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

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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 afftected 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

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(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, residental 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.

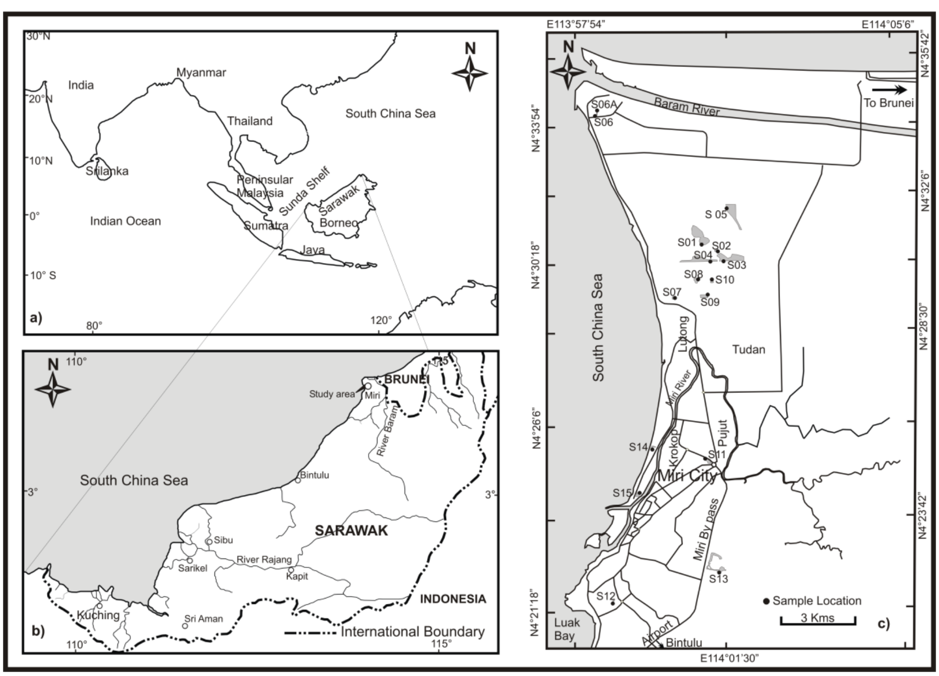

Fig.1: Location map and sampling points of the study area (Prasanna *et al*., 2012a)

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 soilds (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 1
Maximum, minimum and average values of the parameters

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

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.

