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ECONOMIC IMPACTS OF LOGGING INTENSITIES IN THE MUDA-PEDU FORESTED CATCHMENT, KEDAH, MALAYSIA

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By

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IN MEMORY OF MY PARENTS
and
GRAND PARENTS

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirements for the degree of Master of Science.

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This study was conducted primarily to determine benefits associated with logging and to quantify the cost associated with sedimentation in the Muda and Pedu Forested Catchments, Kedah. Data on timber value were obtained form the Ulu Muda experimental site and those on the rate of sediment yield were obtained from a study by Lai *et al.* (1999). The estimated NPV of timber under conventional logging (CL) and modified logging (ML) were RM 119.4 million and RM 87.9 million respectively for a land area of 118,673 ha over a two cutting cycles of 30 years each. The average sediment yield in the Muda and Pedu Catchments was estimated to be 77.9 tonne/ha/year under catchment protection (CP), 188 tonne/ha/year under conventional logging (CL) and 115.5 tonne/ha/year under modified logging (ML). Meanwhile, the estimated NPV of treated water production under catchment protection (CP) was RM 128.8 million, under conventional logging (CL) was RM 121.3 million and under modified logging (ML) was RM 125.8 million. The incremental NPV (ML-CP) under modified logging option (ML) was very small valued at RM 3.0 million as compared with the conventional logging (CL) with RM 7.5 million. The small average incremental NPV under modified logging (ML) was due to the low incremental NPV gained when compared to the conventional logging option. The rise in the sediment concentration caused by CL option was not high enough to cause a high increase in water treatment plant. The above analysis supported conventional logging option over modified logging when only the off-site cost of sedimentation is incorporated. This analysis is inconclusive since other physical impacts of logging have not been incorporated such as the potential welfare loss of biodiversity and climate benefits of protected forest. Nevertheless, the analysis has shown that logging does provide off-site cost in the form of higher water treatment costs. This kind information could be useful to policy makers when deciding upon land use options.

Abstrak tesis yang dikemukan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk mendapatkan ijazah Master Sains

KESAN EKONOMI TERHADAP KEAMATAN PEMBALAKAN DI KAWASAN TADAHAN MUDA-PEDU, KEDAH

Oleh

MOHD RUSLI YACOB

Pengerusi : Profesor Madya Dr. Mohd Shahwahid Haji Othman

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Kajian ini adalah bertujuan untuk menentukan hasil pembalakan dan menilai kos endapan di kawasan tadahan Muda dan Pedu, Kedah. Data hasil balak bagi kajian ini diperolehi dari kawasan ujikaji Ulu Muda dan data hasil endapan diperolehi dari hasil kajian Lai *et al.* (1999). Dianggarkan nilai kini bersih bagi kaedah pembalakan biasa dan kaedah pembalakan ubahsuai masing-masing iaitu RM 119.4 juta dan RM 87.9 juta, merangkumi kawasan kajian seluas 118,673 ha untuk tempoh dua kitaran tebangan selama 30 tahun bagi setiap tempoh kitaran tebangan. Anggaran purata hasil endapan di tadahan Muda dan Pedu ialah 77.9 tonne/ha/tahun bagi kawasan kawalan, 188 tonne/ha/tahun bagi kaedah pembalakan biasa dan 115.5 tonne/ha/tahun bagi kaedah pembalakan ubahsuai. Manakala dianggarkan nilai kini bersih bagi pengeluaran air bersih kawasan kawalan ialah RM 128.8 juta, bagi kaedah pembalakan biasa ialah RM 121.3 juta dan kaedah

pembalakan ubahsuai ialah RM 125.8 juta. Tambahan nilai kini bersih (ML-CP) bagi kaedah pembalakan ubahsuai adalah sangat kecil iaitu RM 3.0 juta berbanding kaedah pembalakan biasa RM 7.5 juta. Tambahan kecil dalam purata nilai kini bersih bagi kaedah pembalakan ubahsuai adalah hasil daripada tambahan nilai kini bersih yang rendah berbanding kaedah pembalakan biasa. Peningkatan hasil endapan dalam kaedah pembalakan biasa tidak begitu ketara untuk menyebabkan peningkatan di dalam loji rawatan air. Analisa di atas menyokong kaedah pembalakan biasa berbanding kaedah pembalakan ubahsuai apabila hanya kos 'off-site' endapan sahaja diambilkira. Analisa ini tidak begitu lengkap sehinggalah kesan-kesan fizikal lain dari hasil pembalakan digabungkan seperti potensi sumbangan kebajikan kepelbagaian biologi dan manafaat iklim sejagat dalam kawasan perlindungan. Walau bagaimanapun, analisa ini jelas menunjukan pembalakan menyumbang kos 'off-site' dalam ertikata meningkatkan kos rawatan air bersih. Maklumat sedemikian mungkin berguna kepada pihak yang membuat keputusan khususnya berhubung dengan pilihan penggunaan tanah.

