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Research Note

Water Quality and Dissolved Heavy Metal Concentrations in Surface Water Collected from Kelana Jaya Lakes

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Abstract: Kelana Jaya lakes are public attraction for its recreational value. However, urban runoff and industrial wastes into these urban lakes could contaminate the environmental quality of the lakes. In this study, water samples from the five lakes of Kelana Jaya were monitored for temperature, pH, conductivity, dissolved oxygen, ammonia, nitrate, phosphate and dissolved concentrations of Cd, Cu and Zn, at four different sampling periods on 5 May, 5 June, 13 Oct and 1 Nov 2003. These physico-chemical parameters indicated that Lakes 1, 2, 4 and 5 were classified under 'Class III' (slightly polluted, recreational use, need treatment) while only Lake 3 was under 'Class II' (clean, recreational use with body contact) according to Malaysian DOE water quality classification (2002). Therefore, the overall poor water quality of Kelana Jaya Lakes indicated anthropogenic impact and future water quality monitoring and control of the wastes into the lakes are strongly recommended.

Key words: Kelana Jaya lakes, dissolved concentrations of heavy metals, water quality.

Introduction

Kelana Jaya lakes are a recreational park situated by the roadside of Lebuhraya Damansara-Puchong (LDP) currently under the care of Municipal Council of Petaling Jaya (Mohkeri, 2003; Ismail et al., 2004). It is a favourite place for the residents of Kelana Jaya and other people staying nearby the park. There are five small lakes in Kelana Jaya lakes (Figure 1).

Lake 4 is inter-connected with Lake 1 and Lake 2. Lake 1 and Lake 3 have an aerator on each lake. Generally, Kelana Jaya lakes function as flood control. The main concern of these lakes is their conditions, which could be heavily polluted by overflow of sewage waste from untreated sewage oxidation pond and rubbish waste from monsoon drain, which include wastes from housing and commercial areas. Knowing about these anthropogenic inputs into the recreation lakes of Kelana Jaya, there is still no information on the water quality of the Kelana Jaya lakes. The objective of this study was to determine some physico-chemical parameters including temperature, pH, conductivity, dissolved oxygen (DO), ammonia, nitrate, phosphate and dissolved concentrations of Cd, Cu and Zn, at four different sampling periods from the five lakes of Kelana Jaya.

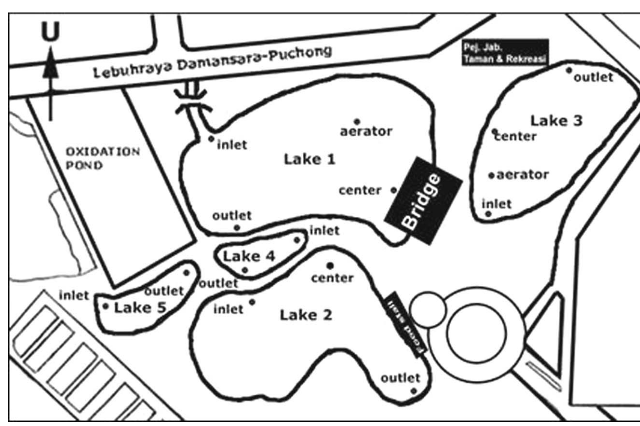

Figure 1: Sampling sites of Kelana Jaya lakes.

