



UNIVERSITI PUTRA MALAYSIA

**FOREST REGENERATION UNDER REDUCED- IMPACT
AND CONVENTIONAL LOGGING IN LOWLAND
MIXED DIPTEROCARPS FOREST OF
EAST KALIMANTAN, INDONESIA**

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By

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requirements for the Degree of Master of Science (Tropical
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IN THE NAME OF ALLAH THE MOST GRACIOUS MOST MERCIFUL

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BELOVED PARENTS, BROTHERS, SISTERS, TEACHERS AND FRIENDS
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ABSTRACT

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The lowland rain forests of the Bulungan Research Forest (now called as Malinau Research Forest) are important for their high species richness which constitutes a portion of the remaining frontier forest in Asia. Lowland dipterocarp forest is the most extensive forest type in the area. Trees may reach up to 35-40 m height. Dominant species with diameter are those of the Dipterocarpaceae family. The commercial timber species in the area is *Shorea* spp, *Dipterocarpus* spp, *Hopea* spp and *Vatica* spp. *Agathis boorneensis* is also another commercial species. It is the unique timber representative of the family Araucariaceae in the lowland and hill mixed dipterocarp forest of Borneo. Reduced-Impact Logging (RIL) trial has been carried out in the compartment of operational scale (over 100 ha). Twenty four permanent sample plots (PSPs), of one ha each have been randomly set up for a long term monitoring. All trees (dbh ≥ 20 cm) were measured and identified. The objective of study was to observe how far RIL can reduce logging damage as compared to conventional logging which was done in state-owned company, PT Inhutani II, East Kalimantan. Residual stand damage were calculated to be compared with initial density. In conventional logging, the damage which was created in diameter class of 20-50 cm dbh versus felling intensity were recorded as amounting 27% (in low logging intensity), 22% (medium), and 27 % (high) from initial density. Meanwhile in diameter class above 50 cm dbh were 3.9% (low) and 6% (both medium and high). In contrast, in reduced-impact logging, residual stand damage in diameter class of 20-50 cm dbh were 10% (low), 20% (medium) and 29% (high). Meanwhile, in diameter class above 50 cm dbh were only 1% (low), 3% (medium) and 6% (high). In line with those activities also to do monitoring PSPs, as well as to examine the stand structure and status of species composition of logged over forest under reduced impact and conventional logging. The study showed the overall density of saplings of approximately 4,600 stems/ha, which is mainly composed of two families, Euphorbiaceae and Dipterocarpaceae. Euphorbiaceae particularly dominated this storey. A total of 705 trees species were recorded from the permanent sample plots, of which 70 trees (9.29%) were dipterocarp species. Among the distributed dipterocarps species are *Dipterocarpus lowii*, *D. stellatus*, *Shorea beccariana*, *S. brunescens*, *S. exelliptica*, *S. Macroptera*, *S. Maxwelliana*, *S. multiflora*, *S. parvifolia*, *S. rubra* and *S. venulosa*. In this study, residual stand damage due to reduced impact and conventional logging with different logging intensity were also be demonstrated.

