SOURCE APPORTIONMENT AND POLLUTION LOADING IN LAKE CHINI WATERSHED USING MULTIVARIATE STATISTICAL ANALYSIS

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Master of Science

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SUPERVISOR'S DECLARATION

We hereby declare that we have checked this thesis and in our opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Master of Science in Civil Engineering and Earth Resources.

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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LIST OF ABBREVIATIONS

AOAC	Association of Official Analytical Chemists
ANOVA	Analysis of Variance
APHA	American Public Health Association
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
DO	Dissolved Oxygen
DOE	Department of Environment
EPA	Environmental Protection Agency
EQRM	Environment Quality Regulations, Malaysia
FAO	Food and Agricultural Organization
GPS	Global Positioning System
ICPMS	Inductively Coupled Plasma Membrane
NWQS	National Water Quality Standards
NH_4-N	Ammonia-cal nitrogen (AN)
ppb	parts per billion
ppm	parts per million
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
WQI	Water Quality Index
TN	Total Nitrogen
TP	Total Phosphate

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ABSTRAK

Kajian ini dijalankan untuk menilai status pencemaran kualiti air permukaan dan sedimen di Tasik Chini dan anak sungai utama disampling untuk mengetahui punca pencemaran melalui teknik statistik yang berbeza. 5 lokasi penting yang berpotensi telah dipilih untuk pensampelan air dan 10 untuk sedimen, selepas selesai kajian, manakala 5 anak sungai penting telah dipilih untuk memahami beban pencemaran tersebut terhadap hiliran sungai. Sampel air telah diambil mengikut kaedah piawaian, sebanyak enam kali meliputi kedua-dua musim kering dan musim hujan. Sebanyak 16 parameter fiziko kimia dan biologi merangkumi 5 jenis logam berat telah diukur. Data yang diperolehi telah dibandingkan dengan NWQS (Piawaian Kualiti Air Kebangsaan Malaysia), WQI (Indeks Kualiti Air) Malaysia dan analisis multivariate. Bagi sedimen, garis panduan kualiti sedimen, indeks geo-accumulation (I_{geo}), faktor pencemaran (CF) dan pencemaran indeks beban (PL_I) telah digunakan untuk membandingkan data semasa dan status pencemaran. Dari kajian ini, didapati bahawa DO, BOD, COD, jumlah koliform dan Fe adalah lebih tinggi daripada had yang biasa dalam air. Kajian sumber pembahagian mendedahkan bahawa sumber utama pencemaran adalah disebabkan oleh aktiviti antropogenik terutamanya pemendakan, perlombongan, pertanian dan pembalakan haram. Peningkatan kecenderungan adalah ketara dari musim kering ke musim hujan untuk semua parameter kualiti air. Kualiti air keseluruhan di semua 15 stesen dikategorikan sebagai kelas II (sesuai untuk sentuhan badan), meskipun kajian mendapati ada dua status pencemaran yang berbeza; bersih dan sedikit tercemar. Stesen di anak sungai, kawasan tasik dan di kawasan perlombongan penyaliran; telah sedikit tercemar. Sedimen dikesan berasid dengan bahan organik tinggi manakala Fe, Co, Pb dan As adalah lebih tinggi daripada LAL (Paras Amaran Rendah). Hanya nilai Fe didapati melebihi had normal mengikut faktor pencemaran (CF) manakala Igeo dan semua parameter yang lain adalah dalam tahap yang normal. Status pencemaran logam berat adalah lebih tinggi berhampiran tadahan sungai (terutama di sekitar kawasan perlombongan) walaupun pencemaran masih boleh diterima. Logam berat mempunyai kecenderungan meningkat apabila musim kering beralih ke musim hujan. Walaubagaimanapun, kedua-dua air dan sedimen telah dicemari pada tahap yang lebih tinggi dalam cabangan anak sungai berbanding dengan bahan pencemaran yang masuk ke dalam tasik. Kualiti air tasik adalah dalam kelas II (88.37) iaitu pada tahap yang boleh digunakan selepas rawatan konvensional dan selamat untuk tujuan rekreasi.

ABSTRACT

This study was conducted to assess the surface water quality and sediment contamination status in the Lake Chini and its major tributaries as well as to find out the sources of pollution through different statistical techniques. 15 potentially important locations were selected for water sampling and 10 for sediment, after completion of a survey, whereas 5 geographically important tributaries were selected to understand the pollution loadings they contribute downstream. Water samples were collected six times following standard methods, covering both dry and wet seasons. A total of 16 physicochemical and biological parameters along with 5 heavy metals were measured. Obtained data was compared with NWQS (National Water Quality Standard for Malaysia) and WQI (Water Quality Index) Malaysia as well as multivariate analysis. For sediments, sediment quality guidelines, geo-accumulation index (I_{geo}), contamination factor (CF) and pollution load index (PL_I) were used to evaluate the current data and its status of contamination. From the study, it was found that DO, BOD, COD, total coliform and Fe were higher than the permissible limit in water. Source apportionment study revealed that the major sources of contamination were due to anthropogenic activities especially settlement, mining, agriculture and illegal logging. There was a prominent increasing seasonal trend from dry to wet season for all water quality parameters. Overall water quality at all 15 stations was categorized as class II (suitable for body contact), but having two different contamination status; clean and slightly polluted. Stations at tributaries, draining area of the lake and at the mining area were slightly polluted. Sediments were detected acidic with high organic matter while Fe, Co, Pb and As were higher than the LAL (Low Alert Level). Only Fe value was found beyond normal limit according to contamination factor (CF) while I_{geo} and all others were within the normal level. Heavy metals pollution status was higher near the tributaries catchment (especially around the mining area) although it was acceptable. Heavy metals contamination had an increasing trend from dry to wet season. However, both water and sediment were contaminated higher in the tributaries channels compared to the lake. The water quality of the lake is class II (88.37) that could be used after conventional treatment and is safe for recreational purpose.

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