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Forest, Science and Sustainability:
The Bulungan Model Forest




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Contents

Acronyms and Abbreviations

AAC	Annual Allowable Cut
ACIAR	Australian Centre for International Agricultural Research
ACM	Adaptive Co-Management
Al	Aluminum
AMDAL	Analisis Dampak Lingkungan (Environmental Impact Assessment)
ANOVA	Statistical Analyses of Variance
APHI	Asosiasi Pengusaha Hutan Indonesia (Association of the Indonesian Forest Concessionaires)
asl	Above sea level
BAF	Basal Area Factor
BALITBANG	Balai Penelitian dan Pengembangan (Research and Development Center)
BAPPEDA	Badan Perencanaan Pembangunan Daerah (Regional Development Planning Board)
BDMS	Bara Dinamika Muda Sukses, a name of coal mining company
[BI]	Indonesian (*Bahasa Indonesia*)
BI	Bifurcation index
BIOMA	Yayasan Biosfer Manusia (Human Biosphere Foundation)
BIOTROP	Southeast Asian Center for Tropical Biology
BRF	Bulungan Research Forest
C	Carbon
C/N	Carbon to Nitrogen ratio
CD-ROM	Compact Disc Read Only Memory
CEC	Cation Exchange Capacity
Chrome	(Soil) Color Purity or Strength
CIFOR	Center for International Forestry Research
CIRAD	Centre de Cooperation Internationale en Recherche Agronomique pour le Développement
CNV	Conventional Logging
C-Org	Organic Carbon
CV	Commanditaire Vennootschap (Limited Partnership)
DAS	Daerah Aliran Sungai (Watershed)
DBH	Diameter at Breast Height
DEM	Digital Elevation Model
DR	Dana Reboisasi (Reforestation Fund)
DRH	Diameter at Reference Height
FAO	Food and Agriculture Organization
Fe	Iron
FORDA	Forestry Research and Development Agency
FPP	Forest Products and People
GIS	Geographic Information System
GPS	Global Positioning System
GTZ	Deutsche Gessellschaft für Technische Zusammenarbeit
H	Hydrogen
ha	Hectare
H_2O	Water
HPH	Hak Pengusahaan Hutan (Forest Concession Rights)
HSI	Heavy Soil Impact
Hue	(Soil) Dominant color
ICRAF	International Center for Research in Agroforestry
IFAD	International Fund for Agricultural Development
IHH	Iuran Hasil Hutan (Forest Product Royalties)
IHPH	Iuran Hak Pengusahaan Hutan (Forest Concession License Fee)
INHUTANI	Eksploitasi dan Industri Hutan (Forest Exploitation and Industries), a name of the State-owned forest enterprise
IPB	Institut Pertanian Bogor (Bogor Agricultural University)
IPPK	Ijin Pemungutan dan Pemanfaatan Kayu (Wood Utilization and Harvesting Permitt)
IRD	Institut de Recherche pour le Développement
ITTO	International Tropical Timber Organization

IUCN	International Union for Conservation of Nature and Natural Resources, now known as the World Coservation Union
[K]	Kenyah language
K	Potassium
KCl	Potasssium Chloride
LIPI	Lembaga Ilmu Pengetahuan Indonesia (The Indonesian Institute of Sciences).
LSD	Least Square Distance
LSI	Low Soil Impact
LUV	Local User's Value
[M]	Merap language
m	Merap ethnicity
me/100g	Milli-equivalent (ionic concentration unit)/ 100 grams
Mg	Magnesium
MLA	Multidisciplinary Landscape Assessment
MOF	Ministry of Forestry
MSI	Moderate Soil Impact
N	Nitrogen
Na	Sodium
NARS	National Agricultural Research System
NGO	Non-Governmental Organization
NH_4OAc	Ammonium Acetate
NRM	Natural Resources Management
NTFP	Non Timber Forest Product
[P]	Punan language
P	Phosphorus
p	Punan ethnicity
PD	Project Document
PDM	Pebble Distribution Method
phi	Statistical measure of relationship strength
PMDH	Pembinaan Masyarakat Desa Hutan (Community Assistance required from Forest Concessions)
PPT	Pusat Penelitian Tanah (Center for Soil Research)
PT	Perseroan Terbatas (Limited Liability Company)
p-value	estimated probability (of result occurring by chance under a stated null hypothesis)
RePPPRoT	Regional Physical Planning Programme for Transmigration
RIL	Reduced-Impact Logging
RKPH	Rencana Karya Pengusahaan Hutan (Forest Management Plan)
RKT	Rencana Kerja Tahunan (Annual Work Plan)
ROADENG	Road Engineering
SD	Standard Deviation
SDM	Sumber Daya Manusia (Human Resources)
SEKWILDA	Sekretaris Wilayah Daerah (District Secretary)
SFM	Sustainable Forest Management
SHK	Sistem Hutan Kemasyarakatan (Forest Community System)
SOFTREE	Computer software for inventory and topographic mapping
sp.	A species (name unknown)
spp.	species (plural) in a given genus
SPSS	Statistical Packages for the Social Sciences ©
Tau ( )	Test statistic of Kendall's rank coefficient
TFF	Tropical Forest Foundation
TPn	Tempat Penimbunan Kayu Sementara (Temporary Log Landing)
TPTI	Tebang Pilih dan Tanam Indonesia (The Indonesian Selective Logging and Planting System).
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNMUL	Universitas Mulawarman (Mulawarman University)
USAID	United States Agency for International Development
USDA	United State Department of Agriculture
Value	(Soil) Color Brightness
WCS	Wildlife Conservation Society
WWF	World Wide Fund for Nature

Foreword

Forest, Science and Sustainability: Bulungan Model Forest

Specialists in tropical forestry generally agree that to achieve sustainable management of production forests one must be able to convince private companies that they can benefit from adopting forestry practices that cause less damage to the residual stand. Likewise, government agencies have to develop new rules and regulations based on solid economic and ecological data that reduce private companies' administrative burdens and operating costs while keeping the environmental impact of production activities to a minimum. One must also find ways to reduce conflict between private companies, local communities, national and local governments and environmental organizations. That, in turn, requires better understanding of the needs and expectations of each party.

These things are much easier to say than to implement in the field. Nevertheless, over the last five years a unique partnership involving researchers from several institutions with government officials, private companies, NGOs, and local communities has made significant strides towards achieving these goals in the District of Malinau in East Kalimantan, Indonesia.

The initial initiative for this partnership came from the Ministry of Forestry of Indonesia and the ITTO. The strong political support from the Ministry and the generous financial support and technical advice from ITTO provided a framework in which it was possible to attract additional contributions from the MacArthur and Ford Foundations, ACIAR, IFAD, CIRAD-Forêt, IRD, PT INHUTANI II, PT Trakindo Utama, Caterpillar Asia, LIPI, and others.

Within the partnership, Indonesia's Forestry Research and Development Agency (FORDA) and the Center for International Forestry Research (CIFOR) have played the leading role on the research side. Scientists and students from LIPI, CIRAD-Forêt, IRD, and several universities have also participated. Indonesia's Ministry of Forestry, PT INHUTANI II, PT Trakindo Utama, Caterpillar Asia, the District Government of Malinau, several NGOs and dozens of local communities have all been heavily involved on the development and implementation side.

Through their experiments at a commercial scale, the researchers have been able to demonstrate that Reduced Impact Logging practices can not only reduce damage to the residual stand by 50%, they can also improve companies' profits by increasing the productivity of their felling and skidding operations. The researchers also showed that companies could harvest 7–9 trees per hectare and still keep the damage to the residual stand and to soil and water resources at an acceptable level. If the companies follow these guidelines they probably wouldn't need to engage in costly regeneration treatments. Thus, the government would no longer have to require such treatments and monitor their implementation. This is obviously of interest to both the companies and the government agencies. Since several companies such as PT INHUTANI II and PT Trakindo Utama have been involved in the process from the start they can feel completely confident about the reliability of the results.

By using a new technique called Multidisciplinary Landscape Assessment the researchers were able to carefully document which animal and plants species different groups of local people used and how important these species were to them. These efforts gave special attention to previously marginalized groups such as the Punan, who have traditionally been hunters and gatherers

and depend very heavily on the forests for their livelihoods. Such assessments, as well as systematic reviews of existing literature from other locations, are now beginning to serve as the basis for discussions about land use planning. They are also contributing to identifying new forestry practices and regulations that can help to protect those plant and animal species that communities value the most. This will help to minimize conflicts between companies and local communities resulting from practices that negatively affect the species that local people depend on.

Multistakeholder dialogues involving national and local government officials, private companies and local communities, and participatory mapping of community land claims provide other important tools for reducing conflict. Indonesia still has limited experience with these tools, so they must be tested to determine what is most likely to work under local conditions. Recent workshops at the district level and mapping exercises in some 22 villages have provided valuable lessons for how such methods could be used most effectively in the future.

To move from tests and validation to wide-scale implementation one needs to train and mentor local foresters, government officials and the students that will be the foresters of the future. Hence, from the beginning, capacity building has been an important part of this partnership.

As the two executing agencies involved in this effort, FORDA and CIFOR are extremely grateful for all of the support that we have received from ITTO, the Ministry of Forestry and the other agencies and groups mentioned above. We have a long-term commitment to working in the Malinau District. We are convinced that efforts such as these will go a long way towards advancing ITTO's Year 2000 objective for sustainable forest management, and towards achieving the goals of all the groups that have taken part in the efforts in Malinau over the last few years. We hope that you will find this report of use in your own activities and we look forward to working together with you to achieve sustainable forest management in the coming years.

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Executive summary

Research in Bulungan Model Forest: the management of a large, multistakeholder forest

CIFOR's research in the Bulungan Model Forest in Malinau, East Kalimantan took the form of a 3-year investigation into ways of achieving forest sustainability in a 'large forest landscape' with diverse, rapidly changing and conflicting uses. CIFOR took a challenging approach to the research that emphasized the need to devise better methods for an iterative research process so that all the key players could participate in defining research priorities to address long-term forest management and sustainability. The work proceeded along several complementary lines where technical, institutional and economic factors could be assessed and combined successfully. The lessons learned provide baseline information that will support longer-term research.

Reducing the impact of logging on the forest

The main objective of this work was to assess how far reduced-impact logging (RIL) can reduce logging damage under varying felling intensities. RIL significantly reduced damage to the residual stand, and the cost savings from RIL skidding outweighed the additional costs of training and supervision. One of the most important benefits was the significant reduction of wood waste left in the forest, representing a saving of about 11% for each cubic metre of commercial volume produced. Introducing RIL increases initial costs, but the fellers and skidder operators involved in the experiment found they were able to meet the same daily volume in a shorter time than using conventional techniques.

RIL is a silvicultural approach, but the techniques can also combine with the forest dwellers' dependencies that the project's biodiversity research highlighted. Reducing damage to forests during harvesting is the most obvious step in lessening the impact of logging on vertebrates. In particular, it is important to minimise the area of severely damaged forest.

RIL techniques, as part of a more moderate extraction regime, are essential, not only from the perspective of the growth and survival of the residual stand, but also the longer-term ecological sustainability of the forest. New silvicultural prescriptions should be considered as a way to improve forest-harvesting operations.

Biodiversity across the landscape

The main objective of the project's research into the biodiversity of the area was to use multidisciplinary methods across the landscape to provide clear, and where possible, quantifiable, information on the local values placed on flora and fauna.

Our studies have provided baseline data on several major taxonomic groups. In many cases, and for plants and fish in particular, the records are part of a wider collection of information that includes geographical locations, ecological parameters and the needs and preferences of local communities.

The natural forest is threatened because current forest degradation is happening so fast. The forest understorey may be a key factor in conserving species that are valuable to local people, as well as preserving the habitat and controlling soil erosion

and water turbidity. The CIFOR research has allowed a GIS database to be started that could be used by all the stakeholders as one of the mechanisms for coordination and consensus on forest management.

The Malinau work has highlighted the need to understand in detail the effect that management techniques have on species important to the local people. There are also many species of global conservation interest in the Malinau area. Through our review of what we know about the sensitivities of these species it will be possible to formulate improved guidelines for forestry practices.

Forest people's dependency on forest products

CIFOR sought to investigate the nature of the forest dweller's dependency on forest products in the Malinau landscape. Economic dependency on forest products is seldom the result of free choice; it is often the sole option available to forest people to generate cash income. The traders decide which product they want to buy; they organize the collecting and control the marketing chain. It is this dependency that needed to be understood.

Research among the Punan people showed that as soon as new options are made available—labouring for concessionaires, migration to Malaysia, etc.—the dependency on forest products is reduced. However, not all forest people are guaranteed equal rights to access these new opportunities.

Up to now, there has been no real conflict over the use of the resource between shareholders or even among the communities. The local government receives taxes and local communities receive royalties, while 'investors' strike more profitable deals than ever. There is a clear consensus on the use of the forest; any conflict is only about the sharing of the benefits. Affirming the community's legitimate ownership and rights to the resource has become the main concern of community leaders.

There are variations in the degree of forest product dependency among ethnic groups and among individual households, as in the case of the Punan hunter-gatherers who depend more on forest products for their livelihood than the Dayak swidden cultivators. Nevertheless, there are common threads evident in development trends. There is inevitable tension between increasing access for economic development and the immediate threat that encourages the illegal use of the forest.

Coordination and agreement in boundary negotiations

Boundary negotiations in Malinau highlighted the deeply political nature of coordination efforts among local communities, government and the private sector in the management of the forest landscape, and the uneven distribution of influence underlying them, even among seemingly homogenous community groups. The more intense the underlying struggle, the more fluid the interests, agreements and coordination are likely to be.

The research pursued mechanisms for constructive conflict management, focusing on the use of agreements to settle dispute. However, the work revealed that agreement building was not necessarily fair or acceptable to all the people concerned. Building a supportive political constituency through consultation and transparent decision making was key to creating a more lasting agreement.

The research demonstrated the nature of coordination and agreement making in Malinau and its current vulnerabilities. Very real gains have been made in empowering local communities to begin the process of asserting claims to their territories and of establishing debate about rights associated with those claims.

Outcomes and future directions

Many views of forest use co-exist within even small and apparently homogeneous groups. Overlapping institutions like local custom and government systems promote different views within groups, but for many stakeholders their access to the resources and benefits of the forest are the keys to their feelings for the forest. The research has also allowed us to understand the community values and dependencies that have been largely overlooked by past governments and concession managers.

The integrated approach to the research allowed the identification of a number of strategic problems that need to be addressed in Malinau, with implications for the management of forests elsewhere. In general, there is insufficient understanding of forest

values and changing livelihood options that guide management objectives. There is increasing competition and demand for land and other forest resources. There is a lack of appropriate institutions for making management decisions. There is a lack of incentives and processes to encourage improved practices.

A secure forest estate requires consensus and stability on where and how the forest will be maintained and who will gain the benefits. The situation in a forest is complex because of the range and diversity of the stakeholders and their overlapping claims of legitimacy. The CIFOR study has highlighted much of this complexity while also clarifying the key aspects. By understanding how the forest can yield timber, while also maintaining other important values to numerous stakeholders, by recognising the threat and institutional means available to address them, by understanding how the needs of the poorest communities of the forest see changes as both threats and opportunities, we can build up the understanding that decision makers need to make better decisions for sustainable forest management into the future.

1. Introduction

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Today the most extensive tropical lowland and hill dipterocarp rainforests remaining in Asia can be found in Borneo, in an area encompassing Central and East Kalimantan, Sarawak and Sabah. This forest block covers a more or less continuous area of more than 5 million ha and the World Resources Institute categorizes it as one of its priority 'Frontier Forests' (Bryant *et al.* 1997). Recently the area has been identified as a potential World Heritage Forest Site. A number of forest conservation priority setting exercises have therefore concluded that the area constitutes one of the most important forest areas in the world for conservation (Sayer *et al.* 2000).

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 forest area was little-disturbed and sparsely populated by the 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 smallscale tree harvesting with low levels of damage but later, large-scale logging operations began and had harsh environmental impacts. As the economy and the population grew rapidly, various development pressures increased, yet by the early 1990s the condition of the forests of Kalimantan was still relatively good.

The financial and political crisis in Indonesia since 1997 led to a rapid change in the situation of the forests of Kalimantan. The depreciation of the Indonesian currency against other major currencies and the increase in the export market value of palm oil and coal led to a rapid expansion of land clearing for oil palm plantations and construction of roads to give access to coal deposits. Another factor that has had a major impact on forest resources has been the devolution of power from the central government to the district level, including the authority to allocate logging and land clearing permits. For instance, permits for oil palm estates are being given for areas that are still the subject of logging concession agreements. Barr *et al*. (2001) stressed that decentralization has promoted an exceptional race for claims to forest benefits and resources in Malinau. The district government has the authority to grant timber cutting licenses (known as IPPK, *Izin*

The vegetation is clearer but after a year or so of cultivation the land is left fallow and the forest regrows

Pemungutan dan Pemanfaatan Kayu) which allowed quick profits and have created incentives for nearly everyone, including district government, local communities and 'investors' mainly from Malaysia, to clear forest area rapidly. Yet the local government has a limited ability to handle the resulting competition and conflict. Permits for oil palm estates are being given for areas that are still the subject of logging concession agreements. These have disconcerting implications for long-term forest management. Illegal logging has also been common in the area and elsewhere. It is a complex system involving many stakeholders and a way for local people to get a share of profits from logging (Obidzinski *et al*. 2001). The situation has been aggravated by the occurrence of large-scale forest fires in some areas. A series of catastrophic fires occurred in fairly rapid succession between 1982 and 1998. The extent and damage caused by these fires of the past two decades has been the worst in history (Dennis *et al.* 2001). Forest fires may have a regional and global consequence because the areas involved are so extensive and the effects are so devastating.

When CIFOR was established in Indonesia in 1993 the agreement committed the Government to providing long-term access to an extensive area where CIFOR could conduct research. The process of selecting the site took some time. Criteria included a requirement for an area with potential for long-term sustainable forest management, a diversity of uses of the forest including traditional uses by forest-dwelling indigenous peoples and high biodiversity values. 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 Malinau District (previously Bulungan District). The area in East Kalimantan, adjacent to the Kayan Mentarang National Park, was finally selected. In January 1996, the Indonesian Ministry of Forestry designated 321 000 ha of forest in this area for CIFOR 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 represented a strong commitment by the Government and CIFOR to work together at an operational scale to conduct and apply research under real operational conditions. The Minister of Forestry approved a decree for the designation of this research forest in January 1996. The area is now known as the Bulungan Research Forest (BRF). CIFOR's intention in this area is to carry out long-term multidisciplinary research activities that cover the full complexity of forest management for multiple use.

Swidden clearance is largely concentrated along river sides and more recently along roads

CIFOR's strategic research is focused on policy issues to enable more informed, productive, sustainable and equitable decisions about the management and use of forests. In pursuit of this objective CIFOR has sought to work closely with the other major international bodies whose mission is to conserve and sustainably manage forests. CIFOR therefore recognises the ITTO as an important strategic partner. Both organisations have an international mandate and constitute fora for cooperation and consultation between governments and non-governmental organizations. As stipulated in the ITTO Action Plan, ITTO aims to encourage and promote sustainable and economically viable management systems. Cooperation between CIFOR, FORDA (the Forestry Research and Development Agency of the Indonesian Ministry of Forestry) and ITTO through this research and development project has not only contributed to the achievement of the ITTO year 2000 objectives but has also enhanced the relationship between these institutions.

Although we are beginning to understand what sustainability requires at the forest management unit level, approaches to achieving sustainability at the larger landscape scale remain poorly developed. One of the greatest challenges for achieving sustainable forest management now and in the future will be to address the increasing complexity of demands on tropical forest resources within a constrained and

declining area. Demands for tropical forest products, and for land for conversion or protection are transforming the way forests look and the way they are managed, with the result that tropical forested landscapes are perhaps the single most rapidly changing land type around the globe. These demands are complicated by coinciding claims for use or control of the same area, the increasing number of social and private interests pursuing their diverse agendas and the multiple contexts of forest management, from the local to the regional, national and international scales.

The aim of the present research is to carry out a systematic investigation of how to achieve forest sustainability for a 'large forest landscape' in the humid tropics, where diverse, rapidly changing and often conflicting land use demands exist. This investigation requires the development of understanding of the technologies, policies and information needed for meeting multiple objectives both within and across forest types in a given area. The focus of such a landscape approach is on the links among different activities. The research will therefore aim to understand how to strengthen the synergies and compatibilities among demands, while minimizing the conflicts and negative impacts on sustainability.

The initial project constitutes a developmental phase within a longer-term research strategy. The final objective is to achieve long-term forest management for multiple uses, integrating social, environmental, biodiversity and silvicultural objectives. For this reason, four of the six CIFOR priority programme areas (Sustainable Forest Management, Biodiversity in managed forests, Forest Products and People, Adaptive Co-Management of Forests) have been involved in the area for this initial three-year period. The first phase of the project has consisted mainly of gathering baseline information on the physical, social and economic situation of the area. A major investment has been made in developing relations with the political, industrial and local communities with an interest in the area. Reduced-impact logging (RIL) experiments conducted in cooperation with a major industrial timber company and applied on a concession scale (1000 ha each year) have been completed. This has included an assessment of impacts on both the environment and economic profitability of improved logging practices. It has already contributed to promoting and integrating these techniques in the current Indonesian forest management system. Other major achievements during this first phase have included innovative approaches to biodiversity assessment and comprehensive studies of a number of types of traditional local use of forests, especially for non-timber forest products.

The specific objectives of the activities conducted with ITTO support were twofold:

(1) Assessment of the effect of reduced-impact logging (RIL) on biodiversity, conservation, ecology and socio-economics.

(2) Assessment of rural development trends and future policy options including the effects of macrolevel development activities on people dependent on the forest.

The following account summarizes the achievements of the objectives and the attachments in the CD provide a comprehensive set of detailed individual technical reports on the activities undertaken by CIFOR, FORDA and their partners in the area and a list of the publications that this work has yielded.

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2. Overview of Approaches and Methods

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The project's general objective is to achieve long-term forest management for multiple uses, integrating social and silvicultural objectives. The underlying issue is: what are the appropriate research methods and conceptual approaches to guide sustainability for a large forest landscape, where diverse, rapidly changing and often conflicting land use demands exist? The potential technical and development benefits of the project remain very high. Indonesia, and especially the people of its outlying provinces, remain highly dependent on forest resources for income, employment and a large diversity of commercial and subsistence products. At the same time the country is undergoing a critical transition towards democracy and sustainable development that is creating new challenges for the achievement of long-term management of forest resources.

The project is located in the Malinau (previously Bulungan) district of East Kalimantan, which comprises one of the richest tropical rain forest areas in the world. As in forests throughout Indonesia and in other tropical forest countries, the forests of Malinau are undergoing rapid change brought on by the pressures of legal and illegal logging, mining and agricultural expansion. To understand and address these pressures, the project has combined social and biophysical approaches, and this has allowed synergies and encouraged flexibility in project design and outcomes.

The area originally allocated to CIFOR comprised 321 000 ha of forest within what is now Malinau District. As our work in the area advanced it become clear that it was not possible to meet all of our objectives whilst restricting ourselves to this area. Many of the issues that we were studying were intricately connected across the broader landscape. Local people and logging companies were active both inside and outside the research forest area. Much of our work gradually came to include the surrounding forests and their people. Ultimately much of the content of this report relates to the entire Malinau District, most of which is forested.

All efforts at sustainable management in mixed dipterocarp forests carry considerable risks due to the lucrative short-term gains from destructive timber extraction. However, we believe that the approach that we have taken has many of the key ingredients of possible success. We have applied the latest technologies, developed intense and ongoing collaboration with industry and the Indonesian government, and significant engagement with local communities. Given the pace of economic and political change in Malinau it will be important to define success as measured on the scale of the overall district, with some forest protected, some forest used for multiple uses and some converted to other land uses. It is hoped that the research forest can serve as a testing ground for community-based approaches to forest management.

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. The most obvious aspect of this complex issue is indeed that the answers require a cross-disciplinary effort and multidisciplinary solutions. With this in mind, CIFOR's multiple-element research design has been a first attempt in developing a suitably broad programme where technical, institutional and economic factors can be

assessed and combined in an appropriate way. Because of the breadth of this effort and the many changes taking place during the life of the project, we are now in a much stronger position to identify both priorities and the steps required to find acceptable solutions to the many local challenges.

Since the project is the first phase of research and much of the information collection has been aimed at establishing a basic assessment of existing conditions and trends, a comprehensive coverage of the main issues and perspectives was given preference over a more restrictive and integrated research programme. The value of maintaining such a flexible approach has been well borne out in view of the many unpredicted changes that have occurred in Indonesia in general and Malinau in particular since we began work in the area. Links have emerged naturally from the various research strands. Thus the Multidisciplinary Landscape Assessment (MLA) approach has much complementarity with the forest product dependency and the redesigned ACM (Adaptive Co-management) approaches. All of these research groups have worked on understanding the diversity of socio-economic and ethnographic issues and particularly on being sensitive to local people's perceptions of the environment and the changes taking place. All the research teams have attempted to explore the potential key aspects of sustainable forest management in the area and particularly of how reduced-impact logging (RIL) might be designed in the future. There has been a major effort to link and integrate the components of the specific Objectives 1 and 2 of the research project.

External factors slowed several components and reduced the overall efficiency of the project. These included a major fiscal crisis within the government of Indonesia preventing intended counterpart contributions and affecting the collection of baseline geographical information. The lack of baseline maps and other ancillary geographic information including basic topographic maps was a major constraint. These are primordial requirements for the planning and implementation of component activities in almost all components, principally in landscape assessment and biodiversity, piloting of RIL, assessment of forest products and the conduct of participatory boundary mapping for villages. Interpretation of existing Landsat satellite imagery for Malinau forest area and Radarsat imagery prepared by a hired private company proved of limited use for the purposes of topographic/contour mapping, precise boundary delineation, and current land use classification. Hence, most of these activities have to be done on the ground with the use of GPS, compass and other surveying equipment supported by ground truth interviews and data gathering in view of the wide geographic discrepancies in control points and the fact that land use classification can only be interpreted at the first level of classification, comprising primary, secondary or logged forest – over forest, coal mining areas, and locational referencing of existing villages. This problem will continue to hamper future phases of project implementation unless more accurate, cost-effective, and acceptable options for base and land use mapping are found and conducted.

The approaches adopted in the implementation of the project are described in the following accounts.

Research on Reduced-Impact Logging and Conventional Logging

The present Reduced Impact Logging (RIL) studies constitute a developmental phase within a longer-term research strategy on sustainable forest management in the Bulungan Research Forest. The initial objective of the silviculture component of the project was to start logging experiments, focusing mainly on the implementation of RIL techniques by INHUTANI II, a state-owned forest enterprise. 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 (CNV) 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.

The RIL technique is one of the important elements of sustainable forest management with which we experimented in the project. The first step of the process was the formulation of RIL guidelines in cooperation with INHUTANI II and in consultation with other cooperating agencies and stakeholders. These guidelines have been summarized as a 'how-to' manual to be used for field training and piloting future large-scale

implementation. The guidelines conform to Indonesia's current selective logging and planting system, *Tebang Pilih dan Tanam Indonesia* (TPTI) and are intended to provide techniques and directions for reducing harvesting damage to residual trees, soils, hydrological functions, and the general forest environment during logging operations. If properly followed and implemented they would ensure a viable residual stand for succeeding cutting cycles, serving as a solid foundation for sustainable forest management. Current TPTI prescriptions can therefore benefit from an improved approach to timber harvesting through the procedures and approaches contained in the RIL guidelines. These guidelines have been used effectively in the training of INHUTANI II technical staff for utilization in its harvesting operations.

Comparative analyses were made on sample plots to compare the impacts of RIL with conventional logging currently being implemented by INHUTANI II in its Malinau concession area. These experiments were carried out on two blocks of about 100 ha each in the hilly mixed dipterocarp forest inside the Bulungan Research Forest. Logging damage was evaluated and compared on the basis of pre- and post-harvesting stand inventories in 24 sample plots of one ha each set up in the above blocks. A comparison of costs was based on another two blocks harvested with CNV techniques in 1998. Since the scale of the experiment did not allow for the inclusion of all logging costs, particularly those related to road planning, road construction and log transportation, this study focused only on planning and the operational costs of felling and skidding.

The results of the RIL pilot phase implementation are intended to be inputs towards improving the current TPTI with the aim of achieving sustainable forest management and development throughout Indonesia. Overharvesting and bad logging practices have to be regulated and sustainable forestry harvesting guidelines implemented if logging intensity, damage to residual stands and environmental damage are to be reduced. Current operating guidelines often result in logging damage that is beyond acceptable thresholds and jeopardises natural regeneration and the integrity of forest ecosystems.

Biodiversity

The Malinau area of East Kalimantan was, until recently, little known biologically. It was suspected that the rugged and forested landscape, adjacent to the Kayan Mentarang National Park, would reveal high value in terms of its plant and animal species. A major emphasis of our activities has been to begin to document this vast biological wealth. This research has had three major components: 1) finding out what occurs where, 2) assessing to whom it matters and in what way, and 3) identifying what steps are needed to maintain this biota in the future. The first two have required extensive fieldwork in both the wider landscape and, in a more focused way, in the experimental harvesting site, while the last has required an extensive review of current scientific knowledge. Together, these three strands of information help define priorities that reflect local considerations and can inform a wide range of processes, from the development of reduced impact logging guidelines to international forestry and conservation policy.

The main activity has been termed the 'Multidisciplinary Landscape Assessments' (or MLA), which has aimed at developing a baseline of environmental information that explicitly includes factors needed for land use planning and biodiversity assessment. Four phases of fieldwork were completed in seven communities with site descriptions for 200 plots. Comprehensive data were collected relating to local landscapes, locations, biodiversity, and local people's perceptions of forest resources using various procedures. The data included vegetation and soil analysis and some information on significant fauna. Socio-cultural information such as history of settlements, people's attitudes to forest resources, and the traditional uses of these resources were included in the study. Additional surveys applied similar methods to fish, reptiles and amphibians.

In addition to these main surveys, wildlife assessments in the RIL and CNV blocks in Malinau were conducted by the Wildlife Conservation Society (WCS) prior to logging. WCS also carried out biodiversity reconnaissance surveys in the Tubu River area of the BRF prior to project implementation to complement the data from the Malinau river catchment.

Forest Product Dependency

This component produced several benchmark studies to elucidate the nature and extent of dependency of various ethnic groups in Malinau on forest products, and their possible contribution to the livelihoods of these people. There are variations in the degree of forest product dependency among ethnic groups and among individual households, as in the case of the Punan hunter-gatherers who depend more on forest products for their livelihood than the Dayak swidden cultivators. While forest products abound in the area and provide much of the livelihood needs of isolated communities, downstream areas have other options available in agricultural and off-farm activities.

A comprehensive agro-economic survey was completed in five villages located along a downstream-upstream transect covering four ethnic groups. Four in-depth anthropological studies were conducted of key forest societies in the study area, particularly the Punan people, in order to understand how they are responding to rapid social change and the implications for forest resource use. Using Indonesian students, a series of five socio-economic studies were conducted on specific topics of relevance to the project objectives. These included a survey of forest product trading activities in the BRF, an assessment of the primary and secondary impacts of forest concessionaires on local households and a comparative analysis of unofficial logging activities in different districts of East Kalimantan, including Malinau. In collaboration with INHUTANI II, local communities made a preliminary study of the potential uses of waste timber. One study focused on the availability and exploitation of fish, a key resource for communities that is rapidly being depleted in the lower reaches of the Malinau River.

Adaptive Co-management of Forests: Negotiating More than Boundaries

This overall objective of this component of the project is to empower local communities to promote their own concerns and hopes for forest use and management. Specifically, we hope to strengthen their ability to resolve conflicts, negotiate, and understand principles of governance and related tools they can use to achieve better outcomes for themselves from the exploitation of their natural resources. A variety of methodologies have been tested for improved coordination of forest management. Workshops on emerging topics have been organised, involving an array of stakeholders. Policy briefs have been prepared to inform communities of new laws and procedures. Visits have been organised to other parts of East Kalimantan to examine future scenarios and experiment with participatory mapping.

The project made preliminary observations of existing decision-making institutions in communities and explored the options for linking these to other stakeholders at the district, provincial and national levels. This has resulted in increased awareness and empowerment on the part of local communities. It has been highly effective in engaging a wide variety of communities in aspects of forest management. We have particularly gained credibility and respect among local people by assisting them with the mapping of their community boundaries. A total of 27 villages have participated in mapping exercises and 22 have initiated agreements with their neighbours.

The initial focus on developing 'future scenarios' with local participation as a tool for investigating potential technological innovation, land use change and general development trajectories was subsequently re-evaluated. The approach was adapted in the light of CIFOR's evolving work on what we now refer to as Adaptive Co-management. This is a more community-driven process with emphasis on action research and participatory mapping. CIFOR has reoriented this component to address how to best coordinate the interests of different stakeholders in a forest landscape in order to strengthen forest management. This component has particularly focused on how to facilitate conflict resolution and community empowerment in forest areas.

After some experimentation, mapping was discovered to be the most suitable entry point for engaging in a participatory, action-oriented research programme with communities. This was after the proposed scenario approach was tested and found to be inappropriate for communities experiencing rapid social, economic and political change. Nevertheless, results from the scenario-building efforts generated a number of Indonesian and English language publications. The methodologies were exchanged and refined through training programmes with Indonesian NGOs, thus broadening the impact of the effort.

3. General Description of the Bulungan Research Forest

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When the Bulungan Research Forest project started, there was very little published information available concerning the region, its people, and its environment. Most of the available information was very general and focussed exclusively on issues of commercial interest such as timber and minerals. To achieve the long term goal of the project, such information is not sufficient. Information on topography, soil conditions, river systems, forest structure and composition, socio-economic conditions of the local people as well as the economic development plan of the local government, including their spatial distribution, are examples of information that all have important ecological factors for forestry and agriculture. This means that baseline information on the Malinau landscape is very much needed to achieve the goal of the project and to ensure the application of environmentally and scientifically sound practices of sustainable forest management in the area. A considerable body of baseline information has been gathered during the course of the project. In some cases this information took substantial research investment and must be viewed as a primary output of the first phase of the project. The information is presented below in the form of an introduction to the location and a general description of the natural resources of the study area.

1. Location

The original Bulungan Research Forest (BRF), as established by ministerial decree, lies administratively within *Kabupaten* Malinau (Malinau District), East Kalimantan. The western site of the BRF lies at 2º45'12.38 N; 115º48'7.87 E and the eastern site lies at 3º21'3.76 N; 116º34'2.79 E (Figure 3.1). The total area of BRF is approximately 300 000 ha. At its closest point, the BRF boundary is about 18 km from the town of Malinau, Malinau District. The area is adjacent to the Kayan Mentarang National Park, where WWF has been collaborating with the Ministry of Forestry for several years on a major conservation programme. The two areas constitute an expanse of more than 1.7 million ha of continuous forest. They lie at the heart of one of Asia's largest remaining areas of tropical rain forest, named by the World Resource Institute as Frontier Forest (Bryant *et al.* 1997). This area covers several million hectares of forest and includes parts of Sabah, Sarawak, Brunei and East and Central Kalimantan.

Undisturbed primary hill dipterocarps forest in Malinau, East Kalimantan, Indonesia

2. Topography

The topography of BRF is rugged throughout, with its most strongly dissected terrain located on the southwestern and western sides. From Digital Elevation Model (DEM) data collected from the

Figure 3.1 Location of the Bulungan Research Forest

Sources:
Peta Administrasi Propinsi Kalimantan Timur, Scale 1: 1,1250,000 BAPPEDA (Land Resources Evaluation Project), 1999
Peta Administrasi dan Obyek Wisata, Kabupaten Bulungan, Scale 1: 800,000, Bappeda Tingkat II, Kabupaten Bulungan, Tanjung Selor
Landsat TM Path 117 Row 58 20-04-1991
Landsat TM Path 118 Row 58 08-01-1988
Landsat TM Path 117 Row 58 22-05-1997

Radarsat satellite, it has been determined that 84.24% of the BRF is mountainous with an altitude range of about 100 m a.s.l. to almost 2000 m a.s.l. Of the area, 11.43% is hilly and a very small proportion is relatively flat (Table 3.1). The rugged topography, which is mostly located next to the Kayan Mentarang National Park, might have important role in the existing high floral and faunal values of the BRF area.

In most of the BRF area, the slopes are in the range of 25–40% (39.97%). Conditions are similar in the area of INHUTANI II Malinau (about 40% of the area). Table 3.2 shows a detailed classification of the slope in the area. The spatial distribution of the slope can be seen on Figure 3.2.

3. Climate

According to the Schmidt and Ferguson (1951) system, the BRF area has an A rainfall type, where the dry period is less than two months and the wet season is more than nine months. Figures 3.3 and 3.4 show the mean monthly rainfall at the town of Malinau and the mean number of rainy days at the INHUTANI II camp at the Sidi River, Malinau concession (Table 3.3).

In the INHUTANI II Malinau concession area, the highest temperatures occur on cleared land and the lowest temperature recorded (23.5° C) was in unlogged forests. Relative humidity is high, ranging from 75% to 98%.

4. Hydrology

The most hilly areas of the research forest are located on the southwestern side and the flatter areas are in the northeastern section. Three main rivers run across the area. The Malinau River flows from west to east and then turns to the north. The Tubu River runs from the middle section of the research forest area to the north, then turns to the east and meets the Mentarang River, which in turns joins the Malinau River at Pulau Sapi. The Mentarang River forms the northern boundary of the research forest. The two rivers form the larger Sesayap River. The third major river is the Bahau River, located on the western side of the area, flowing from north to south and forming the western boundary of the research forest. It merges with the bigger Kayan River. In general, the river network in the BRF has a dendritic pattern.

Based on the pattern of river flows, the area may be divided into three main drainage blocks or watersheds, i.e., the Malinau (44.09%), Tubu/ Mentarang (36.04%) and Bahau (19.86%) watersheds (Figure 3.5).

Table 3.1 Relief amplitude distribution of the BRF area and INHUTANI II Malinau concession

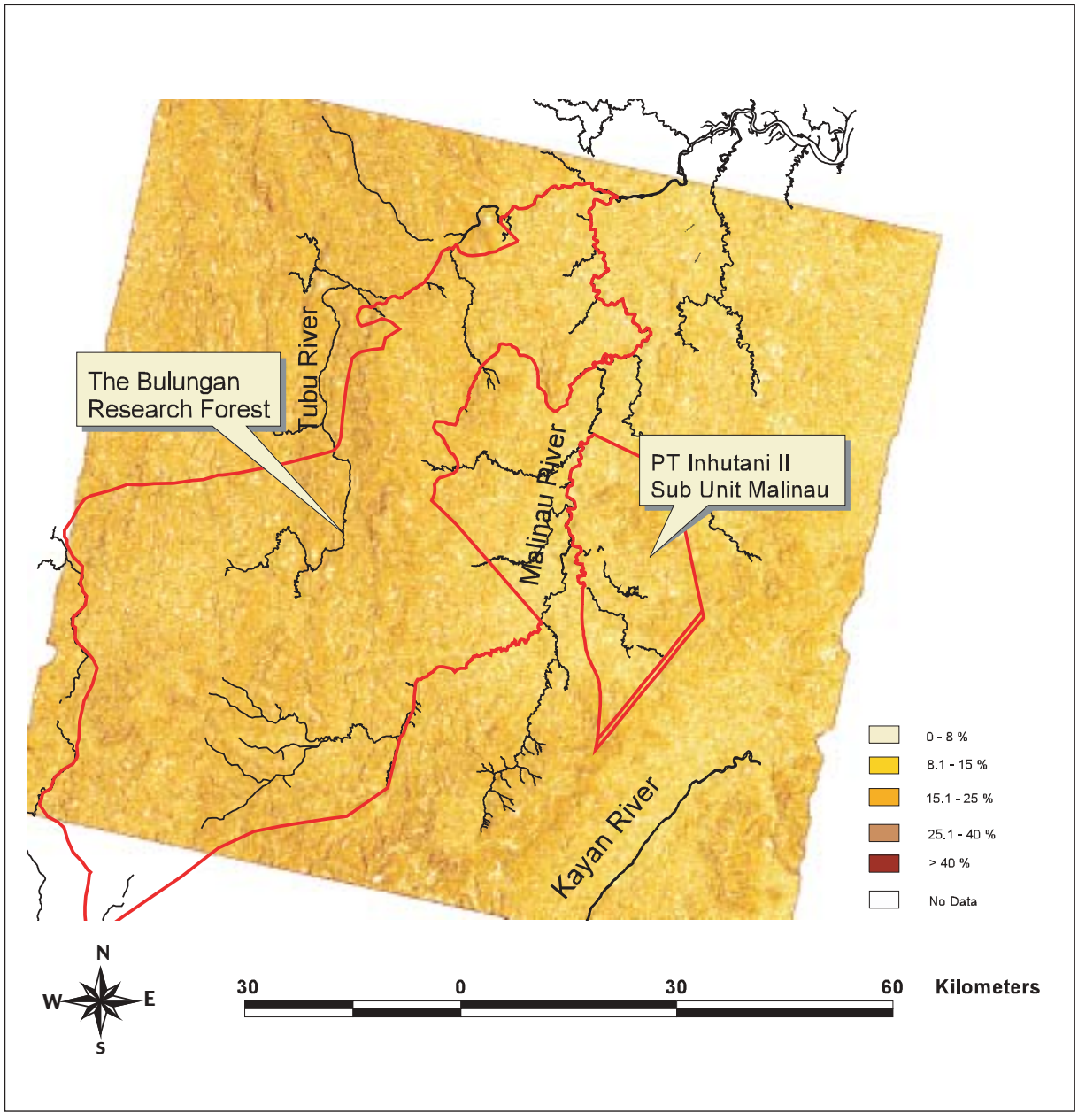
Relief amplitude	BRF (% of the area)	INHUTANI II (% of the area)
Plain	4.32	-
Hilly	11.43	44.47
Mountainous	84.24	55.53

Note: Plain: altitude 0–50 m; Hill : altitude 50–300 m; Mountain: altitude > 300 m.
Source: Radarsat DEM, January 2000.

Table 3.2 Slope distribution in the BRF and INHUTANI II Malinau concession

Slope Class (%)	BRF area (%)	INHUTANI II
0–8%	22.23	9.80
8.1–15%	25.06	13.44
15.1–25%	0.23	30.94
25.1–40%	39.97	37.74
> 40%	12.50	8.08

Figure 3.2 Slope distribution at the Bulungan Research Forest



Sources:
Digital Elevation Model, 2000
Radarsat January 2000
Landsat TM Path 117 Row 58 20-04-1991
Landsat TM Path 118 Row 58 08-01-1998
Landsat TM Path 117 Row 58 22-05-1997

Figure 3.3 Mean monthly rainfall in the town of Malinau (Inhutani II 1997)

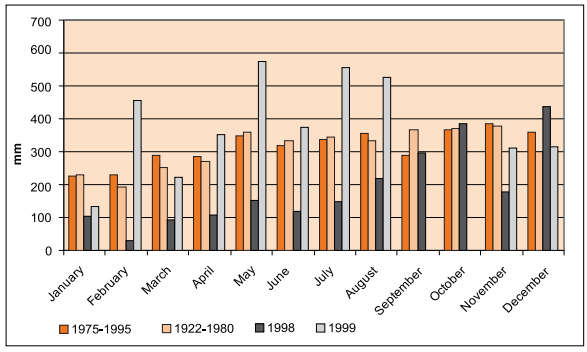
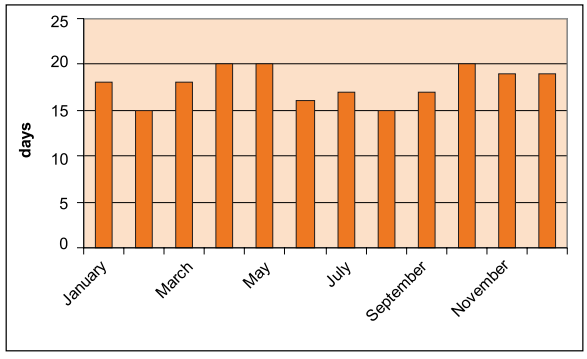


Figure 3.4 Average number of days with rain (per month) at Malinau (Inhutani II 1997)



5. Geology

The geology of the area is highly diverse. Formations include volcanic, metamorphic, and sedimentary rocks (including coal, limestone, sandstones and siltstones etc.), and extensive alluvial deposits.

The geology of an area has a major influence on topography and soil development. According to the geological map of Malinau and Napaku, East Kalimantan, the BRF geology consists of sedimentary rocks and intrusional rocks from the pretertiary and quaternary eras.

Table 3.4 Distribution of the BRF geological groups (Figure 3.6)

No.	Rock Formation	Percentage (%)
1.	Lurah Formation Embaluh Group	16.47
2.	Mentarang Formation Embaluh Group	54.41
3.	Paking Formation	0.29
4.	Sebakung Formation	0.29
5.	Metulang Volcanic	9.12
6.	Langap Formation	2.94
7.	Jelai Volcanic	7.06
8.	Alluvium	<0.01
9.	Plug, dyke	<0.01

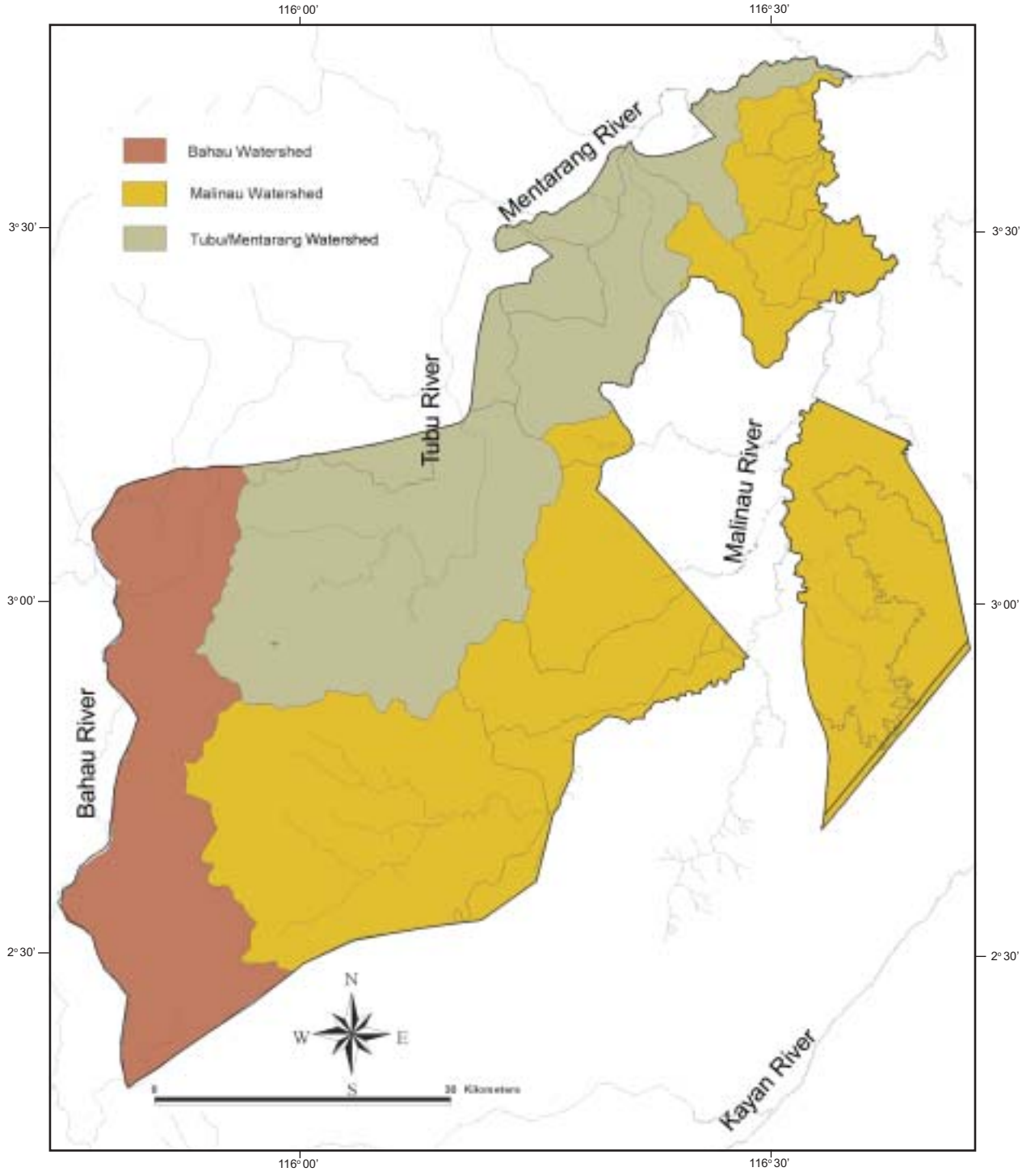
Source: Geological research and development centre (1995)

Table 3.3 Average rainfall (mm/month) at the Malinau weather station

	Period of measurement			
	1975–1995	1922–1980	1998	1999
January	226.4	230	104.1	134.2
February	228.7	191	28.25	456.4
March	289.7	251	92.1	223.1
April	285.3	270	107.7	351.1
May	346.7	360	151.8	575.4
June	317.9	332	119.1	374
July	337.8	345	147.5	554.9
August	354.1	335	218.5	527.4
September	289.9	368	297.7	0
October	367.5	369	383.6	0
November	385.4	379	178.6	309.3
December	359.8	299	436.7	313.3

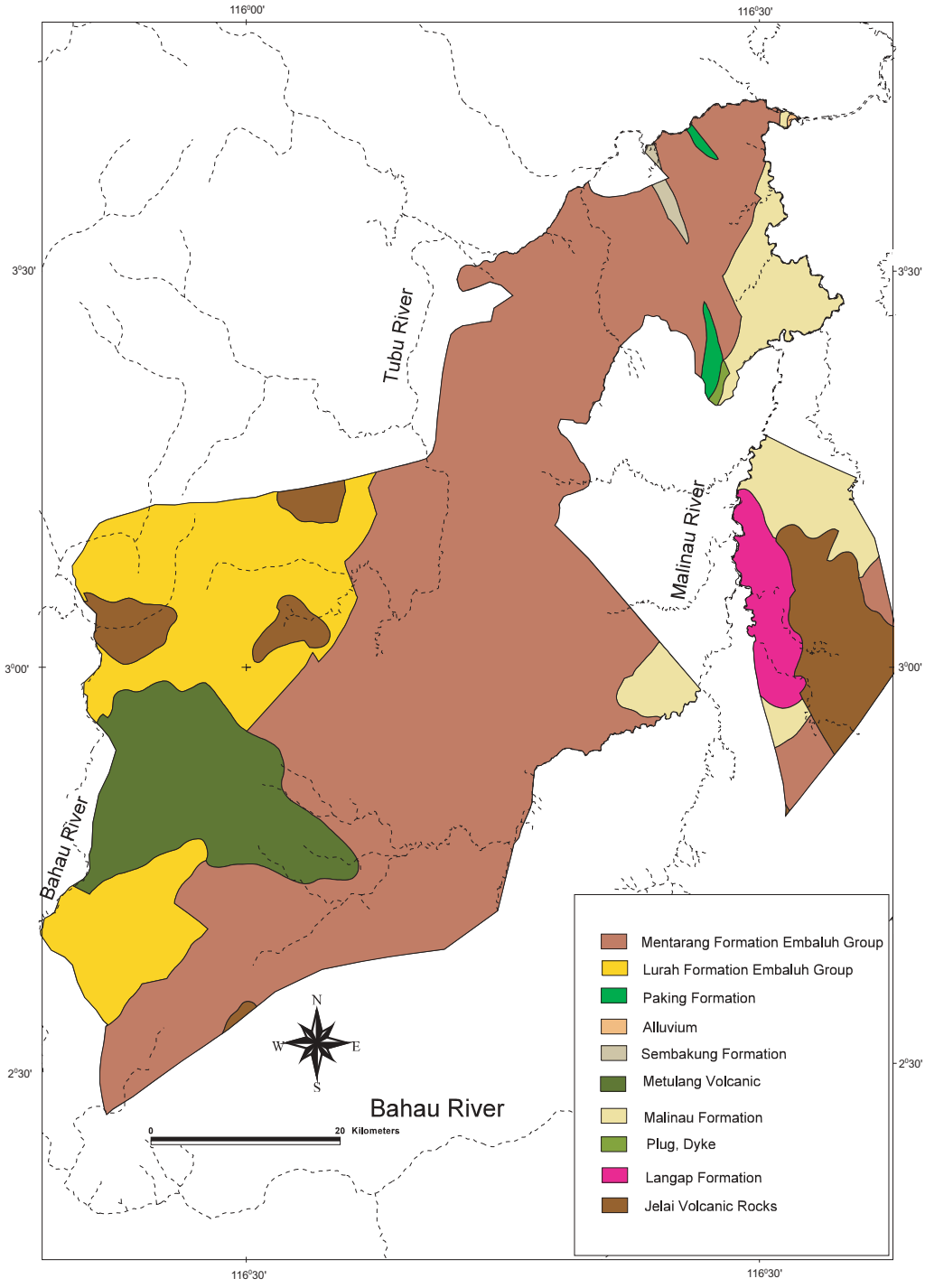
Sources:
Period 1975–1995: INHUTANI II (1997)
Period 1922–1980: INHUTANI II (1996)
Period 1998: INHUTANI II's Binhut Camp rainfall gauge record.
Period 1999: INHUTANI II's Binhut Camp rainfall gauge record.

Figure 3.5 Watershed of the Bulungan Research Forest



Sources:
Radarsat January 2000;
Landsat TM Path 117 Row 58 20-04-1991
Landsat TM Path 118 Row 58 08-01-1988
Landsat TM Path 117 Row 58 22-05-1997

Figure 3.6 Geology of the Bulungan Research Forest



Sources:
Geological Map of the Malinau sheet, Kalimantan. Scale 1: 250,000; 1995 Geological Research and Development Center, Jl. Diponegoro 57, Bandung.
Geological Map of the Longbia (Napaku) sheet, Kalimantan. Scale 1: 250,000, 1995. Geological Research and Development Center, Jl. Diponegoro 57, Bandung

6. Soils

The majority of the soils in the BRF have developed on rolling plains and dissected hills, on sedimentary and on old igneous rocks. They range from strongly weathered and acid ultisols to young inceptisols. Because of high rainfall, soils are constantly wet, and their soluble constituents are easily leached out. High levels of weathering, leaching, and biological activity (decomposition of organic matter) are characteristics of most Kalimantan soils.

According to the Land System map published by REPPProT (1987), most of the BRF area is dominated by three soil groups: (1) Aluvial Gleiik (PPT 1983) or Typic Tropaquepts (USDA 1975 in Tim Survey Tanah 1986) or Gleyic Fluvisol (FAO/ UNESCO 1974), (2) Gleisol Eutrik/Typic Tropaquepts/Eutric Gleysols, and (3) Podsolik Ortoksik/Dystropeptic Tropodults/Orthic Acrisols (Figure 3.7).

CIFOR's MLA team have gathered extensive additional information on local soils (see Chapter 5).

7. The Forests at BRF

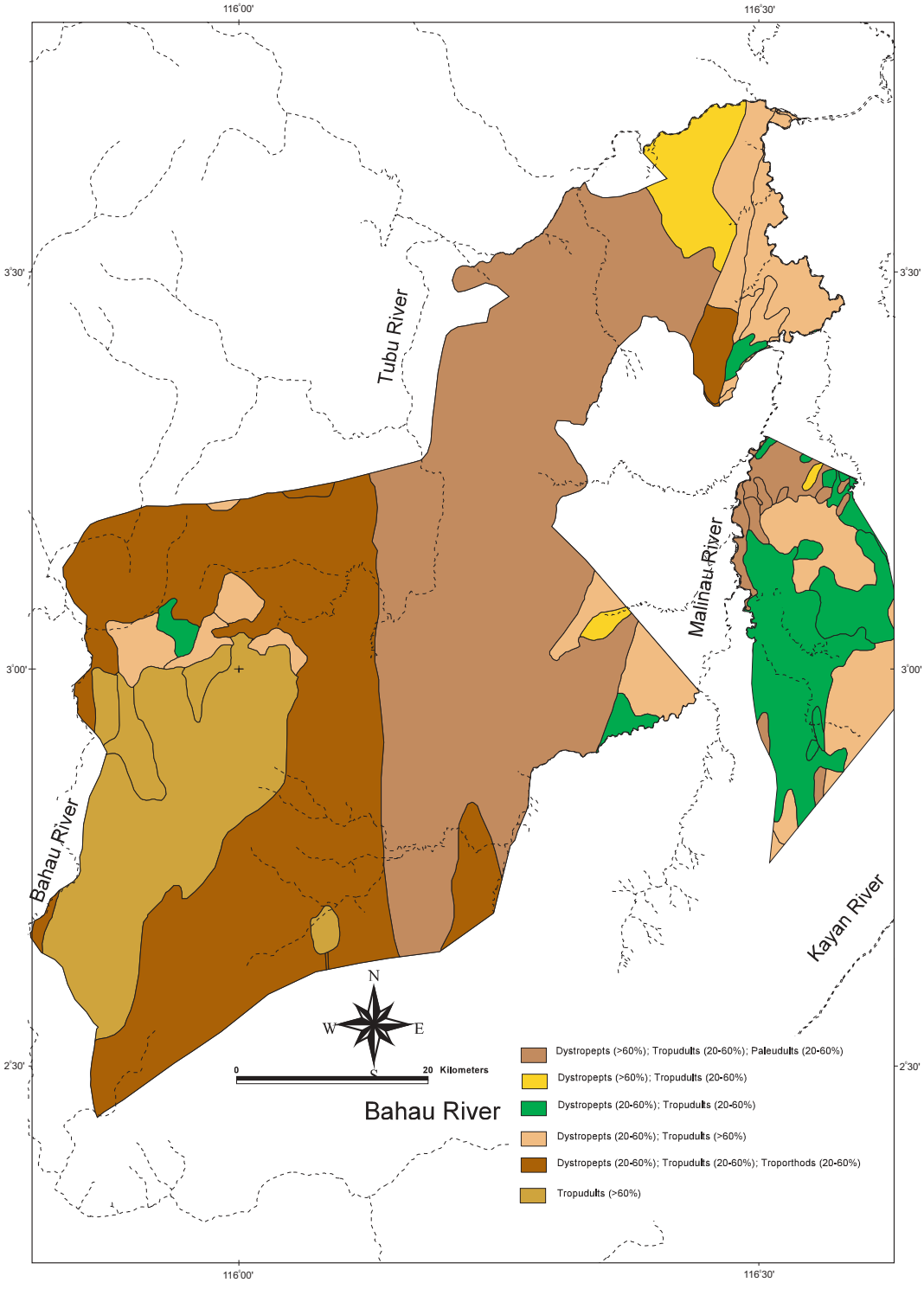
The lowland rain forests of the island of Borneo are globally important for their high species richness and endemism. Approximately 34% of all plant species, 37 species of birds and 44 land mammals are endemic to the island (MacKinnon *et al.* 1996). Existing protected areas, especially below 500 m elevation, are inadequate for the conservation of this rich biodiversity. Therefore, it is important to develop strategies for conserving biological diversity in the lowland forests surrounding existing protected areas in Borneo, as these forests are facing increasing threats from human exploitation.

Much of the research forest area is categorised as *hutan lindung* or protection forest because of its steep topography. However, some of the area is allocated to logging concessions and is currently being logged or will be logged. The reason for giving this area to concessions might be the high stock of commercially valuable trees in the forest. Take, for an example, the Malinau forest concession area of INHUTANI II. This was inventoried in 1996 and its standing stock could produce 25.6 m^3 per ha of logs coming from trees of 60 cm diameter and above, or 45.31 m^3 per ha of logs coming from trees of 50 cm diameter and above (INHUTANI II 1996). The commercial trees are dominated by agathis and dipterocarp. The agathis is considered the most valuable tree because of its high basal area in the concession compared to other commercial tree species(Kartawinata *et al.* 2001: *Poster*). Until 2001, production forest in the entire area of Malinau District covered about 56.74% of the whole forest (Sekwilda 2001). In the core research forest area and its immediate vicinity, commercial logging was already occurring by the 1980s. At first logging was only at low intensities and limited in extent. It caused relatively little environmental damage. The magnitude of shifting cultivation was initially small but developed into larger areas following the logging roads, and this had significant impacts on forest resources in some areas. Government-sponsored transmigration, mostly in accessible areas near the coast and major rivers, was also growing during the 1970s and 1980s and had significant environmental and social impacts at a local level. Various development pressures also increased gradually concomitant with the rapid economic growth of the country. In the early 1990s, coal mining began to encroach into the area and has had a growing impact on the forest resources and local communities.

The lowland forest surrounding Kayan Mentarang National Park in East Kalimantan contains high floral and faunal diversity (O'Brien *et al.*1998). This forest region is important to conservation because: (1) it is relatively intact; (2) it appears to contain a full complement of species; (3) it provides a buffer between human settlements and the park; and, (4) it serves as a lowland extension to the mid–high elevation habitats characterizing Kayan Mentarang National Park. This forest is currently threatened by intense timber harvesting and the expansion of coal mining.

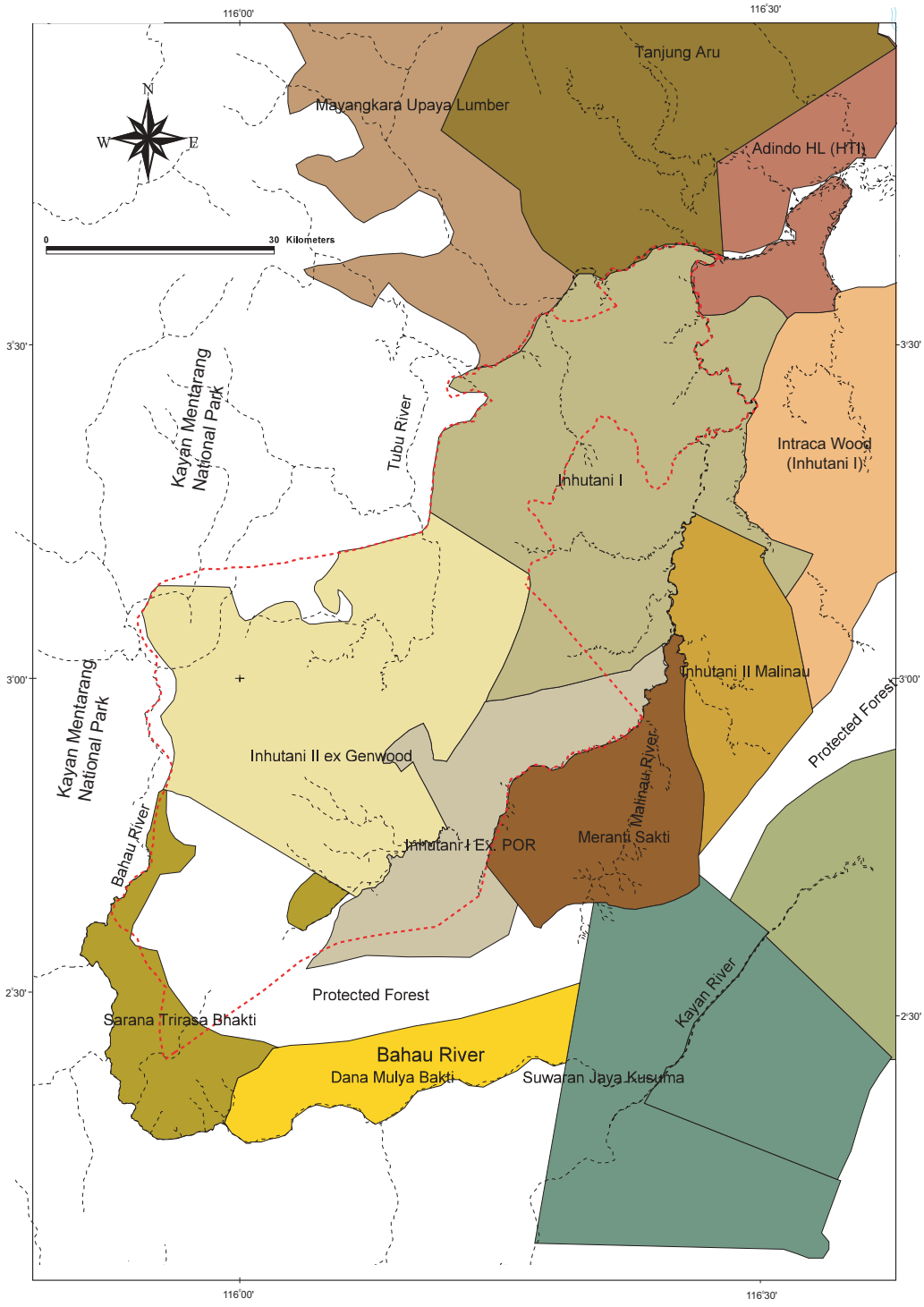
The core area of the legally designated Bulungan Research Forest, which constitutes a portion of the remaining frontier forest in Asia, is covered entirely by tropical rainforest. The Landsat TM –5 imagery taken in 1997 (Figure 3.9) reveals that the forest of BRF consists of primary forest (97.84%), secondary forest (2.12%) and opened lands (0.04%). Figure 3.10 shows the floristic zones in the area. Within the primary forest area the following forest types have been identified.

Figure 3.7 Soil type distribution in the Bulungan Research Forest



Sources:
Land system and land suitability map of Malinau Sheet 1819. Series RePPProt 1987.
Land system and land suitability map of Longbia Sheet 1818. Series RePPProt 1987.