ABSTRAK

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Hutan hujan penyelidikan tanah pamah Bulungan (sekarang dikenali sebagai Hutan Penyelidikan Malinau) adalah penting kerana kepelbagaian spesies yang merupakan sebahagian daripada hutan tertua di Asia. Hutan tanah pamah dipterokarpa merupakan hutan yang terluas di daerah ini. Pokok-pokok di sana boleh mencapai tinggi 35 sehingga 40 m. Spesies yang dominan dengan adalah dalam famili Dipterocarpaceae. Spesies pokok komersial di daerah ini adalah *Shorea* spp, *Dipterocarpus* spp, *Hopea* spp and *Vatica* spp. *Agathis boorneensis* juga merupakan jenis yang komersial. Ianya adalah kayu yang unik dan mewakili famili Araucariaceae di hutan tanah pamah dan hutan dipterokarpa tanah tinggi di Borneo. Pengujian pembalakan secara manpan telah dilakukan di dalam kompartmen dengan skala operasi (sebanyak 100 ha). Dua puluh empat plot sampel kekal (PSPs), dengan masing-masing satu ha telah dibuat secara rawak sebagai pengawasan untuk satu masa. Kesemua pokok tersebut (DBH 20 cm) telah diukur dan dikenali pasti. Tujuan kajian ini adalah untuk melihat sejauh mana RIL boleh mengurangkan kerosakkan pembalakan dibandingkan dengan konvensional yang dilakukan di perusahaan kerajaan, PT Inhutani II. Kerosakkan tegakan dirian juga dikira untuk diperbandingkan dengan kepadatan semula. Pada pembalakan dengan cara konvensional, pada kelas diameter 20 sehingga 50 cm dbh menurut intensity penebangan terekod sebanyak 27% (pada pembalakan berintensiti ringan), 22%(sederhana) dan 27% (tinggi). Pada diameter melebihi 50 cm dbh adalah sebanyak 3.9%(ringan) dan 6% (keduaduanya, baik sederhana mahupun tinggi). Pada pembalakan secara manpan, kerosakkan dirian tinggal pada kelas diameter 20 sehingga 50 cm dbh adalah sebanyak 10%(ringan), 20%(sederhana) dan 29%(tinggi). Pada diameter kelas melebihi 50 cm dbh, kerosakkannya adalah hanya 1%(ringan), 3% (sederhana) dan 6% (tinggi). Justru dengan aktiviti tersebut, pengawasan menggunakan PSPs selain daripada pemeriksaan struktur dirian dan status komposisi jenis hutan bekas tebangan dibawah pembalakan secara manpan dan konvensional. Kajian ini menunjukkan juga bahawa keseluruhan kepadatan dari dirian tinggal mencapai 4,600 batang/ha yang pada amnya terdiri daripada dua famili, Euphorbiaceae dan Dipterocarpaceae. Euphorbiaceae umumnya mendominasi dirian tinggal. Sebanyak 705 spesies pokok telah direkod dari plot sample kekal, dimana 70 pokok (9.29%) adalah spesies dipterokarpa. Di antara jenis dipterokarpa tersebut adalah dari spesies *Dipterocarpus lowii*, *D. stellatus*, *Shorea beccariana*, *S. brunescens*, *S. exelliptica*, *S. Macroptera*, *S. Maxwelliana*, *S. multiflora*, *S. parvifolia*, *S. rubra* and *S. venulosa*.

CHAPTER ONE

INTRODUCTION

General Background

In December 1995, the Indonesian Ministry of Forestry designated 303,000 ha of forest for CIFOR in East Kalimantan (Indonesia) to be developed as a long-term model of exemplary research-based management. The creation of this research forest - the first ever in Indonesia - and the agreement with CIFOR grew out of a provision in the host-country agreement granting access to a long-term research site. CIFOR began the search for an appropriate site in 1994 and, in October 1995, submitted a recommendation to the Ministry of Forestry for an area in Bulungan district, recently it is changed to Malinau (Figure 1). The Minister of Forestry approved the designation in December 1995.

The tropical forest is heterogenous and uneven age with very high tree species composition. In 1 hectare plot of forest in Kalimantan, for example, more than 150 species were found (personal comm. MOF). Based on the characteristics of the forests, the most suitable silvicultural system to be applied on the forest is selective logging system based on the minimum diameter cutting limit, and the minimum number of nucleus trees.

According Sellato (2001), Malinau district (in which the research site is located) covers an area of 8783 km², which include mainly the Malinau (364 500 ha) and Tubu (261 675 ha) river basins , and a portion of Sesayap-Mentarang river.

In Malinau, fluid Punan groups constitute a notable proportion of the population. In 1998, the total population of the Bulungan regency amounting to over 300 000. Bulungan's population has grown by at least 25% in the last ten years. The development of industrial activities, including petroleum, timber, plywood plants, shrimp farms and oil palm estates, must account for this population growth (Sellato 2001).

Conventional logging, i.e. logging operation systems are often described as unplanned, haphazard timber harvesting. In Indonesia, conventional logging refers to TPTI system, which is followed by Concession Company or HPH. Unplanned and uncontrolled timber harvesting will cause excessive logging damage so that it will make imbalance between forest regeneration and production and yield of the forest will be declined.

The term of reduced-impact logging (RIL) surfaced around the mid 1990s, but the concept is also referred to as low impact logging, planned (as opposed to unplanned) logging, environmentally sound harvesting and damage controlled logging (Van der Hout 1999). RIL is the implementation of a collection of forest harvesting techniques which results in low level of damage to the stock of

residual trees, soil and water, so that the production capacity of the forest after logging is sustained, besides maintaining the biodiversity function of the forest.

