



UNIVERSITI PUTRA MALAYSIA

***SPATIO-TEMPORAL VARIATION OF SURFACE WATER
QUALITY AND POLLUTION SOURCE APPORTIONMENT
USING ENVIRONMETRICS IN JAKARA BASIN, NIGERIA***

ADAMU MUSTAPHA

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QUALITY AND POLLUTION SOURCE APPORTIONMENT
USING ENVIRONMETRICS IN JAKARTA BASIN, NIGERIA**

By

ADAMU MUSTAPHA

**Thesis Submitted to the School of Graduate Studies, Universiti Putra
Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of
Philosophy**

January 2013

DEDICATIONS

This thesis is dedicated to the memory of my late father Alhaji Mustapha Mohammed Wudil.



Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Doctor of Philosophy

SPATIO-TEMPORAL VARIATION OF SURFACE WATER QUALITY AND POLLUTION SOURCE APPORTIONMENT USING ENVIRONMETRICS IN JAKARA BASIN, NIGERIA

By

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January 2013

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Spatio-temporal variation of surface water quality and identification of water pollution sources in a river basin are very important and critical element in the assessment of water resources protection and sustainable utilization. In this study, various environmetric tools including principal component analysis (PCA), factor analysis (FA), hierarchical agglomerative cluster analysis (HACA), discriminate analysis (DA), multiple linear regression, structural equation modelling (SEM), analysis of variance (ANOVA), paired sample t-test and Pearson product moment correlation coefficients were used to evaluate the spatio-temporal variation and pollution sources of Jakara Basin, north-western Nigeria. Surface water in the Jakara basin was collected in four phases: preliminary sampling, dry and wet sampling, Getsi River sampling and three other tributaries. PCA and FA were used to investigate the origin of water quality parameters. Seven principal components were obtained with explained 77% total variation of water quality. Hierarchical

cluster analysis grouped thirty sampling sites into three clusters based on similarities of river water quality. The results showed that spatially the Basin can be grouped into three statistically significant potential pollution sources (domestic, industrial and agricultural). Temporal water quality variation was investigated using dry and wet seasons water samples. DA revealed five statistically significant parameters for dry season and six parameters for wet season affording more than 77% and 82% respectively. The results showed that temporal water quality in the basin varied with significant differences ($p < 0.05$). The sources of pollution in the area revealed anthropogenic origin have profound influence in the dry season and natural pollution sources have little impact especially during wet season. Significant monotonous trend directions and magnitude of change in the basin in organic compound were detected by trend analysis using Mann-Kendall and Sen Slope estimates confirming anthropogenic influences. Further, a time series Landsat satellite images of 1987, 1995 and 2006 were used to extract land use changes over the past twenty years. Results indicated that there has been a noticeable and uneven urban growth and tremendous loss of cultivated cover. Overall results obtained are potentially useful to assist policy makers to understand the complex nature of the water quality issues and to determine priorities to improve the water quality in the basin.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

**PERUBAHAN RUANG-MASA TERHADAP KUALITI AIR PERMUKAAN DAN
PENENTUAN SUMBER PENCEMAR MENGGUNAKAN KAEDAH
ENVIROMENTRIK DI LEMBANGAN JAKARA, NIGERIA**

Oleh

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Variasi ruang-masa dalam penentuan kualiti air permukaan dan pengenal pastian sumber punca pencemaran air di lembangan sungai adalah sangat penting dan kritikal dalam perlindungan serta penggunaan sumber air yang mampan. Dalam kajian ini, pelbagai teknik environmetrikS termasuk analisis komponen utama (PCA) atau analisis faktor (FA), analisis hirarki agglomeratif kelompok (HACA), analisis diskriminasi (DA), regresi linear berganda, pemodelan persamaan struktur (SEM), analisis varians (ANOVA), pasangan sampel ujian-t dan korelasi Pearson, digunakan untuk menilai kesan perubahan ruang-masa dan punca pencemaran di Lembangan Jakara yang terletak di barat laut Nigeria. Sampel air permukaan di Lembangan Jakara telah dikumpul dalam empat fasa: pensampelan awal di lembangan, pensampelan musim kering dan basah, persampelan di Sungai Getsi dan persampelen di tiga anak sungai di lembangan tersibut. PCA/FA telah digunakan untuk menyiasat parameter-parameter kualiti air. Hasil kajian ini menunjukkan bahawa secara ruang, lembangan ini boleh dibahagi kepada tiga

kumpulan sumber pencemaran. Secara statistik (domestik, industri dan pertanian) kesan perubahan masa terhadap kualiti air telah dikaji dengan menggunakan sampel air yang di ambil pada musim kering dan basah. Keputusan menunjukkan bahawa kualiti air di lembangan ini berbeza dengan perubahan musim secara signifikan ($p < 0.05$). Punca-punca pencemaran di kawasan tersebut menunjukkan pencemaran antropogenik yang mempunyai pengaruh yang kuat semasa musim kering dan sumber pencemaran secara semula jadi mempunyai kesan yang sedikit terutamanya semasa musim basah. Perubahan tren aliran dan juga magnitud kompaun bahan pencemar organik telah dikesan menggunakan kaedah analisis tren Mann-Kendall. Kaedah anggaran Sen Slope juga mengesahkan pengaruh antropogenik. Di samping itu, imej siri masa satelit Landsat pada tahun 1987, 1995, dan 2006 telah digunakan untuk mendapatkan tren perubahan penggunaan tanah dalam tempoh dua puluh tahun yang lalu. Hasil kajian menunjukkan bahawa terdapat kawasan pembangunan bandar yang ketara dan tidak sekata serta kehilangan banyak kawasan tanaman secara keseluruhan keputusan yang diperolehi adalah berpotensi untuk membantu dalam perancangan dasar untuk memahami sifat rumit semula-jadi kualiti air serta menentukan keutamaan dalam meningkatkan kualiti air di lembangan itu.

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I certify that a Thesis Examination Committee has met on **(29th January, 2013)** to conduct the final examination of **(Adamu Mustapha)** on his thesis entitled **"Spatio-Temporal Variations of Water Quality and Pollution Sources Apportionment Using Environmetrics in Jakara River Basin, Northwestern Nigeria"** in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the **(PhD Environmental Pollution Control Technology)**.

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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

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