

THE EFFECT OF LAND USED ON THE WATER QUALITY OF OXBOW LAKES IN SABAH

(Kesan Gunatanah Terhadap Kualiti Air Tasik Ladam di Sabah)

Ajimi Jawan^{1*} and Viduriati Sumin²

¹Faculty of Applied Science,

² Faculty of Plantation and Agrotechnology,
Universiti Teknologi MARA Cawangan Sabah Beg Berkunci 71, 88997, Kota Kinabalu, Sabah

*Corresponding author: ajimi@sabah.uitm.edu.my

Abstract

The unique and isolated nature of oxbow lakes from its parent river is reflected by its water quality. This study was carried out to determine the water quality of oxbow lake located along the Sg. Sugut, Beluran, Sg. Padas, Beaufort and Sg. Kinabatangan, Sandakan, Sabah with different human activities. Physical and chemical parameters studied on site were dissolved oxygen (DO), temperature, pH value, conductivity and secchi disk depth (SDD) while those analysed in the laboratory were total suspended solid (TSS), total phosphorus (TP) and chlorophyll-a. From the results indicate human activities near oxbow lake cause increment of nutrient. It will lead ecotone by eutrophication that start succession of water bodies to terrestrial land. Number of oxbow lakes and its uniqueness will diminish and its function as organisms sanctuary will be greatly affected.

Keywords: Oxbow lake, water quality, land used

Abstrak

Keunikan dan persekitaran semulajadi tasik ladam yang terpisah daripada aliran sungai utama dapat diperhatikan melalui penilaian status kualiti airnya. Kajian ini telah dijalankan untuk menentukan kesan terhadap kualiti air tasik ladam yang terletak di sepanjang Sg. Sugut, Beluran, Sg. Padas, Beaufort dan Sg. Kinabatangan, Sandakan, Sabah akibat beberapa jenis aktiviti manusia. Parameter fizikal dan kimia yang dianalisis di lapangan ialah kandungan oksigen terlarut (DO), suhu, nilai pH, kekonduksian dan kedalaman cakera secchi (SDD) manakala parameter yang dianalisis di makmal ialah jumlah pepejal terampai (TSS), jumlah fosforus (TP) dan klorofil-a. Keputusan kajian menunjukkan bahawa aktiviti manusia berhampiran tasik ladam menjadi punca terhadap peningkatan kandungan nutrien. Ia seterusnya akan mengubah keadaan tasik melalui proses eutrofikasi yang bermula dengan perubahan tasik menjadi kawasan tanah daratan. Bilangan tasik ladam dan sifat uniknya akan berkurangan manakala fungsinya sebagai tempat perlindungan organisma juga akan terjejas.

Kata kunci: Tasik Oxbow, kualiti air, guna tanah

Introduction

The unique and isolated nature of oxbow lakes from its origin will provide a wide range of habitats as different stages of oxbow lakes formation will bring to different status and diversity of organisms in the water bodies itself. The rich diversity of organisms in the oxbow lakes creates potential value to aquatic breeding grounds for some of the richest freshwater fisheries. Besides that, its isolated nature brings out the various vegetation and habitat of animals such as proboscis monkey and become attraction for nature tourism. Nature based tourism, agro-forestry and other ventures depending on environmental management able to offers new opportunities for economic diversification for local communities and entrepreneurs.

Materials and Methods

Study Sites

Six oxbow lakes located along the Sg. Sugut, Sg. Kinabatangan and Sg. Padas were chosen. All lakes represent the land used namely near village, near oil palm plantation and near non-develop land. Water depth for these studied oxbow lakes ranged from 2.0 to 5.0 meter.

Water Quality

Physical water quality parameters such as dissolved oxygen (DO), temperature, pH value, conductivity and transparency, were monitored in-situ at the sampling stations. These parameters were measured at the surface of the lakes and rivers using a multiprobe YSI Hydro LAB Model 6920M. Transparency of water measured using secchi disk. Nutrients were determined using DR2000 HACH Kit. For nutrient analyses, phosphorus was measured as total phosphorus. Sampled water was stored in polyethylene bottle and preserved using 1 ml of HCl [1]. Chlorophyll-a was analysed using trichlorometric method.

Water quality level were determined with 2 methods namely Water Quality Index (WQI_{min}) [2] and Tropic Carlson Index (TCI) [3].

To study the biological productivity of the oxbow lakes, Tropic Carlson Index (TCI) was used. This index will facilitated in the observation of the effects of eutrophication on oxbow lakes.