RIL implementation which is a component in the management at the compartment level, is an effort to reduce the impact of harvesting in accordance with the requirement of the sustainable forest management system.

Seven elements are common to most RIL system including the following (Sist *et al* 1998):

- Pre-harvest inventory and mapping of the trees, including providing topography map
- Pre-harvest planning of roads and skid trails
- Climber cutting prior to logging
- Directional felling
- Optimum recovery of utilizable timber
- Winching of logs to planned skid trails

The regeneration study in Bulungan Research Forest therefore will play important role to give information to the concession company to improve silvicultural system to be applied on the forest , and also to provide continuous data in growth and yield of the forest taken from the PSPs.

Regeneration stands are an important stage in the reconstitution of the stock and re- presents the potential of the future harvesting. Information about natural

regeneration is therefore very important to ensure the sustainability of the logging operations and silviculture.

Studying regeneration assumes the definition of maximum and minimum size to investigate. Bariteau in Nguyen-The and Kadir (1998) defined two phases of regeneration: small seedlings (<1.50 m) and high seedlings (≥ 1.50 m and dbh <10 cm). In this study, the focus of the investigations are on saplings from 2 to 20 cm dbh, a stand considered as being well-established compared to the unstable seedling phase.

In primary forest growth rates of 0.22 cm/year for all species and 0.3 cm/year for dipterocarps were found (The Nguyen *et al* 1998). Logging had a stimulating effect on growth as a consequence of the canopy opening and the sudden light inflow in the under storey.

Objectives of study

The general objectives of this study was to assess regeneration potential of the two years logged over forest under reduced impact and conventional logging in the lowland mixed dipterocarps forest of East Kalimantan.

The specific objectives of the study were :

1. To examine the stand structure and status of species composition of logged over forest in lowland mixed dipterocarps forest in East Kalimantan under reduced impact and conventional logging
2. To compare the effects of logging operation using conventional and reduced-impact logging to the residual stands

Justification of Study

Forest depletion

East Kalimantan is experiencing ever accelerating loss of primary forest cover, Yet, land use and vegetation patterns, both in spatial and temporal contexts, are not well-documented or understood because the conversions have been taking place so rapidly. Up to about four decades ago, the core of the forest area was little disturbed and sparsely populated by indigenous Dayak population, who practiced shifting agriculture and harvested non-timber forest products. More intensive forest disturbances began in the late 1960s when commercial logging started. Initially it was small scale tree harvesting with low level of damage but later, large-scale logging operations began and consequently harsh environmental impacts.

The need for best forest practice

All efforts at sustainable management in mixed dipterocarp forest carry considerable risks due to the lucrative short term gains from destructive timber extraction. The question of how to achieve 'sustainable forest management' in Malinau is clearly neither purely a biophysical question, nor purely a social or economic one.

In general, forest logging may cause detectable changes on environmental variables, depending on the intensity of disturbance and the extent of cover removed. By the same token, forest clearance and forest conversion to other land use are expected to cause greater impacts on hydrology and soil erosion processes. With the progress towards sustainable forest management, an improved harvesting techniques (i.e. RIL) is being implemented and promoted in various regions. The aim of this techniques is to reduce damage on residual trees, soil disturbance, and impacts on wildlife (Sist *et al.* 1998).

The RIL techniques is one of the important elements of sustainable forest management. The present reduced-impact logging studies constitute a development phase within a longer-term research strategy on sustainable forest management in Bulungan Research Forest. This work was conducted in the Malinau concession of Inhutani II with technical supervision by CIFOR. Research

on the immediate and long term impact of timber harvesting with conventional and RIL techniques from both environmental and economic perspectives was carried out. The overall objective was to promote the integration of RIL into logging techniques at the concession scale.

CHAPTER TWO

LITERATURE REVIEW

Understanding Reduced –Impact and Conventional Logging

Logging in the tropics, as conventionally practiced, depletes timber stocks and causes severe ecological damage to residual forests. Reduced impact logging (RIL) systems are currently being developed in tropical countries in response to concerns over the ecological and economic sustainability of harvesting natural tropical forest stands. RIL systems use an array of best harvesting techniques that reduce damage to residual forests, create fewer roads and skid trails, reduce soil disturbance and erosion, protect water quality, mitigate fire risk and potentially help maintain regeneration and protect biological diversity.

