A Study of some Water Quality Parameters and Metal Concentrations in Engineering and Built Environment Lake Faculty - UKM, Selangor, Peninsular Malaysia during 2019

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Abstract.

A study of water quality parameters (temperature, conductivity, total dissolved solid, dissolved oxygen, pH, and water hardness) in Engineering and Built Environment Lake Faculty - UKM, Selangor, Peninsular Malaysia was conducted in January, April, July, and October 2019. Six metals i.e. cadmium, chromium, lead, nickel, zinc, and copper were determined in the most compartment of the lake namely water. The water samples were collected randomly from different sampling points around the lake. The water quality parameters were tested and recorded at each sampling station using Hydrolab Data Sonde 4® and Surveyor® 4 a water quality multi probe (USA). The metals concentration were determined by Inductively Coupled Plasma Mass Spectrometer (ICP –MS), Perkin Elmer Elan, Model 9000. The water quality parameters were compared with National Water Quality Standard (NWQS Malaysia) while metal concentrations were compared with Malaysian and international standards. Study showed that the averages of water temperature, conductivity, total dissolved solids, dissolved oxygen, pH and hardness values during the months of the study were (29.02°C, 134.37μS/cm, 920 mg/L, 5.92 mg/L, 8.29 and 37.35 CaCO₃ mg/L) respectively. The mean metal concentrations in water (in micrograms per liter) based on monthly sampling (in descending order) for Zn, Cu, Cr, Ni, Pb, and Cd were (10.02), (5.36), (2.89), (2.55), (0.73) and (0.080) respectively.

Key word: metals concentration, water quality, Engineering and Built Environment Lake.
دراسة بعض مؤشرات جودة المياه وتركيز العناصر الثقيلة في بحيرة كلية الهندسة والبيئة بالجامعة الوطنية الماليزية خلال عام 2019م

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الملخص:
INTRODUCTION.

Metal contaminants in aquatic ecosystems cause a serious environmental hazard because of their persistence and toxicity. Toxic metals from various sources namely discharge of industrial or sewage influents, domestic wastewater, periodic precipitation contaminated with airborne pollutants, transport, burning of fossil fuels, and fertilizers containing trace metals could affect fish healthy (Handy, 1994; Jent et al., 1998; Chaisemartin, 1983). Metals have been used in various human activities since thousands of years ago and metal pollution in the aquatic environment has been an issue. Malaysia as a developing country, finds it inevitable avoiding this problem. The existence of metals concentration in the environment could be of natural causes or anthropogenic. The natural causes could be weathering; climate changes (wind and temperature) inflicted on igneous and metamorphic rocks. However the burning of fossil fuels, mining, melting minerals, industrial wastes, the use of fertilizers and pesticides in the agriculture are the main contribution of anthropogenic sources (Kendrick et al. 1992).

In the context of environmental pollution, the existence of metal pollution and the existence of metal concentration could be categorized into 3 important types; non-critical, undiluted toxic metals which hardly exist and toxic metal concentrations which are widely used (Forstner & Wittman. 1992). Unlike organic pollution, toxic metals could be not eliminated through biodegradable process and the impact of toxic metals could remain permanently in the environment. In some heavy metals such as lead and cadmium, are known to have toxic effect although they have low concentrations (Forstner & Wittman. 1992). Heavy metal concentrations in aquatic ecosystems are usually monitored by measuring its concentration in water and biota (Camusso et al. 1995), which generally exist in low levels in water and attain considerable concentrations in biota (Namminga and Wilhm. 1976). Heavy metals including both essential and non-essential elements have a particular significance in ecotoxicology, since they are highly persistent and all have the potential to be toxic to living organisms (Storelli et al. 2005). Heavy metals do not exist in soluble forms for a long time in waters; they are present mainly as suspended colloids or are fixed by organic and mineral substances (Kabata - Pendas and Pendas. 2001). In aquatic ecosystems, water contamination by heavy metals is one of the main types of pollution that may stress the biotic community (Baldantoni et al. 2004).

The objective of this research is to identify the status of some water quality parameters in addition to metal concentrations in water of Engineering Lake Faculty - UKM, Selangor, Peninsular Malaysia during 2019.

MATERIALS AND METHODS.

Study area.

