THE IMPACT OF LOGGING ACTIVITY TOWARDS WATER QUALITY AND ECOSYSTEM OF TASIK CHINI, PAHANG

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ABSTRACT

This study was carried out in March, April and May 2013 during dry day and raining day to determine the impact of logging activities toward water quality and ecosystem of Tasik Chini, Pahang. The result for each parameter in water quality is classified based on National Water Quality Standard (NWQS) and Water Quality Index (WQI). A total of six sampling stations were selected for this study which are Laut Gumum, Laut Jerangking, Laut Kenawar, Laut Melai, Laut Pulau Balai and Resort Tasik Chini. Thirteen water quality parameters were analyzed based on in-situ and ex-situ analysis during two season's period. The methods used for laboratory analysis are based on APHA, HACH and IDEXX Colilert Methods. For physical parameter, the water quality findings were: turbidity (3.1-61.35 NTU), temperature (26.44-31.95 °C) and TSS (3-24.33mg/L). The findings for chemical parameter were BOD (1.6-7.55 mg/L), COD (13-67 mg/L), DO (2.75-8.38 mg/L), nitrate (0.01-0.14 mg/L), phosphate (0.01-1.23 mg/L), pH (4.96-6.48), ammoniacal nitrogen (0.007-0.073 mg/L), and electrical conductivity (16-35 µS/cm). The findings for biological parameter were total coliform (67-739 MPN/100ml) and E-coli (1.7-135.9 MPN/100ml). The range of every parameter is higher during wet day compare to dry day. The water quality was majorly impacted at station Laut Jerangking due to nearest logging activities and rubber plantation while at station Laut Gumum due to nearest agricultural activities, palm oil plantation and settlement of indigenous people. From the analysis, the logging activities near Laut Jerangking did affected the water quality by physical, chemical and biological means. The deterioration of water quality cause the increasing growth of cat tail (*Cabomba furcata*) and the growth of water lily which can be easily found previously (*Nelumbo nucifera*) had currently decreasing. The NWQS for the lake in both seasons is in Class II while the WQI was classified under Class II which is slightly polluted. This shows that the lake is in degradation state which can cause long term deterioration if no drastic lake's restoration is carried out.

ABSTRAK

Kajian ini telah dijalankan pada Mac, April dan May 2013 semasa cuaca panas dan hujan untuk menentukan kesan aktiviti pembalakan terhadap kualiti air dan ekosistem di Tasik Chini, Pahang. Keputusan bagi setiap parameter kualiti air telah diklasifikasikan berdasarkan Standard Kualiti Air Kebangsaan (NWQS) dan Indeks Kualiti Air (WQI). Sebanyak enam stesen persampelan telah dipilih untuk kajian ini iaitu Laut Gumum, Laut Jerangking, Laut Kenawar, Laut Melai, Laut Pulau Balai and Resort Tasik Chini. Sebanyak tiga belas parameter kualiti air telah dianalisis berdasarkan in-situ dan ex-situ analysis dalam tempoh dua musim ini. Kaedah yang digunakan untuk analisis makmal adalah berdasarkan keadah APHA, HACH and IDEXX Colilert. Bagi parameter fizikal, keputusan kualiti air ialah: kekeruhan (3.1-61.35 NTU), suhu (26.44-31.95 °C) dan TSS (3-24.33 mg/L). Hasil kajian bagi parameter kimia ialah BOD (1.6-7.55 mg/L), COD (13-67 mg/L), DO (2.75-8.38 mg/L), nitrat (0.01-0.14 mg/L), fosfat (0.01-1.23 mg/L), pH (4.96-6.48), nitrogen ammonia (0.007-0.073 mg/L), dan kekonduksian elektrik (16-35 µS/cm). Keputusan untuk parameter biologi ialah jumlah koliform (67-739 MPN/100ml) dan E-coli (1.7-135.9 MPN/100ml). Julat setiap parameter adalah lebih tinggi pada hari hujan berbanding hari panas. Kualiti air terjejas teruk di stesen Laut Jerangking akibat aktiviti pembalakan dan ladang getah berdekatan manakala di stesen Laut Gumum kerana aktiviti pertanian, ladang kelapa sawit dan penempatan orang asli berhampiran. Berdasarkan analisis, aktiviti pembalakan berhampiran Laut Jerangking telah menjejaskan kualiti air secara fizikal, kimia dan biologi. Kemerosotan kualiti air menyebabkan peningkatan pertumbuhan ekor kucing (*Cabomba furcata*) manakala teratai yang mudah didapati sebelum ini (*Nelumbo nucifera*) kini telah berkurangan. NWQS untuk tasik di kedua-dua musim adalah dalam Kelas II manakala WQI juga dalam Kelas II yang sedikit tercemar. Hal ini menunjukkan bahawa tasik berada dalam keadaan terjejas dan boleh menyebabkan kemerosotan jangka panjang jika tiada pemulihan tasik secara drastik dijalankan