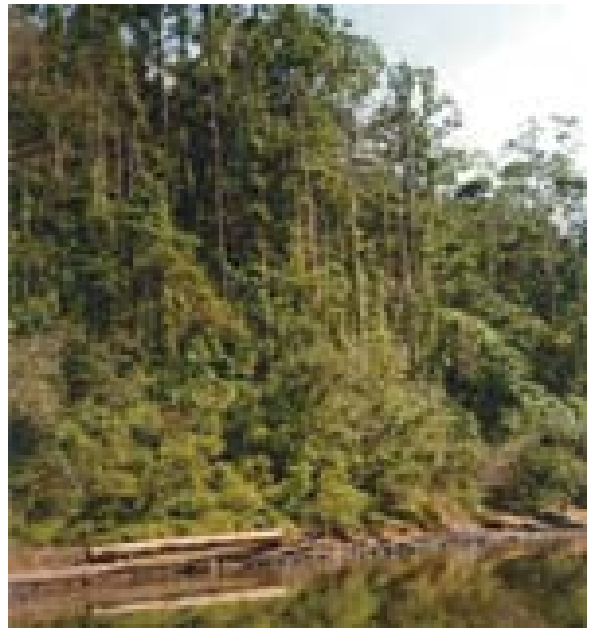
Figure 3.8 Distribution of Timber Concession Holders (HPHs) in the Bulungan Research Forest and its vicinity



Sources:
Peta perkembangan penataan batas areal kerja HPH, propinsi Dati I Kalimantan Timur, Direktorat Pengukuhan dan Perpetaan Hutan, Direktorat Jenderal Inventarisasi dan Tata Guna Hutan, Departement Kehutanan, Bogor 1993

(1) Lowland dipterocarp forest

Lowland dipterocarp forest is the most extensive forest type in the area. It is estimated to cover about 98.44% of the total area. Trees may reach up to 35–40 m in height. Dominant species with diameters of ≥ 10 cm are those of the Dipterocarpaceae family. A survey in a lowland primary forest in the central Tubu River (O'Brien *et al.* 1998) revealed that 60% of the tree families and 36% of the tree genera known for Kalimantan occurred there. Dipterocarps dominated the canopy trees (14.3%) and trees with DBH ≥ 50 cm (27%). A full complement of large diurnal mammals was present and the local Punan people reported a very diverse community of medium sized and small mammals. Preliminary estimates of primate densities suggested that current hunting pressure has not adversely affected the primate populations. Bird diversity was very high, placing the area among the



Lowland dipterocarp in the BRF along Bahau River

Figure 3.9 Landsat TM-5 image of the Bulungan Research Forest

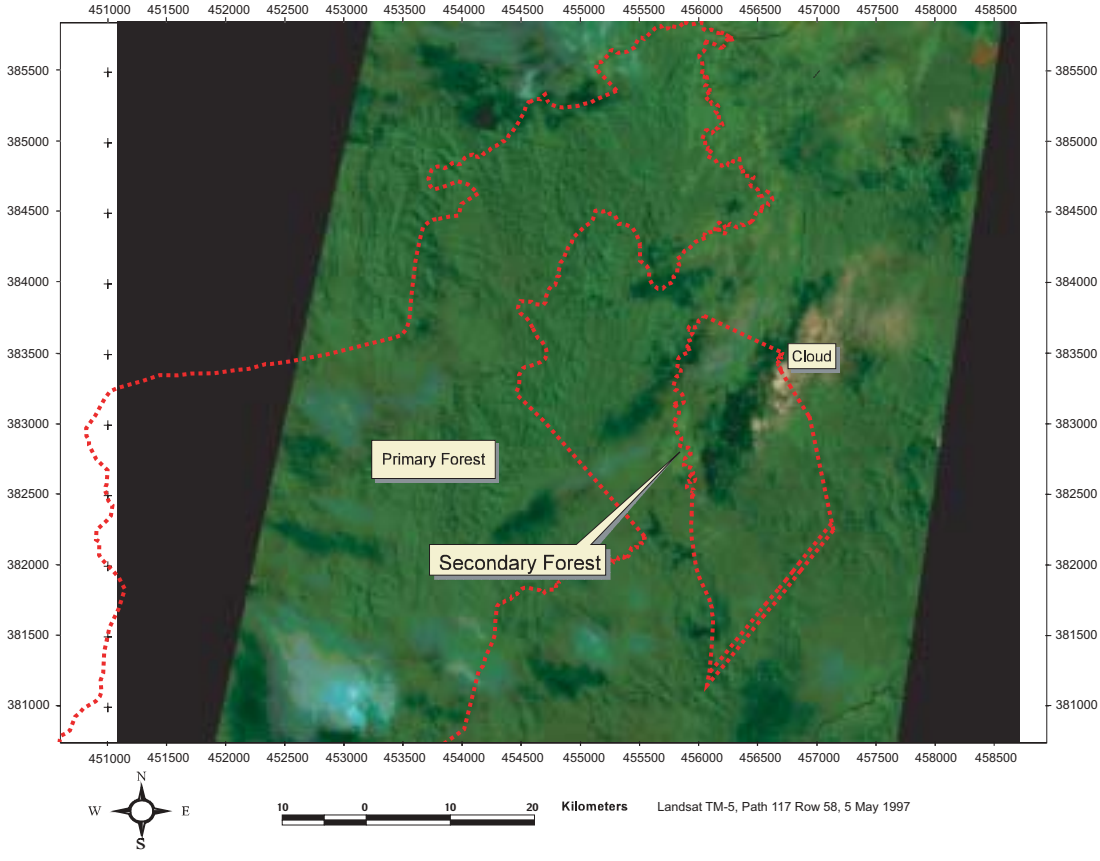
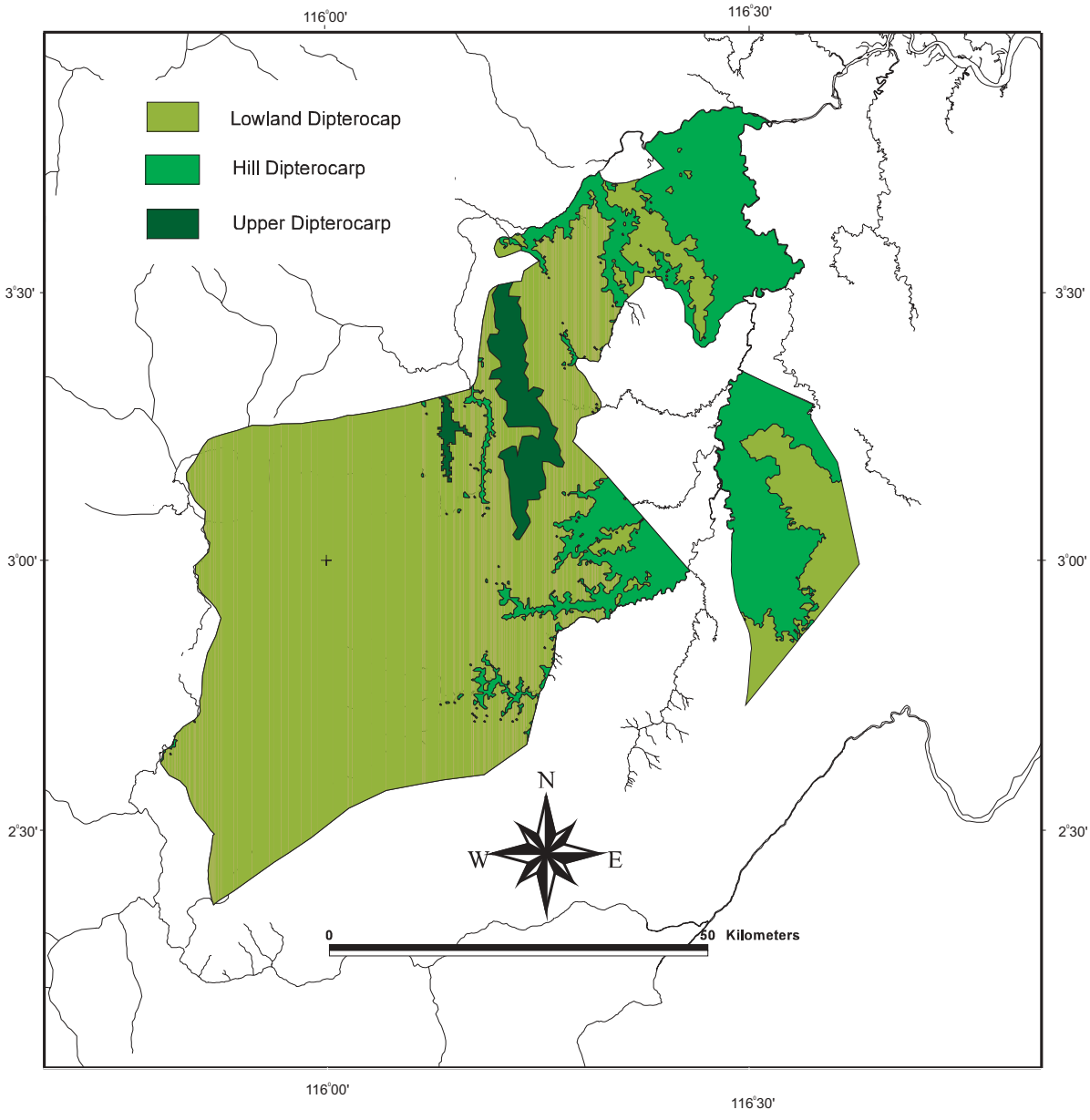


Figure 3.10 Floristic zones in the Bulungan Research Forest



Classification of the forest is based on Mackinnon, K., *et al.* (1996).

Sources:
Digital elevation model 2000
Radarsat January 2000
Landsat TM Path 117 Row 58 20-04-1991
Landsat TM Path 118 Row 58 08-01-1988
Landsat TM Path 117 Row 58 22-05-1997

richest lowland sites in Borneo. About 30% of birds endemic to Borneo occurring in Kalimantan could be found here. At River Tondok and at km-22 within the Malinau concession (Yusuf *et al.,* in preparation), the forest showed a high species richness of trees with DBH ≥ 10 cm, with a mean of 151 tree species per ha and a mean density of 407 trees/ha. More detailed information on forest type is presented in the results of the studies below.

(2) Submontane forest

From the National Forest Inventory Maps of the Ministry of Forestry, the submontane forest is estimated to cover about 0.44% of the BRF area. Most trees are tall and slim with height of no more than 30 m.

(3) Riparian forest

Riparian forest is confined to within a width of 10 m along the riverbanks, mainly in the northeastern part of the BRF area. It is contiguous with the alluvial forest inland. The forest is periodically flooded when the rivers overflow during heavy rains. *Dipterocarpus oblongifolius* is usually dominant along the rocky banks of fast flowing rivers.

(4) Alluvial forest

The alluvial forest occurs in low-lying areas and flood plains. In the research forest, it is confined mostly to the northeastern sector and covers only a small area. The canopy of alluvial forest may reach about 22–26 m in height. Species of dipterocarps are mostly common in this habitat type.

The Landsat imagery showed that secondary forests occurred mostly close to rivers and the most extensive area can be found in the northeastern sector of the research forest, in the vicinity of the villages of Sentaban, Pulau Sapi, Mentarang Baru and Long Paking and along the Malinau River, all the way to Long Loreh. There are scattered patches of secondary forest along the Hong River and Bahau River. Most of them are abandoned shifting cultivation areas.

8. Socio-Economic Aspects

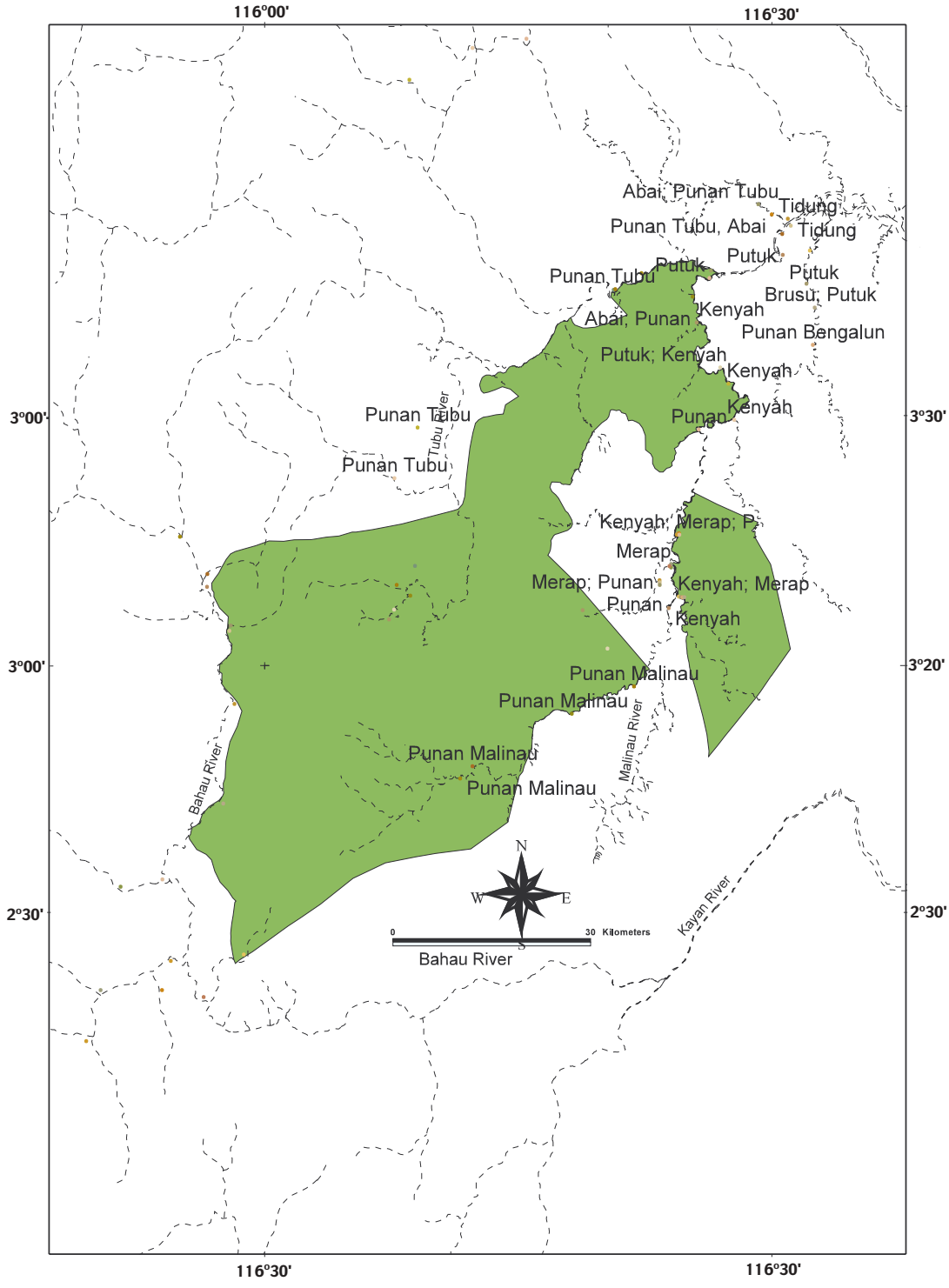
(1) Population

The indigenous population of the BRF, especially in the Malinau and Tubu watershed areas, consists of several ethnolinguistic groups, including the Merap, Punan, Kenyah, Putuk and Abai. The largest group is the Punan, who inhabit approximately 30% of the villages or constitute about 17% of the whole population of Malinau. Other groups, such as the Muslim Dayak, live close to the town of Malinau, outside the research forest boundary. In general, the ethnic groups are considered as forest dependent people. They are considered as agriculturists, practicing swidden cultivation of upland rice and hunting-gathering, and collect non-wood forest products. Of all the ethnic groups, the Punan are the best known for practicing hunting-gathering. Figure 3.11 shows spatial distribution of ethnic groups in the BRF area and its vicinity.

The core research forest area has a low population density, with approximately 5–6000 individuals distributed over an area of about 300 000 ha (i.e. about 2 individuals/km^2). Of the villages in the Malinau and Tubu watershed area, Long Loreh has the highest population. This village is composed of four different communities or *desa*, each one inhabited by one ethnic group. They are Desa Loreh, Desa Pelancau, Desa Sengayan and Desa Bila Bekayuk. Desa Loreh is inhabited by Kenyah Leppo' Ke, Desa Pelancau by Punan Malinau, Desa Sengayan by Merap, and Desa Bila Bekayuk by Punan Tubu. In 1999, the total population of the Loreh area was approximately 1171, comprising 543 Kenyah, 128 Punan Tubu, 250 Punan Malinau, and 250 Merap (Gonzales 1999). There is a small immigrant presence, particularly of Buginese people.

In the Bahau River watershed, the Punan are also dominant and consist of the Punan Benauli, mostly living in the Lurah and Middle Bahau areas, and the Punan Tubu, living in the Upper Bahau. The Punan Benauli came to the region with the Kenyah Badeng about a century ago. They began gardening

Figure 3.11 Spatial distribution of ethnic groups in the Bulungan Research Forest area



Source: Uluk, A. (2002)

(cassava and taro) and subsequently also practiced swidden farming.

(2) Land property

Two kinds of land rights may be recognized in Malinau: individual holdings and community land. Individual land is land from which the products are for family consumption only. Each household has about the same size of individual holding and this is allocated by the community organization (*lembaga adat)* headed by a community leader. On the average, individual holdings are about 1–2 ha per household for short-term farming use and about 0.2–1.0 ha for long-term agricultural use.

Community land is called *Tanah Ulen.* As village-owned forest land, *Tanah Ulen* is protected and managed cooperatively for the common interest of the villagers. *Tanah Ulen* provides a source of supply or storage place for reserves for meeting the needs of the village people. It provides a reserve of construction wood, non-timber forest products such as rattan, gaharu, economically valuable cinnamon and several types of animals including wild pigs, deer, river fish, and vegetables and fruits.

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4. Research on Logging

4.a. Comparison of Reduced-Impact Logging and Conventional Logging Techniques

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There is a grave concern about the sustainability of logging in areas of Indonesia and elsewhere in the humid tropics, particularly with the siting of roads and extraction methods which can cause lasting damage to the soil and impede forest recovery. The impact of logging on tropical forests has long attracted the attention of silviculturists and forest managers. A growing awareness of the need to protect forest ecosystem functions and to maintain biological diversity in production forests raises the question of whether timber harvesting can be compatible with other forest services, values and functions. Efforts in respect of sustainable forest management have promoted the implementation of reduced-impact logging (RIL) techniques. The main objective of RIL is to reduce soil disturbance, damage to residual trees and maintain future production of timber. RIL has recently been implemented and tested in various tropical regions, particularly in Southeast Asia (Pinard and Putz 1996; Bertault and Sist 1995, 1997; Sist *et al.* 1998a) and South America (Hendrison 1989; Uhl and Vieira 1989; Johns *et al.* 1996; Bird 1998). In the context of increased efforts to achieve sustainable forest management, codes of practices and RIL guidelines have been produced by forestry organisations such as FAO, CIFOR and Cirad-Forêt (Dykstra and Heinrich 1996; Sist *et al.* 1998b; Durrieu de Madron *et al.* 1998) as well as national forestry departments (e.g. Vanuatu Forestry Department, and Sabah Forestry Department).

In tropical forests of Southeast Asia, dipterocarps are not only the main commercial timber species but also the main component of the canopy, where 80% of the species belong to this family. Harvesting rates commonly exceed 100 m^3/ha^{-1} (which is equivalent to more than 10 stems/ha^{-1}) (Nicholson 1958, 1979; Pinard and Putz 1996; Bertault and Sist 1997), and logging operations commonly damage more than 50% of the original tree population (Nicholson 1958, 1979; Fox 1968; Kartawinata 1978; Pinard and Putz 1996; Bertault and Sist 1997). In the TPTI (*Tebang Pilih dan Tanam Indonesia*, the Indonesian Logging and Planting System), all commercial trees with a diameter at breast height (DBH) of over 50 cm or 60 cm, depending on the type of forest, can be removed with a felling cycle of 35 years. These heavy cuts, associated with uncontrolled logging, cause high rates of damage, resulting in a seriously depleted residual stand which will be unable to reach an acceptable harvesting volume within the cycle length. The low economic value of these forests makes them vulnerable to conversion into agricultural lands. Large canopy openings, occurring in logged-over forests, increase vulnerability to fire, as was dramatically demonstrated in Indonesia during the recent successive El Niño dry events (Bertault 1991, Laumonier and Legg 1998). Reducing damage to both forest and soil is likely to shorten the felling cycle length because it ensures better natural

regeneration and growth of the desired commercial species (Putz 1994). Minimizing the effect of logging damage to both forest and soil is, therefore, regarded as the main requirement for achieving sustainable forest management. However, the success of RIL implementation in the field will depend mainly on the motives of logging companies. At present, the common belief among loggers in the tropics is that RIL techniques cost more than conventional logging (CNV) methods. However, the few existing comparative studies on economic cost assessments carried out in the Amazon show the opposite (Barreto *et al.* 1998, Holmes *et al.* 1999). Both studies demonstrated that compared with conventional techniques, the main costs of RIL undoubtedly increased in the planning stage. However, proper planning, increased labour productivity, decreased operational costs and reduced waste. Barreto *et al.* (1998) demonstrated that RIL techniques resulted in a net financial benefit of US$3.7 per m^3. In the eastern Amazon, Holmes *et al.* (1999) clearly indicated that the average total cost of a typical RIL operation was 12% less than the average total cost of a typical CNV operation. Both studies suggested that in the eastern Amazon RIL can be financially competitive, primarily due to enhancement of skidding productivity and reduction of wood waste.

Given the importance of logging, experimentation with RIL is crucial for the underlying goals of the research project to promote sustainable forest use within the Malinau landscape. The present RIL studies constitute a developmental phase of a longer-term research strategy within the framework of the Bulungan research project. The initial objective of this component of the project was to start logging experiments, focusing mainly on the implementation of RIL techniques by INHUTANI II, a state-owned forest enterprise, in its Malinau concession in East Kalimantan. Research on the assessment of the immediate and longer-term impact of timber harvesting with CNV and RIL techniques in both environmental and economical terms were carried out to promote the integration of RIL into the current logging techniques at the concession scale.

Central to the successful implementation of RIL is a clear set of guidelines (Sist *et al.* 1998), which define the actions necessary to achieve it. The guidelines adopted by the studies conform with TPTI regulations and are based on the ITTO Guidelines for the Sustainable Management of Natural Tropical Forests (ITTO 1990) and the FAO model code of forest harvesting practices (Dykstra and Heinrich 1996). The purpose of the guidelines was to set up the main rules of RIL implementation in the Malinau concession; they concentrate on reducing the impacts of tree felling and heavy machinery on the remaining stand and forest soil. Under this project the main elements have been further developed into a manual that can be easily understood by operators (Elias *et al.* 2001).

Logging along the Bahau River near BRF

The RIL implementation in the Malinau concession could not have been realised at the concession scale without a preliminary phase of training and testing. It was aimed particularly at tree fellers, tractor operators and forest planners. Chainsaw operators were trained in tree marking and directional felling techniques. Tractor operators were instructed in techniques to reduce damage while skidding by avoiding overuse of the blade and maximising use of the winch. Forest planners were trained on stock survey and topography assessments as well as planning the skidding network using user-friendly computer software. Although these training courses were primarily for INHUTANI II staff, other logging companies in the area and the research and training agencies of the Indonesian Ministry of Forestry also participated. The RIL implementation

was indeed one of the main objectives of the first phase of the Bulungan research project. The following sections present the results of the comparative studies of RIL and CNV techniques in the context of the need for new silvicultural prescription and the cost-benefit perspectives.

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4.b. Reduced-Impact Logging in Indonesian Borneo: Some Results Confirming the Need for New Silvicultural Prescriptions

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Introduction

In the Indonesian selective logging and planting system (TPTI), all dipterocarps (i.e. timber trees in the family Dipterocarpaceae) with a diameter at 1.3 m of over 50 or 60 cm (depending on the type of forest) can be harvested with a polycyclic felling schedule of 35 years. One year prior to logging, forest concessionaires must carry out an inventory to determine the Annual Allowable Cut (AAC) granted by the Ministry of Forestry. However, in practice these inventories are generally too inaccurate to define a satisfactory operational logging plan. In the highly productive dipterocarp forests of Borneo, where harvesting intensity commonly exceeds 100 m^3/ha^{-1} and more than 10 trees/ha^{-1}, conventional logging generally damages more than 50% of the original stand (Nicholson 1958; Kartawinata 1978; Tinal and Palinewen 1978; Abdulhadi *et al*. 1981; Pinard and Putz 1996; Bertault and Sist 1997; Sist *et al*. 1998). Because overharvesting and poor operational practices are now recognised as an important cause of deforestation, ITTO member countries, including Indonesia, are being encouraged to revise practices in order achieve sustainable management of the forest estate.

Reduced-impact logging (RIL) techniques are vital to reduce damage to a level that will preserve forest regeneration and integrity (Dykstra and Heinrich 1996; Sist 2000). Several experiments in mixed dipterocarp forests have demonstrated that RIL techniques can reduce damage by at least 30% to 50% compared with normal operations (Pinard and Putz 1996; Bertault and Sist 1997). Most of the studies comparing damage under RIL and conventional logging have neglected the variability in natural forest and the variation in damage that this implies. Thus it remains difficult to determine how general or local any conclusion can be. The current coverage of such studies is very limited. This is crucial as the proportion of stems damaged is generally correlated with extraction rates (Nicholson 1958; Bertault and Sist 1997; Sist *et al*. 1998a). The main objective of this study is to assess how far RIL can reduce logging damage under varying felling intensity.

Study Site and Methods

Study site

The study area is located in the district of Malinau (2 52'–3 14'N, 116 –116 40'E), within a 50 000 ha forest concession managed by INHUTANI II, a state-owned logging company. The annual rainfall is about 4000 mm, with the monthly rainfall varying around 200–400 mm (Table 3.3.; PT INHUTANI II 1996). The topography is deeply eroded with a dense network of steep ridges and drainage gullies. Elevations at the logging site range from 100 to 300 m asl. The location of this work was adjacent to, but just outside, the formally gazetted research forest allocated to CIFOR. The location was chosen because it provided the closest accessible site where logging was going to occur during the time allocated for this study.

Permanent sample plots and treatments

Three blocks (27, 28 and 29 in INHUTANI II's 5-year plan of operations) of about 100 ha each were selected in the 1998–1999 annual coupe because of their similarity, including the local presence of *Agathis borneensis*, a very valuable timber species, which occurred at similar density in these blocks (3 to 4 trees/ha, INHUTANI II forest survey). Because both blocks 28 and 29 included about 50% of low-lying forest on soft ground (not true 'swamp' forest, but having some similar characteristics) unsuitable for logging, they were merged to form a productive

Poorly planned road construction

forest area similar to that of 27. Blocks 28/29 were logged with conventional logging in 1998 and block 27 with RIL in 1999 (Table 4.1). In the 'conventional' treatment, referred to here as CNV, harvesting operations were not planned and loggers worked without any additional supervision. In CNV, tree map inventory realised before logging was not used in the forest by any operator. In the RIL treatment, all the operators were first trained to apply the harvesting guidelines published in Sist *et al*. (1998b). As part of RIL, pre-harvesting inventory led to the production of an operational map of block 27 at 1:2000 scale showing 5 m contour lines and the position of harvestable timber trees. Skidtrails were opened before felling, following a skidtrail network planned on the operational map. This helped in selecting the best felling direction. In RIL, logs were extracted by two CAT 527 skidders. In CNV, a D7G bulldozer was used for both log extraction and road construction. The 527 skidder was preferred in the RIL compartment to a bulldozer because of its less damaging action on the soil and its higher manageability in the forest involving consequently less damage to the stand. Although we recommended the use of a skidder with a narrow blade (< 2 m) (Sist *et al.*1998b), the two CAT 527 skidders that operated in the RIL block each had a 3 m wide blade. We accept that including multiple differences between the RIL and CNV treatment, such as different machinery, can make it harder to specifically link any one of them to the reduced impacts seen. It should be noted that the INHUTANI II-CIFOR site also serves as a demonstration and training site where we are now able to show the considerable reduction in damage that is possible when *the full range of RIL techniques*, including lighter, narrower skidders, are used.

Seven different subtreatments, each with three replicates and a control, were defined to examine felling intensity (Table 4.1). Before logging, 24 one-ha plots (12 in 28/29 and 12 in 27, see Table 4.1), were selected randomly but stratified according to the respective timber density in each plot, based on the pre-harvest map stock—a number of minor shifts in plot positions were necessary to remove road edge effects and unworkable slopes. Each 1-ha (100 x 100 m) plot was divided into 25 subsquares (20 m x 20 m) delimited by 36 PVC stakes driven into the ground. Before logging, the girth of all trees and

lianas with DBH ≥ 20 cm in the plots were measured and their position located in one of the four quarters of each of the subsquares. In the three control plots of the CNV blocks and the nine plots of RIL 1, 2 and 3, canopy openness was measured using a concave spherical densiometer at each of the 36 grid points. Canopy openness was defined as the proportion of sky hemisphere not obscured by the vegetation when viewed from a single point (Jennings *et al.* 1999).

During the harvesting period of block 28/29, there was increased commercial demand for *Agathis borneensis*. Consequently, extraction focused on this species rather than dipterocarps. Among the nine plots in 28/29 slated for potential harvesting, only the five that included harvestable *Agathis* were logged, whereas four other plots, with no *Agathis*, were left undisturbed. In order to restore the original treatment allocation, four new plots were set up randomly but without overlapping the existing plots (two each in CNV2 and CNV3) in the conventional blocks, in August 1999 (Table 4.1). Taking into account both standing living trees, stumps and stems destroyed by logging (DBH ≥ 20 cm), it was possible to assess the original tree density and basal area before logging. Although some trees destroyed by logging could have been missed during inventory, our analysis shows structural difference between the original and the four additional plots (see results). In the RIL treatment, one plot was subsequently excluded from analysis because only one tree, located at the border of the plot, was felled outside the plot limits, generating no damage inside it.

The fact that CNV appears to only access a limited proportion of the available harvest area is a key contrast with RIL. In RIL the entire compartment was efficiently exploited, while in CNV, only the more accessible areas were accessed. Informal observation of CNV practices suggests that the choice of where to exploit was largely determined by the skidder drivers trying to get access to potential harvest sites from their seat in the skidder and without using any maps or even foot reconnaissance. This leads to many dead ends and turns and is likely a major cause of skidder damage as well as reducing penetration into difficult terrain. Ultimately, however, this difference, and the specific and transient demand for *Agathis* meant that in our study the conventional harvesting actually accessed a much lower area than could have been harvested by RIL. However, it would appear that RIL provides much more efficient exploitation of the forest, whereas conventional methods leave significant amounts of forest intact and probably therefore much lower volume outputs per unit area. While this is an important observation and suggests a number of important research questions that should ultimately be addressed, it is not the emphasis of our analysis at this initial stage, as it cannot be adequately generalised without additional assessment in more harvesting blocks across a wider landscape. It may also be that the concession is unusually privileged in being able to pick and choose where it can most easily harvest.

Bearing these important caveats in mind, our analysis focuses on harvest intensities in areas actually harvested—that is, on damage associated with felling and extraction in the areas where these operations actually took place. To achieve an adequate level of quantification we augmented the original pre-logging sample to achieve a satisfactory replication in the harvested conventional areas. Few

Conventional logging in an Agathis*-dominated forest using D7G*

studies of logging in the tropics have examined these effects at the scale we have achieved. Examining real logging at this scale is never the neat and tidy controlled experiment that would be ideal. Almost all logging studies will suffer from issues of limited replication in time and space—this is indeed why it is important to replicate at the scale of the studies themselves. It bears repeating, therefore, that in all the results and arguments that follow our comparisons are based on the areas actually (not potentially) harvested.

Ideally, future studies would be even larger and provide replication at the compartment level, allowing us to also begin to generalise the degree to which intact forest remains in the post-harvest landscape with RIL and CNV approaches. Only when we have done that can we generalise these patterns.

Logging damage assessment

In both conventional and RIL, damage was assessed eight months after logging (Table 4.1). In each plot, all trees (DBH $\geq$ 20 cm) measured prior to logging were recorded as untouched, injured or dead. Snapped stems without any resprouting were considered dead. Canopy openness was also reassessed in the 17 logged plots. In each block, all the skidtrails were mapped and classified as 'main' or 'secondary'. Main skidtrails were defined as those with at least three branch skidtrails. Secondary skidtrails had usually no branches (Chabbert and Priyadi 2001). The total volume extracted from each block was estimated by measuring the length and diameter at each end of every log removed. Skidtrail area per timber volume extracted could be therefore assessed and compared.

Table 4.1 Permanent sample plots and treatment allocation in conventional and RIL blocks. Conventional = blocks 28 and 29 gathering 12 plots, 1 ha each, set up during June 1998–September 1998; RIL = block 27 gathering 12 plots, 1 ha each, set up March–May 1999)

Treat-ments	Description	Plots	Blocks	Tree measurement	Logging	Damage assessment
CNV1	Conventional techniques with low felling intensity (5 trees/ha)	3	28/29	June to Sept. 1998	Nov.–Dec. 1998	August 1999
CNV2*	Conventional techniques with moderate felling intensity (6–9 trees/ha)	3	28/29	June to Sept. 1998 and August 1999	Nov.–Dec. 1998	August 1999
CNV3*	Conventional techniques with high felling intensity (> 9 trees)	3	28/29	June to Sept. 1998 and August 1999	Nov.–Dec. 1998	August 1999
RIL 1	Reduced-impact logging techniques with low intensity (5 trees/ha)	3	27	March to May 1999	September 1999	May 2000
RIL 2	RIL with moderate felling intensity (6–9 trees/ha)	3	27	March to May 1999	September 1999	May 2000
RIL 3	RIL with high felling intensity (> 9 trees)	3	27	March to May 1999	September 1999	May 2000
CTCNV	Control plots with a 50 m buffer zone, no logging	3	28/29	June to Sept. 1998	-	-
CTRIL	Control Plots, with a 50 m buffer zone, no logging	3	27	March to May 1999	-	-

Every 50 m along each skidtrail, the width and depth of the track were measured. At each point of measurement, the area of the skidtrail was also classed as one of three types: *Low Soil Impact (LSI)* when the skidtrail was very superficial and topsoil was still present, *Moderate Soil Impact (MSI)*, when topsoil was completely removed but the track still relatively superficial (< 20 cm depth), and *Heavy Soil Impact (HSI)* when the trail was deeply excavated (e.g. > 20 cm depth).

Results

Forest structure, species richness and non-timber species (uses) before logging

The mean density and basal area of the four additional plots in the CNV blocks (243.6 trees/ha, SD = 41; 30.4 m″/ha SD = 4.9) were not distinct from those of the 12 plots (230 trees/ha, SD = 35.8 and 32.85 m^2/ha, SD = 4.7) set up before logging (t = 0.57, df = 14, P = 0.58 for density, and t = 0.87, df = 14, P = 0.40 for basal area). RIL (n = 11) and CNV (n = 12) plots showed similar tree densities and basal area (t = 0.52, df = 21 P = 0.60 for density, and t = 1.39, P = 0.18, Table 4.2). The mean density and basal areas in each DBH class were similar in RIL and CNV (Table 4.3).

Trees with a diameter of >50 cm (commercially harvestable trees) constituted 46.2% in the RIL block and 50.3% in the CNV block. Trees with DBH > 60 cm were dominated by species of *Dipterocarpus* and *Shorea* but non-dipterocarp species, such as *Agathis borneensis* and *Koompassia malaccensis*, are also abundant. Species of the Dipterocarpaceae family were dominant, contributing about 27% of the total tree density and 40% of the basal area. They also form the main component of the canopy trees. The largest tree so far recorded was *Shorea venulosa* with a DBH of 199.6 cm. Another prevalent species was *Agathis borneensis*. The Dipterocarpaceae and *Agathis borneensis* were the main commercial timbers harvested by INHUTANI II in the area. The three species with the highest density and basal area were *Agathis borneensis*, *Shorea elliptica*, *S. maxwelliana*, and *S. parvifolia*. The highest density for a single species in a plot was recorded for *Shorea maxwelliana,* followed by *Agathis borneensis* and *D. stellatus*.

Agathis borneensis was considered to be one of the most important timber species in the area, firstly because it has a very high value on the timber

Table 4.2 Mean density and mean basal areas (+ SD) in the RIL and CNV plots before logging. (CNV = 12 plots, RIL = 11 plots)

	dbh (cm)					
	20–29	30–39	40–49	50–59	≥ 60	All
RIL Plots density (n/ha)	124.3 ± 31.2	52.5 ± 12.9	26.3 ± 7.0	14.9 ± 5.6	22.4 ± 6.2	239.8 ± 53.7
CNV Plots density (n/ha)	123.1 ± 27.0	55.0 ± 9.2	26.2 ± 5.6	15.7 ± 4.9	24.6 ± 5.5	244.7 ± 38.0
Mean density RIL + CNV (n/ha)	128.6 ± 24.7	54.3 ± 9.6	27.2 ± 5.8	15.3 ± 5.4	23.0 ± 5.3	248.8 ± 34.1
RIL Plots basal area (m^2/ha)	6.3 ± 1.0	5.0 ± 0.9	4.4 ± 0.9	3.3 ± 1.4	10.5 ± 2.5	29.6 ± 3.8
CNV Plots basal area (m^2/ha)	5.7 ± 1.2	5.2 ± 0.8	4.1 ± 0.9	3.6 ± 1.1	13.8 ± 4.1	32.4 ± 5.1
Mean Basal Area (m^2/ha)	5.9 ± 1.1	5.1 ± 0.9	4.3 ± 0.9	3.5 ± 1.2	12.2 ± 3.7	31.2 ± 4.7

Table 4.3 t-test results comparing mean density and mean basal area in each dbh class in RIL (n = 11 plots) and CNV (n=12 plots)

dbh classes (cm)	Mean density	Mean basal area
dbh 20–29 cm	t = 1.11, P = 0.28	t = 1.02, P = 0.31
dbh 30–39 cm	t = 0.40, P = 0.69	t = 0.75, P = 0.45
dbh 40–49 cm	t = 0.90, P = 0.37	t = 0.52, P = 0.60
dbh 50–59 cm	t = 0.44, P = 0.66	t = 0.43, P = 0.66
dbh ≥ 60 cm	t = 1.49, P = 0.14	t = 2.10, P = 0.04*

All tests are for df = 21 (11 plots in RIL and 12 in conventional), and * indicates that means are statistically different

market, hence is highly appreciated by loggers, and secondly because it was the sole coniferous timber representative of the family Araucariaceae in the lowland and hill mixed dipterocarp forest of Borneo. It was not homogeneously distributed but rather occurred on tops or edges of ridges on well-drained soils.

Altogether, 62 families occurred in the RIL block and the CNV block. The largest families, which each contained more than 10 species and were common to both the RIL and CNV blocks, were Dipterocarpaceae, Euphorbiaceae, Myrtaceae, Lauraceae, Fagaceae, Myristicaeae, Sapotaceae, Clusiaceae, Fabacaeae, Anacardiaceae., Ebenaceae, Moraceae and Burseraceae. Dipterocarpaceae is the most important family in the area.

A total of 705 tree species were recorded from the permanent sample plots, of which 70 (9.29%) were dipterocarp species. Widely distributed dipterocarp species included *Dipterocarpus lowii, D. stellatus, Shorea beccariana, S. brunescens, S. exelliptica, S. macroptera, S. maxwelliana, S. multiflora, S. parvifolia, S. rubra* and *S. venulosa.*

Using published information, we identified that of the 705 species, 181 have uses other than timber, primarily valued as food (93 species) and medicinal plants (55 species). This list will now be greater due to the work reported in Chapter 5. In the CNV block, no less than 230 species of 82 families of trees, shrubs and herbs were identified by the Punan (the people native to the area) as having various uses, such as fruits (*Artocarpus* spp., *Durio* spp., *Nephelium* spp., *Dimocarpus longan, Baccaurea* spp., etc.), medicine (*Melodorum kentii, Polyalthia borneensis, Alstonia angustiloba, Combretum elmer* and *Parashorea smythiesii),* cosmetics (*Willughbeia lanceolata* and *Luvunga eleutherandra*), insect repellent (*Aglaia odoratissima*), dye (*Archidendron clypearia),* incense (*Aquilaria beccariana, A. malaccensis*), etc. Medicinal uses recorded the highest number (84 species) followed by uses for food (58 species).

Logging damage on stand

Mean logging intensities in the CNV and RIL plots were similar in terms of density of trees harvested (7.6 and 7.5 ha^{-1} respectively, t = 0.04, P = 0.48, df = 15), harvested volume (83 m^3/ha and 60 m^3/ha, t = 1.03, P = 0.16), and basal area removed (5.4 m^2/ha and 3.8 m^2/ha respectively, t = 1.38, P = 0.09). However, mean volume per harvested trees was higher in the CNV than in the RIL compartment (10.5 m^3/tree vs. 9 m^3/tree, t = 3.76, df = 708, P < 0.01). This difference was likely due to the higher proportion of large *Agathis* harvested in the CNV areas.

In CNV plots 26.1% (63 trees/ha) of the original tree population was injured while 24.7% (60 trees/ha) was killed (Figure 4.1). In RIL, a similar proportion of trees were injured (23.4%, 59 trees/ha) but, in contrast with conventional logging, only 14.5% (36 trees/ha) were destroyed (Fig. 4.1). In CNV plots, the proportion of trees killed by skidding was double that killed by felling, whereas in RIL, felling and skidding destroyed a similar proportion of trees (Fig. 4.2). In both RIL and CNV, the distribution of injured trees by diameter classes nearly matched the pre-logging tree population (^{2} =7.7, P = 0.05 for CNV and ^{2} = 3.8 P =0.28, df = 3 for RIL). Killed trees were, however, found in higher proportion in the smallest dbh class in both treatments (20–29 cm ^{2} = 32.18, for CNV and ^{2} = 16.2 for RIL, df = 3, P < 0.01).

There was a significant positive correlation between felling intensity and the proportion of trees damaged in RIL, though not in CNV (Pearson's r = 0.78, P = 0.02 for RIL, r = 0.53, P = 0.14 for CNV, Figure 4.3a, b). In RIL, the percentage of trees damaged (injured or killed) increased from 19.4% in RIL 1 to 50.3% in RIL 3, whereas in CNV, the proportion of trees damaged varied only from 46% in CNV 1 to 56% in CNV 3 (Figure 4.1). Correlation between the density of harvested trees and felling damage, though implied positive by the data, did not quite achieve 5% significance levels in either treatment (Pearson's r = 0.63, P = 0.06 for CNV; r = 0.69, P = 0.056 for RIL, Figure 4.3c, d). There was a positive correlation between skidding damage and felling intensity in RIL (r = 0.72, P = 0.04, Figure 4.3e) whereas in CNV this relation was not significant (r = 0.13, p = 0.72, Figure 4.3f).

Impact of logging on canopy opening

Before logging, mean canopy openness in CNV (three plots) and RIL (nine plots) was 3.6% and 3.1% respectively. The distributions of the values according to canopy openness classes in CNV and RIL plots were similar (Table 4.4). After logging, the mean canopy openness was 19.2% in CNV (n = 9 plots) and 13.3%

Figure 4.1 Mean proportions of trees injured (orange bars ± SD) and killed (light orange bars ± SD) by conventional (CNV) and reduced-impact logging (RIL) under different intensities (CL1 mean intensity = 5 trees/ha, CNV 2 = 6 trees/ha, CNV3 = 11 trees/ha; RIL 1 = 3.5 trees/ha, RIL 2 = 7 trees/ha, RIL 3 = 10 trees/ha; dotted bars: injured trees; hatched bars: dead trees)

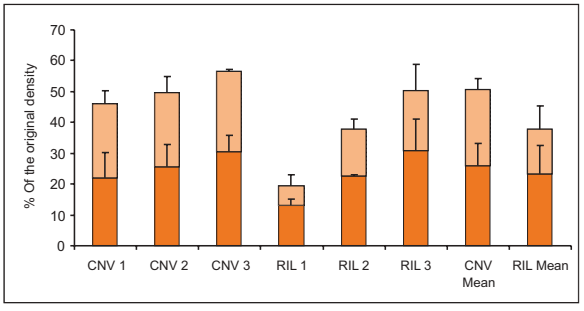


Figure 4.2 Mean proportions (+ SD) of tree damaged during felling and skidding in RIL techniques (orange bars) and conventional logging (light orange bars)

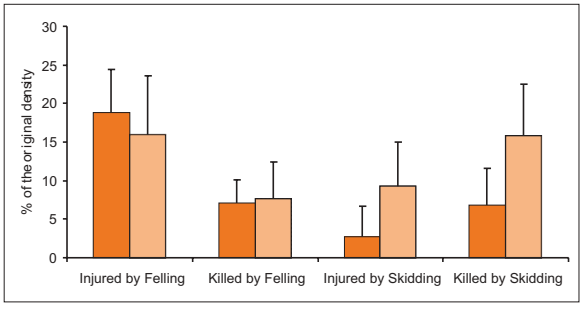


Figure 4.3 Correlation between felling intensity and percentage of trees damaged in RIL and CNV: 3a between felling intensity and total tree damaged in RIL (a) and in CNV(b); between felling intensity and proportion of trees damaged by felling in RIL (c) and CNV (d); between felling intensity and proportion of trees damaged by skidding in RIL (e) and in CNV (f). Orange points show observed data, small black squares those calculated by the correlation equation

Figure 4.3a

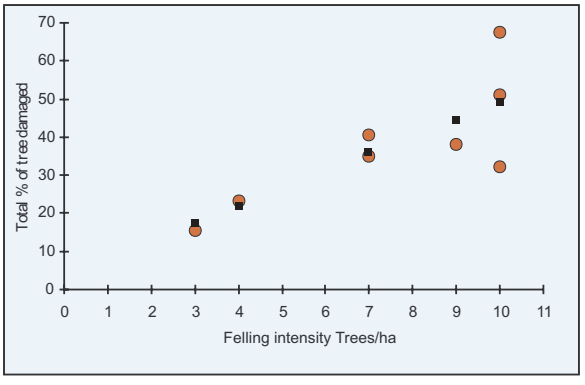


Figure 4.3b

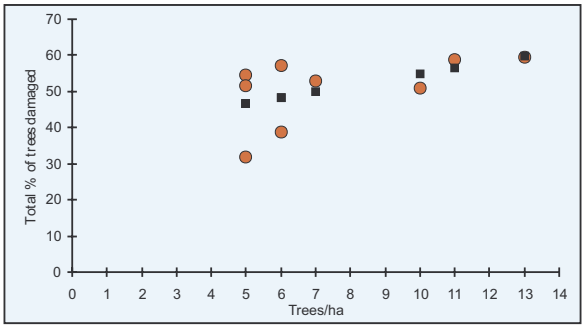


Table 4.4 Percentage of each canopy openness class in RIL and CNV plots (number of measurements in each class) before and after logging (before logging, Conventional = 3 plots and 108 measurements, RIL = 9 plots and 324 measurements; after logging, Conventional = 9 logged plots and 324 measurements, RIL = 8 logged plots and 288 measurements). Before logging ^{2} = 2.73, P = 0.25; after logging ^{2} = 43.56, P < 0.001

	0 – < 5%		5 – < 10%		10 – < 20%		20 – < 30%		> 30%	
Before Logging										
Conventional	80.6	(87)	12	(13)	7.4	(8)	-		-	
RIL	81.8	(265)	14.5	(47)	3.7	(12)	-		-	
After Logging										
Conventional	26.5	(86)	13.9	(45)	13.9	(45)	11.7	(38)	30.9	(110)
RIL	49.3	(142)	12.2	(35)	14.6	(42)	8.3	(24)	15.6	(45)

Figure 4.3c

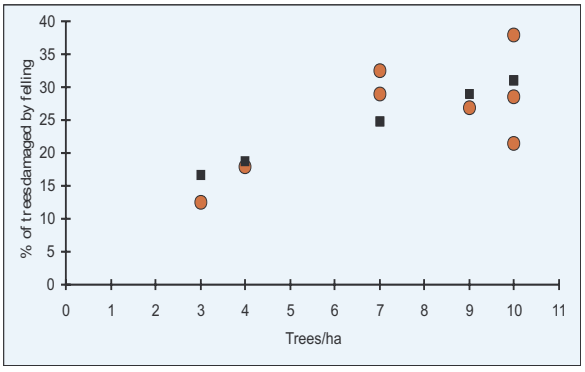


Figure 4.3d

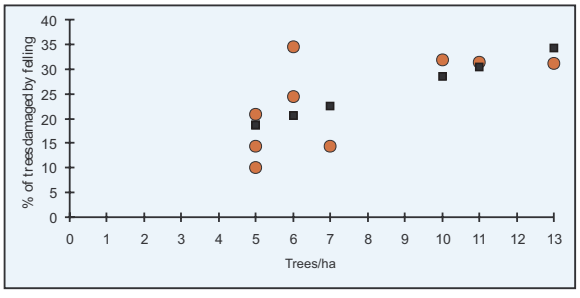


Figure 4.3e

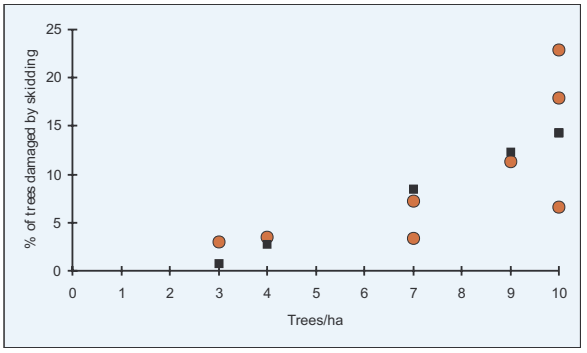
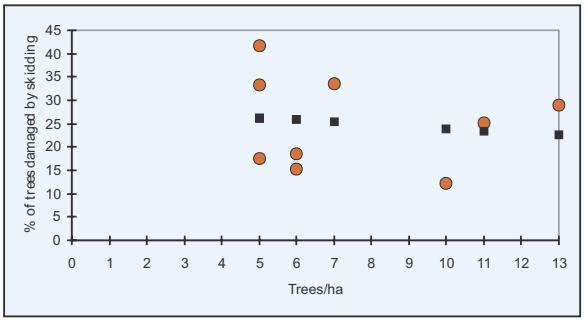


Figure 4.3f



Timber is the most investing cash earning resource in Malinau

in RIL (n = 8 plots). There was a higher proportion of measurements in the 0–5% canopy openness class and a lower one in the last class (= 30%) in RIL than in CNV (Table 4.4). Openness was significantly correlated with felling intensity in RIL but not in CNV (Pearson's r = 0.84, P < 0.01, df = 7 for RIL, r = 0.33, P = 0.38 df = 8 in CNV). Mean-per-plot canopy openness varied from 4% in RIL 1 to 18% in RIL 3 and, from 17.5% in CNV 1 to 20.7% in CNV 3.

Impact of skidtrails in conventional logging and RIL

Skidtrail length and skidtrail area per timber volume extracted were much larger in the CNV than in the RIL compartment (18.6 vs. 8.6 m^2/m^3). Main and secondary skidtrails in CNV blocks were wider than in RIL (mean 8.3 vs. 6.3 m, t = 5.38 df = 223, P < 0.01 for main skidtrails; 7 m vs. 5.4 m, t = 2.37, df = 470, P < 0.01 for secondary skidtrails). Skidtrails belonging to the High Soil Impact type showed excavation in which depth varied from 20 cm to 140 cm, whereas in the Moderate Soil Impact skidtrail type, this only ranged from 10 cm to 50 cm. In the conventional blocks, half of the main skidtrails belonged to the most damaging skidtrail type (HSI) whereas in the RIL compartment, this type represented only 6% (Fig. 4.4a). In the RIL compartment, secondary skidtrails with high soil impact were rare (2%) whereas in the CNV compartment these still represented a third (32%, Fig. 4.4b).

Growth and mortality after logging

Preliminary results from growth and mortality studies two years after logging show that the mean growth rate in the conventional logging block was 0.28 0.14 cm/year for all species and 0.48 0.50 cm/year for dipterocarps. In the unlogged area the growth rate was 0.27 0.16) cm/year for all species and 0.35 0.30 cm for dipterocarps. The growth rate of *Agathis borneensis* was 0.53 0.30 cm/year in the logged area and 0.48 0.20 cm in the unlogged sites. The mortality was 8.1% per year for all species and 8% for dipterocarps. The highest mortality occurred in *Agathis borneensis*, amounting to 24.6%. The mean recruitment was 3.4 trees/ha/year.

In the RIL block, the mean growth rate for all species was 0.31 cm/year. The highest growth was observed in the Fagaceae family, with a mean growth rate of 0.57 cm/year, followed by Clusiaceae (0.48 cm/year) and Dipterocarpaceae (0.35 cm/year). In the unlogged control plot the mean growth rate was 0.23 cm/year for all species and 0.36 cm/year for Dipterocarpaceae. The mean mortality rate was 8.8% per year for all species and 2.7% per year for Dipterocarpaceae. The mean recruitment was 3.5 tree/ha/year.

Figure 4.4 Proportion of the three main types of impact in primary (4a) and secondary skidtrails (4b) in RIL (light-filled bars) and conventional (orange bars). LSI: Low Soil Impact, MSI: Moderate Soil Impact, HSI: High Soil Impact (see text for brief description)

Figure 4.4a

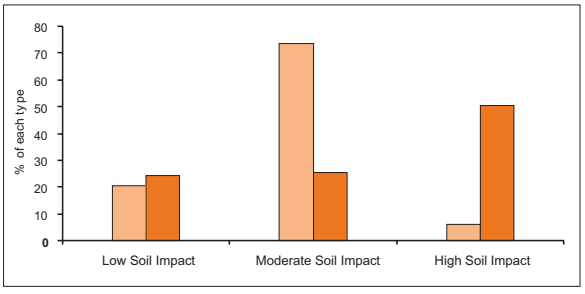
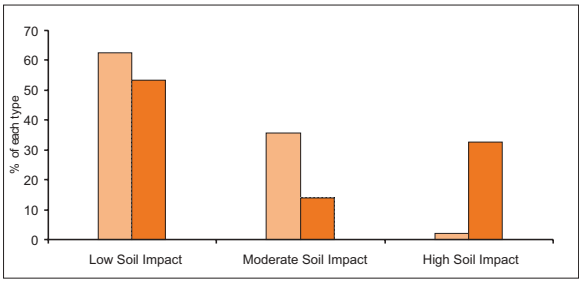


Figure 4.4b



Discussion

RIL reduced the number of trees destroyed by 40% in comparison with conventional harvesting practices. However, the proportions of trees injured were similar in both techniques, affecting about 25% of the original stand. The main benefit of RIL was to reduce skidding damage from 25% of the original stand in CNV to only 9.5%. Because skidding operations are the major

causes of mortality (Bertault and Sist 1997), the low proportion of trees killed in RIL appear to result from improved skidding. In contrast, despite the careful application of directional felling, RIL failed to significantly reduce felling damage, which depends mainly on the height of the tree, the size of its crown and the topography (Cedergren 1996). The absence of a strong relation between felling intensity and felling damage in both conventional and RIL underlines the stochastic aspects of felling damage—here generating a high amount of unexplainable residual variance. Although vine cutting prior to logging has long been regarded as a promising technique to reduce felling damage, its effectiveness is controversial (Cedergren 1996, Parren and Bongers 2001). Directional felling, commonly applied in RIL, aims essentially to lay the logs in positions that facilitate ground-skidding extraction and limit skidding damage on the remaining stand. It is important to note that in a planned logging operation, skidding damage is correlated with felling intensity, whereas in conventional logging, this was not the case. This last result clearly shows that most of the damage can be effectively reduced during extraction.

Under high felling intensity (> 8–9 trees/ha), the proportions of injured and dead trees in RIL were similar to those recorded in conventional harvesting. This result is consistent with previous studies in other tropical forests showing that RIL methods are only effective under low felling intensities (Sist *et al.* 1998a, Van der Hout 1999). The felling intensity threshold of c.7–9 trees/ha in the present study corroborates that of c. 8 trees/ha proposed by Sist *et al.* (1998a) in Berau, also in East Kalimantan. Such general confirmation of the main results is more important than it may initially appear. Virtually all logging studies suffer shortcomings of limited replication and imperfect sampling allocation. This allows anyone to question to what extent any given result is truly generalizable, or whether it is in fact a local result determined by an unknown number of specific local or temporary details. It is thus important to specifically acknowledge the close conformity of the results determined in this study and those found by Sist *et al.* (1998a) in a quite different site in East Kalimantan. Moreover, most of the previous studies related to logging damage assessment have been based on a total random sampling which generally failed to address the issue of the high variability of logging intensity in natural forests (Sist *et al.* 1998a). This study, then, has allowed us to reassess and lend support to the general proposition that RIL techniques must be implemented within a reasonable intensity threshold, and that this boundary lies at around eight trees per ha in hill dipterocarp forests (Sist *et al.* 1998a). Foresters, managers and certifiers must now consider this threshold as an important criterion of sustainability.

If we are looking for some definition of 'best practice' it is relevant to stand back and to ask what is the appropriate measure of an optimal felling regime. For example, in developing RIL techniques, what is the best unit of reduced damage? Are we, for example, looking to minimize trees destroyed per unit volume extracted or per stem cut or per annual coupe? If we consider the wider forest landscape, we might be tempted to consider the possible trade-offs between more intensive extraction in more limited areas and lower extraction or even protection in others. Thus, our questions about what we should measure may continue with our observation that CNV actually makes incomplete use of the potential area available for harvest, raising the question of how to consider this non-damaged area. All these are good questions and they should not be overlooked. It is certainly worth noting, for example, that relic patches of intact forest are highly desirable for many ecological reasons, and are therefore perhaps a desirable outcome of CNV. This, however, points to the fact that this can and should be replaced by *planning such areas in RIL*. In this study we have not developed an adequate database to examine these wider landscape questions but have instead taken a more specific course in seeking to identify the limits of what might be called 'acceptable' as opposed to 'excessive' harvesting. That is, we have tried to find a way to define limits for silvicultural practices in any area where harvesting is actually taking place which allows recovery without jeopardising immediate revenues.

Reduction of harvest damage is not the only criterion we should consider when assessing the technical sustainability of forest management. Even if we restrict our considerations to the stand level, it is clear that high extraction regimes also involve major impacts on dynamic processes and forest composition. There is scant evidence that any commercial dipterocarp species benefits canopy

openings greater than those created by single-tree selection cutting practices (500–600 m^2) to establish and maintain good growth, especially those of commercial value (Kuusipalo *et al.* 1996; Tuomela *et al.* 1996; van Gardingen *et al.* 1998). High extraction rates, by creating big canopy openings, stimulate the growth of pioneer competitors and create desiccating conditions (Nussbaum *et al.* 1995; Kuusipalo *et al.* 1996; Tuomela *et al.* 1996; van Gardingen *et al.* 1998; Clearwater *et al.* 1999; Sist and Nguyen-Thé in press), factors unfavourable to the establishment and growth of dipterocarps. Moreover, large openings are subject to invasion by lianas which can be an obstacle to tree regeneration. Large openings in heavily logged forests increase fire risks and propagation, particularly during long periods of drought as periodically occur in Southeast Asia during El Niño events. Heavy logging also results in a depleted residual stand unable to recover an acceptable timber-harvest volume within a 35-year harvesting cycle (Favrichon and Young Cheol 1998; Sist *et al.* 1998a; Huth and Ditzer 2001). There is a need for simple and practical prescriptions which limit the local densities of trees harvested to 8 per ha or less (50 to 70 m^3/ha) and keep the size of the gap to less than 500–600 m^2. Three simple rules would appear to provide this: 1) a minimum spacing distance between harvested trees, 2) single tree gap formation from harvesting using directional felling, 3) a maximum (as well as a minimum) DBH limit for harvesting. We will now discuss these possible measures.

In a homogeneous spatial distribution under maximum packing (triangular), the distance D between trees in metres is given by the formula:

$$D = 200 / \sqrt{3x}$$

where x is the density in stems per ha. This is slightly longer than packing in a regular square lattice, where

$$D = 100 / \sqrt{x}$$

The minimum spacing distance for a maximum felling intensity of 8 trees/ha for each of these is 40.8 m and 35 m respectively.

Because gap size is largely dependent on tree size, the most effective method of limiting gaps, and thus increasing forest recovery potential, is to favour single tree gaps during felling and avoid harvesting trees over a certain size. We suggest that this might be usefully set at DBH $\geq$ 100 cm. Such trees are normally of huge significance in terms of seed production and hence in long-term regeneration potential, while they are also difficult to harvest effectively, and have high ecological relevance (Sheil and van Heist 2000). These very large individuals often have structural defects that reduce their timber value, but serve as large seed sources representing genetic stock well-adapted to local site conditions, and provide valuable habitat for a myriad of organisms. In the study area the mean density of harvestable trees (dipterocarps and *Agathis*) with DBH $\geq$ 60 cm was 15 trees/ha, whereas that of trees with DBH between 60 and 100 cm decreased to 12.5/ha. Taking a stem rejection rate of 30% (personal observation in several localities of East Kalimantan), the density of harvested trees with 60–100 cm DBH is 8 trees/ha, which remains high in comparison with other tropical forests of Africa and South America. In other parts of Borneo, taking the same rejection rate, the mean density of commercial trees with 60–100 cm DBH is higher, around 10–11 trees/ha (Cedergren 1996, Sist and Saridan 1999). In mixed dipterocarp forest, limiting harvesting to commercial trees with DBH ranging from 60 to 100 cm should not be a constraint on production, but would yield considerable long-term benefits both in terms of long-term sustainable timber potential and ecological values (Sheil and van Heist 2000).

There is a growing awareness that forestry practices need to consider more than timber production. Society increasingly sees the role of forests in terms of numerous goods and services such as biodiversity, climate, non-timber forest products and often to serve the needs of local communities for diverse subsistence and daily needs. For instance, iron wood or ulin (*Eusideroxylon zwageri*) is a species that is important to the livelihood of local communities. Forestry regulations stipulate that only local communities can harvest it for shingles, flooring and heavy construction. Species of tengkawang (*Shorea pinanga, S. seminis, S. singkawang,* etc.), which produce cocoa butter, are also regulated. Nevertheless, the species are currently logged indiscriminately by concessionaires and little is done by local enforcement agencies to control the trade. Our work in Malinau has begun to look at these factors, and we hope to develop these in due course. The point that we need emphasize here is that it is essential that any conception of RIL, or improved

practice generally, should ultimately be defined by much more than simple silvicultural definitions, and that this must be an emphasis for future research.

Conclusions

In the mixed dipterocarp forests of East Kalimantan, where the density of harvestable trees often exceeds 10 trees/ha, the minimum diameter rule results in excessive felling and allows high levels of damage to the remaining forest. RIL techniques, though they would appear to be a vital part of the solution, are useful only under a more moderate extraction regime. Such a reduced felling intensity is essential in any case, both from the perspective of the growth and survival of the residual stand, but also the longer-term ecological sustainability of the forest. New silvicultural prescriptions should be considered as a step forward to improve forest harvesting operations. RIL techniques do not guarantee silvicultural sustainability if based on a minimum diameter cutting limit alone. Additional prescriptions are essential for improving RIL techniques towards achieving sustainable harvesting practices. The rules we suggest are: 1) a minimum spacing distance between harvested trees (c. 35–40 m), 2) single tree gap formation from harvesting using directional felling, and 3) a maximum (as well as a minimum) DBH limit for harvesting (c. 100 cm). In exploring the major issues that remain we highlight an urgent need to expand logging studies to look at impacts and trade-offs across larger forest landscapes.

Acknowledgements

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4.c. Cost-benefit Analysis of Reduced-Impact Logging in a Lowland Dipterocarp Forest of Malinau, East Kalimantan

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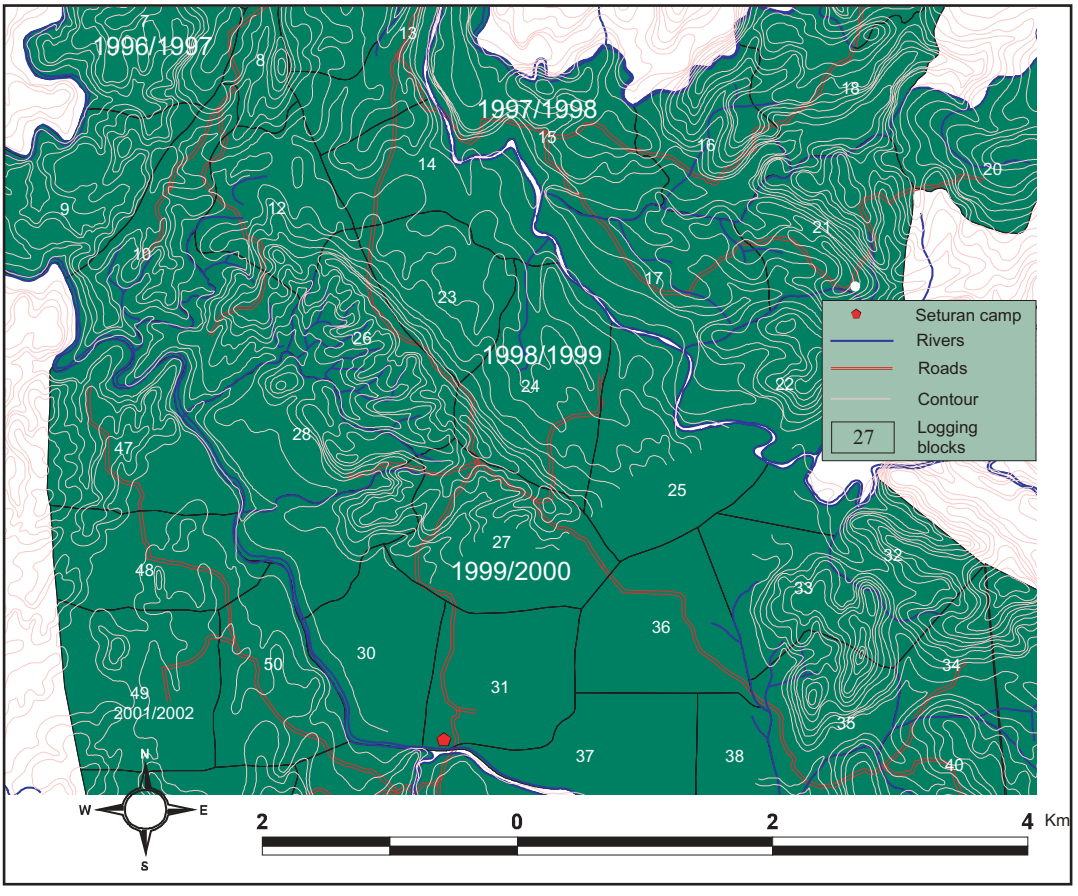
Introduction

The following study is concerned with comparison of costs and was conducted in the same site and blocks used in the studies presented in Chapter 4.b. above (Figure 4.5). It is obvious that the scale of the experiment could not allow the inclusion of all logging costs and particularly those related to road planning, road construction and log transportation. The study, therefore, focused only on the planning and operational costs of felling and skidding.

Methods

A detailed account of the CNV and RIL techniques is given in the unpublished report on *Cost-benefit Analysis of Reduced-Impact Logging in a Lowland Dipterocarp Forest of Malinau, East Kalimantan, Indonesia*, by Hariyatno Dwiprabowo, Stephane Grulois Plinio Sist, and Kuswata Kartawinata (see Annex in the attached CD ROM). Annex 1 below shows a comparison of the main activities in CNV and RIL operations.

Figure 4.5 Logging blocks in the INHUTANI II's Malinau concession



Productivity and cost assessment of CNV and RIL

Pre-harvesting operations

The approach used to assess productivity and the cost of pre-harvesting operations is as follows:

(a) The cost of each pre-harvesting operation was assessed according to the time required to achieve it. Basic data regarding salary and equipment costs were obtained from INHUTANI II.

(b) To calculate the unit cost (per m^3) produced, first, the cost of the activity on an area basis (per ha) was assessed, then the resulting cost was divided by yield (m^3) per ha.

Harvesting operations

The costs of harvesting operations in Rp (*Rupiah,* the Indonesian currency unit) were calculated with the following formula:

$$\text{Cost of skidding in (Rp/m}^3\text{)} = \frac{\text{Hourly cost of skidding in Rp per hour}}{\text{Hourly production in m}^3\text{ per hour}}$$

$$\text{Cost of felling in (Rp/m}^3\text{)} = \frac{\text{Hourly cost of felling in Rp per hour}}{\text{Hourly production in m}^3\text{ per hour}}$$

Daily cost or production was derived from hourly production, which was determined by a time study analysis where the volume and time devoted to each harvesting operation (felling and skidding) were measured. The cost of harvesting was then the sum of per unit costs of pre-harvesting, felling, and skidding operations.

Productivity assessment

Productivity was assessed by the time motion studies. Two levels of investigations were distinguished. First, the workplace analysis which aimed at assessing daily or hourly production. Hourly production was expressed in m^3 per workplace hour. Time spent by the operators on the workplace were recorded and classified in the following sections:

1. Productive time, maintenance of the equipment (chainsaw or skidder), repairing, rest and other delays.
2. Productive time analysis: felling and skidding activities were divided into 'work elements'. A complete succession of work elements corresponds to the felling of a tree or a 'trip' for extraction

CAT 527 Skidder and log landing in RIL operation

activity called the 'work cycle'. The breakdown is aimed at determining the importance of each work element and allowing accurate analysis of the influence of site conditions such as volume of trees and skidding distance, and of techniques, on production.

Felling productivity was calculated on the basis of the felled volume produced per time unit, while skidding productivity was assessed based on the extracted volume skidded per time unit. The unit costs of felling and skidding were calculated based on the commercial volume. Conversion or recovery factors were used to convert from one form of volume to another using waste assessment.