Engineering and Built Environment Lake Faculty is a man - made freshwater lake. It is geographically located at 02° 55’ 30” N and at 101 46’ 20” E. The depth is 1.5 meters. The main source of water was Langat River and rain water, the drainage was through one drainage pipe to the surrounding areas. Engineering Lake covers average of 1.8 acres (Personal Communication) (Fig. 1).
Water Samples for Water Quality Parameters.

Water samples were collected just below the water surface randomly at different locations representing the open water bodies in the lake using a 1000 ml bottles (acid washed, distilled water rinsed polyethylene bottles). The triplicates water samples from the lake were pooled together. The samples were collected at monthly intervals during January, April, July and October 2019. The samples were used to analyze physico-chemical parameters such as temperature (T), electrical conductivity (EC), total dissolved solid (TDS), dissolved oxygen (DO) and pH. The water quality parameters were tested and recorded at each sampling station using Hydrolab Data Sonde 4® and Surveyor® 4 a water quality multi probe (USA). Calibration of Hydrolab Data Sonde 4® and Surveyor® 4 a was conducted in the laboratory before field sampling. For water hardness concentrations of calcium (Ca$^{2+}$) and magnesium (Mg$^{2+}$) were determined using Inductively Coupled Plasma Mass Spectrometer (ICP-MS), Perkin Elmer Elan, Model 9000.

Water Samples for Heavy metals Concentration.

The samples were immediately filtered using 0.45µm membrane filters (APHA, 1992). For metal concentrations, 10 ml filtrate was acidified with 0.5 ml of concentrated HNO$_3$ (70%) to pH < 2 and kept in the cool storage at 4°C. The filtrated water was dried at 70 °C and then digested with 5ml concentrated HNO$_3$ (Smith et al.1996). The metals concentration were determined by Inductively Coupled Plasma Mass Spectrometer (ICP –MS), Perkin Elmer Elan, Model 9000.

Statistical analysis.

One -way analysis of variance (ANOVA) was conducted to see the variation of water parameters and heavy metal concentration among the different months. All data were analysis using the statistical package SPSS (Version 20).

RESULTS.

Physico-chemical parameters of water.

The physico- chemical parameters of water of Engineering Lake are summarized in Table 1. The physico-chemical parameters of water of Engineering Lake were analyzed during January, April, July and October 2010. Temperature, SPC, TDS, DO, pH and hardness of water varied from 28.65 ºC – 29.49 ºC, 1325.3 - 1364 µS/cm, 810-990 mg/l, 5.43-6.37 mg/l, 8.14-8.64 and 37.13-37.63 mg/l as CaCO$_3$, respectively.

Metal concentration in water

The metal concentrations in water of Engineering Lake are presented in Table 2. Engineering Lake contained only detectable amounts of cadmium, chromium, copper, lead, zinc and nickel in water. Zinc values recorded the lower value on April (9.92 µg /L) and the higher value on January (10.14 µg /L), and the average was 10.02 ± 0.09 µg /L. Copper values proved the lower value on April (4.93 µg /L) and the higher
value on January (5.93 µg/L), and the average was 5.36 ± 0.42 µg/L. Nickel values recorded the lower value on October (2.49 µg/L) and the higher values on July (2.63 µg/L), and the average was 2.55 ± 0.07 µg/L. Chromium values explained the lower value on April (2.82 µg/L) and the higher value on July (2.94 µg/L), and the average was 2.89 ± 0.06 µg/L. Lead values proved the lower value on January (0.71 µg/L) and the higher value on October (0.73 µg/L), and the average was 0.73 ± 0.01 µg/L. Cadmium values confirmed the lower value on January, April, July and October (0.08 µg/L) and the average was 0.08 ± 0.00 µg/L. Zinc had the highest concentration while cadmium had the lowest concentration and the accumulation order was Zn>Cu>Cr>Ni>Pb > Cd.

DISCUSSION.

Physico-chemical parameters of water.