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Materials and Methods

Water samples were collected from five small lakes of Kelana Jaya by using a Van Dorn sampler at three stations (inlet, centre and outlet) of Lake 1 and Lake 2. Only two stations (inlet and outlet) were placed in Lake 4 and Lake 5. Water samples were collected for analysis of phosphate, nitrate, ammonia and dissolved concentrations of heavy metals. The physico-chemical characteristics of the lakes recorded directly in the field at each sampling station were temperature, conductivity, pH (potential hydrogen) and DO. Water parameters such as pH, temperature, DO and conductivity were determined by using YSI 556 MPS (Multi-Probe System). A total of two replicates were taken for every parameter. The samples for dissolved metals were filtered through 0.45μ cellulose acetate filters by using acid washed plastic filter heads and they were preserved with high purity nitric acid at pH < 2.0. Water samples were kept in acid-washed polyethylene bottles and later into an icebox to prevent sample deterioration during transportation to laboratory. In the laboratory, the samples were stored at 4°C until analysis. Ammonia, nitrate and phosphate were determined in accordance with Standard Methods for the Examination of Water and Wastewater (APHA, 1989). To avoid possible contamination, all glassware and equipment used were acid-washed (Yap et al., 2002). Deionised water was used for blank analysis and dissolved heavy metals determination were done by using an air-acetylene atomic absorption spectrophotometer, an inorganic analytic instrument made by Perkin-Elmer^{TM}, model AAnalyst800.

A quality control sample was routinely run through during the period of metal analysis. Procedural blanks were prepared and the metal concentrations in the blanks were negligible (Yap et al., 2003). Percentages of recoveries were 100.13% for Cd, 99.95% for Cu and 98.80% for Zn. Quality control was also routinely run by checking standard stock solution for ammonia, phosphate and nitrate for every 10 samples to check for accuracy. The recoveries for the three parameters ranged from 90.3 to 110.3% and these recoveries were acceptable.

All data obtained were analyzed using Statistical Analysis System (SAS) for Windows, Release 6.12.

Results and Discussion

All the water quality and dissolved heavy metal concentrations for the four sampling periods are shown in Tables 1 to 4. Temperatures were relatively constant ranging from 29.13 to 31.99 °C. This may be due to stratification of the lakes (Wetzel, 2001). Lake 2 showed a lower temperature in average when compared to other lakes due to its size and depth, which were the smallest and shallowest. pH measured ranged from 6.57 to 8.37 °C. Lake 1 shows the lowest pH among the five lakes and for the overall sampling periods. The importance of pH in controlling heavy metal partitioning between solid and solution phases had been widely identified (Tessier et al., 1989; Warren and Zimmerman, 1994). pH measured in Kelana Jaya lakes showed variation of range from time to time. The water samples collected from Lake 1 recorded lower temperatures and pH (indicating more acidic condition). This could be due to the inputs from the monsoon drain and also from the nearby oxidation pond.

DO was the highest at 6.917 mg/L in Lake 1 and the lowest also was recorded from Lake 1 at 0.761 mg/L. Oxygen is one of the fundamental parameters to the living organisms of lakes. DO is obviously essential to the metabolism of all aquatic organisms that possess aerobic respiratory biochemistry. From the results, Lake 3 had the highest DO level (8.712 mg/L) on 13 Oct 03. The lowest DO level 0.761 mg/L was recorded from Lake 1 on 5 June 03. Levels of DO in lakes could be affected by many factors such as dilution factor, presence of alga bloom and oxidation of decaying organic materials by bacteria (Nhaphi et al., 2002).

Lake 1 showed the highest conductivity (0.42 mS/cm) while Lake 3 showed the lowest conductivity (0.19 mS/cm) reading. Conductivity is the measurement of the electricity current transported by the ions in the water. Conductivity value was the highest (0.42 mS/cm) in Lake 1 and this may be due to the high loading of nutrients from the monsoon drain and oxidation pond.

Phosphate measured in Kelana Jaya lakes ranged from 1.164 mg/L of Lake 3 to 1.903 mg/L of Lake 1. The highest nitrate concentration was 1.356 mg/L, almost five times higher in Lake 1 when compared to the lowest concentration found in Lake 3 at 0.257 mg/L. Ammonia concentration was the highest in Lake 5 at 94.49 mg/L, almost eight times higher than the lowest concentration in Lake 2 at 12.2 mg/L. High concentrations of ammonia, nitrate, and phosphate found in Lake 1 when compared to other lakes explained the highest value of conductivity in Lake 1. High loading of nutrients rich in ammonia, phosphate and nitrate could have caused Lake 1 to have the lowest DO (0.761 mg/L) although an aerator has been installed in Lake 1. Compared to Lake 3, which also had an aerator installed, Lake 3 recorded the highest concentration of DO (8.712 mg/L). Lake 5 had the highest concentration of ammonia (94.49 mg/L) and higher

Table 1: Water quality and dissolved metal concentrations for each lake of sampling in Kelana Jaya lakes on 8 May 2003 (mean ± standard error, *n* = 3).