Felling production rate (m^3/hour) was calculated using the following formula:

(Average volume per cutting cycle in m^3) x (60min./ Time spent per cutting cycle in min.) x (1/hour)

Skidding production rate (m^3/hour) was calculated using the formula:

(Average volume per trip in m^3) x (60min./Time spent per trip in min.) x (1/hour)

In the felling, the average productivity of both CNV and RIL was calculated based on production rates of two fellers. In the skidding, average productivity was based on two D7G and two CAT 527 unit skidders.

Harvested, commercial volume and waste measurement

Harvested volumes were calculated based on data collected during the felling and skidding time study. The length, top and end diameter of each log were measured. Two perpendicular diameters were measured at each end and the average was used to calculate the volume of the log. If diameter could not be measured, girth was used. In CNV, a sample of logs was measured to assess the harvested volume, while in the RIL compartment all the harvested trees were measured.

The *felled volume* was defined as the volume actually felled by the feller, excluding the waste in the felling site. The *extracted volume* was the volume of logs extracted by the skidder. The *commercial volume* was defined as the extracted volume less the bark and other parts removed on landing.

Waste volumes were estimated with the following definitions:

(1) The cutting of stumps was considered too high if the level of the cross cut was more than 40 cm above the ground for trees without buttresses or more than 20 cm above the highest buttress. In such a situation, the waste volume was calculated by the diameter of the stump (two perpendicular measurements) and the height of the waste portion of the stump.
(2) The volume of a split log (or portion of log) was assessed with the diameter at the midpoint of the tree (or the split section) and the corresponding length.
(3) Although in many cases, defective parts of logs (knots, bumps, insect attack) could be used for sawn wood or, in some cases, for the plywood industry because of the company's grading rules, these parts were never used by INHUTANI II and were left in the forest. This waste was included in our volume assessment study.
(4) The volume of logs left in the forest (i.e. not extracted) was assessed by checking the list of felled trees with that of extracted logs. For this all the logs were marked with labels in the forest during felling operations. Logs fallen in a ravine were inaccessible and therefore could not be measured. For these trees we assume that their volume was equal to the mean volume of logs measured in the block.

Daily costs of harvesting activities

These costs included the owning and the operating costs of the equipment. The FAO method (FAO 1992) was used for the calculation, with the following breakdown:

(1) fixed costs included equipment depreciation, interest on investment, and insurance.
(2) operating costs or variable costs included fuel, lubricants, equipment repairs, and parts.
(3) labour costs were those associated with employing labour, including direct wages, allowances, and food.

Data on operational costs for D7G were provided by INHUTANI II for the year 1998 and those on the CAT 527 skidder by the manufacturer. For the CAT 527 used in the RIL trial, the calculated cost was not the real cost for INHUTANI II but reflected the cost of the equipment with average data collected by the manufacturer from its clients ('manufacturer cost'). Some adjustments were made for fuel consumption and unit price as well as for operators' (drivers and mechanics) wages.

Rapid assessment of logging damage

In both conventional and RIL compartments, all the skidtrails and landings were drawn on a map after logging. Along each skidtrail, the width was measured every 50 m. The harvested area was defined as the area within 30 m to the right and left of the skidtrails (Figures 4.6 and 4.7).

Results

Harvested areas and volume

Overall, mean diameters of measured trees in CNV and RIL blocks differed significantly (CNV: $\bar{}$=92 cm vs 82 cm, t=7.08, df=799, P<0.01). Mean diameters of harvested logs of *Agathis* were similar in CNV and RIL blocks (CNV: $\bar{}$ = 96 cm vs 93 cm, t=1.42, df=366, P=0.16). In contrast, logs of dipterocarps were bigger in the conventional blocks than in RIL (CNV: 88 cm vs 73 cm, df = 374, t=10.17, P < 0.01). This resulted in the average extracted volume in the conventional blocks being higher than in the RIL compartment (10.5 m^3 vs 9.0 m^3, t =3.76, df = 708, P < 0.01). The number of extracted trees in the harvested area showed a difference of only one tree per ha between conventional and reduced-impact logging (6 trees/ha and 7 trees/ha, respectively, Table 4.5).

Figure 4.6 Skidtrails and harvested area in blocks 28 and 29

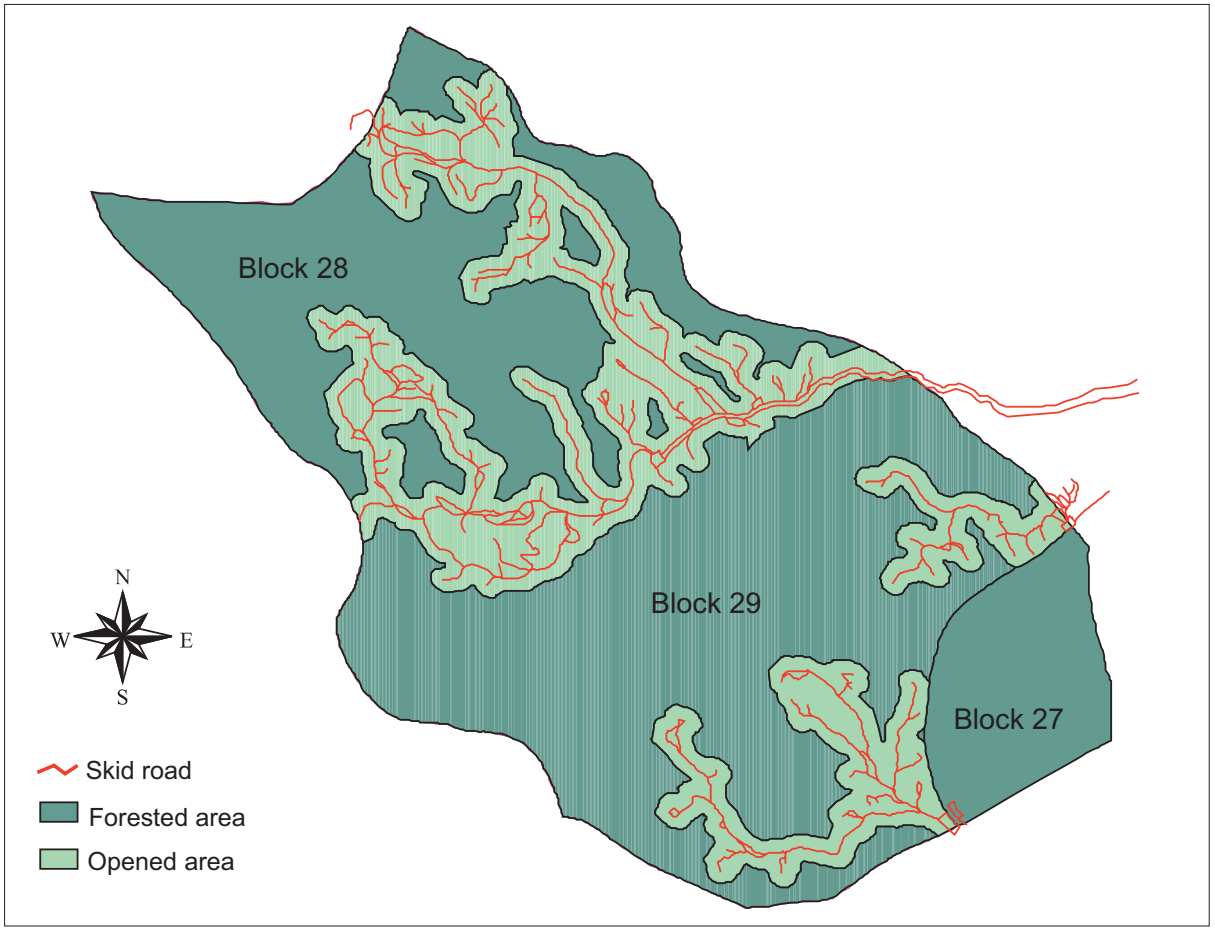


Figure 4.7 Skidtrails in block 27

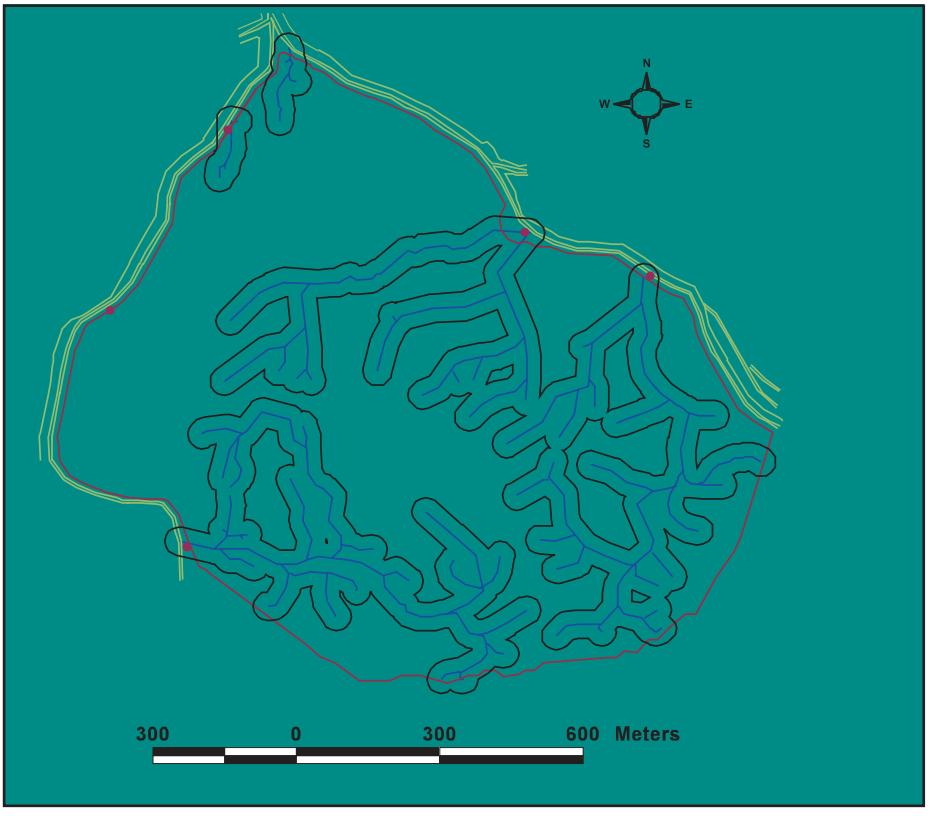


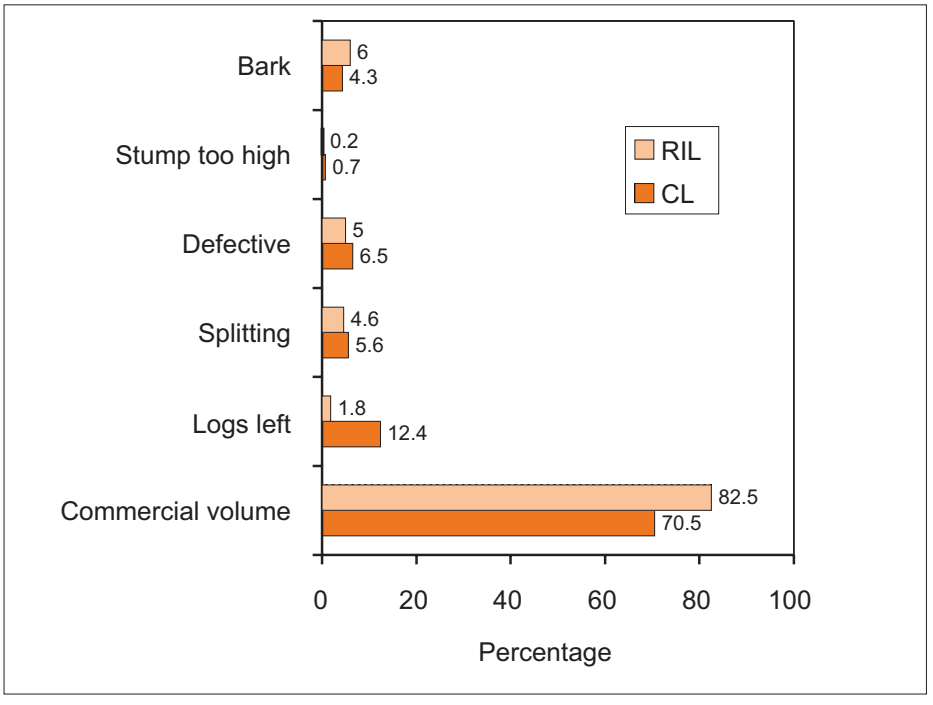
Table 4.5 Characteristics of extracted timber volume and density in conventional (CNV) and reduced-impact logging (RIL) blocks

Characteristic	CNV	RIL
Total area (ha)	244	138
Extracted volume per ha based on total area (m^3/ha)	19.7	24.7
Harvested area (ha;%)	91;37	56;41
Extracted volume based on harvested area (m^3/ha)	52.8	60.9
Total no. of felled trees	536	386
No. of felled trees on harvested area per ha	5.9	6.9
Average extracted volume per tree (m^3)	10.3	9.0

Waste assessment

In RIL, the commercial volume represented 83% of the felled bole volume, while in the conventional blocks this was only 70.3% (Fig. 4.8). The amount of wood waste, which did not include hollowed logs left in the forest, in the CNV blocks 28 and 29 and in the RIL block 27 is presented in Figures 4.8. The total waste volumes in CNV and RIL accounted for 29.5% and 17.5% of felled bole volumes, respectively. In conventional logging, logs left in the forest (i.e. not found or fallen in a ravine) represented 42% of the waste volume while in RIL this proportion was reduced to only 10%. In terms of volume, logs left in the forest represented 580 m^3 in conventional logging and 65.8 m^3 in RIL. In proportion to the commercial volume, the volume of logs left in CNV and RIL are 0.17 m^3/m^3 (17%) and 0.02 m^3/m^3 (2%), respectively. This implies that RIL can reduce the logs left by 0.15 m^3/m^3 (15%). Therefore, wood waste reduction was the major benefit gained from RIL implementation in terms of cost savings and profits.

Figure 4.8 Percentage of waste and commercial volumes in CL and RIL



Productivity and costs

Pre-harvesting operations

(1) Timber inventory and contour survey

The additional task of undertaking the topographic assessment during the inventory in RIL increased the costs by 38% (Rp 13 900/ha), thus the inventory cost was higher than that in CNV (Table 4.6). Other costs related to planning were data checking and block maps for RIL. In CNV, maps were drawn manually and cost Rp 3590/ha. In RIL, maps were produced using SOFTREE computer software. The cost of producing the inventory map in RIL, including the purchase of the software, was Rp 1530/ha.

(2) Vine cutting

The vine cutting for RIL implementation in the 2000–2001 annual coupe was carried out by INHUTANI II concomitant with the forest inventory and cost only Rp 7760/ha—lower than the cost of vine cutting undertaken separately (not simultaneously) during the inventory, which amounted to Rp 22 910/ha.

(3) Training cost

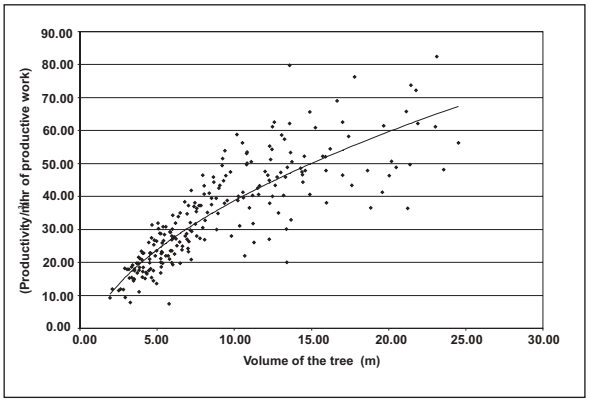
A great deal of on-the-job training was carried out before RIL implementation. The training covered directional felling, timber and topographic surveys, and the use of SOFTREE software for extraction map planning. The estimated costs of the training were as follows:

1. US$ 8275 for timber and topographic surveys (on-the-job training, classes and fieldwork);
2. US$7700 for directional felling (field practice); and
3. US$37185 for the use of SOFTREE for mapping (class and practice).

The first and second training programmes were conducted one year before harvesting, so these two costs were compounded (interest rate 10%/year), hence the costs for the topographic survey and directional felling were US$9103 and US$8470, respectively.

In order to get a realistic estimate for the company, the training costs were divided equally by the number of concessionaires taking part in the training: four in timber and topographic survey, two

Figure 4.9 The relationship between tree volume and productivity (m^3/hr of productive time)



in directional felling, and four in software training. Thus the estimated costs for the timber and topographic survey, directional felling, and software training were US$2276, US$4235, and US$9296 per concession, respectively. We considered training as a company's long-term investment, and we assumed the service period of the training would be up to five years, with an annual interest rate estimated at 12% (at the Rupiah rate). In total, it would cost the company Rp 37 308 930/year, representing a cost of Rp 41 450/ha or Rp 1680/m^3, assuming an annual coupe of 900 ha and a mean harvested volume of 25 m^3/ha.

(4) Skidtrail opening

In the RIL block, skidtrails were opened before felling, according to the skidtrail network plan as prepared in the tactical map. The total length of the skidtrails in RIL block 27 was 9090 m with a total machine time of 17:46 h (510 m/machine hour). Skidtrail opening in RIL cost Rp 293 600 : 510 m = Rp576/m In CNV, skidtrails were opened during extraction and the cost estimate was Rp 300 173: 60 : 2.7 m = Rp1850/m. In total, the RIL extra cost for pre-harvesting operations was Rp 1305/m^3, or 60% higher than the cost of CNV.

Felling

(1) Productivity

The productivity of felling in RIL was 28% higher than in CNV, since a work cycle in CNV was 34.8 minutes vs. 24.2 minutes in RIL. This means that the hourly production rate was higher in RIL than in CNV, but the daily production was very similar (Table 4.7). It was attributed to the behaviour of the fellers, who stopped working when they reached their daily target production of about 100 m^3. In CNV, workplace time was 7 hours for a daily production of 124 m^3 while in RIL it was only 4.5 hours for a daily production of 102 m^3. One of the main reasons for the shorter daily work time in RIL was linked to the fellers' habit of bringing 4.5 litres of oil for a day's work.

The difference in the size of felled trees in CNV and RIL did not allow a direct comparison of felling productivity. There was a significant correlation between productivity and volume of felled trees in the RIL treatment as expressed in a regression:

Table 4.6 Costs of planning and vine cutting in CNV and RIL

	CNV		RIL	
ACTIVITY	Cost (Rp*) per ha	Cost (Rp) per m^3 (of commecial volume)	Cost (Rp) per ha	Cost (Rp) Per m^3 (of commecial volume)
Timber inventory and contour survey*	36220	2020	50120	2230
Data entry and block mapping	3590	200	4700	30
Data checking and mapping			1580	70
Skidtrail marking and checking			3410	150
ROADENG Software purchase			830	40
Vine cutting			2910	1020
TOTAL		2220		3540

* Rp = Rupiah, the Indonesian currency unit

Table 4.7 Work cycle, felling time and productivity in CNV and RIL

No.	Work element	CNV Average time/trip (minutes:seconds)	RIL Average time/trip (minutes:seconds)
1	Preparation	01:42	01:07
2	Cut brush	02:06	01:31
3	Fell tree	04:15	03:31
4	Wedge use	-	00:57
5	Wait for tree to fall and branch clearing	03:24	01:43
6	Crosscutting	04:56	02:55
7	Walk between trees	04:13	03:21
8	Chainsaw care	03:45	02:10
9	Other activities	02:04	01:07
10	Delays	08:26	05:52
	Average time/cutting cycle	34:51	24:15
Hourly production (m^3)		17.8	22.8
Daily production mean sd (m^3)		124.3 38.2	105.6 44.6
Average daily production (6h/d)(m^3)		107	140

Directional felling in a RIL operation

Y=16.01 x v(Tree volume) -11.96, r^2 = 0.71, n = 232 trees) (Figure 4.9). Based on this regression curve and taking a mean tree volume of 10.3m^3, the productivity of felling in RIL increased by 7.7% in comparison with that recorded in CNV (i.e. 32.8 m^3/hour vs. 23.4 m^3/hour respectively in RIL and CNV).

The analysis of the felling work cycle in RIL and CNV allows us to ascertain the reasons for the shorter felling work cycle in RIL (Table 4.7). In RIL, crosscutting took less time than in CNV as the fellers had a better position for bucking due to pre-opened skidtrails and directional felling. The use of wedges helped the fellers both in felling and crosscutting. The time for walk-between-trees was less in RIL than in CNV as fellers very often used the pre-opened skidtrails to walk from one tree to another. Why the time lag between felling and crosscutting was shorter in RIL than in CNV could be explained by vine cutting and gap orientation, as the felled tree position eased the clearing of branches. A common phenomenon in CNV was the chainsaw bar getting pinched between logs in crosscutting and felling. The use of wedges in RIL significantly reduced such incidents, resulting in a delay time reduction of around 30%.

(2) Costs

Based on INHUTANI II accounting data, the piece rate cost of felling in April 1999 was Rp 1500/m^3.

Table 4.8 Net wage received by fellers in CNV and RIL (Rp/day)

Component	CNV	RIL
Chainsaw cost:		
Fixed	14 450	10 801
Variable	26 121	23 224
Net wage	49 429	55 975
Gross wage	90 000	90 000

The prices of a chainsaw and its parts, fuel and lubricant were obtained from dealers and retailers.

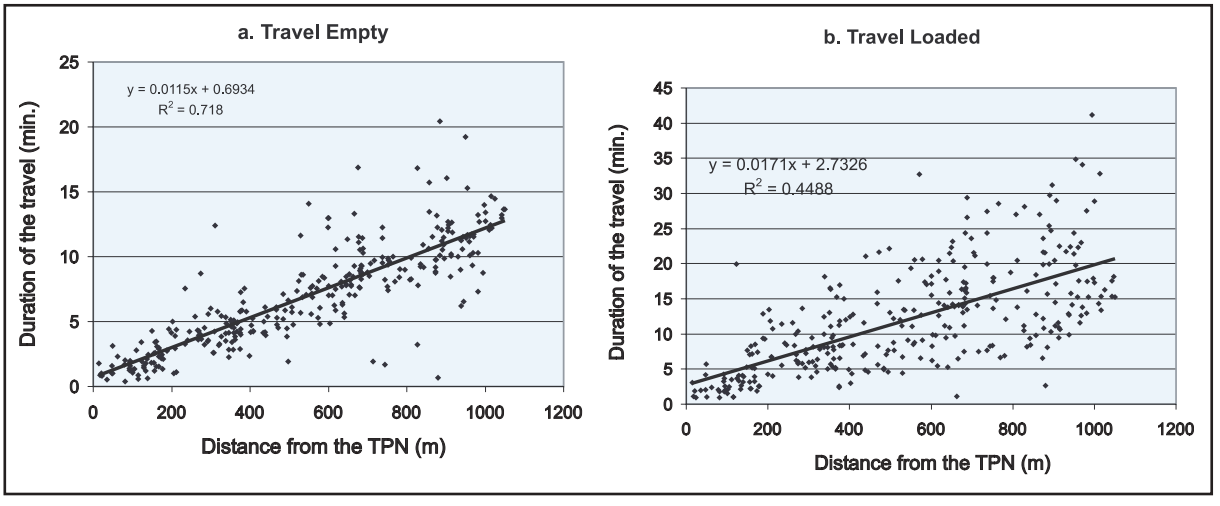
As wages were established based on commercial volume, it was important to know the recovery rate between felled volume and commercial volume in both methods. In CNV, one cubic metre of felled volume resulted in 87% of extracted volume or 79% of commercial volume, while in RIL, one cubic metre of felled volume resulted in 99% of extracted volume or 91% of commercial volume.

The increase of productivity of felling in RIL did not result in a higher profit for INHUTANI II since the concession paid a fixed piece rate of Rp 1500/m^3 regardless of the total volume produced. However, it increased the fellers' income, as described by the equation:

Gross wage/day (Rp/m^3) = chainsaw cost (Rp/m^3) + net wage (Rp/m^3).

The chainsaw cost was borne by the fellers. On the basis of past productivity, a net wage of around 55%

Figure 4.10 Regressions between skidding distance and time in RIL



to 60% of the gross wage was received as net income (Table 4.8). Hence, a productivity increase of 5 m^3/h or 30 m^3/day in RIL would increase the net wage by 1500 x 0.60 x 30 Rp/day = Rp 27 000/day assuming an average workplace time of 6 hours per day.

Skidding

(1) Productivity

The average skidding distances in CNV and RIL were very similar (546 m/trip and 525 m/trip, respectively). However, our time study in the CNV blocks was based on a mean distance of only 285 m (min.= 20 m, max. = 1072 m), while in RIL it was 525 m (min.= 15 m, max.= 1050 m). The productivity comparison of CNV and RIL was, therefore, based on an average skidding distance of 285 m. It was assumed that the harvesting method had no influence on the average volume of the extracted logs, and the distribution of skidding distances is the same both for RIL and CNV. Figure 4.10 shows the regressions to estimate the duration for travel-empty and travel-loaded at 285 m distance. An average volume of 9.5m^3/trip, as measured in the CNV block, was used. Workplace productivity in RIL was 20.4 m^3/h compared with 15.1 m^3/h in CNV, an increase of 25% (Table 4.9). However, the increase in hourly productivity was not followed by an increase in actual daily production due to the shorter workplace time in RIL (i.e. 6.34 h/day vs. 7.07 h/day), lower log volume, and longer skidding distances.

The productive work cycle of skidding in CNV and RIL showed significant differences in travel-empty but very small differences in travel-loaded (Table 4.10). The reduction of travel-empty time in RIL was the result of skidtrail planning as well as skidtrail opening prior to felling. Skidtrail opening in RIL required less time than in CNV because of the pre-harvesting skidtrail planning. Moreover, in contrast to CNV, in RIL no time was wasted looking for the logs since skidtrails were already clearly marked in the field.

RIL reduced delays resulting from skidders being unable to perform because of terrain conditions (such as machines getting stuck), and waiting for other phases of the operation. In total, RIL techniques reduced average skidding time per trip by around 10 minutes or 26% in comparison with CNV techniques.

(2) Costs

The recovery rates from extracted volume to commercial volume in skidding in CNV and RIL were the same, i.e., 91%. For cost calculations we used this rate along with the operating costs of D7Gs for the 1998–1999 period provided by INHUTANI II and of CAT 527 supplied by Trakindo Utama, the Caterpillar dealer. To avoid bias, we used the productivity of an equal distance of 285 m and average volume per log of 9.5 m^3.

Skidding costs in RIL decreased by Rp 6040/m^3 in comparison with CNV, mainly due to higher hourly productivity (Table 4.11).

Because the CAT 527 skidder used in our experiment was new, it was necessary to consider the operational cost of a new D7G, which was provided by its dealer, Trakindo Utama. The cost per hour for a new D7 G was Rp 373 490. The operators received wages on a piece rate basis of Rp 600/m^3 for a volume of 600m^3, Rp 700/m^3 for 600–1000 m^3 and Rp 800/m^3 for volumes of more than 1000 m^3 per month. The number of availability days of a new D7G, according to the manufacturer, is 250/yr or 2000 hours/yr, higher than the availability of INHUTANI II's D7G, which was 178 working days/yr. The cost per hour of the new D7G is higher than that of the CAT 527, i.e. Rp 373 491 vs. Rp 293 589. The unit costs per m^3 of INHUTANI II's D7G, a new D7G (CNV), and the CAT 527

Table 4.9 Skidding productivity in CNV and RIL

	CNV	RIL
Average production (m^3/mach/h)[1]	15.1	20.4
Average production mean sd (m^3/mach/day)[2]	116.6 53.4	92 48.1
Average volume of the logs	9.5	8.5

[1]Based on average skidding distance of 285 m and average volume of 9.5 m^3. Average production in RIL for average distance of 525 m and average log volume of 8.5 m^3 is 14.6 m^3/h.
[2]Based on actual daily production, numbers of observed days in RIL and CNV were 31 and 13, respectively.

Table 4.10 Time and work elements of skidding in CNV and RIL

Logging No.	Work element	CNV Average time/trip[1] (minutes:seconds)	RIL Average time/trip (minutes:seconds)
1	Travel empty	13:01	07:10[2]
2	Positioning	01:29	01:30
3	Hooking up	02:06	02:16
4	Winch	01:44	01:14
5	Travel loaded	07:54	07:36[3]
6	Unhooking	00:40	00:26
7	Decking	01:19	01:25
8	Other activities	02:40	02:58
9	Delays	06:57	03:23
	Average time/trip	37:50	27:58

[1] Number of observed trips (n) in CNV and RIL was 133 and 333, respectively.
[2] Duration for travel-empty was assessed using regression y = 0.0115x + 0.6934, R^2=0.72, x=distance from TPN (m).
[3] Duration for travel-loaded was assessed using regression y = 0.0171x + 2.7326, R^2=0.45.

Table 4.11 Cost of CNV and RIL skidding operations and opening of log landings

	CNV	RIL
Skidding		
Cost (Rp/ hour)	300 175	293 590
Cost (Rp/m^3)[1]	21 910	15 870
Log landings opening		
Cost (Rp/m^3)	400	295

[1] Costs were obtained by dividing Rp/hr by m^3/h commercial volume

(RIL) were Rp 21 910, Rp 27 260, and Rp 5870, respectively, assuming that the hourly productivity of a new D7G for CNV was the same as that of INHUTANI II's D7G. The unit cost of log skidding in RIL using the CAT 527 was lower than that in CNV irrespective of whether the CAT 527 or INHUTANI II's D7G was used.

Log transport

(1) Transport cost

In the present study, road design and planning were not part of the experiment. The transport costs were, therefore, equal in both CNV and RIL. Long distance transport was divided into two sections**:** (1) from log landings (TPn) to log yard where logs were unloaded temporarily, with a distance of 20 km, and (2) from log yard to log pond (shipping/rafting point), with a distance of 72 km. In total, the present long distance transport of logs was about 90 km (Table 4.12). The mean distance between log landings and the log yard was 20 km, and between the log yard and the log pond (shipping/rafting point) was 72 km (Table 4.13). The cost of log transport was Rp 92 260/m^3, a substantial contribution to the overall cost of harvesting operations.

(2) Road opening and maintenance cost

INHUTANI II recorded that the road construction costs were estimated at Rp 55 430 million/km, the depreciation cost of the main roads at Rp 332 165 million/year, and the maintenance cost at Rp 52 million/year. INHUTANI II has been sharing the use of about 55 km of the main road with a coal mining company. In proportion to the length of the main road, the logging cost portion amounted to 70% of the depreciation and maintenance costs, giving a total of Rp 269 million/year. The total road costs in CNV were estimated to be Rp 514 million per year or Rp 568 490/ha/year. Assuming that production per ha is 20 m^3, the road for long distance transport cost the company Rp 28 425/m^3.

Supervision

Although supervision was not part of the RIL trial study, we made an observation of this in the CNV operation, as it is an important activity. Proper

Table 4.12 Productivity of log transport, loading and unloading in CNV

Distance	Production, Load
From log landings to log yard (20 km):	
Average production/trailer/day (m^3)	90.5
1. Average load/trip (m^3)	32.8
2. Average time/trip (h)	2:09:00
From log yard to log pond (72 km):	
1. Average production/trailer/day (m^3)	37.5
2. Average load/trip (m^3)	36.4
3. Average time/trip (h)	5:21:00
Average loading rate (m^3/h)[1]	54.3
Average unloading rate (m^3/h)	60.5

[1]A CAT C980 was used for loading logs on landings, one WA 420 for unloading and loading in the log yard, and one C 980 for unloading at the log pond. We assumed equal loading and unloading rates at all loading points.

Table 4.13 Costs of log transport and loading/unloading in conventional logging

Transport and loading/unloading	Cost (Rp/m^3)
Truck costs	
From log landings to log yard:	27 368
From log yard to log pond:	64 894
Subtotal Truck Transport	92 262
Loading at log landings	2548
Unloading and loading at log yard	18 459
Unloading at log pond	1190
Subtotal	22 197
Total cost (Rp/m^3)	114 459

implementation of RIL requires appropriate logging supervision. Lack of field supervision in logging practices was a common phenomenon in CNV. Supervision in CNV was more concerned with matters related to production, such as block allocation to fellers and operators and meeting the production target. Furthermore, the existing foreman's salary scheme provides little incentive to exercise proper supervision. A foreman supervised conventional felling and skidding and received a monthly salary of Rp 576 000. An assistant to the camp manager also allocated one third of his time to supervise these operations, which in terms of cost equalled about Rp 230 000 per month. Thus the total cost of field supervision in CNV was about Rp 806 000 per month. In RIL, the assistant to the camp manager should be responsible only for production and block allocation and the foreman should fully supervise logging operations. The duty of the foreman should be to ensure that the felling and skidding operations are in compliance with RIL guidelines. In order to achieve RIL objectives it is suggested that an additional foreman should be employed and an incentive should be provided by increasing the present salary scale by 50%, giving a total of Rp 862 500. This implies that the total cost of supervision would be Rp 1 725 000 per month. Given that the estimated monthly production of conventional logging is about 1840 m^3 and the recovery in RIL is about 11% higher than in CNV, monthly production in RIL would be about 2040 m^3, meaning that the cost of field supervision would be Rp 440/m^3 in CNV and Rp 850/m^3 in RIL. This is a very important issue as it relates to higher levels of supervision as well and does constitute a significant added cost.

Table 4.14 Damage associated with CNV and RIL

Damage Parameter	CNV	RIL
Average skidtrail width (m)	5.51	3.24
Total length of skidtrails (m)	17 301	9090
Proportion of skidtrail opening to extracted volume (m^2/m^3)	18.6	8.6
Log landings in proportion to extracted volume (m^2/m^3)	1.34	1.10

Impact of logging damage on forest stand

Reduction of logging damage to the residual stand is one of the main objectives of RIL. Sist *et al.* (in press) reported the overall damage resulting from RIL operations. In terms of land opening, our RIL experiment managed to reduce damage significantly in comparison with conventional techniques on the basis of land opening. On the basis of the area per m^3 of extracted logs, open areas caused by skidtrail opening in RIL decreased by 54% and log landings by about 18% (Table 4.14). The reduction in skidding area was attributed to the planned layout of skidtrails, limiting the movement of skidders outside the skidtrails and the avoidance of the use of the blade during skidding operations. It was also credited to the use of the CAT 527 skidder, which has greater manoeuvrability and is relatively smaller than a bulldozer.

Discussion and conclusion

The overall financial benefit of applying RIL was Rp 3160/m^3 (Table 4.15). RIL reduced skidding costs by a significant 27% compared to CNV. Because the feller wage system is based on a fixed piece rate, the felling cost was the same. The pre-harvesting operations in RIL were 50% more expensive than in CNV. Training in RIL also added to the overall cost. However, the cost saving in skidding in RIL outweighed the additional costs of training and supervision. This margin will be bigger if the value from waste reduction is added. Armstrong and Inglis (2000) showed similar results. Van der Hout (2000), however, demonstrated that in RIL the cost of pre-harvest planning and preparation increased three times and that of felling two times, and these were only partly recovered by lower skidding cost.

Wood waste reduction

One of the most important benefits of the RIL experiment in Malinau was undoubtedly the significant reduction of wood waste left in the forest. In RIL, an average of 2.5 m^3 of commercial volume/ha was saved in comparison with CNV. This represents a saving of about 11% for each cubic metre of commercial volume produced. This is equivalent to 0.11 x 0.9 = 0.1 m^3/m^3 of commercial volume produced. The estimated concession production cost in 1998 was Rp 350 000/m^3 and the average sale price Rp 550 000/m^3. The additional revenue for the company was, therefore, Rp 20 000/m^3 of commercial volume extracted.

Logging waste in Indonesia has been a persistent problem. Compared with other countries

Table 4.15 Logging cost comparison between CNV and RIL (Rp/m^3)

Activity	CNV	RIL
Pre-harvesting	2225	530
Training	-	1678
Felling	1500	1500
Skidding	22 310	16 165
Log transport	114 460	na
Road construction and maintenance costs	28 425	na
TOTAL*	26 035	22 875

*Exclusive of log transport and road costs

such as Brazil, which charge a relatively high fee for logging rights (US$196/ha —Baretto *et al.* 1998), the stumpage value induced by logging rights costs in Indonesia is small. The forest concession license fee (*Iuran Hak Pengusahaan Hutan, IHPH*) subtracted only a small amount of money. Hence, concessionaires incurred almost no cost on the logging waste. Fellers and bulldozer operators are certainly the parties affected by the wood waste as the wages they received were determined by the commercial volume reaching the log landing. Wood waste left in the forest caused lost revenue to the government in the form of log royalties (*Iuran Hasil Hutan*, *IHH*) and rehabilitation funds (*Dana Reboisasi, DR*). In addition to the RIL technique, an incentive or disincentive mechanism that leads to waste reduction and utilization needs to be sought. A regulation (Presidential Decree No. 32/1998) regarding the levies (DR) on different classes of logs imposes the highest rate (US$16/$m^3$) for logs with a diameter of ≥ 50 cm and the lowest (US$2/tonne) for logs with diameter of ≥ 29 cm. Logs with a diameter = 50 cm as the main product are generally graded for veneer and those of ≥ 29 cm for chip wood. Between these two extremes, there are two rates for the diameter classes of 30–40 cm and 40–50 cm. Wood waste assessed in the study was part of a bole with a diameter as big as that of the extracted log. It may not be suitable for veneer but usable for sawn timber. According to the above-mentioned regulation, it is charged at the same rate as the main product. This waste category should get a lower rate as an incentive to reduce waste. One of the weaknesses of the present system is that it does not impose disincentives to wood waste left in the forest. Considering the complexity of the present system, one way to avoid government revenue loss attributed to wood waste is to charge a royalty (or levy) based on the volume of standing trees, in place of the levy mechanism currently being applied. This would also provide a disincentive (cost) to concessionaires to leave logs or other wood waste in the forest. Although the main objective of RIL is to reduce damage, the technique can also be considered as a vehicle for an improved way of reducing waste than the conventional technique.

Felling and skidding

In the Malinau concession, RIL increased felling and skidding productivity by 28% and 25%, respectively, in comparison to CNV. The cost of skidding was also reduced by 27% in RIL. In the Brazilian Amazonia, Holmes *et al.* (1999) reported that RIL increased skidding productivity by 41% in comparison to CNV, while felling and bucking decreased by 20% (Table 4.16). Van der Hout (2000) also reported felling performance reduced by 37% in RIL, while skidding output increased from 14.4 m^3/h to 15.9 m^3/h. The RIL study by the NRM Project in 1994 in West Kalimantan reported an increase in fellers' daily productivity of 24% and skidding productivity of 14% in terms of the number of felled trees and extracted logs. In another RIL study in INHUTANI I's concession in Berau, East Kalimantan, RIL increased hourly skidding productivity from 7.8 m^3 to 11.7 m^3, or 50% in comparison to CNV (Natadiwirya, personal communication). Compared to CNV, RIL in the Berau study showed a decrease in skidding costs of 50%. Due to higher productivity, the unit cost of skidding in both CNV and RIL in Malinau was lower than that in Berau.

Felling and skidding are two very dependent activities. Directional felling in RIL was primarily intended to facilitate skidding in order to avoid damage. Further improved practices in felling might lead to improved skidding productivity, although it might reduce fellers' productivity. Therefore, in order to maintain the quality of work in the RIL, an

Table 4.16 Productivity of felling and skidding in CNV and RIL in different places. Both CNV and RIL production figures were based on regular daily working hours.

Location	Felling		Skidding	
	CNV	RIL	CNV	RIL
Cauaxi, Brazil (m^3/h)	20.46	18.65	22.39	31.66
West Kalimantan:				
- (trees/d)	14.0	17.4		
- (logs/day)			14	16
Berau, East Kalimantan (m^3/h)	n.a.	n.a.	7.8	11.7
Bulungan, East Kalimantan (m^3/h)	17.8	22.8	15.1	20.4

incentive should be given to the feller even if a productivity increase is not achieved. In the interests of cost reduction, a productivity increase in skidding is preferable to such an increase in felling, as it would result in a higher reduction of the unit cost.

In terms of waste reduction, the volume of logs falling into ravines in RIL was lower than in CNV, i.e., 4.20 m^3 (1 log) vs. 49.4 m^3 (5 logs). These accounted for 6.4% of the total logs left in RIL and 8.5% in CNV (0.12% of the total extracted volume in RIL and 0.9% in CNV). The reduction could be attributed to the application of directional felling in RIL. The benefits of this technique were demonstrated particularly in moderate to heavy terrain such as in Malinau.

Log transport

Our study only concerned the RIL experiment and did not include road planning and construction. Accordingly, it covered only the total cost of pre-harvesting operations, felling and skidding, which represented just 15% of the total logging cost [(2225+1500+22 310) x 100%/168 920] in the case of CNV. Future experiments should, therefore, cover road planning, road construction and maintenance. It is expected that within the RIL system, the road planning and construction component will be more expensive than in CNV. However, proper planning and construction are likely to decrease significantly the road maintenance costs and improve the productivity of log transport. At present it is not clear what RIL technique would affect the unit cost of long distance transport and roads. However, the higher recovery per ha in RIL would lower the unit cost. On the other hand, road design requirements in RIL might increase road costs, although this might reduce the maintenance cost. Improper road engineering will induce improper transport operations; the potential consequences of improper transport operations are high transport costs and excessive costs for repair or reconstruction (Dykstra and Heinrich 1996). Therefore, proper road planning in RIL is likely to increase transport efficiency, leading to a lower unit cost.

Damage reduction

RIL reduced the damage to the residual stand resulting from skidtrail opening and log landings. The reduction of open area caused by skidtrails and log landings (m^2 per m^3 extracted volume) in RIL was 54% and 19%, respectively. The implementation of RIL with ground skidding using a bulldozer in Sabah (Pinard *et al.* 2000) reduced soil damage from 13% to 9% in total area. INHUTANI II can expect a potential cost saving from post-logging activities, in which TPTI requires concessionaires to enrich or replant the open area caused by logging. Hence, a reduction in the open area would reduce replanting and enrichment costs. Although the increased value of the residual stand is one of the main benefits, the present study did not cover such assessments.

Loggers' perception of RIL as an obstacle to adopting RIL techniques

Lack of skilled manpower to do the appropriate planning for RIL implementation would hamper adoption by other concessionaires. Therefore, RIL training will be necessary for interested concessionaires. This constraint was also observed elsewhere (Hammond *et al.* 2000). In our RIL experiment the estimated cost of training was Rp 1678 Rp/m^3 (US$0.22/$m^3$, at an exchange rate of US$1 = Rp 7500). The cost of training in Brazil was US$0.21/$m^3$ (Holmes *et al.* 1999, cited in Hammond *et al.* 2000) and US$0.59/$m^3$ in Ecuador (Montenegro 1997, cited in Hammond *et al*. 2000). In the RIL experiment, no difficulties were encountered during the training of fellers and operators due to the years of experience they had acquired in CNV. The training cost would be much reduced if the Indonesian Forest Concessionaires Association (*Asosiasi Pengusaha Hutan Indonesia, APHI*) and the government support the training of trainers.

It is widely perceived by concession holders that good planning will cost more. Part of this problem lies in the lack of knowledge of the costs and benefits of RIL in comparison with CNV. Another impediment stemmed from the fact that the present profit margin earned by concessionaires in conventional logging is very high, i.e., 25–35%. The introduction of a new method such as the RIL technique will reduce this profit margin, hence providing little financial incentive. However, the fellers and skidder operators involved in the RIL experiment expressed their satisfaction, as they were able to meet the same daily volume in a shorter time than in CNV. Overall, RIL has brought up new perceptions of the benefits of good pre-planning and the opening of skidtrails before felling as it made

their job much easier than in CNV. For skidder operators, skidtrail opening in the initial days was non-productive in terms of log gathering, but they found skidding more productive when skidtrails were already opened.

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Annex 1. Comparison of the main activities in RIL and CNV operations

Activities	Reduced-impact logging	Conventional logging
1. Forest Survey	Pre-harvesting survey includes topography assessment and mapping of harvestable trees.	Commercial trees with DBH ≥ 20 cm are mapped and dbh estimated. No topography assessment.
2. Mapping	Topographic and tree location maps, 5 m contour lines, 1:2000 scale produced with ROADENG software.	Tree location maps only produced manually. No topographic contour lines.
3. Vine cutting	All vines of at least 2 cm in diameter growing on each harvestable tree are removed during forest inventory one year prior to felling.	No vine cutting.
4.Skidtrail planning	Skidtrails are planned according to the topography and position of harvestable trees shown in the operational map. Skidtrails are then marked on the field with coloured ribbon flags.	No skidtrail planning.
5. Skidtrail opening	Skidtrails are opened before felling to help fellers with directional felling decisions.	Skidtrails are opened during extraction.
6. Training	Training on topography assessment, use of Roadeng software, directional felling and skidding operations were provided prior to logging.	None.
8. Road construction	Because of the small scale of the experiment, road planning and construction were not included in this study. The road already existed before logging.	Road planning is done two years before harvesting and the construction one year before. Road planning and location are based on rapid field survey and checking but not on a systematic topographic assessment. No topographic maps are produced.

5. Biodiversity Research in Malinau

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Aims

A biodiversity baseline

Effective biodiversity conservation requires not only ability to monitor biodiversity and to predict the impacts of human activities, but also an ability to influence those activities in instances where there is an adverse impact on biodiversity. Human activities are influenced by many factors, including government and international policies, and non-policy factors such as belief systems, or availability of technology. CIFOR is in a strong position to influence forest policies through channels including the Convention on Biological Diversity, the United Nation Forum on Forests, national governments, NARS and NGOs. It is also important to distinguish between the underlying causes of certain activities and the more immediate driving forces. The studies we have undertaken in Malinau provide a detailed case study that contributes to these larger global goals, as well as providing a highly relevant baseline of information for local use.

The Malinau area of East Kalimantan was, until recently, little known biologically. It was suspected that the rugged forested landscape, next to the Kayan Mentarang National Park, would have a high biological conservation value. A major emphasis of our work has been to begin to document this biological wealth. This research has had three major components: 1) finding out what occurs where, 2) assessing to whom it matters and in what way, and 3) identifying how to maintain this biota in the future. The first two elements have required extensive fieldwork in both the wider landscape and in the experimental RIL harvesting site, while the last has required an extensive review of current scientific knowledge. Together these three strands of information help define priorities that reflect local considerations and can inform a wide range of processes, from the development of reduced-impact logging guidelines to international forestry and conservation policy.

The earliest studies involved a wildlife and tree survey in the PT Inhutani II-CIFOR experimental site prior to harvesting. Ultimately this baseline allows the assessment of impacts of local interventions, such as reduced-impact techniques. The tree data are reported in Chapter 4.

Later surveys examined the wider landscape and determined local priorities. More specifically, we developed methods to identify and comprehend those aspects of the landscape that are most significant in determining its importance to local communities. Though the principal activities can still be viewed as biodiversity surveys, we did not seek species records alone. We sought means to indicate the relevance of this information and how it weighs against other considerations. Systematic queries of local attitudes to landscape and biota by a range of techniques assessed what was important and why. The wider studies have involved extensive field surveys emphasizing vegetation and site characteristics, while additional studies have investigated fish, amphibians and reptiles.

To develop a better baseline of what we already know about the animal species in Malinau and what it implies for management outcomes, CIFOR initiated a review of relevant wildlife literature (to be extended to include flora in the

future). The review covered both published and unpublished sources and involved broad consultations with national and international experts and institutions. It helped us to clarify local needs and principles in defining 'wildlife friendly' forest management, and uncovered the main knowledge gaps where further research is likely to prove valuable.

Achievements and outputs

The studies have provided baseline data on several major taxonomic groups. Lists include birds, mammals, reptiles, amphibians, fish, various invertebrates, trees, herbs, climbers, and various other plant groups. These lists are based on extensive observations and collections, as well as information from local communities. Amongst the collected taxa are a number of new species. In most cases, the species records are a part of a wider collection of information that includes geographical locations, ecological parameters, and the needs and preferences of local communities.

We have developed a suite of methods to assess biodiversity, landscape information and what matters to local communities. Our methods emphasise the importance of deciphering the sometimes-complex relations and interdependencies that can exist between local people and their environment. They are a step towards clarifying local needs and concerns, in indicating key areas for further evaluation, and in developing a mutually comprehensible dialogue amongst stakeholders.

Our approach to surveying biodiversity in the context of local people's preferences and needs has inspired similar work elsewhere. Already activities have been initiated by CIFOR in southern Africa (Mozambique), and there are plans to develop comparable studies in Bolivia and central Africa. In addition, NGOs and commercial companies have expressed interest in our methods. Our tree recording method has already been adapted by ICRAF for work in Sumatra.

Ultimately we have five classes of results:

- An account of the biophysical context in Malinau (particularly site and vegetation, but also fish and other fauna).
- How local preferences relate to the landscape in Malinau (with an emphasis on vegetation resources, but with some information on animals). This includes a baseline summary of human-cultural, demographic, and socio-economic context in seven communities.
- Emerging suggestions of how these views may be incorporated into various ongoing activities such as RIL.
- Methods demonstrating how to assess local preferences as a basis for better land use decisions.
- Identification of topics requiring further development and research.

Here we shall focus on the first two. But the third is in draft form, and the fourth, the methods, is the subject of a report to be published separately (Sheil *et al.* 2002). The fifth is a fluid backdrop to ongoing developments, and some examples are provided, especially in the review of wildlife sensitivities.

Reports and publications

See Annex in CD-ROM

Selected research summaries

Exploring biological diversity and local people's perspectives in forest landscapes—the 'MLA survey'

Overview

General

This study combined both biological and social aspects, in order to determine not only what species and habitats were present but also how local communities used and viewed them. Such knowledge helps identify the priorities and needs of local stakeholders. Surveys were undertaken in seven communities, established 200 survey plots, and collected a wide range of specimens and related information.

Our methods addressed the complex relations that can exist between local people and their environment. The survey was not intended as a fully participatory approach to doing biodiversity studies. This is, rather, a first step in increasing our

Punan women (Long Jalan) expressing the relative importance of different types of land and location in their landscape. Logged over forest is generally seen as very undesirable for these forest dependent people. Our evaluations allow steps to be taken to address this.

understanding of local priorities. As we conceived this as an explicitly multidisciplinary approach, and emphasized entire landscapes, the working name for our survey was the 'Multidisciplinary Landscape Assessment' or MLA. The methods were developed and used during surveys in Malinau, East Kalimantan between 1999 and 2000. They were developed through workshops, a series of pretrials, and a full-scale pilot study in two communities, with subsequent application in five additional communities.

We chose to work with Merap and Punan communities who represent two distinct cultures in the Malinau watershed. The Merap are a politically influential group in the local context, with strong affinities to the regionally powerful Kenyah (though the language is distinct). The Punan have been much less politically visible. The main difference between the two groups, at least until very recently, is the emphasis that the Merap place on rice farming, while the Punan have specialized in non-agricultural extractive forest-based activities. Efforts by the government have sought to settle the Punan and encourage their agricultural development.

We examine biodiversity information within a broad context where its relevance to real decisions and choices may become apparent. The work has faced obstacles: transport was difficult due to the extreme ruggedness of the area; background materials, such as maps, were limited; and many collected taxa could not be identified using available references. Our principal delay in processing and finalizing the survey data has been the effort required to determine all the plant records. Many of the results we present *should be seen as provisional* accounts of work in progress. This is especially true with the botanical data, where ongoing taxonomic review must continue to review the less-known taxa.

Overview of Methods

We devised field methods that emphasize landscape-scale characterization through high replication of small data-rich samples, and assessments of communities based on these samples. In addition, there were a series of village-based exercises. Initial meetings with a village community were undertaken jointly but for most purposes, the survey team was divided into two. The *village team* collected a wide range of qualitative and quantitative information about the judgments, needs, culture, institutions and aspirations of the local communities, and examined their perceptions of and relationship with the local landscape. The *field team* assessed site properties, including plant and soil resources, through both 'scientific' and indigenous approaches, at specific georeferenced sample points.

Each community was studied for three to four weeks, though follow-up visits occurred beyond this period (see Table 5.1). Paya Seturan had Kenyah and Merap members, and Laban Nyarit had both Punan and Merap members. In general, efforts were made to keep these separate in the data recording though this was not always practical in general activities such as community meetings.

Though we had originally proposed to develop methods that could yield valuable information in a couple of weeks we later realised the benefits of working a bit longer in each community in order to secure the necessary trust and involvement of the people. For this reason we have more in-depth data on a few communities rather than superficial data on many.

The village team, along with several local assistants, collected data through community meetings and focus group discussions, with household surveys and interviews. In addition, key informants were used to identify, locate and assess the local values of forest products and local landscape units. A series of scoring exercises, known as the Pebble Distribution Methods (PDMs), were used to quantify the importance of products and lands. These classes are also used in the plant use assessment and in scoring field sites. These classes are detailed in Table 5.2.

Two hundred research plots were established in the Malinau watershed in four separate data collection periods (between November 1999 and November 2000). Sample sites represent a wide range of local environments. While forest variation was an

emphasis, we also included a broad range of non-forest sites for comparison. We specifically sought out and included sites that may have restricted biota and are important to local people. To achieve this we developed maps together with the community, in conjunction with more conventional map materials. The distribution of the plots within each village area is shown in Figure 5.1.

Factors used in site selection included land cover, use, local topography, altitude, presence of specific soil features, and special sites (such as old villages and salt springs). The guiding principle was to cover the range of site variation in a reasonable geographical spread of points within logistical constraints. We were rarely able to sample at large distances away from the villages unless transportation allowed. For an overview, the 200 samples have been classified into eight broad categories (see Figure 5.2). These are distributed across all the village territories (Figure 5.3).

The sample plots were constructed around a 40 m long reference line marked with a strong tape. Local informants, generally one male and one female, were interviewed about the site. Then the herbs, climbers (and other non-tree non-shrub lifeforms), would be recorded, followed by the dominant seedlings, saplings, and shrubs and finally the trees. The interview team and local informants followed the botanists and cross-referenced plant-specific data by shared referencing. The soil scientist assessed and collected soil at the same locations during the same period and also linked biophysical and local informant approaches.

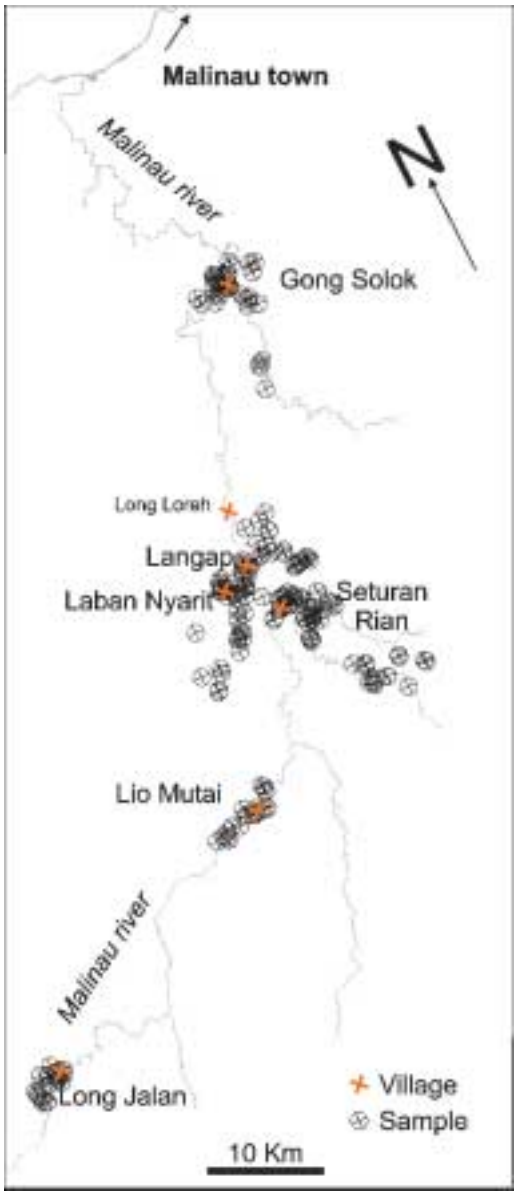
Table 5.1 Survey phases, locations and dates

Phase	Village	Principal ethnicity	Period and notes
1 (Pilot)	Paya Seturan Rian at Kuala Seturan	Merap & Kenyah Punan	September 25 to November 23, 1999 (with Rian also) with follow up (revised methods) December 2000.
2	Langap	Merap	April 23 to May 21, 2000.
	Laban Nyarit	Punan & Merap	May 22 to June 16, 2000.
3	Long Jalan	Punan	July 23 to August 24, 2000.
	Lio Mutai	Punan	August 25 to September 14, 2000.
4	Gong Solok	Merap	November 7 to November 28, 2000.

Table 5.2 Classes for uses and measures of importance

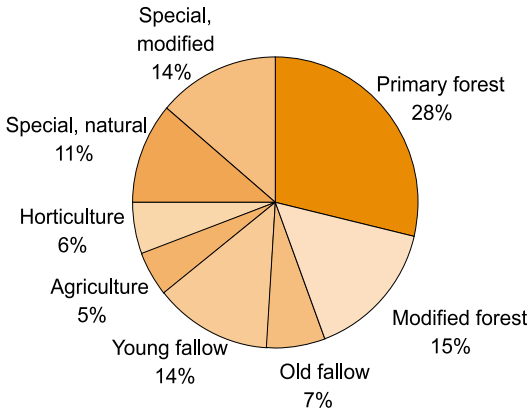
No.	Category	Explanation
1	Food	Primary and secondary foods; famine foods
2	Medicine	Medicinal and health-related
3	Light construction	Poles and cut timbers for huts, forest camp structures, fences
4	Heavy construction	Poles and cut timber for houses
5	Boat construction	Timber for boats (not including oars or punting poles)
6	Tools	Plant parts used for tools in agriculture, hunting, boating: blowpipes, spears, oars, punting poles, rice pounders, tool handles
7	Firewood	Fuel
8	Basketry/cordage	Cord made from vines, rattan canes and bark for weaving or tying
9	Ornamentation/ritual	Plant parts used in ceremony, dress, jewellery
10	Marketable items	Plant parts and processed products that are sold for cash
11	Hunting function	Poisons, bait, gums used to catch animal prey
12	Hunting place	Indirect use of plant as hunting location, usually when fruiting
13	Recreation, toys, fun	Area or forest products used for entertainment needs
14	The future	General (not explained in detail)
	Other	*What we have missed*

Figure 5.1 Distribution of survey villages and plots



Map of the Malinau river basin showing the location of the surveyed villages and field sample points. While distances look slight, this map does not portray the great difficulties of local access and terrain. For example, the survey team took three full days to reach Long Jalan by boat from Long Loreh—an apparent direct distance of 50 km, or around 100 km by river. In reality, the GPS track showed it as 135 km, the difference due to the rugged river course with rapids and numerous hazards.

Figure 5.2 Distribution of plots by eight summary site type classes



The classes are defined as follows:

PF = Primary forest – Forest that has never been greatly modified. This includes all forest that has never been logged, cut, slashed or modified by fire, wind or flooding. If the primary forest is of 'special character' (on limestone, coal, shallow soil, swamp, at a salt spring or has sago) and is restricted in extent, it is labelled as 'Special-natural'.

MF = Modified forest – Forest modified by human (includes logging) or natural causes (wind blow, floods, landslide). If the forest has been logged, cut, slashed or modified by fire, wind or flooding, it is labelled 'Modified' and be given one of the following subtypes: logging (lo), pole cutting (p), wind (w), drought (d), fire (if), flood (fl), understorey slashing (u). See also SM.

OF = Old fallow – Previously cultivated area abandoned more than 10 years ago. Old fallow is generally dense woody regrowth.

YF = Young fallow – Previously cultivated area abandoned less than 10 years ago. A subcode indicates 'years since cultivation'.

H = Horticulture – Perennial crops (often cash crops). If a garden or plantation is not at the same time an old village site, the label 'Horticulture' is given. The following subcodes are used in addition: fruit garden (f), cocoa (cc), coffee (c), old village site (ov).

A = Agriculture – Cultivated in the year of survey. Generally used for plots that were cultivated or tended at the time of sampling, with additional sub code for the type of crop: rice (r), cassava (m), beans (k), sometimes an (s) for swampy location. Plots that were just burned (less than two months ago) were avoided.

SN = Special-natural – Vegetation at special site or with special character, usually very localised, and never modified by people. If primary forest is of 'special character' (e.g. on limestone, coal, rock, swamp, at a salt spring or has sago) and is restricted in extent, it is labelled as 'Special-natural' and will be given one of the following subtypes: swamp (s), salt spring (ss), coal (co), limestone (li), shallow soil (sh), sago (sa).

SM = Special-modified – Vegetation at special site or with special character but modified in some way. As SN, but with modified character as defined above for 'Modified forest'. Also other sites of restricted and/or special character like old village sites or grave yards and bamboo stands. Includes modified forms of sites otherwise potentially 'special natural' and also old village site (ov), graves (g), and bamboo (b).

Figure 5.3 Map of sample locations by type and village location. See Figure 5.2 legend for definition of these types

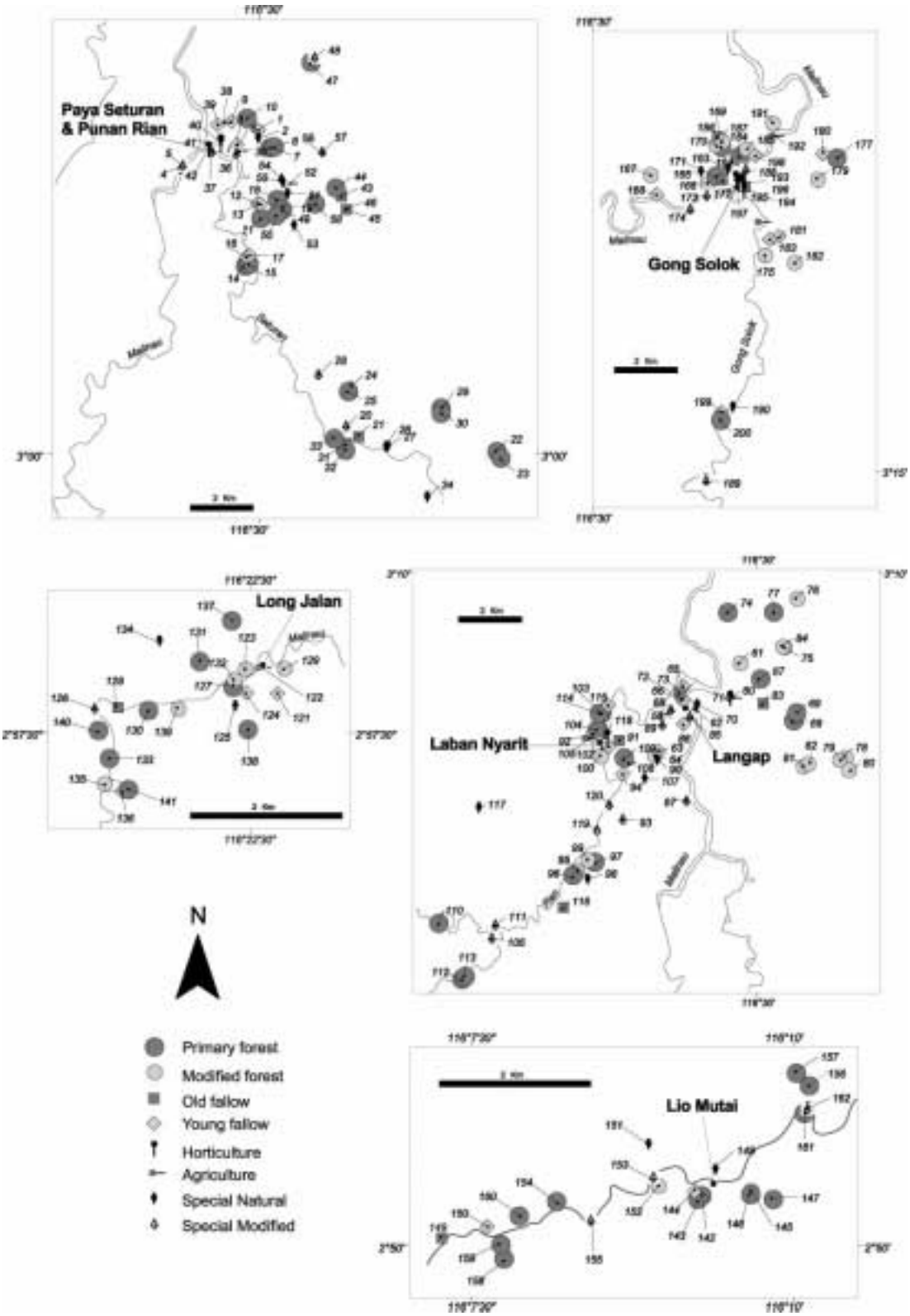
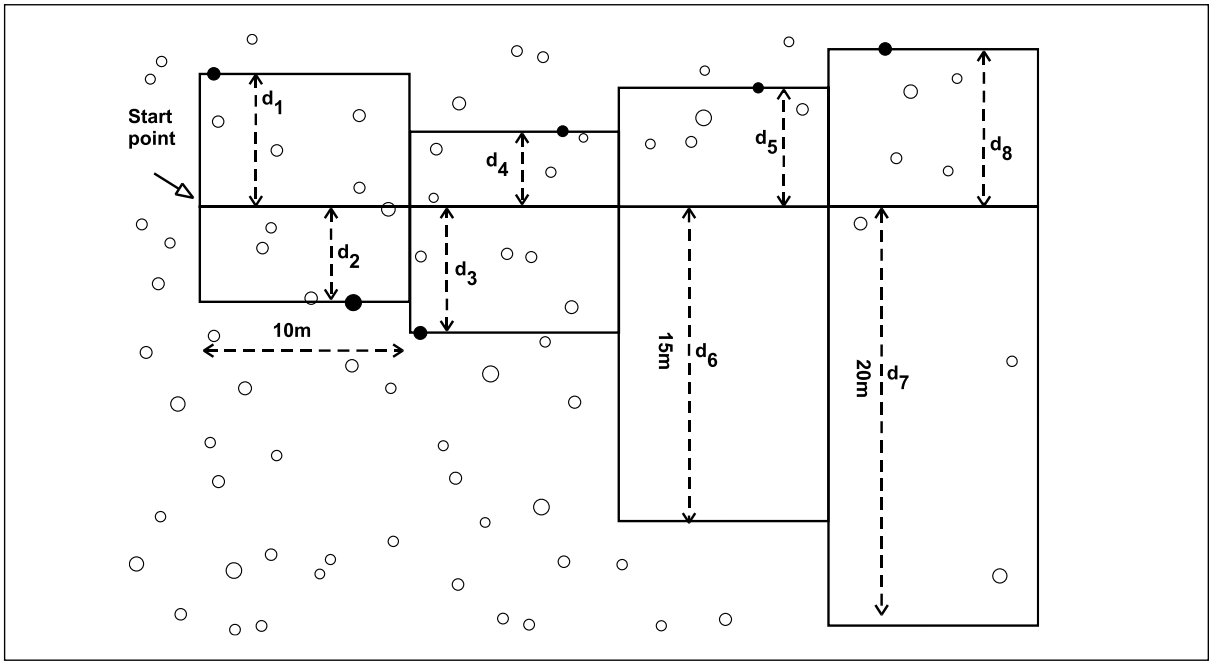


Figure 5.4 Our novel tree sample unit



This is composed of eight 'mini-transect' cells, each 10 m wide, that extend from each side of the 40 m transect line. All distances are defined horizontally. Each cell captures five trees, or fewer, and the distance to the most distant 5th tree is recorded (filled in the figure) (d_1,d_2,.. etc.). The maximum distance searched in each cell before deciding it is 'empty' is 15 m (see d_6). The maximum distance to search to collect up to five stems is 20 m (see d_7). Full details are provided in Sheil *et al.* (in press).