Study demonstrated that the water temperature values increased during the months of the study. The lower and higher values were 28.65 °C and 29.49 °C respectively, and the average was 29.02 °C. Conductivity values increased during the study period with the averages of 1343.3 µS/cm, while the lower and higher values were 1325.3 µS/cm and 1364 µS/cm respectively. Increasing water temperature values lead to increasing the evaporation from the surface area of the lake and finally increasing the content of salts and conductivity values. Moreover, the stagnant of water in some parts of the lake may affect the electrical conductivity. The total dissolved solid values increased due to increased the electrical conductivity values and the water of the lake classified as class (II) according to NWQS Malaysia with the average of 920 mg/L, while the lower and higher values were 810 and 990 mg/L respectively. Conductivity or specific conductance is a measure of the ability of water to conduct an electrical current. It is sensitive to variations in dissolved solids, mostly mineral salts (Chapman, 1998).

The degree to which these dissociate into ions, the amount of electrical charge on each ion, ion mobility and the temperature of the solution all have an influence on conductivity. It is expressed as microsiemens per centimeter (µS/cm) or desisiemens per meter (dS/m) or milli mohos/centimeter (mM/cm) and micro mohos / centimeter (µM/cm), it is related to the concentrations of total dissolved solids and major ions. Concentrations in unpolluted waters are usually close to but less than 10 mg/L (Chapman, 1998 and Gray, 1999). Variations in DO can occur seasonally or even over 24 hour periods in relation to temperature and biological activity (Chapman, 1998 and Round, 1981). Biological respiration including that related to decomposition processes reduces DO concentrations (Chapman, 1998 and Round, 1981). In still waters pockets of high and low concentrations of dissolved oxygen can occur depending on the rates of biological processes (Chapman, 1998).

Waste discharges high in organic matter and nutrients can lead to decreases in DO concentrations as a result of the increased microbial activity occurring during the degradation of organic matter (Chapman, 1998). In severe cases of reduced oxygen concentrations anaerobic conditions can occur (0 mg/l of oxygen) particularly close to the sediment water interface as a result of decaying sedimenting material (Chapman, 1998). Determination of DO concentrations is a fundamental part of a
water quality assessment since oxygen is involved in or influences nearly all chemical and biological processes within water bodies (Chapman, 1998). Concentrations below 5 mg / l may adversely affect the functioning and survival of biological communities and below 2 mg / l may lead to the death of most fish (Chapman, 1998). The measurement of DO can be used to indicate the degree of pollution by organic matter, the destruction of organic substances and the level of self purification of the water (Chapman, 1998, Gray, 1999 and Twort et al., 1985).

It was clear that pH values were higher than the normal ranges with the average of 8.29. The lower value was 8.14 and recorded on July but higher value was 8.64 on October. In addition, the value of hydrogen ion concentration indicated that the water of Engineering Lake was alkaline medium. The pH is an important variable in water quality assessment as it influences many biological and chemical processes within a water body and all processes associated with water supply and treatment (Chapman, 1998 and Gray, 1999). Change in pH can indicate the presence of certain effluents particularly when continuously measured and recorded together with the conductivity of a water body (Chapman, 1998 and Droste, 1997). Diel variations in pH can be caused by the photosynthesis and respiration cycles of algae in eutrophic waters (Chapman, 1998). The pH of most natural waters is between 6.0 and 8.5 (Chapman, 1998 and Gray, 1999) although lower values can occur in dilute waters high in organic content and higher values in eutrophic waters, ground water brines and salt lakes (Chapman, 1998 and Droste, 1997).

It is controlled by the dissolved chemical compounds and the biochemical processes in the water (Gray, 1999). Carbon dioxide dissolves readily in water and is closely linked with the chemical processes that determine the acidity and alkalinity of water. The acidity of water is determined by the abundance or, more correctly the activity of H ions. Higher concentrations of H ions make water more acidic while lower concentrations make it more alkaline (Gray, 1999 and Tebbut, 1983). Aquatic plants can use CO2 or HCO3. During the day uptake of CO2 may become exhausted so that HCO3 is used. Hydroxide ions are secreted replacing the HCO3. Some of the free CO2 will be precipitated as CaCO3 in hard waters and is then permanently lost. The overall result is an elevated pH (9-10) in water containing actively photosynthesizing macrophytes or algal blooms. At night CO2 is released and the process is reversed so that the pH returns to normal. In clean water pH is controlled by the balance between CO2, HCO3, and CO3, as well as organic acids. So CO3, HCO3 and H2CO3 are all inorganic forms of CO2, and their relative contribution to the total CO2 concentration controls the pH (Gray, 1999).