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LIST OF ABBREVIATIONS

PFE	:	Permanent Forest Estate
CP	:	Catchment Protection Option
CL	:	Conventional Logging Option
ML	:	Modified Logging Option
NTU	:	Nephelometric Turbidity Unit
TWL	:	Top Water Level
MSL	:	Minimum Standard Level
JKR	:	Jabatan Kerja Raya
MADA	:	MUDA Agricultural Development Authority
NTFPs	:	Non-Timber Forest Products
Mil	:	Million

CHAPTER 1

INTRODUCTION

Background of the Study

Malaysia like many developing countries has converted some of its forests to agriculture, industry, recreational and urban development uses. These forestlands recorded the highest change to other land use options (37.8%) within the period from 1985 to 1994 (LUCC, 1999). The loss of forest were gained by agriculture (27%), settlement (7.9%) and grassland, bare land and water bodies (2%).

Until the year 2000, Malaysia still retains 62.2% of the total land area under forest. A total of 14.33 million hectares or 43.5% of the land area are designed as Permanent Forest Estates (PFEs) by legislation and to be managed under sustainable forest management (Chin, 2000). Approximately 10.84 million hectares of the PFEs are production forests with the remaining 3.49 million hectares being protection forest. The rest of the forested areas are the state land forests. The production forest is generally associated with timber production, which is managed based on sustained yield management. Other non-timber forest products (NTFPs) such as rattans, bamboo, medical plants and honeybee are also produced from this forest.

The protected forest is generally associated with safeguarding environmental stability, recreation, research and education, water supplies as well as minimising damage to river system.

With increasing demand for timber and non-timber forest products, demand for forest areas to be logged would be expected to increase. This linkages has resulted in logging operations in Peninsular Malaysia to move toward the hill forest (Farid and Abdul Rahman, 1999). The changes of forest areas open to logging in the last decade show a decreasing trend. The annual logging coupes have been reduced from 52,250 hectares per year during the Sixth Malaysia Plan (1991-95) to 45,100 hectares per year in the Seven-Malaysia Plan (1996-2000). Logging from the remaining Stateland forest was approximately 101,500 hectares per year. According to the Department of Forestry, Peninsular Malaysia (1998), the Stateland forests will be available for log production only up to the year 2003. After that, log production will come from the PFEs only. Based on this trend, it is expected that there will be increasing pressure to log the protection forest especially in forested catchment in the near future.

The logging operation in watershed areas is allowed depending on categories of watershed and under strict logging rules and regulations. However, logging in the watershed areas not only causes soil erosion but also affects hydrology of the forest ecosystem. One of the important hydrological effects is called "water yield impacts". Its implies substantial increase in total steamflow due to forest conversion and forest logging. Forest cover generally utilizes more water that other type of vegetation such as agricultural crops and grasses. Consequently, the conversion of forest is usually accompanied by increase in steamflow discharge as a result of reduction in evapotranspiration demands.

Water quality and nutrients are important elements for the forest eco-system. Forest removal or disturbance affect stream water quality. Complex root system of forest and high levels of organic matter encourage infiltration capacity that eventually protect against erosion and thus maintain water quality. It was documented that commercial logging resulted in increase in pH, electrical conductivity and hardness. Increases in chemical concentrations were also observed particularly for alkalinity, silicate, Ferum, Calcium and Natrium. It implies that conversion impacts on water quality was most obvious in reducing potable water supply, recreational use of water and hydropower generation (Abdul Rahim, 1998).

Decision-makers have to increase their attention to timber production and the potential impacts of logging activities on the hydrological attributes of forested catchments. In order to assist decision-makers or forest managers, analytical methods are needed to evaluate the benefits of watershed protection and assess the economic trade-off between timber production and watershed management objectives. The assessment of the physical impacts of timber production on reservoir management and downstream activities require estimates in monetary terms to help making decision on land use options.

Impacts of Logging Intensity

Economic activities in most forested catchment are associated with projects causing land use change, such as agriculture or timber harvesting. These activities produce physical impacts affecting soil stabilization, stream flow and water quality functions of the catchment. The changes in physical effects have economic implications that can be understood through the framework illustrated in Figure 1.