For trees we devised a new versatile sample unit suitable for rapid assessments of tropical forest in heterogeneous areas. The method uses multiple applications of variable area subunits, in which the area was defined by simple and objective rules (see Figure 5.4). Compared with fixed-area approaches the sample unit is quick and easy to apply even in difficult terrain, and the amount of information collected varies little with stem densities. Unlike most variable-area methods, difficult judgements are rare. Further, it cannot be extended to arbitrary size, but remains compact, allowing data to be analysed with respect to site-specific variables. We believe this efficient approach can be beneficially applied elsewhere, even in patchy and divided environments. We have published a more detailed account of this new method (Sheil *et al.* 2002).

Around 8000 voucher specimens were collected during the four survey periods. The preparation of an adequate reference list of vascular plant records of this survey took a long but necessary period of detailed herbarium work (at the *Herbarium Bogoriense*), and was only ready in draft form in July 2001.

A data coordinator ensured that all revisions led to a single best data version. We have three linked databases for plot data, village data and GIS. The plot database contains information on terrain, soil, plants, animals, site history, site importances and ethnobotany from the 200 field sites (Figure 5.5). The village database (see Table 5.3) contains diverse data on population, culture, traditional knowledge, and 'importance scores' from seven villages. Since each plot was taken in the territory of one of the seven villages and these villagers were our informants, the field data also relate to specific villages. All plot locations are geographically referenced and thus can be linked with the GIS that includes information on rivers, roads, villages and their preliminary territory boundaries, from a variety of sources including many of our GPS reference points.

Overview of Results

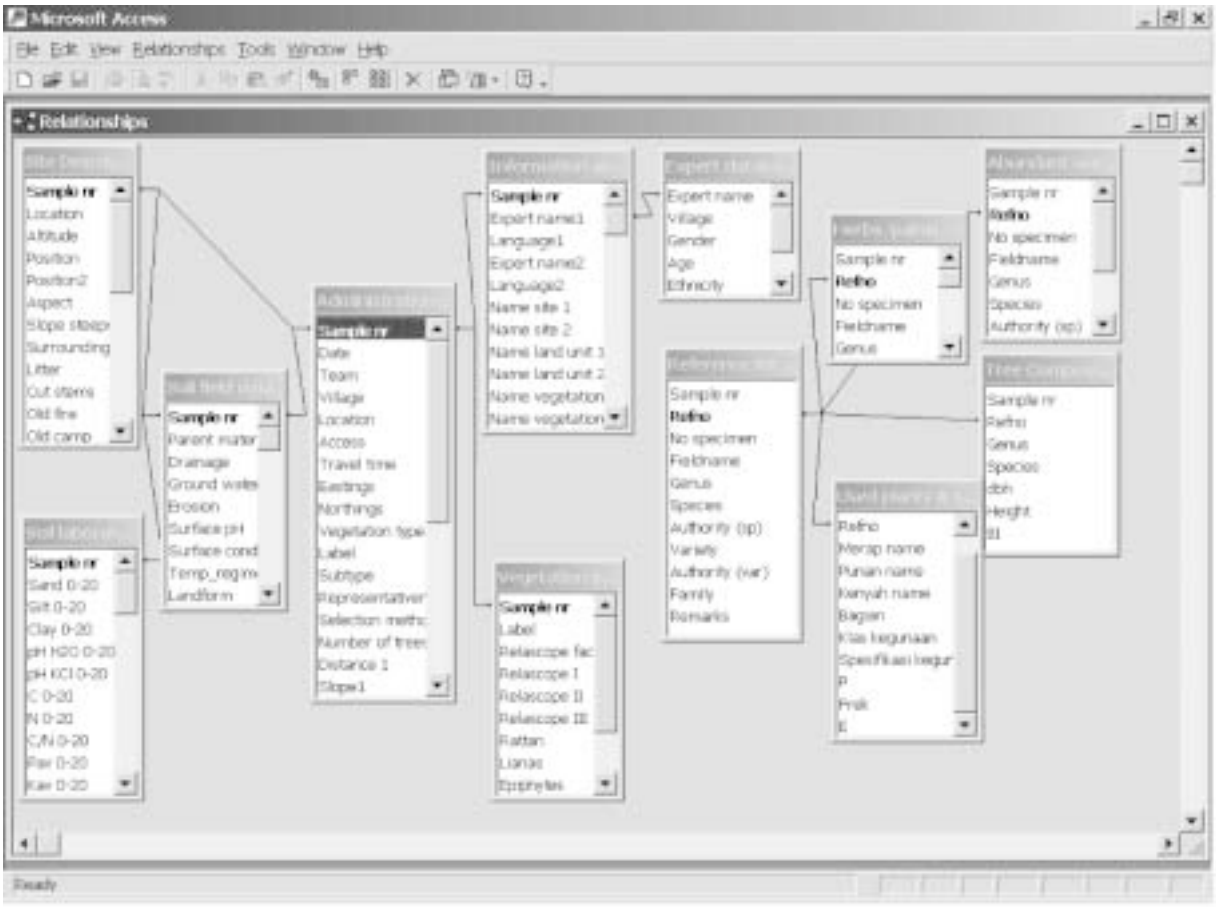
The following sections illustrate the breadth of the survey information, starting with the village data collections, followed by the field data, and some broader generalizations. For many results their significance lies in the specific details they provide. We have collected so much information that only a few illustrative examples can be presented here. Though the resulting account becomes a diverse

Table 5.3 Village Survey exercises

Title of exercise	Method
o Village description/perspective of land use	Interview with village head only
o Cultural background of land use	Interview with traditional leader only
o Settlement history and land use o Disasters and important events	Interview with village head and traditional leader
o Demography	Census and documentation from village head
o Household survey (inc. views and aspirations)	All (or at least 30 households)
o Traditional knowledge on land use o Forest product collection and sale	3–5 key informants
o Price of traded goods	3–5 shopkeepers
o Land and forest types o Forest products	Community meeting
o PDM* landscape units o PDM Past-Present-Future o PDM Distance of landscape units o PDM Sources of products o PDM Most important species per use category	Focus group discussion. Group by women/men, old/young & ethnic group

* PDM = Pebble Distribution Method

Figure 5.5 Links between the tables in the plot survey database



'scrapbook' of results, observations and comments, this should convey the multilayered and multifaceted approach of the survey. The insights and understandings that are gained simply by staying in the villages and undertaking the survey with the community are especially hard to capture in any brief summary. Many survey activities help to develop shared references between researchers and community members, and to stimulate a less formal but deeper dialogue. These may be some of the most precious results—potentially offering the explanation of various puzzles that appear during the survey. To illustrate this wealth of contextual information a few informal stories and illustrations are placed in boxes throughout the text.

Future work

All results presented here should be seen as preliminary. Future analyses will draw the various threads of the survey together to explore linkages and complementarity that can only be alluded to at present. It is also intended that many of our conclusions and the various interpretations or queries they provoke will be discussed further with the communities.

Many future activities will draw on the survey data. The scope of these goes beyond the results presented below. Species list verification is ongoing, and initial results from several aspects of the survey must be reviewed again in Malinau. Work intended includes extending the vegetation analysis to examine the links with other site characters (soils, location, history); relating the PDM patterns with biophysical determinants, and examining the extent to which the species-based PDMs can be used as a basis for assessing the importance of a plot's composition; and developing spatial analyses to identify the key spatial determinants of vegetation and local importance. Crucially we must ensure that the numerous implications of the main findings are fed into relevant processes, such as the revision of RIL guidelines and codes of practice—a vital aspect of the work that will be developed through the ITTO phase two project.

Local people and local views

Maps

The initial community meetings involved a series of mapping exercises, which developed a shared geographical frame of reference. These maps located key features, resources, and sites on a base map and provided a basis for the field sampling. Part of one such map from Laban Nyarit is shown in Figure 5.6. As an exploratory examination of this data we have developed a spatial approximation of the combined data on GIS, though the imprecision in specific resource locations must be recognised (see Figure 5.7). Combining the seven community maps fills out a much wider area than we managed to physically sample. What is striking in many of these maps is the detail presented in even distant and inaccessible areas. Ecologically these maps also highlight the highly localised nature of many resources and their association with specific types of locations, many of which we have validated with our field visits.

Settlement history and important events

Langap village claims the longest history in the area. According to documents, provided to us in Langap, they have a long history of local land use that includes the planting of rattan forest gardens around villages and caves that contain valuable (swiftlet) birds' nests. Ownership has apparently been validated by previous sultans of the Bulungan area, the Dutch colonial government, and recent district court decisions. Langap historically 'invited' various Punan groups to help protect the nest sites and offered them land to live on and cultivate in return. Some Punan communities, however (Long Jalan and Lio Mutai), seem keen to emphasise their independent historical heritage in the region.

While our general observations support the view that the Merap are principally rice farmers and the Punan forest product specialists, this glosses over the differences, both superficial and profound, observed between all communities investigated. For example in Lio Mutai, a remote Punan community, we found them keen to project an apparent lack of concern with the forest, and pride in their (few) fields of rice. Some community members wished to stress that they did not need to eat sago, or even *Parkia* seeds (it appears there is some stigma attached to being a 'forest-dependent' Punan). In Gong Solok, a Merap community only an hour by road from Malinau Town, we were also surprised. We had expected, after working with the Merap in Langap, that this community would be even more linked to farming and cash-based interests, and pay little attention to forest knowledge. In fact they showed a deep knowledge of many aspects of forest lore.

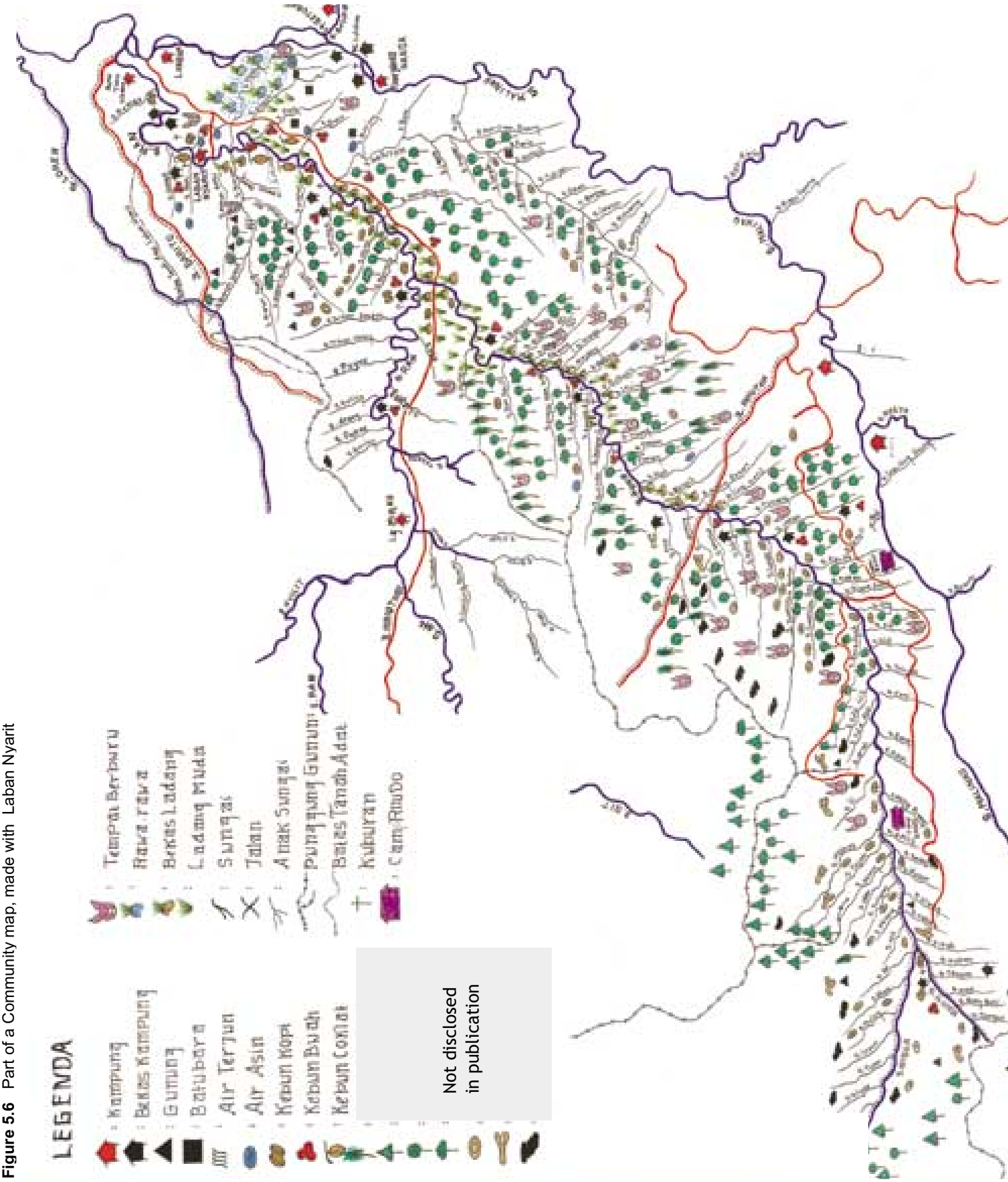
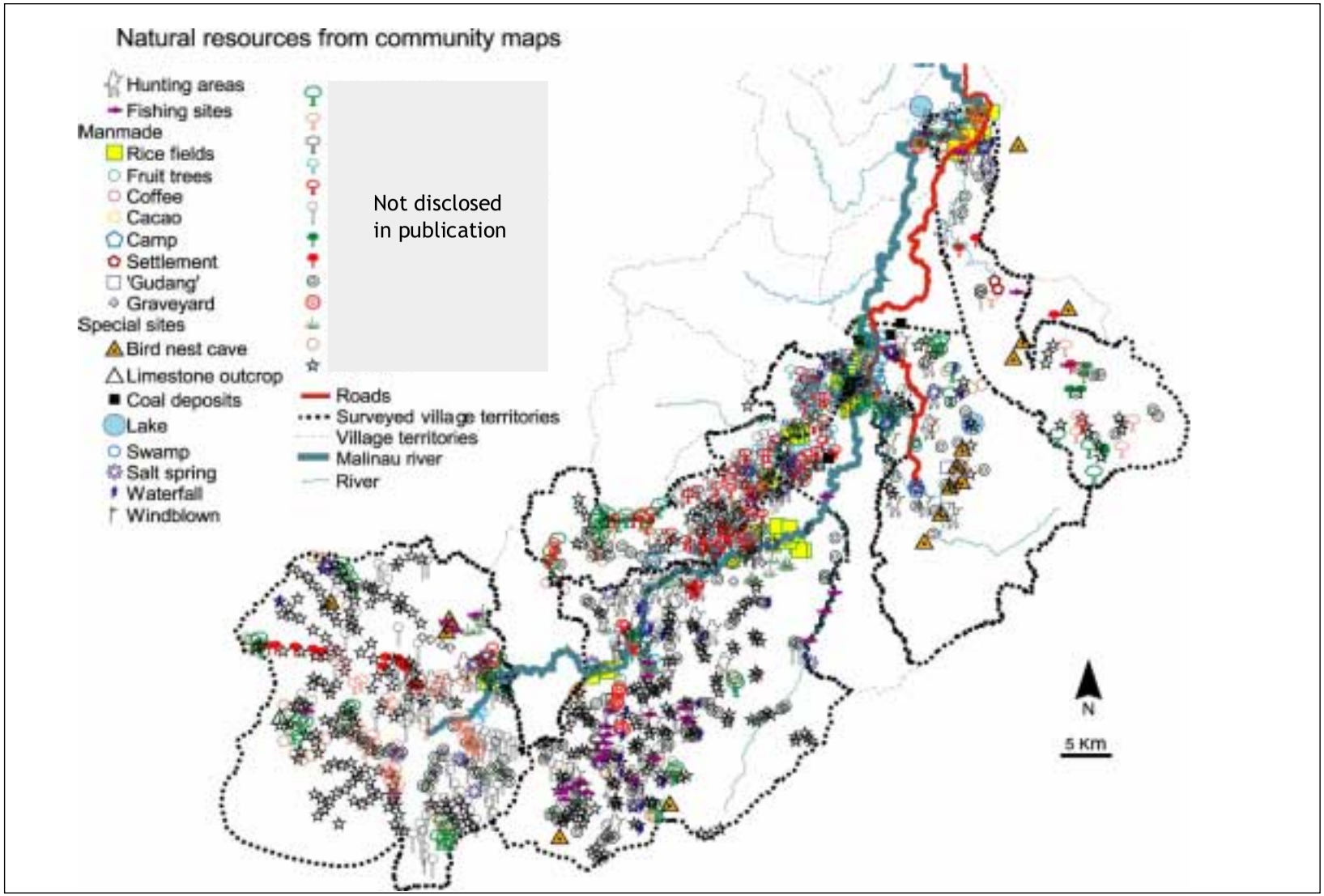


Figure 5.6 Part of a Community map, made with Laban Nyarit

Figure 5.7 A compilation of the principal data recorded in community mapping exercises with the seven communities



The map shows the territories of these villages and the specific sites and values/resources they chose to provide. This overview does not include their notes on soils, concessions, etc. The locations are approximate only.

All local communities have shifted locations several times over the past few decades. Tribal war, floods, disease, and crop failure are generally stated to have caused these movements (Table 5.4). Despite the problem of flooding, most villages are still placed on low riverside locations. More recently, the government has managed to persuade various communities to resettle from upstream locations to more downstream ones within territories of other communities. Modern-day settlements, therefore, are often far from the old village sites of communities that claim the associated territories.

Patterns of intercommunity rights are dynamic. Gong Solok village comprises two communities: a smaller Merap community and a newer larger Kenyah community that came to settle in this area, about 30 years ago. The newcomers somehow gained 'village status'. Land ownership is now in flux. There have been a various agreements, but in some areas rights are interwoven, so for example trees may belong to the Merap community, while the agriculture beneath belongs to the more recent Kenyah. This has caused us some confusion in selecting field sample sites and seeking 'values' that are restricted by such rights.

Interviews and discussions with village leaders yielded histories like those in Table 5.4.

Apart from underlining the type of threats and catastrophes that the communities have learnt to contend with, these disasters illustrate how community identity and territory is fluid. Lio Mutai is a good example. It is a small community that moved recently, having lost their previous settlement, Long Keramu, due to the flood of February 1999. They are a part of the former Long Pelancau community which has split several times. We identified at least four former village locations (Pelancau itself, Ngkah Limpah, Menoreh and Bengawat) which are now partly within the territories of other communities (Long Metut and Tanjung Nanga). Now that territories are claimed for possible compensation from timber and coal companies, these histories pose a complex and politicised basis for assessing rights. This issue has provoked conflict in some areas. For example, Langap Merap claim that according to *'adat'* they should be receiving the compensation that many 'newcomer tenant' communities are receiving in their place (see Chapter 7).

Table 5.4 Summary of village movement history, Langap Village

Name of settlement	Location	Year of leaving	Reason for leaving	Use now
Siram Nyam	*S*. Bahau, S. Kayan*	-	War with the 'Suku Kayan'	Forest (since long ago)
Batu Lalau	*Upstream Sungai Malinau*	-	War	Forest (since long ago)
Gn Nyurat	*S. Kelawit*	-	War	Forest (since long ago)
Long Pelancau	*S. Malinau*	-	War	Forest (since long ago)
Long Lemirang	*S. Malinau*	-	War	-
Long Kelawit	*S. Malinau*	-	War	-
Lio Laban	*S. Malinau*	-	The settlement burnt	Fruit
Lio Tanam	*S. Malinau*	-	War	Fruit
Lou Kenowa	*S. Malinau*	-	War	Fruit
Long Ran	*S. Ran*	Long time ago	War	Fruit
Lou Ngetow	*S. Betung*	Long time ago	War	Fruit
Kuala Kitan	*Kuala Kitan*	c. 1940	War	Fruit
Kuala Sidi	*S. Sidi*	c. 1950	War	Fruit
Langap-I	*S. Idatu*	1963	Floods	Fruit
Langap-II	*S. Idatu*	1993	Floods	Fruit
Langap-III	*S. Idatu*	Now (2000)		Village

*S = Sungai (River)

Table 5.5 Summary of village movement history, Long Jalan Village

Name of settlement	Location	Year of leaving	Reason for leaving	Use now
Long Lake	*Kuala Lake*	1940	Needed somewhere nearer the town	Fruit
Long Jalan	*Kuala Jalan*	1963	(unknown)	Fruit
Lerong Kirip	*Lembo Kirip*	1973	Many died from epidemic	Fruit
Sungai Arah	*Sungai Arah*	1980	The village head wished to move	Fruit
Engkah Bulu	*Sungai Malinau*	c. 1980	Seeking a more level place to stay	Fruit
Long Jalan	*Sungai Malinau*	Now (2000)	-	Village

Table 5.6 Disasters and important events, Langap Village

Year	Disasters and important events
1940	Cholera epidemic; many people died.
1963	Mr. Impang Alang brought cocoa seeds from Malaysia to be distributed and planted in Langap and Malinau.
1969/70	'Banjir kap' resulted in massive riverside timber cutting. (Original entry here 'overwhelmed by logs')
	1969/70 The Kenyah Pua asked for permission to live upstream of Langap, at current location of Tanjung Nanga Village.
1970/71	The Kenyah Lepo' Kuda asked for permission to live downstream of Langap, at the current location of Long Loreh Village.
1975	The customary heads of Malinau (Mr. Alang Impang and Mr. Impan Alang) received rice seeds from President of Indonesia, Soeharto.
1975	Ethnic Punan of Nunuk Tanah Kibang village moved from Tubu River to the Langap area.
1980	Boat engines and chainsaws procured by community members.
1982/83	Forest fire; agriculture fields started to move to the west side.
1986/87	The Punan inhabitants of Metut and Long Lake moved to Seturan Village. At the same time the INHUTANI II logging concession was being established in that area.
1993	The settlement moved to another place since the old village was flooded.
1998	Big flood.
1994	Malaria.
1999	Big flood at Keramu Village.

Table 5.7 Disasters and important events, Lio Mutai Village

Year	Disasters and important events
1945	Dangerous (unknown) disease
1969	Dangerous (unknown) disease
1982	Flood at Mengawat Village
1983	House fire at Mengawat Village after long dry season
1986	Big flood
1979	Tuberculosis spread at Mengawat Village

Land and forest types

Communities have a rich terminology to describe the landscape. Examples of this are illustrated in Table 5.8.

Forest products

People were asked to list the main products they use from the forest, examples of which are shown in Table 5.9.

PDM results

The Pebble Distribution Method exercises were used to score the perceived importance of various land and forest types. Here we present only a few examples.

Table 5.8 Punan names for land and forest types in Long Jalan and Lio Mutai*

Land and forest type *(Bahasa Indonesia)/Punan name*	Site example (Name of place and river)	
	Long Jalan	**Lio Mutai**
Village (Kampung)/ *Tukung*	S. Malinau	Lio Mutai, Long Metut
Old Village (Bekas kampung)/ *Lepuun*	S. Jalan	Keramu, Plancau, Long Menoreh, Engkah Limpak, S. Kurak, S. Cop S. Buka, Bengawat
Cemetery (Kuburan)/ *Tanam*	Lirung Kirip (S.Malinau)	S. Tengkawang, S. Legutung, S. Bekukuk, S. Tanung
Mountain (Gunung)/ *Bota'*	Engkah Bulu (S. Mabi), Bulu' Ran (S. Ketaman)	Tenayung, Abuh, Batu Aron, Loung, Anyen
Swamps (Rawa-rawa)/*Pangkah*	Puten (S. Puten)	Sungai Metut
Agricultural field (Ladang)/*Umoh*	S. Puten, S. Malinau, S. Mabi	S. Metut, S. Uli, S. Malinau
1 year fallow (Bekas ladang tahun lalu)/*Bai/Balah uyung*	Klikut (S. Malinau), Bota Nuying Bulu'	S. Metut, S. Keramu, S. Uli
<5 yrs fallow (Jekau < 5 Th)/ *Balah bai*	S. Bukaha, S. Cop.	S. Lemiling
5–10 yrs fallow (Jekau 5–10 Th)/ *Balah tokan*	S. Loopiyan	S. Lemiling
11–20 yrs fallow (Jekau 11–20 Th)/ *Balah tuan*	S. Ran	S. Mengawat, S. Plencau, Engkah Limpak, Mekayan, S. Buka
Hunting places (Tempat berburu)/ *Deh Mengan*	Available at almost all sites surrounding the village.	S. Metut, S. Keramu, S. Mekawat, S. Piyang, S. Buka
Fruit trees (Kebun buah)/ *Lida bua*	S. Lake, S. Arah, S. Jalan	Engkah Limpak, Loa' mati, Plencau, Kuala Mekayan, Kuala Menoreh
Banana plantation (Kebun pisang)/ *Lida puti'*	-	S. Pasang
Water fall (Air terjun)/ *Oung*	S. Engken, S. Batu	S. Cop, S. Bukaha
Customary forest (Hutan adat)/ *Tano' tuan*	S. Liu, S. Liu Ngalidan, S. Belung, S. Lelum, S. Liu Opu, S. Liu Nou, S. Batu Kuceh, S. Bengaeh, S. Kelayan, T. Nyurat, T. Penaluk Bela	Peta' Pui up to S. Lirip along S. Malinau
Sago forest (Hutan sagu)/ *Tuan vulung*	Bota' Cerebeh (S. Lemusan)	
Koompassia forest (Hutan benggris)/ *Tuan tanyit*	S. Malinau, S. Arah	
Agathis forest (Hutan Agathis)/ *Tuan tumuk*	S. Emgken	
Dipterocarp forest (Hutan tengkawang)/*Tuan avang*	S. Patok, S. Arah, S. Lalau, S. Aci	
Virgin forest (Hutan rimba)/ *Tuan tengen*	S. Bukaha, S. Selawak, S. Puten, S. Kipah, S. Kelapang, S. Pluye, S. Piyang, Tabau Ayo.	S. Cop, Peta' Pui, S. Lemiling, S. Pasang, S. Larip
Salt spring (Air asin)/*Pan*	S. Legun, S. Pebengan, S. Arah, S.Arah Ule, S. Man, S. Liu, S. Nyihung.	Lemiling Ayo', S. Buin, S. Nyom
Bird nest cave (Goa sarang burung)/ *Laa tepilih*	S. Piang, S. Mabat, Sm Kirab	
Hill (Bukit)/ *Tiang*	Hill area	Hill area

* During the field survey we used the local stratifications of the respective villages to plan where to sample.

Table 5.9 Some forest products reported by Long Jalan and Lio Mutai villages

Forest product (Bahasa *Indonesia)/Punan name**)	Product collection/harvesting sites	
	Long Jalan	**Lio Mutai**
Sago (Sagu)/*Vulung* (principally *Eugissonia*)	Sungai (S). Piang, S. Nou, S. Kuli, SPatok, S. Tuan, Tuku' Balau, Tuku' Kaleh.	S. Tengkawang ; S. Legutung; S. Lemiling; S. An
Aquilaria beccariana (Gaharu)/*Lelah*	S. Arah Ule, S. Batu, S. Lungi, S. Liu, S. Patok	S. Kelawit; S. Metut; S. Piang; S. Balau; S. Mekayan; S. Menoreh
Agathis borneensis (Damar)/*Tumuk*	S. Liu Nou, S. Liu Ngalidang, S. S.Liu Uvo, S. Lelung, S. Belung, Upstream S. Batu, mountain top Tuku' Tangeh	S. Kelawit; S. Metut; S. Mekayan; S. Menoreh; S. Piang
Rattan (Rotan)/*We' mla, We' sega, We' tima, We' mule, We' senule* (species to be clarified)	S. Patok, S. Peliran, S.Mekuhut, S. Jeluyang, S. Kao, S. Tekalit, S. Ule, S. Niat, S. Liu	S. Kelawit; S. Metut; S. Mekayan; S. Piang; S. Lemirang; S. Balau; S. Pan; S. Abang; A. Plancau
Koompassia excelsa (Benggris)/*Tanyut*	Mouth of S. Jemak	S. Cop; S.Mutai; S. Metut; S. Kuba S. Keramu; S. Lemiling; S. Bekulu; S. Lubung; S. Ngkah Limpak; S.Mati
Palaquium gutta (Ketipai)/*Ketipai*	S. Betuen, S. Batu	S. Cop; S. Mutai; S. Metut; S. Remit S.Keramu; S.Lemiling Cop; S.Bekulu; S. Tengkawang; S. Buin; S. Pacang
Shorea parvifolia (Meranti)/*Loop*	Upstream S. Inggin, S. Liu and tributaries, S. Jalan, S. Patok.	S. Kelawit; S. Besi; S. Pla; S. Betung; S. Molang; S. Pan; S. Leruk; S. Leruk Kayo
Eusideroxylon zwageri (Kayu ulin)/ *Kacik*	S. Piang	S. Lemiling Lirung; S. Cibun; S. Legutung; S. An; S. Ulen; S.Kejala
Dipterocarps (Tengkawang)/ *Avang*	S. Lalau, S. Bulu, S. Arah	
Bamboo (Bambu)/*Bulu'*	S. Jaa, S. Piang, S. Bulu	S. Cop; S. Mutai; S. Metut; S. Keramu; S. Lubung; S. Mekayan; S. Tengkawang; S. Plancau
Bird nests (Sarang burung)/*Lao Tepilih*	S. Kirap, S. Mabat, S. Lelien, S. Puong.	S. Bau Tele; S. Kerenga'

*Several of the local names still need to be matched with scientific names.

It must be emphasized, to avoid misunderstanding, that these scores are based on a conceptual rating of 'overall relative importance'. This is a person-centred statement of preference rather than a 'value' expressed in terms of any standard economic unit. For a full background, see the survey methods account (Sheil *et al.* 2002)

Land and forest types

How do people value the different land and forest types surrounding them? Forest (*hutan,* a broad term) was considered the most valuable land in six of the seven villages. More specifically, unlogged forest is the most important type, with mountain and swamp forest ranked next.

Table 5.11 summarises the importance score of land and forest types per importance category, as a mean of all groups in all villages. This presentation makes clear that for all categories, and especially for those requiring timber, people value the (unlogged) forest highest. Rivers are preferred for recreation and secondary forests for firewood, but the unlogged primary forest (*hutan rimba,* a term specifically referring to primary natural forest) is without question the most important overall.

Table 5.10 PDM exercise summary for 'all importances' by land types for all seven communities (each result is the mean of four groups, young and old, women and men)

Village*	PS	R	Lg	LN	LJ	LM	GS	Mean	Mean
Ethnicity**	m	p	m	p	p	p	m	p	m
Village	8.5	14	12.25	11.25	19	12	12	14.06	10.92
Old village site	3.75	7.5	5.75	5.75	7.25	5.75	5.25	6.56	4.92
Garden	12.75	10	9	9.75	8.5	15	15	10.81	12.25
River	16.5	**17**	9	12	14.75	12.5	12	14.06	12.50
Marsh/swamp	12.25	7	9.25	9	6.5	3	4.75	6.38	8.75
Cultivation	15.25	14	12.25	11.5	8.5	15.5	17.75	12.38	15.08
Young fallow	5	8.5	6.25	7.25	5.75	6.5	7	7.00	6.08
Old fallow	6.75	6	10.75	11.5	6.5	7.5	6.75	7.88	8.08
Forest	**19.25**	16	**25.5**	**22**	**23.25**	**22.25**	**19.5**	**20.88**	**21.42**
Total	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*
Unlogged forest	24.25	**34**	**34.75**	**24**	29.75	**43.25**	**30**	**32.75**	**29.67**
Logged forest	12.5	13.5	9.25	10.5	4	7.25	14	8.81	11.92
Secondary	22	15.5	14.75	20	16	9.25	13.25	15.19	16.67
Swamp forest	**30.5**	14.5	21.5	22.5	18.25	7	17.75	15.56	23.25
Mountain forest	10.75	22.5	19.75	23	**32**	33.25	25	27.69	18.50
Total	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*

* PS = Paya Seturan, R = Rian, Lg = Langap, LN = Laban Nyarit, LJ = Long Jalan, LM = Lio Mutai, GS = Gong Solok.
** *p*=Punan, *m*=Merap

Having observed that the food importance of forests ranks high, we examine this in further detail in Table 5.12a, per village as well as per ethnic group. Both Punan and Merap communities rank unlogged forest as the most important source of food. At the village level there is some differentiation, with Gong Solok valuing rivers as the primary food source and cultivation ranking the highest in Paya Seturan and Rian. Results are not necessarily intuitive; for example, Langap people, with their apparently more sophisticated modes of cultivation, still rated the forest more important than cultivation.

An example of a more specific PDM result can be seen in the table 5.12b, which illustrates the distribution of counters by our informant group of older women in Long Jalan, per land/forest type, per importance category. Forest again scored highest in all but the firewood and recreation category. One striking aspect of these individual exercises is the large number of zero results that often occur. This implies a clear segregation of the use-classes assessed by the land types listed. However, when results are averaged these zeros disappear, indicating that such 'zeros' are specific, not general.

Importance over time

Another PDM exercise compared the past, present and future importance of forest, and the relative importance of each category of use. A large variation was found amongst respondents, but the mean results (Table 5.13) show an increasing dependence on the forest for timber, saleable items and recreation and a decreasing importance for medicinal use, firewood and light construction. Interestingly, the past value of the forest was lower than its perceived future value. This is explained by informants as due to their previously having 'taken the forest for granted' despite their dependence on it.

Table 5.11 PDM exercise summary; means per land type, by use-classes for all seven communities.

	ALL	Food	Medicine	Light construction	Heavy construction	Boat construction	Tools	Firewood	Basketry/cordage	Ornamentation/ritual	Marketable items	Hunting function	Hunting place	Recreation	Future
Village	12.71	10.18	15.5	1.43	2.32	2.32	1.82	1.61	2.68	13.21	9.21	7.04	0.11	17.75	13.04
Old village site	5.86	6.5	4.82	4.79	1.5	1.5	2.46	2.21	4.46	5.29	6.71	5	6.04	2.11	4.89
Garden	11.43	13.86	8.39	4.71	1.07	1.07	0.25	8.61	2.5	10.46	16.86	4.5	6.96	11.71	15.86
River	13.39	15.46	11.11	10.96	6.71	6.71	8.93	19.04	10.68	15.61	14.57	7.89	14.54	**26.57**	8.54
Marsh/swamp	7.39	6.79	5.71	9.21	9.21	9.21	10.57	3.89	7.93	3.79	4.36	5.57	7.25	1.5	7.21
Cultivation	13.54	14.36	4.71	1.82	1.79	1.79	0.39	17	1.14	0.79	12.32	0.68	7.54	12.39	10.36
Young fallow	6.61	6.43	5.75	1.71	1.25	1.25	2.04	9.96	3.46	3.29	3.64	1.5	5.11	0.29	8.04
Old fallow	7.96	5.5	8.39	27.04	4.93	4.93	12.14	13.79	17.5	14.29	2.54	14.46	14.93	3.18	10.54
Forest	**21.11**	**20.93**	**35.61**	**38.32**	**71.21**	**71.21**	**61.39**	**23.89**	**49.64**	**33.29**	**29.79**	**53.36**	**37.54**	24.5	**21.54**
Total	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*
Unlogged forest	**31.43**	**38.75**	**36.29**	**35.61**	**50.71**	**50.71**	**44.68**	29.07	**39.04**	**30.32**	35.79	**43.5**	**36.46**	**34.26**	**30.68**
Logged forest	10.14	8.75	8.18	8.61	5.89	5.89	5.11	15.89	5.86	9.96	8.43	4.93	7.25	8.41	12.71
Secondary forest	15.82	11.18	15.07	23.04	3.96	3.96	4.75	**35.57**	15.64	26.82	7.07	9.14	11.75	15.34	23.61
Swamp forest	18.86	11.32	12.71	12.11	10	10	14.57	10.14	14.68	12.14	12.36	13.71	15.57	18.19	13.68
Mountain forest	23.75	30	27.75	20.64	29.43	29.43	30.89	9.32	24.79	20.75	**36.36**	28.71	28.96	23.81	19.32
Total	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*

Table 5.12a PDM exercise summary for 'food importances' by land type for all seven communities (each result is the mean of young and old women and men)

Village* ***Ethnic***	***PS*** ***m***	***R*** ***p***	***Lg*** ***m***	***LN*** ***p***	***LJ*** ***p***	***LM*** ***p***	***GS*** ***m***	**Mean** ***p***	**Mean** ***m***	**Mean** ***all***
Village	10.25	**14.5**	9.25	8.75	10.25	10.25	8	10.94	9.17	10.18
Old village site	3.75	8	9.5	7.5	6	7	3.75	7.13	5.67	6.5
Garden	10.75	12	14	12	13.75	17.75	16.75	13.88	13.83	13.86
River	18.25	12	11.75	13.25	16.5	16.25	**20.25**	14.50	16.75	15.46
Marsh/swamp	10.5	12	8	7.25	3.5	1.5	4.75	6.06	7.75	6.79
Cultivation	**19.75**	**14.5**	11.25	15.75	9.5	10.5	19.25	12.56	16.75	14.36
Young fallow	3.5	8.5	8.25	7.5	5.25	4.75	7.25	6.50	6.33	6.43
Old fallow	3.75	6.5	7.5	5.75	6	4.5	4.5	5.69	5.25	5.5
Forest	19.5	12	**20.5**	**22.25**	**29.25**	**27.5**	15.5	**22.75**	**18.50**	**20.93**
Total	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*
Unlogged forest	**37**	**50**	**39.5**	29.5	**35.75**	**45.5**	**34**	**40.19**	**36.83**	**38.75**
Logged forest	16.25	0	8.25	9.5	8	4.25	15	5.44	13.17	8.75
Secondary forest	18.5	0	12.75	13.25	9.25	14	10.5	9.13	13.92	11.18
Swamp forest	13	0	15	14.25	16.5	3.5	17	8.56	15.00	11.32
Mountain forest	15.25	**50**	24.5	**33.5**	30.5	32.75	23.5	36.69	21.08	30
Total	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*

*Villages PS = Paya Seturan, R = Rian, Lg = Langap, LN = Laban Nyarit, LJ = Long Jalan, LM = Lio Mutai, GS = Gong Solok

Table 5.12b Example PDM of importance of different landscape units by older women in Long Jalan

	Village	Old v illage site	Garden	River/lake	Swamp	Cultivation	Young fallow	Old fallow	Forest
ALL	20	7	13	5	10	9	9	5	**22**
Food	9	7	10	9	7	9	9	9	**31**
Medicines	46	-	-	-	-	-	-	-	**54**
Light construction	-	-	-	-	-	-	-	45	**55**
Heavy construction	-	-	-	-	-	-	-	-	**100**
Boats	-	-	-	-	-	-	-	-	**100**
Tools	17	-	-	-	-	-	-	20	**63**
Firewood	-	-	-	**31**	-	28	-	20	21
Basketry/cordage	-	-	-	-	-	-	39	-	**61**
Ornamentation/ritual	-	-	-	46	-	-	-	-	**54**
Marketable items	18	-	19	11	-	20	-	-	**32**
Hunting function	40	-	-	-	-	-	-	-	**60**
Hunting place	-	-	-	39	-	-	-	-	**61**
Recreation	**37**	-	-	29	-	34	-	-	-
Future	22	-	8	12	9	9	-	11	**29**

Table 5.13 PDM for past, present and future importance of forest (*hutan*). Mean of all seven community responses

	30 years ago	Now	In 20 years
ALL	**31.25**	**31.96**	**36.79**
Food	12.07	11.93	10.21
Medicine	*8.46*	*8.11*	*4.71*
Light construction	*10.14*	*7.75*	*5.39*
Heavy construction	**7.68**	**8.39**	**14.21**
Boat construction	**5.46**	**7.04**	**7.46**
Tools	5.43	5.36	6.96
Firewood	*7.54*	*7.18*	*5.21*
Basketry/cordage	7.46	6.43	6.64
Ornamentation/ritual	5.07	6.64	4.68
Marketable items	**6.71**	**8.11**	**8.68**
Hunting function	6.64	6.61	5.39
Hunting place	8.43	7.68	6.36
Recreation	**2.79**	**3.07**	**5.07**
Future	**6.11**	**5.71**	**9**
Total	*100*	*100*	*100*

The exercise shown involved four stages: distributing the 100 counters between the past, present and future categories in general (here presented by the row 'All'), the next three being the relative assessment of the use-classes per time period (each vertical column). Care is needed as column totals (without 'All' included) sum to 100—meaning that row trends cannot necessarily be interpreted independently of the counters placed elsewhere in each PDM—but are relative to these other classes (this can be corrected by weighting the per-column data by the overall 'All value' weight but actually, here this has little overall effect).

A more specific example of changes in valuation over time among older women in Long Jalan uncovers some interesting information (Table 5.14). This points to the rise in importance of boat building, heavy construction, recreation and the future, and a decline in medicinal use, which they believe will continue.

Table 5.14 PDM for past, present and future importance of forest (*hutan*). Example scores from older women of Long Jalan (Punan)

	30 years ago	Now	In 20 years
All value	36	34	30
Food	**13**	**10**	**5**
Medicine	11	5	-
Light construction	15	4	5
Heavy construction	-	11	13
Boat construction	-	8	9
Tools	-	5	6
Firewood	**12**	**9**	**5**
Basketry/cordage	**10**	**8**	**13**
Ornamentation/ritual	**14**	**9**	**6**
Marketable items	8	9	8
Hunting function	**8**	**6**	**10**
Hunting place	**9**	**4**	**10**
Recreation	-	4	6
Future	-	8	4
Total	*100*	*100*	*100*

Importance and origin of plants and animals

We also conducted a series of PDM exercises in each community to find out how people rated wild plant and animal resources compared to farmed or bought alternatives. Table 5.15 presents the results of the Langap Merap with those of the Long Jalan Punan.

Both communities rate total plants as being slightly more important than animals, but for *wild* sources only this pattern is reversed. Not surprisingly, remote Long Jalan places more importance on wild forest products than Langap, and the reverse is true for cultivated plants and farmed animals. The Punan in Long Jalan are relatively dependent on buying rice and crops from traders (using revenue based on the sale of forest products). They find it relatively easy to gain free animal protein by hunting and fishing. All communities, even the most sophisticated cultivators, recognise a considerable dependency on wild plant and animal resources. Breaking down these results (Figure 5.8) reveals that higher preference is given to wild animals by young men, even in the cultivation-oriented communities like Langap. Such clear and intuitive results lend credibility to examining other patterns that appear less self-explanatory.

Importance of species

The most complex series of PDM exercises were those in which informants would first score the 12 importance categories and then rank the top ten 'most important' species (plants and animals respectively) for each category . These exercises were conducted using local names, which were later matched with scientific names through various processes (though this is not yet finished).

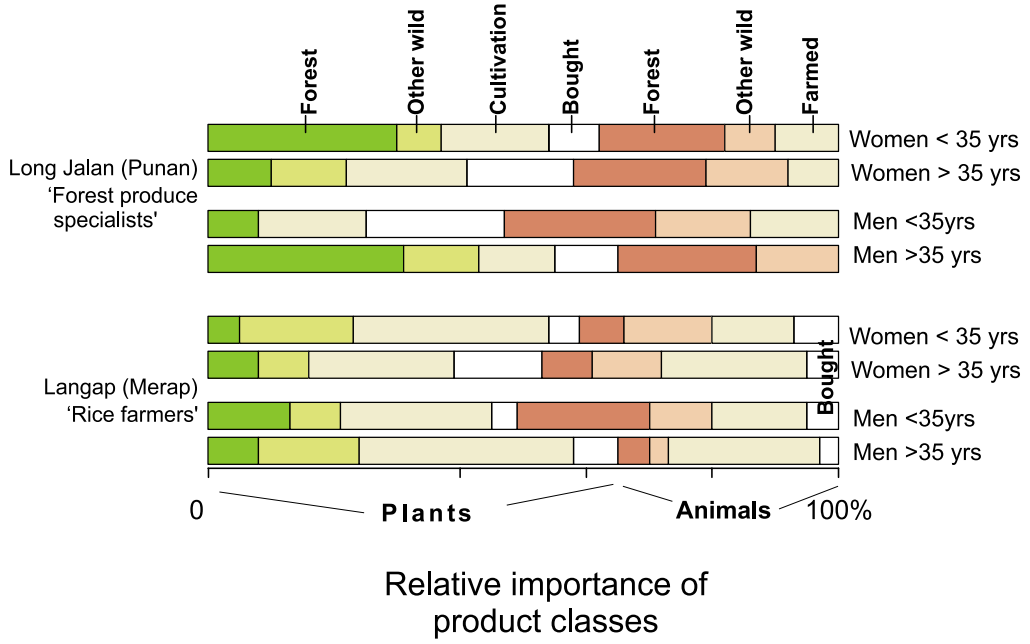
Tables 5.16 and 5.17 present examples for very small parts of these extensive exercises. The illustrations show 'medicinal' (older men in Gong Solok) and 'ornamental and ritual' importance for plants and animals (older women in Gong Solok).

In the plant section of the first table, a 'remainder' of 100% is given. This implies that there are unlisted species, which together have similar total importance to the ten listed. The second table indicates that species that are already of conservation significance have traditional values, e.g. hornbills and bears. A further, more general result is to acknowledge that species outside normal 'subsistence requirements', such as food, shelter and medicine, can be given high levels of importance. High importance is found in all classes, though the ritual use has special significance. This arises because in many uses such as food there are numerous alternative species, while with ritual uses there are not.

General facts

The six survey questionnaires are not easily generalized or summarized. They provide an introduction to, and a general overview of, the respective villages, including land use, livelihood, traditions and environmental issues. A few general

Figure 5.8 Graphical presentation of a PDM importance-scoring exercise in which the residents of Long Jalan and Langap compared the relative importance of various origins of animal and plant products



In Long Jalan, men focus on gaharu collection and collect much wild meat but have little time or suitable land to cultivate and rice is bought, while in Langap the farmers are more self-reliant and grow much of their food, and have time to rear animals other than chickens. Even in Langap, however, young men like to hunt wild animals.

Table 5.15 Mean PDM scores for importance of different sources of plants and animals in Langap (22 Merap informants) and Long Jalan (25 Punan informants)

Products/ Village	Wild forest plants	Other wild plants	Cultivated	Bought plant products	Wild forest animals	Other wild animals	Farmed animals	Bought animal products
Langap	8.5	12.5	**28**	7.5	10.25	9.5	**18.75**	5
Long Jalan	**19.75**	7.75	16.25	14.25	**21.75**	12.25	8	0

Each result is the mean of four groups (men, women, young and old).

facts have been distilled and can be complemented with insights and verifications from the field teams. Part of each village survey was a basic census, which allowed a summary of village populations, sex, age, ethnicity, occupation, religion and capital items (such as boat engines and generators). Some of these are summarized in Tables 5.18–5.20.

Health, education, economy, religion and adat (traditional rules)

Health facilities are limited. For the treatment of any serious illness, people in the middle and upstream ranges of the Malinau River need to travel considerable distances. Communities place significant importance on traditional medicines.

Table 5.16 Example portion of PDM based on species by importance. This shows the medicinal importance for plants and animals given by older men in Gong Solok (Merap)

Plants		**75**		**Animal**		**25**	
Provisional ID	**Local name**	**PDM**	**LUVx100***	***Provisional ID***	**Local name**	**PDM**	**LUVx100**
Argostemma sp	Rou' Helalai	12	0.350	*Ursus malayanus*	Praung Mbuea	19	0.369
Dissochaeta gracilis	Raou' Mbyae	12	0.350	*Python reticulatus*	Ngie Penganen	14	0.272
Zingiber purpuracea	Rou' Ya' tengan	12	0.350	*?*	Tue Tana	11	0.214
Aristolochia sp2	Kah Kedayan	11	0.321	*Tragulus napu*	Nayaung Pelanauk	11	0.214
Zingiber officinalis	Rou' Ya' Mla	10	0.292	*Apis dorsata* (honey)	Ngiet Tanyit	9	0.175
Schefflera singalangensis	Kah Kuceih	9	0.263	*Manis javanica*	Ngaeng	8	0.156
Ziziphus angustifolius	Tanpahelaue	9	0.263	*Collocalia fuciphaga sub sp. Vestita* (birds' nest)	Tepleih Lubuye (sarang burung)	8	0.156
Stephania hernandifolia	Rou' Klingiu	9	0.263	*Hystrix brachyura*	Mblung Tao	7	0.136
Tinospora crispa	Rou' Paay	9	0.263	*Mustela nudifes*	Hlangae	7	0.136
Kleinhovia hospita	Kenga'	7	0.204	*Psyconantus zeylanicus*	Manau Bauq	6	0.117
	Total	*100*	*2.917*			*100*	*1.944*
	Remainder	100	2.917			0	0.000

*LUV is the *local user's value*: a relative index that can be compared across classes. All LUVs of all values and products considered add to one.

Table 5.17 Example portion of PDM based on species by importance

Plants		**49**		***Animals***		**51**	
Provisional ID	**Local name**	**PDM**	**LUVx100**	***Provisional ID***	**Local name**	**PDM**	**LUVx100**
Cocos nucifera	Nyau	27	0.315	*Buceros vigil*	Manauk Talau	19	0.323
Artocarpus elasticus	Kayau hmaug	16	0.187	*Ursus malayanus*	Mbuea	18	0.306
Ficus uncinata	Laaung ntaya	12	0.140	*Buceros rhinoceros*	Manauk tekue	17	0.289
Claderia viridiflora	Rou' Mayau	11	0.128	*Cervus unicolor*	Payau	11	0.187
Knema sp.	Lau	10	0.117	*Pardofelis nebulosa*	Tloeh	10	0.170
Schizostachium latifolium	Mblou Ngana	8	0.093	*Agusianus argus*	Manauk Kuao	8	0.136
Calamus caesius	Ngoe Ngka'	6	0.070	*Muntiacus muntjak*	Telaauh	6	0.102
	Rou Kemalah	4	0.047	*Gracula religiosa*	Manauk Kiue	5	0.085
Geunsia pentandra	Kala'	3	0.035	*Python reticulatus*	Pie Pengenan	5	0.085
Kleinhovia hospita	Kenga'	3	0.035	*Tragulus napu*	Pelanauk	1	0.017
	Total	*100*	*1.167*			*100*	*1.700*
	Remainder	40	0.467			0	0.000

This presents ornamental and ritual importances for plants and animals given by older women in Gong Solok (Merap).

Table 5.18 Populations of survey villages

Name of village	Total area (Km²)	Households	Inhabitants	Population per Km²	Larger boats	Canoes, rowboats	Boats per person
Gong Solok I	324	44	208*	0.64*	19	14	0.159
Paya Seturan	22**	25	116	7.05**	11	1	0.103
Rian		9	39		2	0	0.051
Langap	469	99	415	0.88	33	41	0.178
Laban Nyarit	256	29	138	0.54	15	16	0.225
Lio Mutai	370	11	53	0.14	3	4	0.132
Long Jalan	748	31	114	0.15	9	9	0.158
Summary	Total 2189	Total 248	Total 1083	Mean 0.49	Total 92	Total 85	Mean 0.163

*Gong Solok 1 disputes territory with Gong Solok II. The area also includes some Punan families—the population in this territory may be more than twice this figure.
** These two communities share a territory.

Table 5.19 Ethnicity and religion of the sample villages

Name of village	Dominant*	Other*	Moslem	Protestant	Catholic
Paya Seturan	Merap Kenyah	Lundayeh (Putuk)	-	35	-
Rian	Punan	-	-	-	-
Langap	Merap	Kenyah, Bugis, Lundayeh Chinese, Timor-Timur	13	94	308
Laban Nyarit	Merap Punan	Kenyah, Toraja, Lundayeh	-	138	-
Long Jalan	Punan	Lundayeh	-	114	-
Lio Mutai	Punan	-	-	-	53
Gong Solok I	Merap	Lundayeh, Tunjung, Bugis, Punan, Tidung, Brusu	21	30	157

* For simplicity in this report we will not try to subdivide these ethnic groups further. Locally, however, these divisions are significant.

Table 5.20 Occupations contributing to livelihoods in surveyed villages (Adults only)

Principal occupation	Village*							
	PS	R	Lg	LN	LJ	LM	GS	Total
Farmer	24	7	169	50	17	8	78	353
Gaharu collection	-	2	-	36	34	13	-	85
Labourer	-	-	9	8	-	-	7	24
Forestry operations	-	1	13	-	-	-	8	22
Craftsperson	-	-	15	1	-	6	-	22
Teacher	1	-	10	5	-	-	-	16
Private	-	-	9	-	-	-	6	15
Trader	-	-	3	2	1	-	1	7
Priest	-	-	2	1	1	-	1	5
Technician	-	-	4	-	-	-	-	4
Hunter	-	-	1	2	-	-	-	3
CIFOR	-	-	3	-	-	-	-	3
Medical aide	-	-	3	-	-	-	-	3
Gaharu trader	-	-	-	1	1	-	-	2
Birds' nests	-	-	1	1	-	-	-	2
Carpenter	-	-	2	-	-	-	-	2
Livestock farmer	-	-		-	-	2	-	2
Fisherman	-	-	1	-	-	-	-	1
Other	-	-		2	-	-	3	5

*PS = Paya Seturan, R = Rian, Lg = Langap, LN = Laban Nyarit, LJ = Long Jalan, LM = Lio Mutai, GS = Gong Solok.

Lack of education facilities and infrastructure has impacted local education. Literacy is low in some communities such as Laban Nyarit despite proximity to villages with schools. Many villagers, especially older Punan, are not comfortable in Indonesian, and few can read and write (making it necessary for most interviews to involve local translators).

The communities view their economy at the present time as better than it was five or ten years ago. This is principally because of the greater availability of supplemental income from timber and coal companies.

Most villagers are Christian. Only a few Muslims were found to live in the area, and most of these are immigrants. Older community members still concurrently respect animistic traditions and prohibitions, but this practice is declining.

A system of traditional leaders exists in the villages, consisting of a *Kepala adat* (traditional leader) and *Lembaga adat* (traditional council), which enforce community ethics and resolve disputes. In some locations, especially the Punan communities, *adat* is the dominant legal system. If there is any violation of customary law in the community, whether it relates to social relationships or to the environment, the *Lembaga adat* determines the penalty (usually a fine of gongs, money or chickens). In Long Jalan, under current *adat* (2000) no chainsaws are allowed in the territory except by express permission.

Gravesites are highly respected. We found that those of Merap groups are often visible, with older graves associated with large urns, platforms, and

Christianity has arrived in the last 50 years and many conversions have only occurred in the last three decades. When asked what was the best time for hunting, Pak Usak (Seturan) once answered: 'Now that we believe in God, we have no power over the rain [and the mast fruiting that attracts the pigs] anymore. So we just have to wait and see when it pleases God to give us rain.' While in Gong Solok I (DS) was offered both python and monkey to eat. They explained that in the old days people would not eat either but 'now they were Christian it was no longer a problem'. The *Kepala Adat* explained that he himself would die if he ate python as he was 'from the old time' and was still bound by such taboos.

more recently marked ground burials. All forest product collections seem to be prohibited within an area of c. 1 ha or more of such sites, though it was also implied by some informants that this was voluntary. Such sites often survive as remnant forest patches in more intensively cultivated areas. Despite this, the accidental destruction of gravesites by timber concession planners seems common, and has caused local resentment.

Livelihoods and some field stories

Agriculture is based on a swidden system. Fields are usually grouped in clusters, and are sometimes located deep in the forest. Small quantities of coffee, cocoa, and fruits are grown as cash crops in fields near to the village. Areas are cultivated for one or more years, and then left to fallow due to a decline in fertility and invasion by weeds. In many cases specific plant species, such as palms, fruit trees, and honey trees are left in the cleared fields. The subsequent fallow regrowth produces a wide range of products used by community members.

Agriculture appears better developed amongst the Merap than the Punan groups. For the Merap, agricultural activity is communal, while with Punan it is more individual.

Most Punan families generally cultivate some rice, though not in quantities that will see them through the year. During the 'hungry season' when the rice supply is exhausted, there is reliance on forest products and cash savings and an increased likelihood of sickness and malnutrition. Food shortages also occur, to a lesser extent, amongst Kenyah and Merap due to drought flood, or pest infestations.

New technologies, such as chemical weeding and pest control, are being evaluated at a small scale by some community members. We never observed fertilizer use, though it was a topic of casual interest among some farmers. Chainsaws have reduced the labour involved in field clearance.

Local informant (Pak Aran Ngou, Langap) explaining the importance and significant properties of a sample site's soil. People's knowledge is critical in finding areas suitable for cultivation in the region's poor soils.

Table 5.21 Some examples from the questionnaires addressing perception

Information needed and responses given	**Response from local people**						
	PS	R	Lg	LN	LJ	LM	GS I
Heads of households N=	13	13	30	32	30	14	31
Threats of human activities							
Overcutting by logging company	-	-	28	31	3	7	27
Illegal logging	-	-	-	4	-	-	4
Large scale plantation converts land	-	-	1	-	-	-	2
Coal company uses land	-	-	8	-	-	-	
Swidden cultivation-land shortage	5	5	2	9	4	2	7
Overcollection of *Aquilaria* (Gaharu)	10	10	-	-	11	-	-
Bad research (misinformation)	-	-	1	-	-	-	-
Village's property threatened	1	1	-	-	-	-	-
Unsure (no answer)	2	2	-	-	15	6	4
Measures for preventing/controlling threats							
Disease							
Doctor/medical aide			3	27	17	8	29
Traditional medicine			1	10	7	3	9
Medicine from shop			2	3	16	7	-
Unsure (no answer)			25	-	5	-	-
Flood							
Traditional ceremony to stop the flood			-	-	2	-	-
Evacuation to the forest or mountain			4	3	9	9	21
Unsure (no answer)			26	10	2	5	10
Hunger							
Consuming a food substitute such as cassava, sago, etc.			2	13	8	7	20
Collecting *Aquilaria beccariana* (Gaharu), logs, birds' nests etc. (for money)			6	-	1	2	6
Ask for assistance from outsiders and local government			1	-	-	2	4
Unsure (no answer)			20	10	3	3	-
Fire							
Make a 'fire break'			4	1	-	-	-
Extinguish the fire			2	1	-	-	-
Be more careful with fire			1	2	-	-	-
Unsure (no answer)			5	1	-	-	1
Regulation							
Negotiation with the government and/or companies			3	-	-	-	1
Unsure (no answer)			4	1	-	-	1
Reaction to threats							
Disease							
Prepare traditional medicine			1	8	4	5	3
Cook all food			-	1	2	-	1
Bar outsiders from the village			-	1	2	-	1
Keep healthy/clean			2	5	7	1	16
Unsure (no answer)			19	17	15	8	10

Table 5.21 *Continued*

Information needed and response given	**Response from local people**						
	PS	R	Lg	LN	LJ	LM	GS I
Flood							
Traditional ceremony to stop the flood			-	-	1	1	-
Move village site			12	2	-	4	4
Build a farm in the hills			-	132	-	-	4
Unsure (no answer)			18	10	29	9	23
Hunger							
Gardening (planting cassava)			6	6	1	6	22
Collect *Aquilaria beccariana* (Gaharu), timber trees, birds' nests etc. from the forest			2	3	-	1	3
Work for a company			-	-	-	-	1
Keep the birds' nests in the cave safe.			-	-	-	-	1
Expand farming land			-	-	-	-	3
Unsure (no answer)			15	14	28	7	1
Fire							
To make a 'sekat bakar' (fire break)			4	5	-	-	-
To extinguish the fire			-	-	-	-	-
To be careful with fire			1	-	-	-	1
Unsure (no answer)			7	-	-	-	-
General views							
Is life better now than 5–10 years ago?							
Current life is better than before			18	11	24	9	25
Life 5–10 ago was better than at present			4	8	2	5	3
Similar			8	13	4	-	3
Expectations for young generation							
The young can go to school			13	17	21	8	16
The young can work			-	11	2	1	7
The young can advance			16	2	1	2	5
Unsure (no answer)			1	2	6	3	3
Suggested action to be taken if forest resources are degraded or used up							
Replanting			1	4	3	-	1
Protect trees – ban cutting			4	3	7	4	2
Bar outsiders from entering village area			-	-	2	-	-
Keep the forest as a protected area or customary forest			1	2	2	1	9
Limit the area used by companies			3	7	1	-	8
Grow tree crops			16	13	-	3	3
Unsure (no answer)			6	5	13	6	6
Factors important to maintaining forest value							
Birds, because they spread forest seeds			4	-	17	1	4
Bats, because they spread forest seed			-	-	1	-	-
Wild animals as a heritage for grandchildren			1	2	3	-	1
Fruit trees as a heritage for grandchildren			4	11	5	-	13
Ficus sp. (Beringin), because it has mythical associations			-	-	2	-	-
Gaharu tree (*Aquilaria beccariana*), Sago, *Shorea* sp., *Agathis* sp., etc., because of value for the local people.			2	1	3	-	1
Koompassia excelsa for bees nests			4	5	1	1	3
Trees in customary forest			-	1	-	-	2
Unsure (no answer)			17	13	9	12	11

*PS = Paya Seturan, R = Rian, Lg = Langap, LN = Laban Nyarit, LJ = Long Jalan, LM = Lio Mutai, GS = Gong Solok.

Many factors lead to change. Pak Impang Malang (from Langap) recounted that he had been amongst a group of community leaders who met with President Soeharto in Jakarta in the mid 1970s. He presented the president with a stick of ***gaharu,*** (scented *Aquilaria* resin) and in return received a gift of 'wet' rice seed. Prior to that time the Malinau Dayaks had no experience of cultivating wet rice. They still use this rice on a small scale and have called this variety '*padi kantor*' (office rice) ever since.

Apart from cultivation, local economies are strongly based on river and forest products, including fish, timber, rattan, bird nests, *gaharu* and songbirds. Local people consider that logging and mining companies have threatened the sustainability of the local forest, although smaller-scale land clearing for cultivation by communities is also recognised as a problem in areas where villages have limited territory.

Gaharu collection provides a profitable yet risk-laden source of income, as enormous debts are frequently incurred to organise a collecting party, binding individuals to the traders on a long-term basis, and making them highly dependent. While largely a Punan activity, many Merap men seek *gaharu* when they are young.

When a Long Jalan collector makes a large *gaharu* find, many community members will borrow his money. The result is that the money is quickly exhausted. Despite this, a good find can provide a boat engine, a larger house or an electric generator, despite the fact that after a few months the owner frequently can no longer afford the fuel.

Values of sites

The field sites sampled included many with specific importance to our informants. Some of these are associated with specific types of site. In Figure 5.9 we present one summary, classed by distance from the village, showing how sites have been rated in terms of importance for basketry and for heavy construction. Both appear to increase with distance and may imply some local depletion. However, there are caveats about our sampling that would need to be considered before this was interpreted further.

An odd example is the difference between the Merap and Punan in rating the importance of each sample site 'for the future'. Punan respondents consistently rated almost every site as highly important while the Merap showed more differentiation (Figure 5.10).

Figure 5.9. A summary of the value of basketry and building timber according to increasing distance from the village, reported by local informants. These summarise records from five of the seven communities

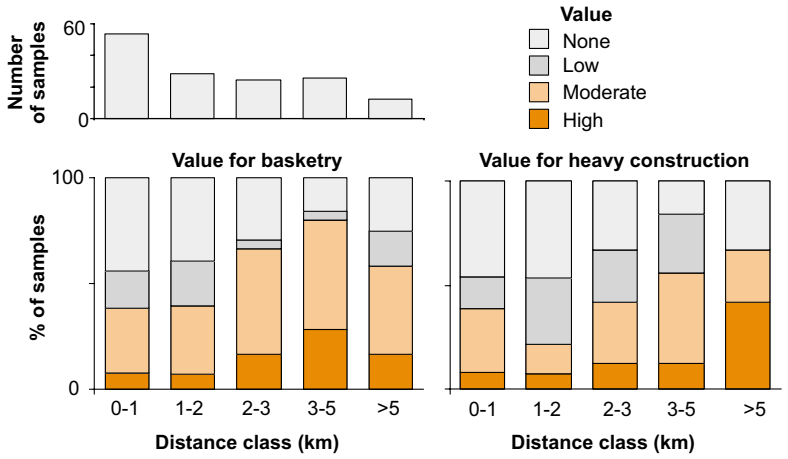
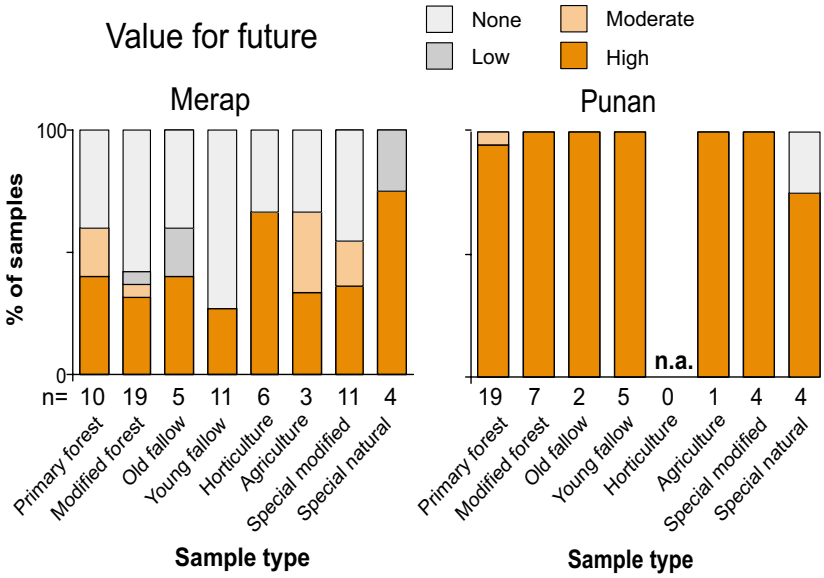


Figure 5.10 A summary of 'importance for the future', reported by Merap and Punan informants in our samples, by site type. These summarise records from five of the seven communities, n.a. = not applicable (see Figure 5.2 for explanation of sample classes)



Soil

Introduction

Soil types varied considerably in the sample area. Much of the landscape is very steep and is dominated by young soils derived from alluvial material.

Most land in the Malinau area is considered by local swidden farmers to be fertile enough to support their agriculture. However, given the high rainfall and nature of the tropical soils, swidden agricultural activity in turn has an impact on soil fertility, as is considered in more detail below.

Description of soil types

Scientific

Five soil types (Soil Survey Staff 1999) were recognised in the survey. Inceptisols were the most common, occurring in more than half of the sites (62.5%), followed by oxisols (27.5%), entisols (6.5%), ultisols (2.5%), and alfisols (1%).

Inceptisols were found to occupy relatively large areas and appear to be the dominant soil type. These young soils are found over a wide range of land formations, including steep slopes and more level terrain. The chemical properties of the inceptisols were varied, presumably due to heterogeneous parent material; in particular, inceptisols in hilly areas were generally less fertile than those in level alluvial regions, due to lower base saturation and pH levels.

Oxisols are deep soils with low CEC (<16 me/100g) due to heavy weathering. These nutrient-poor soils were found across all landforms except swamps.

Entisols were mostly found in flood plains and swamps. Average base saturation was high (67%) and this fertility seems to offer potential for cultivation, but local people often felt that the swampy or stony nature of the entisols rendered them unsuitable for cultivation.

Ultisols were localized and rare but were nonetheless recorded in a wide range of site conditions. These heavily leached soils are acid (soil average pH is 4.5) and have low inherent fertility with only 20% base saturation.

Alfisols were found only in two sites. These rare soils represent the 'best soils' recorded in the area, with high base saturation of nutrients and good depth. The pH value of these soils is nonetheless low (4.7), which could limit cultivation.

All soils have a low to very low intrinsic fertility, with low nutrient content, relatively high acidity, and both low cation exchange capacity (CEC) and base saturation.

