Jurnal Pena Sains Vol. 9, No. 1, April, 2022
p-ISSN: 2407-2311
e-ISSN: 2527-7634

LAKE WATER QUALITY ASSESSMENT IN UNIVERSITI SELANGOR BESTARI JAYA CAMPUS: A PRELIMINARY STUDY

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Accepted: November 25, 2021 Published: April 26, 2022

DOI: 10.21107/jps.v9i1.11583

ABSTRACT

A water quality study on the main lake of Universiti Selangor (UNISEL) Bestari Jaya Campus was conducted weekly for twelve weeks. The level of pollution in the lake was classified according to the Interim National Water Quality Standard (INWQS) and Water Quality Index (WQI). Three sampling stations were chosen, and the concentration of Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), and Ammonia-Nitrogen (AN) were determined. Water samples were analyzed physically and chemically. The physical water quality parameter, Dissolved Oxygen (DO), temperature, and pH were measured in situ. The chemical parameter of BOD, COD, TSS, and AN were analyzed according to the APHA Method. Throughout the study period, the water temperature was recorded in the range of 28.0 ^{o}C to 29.1 ^{o}C, and the pH of the water was recorded at a neutral level. Based on INWQS, COD, TSS, pH, and AN parameters were classified in Class II. DO parameter was classified in Class III, which indicates that the lake was slightly polluted, and the BOD parameter was classified in Class V, which is heavily polluted. Analysis of water parameters according to WQI showed that the main lake was classified in Class IV. Based on these two water quality standards, this can be concluded that the main lake in UNISEL Bestari Jaya Campus was polluted, and further actions need to be taken by the management of the university in order the improve the water quality of the lake.

Keywords: ***Water quality, chemical parameter, mining.***

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Introduction

Surface water resources such as rivers, streams, lakes, and reservoirs have played an important role throughout the history of human civilization development. Surface water quality is affected by a wide range of natural and human influences (Khazaal et al., 2019). Geological, hydrological, and climate are the most important natural influences since these factors affect the quantity and the quality of water available (Park et al., 2011; Walker et al., 2019). Human activities, such as urbanization, industrial, aquacultures, and agricultures, contribute to the decline of water quality (Ghosh, Majumder & Roychowdhury, 2019).

The mining activities have also influenced the quality of surface water (Verada, Valente & Durães, 2019). The most prevalent impact on water quality has been the discharges from abandoned mines containing heavy metals and acid, all entering the waterways (Wu et al., 2020). These problems result in increasing water acidity, and significant metal contamination subsequently disturbs the growth of all living organisms in the water body (Ayoade & Nanthaniel, 2018). These anthropogenic contaminants affect the beneficial uses of water by causing toxicity to water bodies and aquatic life. The bio-accumulation of metals in fish, plants, and living organism is potentially harmful and inappropriate, especially for agriculture and aquaculture purposes (Maurya, 2019).

Bestari Jaya (formerly known as Batang Berjuntai) in the district of Kuala Selangor was once famous for the tin mining industry since the 1940s. The whole mining catchment covers an area of 2656.31 hectares. Now, the abandoned tin mine has become Universiti Selangor's (UNISEL) location, which covers 1000 acres of land. The campus area has one big lake (the main lake entering the campus) and three other ponds. Since 2012, recreation spots for the students have been introduced at the main lake. Although swimming and fishing are prohibited in the lake and ponds, the university management has received a few reports and complaints regarding the illegal activities.

In their research, Ashraf, Maah & Yusoff (2011) reported that most physicochemical parameters and metals concentration in three rivers and two ponds in the Bestari Jaya area exceeds the permissible limits set by Interim National Water Quality Standards for Malaysia. The finding indicates that the Bestari Jaya ex-mining catchment has a high metals pollution potential due to historic mining activities. However, the UNISEL area was not included as a sampling location in their research. Thus, the water quality and contamination characteristic in the main lake of the UNISEL campus has not been determined. This creates doubts about the water quality of the lake and the safety of the users for secondary recreational purposes.