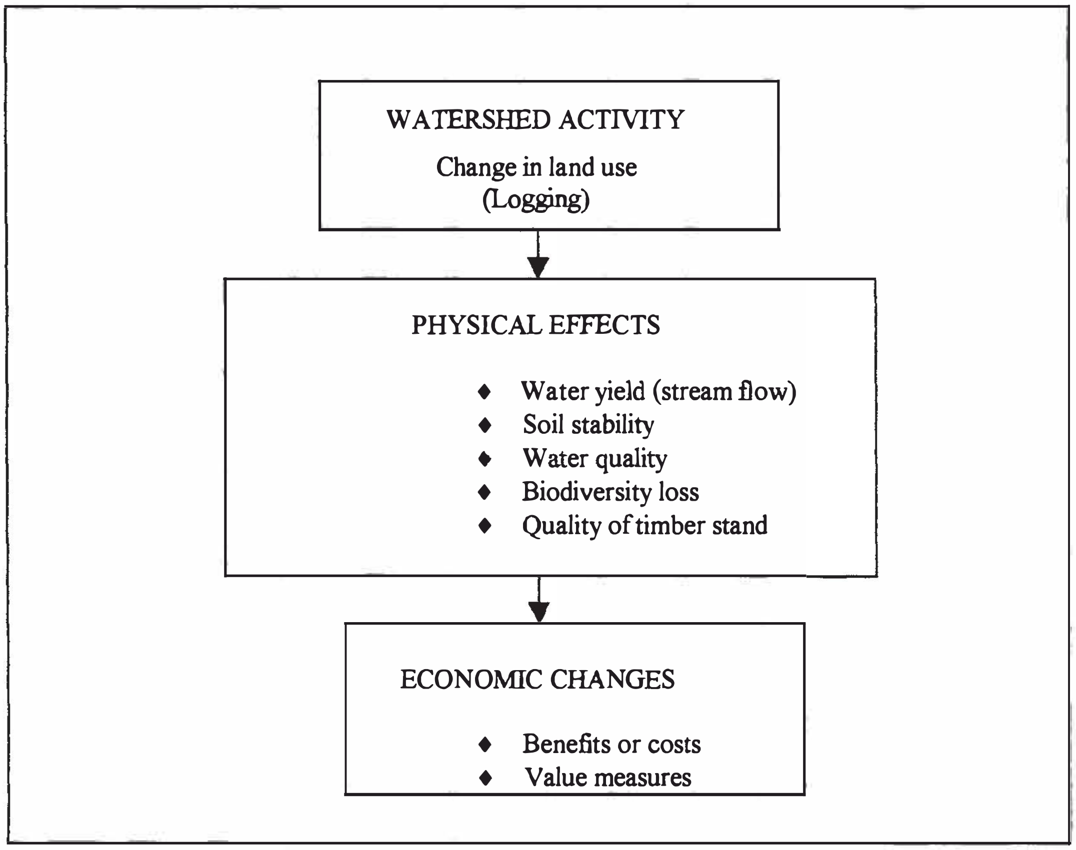

Figure 1: A Framework Illustrating Physical Impacts Upon Catchments

Source: Adapted from Gregersen *et al.* (1987).

On-Site Impacts of Logging

On-site impacts refer to the physical impacts of logging in the upland forested catchments. In this case the critical paths of physical impacts will focus on soil erosion and their other implications. The main impacts of logging activity are the declining quality of land resources itself such as erosion, change in forest management options on forest resources (timber and non-timber), forest rehabilitation and loss in biodiversity (Figure 2).

On-site impacts are most frequently studied, typically by analysis of the effect of soil loss on crop production. Guan (1999) studied the impacts of soil degradation on productivity of farmland in Cameron Highlands, Malaysia. Brooke *et al.* (1997) studied the changing soil hydrology due to rain forest logging in Sabah. Baharuddin (1995) studied the impacts of logging operations on soil physical properties and soil erosion in a hilly dipterocarp forest.

However, there are only few studies that focus on quantifying and valuing the logging impacts on forest plants and biodiversity. Burgess (1998) examined the economics of conversion and fragmentation of forest land. He developed a model to define the effect of forest level and, in particular the interactions between the stand and the total stock of forest land. Vincent and Boscolo (1998) conducted a study on

