UNIVERSITI PUTRA MALAYSIA

STORMWATER QUALITY FROM THE SUNGAI LUI CATCHMENT, MALAYSIA

ABDUL HAMID.

FPAS 2005 8

STORMWATER QUALITY FROM THE SUNGAI LUI CATCHMENT, MALAYSIA

By

ABDUL HAMID

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

2005

Dedicated

To

My father and mother, my father in law and mother in law, my brother and sisters, my late relatives and to my beloved wife Nigar Sultana Sehely and to my son Alvee Jawad Hamid

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

STORMWATER QUALITY FROM THE SUNGAI LUI CATCHMENT, MALAYSIA

By

ABDUL HAMID

December 2005

Chairman: Associate Professor Zelina Zaiton Ibrahim, PhD

Faculty: Environmental Studies

River water is continuously being impacted by pollutants generated from the catchment. In particular, substantial amounts of pollutants can be introduced to the rivers during storm events. This study was carried out to investigate the influence of storm events on the water quality parameters of the forested Sg. Lui catchment. Stormwater samples were collected from the Sg. Lui for 21 storm events between January 2003 to January 2004. Discharge, electrical conductivity (EC), pH, dissolved oxygen (DO), turbidity, total suspended solids (TSS), total phosphorus (TP), ammoniacal nitrogen (AN) and 5-day biochemical oxygen demand (BOD_5) were measured from the stormwater samples. Descriptive and inferential statistical analyses were carried out for the parameters studied.

The storm events sampled from the catchment were found to represent the 24th to 88th percentile of the average daily discharge for a typical year. Total suspended solids and turbidity appeared to be the major pollutants to the Sg. Lui catchment. The

results indicated a dilution-mobilization sequence in the concentration of TSS, TP, AN and the BOD_5 during the rising and falling limbs of the event hydrograph. A late flushing of materials was also observed, where much of the load was transported in the later half of an event. Event mean concentrations (EMC) were calculated for TSS, TP, AN and BOD_5 for the catchment. Hydrometeorological conditions of the catchment were used to explain the differences in the EMC values for the different events.

This study revealed that the water quality of the Sg. Lui catchment is influenced by the hydrometeorological conditions of the catchment. Statistical analyses confirmed the representativeness of the flow and the EMCs calculated for the Sg. Lui catchment. Discrete sampling enabled the detailed analysis of the hydrographs, pollutographs and loadographs. This assisted in understanding the processes influencing the temporal variability of the flow and water quality of the catchment during storm events.

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

KUALITI AIR HUJAN DI KAWASAN TADAHAN SUNGAI LUI , MALAYSIA

Oleh

ABDUL HAMID

Disember 2005

Pengerusi: Profesor Madya Zelina Zaiton Ibrahim, PhD

Fakulti: Pengajian Alam Sekitar

Air sungai dicemari secara berterusan oleh bahan pencemar dari kawasan tadahan. Sebahagian besar bahan pencemar masuk ke dalam sungai terutamanya semasa kejadian hujan berlaku. Kajian ini dijalankan untuk mengkaji pengaruh kejadian hujan ke atas parameter kualiti air di kawasan tadahan Sungai Lui yang berhutan. Sebanyak 21 kejadian hujan disampel antara Januari 2003 sehingga Januari 2004. Kadar alir air, kekonduksian elektrik (EC), pH, oksigen terlarut (DO), kekeruhan, jumlah pepejal terampai (TSS), jumlah fosforus (TP), ammoniakal nitrogen (AN) dan keperluan oksigen biokimia 5-hari (BOD_5) telah diukur daripada sampel kejadian hujan tersebut. Analisis statistik diskriptif dan inferens dijalankan keatas parameter yang dikaji.

Kejadian hujan yang disampel didapati mewakili persentil ke-24 hingga ke-88 daripada purata kadar alir harian untuk tahun 'biasa'. Jumlah Pepejal terampai dan kekeruhan merupakan bahan pencemar yang utama bagi kawasan tadahan urutan Sungai Lui. Keputusan analisis menunjuk perubahan pencairan-pergerakan pada

kepekatan TSS, TP, AN dan BOD_5 semasa tungkai menaik dan menurun hidrograf kejadian hujan. Kadar pelepasan bahan diperhatikan di mana kebanyakan daripada beban muatan telah dipindahkan pada peringkat separuh masa akhir kejadian hujan. Pengiraan kejadian purata kepekatan (EMC) terhadap TSS, TP, AN dan BOD_5 telah dilakukan. Keadaan hidrometeorologi kawasan tadahan digunakan untuk menerangkan perbezaan nilai EMC bagi kejadian hujan yang berbeza.