	N	*Temperature (°C)*	*pH*	*Conductivity (mS/cm)*	*DO (mg/L)*	*Ammonia (mg/L)*	*Phosphate (mg/L)*	*Nitrate (mg/L)*	*Cd (mg/L)*	*Cu (mg/L)*	*Zn (mg/L)*
Lake 1	3	28.84 ± 0.00	6.57 ± 0.08	0.34 ± 0.02	3.267 ± 0.021	56.09 ± 0.01	1.674 ± 0.014	1.118 ± 0.007	0.111 ± 0.001	0.133 ± 0.001	0.032 ± 0.001
Lake 2	3	28.74 ± 0.00	6.81 ± 0.08	0.34 ± 0.02	3.896 ± 0.021	25.82 ± 0.01	1.333 ± 0.014	1.164 ± 0.007	0.116 ± 0.001	0.122 ± 0.001	0.030 ± 0.002
Lake 3	3	30.30 ± 0.00	7.81 ± 0.09	0.26 ± 0.02	3.645 ± 0.016	25.18 ± 0.01	1.164 ± 0.017	0.257 ± 0.005	0.112 ± 0.001	0.105 ± 0.002	0.035 ± 0.002
Lake 4	2	30.65 ± 0.00	7.64 ± 0.06	0.31 ± 0.02	4.980 ± 0.016	57.895 ± 0.01	1.415 ± 0.016	0.309 ± 0.007	0.100 ± 0.001	0.078 ± 0.002	0.025 ± 0.002
Lake 5	2	30.38 ± 0.00	7.27 ± 0.08	0.24 ± 0.02	3.470 ± 0.024	94.49 ± 0.01	1.903 ± 0.014	0.428 ± 0.006	0.094 ± 0.001	0.159 ± 0.001	0.028 ± 0.002
Average	5	29.78 ± 0.00	7.09 ± 0.03	0.30 ± 0.02	3.851 ± 0.018	51.90 ± 0.01	1.498 ± 0.017	0.655 ± 0.007	0.107 ± 0.001	0.119 ± 0.002	0.030 ± 0.001

Table 2: Water quality and dissolved metal concentrations for each lake of sampling in Kelana Jaya lakes on 5 June 2003 (mean ± standard error, *n* = 3).

	N	*Temperature (°C)*	*pH*	*Conductivity (mS/cm)*	*DO (mg/L)*	*Ammonia (mg/L)*	*Phosphate (mg/L)*	*Nitrate (mg/L)*	*Cd (mg/L)*	*Cu (mg/L)*	*Zn (mg/L)*
Lake 1	3	29.61 ± 0.00	6.82 ± 0.08	0.38 ± 0.00	0.761 ± 0.018	26.19 ± 0.01	1.604 ± 0.015	0.974 ± 0.011	0.121 ± 0.001	0.133 ± 0.001	0.040 ± 0.002
Lake 2	3	30.12 ± 0.04	6.81 ± 0.04	0.34 ± 0.01	2.013 ± 0.017	26.50 ± 0.01	1.781 ± 0.018	1.121 ± 0.007	0.088 ± 0.001	0.132 ± 0.001	0.029 ± 0.001
Lake 3	3	30.54 ± 0.02	7.29 ± 0.01	0.32 ± 0.09	3.285 ± 0.017	35.69 ± 0.01	1.246 ± 0.016	0.297 ± 0.004	0.096 ± 0.001	0.109 ± 0.002	0.028 ± 0.002
Lake 4	2	30.91 ± 0.05	7.39 ± 0.08	0.30 ± 0.01	5.671 ± 0.015	50.89 ± 0.01	1.543 ± 0.018	0.371 ± 0.009	0.092 ± 0.001	0.113 ± 0.002	0.027 ± 0.002
Lake 5	2	31.00 ± 0.05	7.74 ± 0.03	0.24 ± 0.09	3.905 ± 0.016	78.68 ± 0.01	1.823 ± 0.013	0.444 ± 0.008	0.090 ± 0.001	0.110 ± 0.002	0.019 ± 0.002
Average	5	30.44 ± 0.07	7.21 ± 0.01	0.32 ± 0.06	3.127 ± 0.016	43.59 ± 0.02	1.600 ± 0.016	0.642 ± 0.008	0.097 ± 0.001	0.119 ± 0.001	0.029 ± 0.002