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LIST OF SYMBOLS

%	Percentage
°C	degree celcius
µS/cm	microsiemen per centimeter
Cr^{3+}	chromic ion
Cr^{6+}	hexavalent chromium
$Cr^2O_7^{2-}$	dichromate ion
E-coli	Escherichia coliform
ha	hectare
H_2SO_4	sulphuric acid
km^2	kilometer square
L	liter
mm	millimeter
m^3/s	meter cube per second
mg/L	milligram per liter
Mm^3	mega meter cube
$Na_2S_2O_3$	sodium thiosulphate
$NH_3 - N$	ammoniacal nitrogen
nm	nano meter
NO_3^-	nitrate
O_2	oxygen
PO_4^{2-}	phosphate
SO_4^{2-}	sulphate

LIST OF ABBREVIATIONS

AN	Ammoniacal nitrogen
APHA	American Public Health Association
BOD	Boichemical oxygen demand
BOD_5	Biochemical oxygen demand for 5 day
CFU	Colony forming unit
COD	Chemical oxygen demand
DID	Department of Irrigation and Drainage
DO	Disssolved oxygen
DOE	Department of Environment
EC	Electrical conductivity
GPS	Global Positioning System
HDPE	High-density Polyethylene
LCRA	Lower Colorado River Authority
LR	Low Range
MMD	Malaysia Meterological Department
MW	mega watt
NAHRIM	National Hydraulic Research Institute of Malaysia
NTU	Nephelometric turbidity unit
NWQS	National Water Quality Standard
ORASECOM	Orange-Senqu River Commision
PLKN	Pusat Latihan Khidmat Negara
SS	Suspended solid
TCU	True colour unit
TDS	Total dissolved solid
TNB	Tenaga National Berhad
TSS	Total suspended solid
WQI	Water Quality Index

CHAPTER 1

INTRODUCTION

1.1 Introduction

Lake is a fresh or salt still water inland body that stored in a basin which is surrounded by land. Usually, a river, stream or other form of moving water are serves to feed or drain the lake. Within this water body, the lake ecosystems are made up of the interaction among biological, chemical and physical processes that are distinct either quantitatively or qualitatively from those on land or in air (Hairston & Fussman, 2002). The lake plays an important ecosystem as many living organisms depend on freshwater for survival. Human depend on lake for drinking water, fisheries, agricultural irrigation, industrial activity and recreational purposes. Lakes are essential for the maintenance of human life as the integral components of our planet's life-support systems (Kumar & Hader, 1999). As a natural wetland, the lake plays an important ecosystem for natural flood retention basin, reduces riverbank erosion, and acts as a natural sponge to absorb flood water in protecting the downstream area from fatal flooding. It also help to recharge groundwater aquifers by holding water and allowing it to infiltrate the ground slowly.