Kajian ini mendapati bahawa kualiti air Sungai Lui dipengaruhi oleh keadaan hidrometeorologi kawasan tadahan. Penyampelan diskrit membolehkan analisis hidrograf, graf pencemaran dan graf beban muatan yang terperinci. Ini membantu dalam memahami proses-proses yang mempengaruhi perubahan berdasarkan masa bagi kadar alir dan kualiti air kawasan tadahan semasa kejadian hujan. Penganalisaan ciri-ciri statistik mengesahkan keupayaan kadar alir dan EMC yang di kira dalam kajian ini untuk mewakili keadaan kawasan tadahan.

ACKNOWLEDGEMENTS

All praises belong to the Allah (SWT) whose blessings and kindness enabled the author to accomplish this project successfully. May Allah (SWT) pardon and forgive my weakness and endow me with knowledge and help.

The author expresses his deepest gratitude and sincere appreciation to Associate Professor Dr. Zelina Zaiton Ibrahim, Chairman of the Thesis Supervisory Committee for her invaluable guidance, time, advice, encouragement and generous supervision throughout the tenure of the project. The author also wishes to acknowledge the contribution of Associate Professor Dr. Wan Nor Azmin Sulaiman and Dr. Mohd Kamil Yusoff, members of the thesis supervisory committee for their constructive suggestions and guidance extended during the research.

The author wishes to extend his thanks to the staff and academics of the Faculty of the Environmental Studies, UPM for all kinds of support provided during the study period. Special thanks to Mr. Mohd Khalib Yahaya who provided the much needed transport to accomplish field sampling in the Sg. Lui, Hulu Langat.

The author wishes to thank the Government of the Peoples Republic of Bangladesh for the permission to undertake the course. The author is grateful to the Public Service Department (JPA), Malaysia, for the scholarship in support of the study. The author also wishes to thank R. Daren Harmel, Ph.D. Agricultural Engineer, Agricultural Research Service, USDA for providing valuable suggestions and the papers used in this research. Sincere appreciation is also due to Associate Professor Dr. Ismail Abustan, Department of Civil Engineering, USM, Malaysia and Associate Professor Dr. Lai Food See of the

Faculty of Forestry, UPM for their constructive suggestions, and guidance in the execution of this research.

The author also wishes to thank Mr. Md. Azmi Zafri, Mrs. Noryati, Mr. Sazali Othman and Mr. Abu Salim Bin Abdul Aziz of the Department of Irrigation and Drainage (DID), Ampang, KL, Malaysia for the permission to use the station 3118445 and for the data of the Sg. Lui catchment. The kampong people of the Kg. Sg. Lui would be remembered for their cooperation in the endeavour. Thanks also to thank the DOE, Malaysia and MMS, Malaysia for data support. Encouragements from some senior colleagues of the author will never be forgotten and the author would like render his deepest appreciation and respect to Mr. Mesbah-ul-Alam - Joint Secretary, Mr. Ishtiaque Ahmad and Dr. A H M Mustain Billah - Deputy Secretary, Government of Bangladesh, and Mr. Md. Moniruzzaman, First Secretary (Commercial), Bangladesh High Commission in Malaysia for their continued support during the study. Also thanks go to Mr. Kazi Tanveer Mahmood (Aushim) who was a mentor for the statistical analysis.

Finally, the author is truly indebted to his father and mother, without their sacrifices the author would not be able to reach the present position. The author is also grateful to his brother Mr. Abdul Quayum Milton, and sisters Lubna and Tania for their moral encouragements. For the years of love and care, the author wishes to thank his wife Sehely for her patience, understanding, sacrifices and prayers. She was the light house for any darkness encountered during our in Malaysia, and in life. Special love is due to my son Alvee Jawad Hamid. The author would like to apologise to those persons who has helped in one way or another but one not mentioned in this narration.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES