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Water Quality and Phytoplankton Distribution of the Lower Kinabatangan River Catchment, Sabah

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Abstract

A study on water quality and phytoplankton distribution was carried out at the Lower Kinabatangan River Catchment, Sabah in November 2013, January 2014 and March 2014. The objectives were to study the surface water quality of the Lower Kinabatangan River Catchment; to identify the composition of phytoplankton in three different types of land use in Sukau, Kinabatangan; and to determine spatial and temporal variations of water quality in Sukau, Kinabatangan. Three sampling stations were selected to represent different types of land use, consisting of oil palm plantation (OP), secondary forests (SF) and oxbow lake (OB). Based on Interim National Water Quality Standards (INWQS) for Malaysia, the parameters were categorized within Class I to Class IV. Statistical analyses ANOVA one-way, paired sample t-test and discriminant analysis have been carried out to both water quality and total monthly precipitation data sets. The distribution of phytoplankton in Kinabatangan River consisted of 5 divisions: the Bacillariophyta, Chlorophyta, Cyanophyta, Cryptophyta and Euglenophyta. Chlorophyta recorded the highest diversity, with 10 species recorded out of 17 species found of the Lower Kinabatangan River Catchment. Discriminant analysis suggested that UV-visible absorption coefficients at 254 and 340 nm were dominant in samples from OP and SF. Temporal variations showed that parameters suspended sediment, UV-visible absorption coefficients at 254 and 340 nm were dominant in samples from collected in January 2014.

1. Introduction

Wetlands are among the most productive ecosystems in the world with ecologically diverse habitats [1]. They are vital to a range of ecosystem processes and provide many important ecosystem services [2]. Annually, wetlands contribute up to ~40% of globally significant ecosystem services [2, 3]. About half of the world’s wetlands area is found in the tropical regions [4]. Tropical wetlands are normally characterised by annual cycles in precipitation, received high solar radiation, [5, 6, 7] and rich in diversity of biological communities [8, 9]. It is also characterised by periodic flood events, which is a complex phenomenon caused by different water sources through numerous pathways [10], and a single inundation could last for months [11].

Extensive land conversion and deforestation for mechanised agriculture such as land clearing, farming, oil palm and rubber plantations, cultivations, industrial and domestic waste discharge often play a parts in wetlands degradation, which affects various aspects such as hydrological cycle, nutrient fluxes, run off characteristics, biotic environments and microclimatic [12, 13, 14]. Cultivated land use significantly influenced dissolved organic matter (DOM) characteristics in streams and rivers and increases the nutrient export to fluvial ecosystems [14]. Estimation of wetlands conversion for agriculture in tropical regions were ~6% in Indonesia, ~8% in Malaysia, ~20% in Thailand and ~50% in Philippines [15]. In Malaysia, rainforest conversion to cocoa and oil palm plantations in Bukit Tekam, Pahang circa 1977 and 1986 [16] and Sabah [17] was showed to increase

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suspended sediment loads, nutrients (i.e. nitrogen and phosphorus) and surface run off.

Water quality assessment and monitoring by using physico-chemical and biological parameters have been widely used to determine the status and quality of water bodies particularly in wetland areas [18]. Phytoplankton has been widely used as indicators for monitoring river quality [19, 20] as its fast population response to a variety of perturbations, changes in water quality, climate or hydrology [21]. However, to date, little work has focused on the knowledge of biological indicators and ecological understanding of the aquatic ecosystems in the tropics compared to those in the temperate regions [22].

This paper presents the results of spatial variations of surface river water quality and phytoplankton in the Lower Kinabatangan River Catchment, Sabah. The aims of this study were threefold: i. to study the surface water quality of the Lower Kinabatangan River Catchment; ii. to identify the composition of phytoplankton in three different types of land use in Sukau, Kinabatangan; and iii. to determine spatial and temporal variations of water quality in Sukau, Kinabatangan.