The water quality of surface water in Malaysia can be classified according to two standards, the Department of Environment-Water Quality Index (WQI) and the Interim National Water Quality Standard (INWQS). The WQI classifies the surface water quality based on the beneficial uses of water. Six water quality parameters, namely pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), and ammoniacal-nitrogen (AN), are selected for the evaluation of water quality status in WQI. (Department of Environment Malaysia, 1985). The WQI is calculated not on the significant parameters but their sub-indices. The sub-indices are SIDO, SIBOD, SICOD, SIAN, SISS, and SIpH. The Department of Environment WQI classification with six parameters is shown in Table 1, and water quality classification according to WQI is tabulated in Table 2. The WQI has been formally used to classify rivers, lakes, and ex-mining pools in Malaysia (Gafri, 2018; Gasim et al., 2015; Hamzah et al., 2020).

The INWQS defined six classes (I, IIA, IIB, III, IV, and V) for classification of the surface water based on the descending order of water quality vis-a-vis Class I being the "best" and Class V being the "worst." The INWQS classification is listed in Table 3. Class I - III requires the water quality level necessary for maintaining the macro aquatic life, where fish is used as an indicator. Conventional treatment systems should treat Class II designated water sources efficiently for the potable water supply, whereas advanced treatment systems are required for a Class III designated water source. Class IV (and below) can still be used for irrigation, whereas Class V water sources have minimal beneficial usage (Zainudin, 2010).

Since the main lake on the campus has been transformed into a recreational lake, the influence of mining activities on the lake's water quality should be taken into consideration. Physical, chemical, and biological parameters in the lake water will give a direct way to assess lake water quality for recreational purposes and aesthetic values. This study will evaluate the water quality of the main lake in UNISEL Bestari Jaya Campus according to pollution level using the Department of

Environment-Water Quality Index (WQI) and Interim National Water Quality Standard (INWQS). Both WQI and INWQS standards can be used as a reference for improving the water quality of the lake to the related future planning activities.

Table 1. Department of Environment WQI

Parameter	Unit	Class				
		I	II	III	IV	IV
pH		>7	6-7	5-6	<5	>5
DO	mg/L	>7	5-7	3-5	1-3	<1
BOD	mg/L	<1	1-3	3-6	6-12	>12
COD	mg/L	<10	10-25	25-50	50-100	>100
TSS	mg/L	<25	25-50	50-150	150-300	>300
AN	mg/L	<0.1	0.1-0.3	0.3-0.9	0.9-2.7	>2.7
WQI	mg/L	>92.7	76.5-92.7	51.9-79.5	31.0-51.9	<31.0

Table 2. Department of Environment water quality classification according to WQI

Sub Index & Water Quality Index	Index range		
	Clean	Slightly polluted	Polluted
SIBOD	91-100	80-90	0-79
SIAN	92-100	71-91	0-70
SISS	76-100	70-75	0-69
WQI	81-100	60-80	0-59

Table 3. The Interim National Water Quality Standard for Malaysia (INWQS)

Parameter	Unit	Class					
		I	IIA	IIB	III	IV	V
AN	mg/L	0.1	0.3	0.3	0.9	2.7	>2.7
BOD	mg/L	1	3	3	6	12	>12
COD	mg/L	10	25	25	50	100	>100
DO	mg/L	7	5-7	5-7	3-5	<3	<1
pH		6.5-8.5	6-9	6-9	5-9	5-9	-
TSS	mg/L	24	50	50	150	300	300
Temperature	°C	-	Normal +2°C	-	Normal +2°C	-	-
Class I	Conservation of natural environment Water supply I – Practically no treatment required Fishery I – Very sensitive aquatic species						
Class IIA	Water supply II – Conventional treatment Fishery II – Sensitive aquatic species						
Class IIB	Recreational use of body contact						
Class III	Water supply III – Extensive treatment required Fishery III – Common of economic value and tolerant species; livestock drinking						
Class IV	Irrigation						
Class V	None of above						

