



UNIVERSITI PUTRA MALAYSIA

**EFFECTS OF LOGGING ON STREAKWATER QUALITY
AND SOLUTE INPUT-OUTPUT BUDGETS IN SMALL WATERSHEDS
IN PENINSULAR MALAYSIA**

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FSAS 1990 5

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AND SOLUTE INPUT-OUTPUT BUDGETS IN SMALL WATERSHEDS
IN PENINSULAR MALAYSIA**

By

ZULKIFLI YUSOP

Thesis Submitted in Fulfilment of the
Requirements for the Degree of Master of Science
in the Faculty of Science and Environmental Studies
Universiti Pertanian Malaysia

December 1990



ACKNOWLEDGMENTS

It gives me much pleasure to acknowledge and thank many individuals and institutions for their significant contributions during the entire course of this study.

I would like to express my sincerest thanks to my supervisor, Dr Anhar Suki, for his original ideas, helpful advice, guidance and stimulating discussions. I am particularly happy with and appreciate his approachable manner which made this exercise a pleasant one. Similar appreciation is extended to my co-supervisor, Mohd Fauzi Zakaria, for his constructive comments on water chemistry.

Thanks are due to the Forest Research Institute Malaysia (FRIM) for giving me the opportunity to undertake this course on a part-time basis. The continuous interest and concern of the Director General of FRIM, Dato' Dr Salleh Mohd Nor, is highly appreciated. Utmost thanks are extended to Dr Abdul Rahim Hj Nik, my project leader at FRIM, for his dedication and unstinting help; also for providing runoff and rainfall data, without which my analyses of solute losses and solute input-output budgets would not have been possible. I am indebted to my colleagues, Baharuddin and Zainuddin for their cooperation. The three-dimensional view and topographic map of the study area were skillfully prepared by Saifuddin who deserves my cordial thanks. My heartfelt acknowledgment is conveyed to Azman Hassan, a former assistant hydrologist,



for checking the English in a significant portion of the draft manuscript. My sincerest thank goes to Dr Zelina Zaiton Ibrahim for proof reading the whole manuscript.

Field and laboratory work were assisted by the research staff and foresters of the Hydrology Section, FRIM. They are Mohd Sahat, Rajendran, Hashim, Ahmad Sahar, Alisbana, Renjer Mohd Nor, Ibrahim, Yusaini, Nazri and Asna. Their earnestness and hardwork were the decisive factors in making this study a reality.

Many thanks are extended to the Chemistry Department, Petaling Jaya, for the chemical analyses; the Government of New Zealand, for providing financial aid in the initial setting-up of the experimental catchment; and the Forestry Department for giving support and cooperation. I am also grateful to lecturers and colleagues at Universiti Pertanian Malaysia; Dr Nasiman, Dr Mohd Awang, Dr Ismail Yaziz, Dr Ramdzani, En Mohd Kamil and Azman for their concern and for sharing nice jokes.

Last but not least, heartfelt appreciation is due to my dear wife, Fadhilah, for her understanding, constant encouragement and sacrifices; and to my children, Zulfadli and Zhafri for being an everlasting source of inspiration. To my parents, brothers and sisters, I wish them every success in this world and hereafter under the guidance and in the path of Allah s.w.t. Wassalam.



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LIST OF ABBREVIATIONS

pH	-	in pH units
S.E.C.	-	Specific electrical conductivity; $\mu\text{S}/\text{cm}$ (micro-Siemen per centimeter at 25°C)
Turb.	-	Turbidity; N.T.U. (nephelometric turbidity units)
Colour	-	True colour; Hazen
S.S.	-	Suspended solids; mg/l
D.S.	-	Dissolved solids; mg/l
Alka.	-	Total alkalinity; mg/l as CaCO_3
Hard.	-	Total hardness; mg/l as CaCO_3
Ca^{2+}	-	Calcium; mg/l
Mg^{2+}	-	Magnesium; mg/l
Fe	-	Iron; mg/l
K^+	-	Potassium; mg/l
$\text{NH}_3\text{-N}$	-	Ammoniacal-nitrogen; mg/l
$\text{NO}_3\text{-N}$	-	Nitrate-nitrogen; mg/l
SO_4^{2-}	-	Sulphate; mg/l
PO_4^{2-}	-	Phosphate; mg/l
SiO_2	-	Silicate; mg/l
Cl^-	-	Chloride; mg/l
F^-	-	Flouride; mg/l
m.a.s.l.	-	meter above sea level
r	-	Coefficient of correlation
r^2	-	coefficient of determination
R^2	-	Coefficient of multiple determination
R^2_{adj}	-	Adjusted coefficient of multiple determination



- S.D. - Standard deviation
- S.E. - Standard error of estimate
- D.W. - Durbin Watson statistic
- N - No of sample or correlation
- SSR - Sum of square due to regression
- MSE - Mean square error
- Sg. - Sungai, a Malay word meaning river



Abstract of the thesis submitted to the Senate of Universiti Pertanian Malaysia in fulfilment of the requirements for the Degree of Master of Science.

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July 1990

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The effects of selective logging on streamwater quality and solute budgets were investigated using three small catchments: C1, C2 and C3. After a three-year calibration period, C1 and C3 were logged using "unsupervised" and "supervised" logging methods respectively, whereas C2 was left as control. Several control measures were imposed in the supervised C3 but none in the unsupervised C1.

During the calibration period the levels for most of the streamwater quality parameters measured were within the standards for potable water. The exceptions were colour, turbidity and iron. Significant increases in pH, specific electrical conductivity, hardness, suspended solids, alkalinity, turbidity, dissolved solids, silicate, calcium, iron, and sodium were recorded in the unsupervised C1. The levels for colour and nitrate were also elevated initially but



recovered to background values within a year. In contrast, in the supervised C3, significant changes were detected only for hardness, magnesium and iron. The impact of logging was enhanced during the wet months especially for suspended solids, turbidity and iron.

Export of suspended solids during the calibration period ranged from 0.08 to 0.24 mt/ha/yr. These levels increased twenty-fold for C1 and two-fold for C3 during the first year after logging. The monthly losses of most solutes also increased significantly for both C1 and C3 but the magnitude of loss was much greater for the former. The losses of calcium, potassium and magnesium showed a tendency to increase over time whereas the increases in nitrate losses were short-lived.

Rainfall samples contained low levels of anthropogenic pollutants and were affected more by terrestrial sources. The inputs of nutrients from rainfall constituted, on the average: 64%, 55%, 40% and 25% of the outputs of potassium, calcium, sodium and magnesium respectively. However, the inputs of calcium and magnesium were calculated based on data of a previous study conducted at a nearby site, Pasoh.

The results of the study show that proper control measures substantially reduce the effects of logging on streamwater quality and solutes losses. Further detail studies may provide better indications on the effectiveness of specific control measure.