2. Materials and Methods

2.1 Study Area

Surface water samples and phytoplankton were sampled in downstream reaches of the Kinabatangan River, in Sabah, Malaysian Borneo. The Kinabatangan River is the largest and longest river in Sabah (560 km) with a catchment area of 16,800 km2 (Fig. 1) [23] and possibly one of the most important wetlands in Malaysia [24]. In 2008, the Lower Kinabatangan-Segama area has been gazetted as the Ramsar site [25]. Sabah Biodiversity Centre has identified several problems that could affect its integrity as one of the Ramsar sites: agricultural impacts include habitat loss, logging, water quality deterioration, oil palm mills and oil palm plantations [25].

The mean annual rainfall varying between 2,500 and 3,000 mm while mean daily temperatures ranging from 22°C to 32°C and [23, 26]. The heaviest rainfall occurs during the northeast monsoon (between October and March). The coastal plain and floodplain are widely inundated within this period. Fig. 2 presents the total monthly rainfall during the sampling campaign.

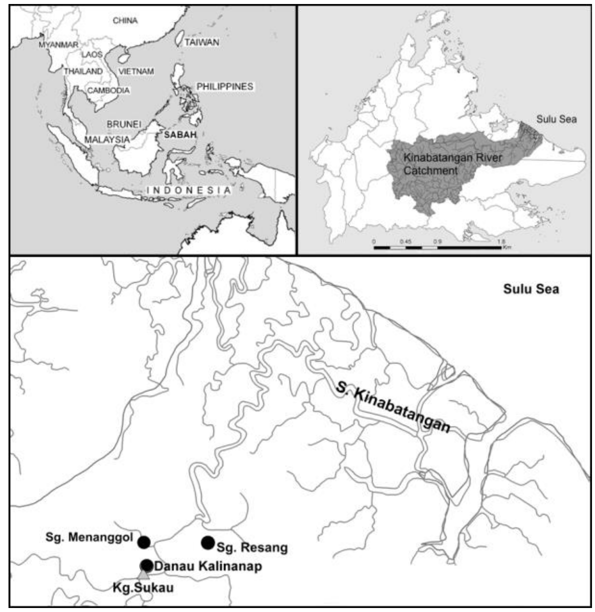

Figure 1: The location of each sampling station (circles) at the Lower Kinabatangan River Catchment.

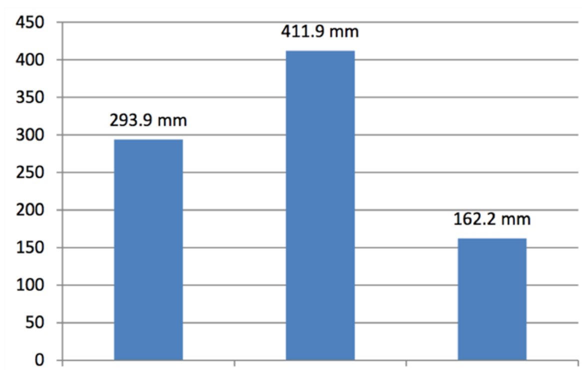

Figure 2: Total monthly rainfall during the sampling campaign (November 2013-March 2014).

Natural floodplain vegetation in the catchment mainly comprises riverine and freshwater swamp forest, with some open reed swamp, while the upper area regularly flooded, pristine lowland dipterocarp forest [26]. In the early 1950s until 1987, the Lower Kinabatangan was subjected to commercial logging activity, and more than 60,000 ha of the lowland rainforest in the flood-free zone of this area

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had been converted to cocoa and oil palm plantations [26]. In 2007, the area cultivated with oil palm in the Kinabatangan District accounted for about 28% (217, 949 ha) of the total oil palm areas in Sabah [27].

2.2. Sampling and Analysis

2.2.1 Surface Water Quality

Water samples were collected from streams in the Lower Kinabatangan River Catchment in Sandakan, Sabah. Sampling stations were located at Kg. Sukau (Fig. 1) and included sites that were selected based on three types of land use and their accessibility: Sg. Resang (oil palm plantation: OP): 05° 32' 906" N, 118° 20' 230" E; Sg. Menanggol (secondary forest: SF): 05° 30' 257" N, 118° 15' 758" E; and Danau Kalinanap (ox-bow lake: OB): 05° 30' 544" N, 118° 17' 647" E. In terms of hydrological connectivity, Danau Kalinanap is classified as semi-lotic oxbow lake.