Local soil classification/characterisation

Each ethnic group has a distinct soil-based terminology. The Merap appear to have a slightly richer terminology, differentiating the soils sampled into 19 generic types, while the Kenyah and Punan identified 14 and 11 types respectively (see Table 5.22).

Soil fertility

Scientific assessment

All Malinau soils are acidic with mean pH values of 4.5 to 5, typically associated with the immobilization of soil micronutrients (Ca, Mg, P, and Mo), and increased Al and Mn solubility. Most soils are high in Aluminium: Silicate clays (1:1), which possess a low cation exchange capacity (CEC) and nutrient absorption.

Local perception of soil quality/fertility

Local communities, the Merap in particular, have a deep understanding of soil and its cultivation potential. Various techniques are used locally to assess soils. Pressing a blade into the ground and then withdrawing it to observe how the soil sticks to it is a common test. Sticky black soils are considered fertile. Another approach is to determine the temperature of the soil by touch. We have begun an investigation of how local people judge soil quality and a full account cannot yet be given. We use a four-point scale of local fertility assessments determined by examining the following variables: soil colour, texture, stickiness, humus, associated vegetation, and flooding.

Table 5.22 Preliminary compilation of Merap, Punan and Kenyah terminology used to describe and distinguish soils. Note the number of samples per ethnic group (in brackets), which was not equal (Kenyah in particular had very few)

Merap (79)	***Punan (87)***	***Kenyah (34)***	**Indonesian**	**Description**
Tiem	*Punyuh*	*Saleng*	*Warna hitam*	Black colour
Mla	*Mengan*	*Bala*	*Warna merah*	Red colour
Mieg	*Jemit*	*Bila*	*Warna kuning*	Yellow colour
Mbloa	*Mpu*	-	*Warna coklat*	Brown colour
Bau	-	-	*Warna abu-abu*	Grey colour
Toi	*Cerouh*	*Pute*	*Warna putih*	White colour
-	*Pekelet; Bulah*	-	*Warna campuran*	Mixed colour
Yie	-	*Ahit; A'bu;*	*Berpasir*	Sandy
Lumpuem	-	-	*Agak lengket*	Moderately sticky
To'ou	*Nyekadit*	*Pulut*	*Lengket*	Sticky
Plub	-	-	*Sangat lengket*	Very sticky
Petlat; Entat	*Praeh*	-	*Tidak keras*	Not hard
-	-	*Mahing*	*Keras*	Compact
Lepei	-	-	*Tipis*	Shallow soil
Petantaung	-	-	*Datar*	Flat area
Laowe	-	-	*Muara*	Downstream
-	*Awa*	-	*Hulu*	Upstream
Matau	*Batuh*	-	*Berbatu*	Rocky
Talayo	*Pakat/Ancut*	-	*Akar*	Small roots
Pangkah	*Pangka*	*Bawang*	*Rawa*	Swamp
Lohoya	*Taong*	-	*Hutan*	Forest
'Ya	-	*Tihgah*	*Subur*	Fertile
-	*Jiet*	-	*Tidak subur*	Not fertile
-	-	*Bengaheng*	*Tanpa warna hitam, putih dan merah*	No presence of black, White or red colour
-	-	*Panas*	*Panas*	Hot

Local informant (Pak Kirut, Long Jalan) explaining the importance and uses of a sample site's vegetation. The survey recorded over one thousand used and valued species in the Malinau Valley.

Soil colour: Black and mixed-black soils (*tana tiem* [M] or *tana saleng* [K] or *tano punyuh* [P]) are classified as 'very fertile' or 'fertile', while white sands (*tana toi* [M]) are considered to be low in fertility.

Texture: While the highest class of fertility was not defined by texture, moderately sticky texture is believed to denote a fertile soil.

Consistency: A very friable soil is thought to be indicative of high fertility.

Stoniness: The presence of rocks (of any size) is generally believed to be indicative of the 'not fertile' category.

Vegetation: The presence of *Koordersiodendron pinnatum*, *Elmerilia tsiampacca*, and *Alpinia glabra* are taken by local people as indicators of 'very fertile' soil, while the presence of bamboo is an indicator of 'fertile' soil.

Other: in addition, deep soil is considered 'fertile', and flat areas are considered 'very fertile'. Sloping ground is generally 'moderately fertile'. The presence of deep humus also indicates fertility.

Local estimates of fertility are usually described by observed productivity. A Merap informant suggested that 200 tins/ha of dryland rice production indicates a 'very fertile' soil. Punan quoted about 150 tins of rice yield from 4 tins of seed to indicate a 'fertile' soil. A return of 3 tins of seed yielding only 3.5 tins of rice was reported by one informant to illustrate inadequate fertility.

The relation between local and scientific perceptions of soil fertility

The four-point classification of local assessments was found to be significantly correlated with some of our measured soil characteristics, including soil depth, silt and sand percentage, carbon-nitrogen ratio (C/N), nitrogen content (%), magnesium content (me/100gr), exchangeable acidity (H^+) and the Munsell components of colour.

Thus initial analyses suggest that the fertility judgments by Merap appear closer to measured parameters, though this may be influenced by sample distributions; more analyses are required.

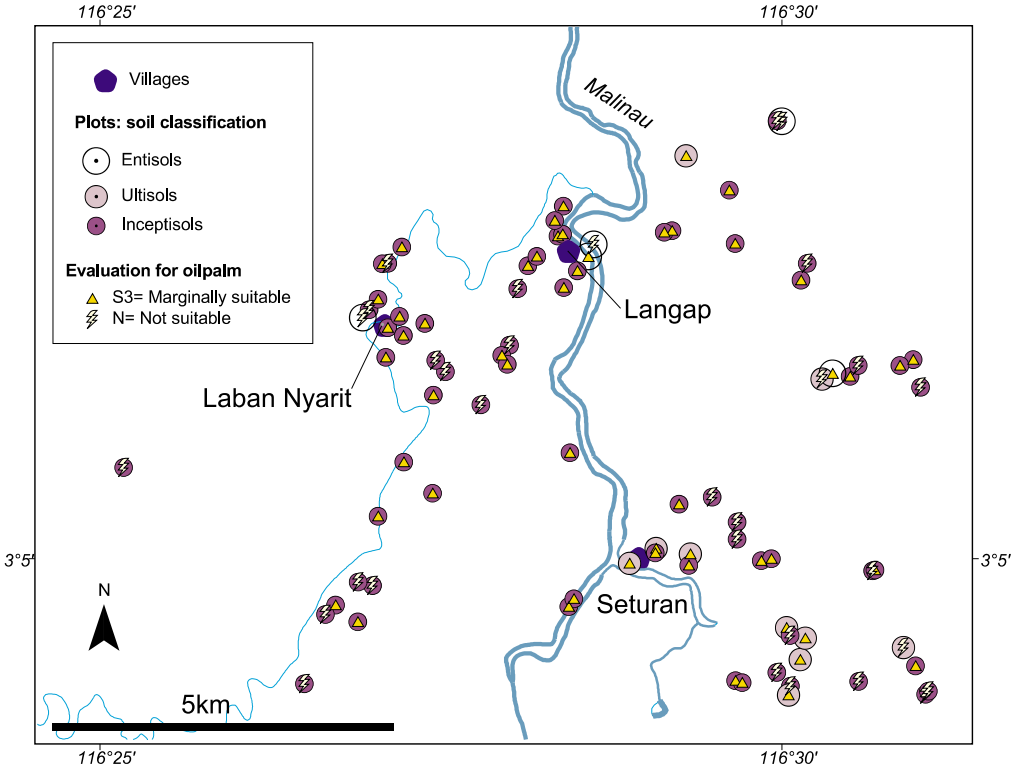
Table 5.23 Significant rank correlations between local fertility perception (very fertile, fertile, quite fertile, and not fertile) and measured soil characteristics (inc. chemical characteristics at 0–20 cm depth)

	Kendall's	N	C/N	Mg	Sand	Silt	H^+	Hue	Value	Chrome	Depth
Local Fertility	Tau Coef.	.174	-.157	.130	-.120	.135	-.096	-.151	-.194	-.137	.119
	p-value	***0.002	***0.006	**0.018	**0.03	**0.015	*0.08	**0.043	***0.009	*0.058	**0.045
	N	197	197	197	195	195	195	141	141	140	197

Table 5.24 Significance determined by Kruskal Wallis Test (df = 3) on measured soil characteristics versus four-point scale of local fertility assessment. (Blank data omitted)

Characteristics	All observations N=197, p-value	Punan only N=84, p-value	Merap only N=79, p-value	Kenyah only N=34, p-value
Sand	0.198	0.436	0.419	0.846
Silt	0.091	0.105	0.259	0.768
Clay	0.669	0.985	0.081	0.770
pH-H_2O	0.314	0.219	0.291	0.108
C	**0.035***	0.245	**0.032***	0.795
N	**0.016****	0.443	**0.001****	0.104
C/N	**0.007****	0.759	0.184	0.172
P_2O_5	0.126	0.368	0.074	0.430
K_2O	0.293	0.749	**0.041***	0.548
Ca	0.426	0.170	**0.001****	0.730
Mg	0.136	0.317	**0.039***	0.200
K	0.267	0.813	0.695	0.353
Na	0.752	0.835	0.318	0.256
CEC	0.597	0.851	**0.019***	0.363
Base-saturation	0.733	0.557	**0.024***	0.614

Figure 5.11 Mapped summary of soil information in the Langap-Laban Nyarit- Seturan area



Main soil orders are shown along with suitability classification for oil-palm. This flood valley area includes many of the best sites for agriculture—most of these sites are already under rice or fallow

Local fertility classes amongst samples appear weakly related to slope, e.g. the Kruskal Wallis Comparison of slope effect on local classes of fertility gives p=0.023 (n=197), indicating that steep slopes are considered less fertile. A weak but significant correlation is found between local fertility assessment and distance from the village, but it is hard to disentangle cause and effect in such a result.

Land evaluation

Scientific assessment

We used soil and site data to make a land evaluation using methods outlined by the Indonesian Ministry of Agriculture (1997) in order to assess each site for potential for field rice, pepper, and oil palm cultivation. Apart from soil quality, many other land characteristics that directly determine productivity and sustainability of a land use were considered. There are four land use classifications: S1—land with no limiting factor for achieving sustainable and optimum output; S2—land with some minor limiting factor(s) and needs input to produce optimum yield; S3—land with major limiting factors that affect productivity and would need more inputs than S2 for optimum yield. N means that the land is not suitable for such crops. All our samples for all three crops were classified as either S3 or N, with more than half in the totally unsuitable N class. While this reflects 'commercial' rather than local cultivation, this tells us that **Malinau is unsuitable for oil palm, and for large-scale pepper and rice farming**. Despite the fact that these soil characteristics would appear to make land unsuitable for commercial cultivation, this has little relations to subsistence use, particularly field rice cultivation.

Local assessment of suitability

Indigenous methods of assessing suitability for particular crops were also recorded, producing a large body of data. Preliminary observations are:

- **Merap.** *Tana tiem* (black soil) is used for the production of dryland rice, corn, banana, butternut, sweet potatoes, cassava and any other cultivation or/and plantation. *Tana toi pangkah* (swampy soils), *tana yie mieg* (sandy soil), and *tana mbla tu'uk* are not fertile and generally remain forested, while the clayey *Tana plub* has been used to develop experimental wet rice fields.
- **Punan.** *Tano batuh* (Rocky soil) is left as forest, while *Tano pangkah* (swampy soils) have been tried for wet rice. *Tano punyuh* (black soils) in Punan sites were used for dryland rice cultivation.

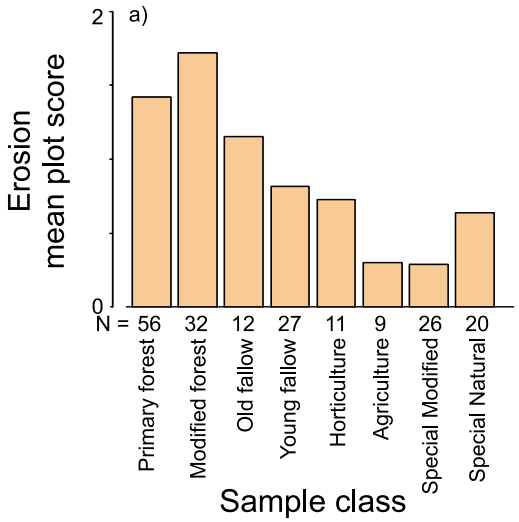
Exploratory analyses, using cross-tab symmetric measures [SPSS], show weak relations between local assessments of land suitability and standard suitability assessment methods (Ministry of Agriculture of the Republic of Indonesia 1997) for pepper and oil palm (both p=0.001, strength/phi value= 0.3), but not for rice (p=0.69, strength/phi value=0.03).

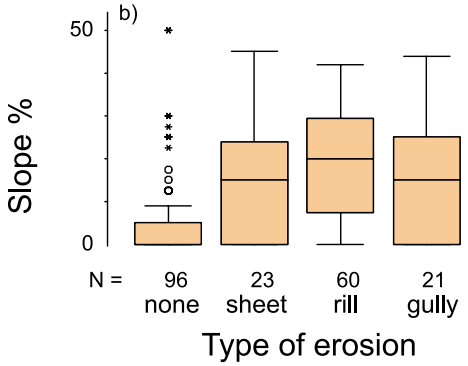
Erosion and compaction

The recorded types of soil erosion are sheet/interrill, rill, and gully types. Rill erosion is recorded in 60 plots, while gully and sheet type erosion are recorded in 21 and 23 plots respectively. Land cover type is related to degree of erosion (by sample type, Kruskal Wallis test, p= 0.001). Modified forest, primary forest and old fallow are the most eroded while agricultural land is the least (Figure 5.12a). The explanation would appear to be that agriculture occurs mainly on flatter areas, whereas modified forest occurs on the steepest terrain. Erosion is positively related to slope (Kruskal Wallis Test, df=3, $p<0.001$, Figure 5.12b). Erosion is also positively related to bulk density (p= 0.05), which is not itself related to slope ($p>0.6$). These observations help explain the relation of woody cover to erosion (Kruskal Wallis Test, df=3, $p<0.001$, Figure 5.12c). The rill type is found under the densest vegetation coverage, while none is observed in more open area—slope again seems to be the explanation.

An initial evaluation of soil compaction is provided by looking at soil bulk-density data (Figure 5.13). The differences are significant (F=3.26, df=7, p=0,003). More specifically, density is higher in modified as opposed to primary forest samples (p value = 0.004, LSD test). The densest, most compacted, soils are often found in sites modified by human activities: logged areas, logging bays, extraction trails and old village areas. The four sample sites with unambiguous reports of heavy machinery use are all amongst the 40 densest soils sampled in the 200 sites (exact probability P=0.0016). These data, viewed in conjunction with the vegetation and site histories, imply that site recovery can be very slow.

Figure 5.12 Erosion scored: a) by severity across sample types, b) by slope, and c) by relascope count—estimated basal area (a measure of tree cover)





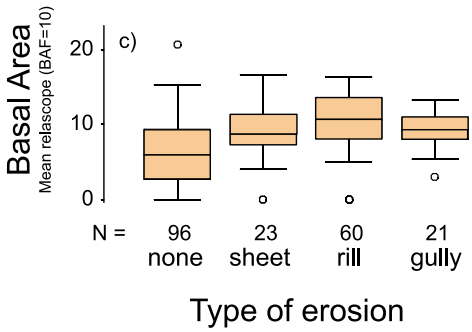
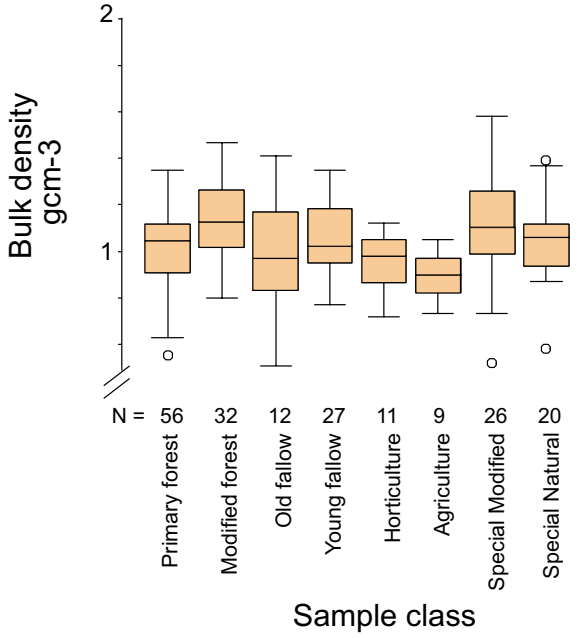


Figure 5.13 Bulk density of the soil surface by sample class (see Figure 5.2 for explanation of sample classes)



Other aspects of sites and generalisations

Soil fertility and suitability for cultivation are major determinants on local livelihood options. Agricultural production would likely show great benefits from the use of fertilizer. Since fertilizer can also increase weed growth, and is likely to be expensive, the management of its application needs to be examined. Soil management to improve organic matter content and raise pH would be useful too. The availability of local limestone may make such recommendations practical. Applications of lime would increase the soil pH value and CEC, and should help mineralise micronutrients.

There is a belief that some locations, especially those with poor drainage, are associated with the spirits and are dangerous for human activities, and these are often avoided, especially at certain times and by people alone. In our studies we found such locations at *air asin* (salt water springs) and *tabau ayo'* (Punan, wide depression area near a ridge top). We found a milder caution associated with some bamboo groves.

Plants—general and ecology

Plant taxonomy and verification

The preparation of a final reference list of vascular from plant records from this survey took considerable herbarium and reference work. The Malinau area is not well-explored taxonomically and the majority of the plants encountered are not easily identified. Even when good herbarium matches have been made, standardising nomenclature and synonymy remains a major task. Though the first stage of the botanical identification has been completed, we still consider the names provisional. From the 15 430 records in the plant reference list, 91% have a complete species name (this is c. 73% of species). The rest, 516 species, are still distinguished taxonomically to identify distinct and consistent morphospecies (usually named [*Genus*] sp1, sp2, sp3 etc.). This required checking and grouping for all such reference specimens. For 51 of the unidentified forms, genus is not known, and for 24, family is unknown (79 specimens).

Some of the incompletely identified material is likely to include rare or previously undescribed taxa. We anticipate, in particular, that additional expertise will allow us to identify unnamed material, and likely cause us to revise some of the lesser-known taxa. In some groups, e.g. Zingiberaceae (gingers), taxonomy itself is confused and needs revision. We collected at least one probable new species, a fruiting tree (genus *Mammea*, family Clusiaceae).

Vegetation ecology

Our field methods emphasize trees, herbs and climbers, but also encourage limited observations of other life forms. Records are summarized in Table 5.25. Some classes overlap at species level.

The number of records per species is highly skewed. Single records were made for 735 taxa, two records for 262 etc. Figure 5.14 shows this as a log-log plot. Such a relationship indicates that additional sampling efforts would continue to discover additional species, and that our 2126 is part of a potentially much higher total.

The sampling effort was not evenly distributed across all types of habitat (See Figures 5.2 and 5.3 and Table 5.26). More effort was made to collect primary and modified forest than other types, though special sites and post swidden fallow are also well represented. However, if we examine the rarer species, it is clear that the special natural sites and forests generally give more such species per sample, suggesting these as being the most likely areas in

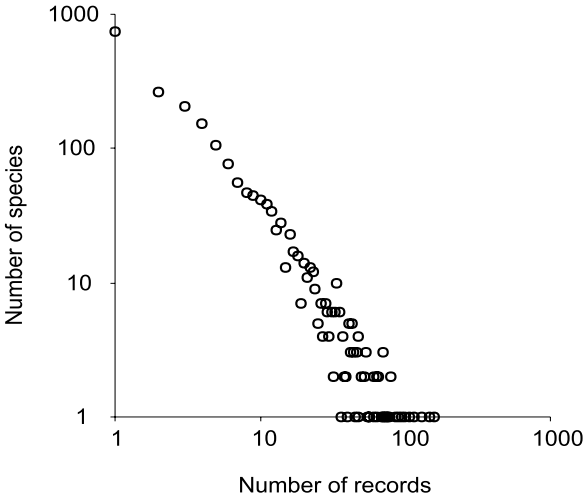
Table 5.25 Overview of number of identified taxa per life form

Life form	Families	Genera species	Unique records	Individual
Aquatic	1	2	2	2
Herbs (not ferns)	48	179	378	2527
Trees	80	280	957	6460
Liana (woody climber)	59	143	348	2350
Non-woody climber	43	107	211	927
Climbing figs	1	1	31	102
Terrestrial fern	26	53	113	643
Climbing ferns	11	13	16	99
Epiphytic ferns	14	21	43	131
Other epiphytes	11	26	38	77
Giant monocots	11	36	67	310
Palms	1	13	69	440
Pandanus	2	3	22	100
Sapling	46	108	227	477
Seedling	37	88	176	418
Shrub or treelet	40	69	125	367
Total vascular plants	*173*	*693*	*2126*	*15 430*

Table 5.26 Plant records by sample type. The fuller explanation to these classes is given under Figure 5.2

	Primary forest	Modified forest	Old fallow	Fallow	Horti-culture	Agricul-ture	Special-natural	Special-modified	Sum
No plots	57	32	13	27	11	10	22	28	200
No plant records	4670	2861	1059	1785	875	374	1785	2021	*15430*
No species	1200	951	479	562	300	187	791	769	*2126*
***N = species recorded once in survey**	229	128	47	71	42	28	99	91	*735*
***N/plots**	4.02	4.00	3.62	2.63	3.82	2.80	4.50	3.25	3.68

Figure 5.14 Number of species recorded by number of separate records per species for the entire 200 samples. Number of species (Y) versus records (X) is closely fitted by $Y= 1077.4X^{-1.56}$ ($R^2 = 0.9138$)



Sample lines are established to guide the vegetation assessment. Here a limestone site is being evaluated by Dr Kade Sidiyasa and Zainal Arifin from Wanariset Sambodja

which to discover additional species with any further sampling. This underlines the efficiency of including such sites in a biodiversity survey.

A cross comparison of the different species according to land use class also highlights these differences (Table 5.27). For example, primary forest samples contain approximately half of the species in each other class.

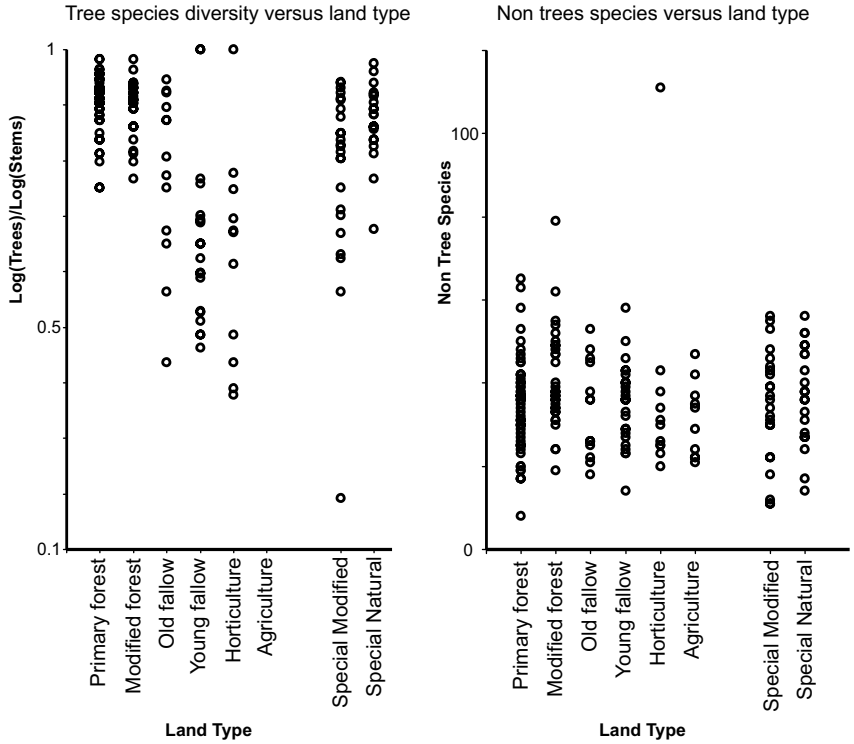
It is perhaps more ecologically meaningful to examine the species richness patterns per plot. In Figure 5.15 the tree diversity and non-tree transect species records are summarised by plot type. The tree richness of primary or lightly disturbed forest is generally higher than other tree communities, but sometimes incomplete clearance leaves quite rich communities of forest trees albeitit at lower densities.

Patterns amongst non-trees are less clear, with considerable variation apparent in all sample classes. Dividing species into different morphological/ ecological types helps clarify this. In Figure 5.16 we see that different groups relate in different ways with tree cover (basal area). Ferns and other herb species-densities seem to benefit from less tree cover, while lianas, palm life forms, and trees themselves increase in life richness with tree cover. These patterns do not necessarily hold over all data ranges or sample types, and may not be monotonic in nature—for example the richest herb communities are found in sites with some (not zero) tree cover.

Table 5.27 Shared species by class of samples. The class given in the row shares the number of species with the class given in the column; percentages are based on the row class (see Figure 5.2 for explanation of sample classes)

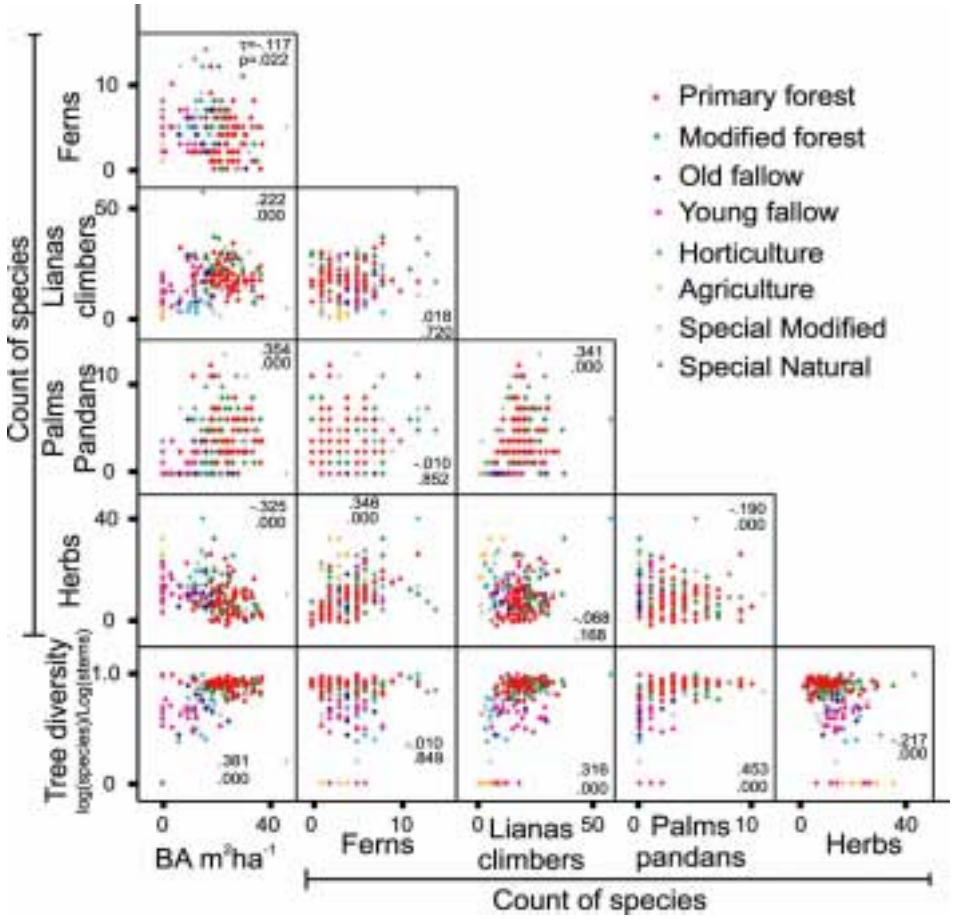
	Primary forest 57	Modified forest 32	Old fallow 13	Fallow 27	Horticulture 11	Agriculture 10	Special-natural 22	Special-modified 28
Primary forest	1200	634	329	325	142	59	529	479
%	*100.0*	*52.8*	*27.4*	*27.1*	*11.8*	*4.9*	*44.1*	*39.9*
Modified forest	634	951	305	310	158	69	478	426
%	*66.7*	*100.0*	*32.1*	*32.6*	*16.6*	*7.3*	*50.3*	*44.8*
Old fallow	329	305	479	229	126	65	276	280
%	*68.7*	*63.7*	*100.0*	*47.8*	*26.3*	*13.6*	*57.6*	*58.5*
Fallow	325	310	229	566	157	123	276	292
%	*57.4*	*54.8*	*40.5*	*100.0*	*27.7*	*21.7*	*48.8*	*51.6*
Horticulture	142	158	126	157	299	72	133	178
%	*47.5*	*52.8*	*42.1*	*52.5*	*100.0*	*24.1*	*44.5*	*59.5*
Agriculture	59	69	65	123	72	187	79	108
%	*31.6*	*36.9*	*34.8*	*65.8*	*38.5*	*100.0*	*42.2*	*57.8*
Special- natural	529	478	276	276	133	79	791	401
%	*66.9*	*60.4*	*34.9*	*34.9*	*16.8*	*10.0*	*100.0*	*50.7*
Special- modified	479	426	280	292	178	108	401	769
%	*62.3*	*55.4*	*36.4*	*38.0*	*23.1*	*14.0*	*52.1*	*100.0*

Figure 5.15 Tree and other plant species richness by sample class. Tree diversity is expressed as Log(species count)/Log (stem count) following Sheil *et al.* (1999)



Primary forest tends to be richer for trees than other land types, but in many partially cleared or damaged areas these rich forest tree communities remain. The richest plot for non-trees is much richer than any other plot. This is a poorly maintained coffee garden in opened forest on steep ground, with many remaining tree stems, and closed forest within 50 m, combining forest remnants, forest regrowth, weeds and streamside species (see Figure 5.2 for explanation of sample classes)

Figure 5.16 An exploratory examination of the relationships between species richness in various species groups in various sample locations



Species classes include ferns, lianas and climbers, palms, pandans, herbs, tree richness and plot basal area. Many strong correlations both positive and negative are seen (Kendall's Tau, given in each figure with a P value beneath). These patterns are readily explained, but also show the complexity involved in using richness in any specific life-form as a surrogate for others. Trees, lianas and palms all do well in closed forest, while ferns and herbs generally reach higher species densities in more open habitat. See Figure 5.2 for explanation of sample classes.

Plants—use

Table 5.28 shows the number of informants, distributed by gender and ethnicity, who assisted us regarding the use of plants. It was easier to find male than female informants willing to take part in the field data collection, but the field team worked with one of each whenever possible.

A very large number of plants and uses/values were recorded (17 603 records). This included 2052 separate species-uses/values in around 1457 species (not including some Kenyah records from the pilot survey). Of these species, 779 were trees, and 620 were herbs and climbers. The number of specific species-uses per use-class is illustrated in Figure 5.17. Firewood and 'hunting place' (species noted for providing food for hunted animals) classes elicited especially long species lists. Yet eliminating these classes only reduces the total useful species lists by

Table 5.28 Number of local informants that accompanied the field team

Ethnicity/gender	Merap	Punan	Total
Male	15	10	15
Female	8	6	14
Total	*23*	*16*	*29*

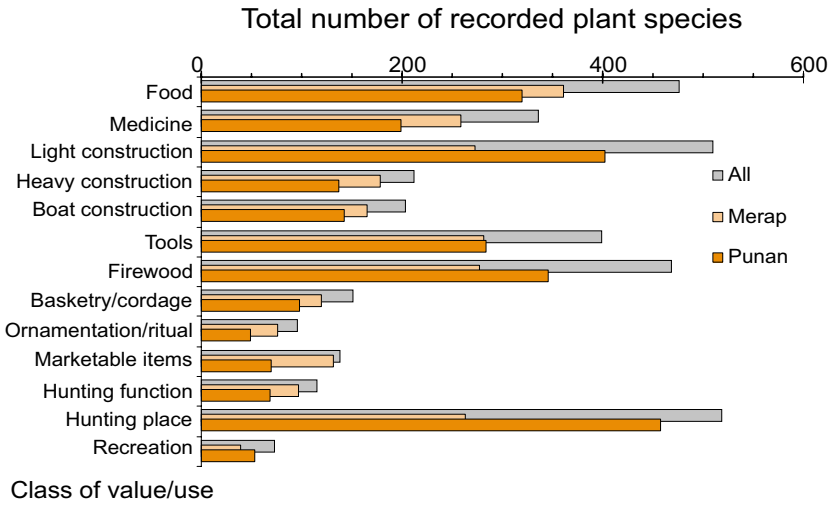
N.B. Three male Kenyah informants were also involved in the pilot study.

Table 5.29 Distribution of plots by type and ethnicity. These sample classes are discribed in Figure 5.2

Sample type/ Primary Ethnicity	Modified forest	Old forest	Fallow fallow	Horti-culture	Agri-culture	Special-natural	Special-modified	Total
Merap	34	24	10	22	11	8	14	21	144
Punan	41	13	8	9	5	6	15	15	112
Total	*57*	*32*	*13*	*27*	*11*	*10*	*22*	*28*	*200*

N.B. Merap and Punan plots do not sum to 200 as in many plots, both were involved.

Figure 5.17 Total number of specific species-uses (Merap and Punan) recorded by value-class. These use classes are described in Table 5.2



117 to 1340 (677 trees and 601 herbs). 119 species were recorded as having values that were in some way viewed by the informant as exclusive to that plant alone—these relate to diverse genera, and encompass 85 families—such records are mainly in the ritual/ornamental, medicinal and tools use-classes (37, 28, 25 species respectively) and are much more commonly reported by Merap than Punan informants. There were no exclusive uses/values recorded in construction or boat building.

As with the ecological data, a different perspective can be gained by looking at the data on a plot-by-plot basis. In Figure 5.18 the total proportion of useful/valued species has been plotted by sample type and ethnicity of the informants. The result is striking in that so many plots have such a high

Table 5.30 Total number of records and taxa of valued plants

		Trees	Herbs etc	Monocots	Saplings	Seedlings	Shrubs	Total	Total (exc*)
Merap	Family	66	90	8	29	27	21	**131**	**128**
	Genus	221	255	28	59	55	28	**478**	**458**
	Species	611	512	44	103	95	46	**1176**	**1043**
Punan	Family	71	83	7	34	26	19	**125**	**122**
	Genus	217	218	19	60	47	33	**432**	**415**
	Species	598	420	27	95	70	46	**1060**	**976**
Combined	Family	73	94	8	37	28	28	**136**	**134**
	Genus	249	286	30	79	63	44	**528**	**515**
	Species	779	620	50	148	116	69	**1457**	**1340**

*Total when 'firewood' and 'hunting place' uses are excluded.

Table 5.31 Total records for plant uses/values reported to be exclusive to a single species

Ethnicity	*Taxa*	Trees	Herbs etc	Monocots	Saplings	Seedlings	Shrubs	*Total*
Merap	Species	20	79	7	4	1	1	106
Punan	Species	9	26	5	2	0	0	40
Total	Family	21	57	8	5	1	1	85
	Genus	24	74	8	5	1	1	106
	Species	24	87	8	5	1	1	119

Table 5.32 Number of different plant uses/values per use-class (see Table 5.2 for explanations)

Ethnicity	Food	Medicine	Light construction	Heavy construction	Boat construction	Tools	Firewood	Basketry/cordage	Marketable items	Ornamentation/ritual	Hunting function	Hunting place	Recreation	Total
Merap	361	259	273	178	165	281	277	120	76	132	97	263	39	1,176
Punan	320	199	402	137	142	284	346	98	49	70	69	458	53	1,060
Total	476	336	510	212	203	399	469	151	96	138	115	518	73	1,457

Table 5.33 Total records for plant uses/values reported to be exclusive to a single species by class of use

Ethnicity	Food	Medicine	Light construction	Heavy construction	Boat construction	Tools	Firewood	Basketry/cordage	Marketable items	Ornamentation/ritual	Hunting function	Hunting place	Recreation	Total
Merap	9	28	0	0	0	18	0	5	35	7	11	0	1	106
Punan	3	1	0	0	0	17	0	5	11	2	4	0	0	40
Total	*12*	*28*	*0*	*0*	*0*	*25*	*0*	*7*	*37*	*7*	*12*	*0*	*1*	*119*

proportion of useful species. If we look within a single use-class the picture is less clear, as is the case with food (Figure 5.19) and medicinal importances (Figure 5.20). We are not ready to interpret all these patterns but the obvious and expected trends (e.g. more useful trees in horticulture) give credibility to seeking explanations for more subtle differences. 'Ornamental/ritual' and 'hunting place' (Figure 5.21 plots these as 'plot-mean' importances) are illustrative of two very different patterns. The first class is scarce and suggests a 'fallow' focus. The second points to likely differences in the ecological knowledge of the Merap and Punan.

Finally, we may ask if vegetation that is richer in species is richer in uses/values. The answer from initial analyses is yes (see Figure 5.22). The proportion of useful species increases in rough proportion to the overall species count (this monotonic relation is highly significant at $P<0.001$, by tree and non-tree vegetation for both ethnic groups). There are no obvious patterns, for either trees or non-trees, of plot richness versus proportion of useful species.

Figure 5.18 Scatter summary of the per-plot proportion of all valued/useful species recorded by plot type, according to Merap and Punan informants (see Figure 5.2 for explanation of sample classes)

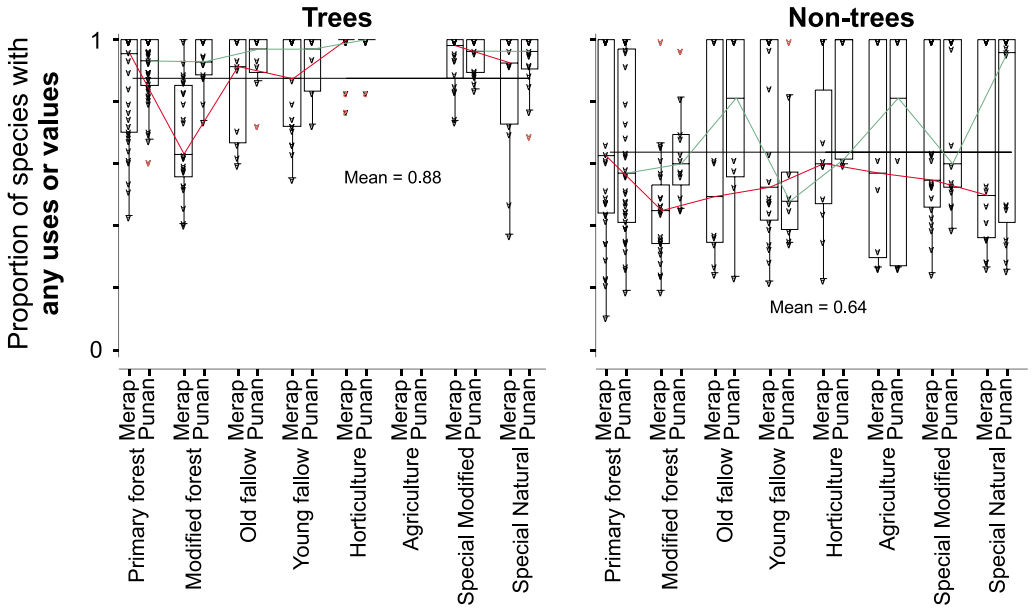


Figure 5.19 Scatter summary of the per-plot proportion of all food-value species recorded by plot type, according to Merap and Punan informants (see Figure 5.2 for explanation of sample classes)

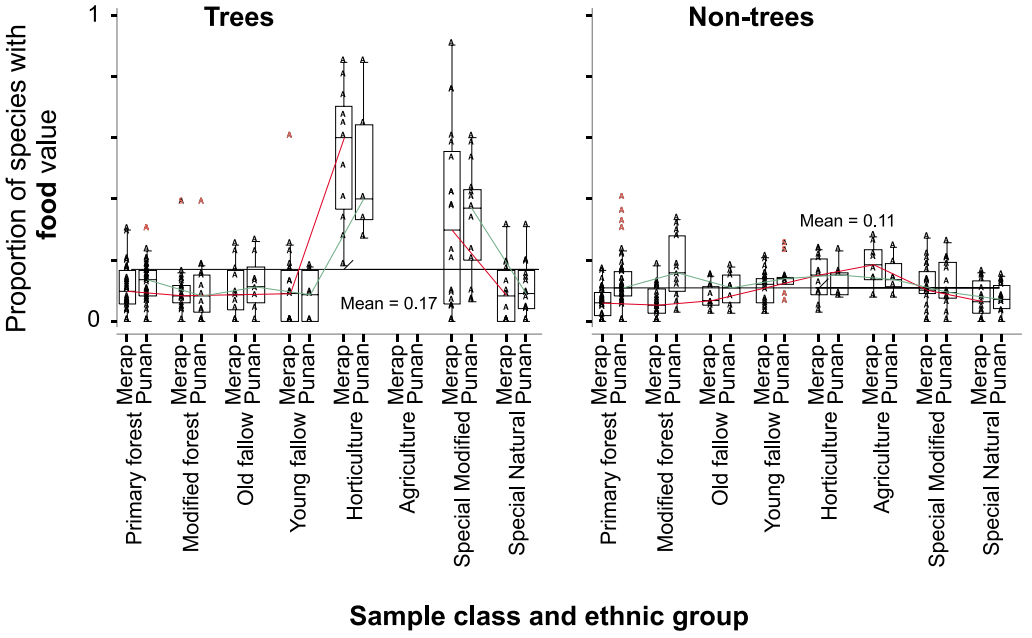


Figure 5.20 Scatter summary of the per-plot proportion of all medicinal-value species recorded by plot type, according to Merap and Punan informants (see Figure 5.2 for explanation of sample classes)

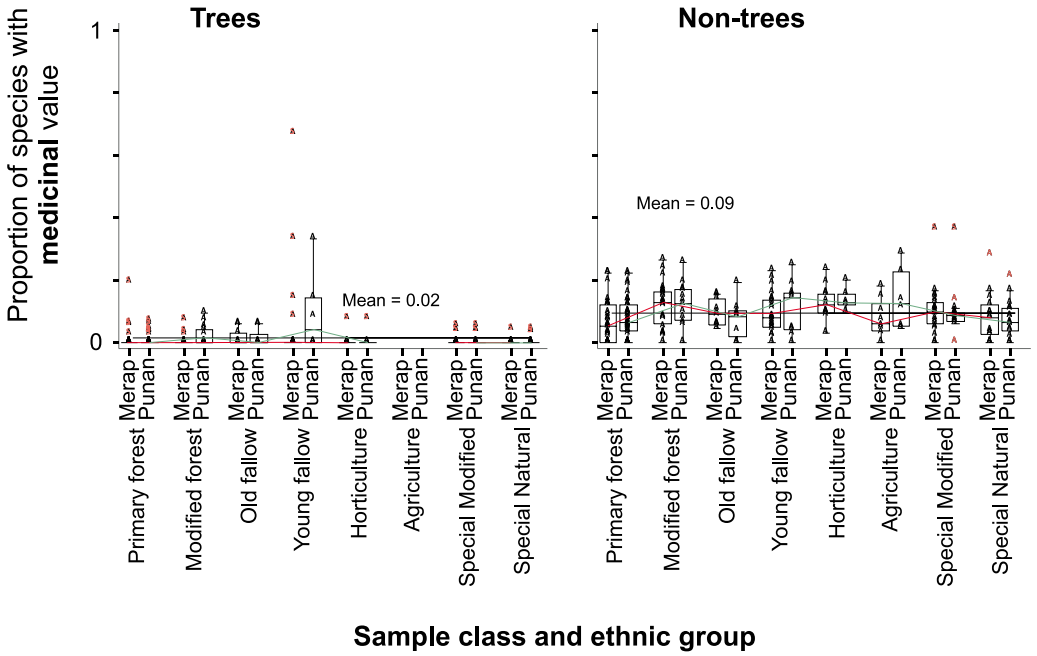


Figure 5.21 Summary of the mean per-plot proportion of useful species recorded by plot type according to Merap and Punan informants for value classes 'ornamentation/ritual' (a, b) and 'hunting place' (c, d) (see Figure 5.2 for explanation of sample classes)

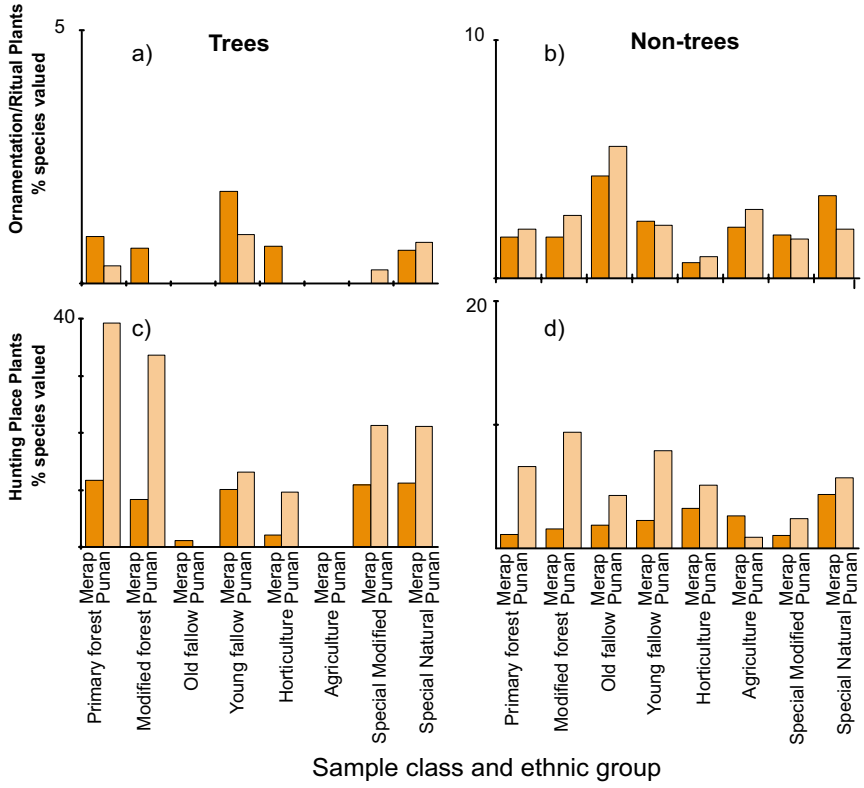
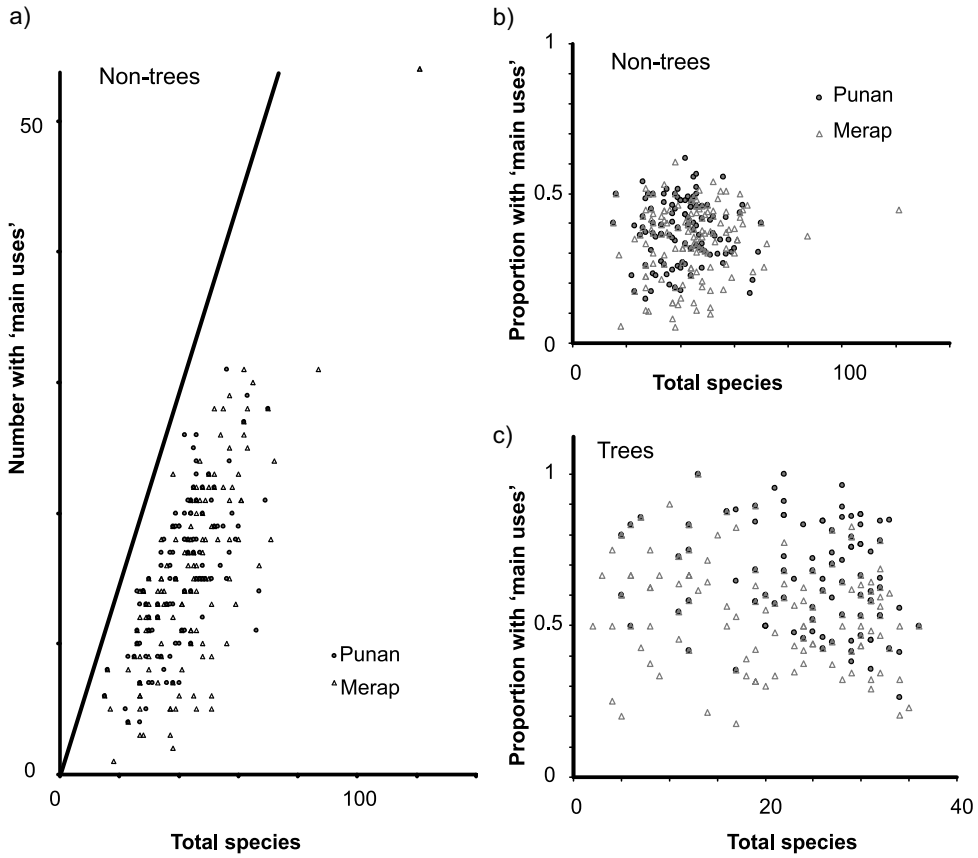


Figure 5.22 a) Plot species richness versus species use. The line is 1:1. While the number of useful species is closely related to the total number of recorded species, there is no clear relationship between community richness and proportion of species used for either trees or non-trees (see b,c). 'Main use' values noted here are all classes except firewood and 'hunting place'.



General conclusions

Many people perceive a decline in important resources, especially the animals they hunt for food and plants they rely on for daily needs and trade.

A shortage of preferred construction materials (e.g. 'ulin' *Eusideroxylon zwagerii*) and boat building materials is already being felt in Seturan village. People from the nearby village of Tanjung Nanga, who are in an even worse position, have been caught stealing timber from Seturan lands. Much of the 'ulin' in the Tanjung Nanga territory has been harvested and, in addition, a fair amount may have been lost in a large fire in the early 1980s. One interesting response to this resource depletion is that in Seturan some communities promote *de facto* protected areas where there is mutual agreement on the need to keep forest cover.

Unlogged forest is considered the most important land for communities, with wild pigs and timber trees amongst the most important species found there. Logged-over forest is given a low preference by local communities. There appear to be a number of reasons for this. These include a diminished level of key resources, reduced physical accessibility and reduced access rights. For example, timber resources for local building are no longer accessible even though these areas are often close to the communities. Even if they had the right to cut the timber the best wood has often been taken already and the damage to the forest makes access difficult. Pigs, a preferred food species, are said to be reduced in logged areas. Certain emergency forest foods, such as sago, are reduced unnecessarily by logging. *Eugissonia*, the most important sago, which grows on ridge tops, is often damaged by skidtrails.

The practice of understorey slashing in logged compartments has hurt local communities and forest biodiversity. Government logging regulations (TPTI) require timber companies to repeatedly slash all undergrowth and climbers (which include many useful and prized species such as rattan), in an effort to encourage regeneration within the concessions. Our observations show that understorey cutting is widely applied as a blanket prescription, but timber seedlings are often slashed along with the rest. Even if applied properly, its silvicultural benefits are dubious and the biodiversity impacts are considerable. The policy should be revoked.

Fish

The main survey did not directly assess aquatic resources, recognising that a different sampling approach and specific expertise were required. To address this Ike Rachmatika was hired from LIPI to undertake a study of fish fauna with a similar emphasis to the main surveys. Again, the linking of species and ecology information with local needs and preferences was emphasised.

The first survey, conducted from November to December 1999, coincided with the rainy season. The second survey, conducted from October to November 2000, started before the rainy season was fully underway and the water levels were generally low. In the first survey fish were sampled from 46 sites, while 59 sites were sampled in the second period. Electro-fishing (10 A, 12 V) was employed for about one hour per sample site. In deeper water, this was combined with ten cast nettings. Apart from this regular sampling, additional specimens were collected using hook and line, at night. Information on fish diversity was also obtained by examining the catches of people in Seturan village. Interviews using illustrated books also added to information. Specimens of all collected species were preserved and taken to the Fish Section, Balitbang Zoologi at LIPI's Research and Development Center for Biology for analysis.

Forty-seven fish species, in 33 genera, 13 families and three orders were recorded. Carps (Cyprinidae) dominated, followed by hillstream loaches (Balitoridae) and bagrid catfish (Bagridae). Fifteen recorded species (31.91%) are Borneo endemics (*Garra borneensis, Hemibagrus baramensis, Puntius sealei, Nematabramis everetti, Parhomaloptera microstoma, Protomyzon griswoldi, Leptobarbus melanotaenia, Homaloptera stephensoni, Betta unimaculata*, *Gastromyzon* cf.*lepidogaster, Gastromyzon* sp, *Neogastromyzon* cf. *nieuwenhuisi*, *Clarias anfractus, Parawaous megacephalus* and *Ompok sabanus).* The genera *Gastromyzon* and *Neogastromyzon* are endemic to Borneo. Many of the hillstream loach species had not been previously known to inhabit the survey area.

Two new forms, a *Puntius* and a *Gastromyzon,* were found in Seturan and Rian Rivers and appear to be undescribed species.

Garra borneensis was the most abundant species in the both samples, and *Nematabramis everetti* and *Garra borneensis* were the most widely distributed in 1999 and 2000 respectively.

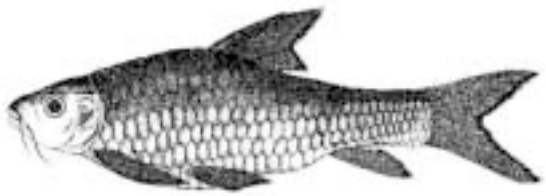
Local informants were able to identify 45 fish species shown to them in pictures. However, small species such as *Pangio anguillaris*, *Parhomaloptera microstoma*, *Protomyzon griswoldi* and *Betta unimaculata* were usually recognised by only the more experienced.

Using a PDM type approach, villagers were asked to rate fish according to the following categories: 'most commonly caught fish', 'most often eaten fish' and 'most preferred fish' Despite the potential for overlap between classes, the differences were illustrative.

The most prized fish are usually those which have fewer bones and can attain a large size. The larger species include *Hampala macrolepidota*, *Tor tambra* and *Tor tambroides*, *Barbodes balleroides, Barbodes* sp., *Leptobarbus melanotaenia* and *Osteochilus kahajanensis*, all of which are widely eaten. *Tor* spp. *(Tor tambra* and *Tor tambroides,* Figure 5.23), are the preferred fish in Seturan and Loreh village and rank a close second to *Pangasius* in Langap. Other popular species include *Leptobarbus melanotaenia*, *Osphronemus* sp., *Barbodes balleroides* and *B.schwanenfeldii*, *Hampala macrolepidota)* and *Lobocheilus* cf. *bo*. *Pangasius*, *Barbodes* and *Tor* are reported as the most important species in the diet in Seturan, while *Barbodes* spp. and *Cyclocheilichthys armatus* are top in Langap, and *Clarias, Ompok* and *Hemibagrus* are the most eaten in Loreh.

Pangasius sp. was not recorded during the sample survey. Local informants said this species migrates annually upstream from the lower reaches

Figure 5.23 *Tor tambra* and *Tor tambroides* are generally the preferred fish in the diet of most people interviewed in the Malinau valley



These much sought-after species are highly forest dependent, eat fruit, are intolerant of siltation, and have low reproductive rates, making them vulnerable to forestry interventions and overfishing.

of the Malinau River up the Seturan River, during the dry season. This species is in high demand and locally expensive, and is said to be increasingly rare in the Seturan watershed.

While some preferred fish are sold or bartered, most people catch fish for their own domestic consumption. Men and women fish differently. Men generally use gill nets (*pukat*), cast nets (*jala*), spool and line (*pancing*) and spears (*tumbak*). Women use dip nets (*tangguk*), traps (*bubu*), and spool and line (*pancing*).

Tor spp. are present in both the Seturan and Rian Rivers. The adults live in deep clear pools while the juveniles live in shallower tributaries. These are important food species and are indicators of both relatively undisturbed forest and good water quality. They are frugivorous and are believed to be associated with the presence of *Dipterocarpus* or *Ficus* growing along the bank. These fish should be viewed as vulnerable as they require clear water, are dependent on forest vegetation, are easily caught, have a relatively low fecundity and are keenly sought. *Tor* spp. are not the only important species with an apparent reliance on forest habitat. Other frugiverous species include the sought-after *Pangasius, Osphronemus goramy* and *Leptobarbus*.

Some fish are also believed to have medicinal value. Eating *Clarias anfractus* is believed to help woman recover after giving birth. The spiny pectoral fin of *Hemibagrus* cf. *nemuru,* is used to treat toothache, while the second dorsal fin of this species can be used to counter an injury caused by the spiny pectoral fin of the same fish. The mashed flesh of *Puntius* sp. is applied to caterpillar stings.

Between the 1999 and 2000 surveys there was a slight decrease in the abundance of several species consumed by people (*Barbodes* cf. *balleroides, Hampala macrolepidota, Leptobarbus melanotaenia, Osphronemus septemfasciatus, Tor tambra, T.tambroides* and *Lobocheilus* cf. *bo*.). However, with only two time points, small sample sizes (and different weather in the sampling periods) such differences are not yet adequate evidence to claim any general decline.

Seven species were not found in the logged areas in 2000: *Garra borneensis, Homaloptera stephensoni, Leiocassis* sp., *Neogastromyzon* sp., *Mastacembelus unicolour*, and *Tor tambra*. The ecology of these fish is not well known. However, this survey suggests that *Leiocassis* sp. and *Mastacembelus unicolour* prefer living in rock- or gravel-bottomed areas and are likely intolerant of siltation.Several other species are identified as sensitive to siltation, including: *Gastromyzon lepidogaster, Anguilla malgumora, Nemachilus* spp. and the shrimp species *Macrobrachium* spp. The absence of *Tor tambra* and *Garra borneensis* in the logged areas is probably not a result of forestry activities, as the sampling localities constituted unsuitable habitat, with small shallow forest streams with muddy-sandy substrate. These species require sufficient water depth, current and a gravel-rocky substrate. Similarly, *Neogastromyzon nieuwenhuisii* and *Homaloptera stephensoni* require faster, clear water.

Poor road construction and blocked culverts often leads to large bodies of still water called 'Ponding'. Three species were abundant in the ponds observed: *Cyclocheilichthys armatus*, *Nematabramis everetti* and *Puntius binotatus*. These are common species.

The water quality in streams in the logged areas (including dissolved oxygen, pH and water temperature) was little different from unlogged areas. All variables seemed acceptable for fish survival. Overall, suspended matter detected in the logged areas, and downstream, varied from 20 to 70 mg/l in 1999 (which is below the threshold value of 80 mg/l considered detrimental to fisheries). By the 2000 survey, however, water clarity in previously logged plots had already improved again and siltation was flushed away.

Several local species seem to have potential for cultivation: *Osphronemus septemfasciatus, Leptobarbus melanotaenia, Tor* spp, and *Osteochilus*

kahajanensis (for food); and *Betta unimaculata*, *Puntius* sp, *Puntius sealei, Osteochilus waandersii,* and *Rasbora* spp. (as ornamentals). However, the practicality of such developments has not been assessed.

Reptiles and amphibians

Amphibians and reptiles were investigated in the area of the CIFOR station and Seturan River during June–July 2000 in research led by Djoko Iskandar from the Bandung Institute of Technology. Seventy-eight species were recorded. Specimens confirmed 51 species, and this was later raised to 65 by additional sampling by two students from Aberdeen (Dyfrig Hubble and Duncon Lang). Not all determinations are complete. By combining data and information from local people, over 125 species of amphibians and reptiles are potentially present in this area. The area is relatively poor in individuals, but species diversity appears high with new taxa being located continuously, up to the end of the field period. Local people had knowledge about many of these but made limited use of them. At least two species representing genera *Ansonia* and *Limnonectes* appear new to science. Only one species of crocodile occurs, though these are very rare.

Although a number of amphibians and reptiles are occasionally hunted as food, they are given low preference in comparison with pigs or indeed with most other mammals. Local people eat four frog species of the frog genus *Limnonectes* (*ibanorum, ingeri, leporinus* and '*kuhlii'*), as well as *Fejervarya cancrivora* (a frog species of cultivated areas) and *Hoplobatrachus rugulosus* (an exotic frog species). These species can attain a size of 10 cm or more and, though valued by local people, are not sold. Under the correct lunar conditions *L. leporinus* is said to aggregate in the river where they are easily collected by cast net (*jala*). Other frog species are used as fish bait. Although *Bufo sumatranus* (*'jau'i'*, also known as *B. juxasper*) is occasionally eaten, toads are generally known to be poisonous and not used .

Among snakes and lizards, only pythons and water monitors are regularly eaten. All turtles are eaten and their eggs are also collected for food. Turtle nesting sites are generally well known. Turtles are also traded, with red-listed *Heosemys spenosa* (spiny hill turtle), being offered for sale to the expedition for Rp. 50 000.

Most local people are afraid of snakes, even small ones, and any snake encountered is killed or avoided. The poisonous *Tropidolaemus wagleri, Ophiophagus hannah, Bungarus flaviceps* and *Naja sumatrana* represent a genuine danger. *Ophiophagus hannah, B. flaviceps* and *N. sumatrana* are deadly. The Punan people collect the poison of *Ophiophagus hannah* for the tips of their blowpipe darts.

The reported occurrence of an undescribed poisonous varanid is biologically interesting. People of all ethnic groups claimed that their dogs died *rapidly* after being bitten by this species. No Asian lizard has ever been proven poisonous.

The occurrence of the invasive Taiwanese frog (*Hoplobatrachus rugulosus*) needs further investigation and potentially threatens the existence of local species. According to local people, it is a recent arrival (since 1997). It was first reported in the wild in Borneo in Sabah in 1978, having escaped local cultivation. These observations suggest that the invasion proceeds at a rate of about 20 km per year. The species is already collected for food.

Although data are preliminary, observations suggest logging has limited immediate impact on the overall diversity of local amphibians and reptiles. However, amphibians are potentially sensitive to various types of interventions, as will be noted in the following sections.

Wildlife survey

The Wildlife Conservation Society (WCS Indonesia) provided CIFOR with a pre-harvesting survey of wildlife in the CIFOR-INHUTANI II study area. An earlier study by WCS in neighbouring areas (O'Brien 1998) will not be summarized here but yielded a pilot evaluation and initial species lists for the wider area. Surveys of mammal, bird, and selected invertebrate communities were conducted during September–October 1998, in three contiguous 100-ha forest cutting blocks assigned for reduced-impact logging (RIL compartment 27) and conventional logging (CNV compartments 28 and 29) and in an adjacent unlogged control (called 'control' here). A full account is provided in O'Brien and Fimbel (in press). The results will be briefly summarized. It should be emphasized that *all these results derive from areas prior to logging*.

Mammals

A total of 31 species from 10 families were identified. An additional five mammal species were observed but could not be positively identified.

The RIL and CNV sites have similar species compositions though sample sizes are limited. Similarity indices (Morista-Horn) between the three treatment sites ranged from 0.65–0.95, with the CNV and RIL sites most alike in their relative abundances of primates (0.95), but less alike in their squirrel populations (0.73).

Two species of particular conservation significance, *Macaca nemestrina* and *Lutrogale perspicillata* which were recorded in the survey area are listed as vulnerable in the *1996 IUCN Red List of Threatened Animals*.

Birds

A total of 239 bird species were recorded in the survey area and surrounding landscapes. Of these, 178 represent lowland-dependent forest birds (c. 73% of the lowland forest birds in Borneo). Families with the most recorded species included Timaliidae (18 species), Pycnonotidae (12 species), and Picidae (12 species).

Twenty-nine bird species belong to an IUCN Red Book class. One is 'endangered' (*Ciconia stormi*); six 'vulnerable' (*Argusianus argus, Carpococcyx radiceus, Lophura ignita, Rhyticeros corrugatus, Rollulus rouloul, Spizaetus nanus*); one 'data deficient' (*Batrachostomus auritus*); and 21 'near-threatened'. Nine species are Borneo endemics.

Species diversity, evenness, and richness varied little between the study compartments. Road counts of already logged areas, however, produced consistently higher values than unlogged blocks. Jaccard's similarity index indicated that the RIL and CNV sites had the most similar bird communities (S_j=0.58), while the RIL and control sites were the least similar (S_j =0.50). The Morista-Horn index for the seven hornbills observed in the study showed a similar relationship among the sites, with the CNV and control sites the most similar (0.96), while the RIL and control sites were the least similar (0.77).

Snares to catch deer and pheasants were often encountered in the forest. Select species such as hill mynahs (*Gracula religiosa*) and blue-crowned hanging parrots (*Loriculus galgulus*) were captured and caged by villagers though both of these were still found in fair numbers in the forest. The straw-headed bulbul (*Pycnonotus zeylanicus*), a popular songbird, appears to have been collected to the point of extirpation.

Invertebrates

Thirteen insect orders consisting of 79 families were collected from pitfall traps, and 16 insect orders, consisting of 168 families, collected from sweep nets. The diversity of insect species within the three sites varied little using Simpson's index, with the control being the lowest, regardless of the survey techniques employed (1-*D* ranging from 0.99–0.89). For ants, however, the control site exhibited the highest diversity (*H'* = 3.52, Shannon-Weiner index), even though only four of the 28 sampling areas occurred in the control. The CNV site was also relatively high (*H'* = 3.43), with the RIL site lowest (*H'* = 2.95). Finally, sites were rather dissimilar in their insect species composition (Jaccard and Sorenson similarity indices; values ranging from 0.26–0.46 and 0.41–0.63 respectively), with the RIL and CNV sites the most similar and the RIL and control sites the least similar, regardless of the survey technique. Ants showed even higher variability in the similarity of their species composition between the three sites (CNV and RIL sites were 0.70, while the CNV and control sites were a mere 0.01; Sorenson index).

A total of 63 butterfly species (excluding Lyceneidae and Hesperiidae families) were recorded in the RIL and CNV sites. This is equivalent to species numbers recorded during similar periods at other forest sites in Southeast Asia.

Ecological processes

Decomposition rates for leaf litter were lower in the CNV site compared to the RIL site but not significantly. Herbivore damage to seedlings was highly localized, but no difference was detected between the treatment areas.

The data presented in this wildlife study provide baseline information against which subsequent data collected from the sites after logging may be compared. While the three study sites were relatively similar in their faunal composition, some significant differences in species composition and richness were observed between the CNV, RIL, and control areas. These differences may be the result of

different site attributes. Post-logging comparisons are liable to be confounded by such differences.

Review of fauna sensitivity

Current conceptions of 'good' practice in tropical high forests are preoccupied with silvicultural practices. Yet, researchers from many disciplines of tropical biology have completed work that has potential relevance to improving forestry practices in tropical landscapes. These studies, even if they do not address forest impacts directly, often contain relevant information about life history and habitat requirements for potentially vulnerable taxa. Studies of the ecology of individual species can thus identify possible changes and vulnerabilities in feeding, ranging or other behaviour following forestry interventions, and how this affects the processes of population change. Such information can guide forestry activities, and may be of greater utility than any statement of how densities of taxa may change in any one logging study.

A literature review and synthesis was completed based upon the list of taxa already recoded by CIFOR and WCS in Malinau. The aim was to synthesize relevant ecological information on each species selected for review. This included studies published in peer-reviewed journals and 'grey' literature. Experts were also invited to contribute relevant information on the species with which they were familiar. These experts were later asked to comment upon the results of the literature assessment and to make further management suggestions. At first glance there appears to be considerable information about the wildlife of Borneo (East Kalimantan in particular). However, our review reveals areas where crucial information is lacking and thus serves as a guide to future work.

The species selected for review were chosen (a) because previous studies had documented their vulnerability to logging (i.e., insectivorous understorey birds) or (b) because of availability of literature.

Literature availability

A total of 152 vertebrate species were reviewed for this study (40 bird, 29 mammal, and 83 amphibian). There were strong biases in the amount of literature found for each vertebrate taxa. Mammals were the most strongly represented in the literature, with 60 peer-reviewed articles and 44 grey literature and secondary literature sources (average = 3.6 articles/species). Birds followed with 49 peer-reviewed articles and 33 grey literature and secondary literature sources (average 2.1 articles/species). Amphibians were far behind with a total of 15 articles (average = .2 articles/species).