3 parameters used for classification of the Water Quality Index (WQI_{min}), namely dissolves oxygen (DO), temperature and pH value. According to WQI, the range of 0–25 is very bad, 26–50 is bad, 51–70 is medium, 71–90 is good and 91–100 is excellent [2]. For Tropic Carlson Index, parameters used are transparency, total phosphorus and chlorophyll a. Scores of all parameters calculated and each lake classify as Eutrophic (excessive nutrients), Mesotrophic (intermediate) or Oligotrophic (low nutrient content) [4].

Results and Discussion

Based on physical and biological parameters, water quality of oxbow lakes was identified into different classes as in Table 1. In general, the lakes are located in the area of village and oil palm plantations are a mid-polluted lakes and eutrophication affected. Lake Kelendaun and Lake Abai are lakes that have the highest eutrophication impact of being in a class eutrophic, both located at Kinabatangan River.

Table 1. Classification of Water Quality Index

Sampling Site	Lake	Location (River)	WQI_{min}		TCI	
			Score	Class	Score	Class
near village	Kelendaun	Kinabatangan	45.45	Bad	10	Eutrophic
near village	Abai	Kinabatangan	55.45	Moderate	11	Eutrophic
near oil palm	63	Sugut	55.45	Moderate	9	Mesotrophic
near oil palm	Rampang	Padas	56.36	Moderate	8	Mesotrophic
near oil palm	Kaboi	Kinabatangan	62.73	Moderate	9	Mesotrophic
near village	33	Sugut	66.36	Moderate	9	Mesotrophic
near village	Lawa	Padas	67.27	Moderate	9	Mesotrophic
non-develop land	117	Sugut	70.91	Good	9	Mesotrophic

Kelendaun lake is located near the village of Sukau and Abai lake is located near the village of Abai. This short distance between the villages and the lakes allows wastes from daily activities to polluting the water, especially during the wet season. In addition, there are deforestation and fishing activities that may interfere with oxbow lake ecosystem.

If viewed in detailed on the score of the WQI_{min} , showed that Lake 63, Lake Rampang and Lake Kaboi which also polluted, with scores approached the range of polluted lake. This shows the oil palm plantation activities affect the water quality changes in an oxbow lakes around it. Groundwater flow and the effects changes in the wet season can lead to increase fertility into the oxbow lake. This situation cause increase in the concentration of chemical nutrients in an ecosystem to an extent that increases in the primary productivity.

Lake 117 is a natural lake located in areas with no pollutant sources as can be seen on the index ($WQI_{min} = 70.91$) as good and ($TCI = 9$) as mesotrofi. In addition, it also has among the high average reading for dissolved oxygen (DO), lower reading of secchi disk depth (SDD) and lower amount of Total Suspended Solids (TSS) (Table 2).

Eutrophication effect is the high level of nutrients in the water body that can result in reduced water clarity, lower dissolved oxygen levels, and toxic water quality. This situation can cause excessive of aquatic macrophyte growth and oxygen depletion. In the long term, water bodies will change the area become a dry land. This effect occurred in Lake Kelendaun and Lake Abai at Kinabatangan River. Both lakes, approximately at least 15% of lake surface area has come filled with floating aquatic plant namely *Salvinia molesta* and water hyacinth. The lake will continue to be shallow and therefore cause termocline level, where the water warms up the lake that will encourage the growth of aquatic plants such as rooted plants and increased organism such as small fish, frogs, water snakes and turtles [5]. In the long term, the lake water will dry up and turn into dry land.

Table 2. Physical and Chemical Parameters of Oxbow Lakes

Lake	Temp. (°C)	TSS (mg/l)	pH	DO (mg/l)	TP (mg/l)	Chl-a (mg/l)	SDD (m)
Abai	29.74 (±0.02)	139.74 (±12.37)	7.82 (±0.26)	4.19 (±0.30)	0.35 (±0.01)	3.90 (±0.50)	1.94 (±0.10)
Kelendaun	29.76 (±0.02)	156.84 (±6.76)	7.24 (±0.03)	2.18 (±0.06)	0.23 (±0.01)	2.57 (±0.55)	1.28 (±0.15)
Kaboi	29.90 (±0.00)	85.94 (±26.31)	6.23 (±0.08)	3.96 (±0.03)	0.34 (±0.02)	5.16 (±0.70)	1.50 (±0.20)
33	29.21 (±0.12)	33.29 (±7.24)	6.41 (±0.06)	3.54 (±0.31)	0.20 (±0.01)	2.29 (±0.75)	2.07 (±0.20)
Lawa	29.60 (±0.00)	78.40 (±4.93)	7.14 (±0.02)	4.35 (±0.05)	0.03 (±0.01)	2.79 (±0.31)	1.70 (±0.10)
117	29.17 (±0.13)	39.23 (±6.65)	6.62 (±0.06)	4.05 (±0.27)	0.23 (±0.01)	3.74 (±0.78)	1.84 (±0.15)

