous studies which was 13.86 NTU.

![Figure 2](image1)

**Figure 2.** Observed data of a) BOD, b) COD, c) TSS and d) Turbidity compared to standards for Teknologi Lake

The range of ammoniacal nitrogen during the sampling was from 3.6 to 4.3 mg/L, with a mean of 3.95±0.38 mg/L. The pH of the water is less than 7 the ammonia is present as ammonium ion while pH increases above 7, more of the ammonia is present as ammonium hydroxide [15]. There have correlation between pH and AN in this study. The AN is increases because the pH is lower than 7 (refer Table 1).The high level of ammoniacal nitrogen present in lake water may cause eutrophication.
to arise [1]. Based on the NWQS, the AN in Teknologi Lake is classified as class V. However, AN values in this study not much different when comparing with AN value of sampling in [10], 2.46±0.32 mg/L. After that, the range of nitrite for the first sampling ranged from 0.13 to 0.11 mg/L or a mean of 0.12±0.01 mg/L. Nitrite exists normally in very low concentrations and even in waste treatment plant effluents levels are relatively low. According to [16] nitrite is an intermediate in the oxidisation of ammonia to nitrate. Principally, the nitrite will tend to exist in the more reduce of ammonia or more oxidised nitrate forms. The main source of NO2 was due to runoff from the restaurant food waste and wastewater from areas around the lake. Based on the NWQS showed NO2 of the Teknologi Lake, and classified as class I. This indicated the lake low of nitrite because the lake far from food industries. Next, the range of nitrate during the sampling was (minimum) from 1.4 to 1.5 mg/L (maximum), with a mean of 1.45±0.15 mg/L. Relatively little of the nitrate found in natural waters most coming from organic and inorganic sources (artificial fertilizers) [8]. The highest NO3 values was received discharge from human activities such as sanitary waste and fertilizers waste. Lawniczak et al. (2016), stated that high levels of nitrate are more likely to indicate significant run-off from agricultural land [17]. Based on the NWQS, the NO3 of the Teknologi Lake was within the normal range and classified as class I. However, when comparing with data from [10] at Cempaka Lake, it is considered high.

![Figure 3. Observed data of a) Ammoniacal nitrogen, b) nitrite and c) nitrate for Teknologi Lake compared to standards](image-url)
4. Conclusion
The results of the study indicated that the mean concentrations of some parameters such as pH, temperature, TSS, COD, DO and turbidity for two different samplings were within the normal range and are classified under Class I. The mean BOD and ammoniacal nitrogen under class IV and V, respectively. The results clearly shown the majority of the water quality parameter is more polluted in term of BOD and ammoniacal nitrogen. Water body in the study area was contaminated may probably originate from the agricultural activities, domestic sewage and industrial activities. These activities were generated both organic and inorganic waste and these wastes are ultimately contaminating the water bodies.

5. References
[1] Huang Y K, Ang S Y, Lee K M and Lee T S (2015) Quality of Water Resources in Malaysia. Research and Practices in Water Quality
[2] NAHRIM SM (2009) Pelan Strategi: Strategi Pembangunan dan Pengurusan Lestari bagi-Tasik dan Empangan Air di Malaysia Jilid 1: Laporan Utama
[3] Wieben C, Baker R J and Nicholson S (2013) Nutrient Concentrations in Surface Water and Groundwater and Nitrate Source Identification Using Stable Isotope Analysis in the Barnegat Bay-Little Egg Harbor Watershed New Jersey 2010-11 US Department of the Interior US Geological Survey
[4] Dressing S A, Meals D W, Harcum J B, Spooner J, Streblng J B, Richards R P and O’Donnell J G (2016) Monitoring and Evaluating Nonpoint Source Watershed Projects. EPA 841-R-16-010. US Environmental Protection Agency Washington, DC. Accessed December 20 2016.https://www.epa.gov/nps/monitoring-and-evaluating-nonpoint-source-watershed-projects
[5] Naidoo S and Olaniran A O (2013) Treated wastewater effluent as a source of microbial pollution of surface water resources International journal of environmental research and public health 11(1) 249-270
[6] DOE 2006 Department of Environment Malaysia Malaysia Environmental Quality Report (2006) In: Chapter 3: River Water Quality Department of Environment Ministry of Science Technology and Environment, Malaysia
[7] APHA (2012) Standard methods for study of examination of water and waste water analysis 20th Ed., Washington DC: American Public Health Association.
[8] USEPA (2014) Water Quality Standards Handbook – Chapter 2: Designation of Uses. Retrieved from website: http://water.epa.gov/scitech/swguidance/standards/handbook/chapter02
[9] DOE (2008) Department of Environment Malaysia, Interim National Water Quality Standards for Malaysia Department of Environment, Ministry of Science Technology and Environment, Malaysia
[10] Gasim M B, Toriman M E, Muftah S, Barggig A, Aziz N A A, Azaman F and Muhamad H (2015) Water quality degradation of Cempaka Lake, Bangi, Selangor, Malaysia as an impact of excessive E. coli and nutrient concentrations. Malaysian Journal of Analytical Sciences 19(6) 1391-1404
[11] Sharma A, Ranga, M M and Sharma, P C (2010). Water quality status of historical Gundolav Lake at Kishangarh as a primary data for sustainable management. South Asian Journal of Tourism and Heritage 3(2) 149-158
[12] Daud N N N, Abdulrahman A and Idrus S (2016) Preliminary assessment of lakes water quality status at campus area in selangor, malaysia Malaysian Journal of Civil Engineering 28 (Special issues 1) 42-49
[13] Rabbani M L and Sarker S (2018) Evaluation of Pollution Status of Turag River, Bangladesh Journal of Water Resources and Pollution Studies 3(1)
[14] Sharip Z, Zaki A T, Shapai M A, Suratman S and Shaaban A J (2014) Lakes of Malaysia: Water quality, eutrophication and management. *Lakes & Reservoirs: Research & Management* 19(2) 130-141

[15] Körner S, Das S K, Veenstra S and Vermaat J E (2001) The effect of pH variation at the ammonium/ammonia equilibrium in wastewater and its toxicity to Lemna gibba. *Aquatic botany* 71(1) 71-78

[16] Ma J, Yao H, Yu H, Zuo L, Li H, Ma J and Li X. (2018) Hydrazine addition enhances the nitrogen removal capacity in an anaerobic ammonium oxidation system through accelerating ammonium and nitrite degradation and reducing nitrate production *Chemical Engineering Journal* 335 401-408

[17] Lawniczak A E, Zbierska J, Nowak B, Achtenberg K, Grześkowiak A and Kanas K (2016) Impact of agriculture and land use on nitrate contamination in groundwater and running waters in central-west Poland. *Environmental monitoring and assessment* 188(3) 172.

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