Preliminary Investigation on Electrochemical Parameters of Lake Waters in and around Miri City, Malaysia

M. V. Prasanna¹*, R. Nagarajan¹, A. Elayaraja² and S. Chidambaram³

¹Department of Applied Geology, School of Engineering and Science, Curtin University, CDT 250, 98009 Miri, Sarawak, Malaysia
²Department of Mathematics and Statistics, Faculty of Science and Engineering, Curtin University, Perth, Western Australia
³Department of Earth Sciences, Annamalai University, India

ABSTRACT

Surface water samples were collected from 16 Lakes in and around Miri City to assess the electrochemical parameters includes pH, Electrical conductivity (EC), Total dissolved solid (TDS), redox potential (Eh), resistivity and salinity. Sampling locations for monitoring were selected in the vicinity of major roads, industries, settlements and agricultural region. Interpretation of data shows that the surface water in the central region of the study area is polluted by various anthropogenic activities, while in the southern part is within the limits of guideline values. This kind of investigation is essential in the study area to save the resources for future perspective. Further detailed studies are also needed to get a clear picture of the surface water quality in Miri city and for future sustainable management of this resource.

Keywords: Lake water, electrochemical parameters, pollution, Miri City

INTRODUCTION

Lakes are distinctive and valued ecosystems, which forms the lifeline of many biota. Lakes are affected by various factors like pollution, loss of biodiversity, incursion of foreign species, watershed disposal, as well as declining water levels (Kaverina & Pogozheva, 2005).

In fact, lakes are subjected to continuous evolutionary changes and finally ends up with the remnants of lake organisms and with soil carried in by floods. These physical and chemical changes of a lake affect the plant and animal populations. However, human activities also give stress to the lakes. The variations in the physico-chemical properties of lakes is due to number of factors, but mainly by rainwater dilution gives seasonal changes...
(Odo & Ijere, 1997) and variety of pollutants discharged into the lakes from surrounding activities (Manahan, 2005). Many works have been focused on human impact on the various ecosystem (Niemi et al., 1990; Issa et al., 1996; Szymanowska et al., 1999; Prasanna et al., 2012a). The spatial and temporal variations in surface waters provides a holistic picture of water quality (Dixon & Chiswell, 1996). The lakes also serve as reservoir for the recharging aquifers (Prasanna et al., 2011), hence the quality of water in these lakes are significant.

Miri city is covered by beaches, industries, residential colonies and agricultural areas. Increasing population and economic development in Miri leads to the scarcity for freshwater resource. Recent literature surveys showed high contamination of the lakes in and around Miri city (Prasanna et al., 2012a&b). Hence, this current research work provides a baseline monitoring information on lake water quality affected by natural and anthropogenic impacts in and around Miri city.

STUDY AREA

The study area falls between the latitudes N4°21’18” – N4°35’42” and longitudes E113°57’54” – E114°05’6” and located in Miri City, the Sarawak State of East Malaysia (Fig.1). The lithology of the area consist mainly of sandstones, and laminated to thin bedded siltstones and mudstones. The residual soil cover derived from these rock types is silty or clayey sand and silty clay, weathered from sandstones and mudstones/shales, respectively. The climate of this region is controlled by northeast and southwest monsoons and the average temperature of a year is 26°C. Sarawak experiences more rainfall than west Malaysia, ranging from 3,000 to 4,000 mm/yr.

Fig.1: Location map and sampling points of the study area (Prasanna et al., 2012a)
METHODOLOGY

Sixteen surface water samples were collected in June, 2011 from various lakes in and around Miri city to assess the water quality (Fig.1). Most of the monitoring sampling points are located in the vicinity of major roads, industries, settlements and agricultural areas. pH, total dissolved solids (TDS), Electrical conductivity (EC), redox potential (Eh), resistivity, salinity and temperature of lake waters were determined in situ using portable pH and conductivity meter (model-Thermo Scientific Orion Star, 4 Star Plus Meter). The instrument was calibrated with standard solutions before each parameter measurement.