In Malaysia, the natural lakes that can be found are Tasik Bera and Tasik Chini in Pahang and also Tasik Loagan Bunut in Sarawak. They formed part of storage basins for water supply, agriculture and also for hydropower function. Lakes also play an important role as flood control detention storage to buffer the different flow between dry and wet season. (Sengupta & Dalwani (Eds.), 2008)

1.2 Problem Statement

Logging activities at Bukit Tebakang which situated at 210m at the north of Tasik Chini may affect the water quality and ecosystem of the lake. The possible effects of logging activities include impacts on streamflow regimes and impacts on erosion and sedimentation (Coats & Miller, 1981). Sedimentation causes the lake to become shallow and the streamflow become slow. The slow motion of the streamflow also encourages the growth of bacteria which pollute the water for domestic used. The function of this study is to define the impact of logging towards the ecosystem and water quality of the lake. The water quality is depending on the eutrophication level of the lake. As the eutrophication become worst, the water quality also will be affected.

1.3 Objectives of the Study

The objectives of the study are:

i) To identify the impact of logging on water quality and ecosystem of the lake in dry and raining day.

ii) To classify the class of water quality at Tasik Chini based on DOE Water Quality Index (WQI) and National Water Quality Standard for Malaysia (NWQS)

1.4 Scope of Study

The scopes of the study include the following procedures:

i) Collect water sample from Tasik Chini during dry and raining day

ii) Conducting in-situ test using YSI Mutiparameter probe based on dissolved oxygen (DO), total Suspended Solid (TSS), turbidity, pH and electrical conductivity (EC).

iii) Conducting laboratory test on water quality based on specified parameter which are chemical oxygen demand (COD), biochemical oxygen demand (BOD), ammoniacal nitrogen (AN), phosphate, nitrate, total coliform test and E-Coli test.

iv) Interpreting and analyzing the data based on the result of the test

v) Classifying the water quality status based on Malaysia NWQS and DOE WQI

vi) Make a conclusion based on analysis regarding the impact towards water quality and ecosystem.

vii) Find the appropriate and effective solution towards the problem regarding the declination of water quality and ecosystem in Tasik Chini

1.5 Significant of Study

The study of physical, biological and chemical water quality parameters will giving the opportunity for the student to conduct water sampling, to carry out laboratory testing for the analysis of the water, to identify the cause of logging toward water quality in Tasik Chini and to come up with the classification of water quality at Tasik Chini based on DOE Water Quality Index (WQI) and National Water Quality Standard for Malaysia (NWQS). The result obtained will be analyzed to overcome the eutrophication process at the lake in maintaining our sustainable development of our natural water resources. The outcome of the study can be forwarded to the responsible authorities such as NAHRIM, DID, and also DOE in forming a strategic development and improvement of the water systems in Malaysia. This will also serve as one of the community service from Universiti Malaysia Pahang.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Water is the most important compound that can only be found at planet earth. About 75% of our earth surface is covers with water which is representing a volume of over one billion cubic kilometer (Smol, 2008). The source of surface water are lake, river and sea. However, nowadays only small portion of water is fresh and accessible. The rest of our source of water are started to be polluted and contaminated by the rapid urbanization and deforestation near the source of water. Most of the waste water discharge from industry is not treated well and cause degradation of water quality especially lake. The properties of lake as the still water inland body stored in the basin will cause the pollutant to be trap in the water. The increasing pollutant will cause eutrophication and affect the declination of aquatic biodiversity in the lake. This causes changes in lake ecosystem leading to loss of biodiversity and retarded the important natural services provided by lakes.