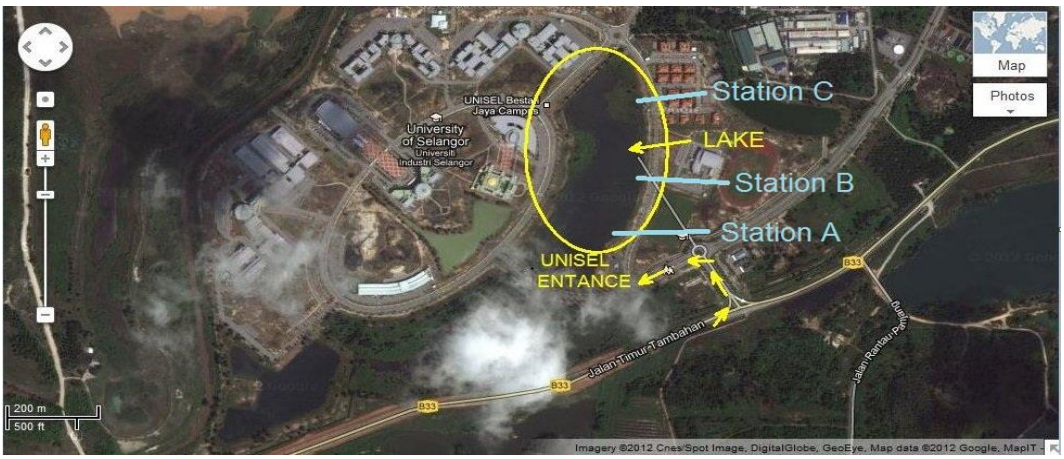

Figure 1. The map of the main lake on the UNISEL Bestari Jaya campus and the sampling location of the study area

Research Methods

The study area and sampling stations are shown in Figure 1. Three sampling stations were identified and recorded with GPS GARMIN (Model OREGON 450). Station A was N 03^{O} 24.933' (1 m) E101^{O} 26.533' (W), Station B was N 03^{O} 24.901' (3 m) E101^{O} 26.525' (E) and Station C was N 03^{O} 24.986' (2 m) E101^{O} 26.543' (E).

Water samplings were conducted weekly, which covered 12 weeks. Sampling procedures were used according to APHA (1998) methods. In-situ parameters for pH, Dissolved Oxygen (DO), and the temperature was measured directly using multiprobe HORIBA Model U-10. Water samples were collected from each station for laboratory analysis of the chemical parameters. All chemical analyses were carried out according to the APHA (1998) and HACH procedure and measured using HACH Spectrophotometer Model DR 2400. The BOD concentration was determined by using the standard method APHA 5210. COD concentration was analyzed using the digestion and colorimetric methods, using the standard method APHA 5220-D. The titrimetric method was applied to determine AN concentration according to the standard method APHA 4500-NH_3 while TSS was determined using APHA 2540 (APHA,1998). Data obtained from all six water quality parameters were applied for the calculation of the subindex and WQI index in the following Equation (1) :

$$WQI = 0.22(siDO) + 0.19(siBOD) + 0.16(siCOD) + 0.15(siAN) + 0.16(siTSS) + 0.12(sipH) \quad \text{Equation (1)}$$

Result and Discussion

INWQS Results

During 12 weeks of water sampling, stations A, B, and C's pH value was recorded in the range of 6.93 – 7.76. The average pH was 7.02, 7.35, and 7.59 for stations A, B, and C. This can be concluded that the main lake in UNISEL Bestari Jaya Campus was observed to be neutral and classified in Class I.

Generally, there were no significant temperature differences for all three sampling stations. The average of the temperature values was normally. They were recorded from 28.8 °C to 29.1 °C. The lowest temperature was recorded at Station B (28.1°C) in week five, while the higher temperature was recorded at Station C (29.7 °C) in week 11. This could be attributed to the high, and equal exposure of sunlight on the lake water surface since the temperature was constantly recorded between 11 am to 11.30 am during every sampling time.

Dissolved oxygen (DO) plays an important role for aquatic life in water and is a crucial parameter in water treatment applications. The DO concentration in water is greatly influenced by the temperature of the waterbody, the depth of water, salinity, and atmospheric pressure (Baharim, Ismail & Omar, 2011). Throughout this study, the average DO concentration of the main lake on the Unisel campus was recorded as more than 3 mg/L for all sampling stations. This indicates that the average DO concentration obtained was classified in Class III according to INWQS. The highest DO concentration for Stations A, B and C was recorded at 3.87 mg/L (week 2), 3.51 mg/L (week 8), and 3.69 mg/L (week 10), respectively. Meanwhile, the lowest DO concentration was recorded at 3.32 mg/L

in week 7 (Station A), 3.38 mg/L in week 12 (Station B), and 3.41 mg/L in week 3 (Station C). Gasim et al. (2015) reported a similar range of DO concentrations in Cempaka Lake, Bangi Selangor, with no significant differences in the average DO concentration within sampling stations.

