Water quality study of four streams within Maliau Basin Conservation Area, Sabah, Malaysia

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ABSTRACT. This paper presents results of a preliminary study of the water characteristics at four main streams in the Maliau Basin Conservation Area in February 2005. A total of 15 stations were chosen from the Ginseng, Giluk, Takob-Akob and Maliau Falls streams. The water quality parameters were recorded as follows: pH values (3.9 - 6.9), conductivity (23 - 42µS/cm), temperature (21.0 - 25.5 °C), dissolved oxygen (4.3 – 6.4 mg/L) and total dissolved solids (TDS) (15 - 27 mg/L). Based on findings, this site could be regarded as an undisturbed conservation area.

Keywords: Water quality, streams, Maliau Basin.

INTRODUCTION

River catchment is a natural component of the landscape, joining the linked terrestrial and aquatic ecosystems or environments, and it encompasses the whole area of land drained by the diverse tributaries and the main river. Aquatic environments are known to support an extraordinary array of life and species (Shabdin *et al.*, 2001). However, according to Nhapi *et al.* (2002), fresh water is a restricted resource and its demand will continue to increase due to population growth, increased irrigation requirements and industrialisation. Botkin & Keller (2005) also note that we are facing an increasing global water scarcity that is related to our food supply.

Water is considered to be polluted if it cannot be used for a particular purpose (Cech, 2002). Within more developed countries, reducing water pollution has been of high priority over the past few decades. Billions of dollars have been spent on control programmes, and considerable progress has been made (Cunningham & Cunningham, 2004).

Water conservation and watershed management are some of the future global water management solutions. In some countries, water conservation will provide additional water supply for future demand. According to Cech (2002), managing water in a watershed context is possible since scientific research has given a more complete understanding of the interrelationships between various natural resources such as groundwater, surface water and wetlands.

METHODOLOGY

The Maliau Basin Conservation Area (MBCA) is located at the centre of the southern part of the Malaysian state of Sabah in Borneo. According to Anton & Johan (1998), Maliau Basin basically is drained by radiating tributaries of Sungai Maliau, forming a unique and imperative catchment for the south-central area of Sabah. The drainage system consists mainly of tea-coloured rivers affected by the brown, humic composites which leach from the heath forest vegetation.

A total of 15 stations were chosen and at each station, a distance of approximately 100 m was sampled. River morphology and the characteristics of habitats chosen were recorded for all stations. Data samplings for non-conservative and non-preservable parameters (temperature, pH, dissolved oxygen (DO), conductivity and total dissolved solid) were measured using a YSI multi-parameter water quality checker (Model 6026 S/N Y5173). The checker was placed in the middle of the stream and allowed to stabilize before readings were taken. The checker was calibrated to ensure the accuracy of data collected.

Results from sampling were compared to the Interim International Water Quality Standards (INWQS). INWQS classifies six classes (I, IIA, IIB, III, IV and V) of water quality in accordance to the highest beneficial uses attainable in each class. The attainable use of a given river segment depends on the physical and chemical characteristics of the river segment (Wang *et al.*, 1999).

RESULTS AND DISCUSSION

Characteristics of sampling stations and a general description of each station are shown in Table 1, whereas the physico-chemical water parameters for rivers surveyed are summarized in Table 2.

Water temperature was generally low, ranging from 21.0 - 25.5^{o}C for all the stations. It was probably due to the study location which was enclosed by forest canopy in most parts and the location of Maliau Basin at high elevation.

The pH of the stream ranged from 3.9 - 6.9, and this could be due to rainy days during the survey. Surveys done by Anton & Johan (1998) showed results that ranged from 4.3 – 5.0. Low pH value concentration is due to the existence of heath forest vegetation (Hazebroek *et al.*, (2004). This feature is typical for tropical heath forests, which is distinctly more acidic compared to drained mixed dipterocarp forest. Humic acids are leached from the vegetation, particularly from the peat on top of sandy soil layers found at higher elevations under tropical heath forest.