Survey studies predominate in the literature. These studies are useful in determining population densities, habitat preferences, and to a limited extent, social behaviour. The results of comparative surveys in unlogged and logged areas have been used extensively to recognise species' population responses to habitat alteration. However, such studies cannot identify the particular ecological characteristics of the habitat by which relative abundance is determined.

Ecological studies of individual species are the most useful in identifying changes in feeding, ranging or other behaviour following logging, and how this may affect their population densities in logged forests. However, the representation of such studies from this region in the published literature is very low. For example, from 1998 to 2000, Indonesian fauna were the subject of less than 1% of research papers in six major ecological journals. Less than 4% of the papers published in these journals were on Southeast Asia. Moreover, many of the studies in the published literature are 'short-term', lasting from 3–6 months. Due to the variability of annual patterns in forest systems, conclusions from such studies can only be considered as tentative. This highlights the importance of grey literature in locating ecological information on Indonesian fauna. The problem is in obtaining it. Most are archived in regional offices and have limited availability.

A majority of the species reported from BRF have no literature available beyond distributional ranges, habitat associations, and qualitative diet. Even among mammals, the best-studied vertebrate group, many species have received no systematic ecological field study.

Of the 40 bird species selected for review there are relatively few whose ecology is known well. Only four species could be considered 'well-known' and 21 'moderately known' within Borneo.

A total of 29 of the 80 mammal species potentially found in the area were reviewed. Of these species the ecology of 41% can be considered 'well

known' and 38% 'moderately known'. Many of these species have a role in seed dispersal and forest regeneration.

Expert input

Twenty ecologists were invited to document relevant natural history findings on species with which they are familiar and to comment on associated forest management issues. They were able to synthesize much of the available data into usable information and to point to specific sources of information. Ten authors were contacted after a working draft of the review for review and comments. Where appropriate, their considerations have been added to the information review and to the conclusions.

Birds

For the observed species, we have general ideas of their actual diet but for most, there is no detailed information regarding diet selection that may be important for understanding causal relationships between vegetation/ environmental changes and changes in species abundance. Detailed analyses of food and environmental requirements, including foraging tactics, are also required to elucidate the questions of competition, coexistence, and displacement.

Small-bodied understorey frugivorous birds, such as flowerpeckers, occur in lesser abundances in recently logged forests. These birds feed on small fruit resources, many of which are destroyed during logging. There is almost no literature on the dietary, social, or breeding habits of flowerpeckers.

The impact of habitat change on the abundance of pheasants is poorly known, and may vary strongly amongst the different pheasant species. Although most species may be found in (selectively) logged forest, the limits of their tolerances to habitat alteration are not known.

The role of predation on bird distribution and abundance is difficult to determine. Logged forests may support higher abundances of potential nest predators and may also make some nests more visible or accessible. Observations are needed to assess natural mortality on the nests, habitat selection for nest sites, and adult recruitment.

There are several studies now on the effects of logging on bird species composition and number. There is, however, a lack of data on the long-term recovery of birds from logging and this is usually in the form of pseudo-time series, which can give misleading results due to variation in logging intensities, and to pre-logging differences.

Why birds forage in mixed flocks, and the composition of these flocks, is poorly understood. The disruption of continuous habitat elements by logging may have deleterious effects on the mobility of these flocks, and the local survival of species that depend on undisturbed flock foraging. Mixed flock data should be collected to clarify the response of different kinds of flocks (canopy, understorey) to forest fragmentation and degradation. There must be foraging niche partitioning in mixed flocks to reduce intra-flock foraging competition. When habitat is disturbed, the food resource must shift and this must change competition dynamics within a flock. This may increase intraflock foraging competition and lead to a reduction in numbers of some species, and an increase in numbers in others.

Mammals

Primates

The findings from most studies of primate populations in disturbed habitats are that some species thrive while others do not. The most important factor affecting a species' persistence is an ability to change the relative proportions of different food types in the diet, specifically to exploit available new leaves in the absence of fruit. Highly specialized frugivores are less able to do this. The most successful species are those which can survive on a largely folivorous diet, even if they are behaviourally frugivorous in primary forest.

Behavioural changes following logging can lead to quite complex alterations in social organization. One study of banded leaf monkeys has shown that smaller and more evenly dispersed food sources lead to groups splitting into smaller foraging subunits following logging. Leaf monkeys also abandoned territoriality.

Territorial species typically avoid moving away from their former ranges even while logging is occurring. Abandonment of territories occurs only where food resources are critically depleted. Highly territorial animals such as gibbons may remain within their former ranges even following forest clearance or fires that destroy a high proportion of trees.

Squirrels

It is usual in tropical rainforests for a large number of diurnal squirrels to live sympatrically. In the dipterocarp forests of Borneo, segregation is seen when fruit is abundant, but this peak fruit crop is not predictable and can be exploited by species able to persist on alternative foods for most of the year. At times of low fruit availability, high dietary overlap occurs, with all species feeding on a few common fruiting trees and alternative foods.

Reported responses of squirrels to logging in Peninsular Malaysia do not follow clear patterns. Terrestrial squirrels seem least able to adapt to conditions in logged forests. This can probably be attributed to changes in food abundance and competition with other taxa, but data is limited.

Southeast Asian flying squirrels of the genus *Petaurista,* despite being naturally frugivorous, are able to incorporate leaf material into their diet at times of fruit shortage and this assists their persistence in logged forests. Densities are said to decline in older logged forests, suggesting an alternative limiting factor, such as availability of daytime refuges or increased predation.

Civets

Civets form a highly diverse and prominent group of carnivores, with both terrestrial and arboreal species. Some civets feed exclusively on sugar-rich and soft-pulped fruit. A decline in civet density has been observed in logged forests in Sabah. Predominantly carnivorous species, mainly feeding on invertebrates, were reduced to a greater extent than palm civets, which incorporate larger quantities of fruit into their diet. In contrast, increases after logging have been documented in Peninsular Malaysia.

Forest ungulates

The genera *Tragulus* and *Muntiacus* are small, forest-dwelling deer. They are among the least studied of ungulates. Until 1992 no field studies had been carried out on any *Tragulus* species (mouse deer), and in the case of *Muntiacus*, no field studies had been completed in Southeast Asia (two were carried out in South Asia). *Tragulus* and *Muntiacus* appear to be more common in logged forests than in mature forests in Peninsular Malaysia. Densities tended to decrease again in older logged forests. However, in Sabah, mouse deer occurred in reduced densities in logged forests, while densities of yellow and common muntjac did not differ significantly between forest types. Fallen fruit forms a significant proportion of their diet.

Mammal research suggestions

Small mammals are important prey for predators. This importance as a prey base argues for long-term research and monitoring of small-mammal populations and communities in a number of habitats throughout the ecosystem. This should include in-depth research on population dynamics, habitat use, community structure and ecosystem influences, including the effects of habitat disturbance and fragmentation. Such population and community studies should be conducted in concert with long-term studies of the entire predator guild. Only in this way can competitive relationships among predators be fully understood.

The role of mammals in seed dispersal and seed predation needs to be examined in detail. Taxa likely to be of particular interest are civets, bats, mouse deer, primates, squirrels, and mice.

An investigation of the role of bearded pigs in forest ecology is also justified. Bearded pigs are known to be major seed predators. Loss of dipterocarp seeds due to logging would result in pigs feeding more on the seeds of other plants, affecting seedling survival and subsequent regeneration. Also, pigs may feed more heavily on the remaining dipterocarp seeds produced after removal of dipterocarps during logging. With fewer trees, fewer dipterocarp seeds would be produced during mast years and the strategy of satiation would be ineffective. Pigs would consequently eat a larger percentage of the dipterocarp seeds produced, limiting regeneration. Exclosure studies could effectively investigate this question.

Amphibians

Anurans are probably the principal terrestrial insectivores in tropical rain forests and yet the ecology of this component of the rainforest has been dealt with in only a relatively few published studies. It is important to examine the ecology of the different anuran life stages separately, in order to assess the effects of habitat disturbance.

Amongst the 83 species of frogs identified at Bulungan, two assemblages are readily differentiated, with little overlap in species

composition: riparian and non-riparian. Forty-one species are associated with streamside environments, 39 do not breed in, or spend their adult life near streams, and three species are incompletely known. Not all 41 species of the riparian environment are wholly restricted to this zone (Inger personal communication). One, *Pseudobufo subasper*, is aquatic. Seventeen species breed and feed along streams and are thus fully restricted to this environment. An additional 22 species breed in streams or in rock pools at the sides of streams, but spread widely through the forest and apparently spend their post-metamorphic stage and much of the remainder of their lives away from flowing water. The last species, *Barbourula kalimantanensis,* is found along stream banks, but its exact breeding site is unknown. Among the non-riparian frogs, 31 species require pools or ponds to lay their eggs. Four species require treeholes and three require swamps or seepages. Only *Philautus mjobergi* lays its eggs directly on the forest floor, omitting an aquatic larval stage.

There is little specialization in the diets of frogs. The entire group feeds mainly on abundant non-aquatic invertebrates and overlap between diets is extensive, though there is some evidence of species specialization. There may be a slight correlation between the size of the frog and the size of the prey consumed.

Terrestrial frogs require either treeholes that fill with water or isolated pools in shallow depressions on the ground or potholes in rock outcrops. Riparian species of tadpoles are not uniformly distributed among stream habitats. Stream width and gradient have been found to have the most significant effect upon variation between frog communities, and

Bornean tadpoles appear to partition habitat and food. There are indications of stability in species composition within sites over time. Three factors seem to be involved:

1. Sites of oviposition determine the range of possible habitats in which tadpoles of a particular species may be found. One distinction is whether females may oviposit in streams or in the forest, at some distance from a stream.
2. Tadpoles are specialized for the physical structure and environmental conditions of the habitats in which they live. The larval *Ansonia albomaculata* have streamlined bodies and expanded suctorial lips, and larval *Amplops* have abdominal suckers enabling them to cling to rocks and maintain position in strong currents. Probably none of these suctorial devices function well in the silty substrates that might occur as a result of the higher runoff documented in forests after logging, possibly limiting occurrence of these larval species in disturbed environments.
3. Five main feeding types are recognised among tadpoles in Malinau: obligate benthic, generalist macrophagous, midwater suspension feeding, and particulate surface film feeding.

Research suggestions

At least one study (Inger 1980) has found that in Southeast Asia hotter, drier forests support fewer arboreal and terrestrial frogs, fewer diurnal arboreal lizards, but more terrestrial lizards than lowland primary rainforests. A literature search failed to locate even one publication that specifically looked at the effects of logging on the ecology and population dynamics of amphibian populations. An investigation of amphibian and lizard populations and their ecology and abundances in logged and unlogged forests in the Malinau area would be helpful.

Logging practices influence change in the relative abundance and species number of phytophagous insects, leading to changes in insectivorous predators. These need to be explored.

Conclusion

What we have summarized and illustrated is the 'baseline data' developed under our ITTO contract. However, it is more than a collection of data; it is, rather, a foundation for future work and recommendations.

We are currently developing and checking data to allow these implications to be made more explicit. Examples of more obvious win-win opportunities include the protection of sago and other forest values in RIL, the prevention of understorey slashing, and the identification of protected areas that can be respected by all major stakeholders (grave sites, birds' nest caves, springs). These data serve as a basis for future research and for evaluating trends over time.

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6. People's Dependencies on Forests

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Introduction

Diversity and change

It is widely accepted that forest people in remote areas such as Bulungan are highly dependent on forests and on forest products for their livelihood and even for their survival. The district of Malinau in East Kalimantan where the Bulungan Research Forest is located presents one of the largest remaining lowland dipterocarp forests in Asia. It also hosts various Dayak ethnic groups and one of the largest remaining populations of hunter-gatherers in Asia: the Punan. In the past, both groups totally depended on the forest for their subsistence. The Dayak are generally considered as agriculturists, practicing swidden cultivation of upland rice, while the Punan are generally considered to be predominantly nomadic hunter-gatherers. This distinction is convenient but does not stand up to in-depth analysis. Some Dayak ethnic groups do not differ much from the Punan, and over time some groups opt temporarily for hunting and gathering before reverting to swidden cultivation. Nowadays, the line between swidden agriculturists and hunter-gatherers is even more blurred (King 1993; Cleary and Eaton 1992). Most Dayak collect forest products during slack periods in the agricultural timetable, while most Punan open swiddens on a regular basis. Again, a head of household can practice hunting-gathering during an early part of his life cycle and later opt for swidden cultivation. Furthermore, some heads of households no longer either own swiddens or collect forest products.

The forest remains of paramount importance to the entire local population. Any Dayak or Punan will be able to name dozens of species of plants and of animals of economic importance to them (Puri 2001). Forest products provide subsistence goods (staple food, vegetables, fruit, game and fish), cash income (eaglewood, bezoar stones, rattan, resins and gums) and building materials and medicinal plants. The forest as a whole is also essential to the sustainability of the swidden agriculture cycle. After one to two years of rice cropping, the swiddens are turned into a bush fallow for 10 to 20 years before being slashed and burnt again. The shading provided by the trees helps the farmer to get rid of grassy weeds, while the slashing and burning provides free and abundant fertilizer. Without quick and vigorous forest regrowth, the swiddens would turn into grasslands, which have little economic value given the techniques and means locally available (Levang *et.al* 1997).

Considering the acknowledged importance of forests to local people, one can easily imagine that the Dayak and Punan would suffer most from deforestation. The loss of access to forests and forest resources would jeopardize their livelihood, force them to quit their traditional way of life and push them into utter destitution. Logically, forest people should be hardline conservationists. It does not take long while wandering around Bulungan to become convinced that they are not! It quickly appears that people only complain about deforestation by concessionaires as long as they do not get adequate compensation, and that 'investors' are welcomed all over the Bulungan Research Forest and beyond

Sago is no longer the main staple but it still serves as a safety net in time of crisis

(Obidzinski *et al*. 2001). Even remote villages of hunter-gatherers send emissaries to Tarakan in order to promote their forests to outside 'investors'.

This apparent contradiction gives rise to many questions. Has local people's dependency on forest products been overstated? Do some depend more than others on forest products? Is hunting-gathering a deliberate choice or the only available option? Are people considering other options for themselves or for their children? Who is taking advantage of ongoing changes? Who will be on the losing side?

Study sites

The Forests Products and People programme sought to understand the nature of the dependency of local communities on forests and particularly on non-timber forest products (NTFPs). The overall objective was to elucidate policies that would lead to more secure and sustainable livelihoods for these people. The impact of changing policies and external threats and opportunities for forest dependent peoples was given particular attention. Surveys focused mainly on the Bulungan Research Forest area but work extended into adjacent areas when this contributed to the understanding of issues. Most of the research was conducted in villages and hamlets in the Malinau and Tubu watershed. As the Long Loreh area had already been intensively studied by other CIFOR teams, and in order to avoid research fatigue, we gave priority to more remote upstream villages. These villages were also assumed to be more forest dependent.

When necessary, complementary surveys were carried out outside the area, as far as Malinau, Tarakan and Tanjung Selor. Work in these areas gave insights on forest dependence in areas which were more open to outside influence and contributed to a better understanding of future developments. Some comparative studies were launched in other districts of East Kalimantan, for instance in Berau, Kutai and Pasir.

Methods

While the overall objective — to assess the importance of the forest and of forest products to local people — is rather similar to that of the previous chapter, the viewpoint and methodology differ considerably. In the previous chapter, multidisciplinary methods were employed across the landscape in order to quantify and organize local values regarding fauna and flora into a hierarchy that could help guide management decisions. In this

chapter, the stress is put on forest products of economic importance to local people. The FPP team privileged ethnographic in-depth methods. Interviews with stakeholders were conducted using standard anthropological survey techniques such as closed, semi-open and open questionnaires. In some specific cases, the interpersonal skills of the consultant allowed the collection of fairly complete and precise data, especially from eaglewood traders and fishermen[1].

For household surveys we used a semi-open questionnaire, given to randomised samples of 30 families in the larger villages and exhaustive samples in villages with less than 30 households. The questions asked concerned family data, farming system characteristics, forest product collection, off-farm activities, and incomes and main expenditures. A more open part of the questionnaire inquired about biodata, perceptions and expectations of the head of household and of his wife. In a first stage, the household survey focused on five villages located along an upstream-downstream gradient in order to account for differences in access to forest resources, access to markets and ethnic diversity. The villages chosen were Long Jalan (a Punan community in the upper reaches of the Malinau River); further downstream, Tanjung Nanga (a Kenyah community with some Punan families) and Langap (an ancient Merap village); and in the lower reaches of the Malinau River, Pulau Sapi (a Lundayeh village which recently became the capital of the Mentarang Baru subdistrict) and Respen Sembuak (a resettlement village regrouping eight Punan villages, one Merap and one Abai village which were relocated in the early 1970s from the Tubu watershed). In the second stage, we focused more on the Punan hunter-gatherer villages and hamlets still remaining in the middle and upper Tubu. The comparison between these villages and the resettled ones in Respen Sembuak provide the most valuable information about the trade-offs and pay-offs linked to resettlement and to a reduction in dependency on forests and forest products. All household surveys were complemented by the collection of anthropological data.

The survey of marketing of forest products used a trading chain approach. The forest product was traced from its collection by hunter-gatherers, its buying and reselling by local traders through to wholesalers and exporters. The survey on the impacts of concessionaires on local people and the survey of wood utilization were carried out with the assistance of the major concessionaires in the study area: INHUTANI I and II, BDMS and the mining company John Holland.

Anthropological data was collected through non-directive interviews of local people, with special attention given to village elders (men and women), heads of villages and *adat* and community leaders. Special emphasis was given to exchanges[2] among family members, neighbours and communities, to cultural aspects of economic activities, and to perceptions, wishes and visions of the future. Formal education and healthcare were given special attention as these two items emerged as the most important for local communities. Local government officials, religious leaders, teachers and development workers were often among the most relevant informants.

Results

1. Dependency on forest products for subsistence needs

The highest level of dependency on forest products for subsistence needs is found in the Punan villages of the upper Tubu. It takes four to five days by boat to reach Long Pada from Malinau. Because of the many rapids, only small boats can be used. Long-tail engines are preferred to outboard engines because the latter's propellers are too expensive. After heavy rains the rapids become too dangerous to pass and the boatmen prefer to wait for the water level to fall again. To pass some rapids the boats need to be unloaded first and then hauled through. The two villages upstream from Long Pada, Long Ranau and Long Nyau, can only be reached on foot via narrow and difficult paths.

Each village hosts about 20 families, all related to each other. Their way of life is still very traditional. Nearly all families open a swidden in primary or secondary forests once a year[3]. All work is carried out on a mutual aid basis by households organized in small neighbourhood groups (Issoufaly 2000). Agricultural activities are mainly limited to upland rice and cassava cultivation. Other crops like coffee, sugarcane, eggplants, cucumbers, peppers, etc. can be found in gardens close to the village but always in small numbers. Only very few households own orchards, generally in former settlement locations.

Fishing provides additional proteins...

In 2000–2001, the average size of a swidden was 1.4 ha and the average yield, 697 kg of paddy per ha. Only 34% of the households covered their staple food needs from the production of their swidden. On average, upland rice cultivation as locally practiced only requires 61 man-days per ha, which implies a rather high return to the man-day i.e. Rp. 15 500 per man-day. Hence, there is also plenty of time available for other activities.

The activity most favoured by men is wild boar[4] hunting. Every fit male aged 16 to 40 goes wild boar hunting on average three times a week. The hunt is organized on an individual or a very small group basis, generally two to three men with spears and three to six dogs. The hunt starts early in the morning and may last until mid-afternoon. The preference for bearded pig is due to its high fat content. In the upper Tubu, pig fat is generally the only source of fat in the diet. Roasted fat is also a feast for the gourmet. Catching anything other than a bearded pig is considered as being tantamount to returning empty-handed. For instance, hunters who catch a barking or a samba deer early in the morning kill it and abandon it in the forest. If they end up empty-handed in the afternoon they will come back to their prey and only take home the hindquarters and the antlers of the deer. Blowpipe hunting is a lonely activity reserved for specialists. Any living creature[5] in the forest becomes a target: birds, reptiles, monkeys and even bearded pig. Different species of plants are used to prepare poison[6] for blowpipe hunting. The hunted animals are always shared among all families in the settlement. Even short-term visitors are entitled to a share. Outstanding hunters enjoy prestige and are widely reputed.

Fish is plentiful in the rivers and their tributaries. Angling, cast-net fishing and trapping are frequent. Most people fish on average once a week (Mannes 2001). Still, fish is considered as merely a poor substitute for bearded pig. Though the forest contains countless edible plants, the Punan avoid porterage as much as possible. Only forest products that can be eaten on the spot are considered worthwhile picking. As a consequence, the major part of the diet is provided by crops — rice, cassava tubers, cassava leaves, bananas, pineapple, etc. — and by spontaneous species from swiddens and fallows close to the village like fern crosier[7] and *terap*[8].

The forest also provides building materials and raw materials for handicrafts. Borneo ironwood[9] or other hardwoods are used in village houses and swidden shelters for stilts. Barks from many tree species and bamboos are used for floors and walls. Leaves of the *Licuala* palm and of other trees[10] are

...but bearded pig is the Punan's favourite meat

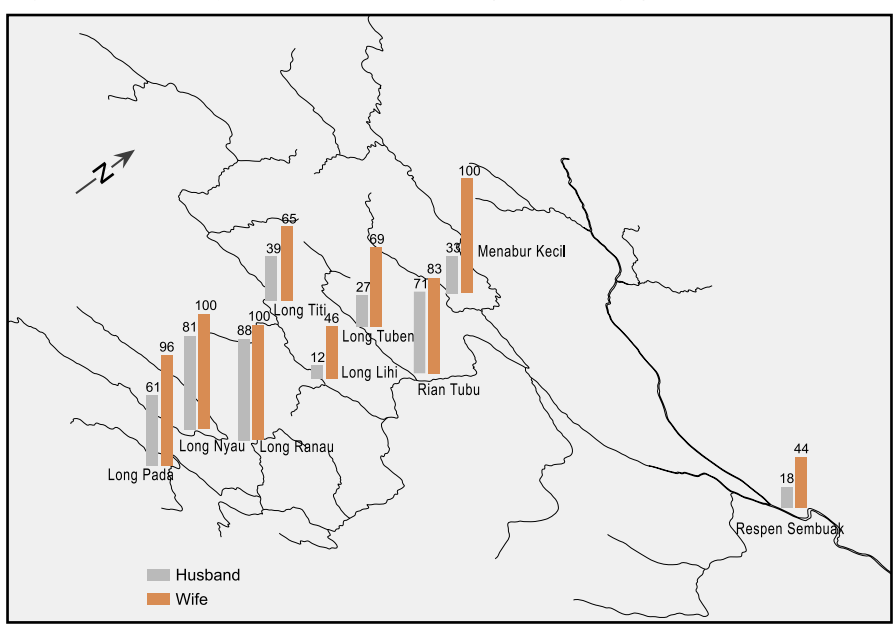
used for roofs and many species of rattan to fix all the parts of the structure together. As most of these components must be replaced frequently[11], people's preference goes to modern houses made of wooden planks with tin roofs fixed by nails. Planks and beams can be produced locally, provided that chainsaws are available. Tin roofs must be bought in Malinau and shipped to Long Pada in the upper Tubu, which doubles the cost. Porterage to Long Nyau or Long Ranau would double the cost once again. This is why only one household in Long Nyau could afford a tin roof.

Countless medicinal products of vegetal or animal origin have been recorded from the area. Information on how to use and prepare them still needs more research, as shamans are rather reluctant to give away their secrets. Shamans generally treat specific diseases, such as possession by spirits and mental disorders, but also fractures (Boedhihartono 2000). More common diseases like malaria, influenza and diarrhoea are considered as originating from downstream and as such must be treated by downstream medicine. Punan hunter-gatherers are large consumers of aspirin and paracetamol. Fever is still the main cause of child mortality and in the upper Tubu, in Long Pada, for instance, 46 children out of 100 die before the age of five.

The forest plays an important safety net role. Only one household out of three enjoys sufficient rice production to cover the family's annual needs. All others depend exclusively on cassava tubers once the rice is exhausted. One to two months before the next upland rice harvest, most families experience a food shortage. This is the period of the *mufut*, when all families leave the villages for a whole month or more (Kaskija 2000). Reviving ancient traditions, small bands of five to ten families live under tarpaulins and roam the forest looking for sago[12], game, vegetables and fruit.

There is no doubt that in remote areas like those in the upper Tubu, people are still totally dependent on the forest for their livelihood. Sago is still a staple food for the poorest families, at least during part of the year. Living in the upper Tubu has drawbacks and advantages. In the early 1970s, when a move to Respen Sembuak, the resettlement community close to Malinau, was proposed, the three villages of the upper Tubu refused to move. The main reason for their refusal was that they did not want to 'split up with the meat'[13]. It was a free choice but also a no-return choice. By opting for bearded pig, they were unable to participate in the general evolution of the province. Having little access to education and healthcare, today they are probably the most marginalized of all communities of Kalimantan. Figures 6.1 and 6.3 compare mortality and illiteracy rates between Respen Sembuak and the villages in the upper Tubu.

Figure 6.1 Illiteracy rates in the upper Tubu (in percentage)



2. Dependency on forest products for cash income

The forest provides countless products for forest people. However, only very few have a market value. The marketing of Borneo's forest products dates back many centuries. Most coastal towns of Borneo were founded by traders in order to capture the benefits of forest products, especially birds' nests for the Chinese market (Sellato 2000). Through history, many forest products had their hour of glory. Some, like Borneo camphor, *damar* resin, numerous gums and rattans, are no longer traded. Others, such as wild honey and bezoar stones, enjoy good sales but are too rare to make a living from. For the time being in Bulungan, apart from timber, swifts' nests[14] and eaglewood[15] are the only forest products that can provide a regular livelihood to collectors (Katz 1997).

Birds' nests are collected in caves, which are privately owned by the finder or his heirs. Nowadays it is rare but still possible to discover productive caves. In the villages surveyed, a handful of households had managed to find new productive caves. However, most productive caves in Bulungan have been known and managed for centuries. Gaining control over caves was even one of the main triggers for migrations and warfare in former times. In Langap for instance, two extended families subdivided into eight households control two caves producing high-grade birds' nests. Each household earns about Rp. 12 million yearly from this activity.

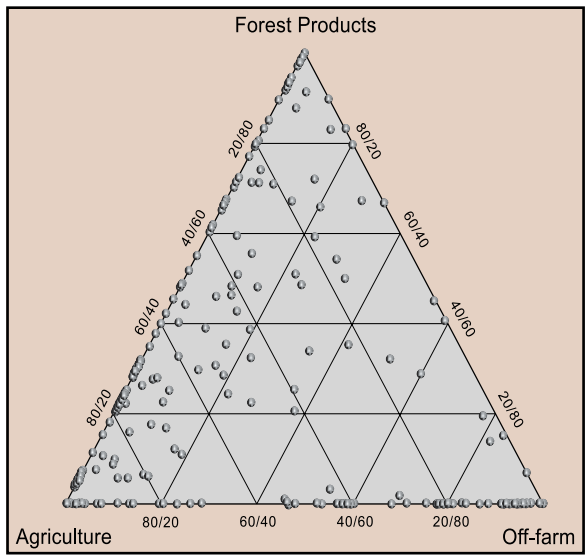
Eaglewood is the only forest product a collector can depend upon in order to make a living. Because of the high demand, the resource is being depleted in most areas. Eaglewood is still available in remote forests in the upper reaches of the rivers. Punan villages try to control access to the resource and ask for collecting fees from outsiders. The latter are generally reluctant to pay the fees and try to avoid coming too close to the Punan settlements.

In the villages of the upper Malinau, Long Uli, Long Metut, Liu Mutai and Long Jalan, nearly all households are totally dependant on eaglewood for their livelihood. Collecting tours are organized all year round, with short pauses only during the slashing of the swidden and upland rice harvesting periods. Gathering activities clearly prevail over agricultural activities. In Long Jalan, for instance, swiddens are rather small, not very well kept, fallow times are short and yields very low. One household out of four did not even bother to open a swidden in 2000. As a consequence, the production of upland rice does not cover the families' needs. In Long Jalan, collecting sago for food is tantamount to a loss of face. People prefer to buy their rice. This is a deliberate choice, as they consider it easier to buy rice with the money from eaglewood gathering rather than producing their staple food themselves. Thus, most households depend on eaglewood collection to secure their cash and subsistence needs (Figure 6.2).

Heads of households and male teenagers generally leave the village for a three-week period to search for eaglewood[16]. Punan collectors are organized in small groups of three to seven people, rarely more. They bring along their dogs, spears and blowpipes for hunting. The group has some basic cooking utensils and a tarpaulin, and each individual takes 10 kg of rice together with salt, cigarettes and medicine. All these items are generally provided on

Eaglewood (gaharu) is the main source of cash for Punan hunter gatherers

Figure 6.2 Bulungan household survey: origin of income



credit by the trader. The latter also provides credit to the families of the collectors remaining in the village. During the collecting, the group moves its camp from time to time depending on the availability of eaglewood. Cooperation amidst the group is restricted to security matters, hunting and cooking. The actual gathering for cash is always an individual activity; the harvest belongs to the finder and is never shared among the group.

After three weeks the group heads back to the village with finds worth Rp. 300 000 to Rp. 600 000 on average. Less experienced gatherers may go home empty-handed, while lucky ones may hit the jackpot. Finds of up to Rp. 30 million or more are recorded at least once a year. Such lucky finds contribute to maintaining the high motivation among the collectors. But on average, once debts are repaid to the trader, it does not take long for the collector to exhaust his pay in basic commodities (rice, sugar, salt, coffee, noodles, cooking oil, cigarettes, alcoholic drinks, medicine and clothes). Even bigger finds are exhausted in a few days on a single trip to the district capital to buy consumption goods such as televisions, generators, VCDs, chainsaws and long-tail engines. After a week's rest in the village, purchased food stocks and cash come to an end. The family quickly reaches its lending limit at the local store and soon the pressure on the collector becomes unbearable. A new expedition to the forest becomes unavoidable.

Eaglewood gathering for cash is not restricted to upstream Punan villages. Other ethnic groups like the Lundayeh, Abai, Merap, Kenyah and even outsiders from Java and Lombok also collect eaglewood. But unlike the Punan, most Dayak groups consider eaglewood collection only as a secondary activity (to agriculture) or an alternative source of income. However, when cocoa and coffee plantations along the Malinau were destroyed by the great floods of February 1999, eaglewood collection regained ground.

In downstream Dayak villages and in resettled Punan villages, eaglewood collecting is limited to one or at most two trips a year during slack periods for agriculture. Collectors are generally young heads of households or young male adults. As the resource is already depleted in nearby forests, they have to forage in forests generally claimed by upstream Punan villages. Collecting parties often consist of 10 to 20 people in order to cope with this increased risk and to avoid paying the fees provided for by customary law. Less experienced than the Punan, these occasional collectors make small finds (on average less than Rp. 300 000 per trip) but they do more damage to the resource[17].

Apart from eaglewood and birds' nests, some other forest products like rattan and game have market potential. The rattan trade came to a complete stop in the area when the commodity price plummeted in the late 1990s. Prices dropped from Rp. 5000/kg wet before the crisis to Rp. 3000/kg after the crisis in current rupiah (or to one seventh of its value in real terms). Pak Abu Bakar, the last trader to attempt to buy rattan, went bankrupt. However, locally rattan is still the basic material for wickerwork. Rattan baskets (*anjat*) and mats (*tikar*) are essential utensils for everyday life. They also play an important cultural role, as they form part of the goods exchanged between families (*sulang*) for a marriage (Césard 2001). Punan women are renowned for their ability in wickerwork and the recent influx of outsiders (concessionaires, scientists and tourists) provided a new market for handicrafts. In villages close to markets handicrafts play an important economic role, as it is generally the only opportunity for women to raise cash.

Game, in particular venison, can easily be sold on the Malinau market. However, a strong Bugis connection prevents Punan hunters from selling game on the market, arguing that the animals were not killed in a *halal* way[18] (Kurniawan 2001). If not brought to the market alive, the meat has to be sold off at

discount prices. Some informants contend that the buyer often later resells the meat at *halal* prices. Lately, direct selling of bearded pig to Chinese traders or to Respen Sembuak dwellers has been recorded.

3. Dependency on markets

Most forest products are only used for subsistence because they cannot be sold. This does not imply that there is no market for those products, but rather that there is little demand for these products on the local market or that potential markets are not accessible. This lack of accessibility can be physical (distance, absence of roads and means of transportation), financial (cost of extraction, shipping, selling price), socio-economic (limited demand, trading barriers, taxation, trade restrictions) or cultural (inappropriate product not appreciated by consumers) and more often a combination of all these factors.

However, such conditions are not immutable. Timber, for instance, is an invaluable forest product, with very little value in the upper Tubu as long as no road allows its exploitation. This is very likely to change in the near future. Agricultural products like coffee or fruits produced in the upper reaches of the watersheds cannot be sold to Malinau as long as transportation costs exceed average selling prices. Again, this is likely to change in the future with the opening of new roads and the increase in demand due to the development of the district's capital. The inland fishery sector in Malinau is a perfect illustration of what may happen with other forest products in response to increased local demand.

In the upper Malinau watershed, local people mainly catch fish for subsistence needs. The resource is very abundant in villages like Metut and Paya Seturan, and present market limitations prevent fish from becoming an alternative source of income for the local population. The only market centre of Malinau town is located more than two days by boat from Metut.

Closer to the town of Malinau, the high urban demand for fish and shrimp provides local people with an attractive alternative source of income. Shrimp fishing has become the favourite activity of many households[19] because of the relatively high prices for local freshwater shrimp (Rp. 22 000 to 25 000/kg). Two techniques are widely used: nets and electric gear. The use of electric gear, though illegal, is tolerated as long as the more 'modern' fishermen do not penetrate the territories of the more 'traditional' ones. According to the techniques used and to the available fishing days, a shrimp fisher can earn on average as much as Rp. 900 000–Rp. 3 000 000 per month. The specialization level is high as 66% to 78% of the total family income is attributable to shrimp fishing (Mannes 2001).

As far upstream as Paya Seturan, river water quality suffers from the negative impacts of logging and mining concessions. Apart from the heavy pollution caused by logging activities and the spillage of mining residues, concession workers are blamed for their intensive use of pesticides and electric gear for commercial fishing. River pollution by concessionaires, overexploitation of river resources and use of unsustainable fishing techniques has triggered many conflicts about water and aquatic resources. Local people claim high compensation from concessionaires and fight each other for control of aquatic resources. The rapid emergence of an urban market in Malinau prompted the use of unsustainable fishing techniques and a strong decrease in the availability of the resource. Moreover, ethnic divides further aggravate already harsh conflicts over the resource.

Such excesses are likely to happen with many other forest products as soon as roads open up the remotest forest areas of the district. However, it would be a mistake to lay the blame on outsiders alone. In the first phase, outsiders are generally better-equipped to take the lead in the business. They have better access to the developing market and generally master more efficient, 'modern' techniques like dynamite, electric or pesticide fishing, night hunting with four-wheel drive cars and shotguns, logging with chainsaws, etc. In the second phase, local people quickly adopt the new techniques[20] and extend them to larger areas. Chainsaws, shotguns and pesticides are items already familiar to local people. For the last 20 years, chainsaws have been the inevitable souvenir for migrants to bring back from Malaysia. Chainsaws even became the usual gift to be included in bride prices.

One starts to wonder if sustainable techniques are reserved for subsistence goods only. As soon as marketing opportunities appear, outsiders as well as local people make a rush on the resource and try to get the most out of it as quickly as possible.

Sustainable ways of exploiting forest products for cash have yet to be found.

4. Dependency on traders rather than on markets

In the upper Malinau, the Punan are as dependent on forest products as in the upper Tubu. However, while the latter depend on forest products for their subsistence needs, the former depend on eaglewood for their cash income, which in turn they use to buy their food. This difference is neither linked to resource abundance nor to cultural preferences but to the level of trading activities. In the upper Tubu although the resource is far from being depleted only very few traders dare to risk their boats on a four-day journey across dangerous rapids. The upper Malinau is easier to reach and four traders[21] compete on a regular basis for the resource.

Trading in forest products is a textbook case of a patron-client relationship. According to a well-off trader, there are three main keys to success in forest product marketing: (1) prompting people to collect, (2) securing the collectors' loyalty and (3) getting the best out of the transaction (Kurniawan 2001).

In order to incite people to collect products in the forest for three weeks in uncomfortable and unhealthy conditions[22] , indebtedness to the trader is the preferred option. Keeping people indebted is good leverage to foster the collecting spirit and to ensure loyalty. As the first step, traders take advantage of the hunter-gatherers' consumerist tendencies. They supply them both with basic necessities and expensive manufactured goods on a credit basis. Quite often, traders make bigger benefits on the manufactured goods they sell than on the eaglewood they buy. The traditional bride price the groom has to pay to his in-laws also serves the traders' objectives. In former times, exchanges were limited to prestigious goods like Chinese jars and gongs, which could be kept from generation to generation. Nowadays, the most sought-after goods, such as long-tail engines and chainsaws, are not only expensive but also need frequent replacement (César 2001).

Once hooked, the client has no other choice but to collect forest products for his patron. In order to finance a two to three-week collecting tour to the forest, the collector usually takes another loan[23] of Rp. 100 000–300 000 from the trader. Later, this loan is deducted from the amount paid to the collector. Quite often the value of the eaglewood sold is insufficient to cover the credit and debts accrue. Most collectors are trapped in debt and are thus obliged to sell their forest products to a specific trader. Such a rule also applies to traders. Those who work with their own capital are free to sell their eaglewood to any wholesaler. Traders working with capital borrowed from a *toke* (wholesaler) are of course obliged to sell their produce to that *toke* (Kurniawan 2001).

Every trader has strong ties with his collectors or *anak buah* and takes all necessary steps to avoid competition with other traders. Securing the loyalty of one's *anak buah* is an absolute necessity. Debt is not always sufficient. To prevent the collector from selling his product to the first trader he comes across, the most efficient way is to make sure to be that trader. Thus, after organizing a collecting tour, traders often stay in the villages and wait for their *anak buah* to return. Adopting local customs and being able to speak the local language are also essential to secure loyalty (Kurniawan 2001).

Most eaglewood traders are outsiders. Very few traders are Punan and they only work on a very small scale (four to five *anak buah*). One trader, Haji Mahfud, controls, directly or indirectly, about 70% of the eaglewood traders of the Malinau watershed. Most traders have family links with him and borrow funds from him. Confidence and trust clearly depend on family links and/or on ethnicity. Thus, there is a strong tendency for traders to marry indigenous women in order to strengthen the relationship with their *anak buah*.

Getting the best out of the transaction is secured by strong dependency ties, by the opaqueness of the market, and by certain level of deception. Being considerably in debt to the trader, the collectors' bargaining power is limited. They generally have to accept the grade and the price decided by the trader. Traders, however, must be careful, because if they go too far they will lose their *anak buah*'s confidence and loyalty. Collectors might well sell their harvest to better-paying traders and never repay their debts.

In marked contrast to agricultural or timber products, the market information regarding demand, supply and price trends for NTFPs is very poor. The problem of non-availability of basic information on actual production, local consumption, and the surplus available for domestic and international trade is very

acute. At national level, except for a handful of very important forest products like rattan, bamboo, oleoresin, etc., very little knowledge exists and most NTFPs are rarely covered in national statistics. Eaglewood marketing is typical in that it suffers from a total lack of transparency. The traders are the collectors' only source of information. From our enquiries, no gatherer had the slightest idea on the use, the users or the final destination of the product he was collecting, not to mention the price levels reached at the other end of the trading chain. The local traders' knowledge was also limited to the wholesalers' level.

Eaglewood purchasing is allegedly based on quality. The quality depends on contents in the resin, its form and general appearance. High quality eaglewood is black and sticky. Thus, colour is the main criteria of quality. The darker the wood, the higher the price. Eaglewood quality appraisal is very subjective, with buyers and sellers using different colour charts. Of course, every trader tends to downgrade the quality of the eaglewood he purchases. Prices also vary greatly from one trader to another whatever the quality. Traders generally tend to pay higher prices for small quantities of higher-grade eaglewood, and to pay less for larger amounts of lower-grade eaglewood. Needless to say, collectors are usually on the losing side.

However, in patron-client relationships deception is always limited to acceptable levels. Exaggeration would cause the breaking of the tie, throw the collector into another trader's arms, or prompt him to renounce collecting and/or disappear in the forest.

The total lack of transparency of the market and the absence of recognized standards of quality at local and national level are the main causes of the failure of the marketing chain. As a consequence, the nominal value of eaglewood is not based on an interaction between supply and demand, and no fair market mechanisms are available.

5. Dependency on forests for swidden cultivation

The former differentiation between Punan hunter-gatherers and Dayak swidden cultivators no longer applies in Bulungan. Nowadays, all communities — with only few exceptions — have adopted rice as their staple food and practice upland rice cultivation. In recent years, some communities have even expressed an increasing interest in lowland rice cultivation.

The adoption of swidden cultivation by the Punan is concomitant to the settling in villages and to the changing of staple from sago to rice. For some Punan groups this change occurred two to three generations ago, whereas for others it is contemporary. Nevertheless, there are great differences between Dayak and Punan methods of managing a swidden. Though techniques are rather similar, this difference expresses itself in the size of the swiddens, in the number of varieties of upland rice seeds, the amount of labour used and the yields of the crop.

Swidden upland rice cultivation is perfectly suited to the specific conditions of the physical and economic environment of Borneo: very low chemical soil fertility, abundance of land and scarcity of labour. The determining factors of this farming system are the burning of the slashed biomass and the bush fallow period between two slashings. Because of rapid mineralization and heavy leaching, the very old soils of Borneo — from a geological point of view — are very poor in nutrients. In the absence of fertilizers, the slashing and the burning of the abundant biomass provides a considerable amount of nutrient in the form of ashes for the crop. A swidden that cannot be burnt is never seeded, as the crop would not be fertile. A swidden is only cultivated for one to two consecutive years, seldom more. This is because, firstly, the ashes are quickly removed[24] and the nutrients leached by the heavy rains. Secondly, once the forest is cleared, grassy weeds tend to overrun the swidden, and after two years yields drop by half if the farmer does not resort to weeding. But weeding is tedious and labour-intensive. Where land is plentiful and labour expensive, it is economically more profitable to open a new swidden than to resort to weeding. The old swidden is not abandoned but left fallow. The luxuriant forest regrowth will help the farmer to get rid of the grassy weeds by shading out without applying any labour. After 10 to 15 years or more, the regrowth turns into a secondary forest free of grassy weeds and the plot is ready to be slashed and burnt again. Short fallows of five years produce enough biomass to fertilize the swidden. However, it takes 10 to 15 years to substantially reduce the stock of grassy weeds. After 20 years of bush fallow the effect of the shading out is similar to that of a primary forest (Levang *et al.* 1997).

The system has many advantages. If practiced properly, it is ecologically sound and sustainable, it requires little labour and provides high returns per man-day. Its main drawback is that it is rather land consuming. A holding of 15 to 20 ha per family is necessary to ensure the system's sustainability. Otherwise, the length of the fallow period has to be reduced, the soil fertility level decreases, the swidden is overrun with weeds, risk of fire increases and regular burning may turn the swidden into *Imperata* grassland.

Another drawback of the system is that it provides rather small yields — compared to lowland rice — and that there is little room for yield improvement without resorting to inputs and applying more labour. On the contrary, there still is room to improve the system's already high return to labour. The introduction of chainsaws, for instance, has a tremendous impact as it reduces labour requirements for felling from 25–30 man-days to three man-days per ha. In other parts of East Kalimantan like Pasir, where land is becoming scarce, herbicides have rapidly gained popularity among swidden cultivators. Herbicides enable the shortening of the bush fallow period without resorting to manual weeding. However, in Bulungan land is still plentiful and the use of herbicides is limited to areas close to Malinau and to outsiders.

In fact, the area under swidden cultivation increased considerably in the district of Malinau during the last decade. Traditionally, swidden cultivation is restricted to areas close to the village or easily accessible by boat. As the harvest must be brought back to the village, a walking distance of two hours is generally the upper limit for opening a swidden. The limit can be extended as long as the harvest can be shipped to the village. The situation totally changed with the building of the road network from Malinau to Loreh and beyond. Thanks to the road, villagers could expand their swidden area as far as 30 km from Loreh. The transportation provided by concessionaires, not the road itself, is the determining factor. Hitch hiking from the village to the swidden and back is commonly practiced. At harvest time, farmers tip the lorry drivers to haul the rice back to the village. Recently, as part of a compensation deal for environmental damage, Loreh villagers obtained transportation facilities from mining company BDMS. Now, every morning, company trucks take commuters from Loreh to their swidden and pick them up again in the evening (Buyse 2001).[25]

Dayak swidden cultivators commuting from Long Loreh to their ladangs (farms)

In villages close to concessionaire camps, some farmers — mostly women — specialized successfully in producing vegetables for the market (Sitorus 2001). However, such opportunities are rare and more often swiddens only provide part of the household's needs in rice and in vegetables. Very few farmers are in a position to sell part of their production. The complement is bought on the market with cash obtained from non-agricultural activities like forest product gathering, part-time work for concessionaires, 'illegal' logging and other off-farm activities.

Though rather high when compared to Java for instance, returns to the person-day in the agricultural sector are lower than wages from other opportunities. Thus, heads of households often give priority to off-farm activities. Farming is at least partly restricted to providing food security for the family. The recent development of lowland rice cultivation in Bulungan is partly linked to this preference for cash-earning jobs. Though requiring rather small amounts of labour, swidden cultivation necessitates the presence of the head of household at least for the slashing and generally also for the seeding and the harvesting. In the case of lowland rice cultivation, as ploughing is not practiced locally, all the work — slashing weeds, transplanting rice seedlings, weeding and harvesting — can be done by women, thus totally freeing the men from agricultural activities[26]. Such evolution is already commonplace in Langap, Pulau Sapi and Respen Sembuak (Issoufaly 2000). But in the two latter villages, the development of lowland rice cultivation is also due to restricted access to swidden cultivation areas, which is usual in resettlement villages.

6. Dependency on concessionaires

Concessionaires such as logging companies or coal mining companies, non-governmental organizations (WWF) and research institutes (CIFOR) draw mixed reactions from local people. In a first approximation, they do not really differentiate between all these outsiders. The general perception is that if a wealthy outsider, living in a comfortable environment and benefiting from the best of development is willing to come to forest, it can only be in order to become richer. At the very least, there must be a trade-off. Thus, local people consider that they are rightfully entitled to tap part of this wealth (Sitorus 2001; Kaskija 2000).

Concessionaires, for their part, consider that they have paid for the right to extract logs or coal, and the government should not ask them to carry out local development in place of the local authorities. Until recently, a good relationship with local people was not really considered an essential asset for concessionaires. Everything changed with the *reformasi* era when it became obvious that bad relationships could end up in costly conflict.

Since then, concessionaires have been eager to demonstrate that they have a considerable impact on local people's wellbeing. They claim they have a significant direct impact on local people by offering employment opportunities, through the PMDH programme (see below), the opening of new roads and the payment of compensation for the loss of agricultural land. But their indirect impact is probably more important, through the opening of new areas for shifting cultivation, through increased marketing opportunities for local forest and agricultural products and through providing secondary employment opportunities. However, concession workers may also compete with locals for forest resources and thus foster new conflicts. Last but not least, by disrupting the traditional way of life of local communities the concessionaires often have a strong negative social impact.

Results from our research showed that direct employment opportunities with concessionaires are still very limited for local people. Though about 80% of the positions could be held by locals, data from companies[27] show that on average only 50% of the jobs are given to locally hired people. In fact, this figure includes quite a lot of outsiders who applied locally for the jobs. Limited skills and low reliability are often the main reasons why concessionaires avoid hiring local people. Local people, for their part, cite ethnic preferences and family connections to explain the discrimination (Sitorus 2001).

The PMDH programme[28] is a government initiative trying to involve concessionaires in local development projects for the benefit of local communities. INHUTANI I and II proposed the development of road infrastructure at village level, and subsidized agricultural development through the distribution of seedlings, pesticides and fertilizers, demonstration plots and agricultural extension. Unfortunately, PMDH programs are generally not very successful. Failure is mostly due to the lack of commitment on the part of the concessionaire's

personnel, the lack of involvement of local people in the process, and limited human resources and funds. Some programmes, however, had greater impact, such as the donation of a truck to a village cooperative for transportation between Loreh and Malinau.

Compensation obtained from concessionaires for the loss of agricultural land has had a tremendous economic impact on local people. Compensation in hard cash is the most popular but many concessionaires prefer to settle for compensation in kind which benefits the whole community: roads, housing, community buildings, and water supplies. Recently the main criterion of the choice to open new agricultural land has been the possibility of obtaining compensation from concessionaires.

Indirectly, the proximity of a concessionaire's activities has a determining impact on the village economy. The access to a new road network opens up new marketing opportunities, especially for timber. The economic centre of the villages often moves from the riverbanks to the roadside. The new roads open up huge areas for shifting cultivation, some farmers opening swiddens and creating plantations as far as 32 km from their village. People from Gong Solok intend to move their village from the Malinau River to the logging road. Some Punan from Long Loreh plan to create a new village along the road between km 49 and km 51. Though they already moved their village three times during the 10 last years, the inhabitants of Langap want to reconstruct their village on the other side of the river in order to benefit from a direct road access to Malinau. The people from Long Loreh obtained transportation facilities from BDMS. Every morning and evening tens of farmers wait on the roadside as commuters to be transported to and from their swidden. Concessionaires' camps are also popular spots for marketing forest and agricultural products like vegetables, fruits, game, goats, fish, birds, and handicraft products. These new marketing opportunities have helped to increase the price of agricultural products by 20% to 40%. These commodities are now the main source of income for local people.

Numerous indirect job opportunities are also linked to the presence of the concessionaires. In villages close to camps the influx of workers had a tremendous impact on the development of shops, restaurants, houses or room rentals, jobs as cooks and washerwomen and so on. The price of land in the village of Loreh increased by 400% and a small room can be rented for Rp. 30 000 to 60 000 per month.

The social impact of concessionaires has also been tremendous. By increasing economic opportunities and by opening remote villages to the market, concessionaires considerably disrupted the traditional social order. Family ties get looser and self-help is no longer popular. Everybody is looking for big and easy money. Greed is generally at the source of new conflicts with the concessionaires but also with other villages and among villagers. There is no doubt that the indirect impact of concessionaires has been much more important than their direct impact. However, concessionaires are not to be held responsible individually. The disruption of the traditional society would probably have happened anyway[29]. The concessionaires only accelerate the process by creating a conducive environment.

In a bid to improve relationships with local people, INHUTANI II considered the possibility of helping local people to exploit the waste wood from timber extraction. Our research showed that a quite considerable amount of wood usually left to rot could be reclaimed this way. However, such an operation would need considerable involvement from the logging company in matters of organization, transportation and maintenance, not to mention the legal aspect of the problem (Gumartini 2001). But the main drawback, for the time being, is the rapid development of IPPKs[30]. With the latter, villagers are offered royalties by 'investors' for the logging of so-called traditional forests. Local people no longer see why they should be content with waste wood when they can enjoy the benefits from all the timber. All over the district of Malinau, the craze for IPPKs is pushing villagers into deals with investors (Obidzinski *et al*. 2000). Huge advance payments to village heads are later deducted from royalties, and promises of conversion into plantations are generally fallacious. The lure of easy money is the main driving force. But at present rates of deforestation there will be no forest left in the Malinau district in 12 years' time.

Recently there has been an escalation in the number of claims for compensation from companies. Resorting to demonstrations and roadblocks to extort money from concessionaires has become commonplace, even for the most trivial reason[31].

People learn fast. Following Jakarta's example, some wealthier groups recently created new job opportunities hiring demonstrators by the dozen to put pressure on companies. Though many of these claims are legitimate, there is an increasing tendency to seek easy money from outsiders or from the government rather than to involve oneself in economic activities. In line with this, it seems that the forest is no longer considered as essential for making a living but rather as a source of easy money.

7. Dependency on outside goods and services

In former times, forest people bartered forest products mainly for salt, tobacco, loincloths and iron blades. Chinese jars and gongs, and to a lesser extent beads and betel chewing kits were the most sought-after prestige goods. Jars were used daily as containers but also as funeral urns. Jars served as units of value, and a family's reputation could be measured by the number of jars owned[32]. They were the most important item of the bride price (Césard 2001).

In the context of active headhunting, the survival of a small group depended on its ability to secure strong ties with other bands. Such ties were mostly based on matrimonial links and materialized by the exchange of prestigious goods like jars, gongs, blowpipes, etc. There is no doubt that the main trigger for bartering forest products[33] was the necessity of obtaining these luxury goods from the outside world. In stratified ethnic groups, the ownership of 50 jars was commonplace for an aristocratic[34] family. As exchanges were taking place among small numbers of families and over generations, wealthy families were able to accumulate prestige goods over time.

Nowadays, such accumulation is no longer possible for various reasons. First, the spectrum of prestige goods has increased considerably. Chinese jars are still sought after but have lost popularity in favour of modern manufactured goods like long-tail engines, chainsaws, motorcycles and electronic goods. These modern goods are not only costly, they are also easily damaged and need maintenance or quick replacement[35]. Second, the bride price has increased considerably. Nowadays, the bride price asked for a Punan girl from Respen is totally out of reach for a young man living in the upper Tubu. In the Putuk ethnic group, the bride price has become so excessive that many young men look for wives from other ethnic groups. Thus, prestige goods are lost to other groups and not replaced. This last trend worries many customary leaders who try desperately to fix the bride price to acceptable levels and to fine families who do not respect the ancient rules on the exchange of goods. However, they are unlikely to succeed as the traditional exchange of goods has already turned into a monetary transaction that no longer serves to strengthen links among the groups.

Last but not least, local people developed over time strong ambitions for their families and children. Their desire for educational and health services has rarely been met by government projects, especially in remote locations. Local people's frustration at the government for not providing adequate educational and health services has made communities willing to take matters in their own hands and strike deals with logging companies and plantation developers for these services. Aspirations for health care and formal education developed an increased dependency on cash earning activities. Considerable amounts of cash are necessary to pay for transportation, tuition and boarding fees, especially for higher education, as no infrastructure is locally available. Village dispensaries are seldom well-equipped, and if necessary people do not hesitate to go to Malinau or Tarakan for medical care[36].

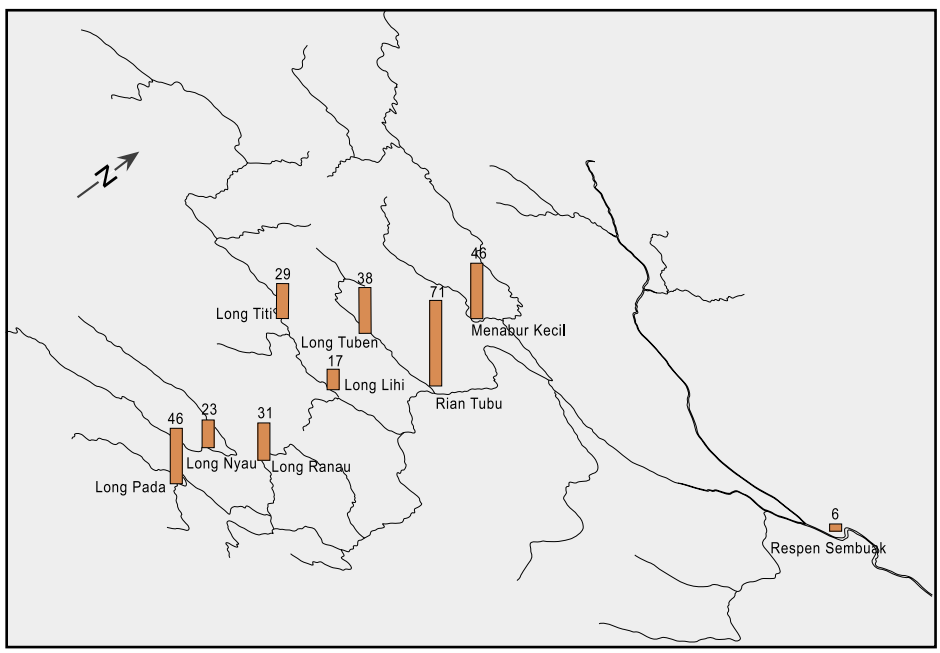
For all these reasons, forest people are increasingly dependent on cash. And, for the time being, the forest — for its timber and non-timber forest products, concessionaires and 'investors' — is the only potential provider of cash. As long as no alternative source of cash is made available to local people, the pressure on the forest is unlikely to be relaxed.

8. An overall dependency on accessibility

The comparison of the difference between upstream and downstream villages, between well- and badly-served villages leaves no doubt: accessibility is the main determining factor. Low accessibility has some advantages and many drawbacks. Be they Dayak or Punan, all agree that the main advantage of living in a remote settlement surrounded by primary forest is that 'meat is easy'. And by 'meat' people generally mean 'wild boar'. Bearded pig is always ranked higher than any other forest product, even cash-earning ones. Living closer to eaglewood-rich forests only reduces the length of a collecting tour from three to two weeks. Of little concern to eaglewood

collectors, this one-week difference is paramount for hunters[37]. Low accessibility is synonymous with preserved forest. But it also means high transportation costs and reduced competition among traders, low access to markets, and thus low prices for forest products and agricultural commodities, and high prices for manufactured goods. Bad communications with the outside world do not encourage teachers or paramedics to stay in the village. Being unable to access formal education further marginalizes upstream communities, while they pay a heavy toll in the absence of health care[38] see Figure 6.3).

Figure 6.3 Mortality rates in the upper Tubu (number of deaths per 100 births)



Punan family from the upper Tubu. Infant mortality is still very high

Good accessibility has many advantages but also some drawbacks. The opening of the road — and its good maintenance by concessionaires — between Malinau and Loreh had a tremendous impact on economic exchanges. Transportation time between the two localities dropped from one day by boat to three hours by car. The cost of outside goods was consequently reduced and new market opportunities were opened for local people, especially due to the influx of concession workers. Thanks to the new opportunities Loreh has been developing quickly: electricity, water supplies, a small hospital, television and VCDs are all now available. Such rapid development is not without its drawbacks. The intense activity of concessionaires leads to increased environmental damage, deforestation, air and water pollution, and disruption of traditional village life. Mutual aid among villagers gives way to individual enrichment. Competition for natural resources leads to conflicts with outsiders and among villagers, economic differentiation leads to *nouveau riche* behaviour and to jealousy, not to mention social pathologies such as alcoholism, gambling, and prostitution.

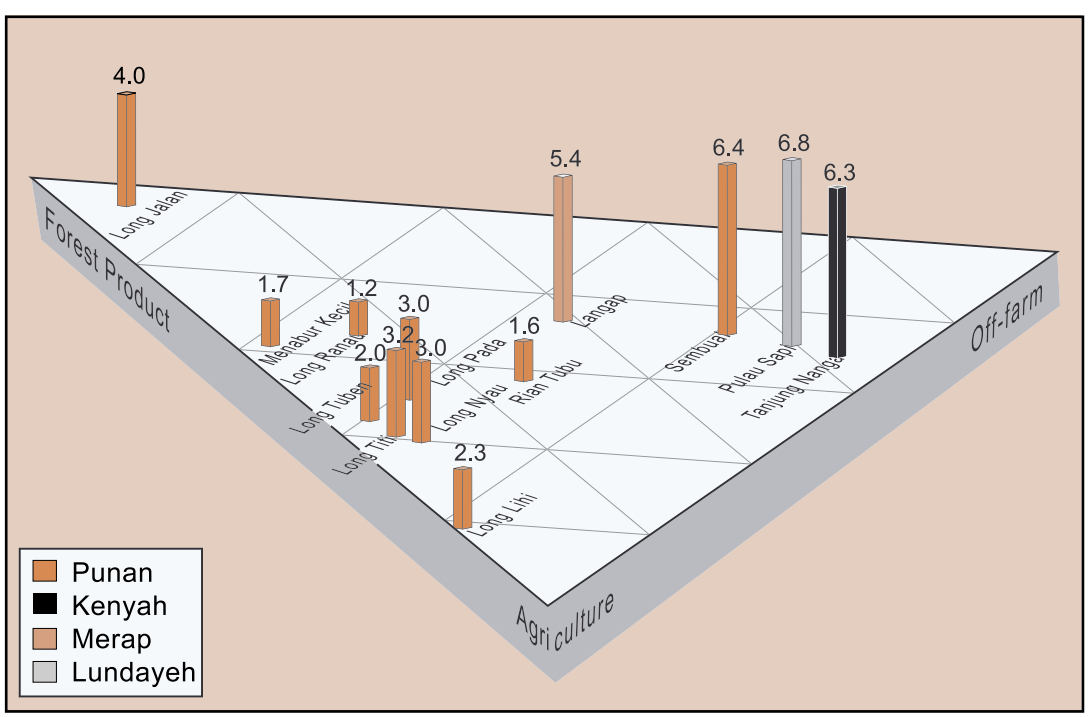
But for local people there is no hesitation: 'let's benefit from the advantages first, we'll deal with the drawbacks later'. And in the upper reaches of the rivers, where the countless rapids prevent the floating of the logs, there is no other choice than building roads to cash in on the royalties from IPPKs.

9. A general trend: securing cash income

By comparing villages in different locations and at different stages of development, a general trend comes to light (Figure 6.4). This trend goes from forest product gathering to agricultural activities and to salaried activities. Even in remote areas, forest people are no longer dependent on forest products for their staple food. Sago only plays a role as a safety net in case upland rice and cassava harvests are insufficient to meet the family's needs. In places where rice can be bought, sago is no longer part of the diet, as people prefer to buy their rice with the income provided by eaglewood collection. Nowadays dependence on sago as a staple is restricted to *mufut* periods.

Further downstream, where eaglewood is no longer available (or in the absence of traders), people

Figure 6.4 Average household income (million rupiah per year)



make a living from agricultural activities. There, swidden cultivation becomes essential, some people try their luck with plantation crops like coffee or cocoa, and forest products collection becomes a secondary activity during slack periods. Temporary work for concessionaires or 'illegal' logging is also considered an attractive option.

Even further downstream or in places close to concessionaires where salaried activities are available, swidden rice or lowland rice cultivation becomes secondary and is mostly entrusted to women. The men work for the concessionaires in the area and sometimes migrate temporarily as far as Sabah and Sarawak. In big villages like Pulau Sapi or in Malinau, many households benefit from regular wages and sometimes no longer practice agriculture.

This general trend goes along with the search for greater security and regularity in cash income and a more settled way of life. Pure foragers do not exist anymore but seasonal mobility is still high in remote Punan villages. For the Punan, settling down in a village implies adopting swidden cultivation. In the upper reaches of the rivers, where population density is low and eaglewood still available, most households specialize in forest product gathering. Eaglewood collecting provides a fairly regular source of income but what attracts collectors is the hope of hitting the jackpot — one lucky find and all your dreams come true.

In the middle reaches of the rivers, where people mostly depend on agricultural activities, securing cash income becomes problematic. Swiddens provide part of the household's staple food needs but not cash. Plantations such as coffee or cocoa are managed too extensively to provide regular incomes. At the present technological level — i.e. no fertilizing, infrequent weeding and no pest management — these plantations are unlikely to play an economic role either at the household or at the regional level. Promoting higher-level technology is unlikely to succeed, as it would imply higher costs in terms of inputs and higher labour requirements, which in turn would imply more financial risks for the farmer and lower returns per person-day. For the time being, agricultural activities cannot compete with the more lucrative opportunities offered by concessionaires and 'investors'.

Wage earning is the dearest wish of most heads of households, if not for them, then at least for their children. However, securing regular cash income also has numerous drawbacks. Local people still find it difficult to abide by the rules of salaried work: fixed working hours, targets, and restrictions on leave and so on. Positions as civil servants are still the most sought-after as they provide low wages but the highest degree of flexibility. They also provide pensions.

However, salaried jobs are set aside for skilled and educated personnel. Thus, local people are seldom successful when they apply for well-paid jobs at concessionaires. Know-how and education are required but are not in themselves sufficient, as family ties and ethnic relationships generally prevail over other qualities of the applicant. The local administration is clearly in the hands of the most prominent ethnic groups. A young graduate from a marginalized group has little chance of being considered. For the most enterprising, migrating to Malaysia was the easiest way to get a well-paid job until the outbreak of the Asian crisis. Nowadays the situation is more problematic for immigrants but the Malaysian option still has its advocates.

But today, for all groups, from Malinau to the upper reaches of the rivers, from the most prominent to the most marginalized, the best option of getting huge amounts of cash is to strike a deal with an 'investor' to sell one's forest to loggers[39].

10. The forest's last stand

Has local people's dependency on forest products been overstated? Certainly not from a cultural point of view. Interethnic relations, social organization, way of thinking, sense of wellbeing, and system of values still totally depend on the forest. But from an economic and materialistic point of view this dependency has decreased considerably over time. Formerly, to nomadic bands of Punan hunter-gatherers, sago and game was paramount to their subsistence. To settled Dayak swidden cultivators, the maintenance of the forest ecosystem was essential to the sustainability of the farming system. Bartering forest products, for prestige goods and salt, tobacco, loincloth and iron blades, was essential to the survival of both groups. But if one takes a close look at recent developments in the area, it is clear that the dependency on forests and forest products is not absolute but relative. Dependency on forest products is seldom the result of free choice; it is merely the sole option available. As we saw, forest people do not collect forest products

on their own initiative. Traders decide which product they want to buy; they organize the collection and control the marketing chain. As soon as new options are made available, i.e. labouring for concessionaires, wage working, migration to Malaysia, etc., the dependency on forest products is reduced. People analyse the options at hand in a rational manner, from economic, social and cultural viewpoints. They weigh the pros and cons of regular and secure earnings, of higher but riskier earnings, of short-term versus long-term employment, of local versus distant job opportunities, etc.

Nowadays, available opportunities are no longer restricted to forest product gathering. However, not all forest people are guaranteed equal rights to access these new opportunities. First, most forest people lack the know-how and level of formal education required for the most sought-after positions with concessionaires, the civil service and other private companies. Second, strong networks based on family and ethnic group links bar outsiders' access to better positions. Local people regularly complain about the preference given by concessionaires to Javanese, Bugis, Batak and other groups from outside Borneo. But the same rule applies in the local civil service, where Tidung, Kenyah and Lundayeh take the best at the expense of other ethnic groups. The Punan are by far the most marginalized for the reasons given above. Their exceptional knowledge of the forest confines them to the role of hunter-gatherers. But this is no longer a deliberate choice, especially among young Punan graduates, who experience a growing feeling of frustration.

This feeling is not restricted to Punan but also to other ethnic groups. Parents often make big sacrifices to ensure a proper education for their children, and both parents and children resent the absence of adequate job opportunities. Again, resentment is generally directed against outsiders to Borneo, which fuels the potential for ethnic conflicts.

Clearly, not everybody will be able to take advantage of ongoing changes. However, with the implementation of regional autonomy, some ethnic groups, and more precisely the leading classes[40] of these groups, will probably be able to compete with outsiders. But the poorer classes and the marginalized communities will likely remain dependent on forest product gathering to make ends meet. But for how long will they be able to rely on the forest? Eaglewood is already depleted and no other NTFP is likely to take over its role. *Damar* resin and rattan are plentiful in the forest but traders are not interested. Plantation crops like coffee, cocoa or oil palm? For the time being, the returns from agriculture cannot compete with other opportunities at hand. Forestry plantations? Planted forests might be the best option for the future but not while large stands of primary forest are available in the vicinity.