Table 3: Water quality and dissolved metal concentrations for each lake of sampling in Kelana Jaya lakes on 13 October 2003 (mean ± standard error, *n* = 3).

	N	*Temperature (°C)*	*pH*	*Conductivity (mS/cm)*	*DO (mg/L)*	*Ammonia (mg/L)*	*Phosphate (mg/L)*	*Nitrate (mg/L)*	*Cd (mg/L)*	*Cu (mg/L)*	*Zn (mg/L)*
Lake 1	3	29.13 ± 0.05	6.81 ± 0.06	0.42 ± 0.05	2.380 ± 0.014	16.83 ± 0.01	1.427 ± 0.014	1.195 ± 0.002	0.120 ± 0.001	0.090 ± 0.001	0.034 ± 0.001
Lake 2	3	30.00 ± 0.09	6.99 ± 0.05	0.41 ± 0.03	3.962 ± 0.018	40.20 ± 0.01	1.716 ± 0.010	1.234 ± 0.009	0.090 ± 0.001	0.087 ± 0.001	0.040 ± 0.002
Lake 3	3	30.94 ± 0.09	7.90 ± 0.08	0.27 ± 0.02	8.712 ± 0.013	44.34 ± 0.01	1.367 ± 0.017	0.342 ± 0.007	0.092 ± 0.001	0.093 ± 0.002	0.032 ± 0.002
Lake 4	2	30.86 ± 0.01	7.42 ± 0.04	0.31 ± 0.04	4.087 ± 0.019	26.64 ± 0.02	1.498 ± 0.020	0.318 ± 0.005	0.122 ± 0.001	0.083 ± 0.003	0.030 ± 0.002
Lake 5	2	31.07 ± 0.02	7.01 ± 0.08	0.23 ± 0.08	4.123 ± 0.019	14.40 ± 0.01	1.591 ± 0.014	0.826 ± 0.006	0.079 ± 0.001	0.060 ± 0.001	0.029 ± 0.002
Average	5	30.40 ± 0.01	7.23 ± 0.01	0.33 ± 0.03	4.653 ± 0.017	28.48 ± 0.01	1.520 ± 0.015	0.786 ± 0.006	0.101 ± 0.001	0.083 ± 0.002	0.031 ± 0.002

Table 4: Water quality and dissolved metal concentrations for each lake of sampling in Kelana Jaya lakes on 1 November 2003 (mean ± standard error, *n* = 3).