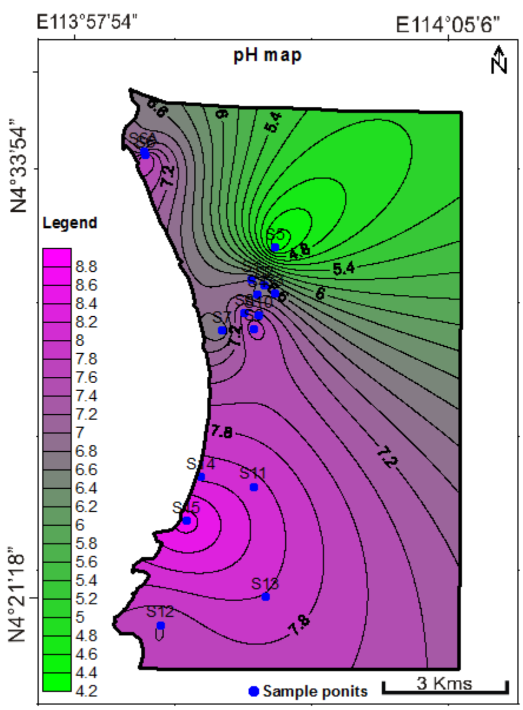

Fig.2: Spatial distribution map for pH

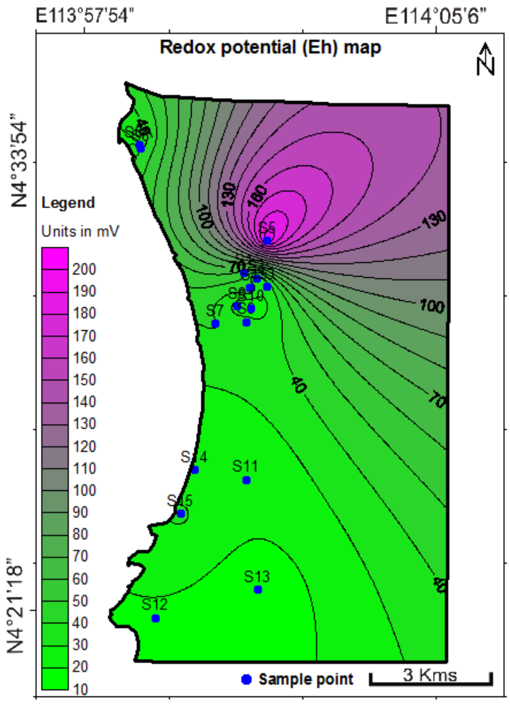

Fig.3: Spatial distribution map for Eh

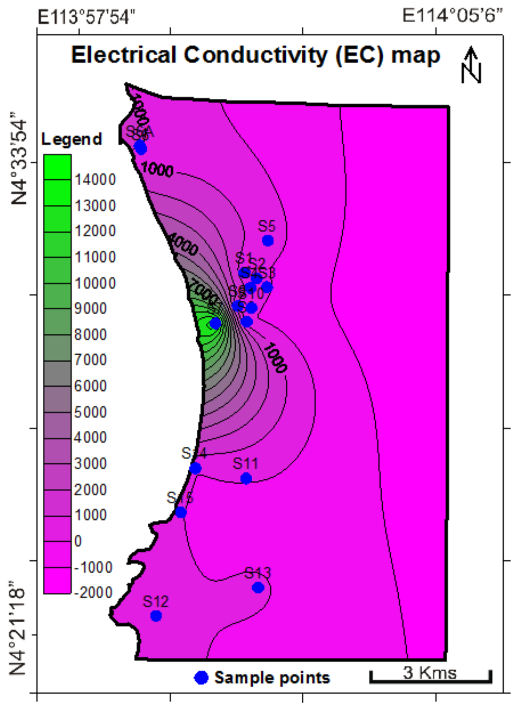

Fig.4: The spatial distribution map for EC in µS/cm

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 resisitivity map (Fig.5) shows that the low resistivity values were observed in the residental 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 judisiously manage the fresh water lakes and to adopt strategies to prevent further pollution in these water bodies.

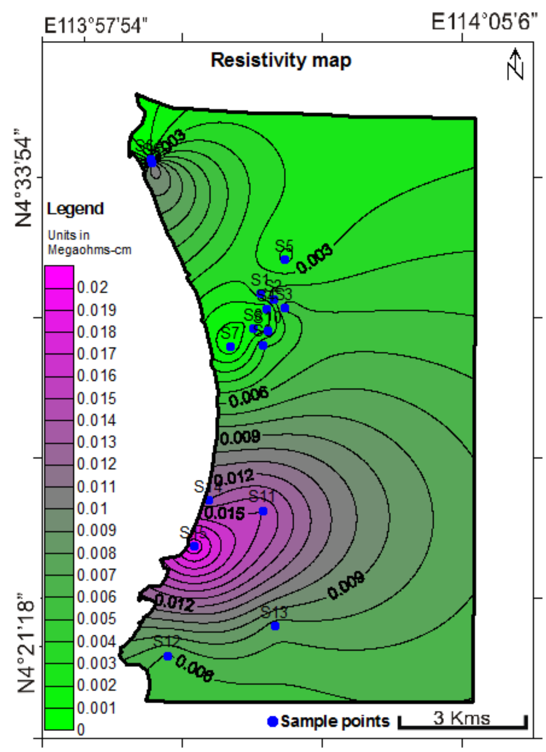

Fig.5: Spatial distribution map for Resistivity

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REFERENCES

Dixon, W., & Chiswell, B. (1996). Review of aquatic monitoring program design. *Water Research, 30*, 1935-1948.

Hem, J. D. (1985). *Study and interpretation of the chemical characteristics of natural water* (3rd Edn., p. 2254). Jodhpur, India: Scientific.

Issa, Y. M., Elewa, A. A., Rizk, M. S., & Hassouna, A. F. A. (1996). Distribution of some heavy metals in Qaroun lake and river Nile, Egypt, Menofiya. *Journal of Agricultural Research, 21*, 733-746.

Kaverina, I., & Pogozheva, V. (2005). *Geochemical study of Lake Imandra, Russia. Evaluation of effect of mining industries on the water quality.* Master Thesis, Lulea University of Technology, Sweden, 56p.

Manahan, S. E. (2005). *Environmental Chemistry* (8th Edn). CRC Press LLC, USA. pp. 169-180; 687.

Niemi, G. J., Devore, P., Detenbeck, N., Taylor, D., & Lima, A. (1990). Overview of case studies on recovery of aquatic systems from disturbance. *Environmental Management, 14*, 571-587.

Odo P. E., & Ijere, J. A. (1997). Quality analysis of water from Alau dam area in the north eastern Nigeria for irrigation suitability and some related agronomic and environmental implications. Issues in environmental monitoring in Nigeria. *Nig. Geographical Ass*., 63-67.

Prasanna, M. V., Chidambaram, S., Gireesh, T. V., & Jabir Ali, T. V. (2011). A study on hydrochemical characteristics of surface and sub-surface water in and around Perumal Lake, Cuddalore district, Tamil Nadu, South India. *Environmental Earth Sciences, 63,* 31-47.

Prasanna, M. V., Chidambaram, S., Shahul Hameed, A., & Srinivasamoorthy, K. (2010). Study of evaluation of groundwater in Gadilam basin using hydrogeochemical and isotope data. *Environmental Monitoring and Assessment, 168*, 63-90.

Prasanna, M. V., Nagarajan, R., Chidambaram, S., & Elayaraja, A. (2012a). Assessment of metals distribution and microbial contamination at selected lake waters in and around Miri City, East Malaysia. *Bulletin of Environmental Contamination and Toxicology, 89,* 507-511.

Prasanna, M. V., Praveena, S. M., Chidambaram, S., Nagarajan, R., & Elayaraja, A. (2012b). Evaluation of water quality pollution indices for heavy metal contamination monitoring: a case study from Curtin Lake, Miri City, East Malaysia. *Environmental Earth Sciences, 67,* 1987-2001.

Siddharth, S., Jamal, A., Tiwary, R. K., & Dhar, B. B. (2004). Pridicting drainage quality for sustainable exploitation of coal. *Journal of Scientific & Industrial Research, 63*, 919-926.

Szymanowska, A., Samecka-Cymerman, A., & Kempers, A. J. (2009). Heavy metals in three lakes in West Poland. *Ecotoxicology and Environmental Safety*, *43*, 21-29.

WHO (2004). Guidelines for drinking water quality recommendations (2nd Edn). Geneva: WHO.