The conductivity values were low and ranged between 23 - 42µS/cm. This is partly due to water acidity, as conductivity depends on the concentration of ions in solution (Balance, 1996). A previous survey by Anton & Johan (1998) showed lower conductivity values ranging from 21.1 – 36.6 mS/cm. Low values recorded for "black" waters in the Amazon Basin ranged from 6.8 – 10.4 mS/cm (Anton & Johan, 1998). Chapman & Kimstach (1996) noted that the conductivity of most freshwaters range from 10 to 1000 µS/cm. However, it may exceed 1000 µS/cm, especially in polluted waters, or those that receive large amounts of land run-off.

The concentrations of total dissolved solids (mg/L) were low and in the range of 15 – 27 mg/L. A previous survey done in 1996 by Anton & Johan (1998) showed that low values of total dissolved solids were measured and ranged between 6 – 17 mg/L.

The concentrations of dissolved oxygen ranged from 4.3 – 6.4 mg/L. According to Cech (2002), dissolved oxygen basically is related to temperature, salinity, atmospheric pressure and oxygen demand from aquatic plants and animals. Changes in dissolved oxygen can be an early indication of shifting conditions in the water body (Balance, 1996).

According to the Interim National Water Quality Standardization (INWQS), the water quality of the rivers based on the physico-chemical parameters (except for pH and dissolved oxygen in certain stations for each stream) fall into Class I. Class I is defined as very clean and treatment is not required at this stage, except by disinfection or boiling. Water

Table 1. The characteristics of each station surveyed at 15 sampling stations in Ginseng, Giluk, Takob-Akob and Maliau Falls streams.

Station	Stream	Width (m)	Depth (m)	Description of sampling station
Station 1	Sg. Ginseng (Downstream)	6.05 to 10.33	0.28 to 0.52	Consist of riffles, runs and with small pools. Substrate rock, gravel and sand.
Station 2		6.85 to 11.10	0.12 to 0.45	Some riffles, runs and small pools.
Station 3		7.06 to 10.32	0.30 to 0.57	Mixture of big riffles, deep flow and fast-flowing runs. Substrate bedrock and sand.
Station 4		6.35 to 10.11	0.23 to 0.45	Abundant riffles and some pools. Substrate rock and gravel.
Station 5	Sg. Ginseng (Upstream)	6.75 to 9.12	0.16 to 0.55	Some riffles, runs and pools. Substrate bedrock and sand.
Station 6		5.38 to 8.55	0.46 to 0.63	Some riffles and abundant pools. Substrate gravel, sand and some mud.
Station 7		5.32 to 7.33	0.35 to 0.58	Abundant pools and some riffles, substrate pebble with some sand.
Station 8	Sg. Giluk	6.03 to 8.22	0.33 to 0.58	Some big riffles and abundant runs, fast flowing runs. Tea-coloured water due to the existence of heath forest. Substrate rock, gravel and some sand.
Station 9		7.06 to 8.54	1.03 to 1.78	Abundant pools and some big riffles. Tea-coloured water. Substrate rock, gravel and some sand.
Station 10		7.34 to 10.43	1.23 to 1.65	Abundant pools. Tea-coloured water, substrate rock, gravel and sand.
Station 11	Sg. Takob-Akob	>10	>5	Some big riffles and small pools. Substrate gravel, sand and some mud.
Station 12		>10	>5	Mixture of big riffles, deep flow and fast-flowing runs. Substrate gravel, sand and mud.
Station 13		>10	>5	Abundant pools and some big riffles. Substrate gravel, sand and some mud.
Station 14	Maliau Falls	>20	>5	Abundant pools. Fast flowing runs. Substrate rock, gravel and sand.
Station 15		>20	>5	Abundant pools, substrate rock, gravel and sand.

Table 2. Range of water quality parameters in each station.