2.2 Lake and Reservoir in Malaysia

Malaysia's inland water bodies can be divided into natural lake and man-made reservoir. Lake is a natural, standing freshwater or saline water body found on the earth's continental land masses while reservoir is water body that have been constructed by human by damming river with different shapes and sizes. Natural lake are generally rich in nutrients and aquatic life, and are often shallow while man-made reservoir were created to

fulfill the needs of the nation such as hydropower generation, flood mitigation, water supply, irrigation and others. Generally, the numbers of natural lakes in Malaysia are few compared to man-made reservoirs. Most of the natural lakes form as part of the swamp wetland. (Sengupta & Dalwani (Ed.), 2008)

The National Lakes Information Database of Malaysia, compiled by the National Hydraulic Research Institute of Malaysia also known as NAHRIM, (2005) lists about 90 lakes both natural and man-made, found in Malaysia. The lakes have a multi-purpose functions. About 55 lakes (61%) are used for water supply and irrigation while other 35 lakes (39%) are used for hydropower, flood control, silt retention and recreational. (Shahrizaila, 2009)

Based on Omar (2010), the inventory of Malaysia Lakes and Reservoir with their respective area and volume shows that the current estimate of the total Malaysian lentic environment is about 1000 km^2, with a total volume of 30400Mm^3.

2.3 The Importance of Lake

Lakes and reservoir are important sources of water in Malaysia and can have multipurpose functions. For human survival and well being, an adequate supply of clean, safe fresh water are fundamental. Besides, fresh water is also a basic requirement for the economic development of nations and regions. Healthy and clean lakes play an important role toward our country by providing us with a number of environmental benefit, influence our quality of life and strengthen our economy development.

2.3.1 Agriculture Irrigation

The important of lake in agriculture is for the irrigation purpose. The main supply of water to fulfill the agriculture need is come from the lake such as paddy field and palm oil plantation. Oil palm is considered a major land use type in Malaysia due to the high demand of its product both at local and international market (Sujaul, Ismail, & et al., 2010).

2.3.1 Hydropower Generation

Hydropower is the only renewable energy that is currently commercially viable on a large scale. Hydropower is generated by most of the conventional hydropower plant which include reservoir. The purpose of reservoir as a dam to raise the water level of the river in creating falling water. The dam also controls the flow of water and the reservoir created is in effect store energy. Examples of major hydropower plants in Malaysia are those belonging toTNB, namely the Kenyir Sultan Mahmud Power Station with 400MW installed capacity, the Pergau Hydroelectric Power Station with 600MW installed capacity and the Temenggor Hydroelectric Power Plant with 348MW installed capacity. (Othman,2005)

2.3.2 Recreational Site

Lake and reservoir also supports important ecosystem and repository of biodiversity of rare, endemic and endangered species. Due to its economic potential, many lakes and ponds have become popular tourism and water based recreational, sports and commercial fishing activities. (Sengupta & Dalwani (Ed.), 2008)

2.3.3 Water Supply

Lakes can also provide man kind with water supply for household and also industrial. About 75% of surface water are from reservoir used for water supply (Omar, 2010). However, the water supply from the lakes need to be treated before being used for municipal and industrial need.

2.3.4 Flood Detention

Proper lake function can reduce the impact of floods and droughts by storing large amounts of water and releasing it during shortages. During heavy rainfall, lakes prevent flooding and during the dry season the large amounts of water stored in the lake can be used. Lakes also work to replenish groundwater, positively influence water quality of downstream watercourses, and preserve the biodiversity and habitat of the area.(Brunswick,2013).

2.4 Surface Water Classification in Malaysia

In Malaysia, it is necessary to quantify the degree of pollution for surface water such as lake in order to manage the pollution issues in a systematic and optimized fashion. Based on Zainudin (2010), there are two primary methods employed to classify the lake water quality which are Water Quality Index (WQI) and National Water Quality Standard (NWQS).

2.4.1 National Water Quality Standard (NWQS)

While NWQS is a set of standards derived based on beneficial uses of water. The water quality is considered to be suitable for a specific use (shown in Table 2.1 and Table 2.2) as long as it is within the range specified for the designated classes.