* average (S.E)

Temperature is one of the important parameters in affecting the solubility of oxygen in water, the photosynthesis and the metabolic rate and growth process of aquatic organisms. The temperature of surface water is influenced by latitude, altitude, season, time of day, air circulation, cloud cover, also the flow and depth of the water body [6]. Water temperatures of oxbow lakes in this studies were in the normal range of water temperatures of tropical lakes and were influenced by the presence of tree canopies over the lakes and time of the day.

Total Suspended Solid (TSS) includes all particles suspended in water such as plankton, clay and mud. Content would cause turbidity can block sunlight, disrupt the process of respiration thus being in a body of water. The development of algae in the water can also able to prevent the rays of lights are important resources for aquatic life

[7]. Comparison between areas with human activities and natural areas shown that there are differences in the reading of the TSS (Table 2). This shows the effect of land use has affected oxbow lake water quality.

pH is an important variable in the water quality assessments as it influences many biological and chemical processes within a water body. Changes in pH can indicate the presence of certain effluents. pH of most natural waters ranges between 6.0-8.5 [6]. pH of the oxbow lakes waters were in nature range with a range 6.23-7.82 (Table 2). This value shows the studied oxbow lake water bodies are in neutral condition. The monitoring of pH value is important to the aquatic organisms growth especially for the algal bloom.

Low dissolved oxygen content is often an indicator of organic pollution. According to Wetzel and Likens [8], the low dissolved oxygen value indicates that there is an oxygen demand by the organic wastes. Besides, dissolved oxygen value recorded below 5 mg/L can effect the functioning and survival of biological communities. The dissolved oxygen concentrations were recorded in low values, with a mean of 3.71 mg/L where Lake Kelendaun at Kinabatangan River is the lowest with 2.18 mg/L (Table 2). This shows that there are plenty of aquatic organisms colonizing the oxbow lakes and these oxbow lakes are having the probability of facing eutrophication problem due to algal bloom. Readings of chlorophyll-a also shows this effect where all the lake are reading more than 2.00 mg/L.

Total phosphorous (TP) content is excess of 0.03 mg/L (Table 2) would lead to the growth of phytoplankton and aquatic life and cause eutrophication. Value of total phosphorous (TP) in natural water that is not polluted is less than 1 μ g/L [8]. All these studies shows that the number of lake total phosphorus exceeding the range and shows the effect of eutrophication.

Conclusion

The physical and nutrient parameters recoded indicate these oxbow lakes are having moderate pollution. These pollution contributor are suggested from an agricultural and human activities. Therefore, from this study, some management plan can be suggested and built upon through understanding of how the water quality, biological productivity and how physical, chemical and biological interactions in the lake will further modify lakes quality. Besides continuing the effort to determine the status and potentials of this kind of oxbow lakes model ecosystem, conservation and treatment must be not forgotten in order to develop a quality and commercial nature tourism of oxbow lakes ecosystem.

References

1. APHA., (1989). *Standard Methods for the Examination of Water and Waste Water*. 17th Edition. Washington: American Public Health Association.
2. Kannel, P. R., Lee, S., Lee, Y.-S., Kanel, S.R. and Khan, S.P., (2007). Application of Water Quality Indices and Dissolved Oxygen as Indicators for River Water Classification and Urban Impact Assessment. *Environment Monitoring Assess.* 132:93–110.
3. Carlson, R.E. and Simpson, J., (1996). *A Coordinator's Guide to Volunteer Lake Monitoring Methods*. Kent: North American Lake Management Society.
4. Mason, C.F., (1996). *Biology of Freshwater Pollution* (3rd edition). Department of Biology, University of Essex: Longman.
5. Benton, A. H. and Werner, W., (1974). *Field Biology and Ecology*. New Delhi: McGraw-Hill Publishing Company.
6. Chapman, D., (1992). *Water Quality Assesments- A guide To The Use of Biota, Sediments and Water in Environmental Monitoring*. London : Chapman & Hall.
7. Brönmark, C. and Hansson, L., (1998). *The Biology of Lakes and Ponds*. Oxford: University Press Inc.
8. Wetzel, R. G. and Likens, G., (1991). *Limonological Analyses*. New York: Springer-Verlang.