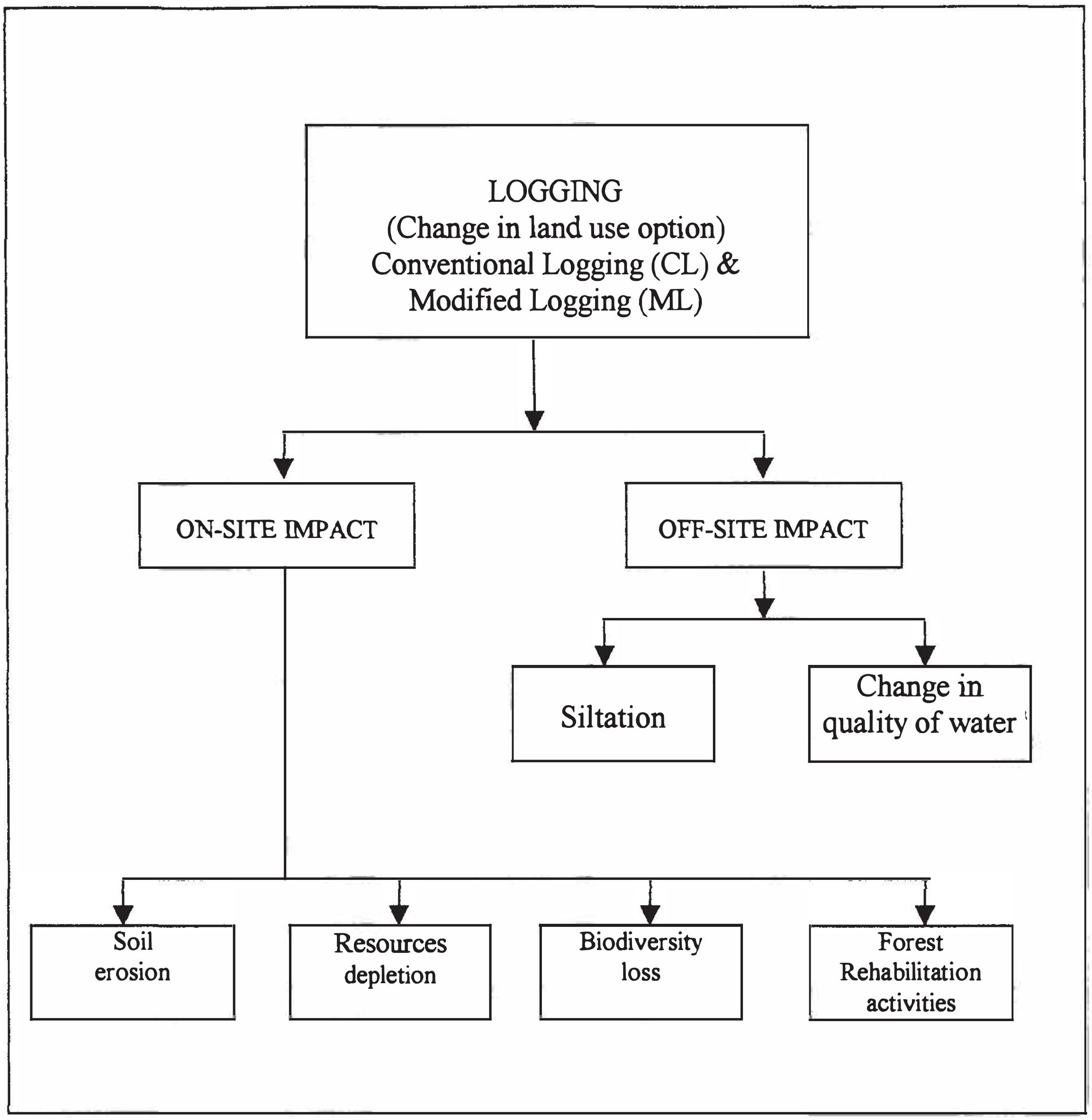

Figure 2 : Identification of Physical Impacts

Source: Adapted from Gregersen *et al.* (1987).

promoting a better logging practice in tropical forests using a simulation analysis of the impacts of alternative logging regulations on carbon storage and biodiversity.

In Malaysia, not many researchers have focused on the complete on-site impacts of logging. Most studies focused on the impacts of soil erosion on the productivity of agriculture and not on forest productivity (Klock, 1982). Although there are numerous models to predict the physical impacts of logging, they are very difficult to apply to forest conditions because soil erosion and transportation processes in forestland are not well understood. Furthermore, introduction on forest soil disturbance is often patchy and discontinuous and the erosion and deposition process are more complex compared to agricultural land (Dissmeyer and Foster, 1985).

Off-Site Impacts of Logging

The off-site impacts (also called externalities) of logging in this study refer to the indirect impacts from logging operations to downstream areas. These possible impacts are mainly from water-borne runoff and sedimentation. Most of the impacts of sedimentation are captured by looking at reservoir sedimentation and its effects on the multiple services provided by the dam. Reservoir sedimentation reduces potential benefits by shortening reservoir or dam service life and storage capacity. Other impacts are the decline in water quality for domestic and industrial use, water