Acidity and alkalinity are the base and acid neutralizing capacities of water. If the water has no buffering capacity then these are inter-related with pH. Most natural waters will contain weak acids and bases, so acidity and alkalinity should also be tested with pH. Acidity in water is controlled by the presence of strong mineral acids, weak acids (for example carbonic, humic, fulvic) and the hydrolyzing salts of metals (for example iron and aluminium). It is determined by titration with a strong base up to pH 4 (free acidity) or to pH 8.3 (total acidity) (Gray, 1999 and Droste, 1997). Thus the pH values of most natural waters are in the range 4 to 9. Waters of low pH tend to be more corrosive and if the pH value is very low a water can have a sour or acidic taste (Twort et al., 1985, Tebbut, 1983, Droste, 1997 and Round, 1981). The hardness
values were within the normal ranges during the study period with the average of 37.35 CaCO₃ mg/L, and the lower and higher values were 37.13 CaCO₃ mg/L and 37.63 CaCO₃ mg/L, respectively. Furthermore, hardness values indicated that the water of the Engineering Lake classified as soft water (Table 1). The hardness of water varies from place to place reflecting the nature of the geology with which the water has been in contact. In general surface waters are softer than ground waters, although there are many extremely soft ground waters. Hardness is caused by divalent metal cations which can react with certain anions present to form a precipitate. Only divalent cations cause hardness. In hard water Ca, Mg, SO₄, CO₃ and HCO₃ ions are more abundant (Chapman, 1998, Gray, 1999 and Twort et al., 1985).

**Metal concentration in water**

In natural aquatic ecosystem, metals occur in low concentrations, normally at the nanogram to microgram per liter level. In recent times however, the occurrence of metal contaminants especially the heavy metals in excess of natural loads has become a problem of increasing concern. This situation has arisen as a result of the rapid growth of population, increased urbanization and expansion of industrial activities, exploration and exploitation of natural resources, extension of irrigation and other modern agricultural practices as well as the lack of environmental regulations (FAO 1992). In the present study, the mean of six metals (Zn, Cu, Cr, Ni, Pb and Cd) were lower than maximum concentrations allowed by Malaysian and international standards (Table 2). It was obvious that the mean metal concentrations (µg/L) in the water of Engineering Lake based on monthly sampling for (Zn,Cu,Cr,Ni,Pb and Cd) were 10.02,5.36,2.89,2.55, 0.73 and 0.08 µg/L respectively. The maximum concentration of the metals in the water was zinc followed by copper, chromium, nickel, lead and cadmium. The comparison of trace metals with surface water quality guidelines (USEP-Criteria Maximum Concentration (CMC), USEP-Criteria Continuous Concentration (CCC), Canadian Council of Ministers of Environment (CCME), NWQS (Malaysia) - National Water Quality Standards Malaysia) showed that all six metal concentrations below Criteria Maximum Concentration (CMC), thus toxic effects for these metals would be rarely observed, and the adverse effects to aquatic organisms would not frequently occur. Furthermore, the level of heavy metals recorded in water in this study were generally low when compared with the limit of chronic reference values suggested by WHO (1985) and USEPA (1986).

**CONCLUSIONS**

The heavy metals concentration in the water are described in descending order of Zn>Cu>Cr>Ni>Pb > Cd at all sampling sites. The present results indicate that metals concentration in Engineering Lake were lower than the international standards for six metals. For water quality parameters, study showed that the parameters were above natural concentration range (class II) according to National Water Quality Standard (NWQS Malaysia).
REFERENCES.


Baldantoni, D., Alfani, A., & Tommasi, P.D, 2004. *Assessment of macro and microelement accumulation capability of two aquatic plants*. Environmental Pollution, 130, 149-156


Chaisemartin, C., 1983. Natural adaptation to fertilizers containing heavy metals of healthy and contaminated populations of Austropatamobius pailpes (LE). Hydrobiology 17, 229-240.