Table 2.1: National Water Quality Standards for Malaysia

PARAMETER	UNIT	CLASS					
		I	IIA	IIB	III	IV	V
Ammoniacal Nitrogen	mg/L	0.1	0.3	0.3	0.9	2.7	> 2.7
Biochemical Oxygen Demand	mg/L	1	3	3	6	12	> 12
Chemical Oxygen Demand	mg/L	10	25	25	50	100	> 100
Dissolved Oxygen	mg/L	7	5-7	5-7	3-5	< 3	< 1
pH		6.5-8.5	6-9	6-9	5-9	5-9	–
Colour	TCU	15	150	150	–	–	–
Electrical Conductivity*	µS/cm	1000	–	–	–	6000	–
Floatables	–	N	N	N	–	–	–
Odour	–	N	N	N	–	–	–
Salinity	%	0.5	–	–	–	2	–
Taste	–	N	N	N	–	–	–
Total Dissolved Solid	mg/L	500	1000	–	–	4000	–
Total Suspended Solid	mg/L	25	50	50	150	300	300
Temperature	°C	–	Normal +2°C	–	Normal +2°C	–	–
Turbidity	NTU	5	50	50	–	–	–
Fecal Coliform**	count/100ml	10	400	400	5000 (20000)[a]	5000 (20000)[a]	–
Total Coliform	count/100ml	100	5000	5000	50000	50000	> 50000

Notes:

N = No visible floatable materials or debris, no objectional odour or no objectional taste

* = Related parameter, only one recommended for use

** = Geometric mean

[a] = maximum not to be exceeded

Source: Malaysia Environmental Quality Report 2010

Table 2.2: Water Classes and Uses

CLASS	USES
Class I	Conservation of natural environment Water Supply I - Practically no treatment necessary Fishery I - Very sensitive aquatic species
Class IIA	Water Supply II - Conventional treatment required Fishery II - Sensitive aquatic species
Class IIB	Recreational use with body contact
Class III	Water Supply III - Extensive treatment required Fishery III - Common of economic value and tolerant species; livestock drinking
Class IV	Irrigation
Class V	None of the above

Source: Malaysia Environmental Quality Report 2010

2.4.2 Water Quality Index (WQI)

A WQI ascribes quality value to an aggregate set of measured parameters to summarized large amounts of water quality data for a specific lake into simple terms. It is usually consist of sub-index values assigned to each pre-identified parameter by comparing its measurement with a parameter-specific rating curve, optionally weighted and combined into the final index.

Table 2.3 below shows the DOE Water Quality Index Classification with six parameter involved which are AN, BOD, COD, DO, pH and TSS. The index range for WQI is based on Table 2.4. While the description of classes for the five classes are shown in the Table 2.5 below.

Table 2.3: DOE Water Quality Index Classification

PARAMETER	UNIT	CLASS				
		I	II	III	IV	V
Ammoniacal Nitrogen	mg/L	< 0.1	0.1 - 0.3	0.3 - 0.9	0.9 - 2.7	> 2.7
Biochemical Oxygen Demand	mg/L	< 1	1 - 3	3 - 6	6 - 12	> 12
Chemical Oxygen Demand	mg/L	< 10	10 - 25	25 - 50	50 - 100	> 100
Dissolved Oxygen	mg/L	> 7	5 - 7	3 - 5	1 - 3	< 1
pH		> 7.0	6.0 - 7.0	5.0 - 6.0	< 5.0	> 5.0
Total Suspended Solid	mg/L	< 25	25 - 50	50 - 150	150 - 300	> 300
Water Quality Index (WQI)		> 92.7	76.5 - 92.7	51.9 - 76.5	31.0 - 51.9	< 31.0

Source: Malaysia Environmental Quality Report 2010

Table 2.4: DOE Water Quality Index Classification Based on Water Quality Index

SUB INDEX & WATER QUALITY INDEX	INDEX RANGE		
	CLEAN	SLIGHTLY POLLUTED	POLLUTED
Biochemical Oxygen Demand (BOD)	91 - 100	80 -90	0 - 79
Ammoniacal Nitrogen (NH_3 -N)	92 - 100	71 - 91	0 - 70
Suspended Solid (SS)	76 - 100	70 - 75	0 - 69
Water Quality Index (WQI)	81 -100	60 - 80	0 - 59

Source: Malaysia Environmental Quality Report 2010