Forest people from the Malinau district cannot be labelled as poor. With little exception, all still have access to relatively good sources of cash and no one ever experienced starvation[41]. Poverty in Malinau is not linked to income but to lack of access to education and health facilities. In the upper reaches of the Malinau and Tubu rivers, there are no schools and sanitary conditions are appalling. Most people are illiterate and children pay the heaviest toll. In order to alleviate poverty in these remote areas, the government decided some 30 years ago to resettle villages in areas closer to the district capital. Over time, the resettlement proved a success, at least in matters of access to education and to healthcare. Recently, as resettlement is no longer considered a viable option, the district government decided to build roads linking the remotest villages to the district capital. This much-awaited move gained the support of most local people but frightened conservationists.

The latter have every reason to be worried. Once opened up, the rich primary forests of the upper Tubu and Malinau will fall victim to the loggers' greed. Most communities of the Tubu have already contacted 'investors' in order to attract them to their village. None of these so-called 'investors' is ready to invest in road building, but as soon as the area is opened up, no doubt they will flock in in great numbers. Local communities seem little concerned about forest conservation and are not afraid of deforestation. In fact, there is little awareness of the consequences of deforestation. These communities have always lived in or close to the forest. They believe — or want to believe — that the loggers will just remove a few logs without destroying the forest, or that they will convert the forest into productive plantations. It is hard to say to what extent they are fooled by 'investors' or they fool themselves.

It is difficult to hold it against them. Local communities are in dire need of hard cash and, for the time being, the forest represents the 'best' — if

Small Punan settlement in the upper Tubu. None of these children were able to attend school

not the only — way to obtain a large amount of cash quickly with a minimal input of labour. No other opportunity can compete with it. And as long as this opportunity is open, no other development will be conceivable.

Up to now, there has been no real conflict over the use of the resource between shareholders or even among the communities. The local government receives taxes and local communities receive royalties, while 'investors' strike more profitable deals than ever[42]. There is a clear consensus on the use of the forest; any conflict is only about the sharing of the benefits. In that sense communities have become increasingly interested in territorial matters, mapping village areas and fixing and materializing borders. Anteriority of settlement in the area has become a disputed issue, as well as former political dependencies. Affirming the community's legitimate ownership and rights to the resource has become the main concern of community leaders.

For the resettled communities of the Tubu watershed, such concern has unprecedented implications. To the nomadic Punan hunter-gatherers, living in a village is something rather recent and the concept of village territory traditionally unknown. The forest resources of the Tubu watershed are open access to all Punan Tubu. The rate of intermarriage is very high between all villages and only former swiddens or orchards or birds' nests caves are clearly appropriated. The forest is not. Thus, it is difficult to secure one's ownership over former village territories without being physically present. As a consequence, most village leaders in Respen are considering moving back to their former village to reinforce their claims and to avoid conflicting claims over their land (Kaskija 2000). At the same time, families from upstream settlements who planned to move downstream are reconsidering their decision.

For the time being, everybody's hopes are pinned on the forest. Not as a sustainable source of forest products, not as a support for an ancient way of life, but as a principal source of hard cash. The risk is great that the first IPPK will be followed by many others. If nothing is done to counter the present trends, in a short while, one of the last stands of lowland dipterocarp forest of Borneo will end up as sawn timber, plywood, pulp and paper. The risk of seeing forestland converted into wasteland is high. Some people might benefit from the process, and it is easy to imagine who will be on the losing side.

However, it is not all doom and gloom. The local people's commercial orientation and strong aspirations for development are in itself a very valuable resource. The education level is rising quickly, accounts from deforested areas become available and conservation issues are often discussed

among villagers. Many wonder if a future without forest would be a viable option. With the implementation of regional autonomy local people have an opportunity to take matters into their own hands. Dayak and Punan in general, because of their history of trade in forest products, strong migratory history, and decision-making structure that favours a combination of village debate and reliance on key aristocratic elders, has profound implications for how they respond to new economic opportunities. Up to now, these opportunities have generally been seized by local elites. However, more and more people question their leaders' choices and long for a more democratic decision-making process. Reconciling development and conservation objectives in Bulungan is not (only) a technical problem but a rather a matter of good governance. The next chapter will explicitly look at the prospects of communities making their aspirations heard.

Endnotes

[1] In one case, data was obtained on the condition of providing private lessons to the fishmongers' children.

[2] Exchanges of goods, labour, information, knowledge, know-how, etc. and marital exchanges.

[3] In year 2000/2001, only 7% of the households did not open a swidden.

[4] *Sus barbatus,* commonly known as the bearded pig.

[5] During headhunting times the Punan were feared for their ability with blowpipes and skill in preparing poisonous darts.

[6] *Strychnos* sp. and *Antiaris* sp. are commonly used for preparing blowpipe poison. *Dioscorea hispida* and *D. piscatorum* as well as *Derris elliptica* are used for poison fishing.

[7] *Asplenium, Lygodium, Nephrolepis, Diplazium* and *Pteris* spp.

[8] *Artocarpus odoratissimus.*

[9] *Eusideroxylon zwageri.*

[10] *Licuala* spp. leaves are the favourite material for thatching, but other leaves (*Marantaceae* and *Dilleniaceae)* may also be used.

[11] At least every two years for a vegetal roof.

[12] Three species of palm are locally used for sago: *Metroxylon* sp., *Arenga undulatifolia* and *Eugeissona utilis*.

[13] *Tidak mau cerai dengan daging.*

[14] *Sarang lumut* in Indonesian.

[15] *Aquilaria* spp. or gaharu in Indonesian.

[16] Eaglewood or eaglewood is a resin produced by various trees of the *Aquilaria* genus. The resin is produced as a reaction to fungal infection following injuries. The tree is chopped to pieces during the harvesting process, which is why the resource is fast disappearing.

[17] The Punan claim that outsiders being unable to recognize trees containing resin carelessly chop down any *Aquilaria* tree, thus compromising the renewal of the resource.

[18] The city of Malinau is predominantly Muslim, thus animals must be killed according to Islamic rites, and of course pork is prevented from entering the market.

[19] Mostly belonging to the Tidung ethnic group.

[20] They often blame outsiders for using destructive techniques as long as they are not in a position to do the same.

[21] Two traders run shops and have more or less permanent representatives in Long Jalan. Other traders occasionally visit the village and try to divert the local production.

[22] Malaria outbreaks are frequent while camping in the forest.

[23] Called *ongkos*, this credit in kind — rice, salt, tobacco and medicine — covers the collector's and his family's basic needs.

[24] Especially on steep slopes. Yields are always higher on flatland or at the foot of the slopes where ashes concentrate.

[25] In remote areas like in the upper Tubu, there is not a big difference between living on a swidden or in the village. Thus, some families or group of families may choose to live on swiddens even far away from the village. In Long Pada, for instance, some families live at a one-day distance by foot.

[26] Lowland rice cultivation is also commonly practiced by elderly people lacking the manpower to clear swiddens.

[27] Special attention was given to five 'concessionaires': the mining companies BDMS and John Holland, the logging companies INHUTANI I and II and the international research institute CIFOR. The local communities concerned were: Seturan, Langap, Long Loreh, Bilah Bekayuk, Sengayan, Plancau, Gong Solok, Batu Kajang, Tanjung Lapang, Pimping, Terasnawang and Salim Batu.

[28] PMDH stands for *Pembinaan Masyarakat Desa Hutan* (forest community training programme).
[29] The influence of mass media (radio and television) has probably been more determining.
[30] IPPK stands for *Izin Pemungutan dan Pemanfaatan Kayu* and addresses smallscale logging concessions attributed by the Bupati.
[31] In August 2001, three roadblocks were organized between Loreh and Malinau in the same week. Compensation of Rp. 3 million was demanded for a dog run over by a truck. The deal was settled at half this amount.
[32] And by the number of trophies, i.e. heads severed.
[33] Another opportunity was the capture and sale of slaves to the coastal kingdoms (Sellato 2000).
[34] A stratified social organization appears in most ethnic groups. More research is needed on this subject.
[35] In upstream villages, the life of a long-tail engine seldom exceeds two years.
[36] In theory the Malinau dispensary sends a medical team upstream every three months for check-up, vaccinations, etc.
[37] First, conserving wild boar is problematic. The meat is either pickled in brine or smoke-dried; in both cases it loses its taste. Second, organizing a hunting party to the upper reaches of the rivers is expensive and not profitable as the product of the hunt is traditionally shared among all villagers. Only on special occasions, such as marriages, do Punan families from Respen organize a hunting party in order to provide guests with delicacies.
[38] In the upper Tubu, one child out of two dies before the age of five. This figure drops to one in three in the middle Tubu, and one in ten in Respen.
[39] Underlying motivations to this behaviour still need to be explored. Today local people want their share of the manna from timber extraction. The dominant perception is that the forest will disappear anyway, so better take one's share as quickly as possible. Persistent legal uncertainty is also favouring the unsustainable use of the forest.
[40] It is no surprise that the leading ethnic groups are also the most stratified ones, and that the aristocratic classes of these groups have been able to maintain their dominant position.
[41] Though some food shortages during El Niño years and occasional malnutrition cases have been reported.
[42] Before the implementation of regional autonomy, neither the local administration nor local people benefited from logging. Timber barons had to obtain authorizations from Jakarta and to bribe bureaucracy at the highest levels of the state.

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7. Negotiating More than Boundaries:
Conflict, Power and Agreement Building in the Demarcation of Village Borders in Malinau[1]

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In Malinau, the poor and the more powerful increasingly compete for the same land and forest resources. Swidden farmers, hunter-gatherers, timber companies, mining companies and local government make diverse demands on the forest. Yet coordination[2] of forest management among these different land users has been weak. During the implementation of decentralization reforms between 1998 and 2001, when demands on the forest increased and local coordination was at its lowest, social conflict increased dramatically and forest degradation occurred at unprecedented levels.

Malinau is not unique. Large forest landscapes everywhere are under increasing pressure from diverse and incompatible demands. In this report we argue that unless appropriate mechanisms are in place for forest users to coordinate among themselves, large forest landscapes such as those in Malinau are subject to the risk of escalated and entrenched social conflicts, increasing social injustice, open access competition for resources and even wilful destruction of forest resources. Because of recent reforms, stakeholders in Malinau face the additional challenge of making a transition between the top-down more coercive coordination by forest departments in the 1970s to 1990s, when conflict was rarely openly acknowledged, to more deliberative[3] and pluralistic coordination, where self-organization, transparency in government, conflict management and greater citizen participation in decision making (DiZerega 2000, Anderson *et al.* 1999) guide decision making.

We report here on the findings that lead us to these conclusions.[4] We focus on village-to-village coordination as a subject that has received little attention, yet is fundamental to multistakeholder processes. We were interested to know whether the principles guiding more formal and complex multistakeholder processes were relevant to intervillage coordination, where lower numbers of people, more familiarity among people and more of a moral economy and stronger kin obligations occurred. We asked the research question: *What conditions facilitate coordination of interests within and among villages?* We were also curious to learn more about local people's concepts of conflict and agreement in Malinau and how these might be changing during the reform period. The work focused on village boundary demarcation as a means of land use coordination and as a tangible source of conflict about which agreements could be negotiated.

Below we briefly present current thinking about coordination processes, our study methods and a history of village-level coordination efforts in Malinau. We then present the results of the study, with data about sources of boundary conflict among communities and how they sought to overcome that conflict. We conclude with recommendations.

Background

What constitutes 'good' coordination in forest management? During the last two decades, proponents of community management have often advocated that the state should decrease its involvement as the primary coordinator of local

management (Poffenberger 1990, Sarin forthcoming). However, where government coordination has been weak, local entrepreneurs and strongmen often gain control over the forest at the expense of communities (Kaimowitz 1999, Barr *et al.* 2001, Dove 1993). A new paradigm is emerging in which coordination occurs through more pluralistic processes that take into account the interests of different stakeholders. In these multistakeholder processes, the central challenge is 'how a society composed of formally equal citizens could be ordered so that those having access to more political resources, luck or talent would not use their advantages to exploit others weaker than themselves' (DiZerega 2000).

To answer this challenge, current principles of multistakeholder processes in forestry suggest that coordination should be grounded in negotiations that involve all relevant stakeholders, identify their interests, facilitate effective communication and learning, create a neutral space for interaction, and seek to achieve consensus (Allen *et al.* 1998; Borrini-Feyerabend 1996; Fisher 1995; Röling and Wagemakers 1998; Röling and Maarleveld 1999; Porter and Salvesen 1995). Iterative cycles of conflict and adjustment are likely to occur and conflict should be managed (Lee 1993, Ramirez in press).

Experience in forest areas—including formal co-management agreements between states and communities and the decentralization of decision-making authority—indicate, however, that some of these aims might be unrealistic and even work against politically weak groups, such as local forest-dependent communities and vulnerable groups within communities (Contreras *et al.* 2001; Sundar forthcoming; Edmunds and Wollenberg 2001; Wollenberg *et al.* in press a; Anderson *et al.* 1999; Baviskar in press; Antona and Babin in press).

We argue that a more realistic view of coordination thus requires modification of these principles. First, in contrast to certain current beliefs about conflict mediation, there is strong evidence to suggest that it is difficult, if not impossible and undesirable, for facilitators or people engaged in negotiation to define stakeholders' interests clearly. Interests are many-layered and we tend to construct our interests in response to specific contexts and for strategic purposes (Baviskar in press, Leach and Fairhead in press). Especially where trust among groups is low, it may be unwise to reveal one's true interests or to assume that other groups are communicating their interests honestly. Baviskar argues that we can best infer interests from people's actions, not from what they say.

Inter community meeting in Setulang

Second, as suggested by proponents of pluralism (Anderson *et al.* 1999, Rescher 1993, Bickford 1999), consensus is impossible and participants in a multistakeholder process should treat agreements as inherently partial and unstable. Complete agreement is impossible because differences in experiences prevent even two individuals from ever having the same desires (Rescher 1993). As only temporary states of coordination can occur, coordination is best thought of as a process of ongoing accommodation and negotiation involving multiple actors. Agreements are not the end of the process, so much as a set of principles providing guidelines and legitimacy for new actions. People negotiating contractual agreements and management plans should therefore build in flexibility to accommodate adjustment and acknowledge these as temporary measures (Wollenberg *et al.* in press b). Boundary agreements should acknowledge flexibility in rights allocated across borders. Facilitators of coordination should work with the plurality of institutions with which local actors interact, and not just through single user groups or local forest departments (Leach and Fairhead in press).

Third, some parties consistently enjoy disproportionate control over coordination processes. Weaker groups' interests have been routinely excluded, represented ineffectively, co-opted or negotiated away (Anderson and Grove 1987, Hecht

and Cockburn 1989, Parajuli 1998). Power has been exercised according to who assumed the convenor and facilitation roles (or controlled these roles), who was represented in the process, and differing capacities for communication and negotiation among participants (Steins and Edwards 1999, Ramirez, in press). Government agencies have often assumed this role in regard to forestry by working in an expertocratic mode that relies on opinions of professionals rather than wider citizenry (Rossi 1997: 237). In these situations, the interests of disadvantaged groups are often masked under the guise of agreements (Edmunds and Wollenberg 2001). Well-intentioned efforts to expand participation in forest management by including marginalized groups can actually work to their detriment, unless certain checks and balances and accountability measures are used. Multistakeholder negotiations are likely to be more socially just by acknowledging existing power relationships and enabling disadvantaged weaker groups to work politically in more effective ways, rather than assuming that negotiations can ever be neutral.

From the points documented above, we suggest that more strategic principles[5] for multistakeholder processes are necessary. These require facilitators to manage sensitively and for participants in the processes to demand. Any group or coalition that takes the facilitator role will seek to meet their own self-interest to some extent, so it is necessary for the group of participants to collectively agree on norms, rules and sanctions that encourage socially responsible facilitation. Principles include the following:

- Acknowledge the fluid and complex nature of interests, agreements and coordination processes and encourage institutions that enable multiple groups to communicate, debate and negotiate about these. Create agreements and coordination mechanisms that can acknowledge underlying conflicts and accommodate flexibility and adjustment. Assess interests through people's actions, not statements.

- Improve the preconditions for disadvantaged groups to participate and negotiate effectively. Seek out possibilities for alliances among select stakeholders, rather than trying to achieve an apolitical agreement among all stakeholders. Working in, with, and through alliances, disadvantaged groups can achieve significant gains for themselves, while maintaining greater control over the types of information made available to their antagonists. Enhancing the power, urgency or legitimacy associated with certain stakeholders can increase the likelihood of their being noticed and involved in decisions (Ramirez, in press). Enable excluded stakeholders to work through parallel arenas to challenge decisions.

- Ensure accountability of coordination decisions to interest groups through effective representation (facilitating proximity of leaders to their constituencies, elected leaders and delegates and fostering an ideology of civic dedication), transparency (third party monitoring, public meetings and reporting, participatory processes), and checks on power (legal appeals to existing decisions, separation and balance of decision-making power across several authorities, enabling civic education and social movements) (Ribot in press).

- Situate the legitimacy of negotiation processes, decisions and agreements. This means analysing the reasons for participation or nonparticipation by each group in negotiations, how groups are represented, the roles of convenors and facilitators, and the historical context for such agreements. It also means treating legitimacy as partial and contingent rather than assuming that an unproblematic legitimacy is assured through open negotiations.

To test the applicability of these principles and refine them, we examined the extent to which they were relevant to village-to-village coordination about land claims in Malinau. We report our findings below.

Methods

CIFOR used action research to examine negotiation among stakeholders in relation to forest land claims and coordination of land use in the 27 villages of the upper Malinau River (see Map). Action research enabled us to conduct research that would mutually benefit CIFOR and local stakeholders by generating

local impact immediately, as well as enable us to directly observe how these impacts occurred. The methods and focus of the work evolved in response to local needs in iterative stages.

Initiation

We began in the village of Long Loreh in 1997, where we stationed a local research assistant to collect baseline information about forest dependence, villagers' concerns and local governance. In early 1998, we explored developing scenario-based methods as a tool for building a common vision and negotiation among stakeholders. At the time, there was little local interest in these methods.[6] We looked for another entry point for collaboration and action research, and in the meantime, produced a review and guidelines to scenario methods for multistakeholder planning (Wollenberg *et al.* 2000; Wollenberg *et al.* in press a, b). These have been shared in training seminars and international conferences.

Because of the opportunities for community land claims created with reform under President Habibie, we subsequently explored research on methods for different groups to reach agreements about village boundaries, using participatory mapping of village lands as a platform. WWF's participatory mapping of village territories or *tana' ulen* in Kayan Mentarang National Park also provided a precedent. We conducted training in participatory mapping with the NGO SHK in the village of Long Loreh in late 1998. Communities' interest in settling land claims was high, and other communities expressed a desire to join the process. We decided to also gather more information about other communities to better understand their perceived problems and priorities and subsequently expanded our work area to the 27 villages of the upper Malinau River.

In 1999, we conducted a systematic survey of stakeholders, land tenure and forest-related conflict in these 27 villages, as well as organized a five-day community workshop involving representatives from throughout the watershed to identify a mutual agenda for collaboration between communities and CIFOR (Padan and Laway 1999, Anau 1999, ACM-CIFOR 1999). The survey demonstrated that all the communities had a strong interest in mapping their lands. The workshop showed that villagers' highest development priorities were securing reserved or protected forest, clean water and electricity (and other infrastructural improvements), in addition to the mapping of village boundaries. The activities also revealed high levels of conflict among villages and between villages and companies about a range of forest-related issues, including land claims.

Participatory mapping of administrative boundaries

In response to the high interest in mapping, CIFOR trained village-level committees in participatory mapping techniques and, from January to July 2000, facilitated conflict mediation and mapping among the 27 villages. CIFOR created a core team of nine trainers-researchers-mappers that included six Malinau community members. This team documented and analysed the types and causes of conflict over boundaries (Tim Pendampingan Pemetaan Partisipatif, 2000). Twenty-one villages produced draft maps. A community workshop was held in 2000 to review next steps with the communities. Communities recommended that CIFOR continue to mediate the boundary demarcation process, although local government at the same time expressed an interest in taking on the mediation and mapping themselves. Because of the long-term nature of boundary adjudication and the role of local government in approving boundaries, CIFOR and the Malinau District government recommended that local government would be better placed to continue the mapping. Communities also requested more information about decentralization, local government and negotiation methods for dealing with IPPK (*Izin Pemungutan dan Pemanfaatan Kayu*[7]*)* holders.

In each village the steps planned by the Core Team to facilitate community mapping were:

1. The Core Team initiated work with a community once they had had internal discussions and negotiations with neighbours to decide their boundaries and had formed an internal village mapping committee of five to six members.
2. The Core Team began by facilitating a community meeting to discuss the purpose of mapping, the process, the responsibilities of the community and how they wished to store/control use of the map once it was finished.

3. The Core Team trained the village mapping committee in GPS (Global Positioning System), compass and mapping skills.
4. Together the Core Team and village mapping committee visited boundary areas to collect GPS points. Those areas that could be mapped according to topography or rivers were drawn in on a satellite photo. The Core Team provided leadership in these activities.
5. Both teams entered GPS points to the satellite photo and a base map.
6. At the completion of fieldwork, the Core Team reported about the process and results of mapping back to the community.
7. One draft map was left with the community, and the other was sent to Bogor for processing by CIFOR.
8. Processed maps were returned to communities for crosschecking.
9. Communities begin negotiations with government to acquire legal recognition of their boundaries.

We faced several challenges in implementing these steps fully. Although we attempted to genuinely build the capacity of local villagers to undertake the mapping on their own, we found that few communities, even after several training sessions and experience in mapping, were able to participate in the mapping as much as we had expected (see discussion below).

The Core Team also helped to mediate conflict on several occasions when requested to do so by communities. During the mapping and separate monitoring activities, Core Team members observed conditions affecting how agreements were reached. They also observed the types of conflicts occurring and the strategies of communities to achieve agreements.

The Core Team was not always able to hold meetings about the results of the mapping because community members were often preoccupied with other business and the large distances and tight schedule did not permit the team to wait in an open-ended way for village leaders to call a meeting.

The project was not able to complete the last two steps of the mapping because of the requests for changes in boundaries and the lack of information about how to formally recognize the boundaries. From July 2000 until the end of the project period (December 2001) the completion of the process was therefore put on hold in anticipation of the local government's plan to facilitate the conclusion of the mapping.

Land use under decentralization

Beginning in 2001, because of the increasing conflicts about land use among all stakeholders and rapid deforestation, CIFOR decided to broaden the stakeholders in the project. To that end, CIFOR and the Malinau local government co-sponsored a multistakeholder workshop in May 2001,[8] involving 69 participants including the Malinau local government, local concession holders, 19 community members (additional community members were also represented in government and NGO positions), church leaders and NGOs. The participants identified their shared hopes for the future:

- Increased income
- Land use that is clear and occurs according to assigned rights and functions
- Development of institutions that are efficient, coordinated and transparent
- Environmental conservation.

Participants jointly produced action plans to achieve these desires. These plans included the recommendation that land use and boundary decisions should include participation of representatives of all affected groups in all stages, from field inventories to rule making and implementation. The meeting was the first-ever multistakeholder meeting of its kind in the district. Participants, especially local villagers, were highly enthusiastic about the opportunity to meet with so many different groups to discuss these issues together. The meeting created a high level of optimism and good will about the potential for future stakeholder collaboration.

CIFOR is presently in discussions with local government to determine a program for next year to follow-up on these recommendations. We have been also working intensively in the Loreh and Langap sites (seven villages, four ethnic groups) to discuss with communities their priorities for action related to decentralization and land use management. A workshop will be held in November with the communities of the upper watershed and other stakeholders. Two members of our team, sponsored

by the Ford Foundation, have been preparing legal literacy materials for communities and local government.

Preliminary outcomes of these discussions indicate strong interest from communities and local government in:

- Completing the conflict mediation and boundary demarcation process
- Improving understanding of future economic options for increasing local incomes
- Improving legal literacy related to decentralization and community rights
- Identifying ways of reserving forests for local use and protection.

During the course of these three phases of work, we have worked with officials in the *kabupaten* and *kecamatan* offices, Bappeda, INHUTANI II, Meranti Sakti (another local HPH), and *Dinas Kehutanan* at the provincial and *kabupaten* levels of government, mostly in the capacity of exchanging information about our plans. We have also collaborated with Plasma, SHK-Kaltim, PPSDAK, Padi, LPMA, the University of Victoria (Canada), Wageningen University and Yale University in various components of the work. We have coordinated with and informed partners in Samarinda periodically, particularly Plasma, SHK, Putijaji, APKSDA, The GTZ Sustainable Forest Managament Project and WWF-Kayan Mentarang (now in Tarakan).

Committee members of two neighbouring villages collect GPS coordinates along the village border, assisted by members of the facilitation team

The context for struggles over land and forest

Struggles over land and forest in Malinau have been long-standing, even if the reasons and means of managing them have changed. We can trace the shifting authorities that worked to overcome these struggles and served to coordinate control over land during the last several centuries. For the earliest periods we can only draw evidence from historical documents, oral histories and try to extrapolate from conditions observed in more 'traditional' villages, although the latter is risky (see Sellato in press for a historical overview of Malinau during the last 150 years).

At least until the early 1900s, intergroup warfare was common, as was migration in response to the threat of war. Minor customary leaders (*kepala adat*) and their circle of close advisors helped to control access to land, manage conflicts and coordinate decisions within their ethnic group, while major customary leaders (*kepala adat besar)* helped to coordinate these matters at yet larger scales. Most settled rice farming communities (e.g. the Kenyah) seem to have sought control over territories, while others (e.g. the Punan) seem to have been more concerned with access to settlements and key resources. Where they existed, territories seem to have been conceptualised in terms of a central settlement point or river and its watershed, with less emphasis on the exact location of the outer bounds. In many places, customary leaders controlled rights to valuable resources like birds' nest caves nested within the territory of a sultanate.[9] The sultanate in turn levied taxes on the traded products.[10]

Coordination occurred through these customary leadership structures, which used hierarchical social controls within their villages and periodic consultation—especially with a close circle of

influential villagers or *tokoh masyarakat*—to manage conflict within the group. Unresolved conflict was handled though the fission of the group, with one faction moving to a new settlement or, in the case of external groups, by violence. Around 1900, Kayan groups repeatedly attacked Merap groups on the Malinau to reclaim caves taken over by the Merap. Marriage or trade alliances were used to build relationships with external groups. Rights of access to village territories were based on these ethnic and trade alliances as well as respect for customary authority, requests for permission and verbal agreements, although people often casually entered watersheds for hunting or collection of forest products without permission. Rivers and mountain tops marked boundaries. Reflecting the economic value of forests at the time, some leaders requested fees from outside groups wishing to collect forest products in their area (Sellato in press). Evidence suggests that in the upper Malinau, the Merap *kepala adat besar* was the reigning local power, together with the local Tidung Sultanates, for most of the 20th century.

As warfare declined, the Dutch[11] and later in 1950s the Government of Indonesia[12] became additional layers in the institutional hierarchy in what was first the Bulungan sultanate and later the *kabupaten* or district of Bulungan. The new Indonesian government established an infrastructure of centralized control. The role and direction of accountability of customary leaders became muddled over time as many were appointed by outside officials as village government heads (*kepala desa*) and became upwardly accountable to a *camat*, *bupati*, governor and the president. Local social institutions were severely weakened with the delegitimation of customary laws and leaders. Government maps of villages bore little, if any, relationship to actual settlements and their claims. Unfortunately, local villagers became increasingly politically disenfranchised and distanced from under this system. Most matters of village concern continued to be settled by customary leaders, especially those who also worked for the government as *kepala desa*. These leaders made decisions among a group of ethnically homogenous people. Access to land and forest continued to be managed as before.

In addition to establishing new administrative overlays, the state staked extensive claims to forested territories starting in the 1960s as the timber boom began. Nearly 95% of what is now the district of Malinau was designated as state forest land, and in the late 1960s the central government allocated all the state forest land to timber concessions. Suddenly villages found themselves sharing the forest with timber harvesters and being told that the land belonged to the government of Indonesia. The state's assertion of authority over land through the logging companies' presence openly challenged local sovereignty and claims to land in a way that sultans and the Dutch had never done. Villagers for the most part accommodated the concessions, largely out of feelings of intimidation (military officials usually accompanied logging company staff or otherwise harassed potentially troublesome villagers). The gradual degradation of forest, loss of wildlife for hunting and lower water quality that they experienced were also partially offset by the construction of roads, provision of transportation, generation of employment (albeit limited) and occasional contribution to a village project. Local concessions did not strictly enforce hunting and burning prohibitions and allowed swiddening in some forest areas in an effort to maintain good relations. During this time, forest-related conflicts were predominantly intervillage quarrels about access to agricultural plots and for a few individuals, efforts to maintain claims to birds' nest caves. The state did not allow conflicts with the government or concessions to occur.

The authority of village customary leaders further eroded and land claims became more complex as ethnic groups began to share territories. Government resettlement programs of the 1960s through 1980s, and an *ad hoc* case of government-sponsored resettlement in 1999, reallocated mostly formerly Merap[13] lands along the upper Malinau River to Dayak groups who had moved from more remote parts of the area. The newcomers did not, however, always sever ties with their former territories. As a result of these programs, two to four ethnic groups now reside collectively in each of nine of the 16 settlements (*lokasi*) along the upper Malinau River. Population pressure has also increased substantially on local resources. These groups now make claims to multiple territories that overlap with other group's claims, calling into question who maintained authority over which land and what the role of customary and government authorities is in settling these claims. Because of the resettlement programs, the upper Malinau River area suffers more from these sorts of multiple claims than any other part of the district.

The final and most recent major development occurred with three overlapping phenomena: decentralization reforms, new access for villagers to monetary payments for timber and land and the creation of the new *kabupaten* Malinau. With the initiation of decentralization and the associated uncertainty, local people from all sectors of society have sought to seize their share of Malinau's resources. Even before decentralization policies were formally implemented at the *kabupaten* level, *de facto* decentralization began taking place with villages making claims to *adat* lands and negotiating directly with local investors (Rhee forthcoming). Villagers made demands for compensation or benefits from timber and mining companies more freely and requested larger amounts than ever before.[14] Since former President Soeharto stepped down, villagers say they can express their discontent without fear and have been much freer about speaking out against their leaders and the government. Military officials only rarely accompany timber companies or government entourages any more. New political associations have formed among different ethnic groups. Village leaders can be seen as often in the central town of Malinau, meeting with government or company officials as they are in their own villages.

Fuelling the race for resources was the offer of payments by companies for harvesting timber. In 1996, the exploitation of coal in the Loreh-Langap area resulted in payments to some 10 to 20 households and to the customary Merap leader of Langap for rights to excavate their fallowed swidden fields. In 2000, the Governor of East Kalimantan passed a provision (stimulated by the new Basic Forestry Law 41, 1999) enabling communities to claim compensation from timber companies for logs harvested in their areas.

The most lucrative deals, however, were the IPPKs, or *Izin Pemungutan dan Pemanfaatan Kayu*. Beginning in April 2000, the *Bupati*[15] began allocating these small scale logging permits for 100 to 5000 ha each to hastily formed small local companies (CVs). With decentralization, the *kabupaten* became responsible for generating its own income, and could also keep a larger proportion of the income it generated than ever before. The incentives for intensive resource use were therefore high. The presence of the Kayan Mentarang National Park increases the pressure on the *kabupaten* to make more intensive use of the remaining areas, such as the upper Malinau River, which are also more accessible and have better infrastructure. The result has been extraordinarily high levels of timber extraction among more diverse groups and increasing conflict among nearly all parties, including smallscale timber harvest permit holders, concession holders, villagers (themselves often forming factions) and mining interests (Barr *et al.* 2001). Thirty-eight IPPKs have been issued granting access to more than 53 000 ha in Malinau since April 2000. Underlying the logging deals has been the negotiation of territorial claims and speculation about the value of these lands for future claims or compensation. A *laissez-faire,* frontier atmosphere has emerged in which making money has become more important than always being lawful or fair.[16]

The symptoms of trouble are clear: community protests against the investors for not paying expected fees or wages to local harvesters; complaints among villagers about opaque deals struck between leaders and investors; and forest logged in areas where permission was not granted by villagers. In most villages, few people know the content of the evolving law or are aware of their entitlements. Usually only a select elite close to the village head (*kepala desa)* are involved in *kabupaten* matters and negotiations with investors. Many villagers are excited about trying new economic options, but lack the information about how to consider trade-offs in livelihood security and long-term resource use. The communities' euphoria—unchecked by a lack of information—about receiving several thousands of dollars now will most likely be forgotten in a few years when both the forest and their money have run out.

In addition to the above, the formation of the new *Kabupaten Malinau* in October 1999 (one of three new districts formed from the district of Bulungan) has meant that there was a one and a half year period of temporary leadership of the district that was not accountable to a local assembly. Not coincidentally, this was also the time when the bulk of the IPPKs were issued. Many government offices were only filled in 2001, including the forest service (*Dinas Kehutanan*). Another significant aspect of the new local government is that for the first time, most posts were filled by people originating from the *kabupaten* (or married to someone from the *kabupaten).* Previous officials were mostly from Java, Sulawesi or other parts of Kalimantan (especially

Samarinda or Banjarmasin). The Dayak-ization of local government has meant that authority is now rooted in the local politics of more than 18 different ethnic groups. Local relationships of power are more intertwined and complex than ever before.

These evolving relationships have affected how struggles over land play themselves out. Current alliances in Malinau reflect a set of fluid, interlocking networks of ethnic affiliations, economic interdependencies, strategic kin relationships and even historical alliances from the headhunting period. Kenyah, Lundaye and Tidung groups have been the most politically aggressive groups in recent years and dominate Malinau's new local government. These groups, together with the Merap, have also worked most aggressively to consolidate their claims to land. Punan groups, meanwhile, have had little representation in the *kabupaten* government, as well as weak historical claims to lands, and are always the weaker partner in alliances with other ethnic groups.[17] Individuals from all groups have maintained an opportunistic attitude towards building alliances and sought to strike new deals as they may, making it difficult to know at any one time precisely who has control where. Unfortunately, only a relatively small group of leaders and their circles enjoyed the benefits of these deals and exerted any real influence over decisions.

Decisions made in the next several years will have huge consequences for who controls land and how that land will be used in the medium term. Current trends indicate very real threats of rapid deforestation, disenfranchisement of the Punan, and ultimately the loss of opportunities for long-term economic gain by most local groups. As one of Asia's largest remaining expanses of continuous forest and home to the largest group of Punan in Borneo, it is vital that coordination be improved to encourage a longer-term and more integrative view of how the areas's forest can be managed to provide more equitable and long-term benefits for local communities. Local stakeholders feel these challenges intensely.

Setting Village Boundaries

It was in the context of this last set of developments that CIFOR's action research on intervillage boundary conflict took place. Below we report our results. We report on the lessons learned about the types of conflicts encountered, the factors influencing how communities reached agreements, and the impacts of the boundary demarcation process. We also note some technical lessons learned about the participatory mapping process.

Sources of Conflict

The most common sources of conflict between villages over boundaries were the overlap in ownership or use of agricultural lands (swidden fields, wet rice fields and perennial gardens) and a history of mistrust and non-cooperation. Other sources of conflict included timber, valuable non-timber products like gaharu or birds' nests, and land containing coal deposits. Every village experienced however its own unique constellation of specific conflicts (Table 7.1). A general pattern can be seen among the different parts of the watershed. In the far reaches of the upper Malinau, where mostly Punan groups lived, conflict focused on access to forest products, in addition to the sources mentioned above. In the central portion of the upper Malinau, where rich coal deposits occurred, conflicts emerged because of efforts to claim compensation from the coal mining company for the use of cultivated or fallow fields. In the lower stretches of the upper Malinau, problems focused only on access to agricultural lands and historically problematic relationships of mistrust.

Underlying the mistrust and lack of cooperation were disparities in economic or political status between villages. These disparities affected how a conflict over boundaries manifested itself, as well as the possibilities for resolving the conflict. As we discuss further below, the larger the discrepancies between villages, the less likely it was that villages were able to reach agreement about boundaries.

Although many of these conflicts had existed formerly, villagers noted that the intensity of the conflict increased with the advent of outside parties seeking to exploit local resources such as timber and coal and offering compensation payments for them. The possibility of earning large amounts of extra income raised the stakes of the conflict, and made people determined to protect or expand their claims to timber or coal-bearing areas. When high stakes occurred, more latent, long-term conflicts related to intervillage differences or rights to agricultural land

Table 7.1 Sources of conflict affecting boundary negotiations

Boundary	Source of conflict				
	Coal deposits	Agricultural lands[1]	Non-timber forest products[2]	Timber	History of poor relations
Lidung Keminci - Sentaban		X			X
Sentaban - Setulang		X			X
Setulang - Setarap		X			
Setarap - Batu Kajang		X			
Batu Kajang - Gong Solok		X			X
Batu Kajang - Adiu					
Gong Solok - Adiu		X			X
Adiu - Loreh		X		X	
Adiu - Nunuk Tanah Kibang					
Long Loreh - Gong solok					
Long Loreh - Nunuk Tanah Kibang					
Long Loreh - Langap	X	X	X		X
Langap - Seturan/Punan Rian	X	X	X		X
Langap - Nunuk Tanah Kibang	X	X			X
Langap - Laban Nyarit	X	X			
Langap - Tanjung Nanga'	X	X			X
Laban Nyarit - Mirau		X	X		
Laban Nyarit - Halanga'		X			X
Laban Nyarit -Tanjung Nanga'	X	X			X
Laban Nyarit - Metut					
Laban Nyarit - Pelancau					
Laban Nyarit - Long Lake					
Tanjung Nanga' - Seturan					
Tanjung Nanga' - Metut		X		X	
Metut - Pelancau		X	X	X	X
Pelancau - Long Lake					X
Long Lake - Long Jalan			X		X
	6	17	5	3	13

[1] Swidden fields, rice fields, perennial gardens

[2] Birds' nests, gaharu etc.

were drawn to the fore and further fuelled the intensity of the immediate conflict.

The Process of Negotiation

Community Participation

Community participation in the negotiation and mapping process was lower than CIFOR anticipated. It was also less than necessary for the mapping to genuinely reflect diverse villagers' interests. In retrospect, however, we found that low participation is common in participatory mapping (Fox in press) and generating adequate participation is a central challenge of populist approaches (Rossi 1997). In Malinau, we observed that the lack of broad participation or at least effective representation in the negotiations in particular affected the ability of villages to achieve stable agreements. Although villagers asked us to conduct the mapping during a period of low agricultural activity (April to July) so that they would have more time available, and CIFOR's Core Team actively sought to stimulate broad community participation through meetings and informal interaction, decisions tended to be controlled by only a few individuals. We observed this decision-making pattern to be typical in villages of the upper

Malinau River for most matters at the village or intervillage level.

In relation to mapping, participation was ineffective both within villages as well as in meetings between two or more villages. Within villages, participation in meetings was low. For example, in the Loreh site (four villages) only 50 people of a total of over 1000 ever attended most public village meetings, including the mapping consultations. Only 20 people from the Loreh villages were later involved in the final negotiation with Langap. Of the 60 people interviewed in the Loreh villages after the mapping had been completed, only a small proportion knew that the mapping took place. Factions were common in even small villages. Representatives of these factions were frequently not present in meetings, either because they had not been invited or they purposely did not attend. Boycotts of meetings were a common means of quiet protest against the group calling the meeting. Village leaders usually only consulted with a small circle of influential colleagues among the *tokoh masyarakat* and never actively sought the views of different groups, let alone represent them. Women rarely participated in meetings, and if they did, rarely spoke. Predictably, village politics led to some groups giving more weight to their own preferences, while marginalizing others.

In intervillage meetings, villages were represented by only one to six influential village members (*tokoh maysarakat*), including among others the village head (*kepala desa*), members of his staff (*aparat desa*) and customary leaders. Even though there were village leaders representing villages, decisions often could not be reached if a key leader was absent. In Langap, for example, a decision could not be taken without the endorsement of the Merap customary leader or *kepala adat besar*. In Metut, the absence of the village secretary completely stalled negotiations with Pelancau. In cases where the village leader only needed to reaffirm an existing agreement, the participation of a few individuals was sufficient for ensuring acceptability to other villagers and the stability of the decision. A small delegation became problematic, though, where changes needed to be negotiated and consultations with key influential people and representatives of groups were needed before settling on a particular option on behalf of the village. People attending meetings on behalf of a village rarely reported back to the village about the outcome of their negotiations.

One of the most important factors affecting participation was the location of a meeting. The number of people attending a meeting was strongly affected by its location in one village versus another. Time and transportation expenses limited the number of people willing to travel. For example, a meeting between Langap and its neighbours held in Langap involved 21 members of Langap and none to three members of the eight neighbouring villages. Similarly in a meeting held in Setulang, 30 people attended from Setulang, compared to the three from the neighbouring village of Setarap. If negotiations are held repeatedly in the same village, other villages face difficulties in sending representatives, which then compromises their ability to reach more stable decisions.

Representation and participation among the Punan was especially poor. The Punan faced special constraints participating in meetings called in villages. First, Punan families frequently went to the forest for long periods of time (*mufut*), with men additionally going into the forest to look for gaharu (*Aquilaria* sp.) for weeks or months at a time (*ngusah*). Their absence meant that they also would often not know about meetings in advance and therefore lacked time to consult with other community members before attending a meeting. Second, where the Punan lived in a settlement with other ethnic groups, the Punan did not always feel comfortable expressing themselves in meetings. More dominant groups did not always invite them to meetings and information from meetings was not always shared with them. Selection of representatives to meetings appeared to be more *ad hoc,* and these representatives were rarely accountable to anyone in the village. Among the nine locations where Punan villages coexisted with other ethnic groups, participation of Punan groups was extremely weak in three communities (Seturan-Punan Rian, Tanjung Nanga'-Respen, and Gong Solok I and II). Third, in at least Langap, the Punan living in neighbouring Long Rat and Punan Rian had a historically subservient relationship with the Merap, having been given land locally to facilitate their work as forest collectors for the Merap, especially of birds' nests. A final reason for weak Punan participation was that in four settlements (Pelancau, Long Lake, Metut and Long Jalan), members of the village were scattered in several locations, making it difficult to involve representatives from all groups and distribute information to everyone.

Internal village processes

Internal village consultations strongly affected the ability of villages to reach agreement among themselves, as well as with other villages. In each case, the village head (*kepala desa)* coordinated whether these consultations occurred or not, sometimes together with the customary village head (*kepala adat*). Of seven pairs of villages that engaged in broad consultations within their respective villages before negotiating with their neighbours (Setarap-Setulang, Setarap-Batu Kajang, Batu Kajang-Gong Solok, Tanjung Nanga'-Langap, Langap-Laban Nyarit, Langap-Loreh, Metut-Pelancau), five resulted in agreements. Internal preparations served the purpose of ensuring that the negotiated decision would be acceptable to the broader community. They also helped community representatives to explore different options and have more information at hand to be able to negotiate better. These preparations differed among villages. Only 11 out of 27 villages held formal community consultations or *musyawarah*. Others held small informal meetings. Aspects of internal consultations that seemed most important in producing a stable, broadly acceptable outcome were as follows:

- Transparency, indicated by the holding of a community meeting attended by a majority of the families. Where transparency was lacking (e.g. Metut, Sentaban and Laban Nyarit), people within the village later challenged the agreement determined by the village head.
- Community capacity to work together and trust and support each other (community cohesion), indicated by a history of lack of factionalism, cooperative efforts at the village level and support for the village leader. Such capacity was high, for example in Tanjung Nanga' and Setulang. Where people did not work together, negotiations were less effective. Langap representatives negotiated demands from Tanjung Nanga' that were not supported by other Langap villagers (where at least four factions exist), such that when the mapping team tried to identify boundaries, the agreement was rejected.

Negotiations between villages

In observing the negotiation process, we sought to understand how negotiations were organized and the factors influencing their outcome. Although we

People were often eager to mark their boundaries, especially along a road

initially encouraged parties to reach agreement[18] quickly and described this as a 'successful' negotiation, we soon learned that many such agreements were short-lived and partial in their support. An agreement reached quickly enabled communities to conduct the mapping of their territory, but we fear this occurred too often at the expense of a more socially inclusive process that would have probably resulted in more stable results. We learned that *we should have evaluated the process underlying how a village reached their agreement as a basis for proceeding with the mapping, not just whether an agreement had been reached.*

Two approaches were used in negotiations between villages: meetings between village heads or meetings between selected village representatives. Meetings between village heads usually occurred where there had been no previous village consultation. As noted above, this occurred in several cases where both parties already accepted a boundary and the boundary only required affirmation (Laban Nyarit-Pelancau, Laban Nyarit-Metut, Laban Nyarit-Long Lake). In these cases one meeting was sufficient to agree on boundaries. Where there was a disagreement about the boundary, however, community members consistently rejected agreements reached only by their village heads. For most villages, negotiations with other villages commonly involved one to five meetings, although in one case 19 meetings were held! As noted above, both village heads and other representatives were only partly, if at all, accountable to their broader village constituency.

In the negotiation process, five factors appeared to help communities reach agreements, in addition to the influences mentioned above. First was consultation with the other village. Among the 27 villages, eight held consultative *musyawarah* meetings with neighbouring villages as part of their preparation for the mapping. Six of these villages successfully negotiated agreements. Good relations did not predispose these villages to having meetings and reaching agreements, since at least half of the six were communities with long-standing historical difficulties with their neighbours.

Second, family relations among villages encouraged compromise that led to more rapid agreement. Six villages (Long Jalan, Long Lake, Pelancau, Metut, Laban Nyarit, Langap) sought agreements based on compromises because of family relationships with another village. Although they may have wished to expand their territory due to the changing value of resources, because they were all members of the same extended family, these communities decided to maintain existing boundaries.

Third, financial incentives encouraged speedy resolution. Potential compensation payments by the coal company or sharing of benefits from small scale timber harvesting (IPPK) holders promised concrete benefits that encouraged villages to act quickly to reach agreement and get on with mapping their lands to secure additional income. With the uncertainty of decentralization policies, a first-come, first-served attitude developed where people feared someone else would benefit from the resource if they did not make use of it first, or the policy would change and the benefits would no longer be available.

Fourth, villages with similar institutional capacities and power were more likely to reach agreements than villages that differed.[19] In a number of cases, especially the case of Langap and its weaker neighbours such as Long Rat or Paya Seturan, more powerful villages presumed themselves entitled to exert their will about a boundary decision, and disregarded the need to build agreement with a weaker village. Weaker villages often passively resisted these decisions by the more aggressive villages. This pattern is evident with the application of a simple scoring system,[20] the results of which are summarized in Table 7.2. Even where agreements were ostensibly reached, there was a clear pattern that villages having lower capacity-power differentials were more likely to reach stable agreements. The more similar two villages were, the more likely they would not challenge boundary agreements.

The fifth factor influencing outcomes was the opportunity to share benefits across villages. CIFOR assisted villages to reach agreement in several cases by encouraging villagers to treat the boundary not as a fence excluding non-villagers, but as a set of rules about sharing access or benefits. In seven cases (meaning the unique boundary between two villages), villages negotiated agreements enabling neighbours to maintain their swidden fields, perennial gardens, or hunting rights (Langap-Loreh, Langap-Seturan/ Punan Rian, Langap-Nunuk Tanah Kibang, Langap-Laban Nyarit, Laban Nyarit-Tanjung Nanga', Metut-Pelancau, Long Lake-Long Jalan). In five of these cases agreements were reached. Langap and Nunuk

Table 7.2 Difference in capacities and power status between two negotiating villages and nature of agreements reached

Difference in capacities and power status between two negotiating villages	Difference in capacity-power scores	Agreement reached?		Stability of decision[1]	
		No	Yes	Stable	Not stable
No difference	0	0	6	5	1
	0.5	1	7	6	1
Moderate difference	1	2	2	1	1
	1.5	1	5	2	3
Large difference	2	1	1	0	1

[1] Stability was only counted for cases where agreement was reached.

Tanah Kibang agreed to share future compensation payments from the coal company. Langap and Long Loreh reached agreement about an area under which lay valuable coal, by acknowledging that Loreh could continue to use existing cultivated plots in the Langap territory. Although both parties appeared satisfied with the current arrangement, there was no discussion of who would gain rights to compensation payments should these agricultural plots be converted for mining. In negotiating these agreements, village decision makers had to carefully weigh the benefits of working out an agreement in highly specific detail against working out only the broad principles. Negotiating too many details creates the risk that agreement would not be achieved. Negotiating only general points enables at least a partial agreement to be achieved—but at the risk that additional conflict will occur later.

To the extent these factors were not present, villages with conflicting boundary claims were not able to reach agreement. These villages were ultimately not able to sustain a supportive political base. We observed in particular that community members in these villages frequently did not support agreements produced by their leaders and in several villages refused to map the suggested boundary. For two villages, there was also the practical problem that they were not sure whose territory adjoined their own because their borders were far, hence their preparations with these neighbours were lacking and preliminary agreements had to be renegotiated (Gong Solok-Long Loreh, Batu Kajang-Adiu).

The Results of Negotiation: Boundary Agreements

Of the 27 boundaries among villages in the upper Malinau, 21 were negotiated to the point of agreement between the villages concerned during the seven-month period during which CIFOR conducted the mapping (Table 7.3).

During the period of the mapping, most villages relied on written agreements between villages, which for many was a new development. Verbal agreements had previously been more common for boundaries. Written agreements were produced as *berita acara,* or public announcements signed by two parties and sometimes further signed by the local subdistrict leader (*camat*). Although in the past, some community leaders amended documents to include extra signatures from another group, it appears that the *berita acara* produced during the mapping process were legitimate. In the past, one village in particular had attached the signatures from attendance at a meeting to a statement of supposed agreement and produced a map showing their own version of the boundary. Trust in written agreements appears to be increasing despite such past abuses. Trust in verbal agreements has certainly declined, perhaps because they are seen as no longer binding and less legitimate.

Negotiations conducted transparently with written agreements tended to be more stable than those that were not. Of 21 boundary agreements, 14 were stable, while seven changed within the seven-month period. The 14 stable ones used more

Table 7.3 Results of Boundary Negotiations among Villages of the Upper Malinau River

Village boundary	Agreement reached	Documented in writing	Agreement stable[1]
Lidung Keminci - Sentaban			
Sentaban - Setulang		X	
Setulang - Setarap			
Setarap - Batu Kajang	X	X	X
Batu Kajang - Gong Solok	X	X	
Batu Kajang - Adiu	X		
Gong Solok - Adiu	X	X	X
Adiu - Loreh	X	X	X
Adiu - Nunuk Tanah Kibang	X		X
Long Loreh - Gong Solok	X		
Long Loreh - N.T. Kibang	X		X
Long Loreh - Langap	X	X	X
Langap - Seturan/P.Rian	X	X	
Langap - Nunuk Tanah Kibang	X	X	X
Langap - Laban Nyarit	X	X	X
Langap - Tanjung Nanga'	X	X	
Laban Nyarit - Mirau	X		
Laban Nyarit - Halanga'			
Laban Nyarit -Tanjung Nanga'			
Laban Nyarit - Metut	X	X	X
Laban Nyarit - Pelancau	X	X	X
Laban Nyarit - Long Lake	X	X	X
Tanjung Nanga' - Seturan	X		X
Tanjung Nanga' - Metut	X		
Metut - Pelancau		X	
Pelancau - Long Lake	X	X	X
Long Lake - Long Jalan	X		X

[1]Stability means here that there were no challenges to the agreed boundary by the two villages involved by July 2000.

transparent negotiation (negotiations that were conducted in a more secretive manner where negotiators did not share information about the process or contents of their meetings were Setulang-Setarap, Batu Kajang-Adiu, Long Loreh-Gong Solok, Laban Nyarit-Mirau, and Tanjung Nanga'-Metut) and ten of the 14 used written agreements.

However, as of December 2000, *nearly all villages requested changes even to previously stable boundaries*. We attribute these demands to the increasing activity of the small scale timber permit (IPPK) holders during the latter half of 2000 and a new provision at the provincial level enabling villages to claim compensation from timber companies for timber previously harvested. As the stakes rose, villages sought to increase their land claims even further. The lack of a clear higher third party institution with the authority to provide formal recognition of boundaries and control *ad hoc* revisions also made it possible for this fluidity to occur. With decentralization, just where this authority lies is not clear, although many have assumed it is

now with the *kabupaten.* The establishment of the new Malinau *kabupaten* has delayed the local government's involvement in the boundary demarcation to date. As the *kabupaten* asserts its authority and endorses boundary agreements, we can expect to see more stable results. The authority vested in this higher institution would have to be controlled by checks and balances and maintain downward accountability to ensure just decisions.

Impacts of Mapping

Viewed in November 2001, more than one year after the completion of the mapping, several important impacts of the negotiation process and mapping activity can be observed. First, a new awareness has emerged among all stakeholder groups of the location and extent of different villages, as well as the value of mapping as a means for making claims to land. This awareness can be considered a necessary basis for coordinated landscape management. Although CIFOR did not distribute maps of a village to others and clearly marked maps as drafts, villagers themselves often shared them (especially with local investors) and CIFOR displayed the maps in several meetings with other stakeholders.

New types of boundaries emerged as some villages (e.g. Tanjung Nanga' and Langap) reconceptualised boundaries as straight lines or along roads rather than natural boundaries. For most groups, there is a subtle shift in the conceptualisation of territory as defined by its centre settlement point or a main river of a watershed to an emphasis on outer boundaries. For some groups, especially the Punan, we suspect that the mapping has reinforced the historical trend of gradual territorialisation of previously nomadic or shifting groups, a trend accompanied by an increasing tendency among inland groups to want to register their land as property, and even to seek private rather than communal property. Whether such changes are significant and occur to the benefit or detriment of Malinau's populations and forest, it is too early to tell, but they do signal changing attitudes and values related to land. Developments in the policy environment related to *adat* and IPPK claims will strongly influence how these changes play out.

Second, the mapping process, in combination with other changes related to decentralization and changing attitudes towards land, affected relationships among and within villages. The mapping brought out conflicts that had been latent, thereby exacerbating conflicts in some villages and alleviating it in others through negotiations. New alliances and coalitions among communities emerged as weaker communities sometimes conferred among themselves about how to deal with a common, more powerful, community. For five pairs of villages we observed improved relationships after boundaries were settled. For five others, relationships declined, and for the remainder relationships stayed more or less the same. Where there were multiple villages in one site (e.g., the sites of Gong Solok, Long Loreh and Sentaban), financial offers from investors arriving after the maps were completed contributed to the villages in each location wanting to have separate territories, resulting in more antagonistic relationships among villages in the location.

Within communities, we saw five communities where new factions emerged as a result of the mapping, despite these particular villages having relatively strong leadership, community cohesiveness and good access to information. Three of these occurred because a faction did not accept the decision handed down by the village leader. Two occurred because of a subgroup of the village wanting to make claims for themselves, e.g., Liu Mahan in Long Loreh, and the case of Laban Nyarit and Halanga'. As attitudes and values about land changed, so did village relationships. There was no significant overall trend, however, towards better or worse relationships.

Third, community capacities for mapping and negotiation improved. Small teams of people in each community mapped gained experience in the methods and equipment necessary to geographically reference and plot a series of point in their village on a map. Understanding of maps—including scales, legends, orientation and their uses—became stronger in each village. Through the process of negotiation and with input from CIFOR, communities' understanding of representation and the need for building a wider political base of support for reaching an acceptable agreement also increased.[21] Since the project began, there have been more demands from villagers for their leaders to use more transparent, inclusive processes for consultations and decision making.

We report observations about the participatory mapping process in Attachment 2.

Conclusions

What did the Malinau experience in boundary demarcation indicate about the kinds of conditions necessary to facilitate better coordination with other stakeholders and improved negotiations by communities? What do they add to our understanding of emerging principles related to multistakeholder processes? We summarize our observations below and draw conclusions about the lessons that seem most generalizable to other settings.

Facilitating coordination requires handling political factors

Boundary negotiations in Malinau highlighted the deeply political nature of coordination efforts and the skewedness of power relations underlying them, even among seemingly (to an outsider) homogenous community groups. Portraying the agreement-seeking process as apolitical or neutral would ignore fundamental relationships that our experience showed influenced *whether agreements were reached, how resources were distributed in agreements,* and *the stability of outcomes.* Political aspects of coordination that we noticed to be especially important in Malinau were *how conflicts were defined* (e.g. history of mistrust between villages), *the differences in capacity and power status* among villages that made agreements hard to reach or less stable, and *the lack of representation and attention to weaker or more marginalized groups in negotiations.*

Dealing with fluidity

As political struggles in Malinau played themselves out through shifts in alliances, stakes and negotiating conditions, people's interests, agreements reached and coordination efforts tended to change frequently. Our experiences support the pluralists' position that *agreements are best thought of as partial and temporary,* and we observed such fluidity to be extreme in Malinau. We conclude from our three years of study that *the more intense the underlying struggle, the more fluid interests, agreements and coordination* are likely to be. In Malinau, periodic opportunities to claim resources—as with the event of decentralization, the changing monetary value of local resources, the new *kabupaten* and the mapping activity—directly caused struggles to increase. Reaching stable decisions may have sometimes been actively avoided by villagers in part because of a lack of knowledge of an appropriate 'solution' given the rapidly changing conditions.

Facilitators of multistakeholder processes should anticipate fluidity and adjust coordination practices to accommodate it. In hindsight, the instability of boundary agreements in Malinau that were reached before July 2000 was predictable. During periods of fluidity, instead of investing in formalizing and implementing agreements likely to change, it might be more useful to anticipate increased conflict and seek only tentative agreements that require a testing period of several months or longer, depending on the volatility of opportunities and the extent to which agreements are likely to be challenged. In this way, vague arrangements (e.g. Loreh-Langap) resulting from efforts to achieve agreements quickly could be tested for their loopholes. During such periods, a focus on *managing conflict* to maintain constructive levels of debate is likely to be more productive than forcing an agreement. Also, as the concept and practice of agreements appear to be evolving and becoming more formalized, villagers may need time to develop a shared understanding of what such agreements are and imply. Investment in implementing the agreement could occur after evidence of reasonable stability.

Although some fluidity is inevitable and facilitators should manage it to adapt to changing forest conditions and managing political tensions, the extreme fluidity witnessed in Malinau imposed high costs on everyone. Agreements reached quickly were not necessarily fair or acceptable to the people concerned. Groups—including CIFOR—that invested time to carefully negotiate boundaries and then engaged in the tedious process of mapping, felt frustrated when these agreements were later changed. We observed that there is a need for facilitators and participants in negotiations to *build a supportive political constituency through consultation, and transparent decision making appeared to be key to achieving and then keeping an agreement.* Building such a constituency requires adequate time and deliberation. In addition to building support from the bottom, we think authority from the top can also stem extreme fluidity. The challenges to agreements in Malinau would have most likely been fewer if a third party with authority and legitimacy above the level of the village level had been involved to set the criteria

for resolving conflicts and validate and enforce legitimate agreements. Coordination processes may therefore need *to take both bottom-up and top-down measures to balance the need to flexibly respond to fluid conditions against seeking to limit excessive change that imposes excessive costs.* Such top-down measures probably need to include *kabupatens* making use of provincial and national policies and agencies to reinforce local decisions.

Complexity of conflict

The political nature of agreements and negotiation also suggests the need to consider *power relationships in understanding the complexity of conflicts.* In Malinau, conflicts over village boundaries involved multiple dimensions of historical, ethnic, class and economic relationships among and within villages. Boundaries were not just lines on maps, but major determinants of monetary flows and resource use to villages and individuals within them. Profound changes in people's attitudes towards land and its values created new dimensions of struggle related to speculation.

Our observations in Malinau suggest that it is indeed impossible to ever really know other people's interests, as leaders covertly negotiated among themselves and changed their minds about previous agreements. Instead, to better understand the factors driving negotiation, we suggest that an understanding of the diverse political relationships among groups can facilitate coordination and negotiation. Such an understanding is particularly important for promoting coordination and negotiation that deals fairly with differences in power among stakeholder groups. With such information, *facilitators of negotiation can better select representatives, fora for decision making, and subjects of negotiation that deal with the different aspects of the conflict.* They should *use a phased process that allows layers of conflict and awareness of changing political conditions to unfold and be identified.* An open framework of conflict management and flexible schedule is needed to allow for new elements of conflict or new authorities to be incorporated.

Accountable decision making

In Malinau, only a handful of people tended to be involved in each village in negotiating boundary decisions and these representatives, if the label is even apt, were weakly, if at all, accountable to their communities. Networks, communication and trust were frequently strong among selected leaders, or between leaders and companies, but often less strong between leaders and their constituencies. Decisions were usually made without consultation. A number of villages attempted to map their boundaries without even consulting their neighbours. These conditions made it difficult for conflict to be managed in transparent ways, which kept disagreements from being acknowledged and agreements from being implemented.

Abuses of power are likely to persist unless certain checks are put in place. Central among these checks is the need for better representation and transparent decision making to negotiate decisions that constituencies will accept and support. Where community representatives were more accountable to their constituencies and built a strong political base of support, decisions were less frequently challenged. *Broader consultation with factions in communities and better reporting back to communities can assist with building transparency*. *Leaders need to be more downwardly accountable to their constituency* to create incentives for them to be more responsive to community interests, although this would be difficult to fully implement in groups like the Kenyah and Merap due to a strong tradition of hierarchical control by the aristocratic class. Interlocking family, ethnic and economic relationships would help to foster agreements, but could work to marginalize outgroups and encourage corruption. In Malinau, the history of upward accountability of government representatives, the hierarchical nature of customary leaders, strong local networks and the pressures for striking quick deals have led to regular abuses of power that will not change easily. The more open environment of the post-Soeharto reform era creates the opportunity to question these networks, but changing how they work is a much more ambitious task.

Improving involvement of disadvantaged groups

Conventional multistakeholder theory seeks to establish neutral conditions that enable fair negotiation. We agree that s*pecial effort is needed to encourage effective participation and representation of weaker or disadvantaged groups.* Historical

information and analysis of the multiple aspects of conflict will help to indicate who is most disadvantaged. We would add, however, as argued in Edmunds and Wollenberg (2001), that *political relationships pervasively influence even so-called neutral processes and should be dealt with explicitly throughout the coordination process*. In Malinau, *differences between villages in capacity and power status affected nearly all aspects of negotiation*, including how the conflict was defined and who defined them. We suggest that at a minimum, facilitators of coordination efforts pay attention to these differences and seek to give certain advantages to weaker groups. These include, for example, distributing information to them earlier, giving them priority access to resources, and facilitating their preparations for negotiations. More significant measures for longer-term empowerment would include community organizing, assisting them to mobilize resources and helping them develop strategic alliances.

All of this depends of course on the desire of the group in question to receive such extra attention, and facilitators should take care not to create an identity of disadvantage that prevents the group in question from seeking to empower themselves. Facilitators also need to take care not to alienate more powerful groups in the process by creating unfair advantages or overprotecting the group in question.

Legitimacy: Effective coordination requires shared operating principles

Participants in a coordination process, with the assistance of outside parties, should periodically assess the legitimacy of any process of negotiation, agreement making or coordination to identify how well accountability measures and attention to disadvantaged groups are working. Given the nature of ongoing struggles and highly unequal power relationships in places like Malinau, the potential for abuses of power in multistakeholder coordination processes is high. Such abuse can cause existing conflicts to escalate, particularly under the conditions of greater openness enjoyed now in Indonesia, and result in protests involving disruption of work, degradation of forest resources, and destruction of property, as has already been demonstrated in Malinau.

There is thus a need to build coordination upon stronger social foundations about what are considered legitimate operating principles and outcomes. In Malinau, there is presently an institutional gap, such that there are no clear authorities on either the customary or the government side for settling conflicts among stakeholders in ways considered legitimate by all groups. Some groups are presently seeking to build that legitimacy, especially the *kabupaten* government, by, for example, creating new sets of local regulations about customary land claims. Following pluralist principles, they have been seeking in 2001 to better accommodate other authorities, including customary leaders. However, because of the close relationships between many of the government officials and local customary leaders, self-interest appears to prevail even here. Ultimately there may be a need for a consortium involving outside groups with few local relationships. The consortium would facilitate debate and develop and articulate the shared operating principles, as well as identify who should best act as the authority for implementing and enforcing the principles. Even within this consortium though, there would need to be vigilant attention to the nature of operating principles as something negotiated and subject to abuse by more powerful parties.

Participatory Mapping as a Tool for Achieving Coordination

Participatory mapping is, in theory, one approach for building a strong bottom-up political base of support for demarcating boundaries. It also, in theory, should build local capacities and empower groups that would not normally be involved in such processes to better understand maps and the types of decisions involved in mapping. While we agree that boundary demarcation is an essential tool for achieving bottom-up coordination and builds capacities, we note some differences between our experience and that in the literature.

Most documentation of participatory mapping focuses on the technical aspects of the process and its outcomes (Momberg *et al.* 1996, Gupta and IDS Workshop 1989) with little, if any, attention to the negotiation process underlying decisions or the acceptability and stability of outcomes (exceptions being Fox 1998, Peluso 1995). More attention needs to be given to the limits of making such processes

truly participatory (see Fox, in press), identifying appropriate stakeholders, developing operating principles for negotiation and identifying institutions for settling conflicts and legitimising outcomes. Bottom-up approaches alone will not work if there is a need for an authority at a higher level to resolve conflicts or support agreements. The factors that led to stable, accepted outcomes should be noted to assist others in seeking to replicate these conditions. As highlighted throughout this report, more effort needs to be given to making processes more fair for disadvantaged groups by giving them extra attention in training, working with their schedules, holding meetings in places convenient for them and enabling negotiations that acknowledge differences in power.

Experience in Malinau and elsewhere suggests that such deliberative and pluralistic coordination can be achieved through meaningful consultation among affected groups, accountable representation, fair negotiation, transparent decision making, public reporting and safeguards for effective representation of disadvantaged groups. Agreements among parties should be recognized as partial and temporary, with attention given to understanding not only how to reach agreements, but also on how to manage the conflicts resulting from the evolving interests of each group.

In conclusion, our experience in facilitating boundary demarcation in Malinau marked only the beginning of a long and multistranded process for achieving better coordination among the very diverse stakeholders interested in Malinau's forests. The research demonstrated the nature of coordination and agreement making in Malinau and its current vulnerabilities. The base of political support for coordination is fluid and often fragile. There are few safeguards to ensure fair negotiations for weaker groups. The authorities for supporting and endorsing these processes are unclear. Very real gains have been made, however, in empowering local communities to begin the process of asserting claims to their territories and of establishing debate about rights associated with those claims. A process has been started that communities, government and companies are now keen to complete. Further efforts at coordination will hopefully heed the lessons of this experience, and in the process generate its own local brand of democracy that enables the people of Malinau to embark upon the exciting journey that lies ahead.

Endnotes

[1] The project was conducted by the following members of the Bulungan Adaptive Co-Management Team and Core Mapping Team from 1998–2000: Salmon Alfarisi, Sargius Anye, Njau Anau, Ramses Iwan, Pajar Gumelar, Miriam van Heist, Godwin Limberg, Made Sudana, Nyoman Wigunaya, Asung Uluk, Lini Wollenberg. We wish to express our thanks to and acknowledge the support of the following parties: the local government of Malinau District; Roem Topatimasing and INSIST; Carol Colfer, Kuswata Kartawinata, Steve Rhee, David Edmunds, Yurdi Yasmi and Herwasono Soedjito from CIFOR; Jalong Lawai, and Paulus Irang of Long Loreh; Samuel ST Padan and WWF-Kalimantan Action Network; WWF-Kayan Mentarang; Ade Cahyat and Konsortium Sistem Hutan Kerakyatan-Kaltim; Niel Makanuddin and Plasma; Franky and Yayasan Tanah Merdeka; Amin Jafar and Yayasan Padi; H. Sayo and Pemberdayaan Pengelolaan Sumber daya Alam Kerakyatan; Mairaji and Lembaga Pemberdayaan Masyarakat Adat; and Jon Corbett and the University of Victoria. The work was jointly funded by ITTO (primary donor) and the International Fund for Agricultural Development.