For the Biochemical Oxygen Demand (BOD), the average value for all stations ranged from 12.30 mg/L to 20.58 mg/L, which falls in Class V. Water with a BOD value higher than 12 mg/L is classified as heavily polluted water. The minimum average value of BOD was observed at Station A might be due to the location of that sampling station, where it is situated closest to the tributary of the main lake. This might be caused by external waste flowing into the lake's water body, subsequently minimizing the BOD values.

Chemical oxygen demand (COD) provides an index for assessing organic pollution in the water body. A higher COD value indicates a greater amount of oxidizable organic material in the water, reducing DO concentration. The COD value of the Unisel main lake was recorded at 24.72 mg/L to 26.04 mg/L, where the average value for all stations was more than 25 mg/L. Based on INWQS, the COD values of all stations were classified to be in Class II. High COD values were typically recorded at Station A, indicating more organic and inorganic matters than at Station B and C.

Total suspended solids (TSS) measure the particulate matter larger than 2 microns drifting or floating in the water, from sediment, silt, and sand to plankton and algae found in water (Wetzel, 2001). A large quantity of suspended solid absorbs more heat from sunlight, causing an increase in the temperature of the water body, subsequently causing the DO concentration to be decreased. The TSS concentration of the collected water samples ranged from 52.8 mg/L to 59.3 mg/L. The average TSS concentration was 53.9 mg/L, 57.1 mg/L, and 54.2 mg/L for Stations A, B, and C. These results indicate that the TSS concentration of the Unisel main lake was in Class II.

Analysis result for Ammonia Nitrogen (AN) showed the water quality of the main lake was classified in Class II since the average AN concentration was recorded at 0.36 mg/L for Station A, 0.34 mg/L for Station B, and 0.37 for Station C. The highest concentration (0.39 mg/L) was recorded at Station A on week four and week 11, while the lowest (0.30 mg/L) was recorded on week 6. The water quality of the Unisel main lake can be considered non-toxic to aquatic life due to the low AN concentration in the water body.

WQI Results

The weekly Water Quality Index (WQI) for Stations A, B, and C were calculated using Equation (1) and listed in Table 4. The lowest WQI value was recorded in week 2 at Station B. In contrast, the highest WQI value was recorded in week 4 at Station C. Based on the average WQI value for all stations. The main lake is classified in Class IV, which indicates the lake water was polluted.

Table 4. WQI Results

Week	**Water Quality Index Value**		
	Station A	Station B	Station C
Week 1	49.54	49.19	50.76
Week 2	46.40	44.65	49.95
Week 3	48.80	48.39	52.77
Week 4	47.55	50.37	52.57
Week 5	59.89	44.67	45.93
Week 6	50.93	47.86	51.02
Week 7	50.11	46.20	50.82
Week 8	49.35	48.80	52.10
Week 9	50.10	49.45	49.88
Week 10	48.77	49.52	48.31
Week 11	50.78	48.96	49.37
Week 12	49.26	50.04	50.22
Average	50.12	48.18	50.31
Class	IV	IV	IV

Conclusion

The water quality of the main lake in the UNISEL Bestari Jaya Campus was polluted based on the Water Quality Index (WQI) value. For the Interim National Water Quality Standard (INWQS), COD, TSS, pH, and AN parameters were classified in Class II, DO parameter was classified in Class III, and BOD parameter was classified in Class V. These preliminary results can be used for further investigation on the source of the pollutant in the lake and later proper action for treatment can be taken in order to ensure the lake to be suitable for the recreational purposes.

Acknowledgment

The author would like to thank the Universiti Selangor (UNISEL), especially the Faculty of Engineering and Life Sciences, for the facilities provided during this study.

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