One of the key issues regarding sustainable forest management in many tropical countries is the degree of damage inflicted to the residual stand as a result of logging operation. Appanah and Weinland (1990) had reported some studies undertaken in Southeast Asia on logging damage to residual stands. The damage to residual trees varies from 8% to 72%, and most of the study reported more than 40% logging damage to residual stand. This variation in logging damage to residual stand can be attributed to many factors : 1) number of trees

felled; 2) volume of timber removed; 3) initial stand density; 4) spatial distribution of felled trees and retained trees; 5) types of harvesting and machinery used; 6) road planning and design; 7) directional felling; 8) size of trees felled and 9) topography and slope. In line with the objectives of sustainable forest management, the reduced-impact logging plays important role as an appropriate techniques in order to achieve sound forest management. A lot of results from the research seem to agree with the advantages of implementing RIL in the harvesting techniques.

The term of 'reduced-impact logging' (RIL) surfaced around the mid 1990s, but the concept is also referred to as 'low impact logging', planned logging, environmentally sound harvesting and damage-controlled logging. The adjective 'reduced' hints at a comparison with another logging method, which is obviously the current, local conventional practice.

Six basic features of RIL

The reduced-impact logging system has six basic features (Van der hout 1999):

1. Pre-harvest inventory
2. Climber cutting
3. Tree selection
4. Skid trail planning
5. Directional felling
6. Planned skidding and winching

Some of these elements may be already present in conventional practice; in some cases, they may rudimentary, in other cases they may be close to 'standard practice'. These elements are often depicted as being newly developed. Although directional felling and proper bucking techniques were already used by lumberjacks in the 17th century, the introduction of chainsaw requires proper sawing techniques to ensure safety of the operator, to achieve high standards of utilization and maximize efficiency.

Pre-harvest inventory

In both the conventional and reduced impact logging systems that were studied, pre-harvest inventories were conducted. The critical distinction between the inventories of the two systems lies in difference of in the detail and the accuracy of data collections. Based on field observation, in TPTI , topography survey is not conducted during forest harvesting planning and no a such close monitoring from forestry authority. Topo map is a basic and very important information in order to have clear condition the area to be harvested. Tactical logging map which describes rivers and creeks network, contour line (2 m scale), trees distribution, and planned skidtrail will be useful for forest planner to do forest harvesting. Therefore, it will give better orientation for feller and tractor operators to cut and skid the trees.

Climber cutting

Climbers are important structural component of the forest canopy, often linking tree crown. It is generally considered that presence of climbers contributes a lot to logging damage. By cutting climbers some time prior to felling, it may be expected that they will have died and physical connections binding one crown to another will have weakened considerably. Felling trees may then be less liable to carry down with their neighbours.

Tree selection criteria

Tree selection criteria were based on different diameter limits for different species according to their specific growth pattern, the abundance of commercial species in a plot and the distribution of suppressed future crop trees.

Directional felling

Directional felling aims specially at:

1. ensuring the safety of the felling crew;
2. preventing breakage of the log by felling the tree downhill, in depressions, over ridges or on a solid obstacle such as stumps, rocks or windfalls;
3. preventing damage to the standing commercial timber surrounding the tree to be felled;
4. avoiding excessive crushing of seedlings and saplings commercially desirable species; producing a felling pattern geared for the subsequent operation-skidding.

Planned skidding and winching

The skidtrail system is designed to minimize skidding distance, skidding on steep slopes, skidding downhill, and stream or gully crossings. In order to facilitate winching and to improve the efficiency of the operation, the skidder is equipped with detached choker straps. The use of the dozer blade is minimized and scrapping of the top soil during skid trail construction is discouraged.

Efforts towards sustainable forest management have promoted the implementation of Reduced-Impact Logging techniques (RIL), also called LIL (Low Impact Logging) or LIH (Low Impact Harvesting) techniques. The RIL main objective is to reduce soil disturbance, impacts to biodiversity, and damage to residual trees. Reduced-Impact Logging is a package of tools which has the objective to minimize damage to the residual stand, based on an accurate inventory and a topographical stock map showing the position on all the potential crop trees for felling.

RIL has been recently implemented and tested in various tropical regions, particularly in South East Asia and Latin America (e.g. Sabah by Pinard and Putz 1996; East Kalimantan, Bertault and Sist 1997, Sist *et al* 1998, Sist *et al in press*; South America Hendrison 1989, Uhl and Veira 1989). In the context of increased effort to achieve sustainable forest management, codes of practices and RIL guidelines have been produced by forestry organisations such as FAO,