RESULTS AND DISCUSSION

A summary of the measured parameters of samples is given in Table 1. The pH values of the lake water were found to ranges from 4.20 to 8.72, with an average of 7.24. This indicates that the lake water is mainly from neutral to alkaline, except at the sampling point (S5), which shows a low pH value (4.20), indicating acidic in nature. A record of a high pH value (8.72) was observed at S15, which is higher than the permissible limit of the standard outlined by the World Health Organization (WHO, 2004). The spatial distribution of pH map (Fig.2) shows that the highest values were noted in the southern part and a small pocket in the northern side, while the lowest values were observed in the north eastern part of the study area. The highest pH values were observed in lake waters that are situated near recreational centres, restaurants and settlements. Waste disposal and discharge of domestic wastes from this region may have increased the pH values in the surface water. Meanwhile, the lowest pH value of 4.20 was observed at S5, which is mainly due to the presence of sulfide minerals in the shale formation and minor coal seams in sandstones and shales (Siddharth et al., 2004). This was also confirmed by the low turbidity observed in that sample. Intensive agricultural activities and leaching of peat soils in this region are also responsible for the transport of salts into the lakes (Prasanna et al., 2010).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Min</th>
<th>Average</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temp °C</td>
<td>27.00</td>
<td>31.04</td>
<td>34.60</td>
</tr>
<tr>
<td>pH</td>
<td>4.20</td>
<td>7.24</td>
<td>8.72</td>
</tr>
<tr>
<td>EC (µS/cm)</td>
<td>49.50</td>
<td>1208.44</td>
<td>13770.00</td>
</tr>
<tr>
<td>Salinity (ppt)</td>
<td>0.10</td>
<td>0.66</td>
<td>8.00</td>
</tr>
<tr>
<td>Resistivity (MΩ-cm)</td>
<td>0.0001</td>
<td>0.0060</td>
<td>0.0200</td>
</tr>
<tr>
<td>Eh (mV)</td>
<td>13.70</td>
<td>41.34</td>
<td>196.90</td>
</tr>
<tr>
<td>TDS (mg/l)</td>
<td>24.00</td>
<td>592.25</td>
<td>6749.00</td>
</tr>
</tbody>
</table>

On contrary to the general decrease in the pH values in the north eastern side of the study area, results a general increase in the Eh values. The Eh values ranged from 13.70 to 196.90, with an average of 41.34, indicating that surface water could be characterized as a low oxidizing
environment. The high values of the Eh was recorded in the north eastern part of the study area (Fig.3) indicating high oxidation conditions and also serves as a favorable condition for aquatic biota. It is also inferred that the increase of $O_2$ content in water increases the Eh value. Interestingly at S6, the Eh value is higher (40.4mV), but it is very near to S6A which shows a comparatively low value (29mV). This is due to the aquaculture activity in Lake S6, the continuous process of aeration increases $O_2$ in this lake.

In general, electrical conductivity (EC) depends on various factors like temperature, ionic concentration and type of ions in the water (Hem, 1985). EC is used to monitor the water quality for irrigation and drinking purposes, depending on salinity, ionic concentration and temperature. The EC values range from 49.50 µs/cm to 13770 µs/cm, with an average of 1208.44 µs/cm. The EC value of the surface waters indicate that all the samples fall within the permissible limit of WHO standard, except at S7 Lake. The spatial distribution map of EC (Fig.4) shows that higher values (particularly at S7 with EC value 13770 µs/cm) were observed in the central part of Miri, where is highly occupied by settlements. Such anomalous values arise from various anthropogenic activities near the residential area. Interestingly, the salinity at S7 is 8 ppt, which is also quite higher than the salinity of other lakes due to the increasing ionic concentration due to the discharge of domestic sewage. The TDS values of the lake waters ranged from 24mg/l to 6749mg/l, with an average value of 592.25 mg/l. All the samples fall within the permissible limit of WHO standard, except at S7.

![Fig.2: Spatial distribution map for pH](image-url)
Fig.3: Spatial distribution map for Eh

Fig.4: The spatial distribution map for EC in µS/cm
Resistivity value is dependent upon the conductance of water. In surface waters, resistivity values range from 0.0001 MΩ-cm to 0.0200 MΩ-cm, with an average of 0.0060 MΩ-cm. The spatial distribution of the resistivity map (Fig.5) shows that the low resistivity values were observed in the residential area, which determined the poor water quality zone caused by various anthropogenic activities. In the southern part of the study area, the resistivity values were higher, indicating the non-polluted zone. It was also substantiated with the low values of EC and TDS observed in these regions.

CONCLUSION

This study shows that the lake water in and around Miri City is neutral to alkaline in nature. All the samples are within the permissible limit, except at S7, which is highly contaminated by waste disposal from the residents. This research study also reveals that the lakes in the central part of the study area are contaminated by various anthropogenic activities and safe in the southern part. In future studies, seasonal monitoring approach is required to explicate the degree of pollution using major ions, metals and organic parameters. This also helps us to judiciously manage the fresh water lakes and to adopt strategies to prevent further pollution in these water bodies.
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REFERENCES