Fig. 1. Geographical location of Engineering and Built Environment Faculty Lake - UKM, Selangor, Peninsular Malaysia.
Table 1: Monthly averages ± standard deviation of water quality parameters of Engineering Lake, Selangor, Peninsular Malaysia (2019).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Jan</th>
<th>Apr</th>
<th>Jul</th>
<th>Oct</th>
<th>Aver</th>
<th>NWQS Malaysia (class I)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature (°C)</td>
<td>29.49</td>
<td>28.67</td>
<td>29.26</td>
<td>28.65</td>
<td>29.02±0.43</td>
<td></td>
</tr>
<tr>
<td>SPC (µS cm⁻¹)</td>
<td>1333.3</td>
<td>1352</td>
<td>1364</td>
<td>1325.3</td>
<td>1343.7±1.76</td>
<td>1000</td>
</tr>
<tr>
<td>TDS (mg L⁻¹)</td>
<td>990</td>
<td>930</td>
<td>940</td>
<td>810</td>
<td>920±0.08</td>
<td>500</td>
</tr>
<tr>
<td>DO (mg L⁻¹)</td>
<td>5.43</td>
<td>6.27</td>
<td>6.37</td>
<td>5.60</td>
<td>5.92±0.47</td>
<td>± 7</td>
</tr>
<tr>
<td>pH</td>
<td>8.17</td>
<td>8.22</td>
<td>8.14</td>
<td>8.64</td>
<td>8.29±0.24</td>
<td>± 6.5 - 8.5</td>
</tr>
<tr>
<td>Hardness CaCO₃ (mg L⁻¹)</td>
<td>37.20</td>
<td>37.63</td>
<td>37.13</td>
<td>37.44</td>
<td>37.35±0.23</td>
<td>± 50</td>
</tr>
</tbody>
</table>

Notes: NWQS (Malaysia) - National Water Quality Standards Malaysia.

Table 2: Metal concentrations (µg / L) in water of Engineering Lake, Selangor, Peninsular Malaysia (2019).

<table>
<thead>
<tr>
<th>Metal (µg/L)</th>
<th>Jan</th>
<th>Apr</th>
<th>Jul</th>
<th>Oct</th>
<th>Ave</th>
<th>USEP-(CMC) (µg/L)</th>
<th>USEP-(CCC) (µg/L)</th>
<th>CCME - Protection of aquatic life (µg/L)</th>
<th>NWQS Class II (µg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cd (µg/L)</td>
<td>0.08</td>
<td>0.08</td>
<td>0.08</td>
<td>0.08</td>
<td>0.08±0.00</td>
<td>2</td>
<td>0.25</td>
<td>0.017</td>
<td>10</td>
</tr>
<tr>
<td>Cu (µg/L)</td>
<td>5.93</td>
<td>4.93</td>
<td>5.26</td>
<td>5.31</td>
<td>5.36±0.42</td>
<td>13</td>
<td>9</td>
<td>2 - 4</td>
<td>20</td>
</tr>
<tr>
<td>Pb (µg/L)</td>
<td>0.71</td>
<td>0.73</td>
<td>0.73</td>
<td>0.73</td>
<td>0.73±0.01</td>
<td>65</td>
<td>2.5</td>
<td>1 - 7</td>
<td>50</td>
</tr>
<tr>
<td>Zn (µg/L)</td>
<td>10.14</td>
<td>9.92</td>
<td>10.02</td>
<td>10.01</td>
<td>10.02±0.09</td>
<td>120</td>
<td>120</td>
<td>30</td>
<td>5000</td>
</tr>
<tr>
<td>Cr (µg/L)</td>
<td>2.87</td>
<td>2.82</td>
<td>2.94</td>
<td>2.93</td>
<td>2.89±0.06</td>
<td>570</td>
<td>74</td>
<td>8.9</td>
<td>2500</td>
</tr>
<tr>
<td>Ni (µg/L)</td>
<td>2.59</td>
<td>2.51</td>
<td>2.63</td>
<td>2.49</td>
<td>2.55±0.07</td>
<td>470</td>
<td>52</td>
<td>25 - 150</td>
<td>50</td>
</tr>
</tbody>
</table>

Notes: USEP-Criteria Maximum Concentration (CMC), USEP-Criteria Continuous Concentration (CCC), Canadian Council of Ministers of Environment (CCME), NWQS (Malaysia) - National Water Quality Standards Malaysia.