At each sampling station, water samples were obtained from near the surface. Water quality physico-chemical parameters (total dissolved solids (TDS), pH, temperature, dissolved oxygen (DO) and conductivity) were measured in situ in November 2013, January 2014 and March 2014 by using a water quality multi parameter (HANNA HI9828 model). A total of 81 samples were collected in 250 ml high-density-polyethylene (HDPE) bottles pre-washed with 10% hydrochloric (HCl) acid and deionised water. Water samples were filtered in field immediately by using GF/C 47 mm Whatman using a pre-combusted glass-fibre filter and kept in dark at 4□C. Suspended sediment (SS) and UV-visible absorbance (254 and 340 nm) were determined in the laboratory by using Gravimetric method [28] and Agilent Cary 60 UV-Vis spectrophotometer respectively.

2.2.2 Phytoplankton Sampling

Phytoplankton was collected at the same station for surface water samples by using plankton net (mesh size 50 µm) and preserved with 4% formalin. Phytoplankton in the concentrated samples was counted and identified up to genus level following Bellinger & Sigee [29]. Species diversity was estimated by using Shannon-Wiener Index.

2.3. Statistical Analysis

One-way ANOVA has been carried out to compare significance of the physico-chemical parameters during the sampling campaign, while paired sample t-test was carried out to find significant difference for total monthly precipitation during the sampling campaign. Consequently, discriminant analysis (DA) has been employed in this study to discriminate the water quality data according to types of land use into mutually-exclusive clusters in the Lower Kinabatangan River Catchment, Sabah. The analysis derives as a first explanatory evaluation of the spatial and temporal variations, while the detail of these differences are not presented [30]. Discrimination among groups and minimal misclassification error produced linear combinations (sum) of the discriminating independent variables [30, 31]. Additionally, DA can be interpreted by using the group means of the independent variables, which also known as 'centroids' [32]. The centroids suggest the most typical location of any variable from a particular cluster, and a comparison of the group centroids indicates the distance of the groups along the dimension that is being tested.

3. Results and Discussion

To make description of results obtained from data analysis more convenience, discussion will be divided into two parts; result and discussion for data analysis of controlled parameters followed by results and discussion for response variables.

4. Conclusions

Study to identify parameters that affect growth of *Synechococcus* sp. using PCA conclude that in the presence of low concentration of NPK fertilizer, low light intensity improved organism's growth. Conversely, with the presence of high concentration NPK fertilizer, growth rate reduces.

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References

[1] Vu, T. T., Hill, E. A., Kucek, L. A., Konopka, A. E., Beliaev, A. S., & Reed, J. L. (2013). Computational Evaluation of *Synechococcus* sp. PCC 7002 Metabolism for Chemical Production. Biotechnology Journal, 8(5), 619-630. doi: 10.1002/biot.201200315

[2] Atsumi, S., Higashide, W., & Liao, J. C. (2009). Direct Photosynthetic Recycling of Carbon Dioxide to Isobutyraldehyde. Nat Biotech, 27(12), 1177-1180. doi:

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http://www.nature.com/nbt/journal/v27/n12/suppinfo/nbt.1586_S1.html

[3] C. Coman, V. B., C.Sicora. (2013). The Study of ps II Photochemical Activity in *Synechococcus* sp. Pcc 7002 Under Different Light Intensities. Annals of RSCB, XVII(2), 7.

[4] Ludwig, M., & Bryant, D. A. (2012). *Synechococcus* sp. Strain PCC 7002 Transcriptome: Acclimation To Temperature, Salinity, Oxidative Stress and Mixotrophic Growth Conditions. Frontiers in Microbiology, 3. doi: 10.3389/fmicb.2012.00354

[5] Aiko Kimura, T. H., Eugena H. Morita, and Hidenori Hayashi. (2002). A High Temperature-sensitive Mutant of *Synechococcus* sp. PCC 7002 With MOdifications in The Endogeneous Plasmid, pAQ1. Plant Cell Physical, 43(2), 7.

[6] Badr, N., & Noureldien, N. A. (2013). Examining Outlier Detection Performance for Principal Component Analysis Method and Its Robustification Methods. 6(2), p. 573

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