Station	Stream	Temperature (°C)	pH	Dissolved Oxygen (mg/l)	Conductivity (µS/cm)	Total Dissolved Solid (mg//L)
1		22.9	6.9	4.8	40	26
2	Sg. Ginseng	23.4	6.8	5.6	41	27
3	(Downstream)	24.3	6.8	6.4	42	27
4		23.9	6.4	5.8	41	26
5	Sg. Ginseng	23.2	6.5	5.3	40	26
6	(Upstream)	23.2	6.5	5.6	40	26
7		23.2	6.5	5.4	41	27
8		21.0	4.2	4.3	25	15
9	Sg. Giluk	21.1	4.2	4.4	23	16
10		21.1	4.2	4.3	25	16
11	Sg. Takob-	21.7	4.6	4.6	41	27
12	Akob	21.7	4.0	4.7	41	27
13		21.7	3.9	4.6	42	27
14	Maliau Falls	25.2	5.9	5.1	30	17
15		25.5	5.8	5.2	29	19

quality which falls into Class I is suitable for conservation of the natural environment (Wang *et al.*, 1999).

According to Cech (2002), raw water found in rivers and lakes generally has a pH of between 4 and 9. Even though the pH of most rivers and tributaries in Maliau Basin have a range of 3.9 - 6.9, normal ranges of pH in drinking water do not have a direct effect on human health. However, the World Health Organization (WHO) and the U. S. Safe Drinking Water Act has standardized that the maximum and minimum allowable ranges of pH for drinking water is from 6.5 to 8.5 (Cech, 2002).

CONCLUSION

Low values of pH, conductivity, dissolved oxygen content, total dissolved solids (TDS) and temperature were measured in this survey. River water quality is attributed to the existence of heath forest vegetation in the Maliau Basin Conservation Area (MBCA). Each physico-chemical water quality parameter, except for pH and dissolved oxygen, were classified in Class I by the Interim National Water Quality Standardization (INWQS).

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REFERENCES

Anton, A. & Johan Alexander. 1998. Limnology of Maliau Rivers. In: Maryati Mohamed, W. Sinun, A. Anton, Mohd. Noh Dalimin & A.H. Ahmad (eds.) *Maliau Basin Scientific Expedition*. Kota Kinabalu: Universiti Malaysia Sabah.

Ballance, R. 1996. Field testing methods. In: Ballance, R. & Bartram, J. (eds.). *Water quality monitoring: A practical guide to the design and implementation of freshwater quality studies and monitoring programmes.* Great Britain: E & FN Spon.

Botkin, D.B. & E.A. Keller. 2005. *Environmental science: Earth as a living planet.* USA: John Wiley & Sons.

Cech, T.V. 2002. *Principles of water resources: History, development, management and policy.* USA: John Wiley & Sons.

Chapman, D. & V. Kimstach. 1996. Selection of water quality variables. In Chapman, D. (ed). *Water quality assessments: a guide to the use of biota, sediments and water in environmental monitoring.* 2nd Ed. UNESCO/WHO/UNEP.

Cunningham, W.P. & M.A. Cunningham. 2004. *Principles of environmental science: inquiry and application.* 2nd Ed. New York: McGraw-Hill.

Hazebroek, H.P., T.Z. Adlin & W. Sinun. 2004. *Maliau Basin: Sabah's Lost World*. Kota Kinabalu: Natural History Publications (Borneo), 235 pp.

Nhapi, I., Z. Hoko, M.A. Siebel & H.J. Gijzen. 2002. Assessment of the major water and nutrient flows in the Chivero catchment area, Zimbabwe. *Physics and Chemistry of the Earth* 27: 783 – 792.

Shabdin, M.L., A. Fatimah & A.A.R. Khairul. 2001. The macroinvertebrate community the fast flowing rivers in the Crocker Range National Park Sabah, Malaysia. *A scientific journey through Borneo: Crocker Range National Park Sabah (Volume 1) Natural ecosystem and species components.* United Kingdom: ASEAN ACADEMIC PRESS LTD.

Wang, C.W., A. Anton, Mashhor Mansor, M.T. Norhayati, Nazari Jaafar, Pazim Othman, Rahmalan Ahmad, Sharifuddin Mohd. Zain, S.L. Tong & S. Wan Nor Azmin. 1999. Classification of Malaysian Rivers: Volume 1: Executive Summary. In *Project Report: Project on water pollution control: a study to classify rivers in Malaysia*. University of Malaya Consultancy Unit (UPUM).