	N	*Temperature (°C)*	*pH*	*Conductivity (mS/cm)*	*DO (mg/L)*	*Ammonia (mg/L)*	*Phosphate (mg/L)*	*Nitrate (mg/L)*	*Cd (mg/L)*	*Cu (mg/L)*	*Zn (mg/L)*
Lake 1	3	31.32 ± 0.01	7.43 ± 0.05	0.29 ± 0.04	6.917 ± 0.032	29.18 ± 0.01	1.707 ± 0.014	1.356 ± 0.006	0.027 ± 0.001	0.099 ± 0.001	0.035 ± 0.001
Lake 2	3	30.04 ± 0.04	7.00 ± 0.09	0.34 ± 0.03	3.456 ± 0.031	12.20 ± 0.01	1.581 ± 0.013	1.124 ± 0.006	0.087 ± 0.001	0.117 ± 0.001	0.045 ± 0.002
Lake 3	3	29.63 ± 0.04	7.39 ± 0.05	0.19 ± 0.02	5.861 ± 0.018	26.67 ± 0.01	1.377 ± 0.014	0.280 ± 0.004	0.089 ± 0.001	0.122 ± 0.002	0.023 ± 0.002
Lake 4	2	31.99 ± 0.08	8.37 ± 0.07	0.29 ± 0.01	5.198 ± 0.020	22.44 ± 0.01	1.597 ± 0.011	0.327 ± 0.007	0.098 ± 0.001	0.119 ± 0.002	0.027 ± 0.002
Lake 5	2	31.15 ± 0.05	7.92 ± 0.04	0.23 ± 0.04	5.278 ± 0.033	17.95 ± 0.01	1.788 ± 0.011	0.865 ± 0.005	0.083 ± 0.001	0.103 ± 0.001	0.027 ± 0.002
Average	5	30.83 ± 0.08	7.63 ± 0.06	0.27 ± 0.03	5.342 ± 0.027	21.69 ± 0.01	1.610 ± 0.013	0.790 ± 0.006	0.077 ± 0.001	0.112 ± 0.001	0.031 ± 0.001

temperature than the rest of the lakes due to the oxidation sewage. Discharge of sewage into Lake 5 caused the lake to have low DO level. This was due to the presence of bacteria activity in oxidizing the organic materials from the sewage pond.

Dissolved heavy metal concentrations in Kelana Jaya lakes were fluctuating from time to time. The dissolved concentrations (mg/L) of Cd, Cu and Zn were 0.027-0.122 mg/L, 0.060-0.133 mg/L and 0.019-0.045 mg/L, respectively. Concentrations of dissolved heavy metals in Lake 5 were lower when compared to the other lakes due to the presence of macrophyte plants especially *Eichhornia crassipes* and *Lemna* sp. since they were found abundantly and covered almost 80% of the lake surface. Dissolved concentrations of Cu and Zn are trace metals required by plants for survival, whereas nonessential Cd could be toxic to plants (Ridley and Banks, 1996). Lakes 1, 2 and 4 are interconnected, so the levels of trace metals concentration among these lakes were not significantly different ($P > 0.05$). Lakes 3 and 5 are separated from the rest and showed different levels of trace metals. Kelana Jaya lakes were heavily polluted by dissolved Cd, which exceeded the limit for drinking water (DOE, 2002). High levels of dissolved Cd could be originated from industries involved in electroplating, and car repairing workshop. Above all, these lakes received high inputs from nearby highway and maybe seepage from nearby lakes. However, the level of dissolved Cu and Zn were below the permissible limits for drinking water (DOE, 2002). High inputs of nutrients, especially nitrogen based, stimulated algae blooms which in turn caused eutrophication (Wetzel, 2002). Wastewater from the monsoon drain in the Kelana Jaya lakes with sewage and industrial wastes could have caused the lakes rich with ammonia, phosphate and nitrate to become eutrophicated. Recently, Ismail et al. (2004) reported that Kelana Jaya sediments were found to have elevated levels of Cu and Zn and this agreed with the water data of the present study.

According to the Malaysian water quality classification set by DOE (2002), all lakes except for Lake 3, were under Class III (slightly polluted, recreational use, need treatment) and only Lake 3 was under Class II (clean, recreational use with body contact) for DO. Lake 3 was the better lake than the other lakes in terms of water quality as it was completely separated from the rest of the lakes. Our results agreed with that found by Mohkeri (2003) in which the Kelana Jaya lakes were classified as class V exceeding the permitted levels set by Malaysian Department of Environment (DOE) (2002). Therefore, these lakes are classified as polluted, unhealthy and not suitable for water contact activities.

Conclusion

The present data indicated the potential of further water quality deterioration and pollution from nearby anthropogenic inputs. Therefore, any future pollution should be reduced and this, of course, should involve the authority to control the pollution sources that would aggravate the pollution levels of Kelana Jaya lakes. Since a lot of observable inputs could be seen, monitoring of water quality of Kelana Jaya lakes should be done regularly. Our present data should serve as baseline for future reference.

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