[2] Coordination refers here to decisions that seek to achieve an aim on behalf of a group in light of the many self-interests of individuals that exist in that group. Coordination can be self-organized (Ostrom 1999, DiZerega 2000) or imposed from outside the group. We assume here that coordination is likely to be more successful where it can balance self-determination by group members with institutions at the group or supragroup level that maintain authority and legitimacy to make and enforce decisions on behalf of the group.

[3] We use Rossi's (1997) interpretation of deliberative here, meaning dialog and discussion that operates in an 'engaged mode, somewhere between mere respect and confrontation,' (p 205), and deliberative democratic decision making, in which individuals seek to go beyond their self-interest (although such interests might be part of the dialog), and make decisions based on their perception of the common good.

[4] Sections of this report are drawn from the CIFOR report '*Pemetaan Desa Partisipatif sebagai alat menyelesaian konflik: Studi kasus desa-desa daerah aliran Sungai Malinau, Januari s/d Juli 2000*, *Tim Pengelolaan Hutan Bersama secara Adaptif,* 2001.

[5] These recommendations are drawn from Edmunds and Wollenberg 2001 and Wollenberg *et al.* 2001, the latter of which is a synthesis of other papers (see References).

[6] The *Kabupaten* has recently expressed an interest in learning more about scenario methods.

[7] License to fell and utilize timber.

[8] Funded by ACIAR.

[9] Fox (in press) characterizes overlapping sovereignties in late 1800s Thailand, writing that sovereignties were 'neither single nor exclusive' (p. 2), but rather (citing Winichakul 1994: 88) 'capable of being shared—one for its own ruler and one for its overlord—not in terms of a divided sovereignty but rather a sovereignty of hierarchical layers.'

[10] Interestingly, the letters of tax payment have been used in more modern times to establish ownership over the caves.

[11] According to Sellato (in press) Dutch control in the Bulungan Sultanate began in 1850 with a *Politiek* Contract, was furthered in 1877 with an agreement for the Dutch to handle some of the sultanate's affairs and formalized in the late 1880s as part of the Dutch colony. In the early 1900s they forced the Sultan to turn over control of the remoter regions of the Bahau River, Pujungan River and Apo Kayan. They also worked with the sultanate, for example to put down a Dayak rebellion in 1909 in the Tidung lands (includes the current Malinau River area).

[12] According to Sellato (in press), in 1950 Bulungan became a *Wilayah Swapraja* (Autonomous Territory, 1950) of Indonesia after the Japanese occupation, and then in 1955, a *Wilayah Istimewa* (Special Territory). In 1959, after the last sultan, Jalaluddin, had died in 1958, the sultanates were abolished and Bulungan became an ordinary regency (*Daerah Tingkat II or kabupaten)*.

[13] Prior to the Merap, it is believed that the Berusu' and Punan occupied the area (Sellato in press, Kaskija 2000).

[14] Even though demands for compensation had been made previously, villagers received few, if any, benefits in response.

[15] The young *kabupaten* has so far had two *bupatis*; Bapak Asmuni Alie served as a temporary *bupati* and issued all of the 38 IPPKs now functional in Malinau. In March 2001, he was replaced by Bapak Marthin Billa, a forward-thinking leader who helped to first establish the '*tanah ulen*' concept with WWF in Kayan Mentarang in the mid-1990s.

[16] This is not to imply that conditions before decentralization were always lawful or fair. There are numerous examples of smaller scale illegal logging and other illicit and unfair activities from the pre-reform era.

[17] Historically they have lacked the strong social cohesion of groups like the Kenyah or Lundaye and have lacked effective institutions for representing their interests. Only in the mid-1990s did the Punan in Malinau organize the appointment of a Punan customary leader.

[18] We defined agreement as concurrence between two villages about the location of their boundary.

[19] We used *strength of leadership* (economic status of leader, e.g. food surpluses, quality of home construction, access to significant or regular cash income, possession of productive assets like rice mills or luxury items like parabolas; alliances with powerful external groups; support of leader by community and level of leader's education), *cohesiveness of community* (economic status of community, e.g. see above; internal loyalties and mutual supportiveness; alliances with powerful external groups; skills and education levels; support of leader by community and level of leader's education) and *access to information* (transparency of mapping process within village, knowledge of their territory) as indicators of a village's institutional capacities and power.

[20] A score of 0, .5 or 1 was assigned for each of the three dimensions above. Attachment 1 summarizes the scores.

[21] This understanding increased among broader community members. Many community leaders were savvy enough to know, and decide when to use more (or as was usually the case, less) participatory approaches.

[22] Even at the time that this report was written, there are, however, conflicting interpretations of what '*wilayah desa*' or village area implies. Among villages, there was disagreement about whether to join, for example, all the village in one location in one area. Government authorities and local companies were not amenable to communities claiming areas within concessions and would prefer to see land reserved for exclusive government use (Marthin Billa, personal communication November 2001).

[23] We developed our approach based on the examples of participatory mapping conducted by the World Wide Fund for Nature in Kayan Mentarang and by several NGOs in West Kalimantan.

[24] As a response to IPPK developments, we did make an effort to increase attention to building community negotiation skills, hold multistakeholder dialogues and build community and government knowledge of decentralization laws, as well as to send a group of villagers on a cross-visit to oil palm estates in the Paser region of East Kalimantan.

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Attachment 1

Scores of village capacity and power status

Village	Leadership strength	Strength of community organisation	Information access	Village score
Sentaban	Lemah	Weak	Medium	0.5
Setulang	Medium	Strong	Strong	2.5
Setarap	Medium	Medium	Medium	1.5
Batu Kajang	Strong	Strong	Medium	2.5
Gong Solok	Weak	Weak	Medium	0.5
Adiu	Medium	Strong	Medium	2
Long Loreh	Weak	Medium	Strong	1.5
Langap	Weak	Weak	Strong	1
Seturan	Weak	Medium	Medium	1
Nunuk tanah kibang	Medium	Medium	Medium	1.5
Laban Nyarit	Strong	Medium	Weak	1.5
Mirau	Weak	Weak	Weak	0
Halanga’	Weak	Weak	Weak	0
Tanjung Nanga’	Strong	Strong	Medium	2.5
Metut	Weak	Medium	Medium	1
Pelancau	Medium	Medium	Medium	1.5
Long Lake	Medium	Medium	Medium	1.5
Long Jalan	Weak	Strong	Medium	1.5

Vilage score is calculated by the value of leadership strength, strength of community organisation, information access

Value: Weak = 0; Medium = 0.5; Strong = 1

Notes:

Leadership strength is measured by:

Economy

Outside relations

Support of community

Education

Strength of community organisation is measured by:

Ability to work together

Economy

Human resources

Outside relations

Information access is viewed by:

Knowledge of field

Information about mapping activities and results of meetings

Attachment 2

Observations about Participatory Mapping

Because participatory mapping by rural communities has become popular in recent years, we report here on the lessons we learned and what we think could be improved. Additional information about the technical aspects of the mapping can be found in Van Heist (2000).

Our most significant lesson was that it was extremely difficult to make participatory mapping truly participatory in the sense of village self-sufficiency in mapping. Participation was lacking in two regards—the proportion of the community involved in decisions about mapping and the degree of village capacity to conduct the mapping on their own. As noted, however, by Fox (in press), lack of community self-sufficiency in mapping is common in much participatory mapping and may be less important than who controls the maps in terms of its impact on empowering local communities. Also, as discussed above, the level of participation in the mapping exercises and related negotiations was not unusual compared to participation in other village level efforts. If communities or facilitators of projects wish to increase long-term mapping capacity, training exercises should occur over longer periods of time than the one to two weeks used by CIFOR. There should be careful selection of participants to identify qualified individuals and exercises should be repeated several times.

We feel the more important dimension of participation that requires attention is the need for community decision making to better engage its members in debate and discussion and to give more attention to the interests of its members. We observed a *general lack of adequate representation and accountability of leaders to their constituencies*. CIFOR's efforts to reach 27 villages with the funding and grant schedule given also meant that the *time to work with any one village to stimulate interest and build skills was constrained* by limited funds and the schedule of the grant. Where problems are expected with representation, more time should be allocated to working with villagers to engage more people directly.

CIFOR's core team found that they needed to take an active, facilitating role in nearly all phases of the process. Although we were least involved in the negotiation stage, there were even calls from communities for CIFOR to assist in that process. We suggest it is realistic for others attempting participatory mapping to assume that they will need to play a strong facilitating role. Care needs to be taken though to *facilitate in a manner sensitive to different communities members' interests and empowerment*. The risk in assuming the facilitator's role is that the purpose and results of the mapping reflect more of the facilitators' interests than that of the villagers. In CIFOR's case, for example, we would have preferred to focus on mapping forests to be sustainably managed, which would have involved more of an emphasis on institutions and rules. However, because we wanted to accommodate villagers' interests to empower them and build their ownership of the process, we agreed to focus on administrative boundaries.[22] Participation should not mean that villagers become mostly labourers to carry out the aims of the facilitator. Methods need to be built in for communities to be able to control the process and take responsibility for key decisions. In CIFOR's case, this meant that communities decided and negotiated their own boundaries, and rechecked and approved all maps.

Second, the mapping occurred during a time when the authority for determining criteria for boundaries, settling intervillage conflicts, approving boundaries and even the definition of a village itself were in transition. Since we started the process before decentralization policies were implemented and the new *kabupaten* established,[23] we had not anticipated these events and were unsure of how to adapt to them.[24] Consequently we found ourselves working with the status quo and assuming that existing claims by formally acknowledged villagers were legitimate. In retrospect, we should have probably *sought to engage communities and local authorities, even as they shifted, in more discussion about the basis for allocating land fairly in the watershed and what constituted a village, and to build this into the mapping process.* Having a firmer shared framework of criteria for determining what constituted a village or a village's legitimate boundary could have probably helped to settle conflicts and prevent the fluidity of boundary revisions and land claims that later occurred.

Because the authorities for settling these matters were themselves unclear or nascent and not as yet operational, it would have been difficult to create an effective framework within the time constraints of the project. As an intervillage affair, it

would not have been sufficient for villages themselves to determine the framework or for even an outside relatively neutral party such as CIFOR to play this role. Disagreements and changes of heart are inevitable, such that *a supravillage institution with the legitimacy and authority to make, validate and enforce decisions is necessary*. As an example, much debate occurred between adjacent newcomer villagers and older villages about the role of prior historical presence in establishing land claims (e.g. Setulang and Sentaban). Older villages tried to claim lands of newer villages for themselves. Although villages nominally agreed to not use history as a basis for land claims (supported by the urging of several government leaders), the lack of a clear statement endorsed by government authorities has encouraged older villages to persist in trying to expand their territories.

Third, related to the two first points, the *meaning of the maps produced was not always clear* to the communities or other stakeholders. We understood the maps to be of village administrative boundaries, with rights within those boundaries to be determined by other processes. However, despite numerous statements by CIFOR, INHUTANI II and government to the contrary, a number of communities considered the maps to be evidence of their ownership and control over the territories. Many communities therefore treated the completion of the mapping as an end in itself, rather than as a tool to be used for negotiating their rights with other parties. We discovered after the fact that some villagers even thought the mapping was intended primarily to service CIFOR's research projects. In hindsight, more intensive attention should have been given to developing a shared understanding of the mapping and use of the maps in the early stages of the project. In addition, we suggest that effective community-based mapping also requires higher scale social institutions and effective representation that can help to coordinate such understanding. Follow-up is necessary now to organize communities to work with local government to approve their boundaries and discuss associated rights, responsibilities and future land use.

A fourth lesson was that we should have *worked more strategically with a broader range of stakeholders* as policies and the social landscape evolved. In the effort to focus on community empowerment and build communities' trust, we worked primarily with communities and less with other stakeholders like local government and INHUTANI II in the early stages of the project. Local government was often seen as a force that had exacerbated rather than helped resolve conflict. Where local government had previously mediated conflicts, villagers commented that the outcome was determined by which side paid more to the official, rather than by a considered assessment of the situation.

Given the interests of these other groups in controlling communities' claims, we felt that the communities' own goals needed to be developed independently and that we needed to concentrate on building a solid relationship with communities. We expected communities to negotiate with these other parties at a later stage. Our experience suggests, however, that such empowerment activities can come at the expense of building relationships with other stakeholders. With more of the latter we might have lessened some of the suspicion other stakeholders had about our intentions and encouraged the development of the supravillage framework necessary for guiding land claims; however, this might have been at the cost of empowering communities.

Fifth, *good preparation and flexibility in schedules were necessary*. The mapping process proceeded smoothly in large part because CIFOR had invested in getting to know the communities since 1995. Villagers knew about CIFOR and had developed a certain level of trust in CIFOR. The Core Team also had very thorough preparation in developing their facilitation skills. Flexibility allowed us to adjust to villagers' own schedules. We completed the first phase of mapping in seven months, and even with that some villages had not yet resolved their boundaries while others decided to change boundaries previously mapped. The length of time was most drawn out by the need to settle conflicts about boundary location. The actual mapping was relatively quick. This suggests again that more adequate preparation in developing institutions and governance mechanisms to guide between-village decisions would have been helpful.

Sixth, as a technical note, in areas such as Malinau for which existing maps are generally poor, participatory mapping needs to give significant attention to producing a well-geo-referenced base map. In Malinau we did this through the use of satellite imagery and determining GPS coordinates at ground control points at major tributaries and other visible landmarks.

8. Research in Bulungan Model Forest: The Management of a Large, Multistakeholder Forest

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CIFOR's research in the Bulungan Model Forest within Kabupaten Malinau took the form of a systematic investigation into ways of achieving forest sustainability in a 'large forest landscape' with diverse, rapidly changing and often conflicting land use demands. The ultimate goal was to integrate the social, environmental, biodiversity and silvicultural aspects of the forest into a sustainable system of management that would benefit all stakeholders. In the dynamic, ethnically diverse setting of Malinau, CIFOR took a challenging approach to the research that emphasized the need to devise better methods for an iterative research process so that all the key players could participate in defining research priorities to address long-term forest management and sustainability.

The work proceeded along several complementary lines of research. This multi-element design demonstrated the value of developing a broad research programme where technical, institutional and economic factors could be assessed and combined successfully. Integrating the results from the different strands of the research allows a vital step to be made in developing a mutually comprehensible dialogue amongst stakeholders, in particular illustrating how local preferences relate to the landscape in Malinau and pointing at how to assess local preferences as a basis for better land use decisions.

The lessons learned provide baseline information that will support longer-term research. Because of the breadth of the effort and the many changes that took place during the life of the project, we are now in a much stronger position to identify both priorities and the steps required to find acceptable solutions to the many local challenges. The first phase of this investigation has provided clues to the technologies, policies and information that are needed to meet multiple objectives both within and across forest types in a given area. The focus of such a landscape approach is on the links among different activities and on the participation of the stakeholders in setting the research agenda.

Many views of forest use coexist within even small and apparently homogeneous groups. The people themselves are divided about whether they need the forest or are willing to cut it down, and their views change often. Overlapping institutions like local custom and government systems promote different views within groups, but for many stakeholders their access to the resources and benefits of the forest are the keys to their feelings for the forest.

The research has also allowed us to understand the community values and dependencies that have been largely overlooked by past governments and concession managers. These values are undergoing a period of particularly rapid change and re-examination, as new cash earning opportunities occur and the value of cash increases to the stakeholder. Competition for increasingly valuable resources develops and the different groups disagree about their claims and entitlements. Secure access to resources and benefits is the most important factor to many stakeholders. It is clear that these uncertainties in access discourage a concern for longer-term benefits and the environment. As the value of the resource increases, policy changes and uncertainty grows, then

the competition for benefits and conflict over ownership increases. Multiple demands exist and the poor are inevitably disenfranchised, encouraging them to take a short-term view of the exploitation of the resources available to them.

Stakeholders in a forest must coordinate management approaches if the forest is to survive. What has become obvious from CIFOR's collaborative work is that economic development in the area will require a very broad approach. As institutional mechanisms for coordination are in transition and not fully established for landscape-level or district-level management, mechanisms to facilitate communication and negotiation are required to accommodate the different values of the stakeholders. Higher-level district institutions will need to coordinate the efforts to develop the area, but their approach needs to be transparent so that all sectors will support the work.

The principles of the CIFOR-developed Model Forest would be useful in any future development work. The model operates on the basis of all stakeholders working to identify, develop and apply innovative forest management options. The management structures of the model ensure public participation in the planning processes. Workshops, presentations and informal consultations ensure that the district government understands the conflicting needs of the stakeholders involved in forest resource management. Such an approach will also lead to establishing mechanisms for conflict resolution and for specific procedures that ensure transparent decision making in the development of the district. In addition, the approach allows environmental, social and economic forces to operate in a consensus-based, decision-making process. The approach also requires researchers to identify research needs, test new methods in the field, then disseminate these new techniques to local stakeholders. The CIFOR research is already helping to reveal the needs of the area. In this way, forest resources be protected now and into the future as a productive element of the landscape.

Reducing the impact of logging on the forest

Overharvesting and poor operational practices are now recognised as an integral part of deforestation. In the Indonesian selective logging and planting system, all dipterocarps with a diameter at 1.3 m (height dbh) of over 50 or 60 cm can be harvested with a polycyclic felling schedule of 35 years. In the mixed dipterocarp forests of East Kalimantan, where the density of harvestable trees often exceeds 10 trees/ha, this minimum diameter rule results in excessive felling and produces high levels of damage to the remaining forest. Several experiments in mixed dipterocarp forests have demonstrated that reduced-impact logging (RIL) techniques can reduce damage by at least 30–50% compared with normal operations. Most of the studies comparing damage under RIL and conventional logging have neglected the variability in natural forest and the variation in damage that this implies. The main objective of this work was to assess how far RIL can reduce logging damage under varying felling intensities.

The research showed that RIL significantly reduced damage to the residual stand, and the cost savings from RIL skidding outweighed the additional costs of training and supervision. One of the most important benefits of the RIL experiment in Malinau was the significant reduction of wood waste left in the forest, representing a saving of about 11% for each cubic meter of commercial volume produced. However, it is widely perceived by concession holders that good planning costs more. Introducing RIL increases initial costs, but as the fellers and skidder operators involved in the RIL experiment found, they were able to meet the same daily volume in a shorter time than using conventional techniques. Overall, RIL has brought new perceptions of the benefits of good preplanning as a way of increasing logging efficiency.

RIL is a silvicultural approach, but the techniques can also combine with the forest dwellers' dependencies that the project's biodiversity research highlighted. In detailed exercises with local communities it was clear, for example, that wild pigs and timber trees are among the most valued species. Reducing damage to forests during harvesting is the most obvious step in lessening the impact of logging on vertebrates. In particular, it is important to minimise the area of severely damaged forest, such as along broad skidtrails and log-loading areas, where all trees and most of the topsoil are removed.

Other simple techniques could be incorporated into RIL, with powerful benefits for local people. For example, many poorer households are vulnerable to crop failures, floods, etc. and often depend on wild

foods for certain periods. A critical emergency food is sago (*Eugeissonia utilis*), which tends to grow just below the ridge tops, which is exactly where skidding machinery is used to extract logs on undulating local terrain. Protecting these palms is easily possible once the objective is recognised and the techniques developed and disseminated.

RIL techniques, as part of a more moderate extraction regime, are essential from the perspective of the growth and survival of the residual stand, but also for the longer-term ecological sustainability of the forest. New silvicultural prescriptions should be considered as a way to improve forest harvesting operations.

Biodiversity across the landscape

The main objective of the project's research into the biodiversity of the area was to use multidisciplinary methods across the landscape to provide quantifiable information on the local values placed on flora and fauna. This research has had three major components: finding out what occurs where, assessing to whom it matters and in what way and identifying what steps are needed to maintain this biota in the future. Together, these three strands of information help define priorities that reflect local considerations and inform a wide range of processes, from the development of reduced-impact logging guidelines to international forestry and conservation policy.

The research collected and quantified a vast amount of information on an area that was, until recently, little known biologically. The earliest studies involved wildlife and tree surveys prior to harvesting. Later surveys examined the wider landscape and determined local priorities. Our studies have provided baseline data on several major taxonomic groups. In many cases, and for plants and fish in particular, the records are part of a wider collection of information that includes geographical locations, ecological parameters and the needs and preferences of local communities.

We have developed a suite of methods to assess biodiversity and landscape information and what matters to local communities. Our methods emphasize the importance of deciphering the sometimes complex relations and interdependencies that can exist between local people and their environment. They are a step in clarifying local needs and concerns, in indicating key areas for further evaluation and in developing a mutually comprehensible dialogue amongst stakeholders, in particular illustrating how local preferences relate to the landscape in Malinau and pointing at how to assess local preferences as a basis for better land use decisions.

The natural forest is threatened because current forest degradation is happening so fast that it is difficult to implement conservation quickly enough. The forest understorey may be a key factor in conserving species that are valuable to local people, as well as preserving the habitat and controlling soil erosion and water turbidity. We already observe various responses by local communities in how they regulate their own impacts on the forest, such as the development of *de facto* protected areas. However, appropriate land uses require detailed study. The CIFOR research has allowed a GIS database to be started that could be used by all the stakeholders as one of the mechanisms for coordination and consensus on forest management. Once finished, it will also provide a means for monitoring changes in local values of biodiversity as well as the status of biodiversity in different localities.

The Malinau work has highlighted the need to understand in detail the effect that management techniques have on species and sites important to local people. In some cases, as with the ridge top sago, or the fish that are sensitive to turbidity and forest loss, the links are clear. In other cases, such as the species (for example, hornbills) that depend upon and compete for hollow trees, the implications remain less clear but justify consideration. All such factors must be taken into account in revising the RIL guidelines.

As well as the forest's importance to the local people, there are also many species of global conservation interest in the Malinau area. Through our review of what we know about the sensitivities of these species it will be possible to formulate improved guidelines for forestry practices. In some cases these will involve responsibilities and enforcement requirements for controlling actions that lie outside activities conventionally viewed as concession management, for example, controlling fishing using pesticides and limiting hunting.

Forest people's dependency on forest products

CIFOR sought to investigate the nature of the forest dweller's dependency on forest products in the Malinau landscape. We focused particularly on economic dependencies, although anthropological background studies were also made in communities where there was little previous information. Most of the people do not collect forest products on their own initiative. Economic dependency on forest products is seldom the result of free choice; it is often the sole option available to forest people to generate cash income. The traders decide which product they want to buy; they organize the collecting and control the marketing chain. It is this dependency that needed to be understood further.

Research among the Punan people in Malinau showed that as soon as new options are made available—labouring for concessionaires, wage working, migration to Malaysia, etc.—the dependency on forest products is reduced. People analyse the options at hand in a rational manner, from economic, social and cultural viewpoints. They weigh the advantages and disadvantages of regular and secure earnings, of higher but riskier earnings, of short-term versus long-term employment, of local versus distant job opportunities, and make informed decisions.

Nowadays, available opportunities are no longer restricted to forest product gathering. However, not all forest people are guaranteed equal rights to access these new opportunities. With the implementation of regional autonomy, some ethnic groups, and more precisely the leading classes of these groups, will probably be able to compete with outsiders. But the poorer classes and the marginalized communities will likely remain dependent on forest product gathering to make ends meet.

Up to now, there has been no real conflict over the use of the resource between shareholders or even among the communities. The local government receives taxes and local communities receive royalties, while 'investors' strike more profitable deals than ever. There is a clear consensus on the use of the forest; any conflict is only about the sharing of the benefits. Local populations need secure food and cash sources. The forest presently provides a large proportion of this. Affirming the community's legitimate ownership and rights to the resource has become the main concern of community leaders. Further steps to introducing practical conservation measures could involve local communities in forest management where they receive compensation for conserving forest as an attractive substitute for selling trees for logging.

There are variations in the degree of forest product dependency among ethnic groups and among individual households, as in the case of the Punan hunter-gatherers who depend more on forest products for their livelihood than the Dayak swidden cultivators. While forest products abound in the area and provide much of the livelihood needs of isolated communities, downstream areas have other options available in agricultural and off-farm activities. Nevertheless, there are common threads evident in development trends. There is inevitable tension between increasing access for economic development and the immediate threat that encourages the illegal use of the forest. A question that must be addressed is what kinds of precautions can be taken institutionally to prevent the unrestrained, short-term exploitation use of forest. Uncertainty in long-term access encourages all players, even those who will lose most, to take the short-term opportunities for cash, rather than risk the eventual complete loss of the resources. Solutions can be found by agreement amongst stakeholders. For example, local communities are often in favour of designating various forms of protected forest areas. The implementation of such solutions is however rendered difficult by conflict and short-term competition, as was revealed in the research on boundary negotiations.

Coordination and agreement in boundary negotiations

Boundary negotiations in Malinau highlighted the deeply political nature of coordination efforts among local communities, government and the private sector in the management of the forest landscape, and the uneven distribution of influence underlying them, even among seemingly homogenous community groups. Three years of study showed that the more intense the underlying struggle, the more fluid the interests, agreements and

coordination are likely to be. In Malinau, periodic opportunities to claim resources, as in the advent of decentralization, the changing monetary value of local resources, the new *Kabupaten* and mapping activities, immediately intensified competition for resources.

The research pursued mechanisms for constructive conflict management, focussing on the use of agreements to settle disputes. However, the work revealed that agreement-building processes were not necessarily fair or acceptable to all the people concerned. Building a supportive political constituency through consultation and transparent decision making appears to be the key to a lasting agreement. Mediators need to understand the diverse political relationships among groups to play a successful role in coordination and negotiation.

In Malinau, differences among villages in capacity and power affected nearly all aspects of negotiation, including how the conflict was defined. There is a need to build coordination upon sound social foundations about what are considered legitimate operating principles of negotiation and outcomes. Participatory mapping is an approach for building a strong bottom-up political base of support for demarcating boundaries so long as attention is given to the limits of making such processes truly participatory. Efforts need to be given to making processes more fair for disadvantaged groups, by giving them extra attention in training, working with their schedules, holding meetings in places convenient for them and enabling negotiations that acknowledge differences in power.

The research demonstrated the nature of coordination and agreement making in Malinau and its current vulnerabilities. The base of political support for coordination is fluid and often fragile. There are few safeguards to ensure fair negotiations for weaker groups. The authorities for supporting and endorsing these processes are unclear. Very real gains have been made, however, in empowering local communities to begin the process of asserting claims to their territories and of establishing debate about rights associated with those claims. A process has been started that communities, government and companies are now keen to complete.

Outcomes and future directions

The integrated approach to the research allowed us to identify a number of strategic problems that need to be addressed in Malinau, with implications for the management of forest elsewhere. In general, there is insufficient understanding of forest values and changing livelihood options that guide management objectives. There is increasing competition and demand for land and other forest resources. There is a lack of appropriate institutions for making management decisions. There is a lack of incentives and processes to encourage improved practices.

A secure forest estate requires consensus and stability on where and how the forest will be maintained and who will gain the benefits. An overriding concern is that the costs and benefits of forest management must be allocated with sensitivity to the needs and capacities of the many stakeholders. This requires in-depth analyses as to what the stakeholders 'do need and require', an evaluation of how various outcomes can be assessed, and how equitable agreements can be reached and maintained.

The situation in a forest is complex because of the range and diversity of the stakeholders and their overlapping claims of legitimacy. It also comes from the complexity of the biological system and the multitude of processes by which it relates to local livelihoods and wellbeing. Added to this are the complexity of the landscape and the way different impacts and benefits are felt or accessed at different locations in the landscape or beyond. Most of all, however, the complexity is in the way that all these aspects interact, multiple stakeholders and processes at a multitude of spatial and temporal scales.

The CIFOR study has highlighted much of this complexity while also clarifying the key aspects. By understanding how the forest can yield timber, while also maintaining other important values to numerous stakeholders, by recognising the threats and the institutional means available to address them, by understanding how the needs of the poorest communities of the forest see changes as both threats and opportunities, we can build up the understanding that decision makers need to make better decisions for sustainable forest management into the future.

Technical Report

Phase I 1997-2001

ITTO PROJECT PD 12/97 REV.1 (F)

Forest, Science and Sustainability:
The Bulungan Model Forest

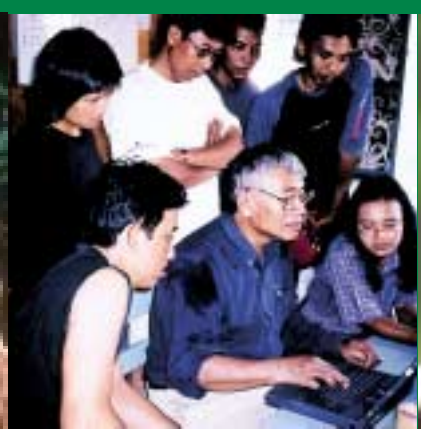
Bogor, Indonesia

March 2002

ITTO PROJECT PD12/97 REV.1 (F)

Forest, Science and Sustainability:
The Bulungan Model Forest






Completion Report

Phase I 1997–2001

CIFOR
CENTER FOR INTERNATIONAL FORESTRY RESEARCH

ITTO

ITTO PROJECT

PD12/97 REV.1 (F)

Forest, Science and Sustainability: The Bulungan Model Forest

COMPLETION REPORT

PHASE I

1997–2001

January 2002

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Preface

This Completion Report of ITTO Project PD 12/97 Rev.1 (F), Forest, Science and Sustainability: Bulungan Model Forest was prepared with reference to the format provided in Annex D of the ITTO Manual for Project Monitoring, Review and Evaluation, ITTO, May 1999.

The headings in the Contents, as well as the content of the Completion Report, follow the headings and subject matter as stated in the aforementioned Annex D.

CIFOR and FORDA, as the Project Executing Agencies, wish to thank ITTO, the Ministry of Forestry of the Republic of Indonesia, CIRAD Forêt, IRD, PT Inhutani II, PT Trakindo Utama, Caterpillar Co., the MacArthur Foundation, the Ford Foundation, IFAD, ACIAR, LIPI, local governments and all partners and collaborators for their full support in the execution of the project.

Sincere thanks and appreciation go to the members of the Project Steering Committee for their support and invaluable advice and criticism.

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Bogor, 20 January 2002

Project Identification

1. Title	:	Forest, Science and Sustainability: The Bulungan Model Forest
2. Serial Number	:	PD 12/97 Rev.1 (F)
3. Implementing Agency	:	Center for International Forestry Research (CIFOR) and Forestry Research and Development Agency (FORDA)
4. Host Government	:	Republic of Indonesia
5. Starting Date	:	2 September 1997
6. Actual Duration (months)	:	52 months
7. Actual Project Costs	:	ITTO US$1,096,391 CIFOR US$144,000

Part 1: Executive Summary

1.1. BACKGROUND INFORMATION

1.1.1. Pre-Project Situation

In January 1996, the Indonesian Ministry of Forestry (MOF) designated 321 000 ha of forest for CIFOR in East Kalimantan to be developed as a long-term model of exemplary research-based management. The creation of this research forest, known as the Bulungan Research Forest (BRF), grew out of a provision in the host-country agreement granting access to a long-term research site, where CIFOR would carry out multidisciplinary research activities able to cover the complexity of forest management for multiple uses. CIFOR and MOF expect to maintain research and development activities at BRF for a period of 10–20 years.

CIFOR's strategic research is focused on policy issues to enable more informed, productive, sustainable and equitable decisions about the management and use of forests. Cooperation between CIFOR, FORDA (Forestry Research and Development Agency of the Ministry of Forestry) and ITTO through this research will contribute to the achievement of the ITTO Year 2000 Objective and also enhance the relationship between these institutions.

The general objective of the present research is to carry out systematic investigation of how to achieve long-term forest sustainability for a 'large forest landscape' by integrating social, ecological and silvicultural aspects.

The initial project constituted a developmental phase within this long-term research strategy. The first phase focussed mainly on gathering baseline information on the physical and human environment. Reduced-Impact Logging (RIL) experiments applied on a concession scale and the assessment of their impacts on both the environment and economic costs would lead to promoting and integrating these techniques into the current Indonesian forest management system.

1.1.2. Specific Objectives and Outputs

1.1.2.1. Specific Objective 1

Assessment of the effect of Reduced-Impact Logging (RIL) on biodiversity, conservation, ecology and socio-economics. Detailed Outputs: see Section 2.1.3.1.

Output 1.1. Formulation of RIL guidelines

Output 1.2. and 1.3. Comparison of the impacts and cost analysis of RIL and conventional logging (CNV).

Output 1.4. Improvement of the current Indonesian forest management system.

Output 1.5. and 1.6. Biodiversity and multidisciplinary landscape assessment.

Output 1.7. Publications and workshops on the main results.

1.1.2.2. Specific Objective 2

Assessment of rural development trends and future policy options including the effects of macro-level development activities on people dependent on the forest. Detailed Outputs: see section 2.1.3.2.

Output 2.1. and 2.2. Susceptibility and resilience of forest products and responses of forest product uses to economic changes and ecological disturbances.

Output 2.3. Models of trends in forest dependence, livelihood strategies, institutions for forest management and rural development, into which were merged Outputs 2.4 and 2.5.

1.1.3. Project Strategy

The planning and implementation of the project adopted the following strategies:

1.1.3.1. Site selection

The Malinau area of BRF was selected as the project site. It has been used for harvesting timber and collection of other forest products by local people living within and outside the area. Proposed new development activities combined with previous traditional uses make it an excellent location for studying response to disturbance.

A partnership with PT Inhutani II allowed a study on changes in forest policy and concession behaviour regarding logging practices, and translating these changes into field operational levels. It allowed PT Inhutani II to test the feasibility of, and implement Reduced-Impact Logging (RIL) techniques, to achieve sustainable forest management practices as required by MOF in line with ITTO's Year 2000 Objective.

1.1.3.2. Lessons drawn from past experience

The project benefited from previous experiences in forest management planning projects in Sarawak, Malaysia and East Kalimantan, as well as WWF Indonesia projects carried out in the adjacent Kayan Mentarang National Park (KMNP) and extensive data collected from KMNP by CIFOR social science staff since 1994.

1.1.3.3. Technical and scientific aspects

1.1.3.3.1 Assessment of the effect of RIL on biodiversity, conservation and socio-economics

Previous RIL studies clearly indicated that applying simple techniques within a forest management plan, including the provision of training and RIL guidelines, could significantly reduce damage. The Indonesian Selective Cutting and Planting System (*Tebang Pilih dan Tanam Indonesia,* TPTI) has not been widely applied on a concession scale. Under a RIL regime various costly regeneration treatments may be unnecessary. Policy may be developed to induce the MOF to change TPTI requirements regarding treatments after logging.

Due to various constraints, the ecological assessment of the biophysical impacts of RIL and conventional logging (CNV) concentrated on damages to residual stands and soils through a better harvesting plan, directional felling, planning of skidtrails and landings and use of less destructive skidders. A system of permanent sample plots (1 ha each) in both CNV and RIL coupes were maintained for long-term monitoring and will be used for various forestry research activities, including studies on forest regeneration, productivity and forest dynamics modelling.

The socio-economic assessment of RIL focused on an analysis of the costs and benefits of RIL in comparison with conventional logging operations.

1.1.3.3.2 Biodiversity assessment

The initial design was revised and a more integrated multidisciplinary approach to landscape assessment, termed a 'Multidisciplinary Landscape Assessment' (MLA), was adopted. This provides a framework for much of the biodiversity, socio-economic, and land/resource surveys. The ultimate goal is to develop a baseline of environmental information that explicitly includes factors that should determine good land use planning with special reference to biodiversity and the needs and preferences of local people. This innovative approach can potentially be developed and adapted to other areas.

A pre-logging wildlife inventory in the CNV and RIL blocks was undertaken. Due to budgetary, technical and biological constraints a comprehensive review was

developed of the literature and expertise pertinent to the species known to occur in Malinau, in order to identify factors that make species vulnerable to forestry activities and other landscape interventions, and relate findings to the design of 'biodiversity-friendly' reduced-impact forestry guidelines. This study should help to develop specific recommendations and guidance on management interventions and identify the most important unknowns and controversies for additional research. The process will also be replicated in other tropical regions.

1.1.3.3.3. Assessment of rural development trends and future policy options including the effects of macro-level development activities on people dependent on the forest

It is generally accepted that forest people strictly depend on forest resources for their livelihood and that forests must be preserved to ensure their survival, and that indigenous communities may act as conservationists. In Malinau, however, dependency on forest products varies greatly among villages and among households.

The research questions were: (1) Who depends on forest products for their livelihoods and to what extent? (2) Is it a deliberate choice or a forced one? (3) Would people seize other opportunities if offered? The answers will help to understand what is happening in Malinau and how such dynamic situations evolve in order to determine the best way to favour positive initiatives and avoid unwanted extremities.

1.1.3.3.4. Future scenarios for rural development

This activity addressed the problem of how to improve local people's livelihoods and forest management practices by anticipating economic development trends and policy needs.

The scenario research was linked to research on adaptive co-management (ACM) of local forests and the creation of resource management agreements.

The research topics were: (1) What information can be gained about trends in livelihoods, forest management and rural development? (2) The testing of the scenario method as a tool; and (3) What sort of attention to governance issues associated with use of this tool is necessary, especially the representation of different stakeholders? Due to the prevailing policy environment, the field research strategy was shifted to better reflect local priorities related to land tenure and claims on local resources, using action research based on participatory mapping.

1.1.4. Project Planned Duration and Planned Overall Cost

Phase I was planned to last three years with the following budget allocation:

ITTO funding	US$ 965,650
Government of Indonesia funding	US$ 362,500
CIFOR funding	US$ 144,000
TOTAL	*US$1,472,150*

However, various constraints, such as dependence on partners for heavy equipment and field operations, unstable political situations, availability of skilled human resources, unpredictable weather resulting in floods, late arrival of equipment, scattered distribution of and large distances between villages, different ethnic groups dealt with, high travel costs between villages, and other factors, not only led to a delay in the initiation and slowed down progress, but also resulted in unpredictable and high operational costs. The ITTC XXIX Session approved an extension until December 31, 2001, with an additional budget of US$130,741. The new budget allocation was:

ITTO funding	US$ 965,650
ITTO additional funding	US$ 130,741
Government of Indonesia funding	US$ 362,500
CIFOR funding	US$ 144,000
TOTAL	*US$1,602,891*

Due to the economic crisis, the GOI was unable to fulfil its commitment, thus leaving a total operating budget of US$1,240,391.

Complementary financial contributions were provided by CIFOR (on top of the amount indicated above), CIRAD Forêt, IRD, the MacArthur Foundation, USAID, PT Inhutani II, PT Trakindo Utama, IFAD, ACIAR, and the Ford Foundation.

1.1.5. Intersectoral Linkages

The Government of Indonesia has given top priority to the attainment of ITTO's Year 2000 Objective. This project, by integrating silvicultural (Reduced-Impact Logging assessment), ecological (biodiversity assessment) and social aspects of natural forest management for multiple use, is a major contribution to sustainable forest management. The project will provide some guidelines for long-term natural forest management and therefore makes an important contribution to the improvement of the current Indonesian Selective Cutting and Planting Systems (TPTI).

1.2. PROJECT ACHIEVEMENT

1.2.1 Outputs Achieved

The following major outputs were achieved in Phase I:

Output 1.1. Publication on RIL guidelines according to the biophysical features of the area (topography, stand volume, tree distribution).

Output 1.2. Report on the comparison of the impact of RIL and CNV on the forest ecosystem.

Output 1.3. Report on the comparison of the economic and financial cost of RIL and CNV techniques.

Output 1.4. Improvement of the current Indonesian forest management system. This was not implemented by the project, but it is expected that the project results on comparative analyses of cost benefits in RIL and CNV, the RIL guidelines (Output 1.1.), and data and information from other projects will be applied by MOF and forest concessionaires to improve the TPTI.

Output 1.5. and Output 1.6. were merged. Reports on multidisciplinary landscape assessments and a review of the literature and expertise pertinent to the species known to occur in Malinau.

Output 1.7. A workshop presenting the main results was organized during the 4th PSC Meeting on 15 August 2000 and the final seminar was held on 27 November 2001.

Outputs 2.1 and Output 2.2. were merged. Reports on the resilience, susceptibility and response of local forest use following economic and ecological disturbances.

Output 2.3, Output 2.4 and Output 2.5 were merged. Reports on models of trends and future scenarios in forest dependence, livelihood strategies, institutions for forest management and rural development.

Publications and reports are presented in the attached CD ROM.

1.2.2. Specific Objectives Achieved

More detailed achievements of the objectives are given in the Technical Report presented separately to ITTO.

1.2.2.1. Specific Objective 1: Assessment of the effect of Reduced-Impact Logging on biodiversity, conservation, ecology and socio-economics

Outputs 1.1–1.4. The *Reduced-Impact Logging Guidelines for Lowland and Hill Dipterocarp Forests in Indonesia* provided the minimum standards for the RIL vs. CNV experiments. The *Reduced-Impact Logging Guidelines for Indonesia* were prepared on the basis of research results from

the RIL experiments and other published guidelines and codes. The results showed that RIL reduced damage by 50% and that a felling intensity of 7–9 trees per ha caused acceptable levels of damage to the residual stand and soil and water resources. Analysis of the costs of RIL and CNV showed that productivity increases in felling and skidding of 28% and 25%, respectively, were possible. RIL was less expensive than CNV under these conditions and benefits from waste reduction were estimated at Rp 20,000/m^3. Improvements to timber harvesting in the concession were undertaken through training to increase the accuracy of contour maps (a basic requirement for harvest planning), directional felling training, planning of skidtrail layout, landings and an understanding of environmental issues relating to buffer zones and other timber harvesting exclusion areas.

To date, the activities have produced ten publications three articles in preparation for publication and 16 unpublished reports (see Annex 3 in the attached CD ROM) and more publications are forthcoming.

Outputs 1.5–1.6. These were merged. The overall technical report is summarized below.
The ultimate goal is to develop a baseline of environmental information that explicitly includes factors that should determine good land use planning. A multidisciplinary process was developed to collect the most useful or decisive information with regard to environmental impacts and the values or preferences of local people. Special emphasis was placed on environmental costs that are not well-recognized by other stakeholders, and upon the uncertainties related to weighing up the real importance or relevance of a given facet of the landscape (decisive uncertainty). A database describing how local people perceive and value natural resources in the forest landscape, based on surveys conducted in seven villages, has been developed. The data show, among other things, > 20 000 references of specific uses and or values attributed to natural forest products (see technical report). To date, five publications, three articles in preparation for publication and eight unpublished reports (see Annex 3 in the attached CD ROM), and more publications are forthcoming.

1.2.2.2 Specific Objective 2: Assessment of rural development trends and future policy options, including the effects of macro-level development activities on people dependent on the forest.

Outputs 2.1. and 2.2. The main research objective was to assess the actual dependency of local people on forest products and how they react or would react if major disturbances affected the availability of the resource. A comprehensive survey of villages showed the dependency of different communities on forest products. Special attention was given to Punan hunter-gatherer groups for which little information has been available. To date, the activities have produced three publications, two articles in preparation for publication and eight unpublished reports in English and Indonesian (see Annex 3 in the attached CD ROM), and more publications are forthcoming.

Output 2.3. Outputs 2.3–2.5 were merged into Output 2.3. The results of surveys of stakeholders, land tenure and forest-related conflict in 27 villages at the district level showed significant increases in conflicts, which can be grouped by type and source. Draft participatory maps of land claims were produced for 22 villages. Initial training in policy reform and conflict management was conducted for communities. A multistakeholder workshop in May 2001 indicated the high level of interest in working with FORDA/CIFOR on an integrated land use plan and resolving conflict related to forest management. To date, the activities have produced 15 published articles, four in preparation for publication and 25 unpublished reports (see Annex 3 in the attached CD ROM), and more publications are forthcoming.

1.2.3. Contribution to the Achievement of the Development Objectives

The present project collected baseline information on the biophysical and human environment in support of achieving the development objective of long-term forest management for multiple uses, integrating social, environmental, biodiversity and silvicultural aspects.

RIL techniques, together with guidelines, were developed and applied on a concession scale by PT

Inhutani II. The assessment of RIL impacts on the environment and the cost/benefit analysis provided data leading to the promotion and integration of these techniques into the current Indonesian forest management system and subsequent policy changes in this system.

The MLA studies have developed a framework to integrate social, environmental, biodiversity and silvicultural aspects by making local choices and needs more explicit and available to guide any interventions that may be led by outsiders. This information provides a baseline from which future choices and developments can be better judged.

The ACM research has indicated the nature of conflicts among stakeholders related to forests, and principles for managing conflict and reaching agreements to better coordinate their interests.

The Forest Products and People (FPP) research focused more on cultural, social and economic aspects of human activities. It provided information on the past, present and future roles and importance of forest products in local peoples' livelihoods. It analysed development opportunities for forest products and compared them to other opportunities presently available to local people.

1.2.4. Situations at the End of the Project

Upon completion of Phase I, the achievements include aspects of capacity building and provision of a database, guidelines, methods, publications, reports and maps (see Section 2.5.1. for details).

1.3. TARGET BENEFICIARIES' INVOLVEMENT

The main beneficiaries were involved in the projects in the following ways (see also Section 2.3.5.):

1. The people living in the area actively took part in the project, through participatory mapping, provision of local data and information and other active collaboration.

2. The Ministry of Forestry and policy makers, through provision of full support for the project towards improvement of the TPTI. FORDA actively collaborated with CIFOR in the project execution. Other agencies within MOF gained benefits through training and use of the project facilities for training purposes.

3. PT Inhutani II managed its concession and provided facilities at Malinau for the project, and in addition, acquired technical knowledge for RIL implementation.

4. Other concessionaires in the vicinity of the project sites took part in the training activities organized by the project.

5. ITTO member countries participated in the project through the provision of consultancies and undertaking of research on subjects complementing the project as well as using the project sites at Malinau district as a site for testing a model on Integrated Natural Resources Management (INRM).

6. CIFOR and FORDA have assumed primary responsibility for the design and execution of research activities within the project.

7. Young scientists, students, technicians participated in various aspects of the research.

1.4. LESSONS LEARNED

1.4.1 Development Lessons

a. Project design

1. The well-structured and workable design, approaches and strategies of the project, complemented by the availability of qualified scientists and technical personnel and institutional, scientific and technical support provided by collaborators and partners, were important for the smooth execution of the project. They were likely to contribute a great deal to the attainment of the development objective.

2. The budget formulation and inaccurate design of the project, which were not based on accurate estimates or a detailed workplan and methodologies of the project's implementation, led to the budget shortfall and the need to reorient and modify the component research outputs.

b. Changes in intersectoral links that affect the project's success

The Government of Indonesia has given top priority to the attainment of ITTO's Year 2000 Objective. This project is a major contribution to sustainable forest management and, by providing guidelines for long-term natural forest management, makes an important contribution to the improvement of the TPTI.

The financial and political crisis in Indonesia since 1997, however, led to a rapid change in the situation of the forests of Kalimantan. The depreciation of the Indonesian currency against other major currencies and the increase in the export market value of palm oil and coal led to a rapid expansion of land clearing for oil palm plantations and construction of roads to give access to coal deposits. The situation has been aggravated by the large-scale forest fires in some areas.

c. Additional arrangements that could improve cooperation between relevant parties interested in the project

Although there was no serious problem with cooperation between all the parties involved in the project, cooperation could be improved by:

1. Holding the PSC meetings more frequently.

2. Organizing formal and informal meetings between scientists and stakeholders who are not PSC members.

3. Stakeholders, such as PT Inhutani II, local governments and local NGOs, should be more involved in the execution of the project.

d. Factors that will most likely affect project sustainability after completion

The activities which will likely affect project sustainability after completion:

1. The implementation of the Project Phase II, which is an expansion of Phase I, has a wider relevance to the development of Malinau and will involve more stakeholders, including local government and local people.

2. Follow-up activities to the RIL project, including PT Inhutani II's plan to implement RIL on a commercial scale, along with an associated training agenda and possibly a research programme.

3. Maintenance of the Seturan Field Station at the Malinau concession for:

   (1) monitoring of permanent plots on growth and regeneration studies,

   (2) use of the research sites, facilities and information for training on RIL and research by local, national and international institutions and universities, and

   (3) development of a model on the scheduling of logging using data obtained during the project.

4. Extension of MLA activities to other parts of BRF, in view of the fact that the expected research results will likely improve practices and lead to better 'sustainability' in management (e.g. by means of improved RIL) and that there is some interest in using the MLA approach as part of a wider planning process.

5. The proposed designation by UNESCO of BRF and the neighbouring Kayan Mentarang National Park as a World Heritage Forest Site.

6. The use of the Malinau area as one of the test sites in the tropics for developing an Integrated Natural Resource Management model.

7. The possible participation of the BRF programme in the ITTO-supported development of the Kayan Mentarang National Park as an Indonesia-Malaysia transborder conservation area.

8. The interest of PT Inhutani II and the local government in the development of the research sites in Malinau and beyond for scientific tourism and ecotourism.

9. The devolution of power from the central government to the district level, including the authority to allocate logging permits.

1.4.2. Operational Lessons

a. Project organization and management

1. The Project Steering Committee, representing ITTO, MOF, CIFOR, CIRAD-Forêt, PT Inhutani I, PT Inhutani II, NGOs, local governments, local communities, universities, and representatives of donors, supervised the implementation of the project. Fewer members would have made the committee more efficient and effective.

2. The project would run better if a project research assistant was seconded to the Project Coordinator.

3. The failure of MOF to provide a budgetary (cash) contribution to the project led to the modification of the outputs and their activities, reduction of participation of FORDA scientists, and inability to purchase and provide vehicles.

4. RIL underwent implementation changes due to the dependence on PT Inhutani II and other partners' schedules and availability of heavy equipment and personnel.

5. Outputs 1.5 and 1.6 were revised and merged into a 'Multidisciplinary Landscape Assessment' (MLA), an integrating framework for much of the biodiversity, socio-economic, and land/resource surveys to assess what actually''matters' in the local landscape.

6. Review of Outputs 2.1 and 2.2 led to combining them into a research agenda on the assessment of the actual dependency on forest products of local people in the Bulungan Research Forest.

7. The reorganization of CIFOR's work on community-based management has shifted the scenario research that was linked to research on adaptive co-management (ACM) of forests. It led to the merging of Outputs 2.3–2.5 into a single output, 2.3.

b. Project documentation

1. A skilled staff member, preferably full time, was required to undertake project documentation, to compile all data and information from the research and complementary data from other sources and make them meaningful and easily available, not only to the project but also to other users.

2. Baseline biophysical and social data and information compiled were not only from the project but also other data relevant to the project and development of the Malinau area. These will provide good bases for developing and implementing the next phase of the project as well as for the development of Malinau in general.

3. The results of the project were disseminated through the provision of guidelines, methods, scientific publications and reports.

c. Monitoring and evaluation; quality of project planning

1. Monitoring by the PSC should be systematic and continuous and the quality of project planning and results reviewed accordingly.

2. PSC meetings organized in the field, providing opportunities for members to visit field sites, would increase the quality of planning and the results of the project.

4. An annual mid-term evaluation would have been beneficial to the project.

5. Funding for the above activities should have been incorporated into the overall budget.

d. Definitions of roles and responsibilities of the institutions involved in project implementation

1. While each institution involved understood its roles and responsibilities, these were sometimes complicated by unforeseen circumstances. Additionally, their capacities, functions and operational objectives were not always in line with the needs of the project. This led to delays in project implementation.

1. CIFOR and FORDA assumed primary responsibility for the design and execution of research activities within the project.

2. The people living in the area actively took part in the project through participatory mapping, provision of local data and information and other active collaboration in the project's implementation.

3. MOF and policy makers took part through their support for the project, anticipating the project outcome of the improvement of the TPTI. Where required, MOF retained overall responsibility for the policies and activities carried out in BRF.

4. PT Inhutani II was responsible for the management of its concession area, and provided facilities and its concession for the project, especially for the RIL experiment and subsequent implementation on a commercial scale.

5. ITTO member countries and the global community participated in the project through the provision of consultancies and research activities on subjects complementing the project. The project sites in Malinau district were also used for testing a model of Integrated Natural Resources Management.

e. Actions to be taken to avoid variations between planned and actual implementation (schedule, costs, etc.)

1. The following measures and actions taken could have avoided the above variations: (1) better project formulation and planning during the proposal preparation stage, and (2) better planning during implementation, including regular revisions of existing plans adjusted to prevailing situations and budgetary conditions.

2. The actions taken to overcome the problems include (1) use of national scientists instead of expatriates; (2) use of funds from other sources for research station facilities, personnel, equipment, and vehicles, and (3) modification of outputs and reduction of activities.

f. External factors that influenced the project implementation and that could have been foreseen

1. Several field activities were still active until early August 2001, large amounts of biodiversity data needed additional verification and processing, the critical process of reaching agreement with the government and P.T. Inhutani II on participatory mapping and other ACM aspects required completion, and opportunities for developing agreements among communities needed documentation. Employing young national scientists, while enhancing their capability, has also required the additional support of more senior and experienced scientists.

2. Insufficient skilled human resources and experts in East Kalimantan forced the project to hire them from Java, resulting in higher travel expenditure and other costs.

3. External monitoring and evaluation should have been undertaken continuously in order to avoid variations between planned and actual implementation and to take necessary actions should such variations exist.

g. External factors that influenced the project implementation and that could not have been foreseen

1. The inability of the GOI to provide the counterpart budget resulted in a budget shortfall (which was compensated by funds from other sources) that led to a reduction of the number of outputs and activities, modification of the methods employed, and limited the number of FORDA staff participating in the project.

2. The financial constraints and unpredictable political situation led to the delay of several activities and hampered the progress of the project. More specialized consultants were required to implement the field activities than planned, leading to higher-than-anticipated expenses for this budget line.

3. Dependence on the tight logging schedules of PT Inhutani II, availability of consultants and workers, unpredictable weather resulting in floods, late arrival of tractors and other factors led to the delay in the initiation and slowed down the progress of the project.

4. Relationships with stakeholders have to be taken into account in the socio-economic and landscape studies. These have not only slowed down the activities but also resulted in unpredictable and high costs of operation, particularly in the later stage of the project implementation.

5. Complementary financial contributions from CIFOR, the MacArthur Foundation, USAID, PT Inhutani II, PT Trakindo Utama/Caterpillar, IRD and IFAD helped a great deal in overcoming the budgetary shortfall, without which the project would have achieved less.

1.5. RECOMMENDATIONS

1.5.1. Identification

1. The project should support national and international commitments.

2. The specific objectives to be tackled should be relevant and in accordance with criteria of sustainable forest management as defined by ITTO.

3. The selection of problems to be addressed should reflect the critical needs of the country but their solutions should have national and international applications and implications.

1.5.2. Design

1. It is important to develop a common vision among stakeholders of what sustainable forest management on a landscape scale for BRF should be and provide them opportunities for more participation in the planning and implementation of a project. Project formulation and planning should be prepared by CIFOR and FORDA in collaboration with other stakeholders.

2. The momentum of research generated in Phase 1 should continue and expand to achieve a more intensive understanding of the biophysical and socio-economic environments in the forest area.

3. Phase 2 should be built upon Phase 1, which has satisfactorily laid the foundations for these long-term sustainable forest management objectives through baseline data gathering and synthesis and the piloting of RIL as a better option to conventional logging.

4. Many of the needed inputs for a sustainable forest management plan for the BRF as a model forest, including all required base maps on current land use and forest cover as well as more precise topographic maps, can be completed in Phase 2, hence this plan should be the principal output projected.

5. A project plan should (i) design activities in detail during the formulation and prior to the implementation of a project and use them as a basis for budget allocation and monitoring of the progress of the project, and (ii) include a scheme for the dissemination of results of the project through the provision of guidelines, methods, scientific publications and reports in both English and Indonesian, as well as translation of scientific results into policy, management and practical application.

1.5.3. Implementation

1. Involvement of stakeholders and confirmed institutional commitments in project implementation will likely ensure the success of sustainable forest management and development of a model forest.

2. It is important to demonstrate how to incorporate sustainable forest management principles into the district spatial land use plan.

3. Implementation should be based on a workplan and carried out jointly by CIFOR and FORDA in collaboration with partners, under the supervision of the PSC.

4. Stakeholders, such as PT Inhutani II and local governments, should be more involved in the execution of the project.

1.5.4. Organization

5. The project should have a competent coordinator who has a solid background in forest ecology and silviculture but has a multidisciplinary vision so that he or she is able to integrate social and biophysical aspects of the project.

6. Effective coordination and organization among partners, stakeholders and other relevant institutions should be ensured.

7. The PSC should monitor the project continuously. It should be small yet effective and efficient and consist of professionals who will be able to be actively involved in steering and supervising the project execution.

8. The PSC, scientists and policy makers should meet regularly to ensure the smooth execution of the project.

9. Throughout the implementation of the project, constant cooperation among ITTO, CIFOR, FORDA, MOF, PSC, scientists, local government, local people, partners and collaborators should be ensured.

1.5.5. Management

1. The Project Coordinator should manage and coordinate all activities, including financial management and periodic reporting. He or she should be a competent manager and scientist who has an interdisciplinary vision of the project and has an ability to deal with people from the lower level in villages to high officials elsewhere, as well as good contact with national and international scientists and scientific institutions.

2. The Project Coordinator should ensure a strong link between the different parties involved in the project and overview the gathering of baseline information.

3. The project would benefit from a project research assistant and a field project supervisor being seconded to the Project Coordinator and included in the overall budget of the project.

4. CIFOR senior scientists, together with FORDA scientists, should direct the research activities in the site in consultation with the Project Coordinator.

Part 2: Main Text

2.1. PROJECT CONTENT

2.1.1. Development Objectives

The final objective is to achieve long-term forest management for multiple uses, integrating social, environmental, biodiversity and silvicultural aspects. The initial project was to constitute a developmental phase within a longer-term research strategy and was concerned mainly with gathering baseline information on the physical and human environment. Reduced-Impact Logging (RIL) experiments applied on a concession scale, and the assessment of their impacts on both the environment and economic cost were expected to lead to promoting and integrating these techniques in the current Indonesian selective cutting and planting system.

2.1.2. Specific Objectives

1. Assessment of the effect of Reduced-Impact Logging on biodiversity, conservation, ecology and socio-economics.

2. Assessment of rural development trends and future policy options, including the effects of macro-level development activities on people dependent on the forest.

2.1.3. Outputs

2.1.3.1 Specific Objective 1:

Assessment of the effects of Reduced-Impact Logging on biodiversity, conservation, ecology and socio-economics.

Output 1.1. Formulation of RIL guidelines in cooperation with PT Inhutani II according to the biophysical features of the area (topography, stand volume, tree distribution, etc.).

Output 1.2. Comparison of the impact of RIL and conventional logging on the forest ecosystem, including system modelling.

Output 1.3. Comparison of the economic and financial costs of RIL and conventional techniques.

Output 1.4. Improvement of the current Indonesian forest management system.

Output 1.5. Spatially-referenced database on target groups of plant and animal species of concern to management.

Output 1.6. Potential distribution maps of target species and related forest productivity; land allocation model and decision support system for reserve selection and for designing management options to minimize impact on biodiversity.

Output 1.7. Publications and workshops on the main results.

2.1.3.2. Specific Objective 2:

Assessment of rural development trends and future policy options, including the effects of macro-level development activities on people dependent on the forest.

Output 2.1. An analysis of what makes a particular forest product susceptible or resilient to change following economic or environmental disturbance.

Output 2.2. Improved ability to predict responses in forest product use following major economic or ecological disturbance.

Output 2.3 Models of trends in forest dependence, livelihood strategies, institutions for forest management and rural development, into which were merged Output 2.4: Future scenarios demonstrating how hypothesized changes in economic growth, rural development and the forest condition will affect livelihood opportunities and forest sustainability, and Output 2.5: Policy briefs describing policy trends and projected impacts of different policy options based on scenarios.

2.1.4. The Strategy Adopted in Carrying Out the Project

2.1.4.1. Reasons for selection

The Bulungan Research Forest (BRF) has been used for harvesting timber and collection of other forest products by local people living within and outside the research area. There has been a considerable amount of dynamism in the situation with government-encouraged migration of villages to areas with better access to infrastructure, in particular schools and medical services. This has led many villages to move out of the area while still maintaining traditional links with it, especially for high-value forest products. Diverse new activities have been proposed for this area (including oil palm plantations, coal mining and logging), which have been rapidly opening the area, and when combined with previous traditional use, make it an excellent location for studying response to disturbance.

A partnership with PT Inhutani II provided an ideal opportunity to study the influence of changes in forest policy and the incentive structure on concession behaviour regarding logging practices, and the translation of these changes to the field operational level. In the context of the approaching timber eco-certification deadline, and as a state-owned company, PT Inhutani II must achieve sustainable forest management practices by the year 2000 as required by MOF in line with ITTO's Year 2000 Objective. Since RIL is an essential component of those practices, PT Inhutani II was willing to cooperate with the project on this particular topic. This offered PT Inhutani II the opportunity to test the feasibility of those techniques and, more importantly, to acquire thorough technical knowledge for RIL implementation.

2.1.4.2. Lessons drawn from past experience

The project benefited from previous experience in forest management planning (ITTO project in Sarawak, Malaysia, ref: PD 104/90) and in RIL trials carried out in Sabah (Danum valley, Innoprise concession) and East Kalimantan (STREK project, PT Inhutani I concession, and projects of other timber companies). Those past experiences demonstrated that training in RIL techniques was essential for the success of the operation. WWF has been facilitating and carrying out research since 1990 in the adjacent Kayan Mentarang National Park on both ecological and social topics. CIFOR social scientists have been conducting a study on household livelihoods and forest use in the area since 1994 and have extensive data holdings on household incomes, demography and forest product collection.

2.1.4.3 Technical and scientific aspects

2.1.4.3.1 Assessment of the effect of Reduced-Impact Logging on biodiversity, conservation and socio-economics

Previous RIL studies in Southeast Asia have clearly demonstrated that damage can be significantly reduced by applying simple techniques within a forest management plan, including a pre-harvesting survey, pre-mapping of timber trees, vine cutting, design of skidtrail networks before logging and directional felling. Although the TPTI recommends the

achievement of almost all these RIL rules, they have not been widely applied on a concession scale for various reasons, including lack of technical knowledge, lack of control of harvesting practices and the high economic cost of RIL if combined with enrichment planting. One of the objectives of RIL implementation at BRF is to demonstrate the advantage of those techniques in post-harvesting forest management. Under a RIL regime that avoids damage to advanced and understorey regeneration, artificial regeneration, as required by TPTI, might be rendered wholly or at least partially unnecessary. A policy question might be put forward as to whether the economic and time savings made by reducing the TPTI regeneration requirements would provide sufficient incentives for a concessionaire to invest in the planning and training required for RIL. Another possible policy question that might be considered by MOF is to waive both liberation thinning and enrichment planting requirements after logging.

Before the implementation of RIL, technical guidelines were published by CIFOR and evaluated by PT Inhutani II in order to assess their feasibility in the field. These guidelines took into account the physical features of the area and particularly the topography. A first assessment of the topographic features of the PT Inhutani II concession and particularly of the 5000 ha scheduled for logging over the next five years was a first priority. Forest inventory and a tree location map provided important information on the forest resource of the concession. This assessment allows a logging plan to be developed according to the field characteristics and forest resources. Training on topographic and tree mapping, skidtrail planning and directional felling for staff of PT Inhutani II, MOF and other concessionaires, was carried out in collaboration with forestry consulting companies (Forestec and Nordfor), and the Tropical Forest Foundation (TFF).

The assessment of the biophysical impacts of RIL was initially planned to focus on biodiversity, changes in soil and water, non-timber forest products, forest regeneration and productivity, and fire risk. Due to various constraints, particularly financial limitations, the impact studies were concentrated mainly on damage to residual stands and soils through a better harvesting plan, directional felling, planning of skidtrails and landings and use of less destructive skidders. The assessment of the logging impacts required the establishment of a system of permanent sample plots (1 ha each) in both conventional logging (CNV) and RIL (1997–1998 and 1998–1999 coupes, respectively) before logging operations. They offer possibilities for a wide range of long-term forestry monitoring, research and training on forest regeneration, productivity, growth and forest dynamics modelling.

The socio-economic assessment of RIL involving comparisons of financial analyses of the assessment of forest management planning and control costs, including RIL, have not yet been carried out on a concession scale. An assessment of the advantages and disadvantages of adopting RIL techniques requires an understanding of both the economic benefits and costs of RIL operations in comparison with CNV practices. By reducing damage to the remaining stand and limiting soil compaction, RIL has the potential to provide economic advantages in long-term management, thus benefiting society and the landowner (the Government of Indonesia). Forests harvested with RIL techniques are likely to regenerate better and faster than those harvested with CNV. It should be demonstrated that by adopting RIL techniques, concessionaires could avoid the necessity of enrichment planting and liberation thinning, which would serve as an important economic incentive to induce concessionaires to adopt RIL procedures on a wide scale.

2.1.4.3.2. Biodiversity assessment

The initial design was revised and a more integrated multidisciplinary approach to landscape assessment, termed a 'Multidisciplinary Landscape Assessment' (MLA), was adopted. The shift in approach of the planned biodiversity assessment provides an integrating framework for much of the biodiversity, socio-economic, and land/resource surveys. The ultimate goal is to develop a baseline of environmental information that explicitly includes factors that should determine good land use planning with special reference to biodiversity and the needs and preferences of local people. This innovative approach has stimulated much interest as a useful new assessment paradigm that can potentially be developed and adapted to other areas

On the study of logging impacts on wildlife, the WCS-IP undertook a pre-logging wildlife

inventory in the CNV and RIL blocks. However, the field reassessment of wildlife was not carried out as originally foreseen due to budgetary, technical and biological constraints. Owing to the very short-term nature of any post-harvest changes, and the many interventions in the surrounding landscape which would confound any careful re-survey assessment (e.g. roads, hunting), it would be impossible to understand the reasons for any changes in the fauna of the composition. It is also intended to take a different approach that involved aggregating on 'what is known already'.

Some background information on this idea is as follows. Current conceptions of 'good' practice in tropical high forest are almost exclusively preoccupied with silviculture (e.g. reduced-impact logging). Yet, researchers from many disciplines of tropical biology claim their work has potential relevance to improving forestry practices in tropical landscapes. Capturing this knowledge may help to improve current logging practices. It is believed that much more is known about vulnerable forest taxa than is currently recognised and applied. Many experts have quite clear views on what types of landscape properties or habitat elements are required to maintain, for example, woodpeckers, hornbills, tree frogs, *Rafflesia*, gibbons, ungulates, etc. This includes clearly documented natural history information and the more context-specific expertise that might have been built up without such documentation. A synthesis of both types of information would be useful to guide forestry activities, and is arguably of much greater use than any statement of how densities of taxa change in any one logging study.

Based on this reasoning we developed a comprehensive review of the literature and expertise pertinent to the species known to occur in Malinau. The aim was to identify the factors that make species vulnerable to forestry activities and other landscape interventions, and relate findings to the design of 'biodiversity-friendly' reduced-impact forestry guidelines and to invite a broad range of expert opinions including local experts in Indonesia. We believe this study will help develop specific recommendations and guidance on management interventions and also identify the most important unknowns and controversies for additional research. Based on the Malinau experience, this process will also now be replicated in other tropical regions.

The WCS-IP undertook the review. The compiled database should be an invaluable tool with which to assess the potential impact of logging and to refine the existing RIL guidelines for hill dipterocarp forests. Previous documents (e.g. ITTO guidelines, FAO Code of Practice, Sist *et al.*'s RIL Guidelines for Lowland and Hill Dipterocarp Forests, Government of Indonesia Logging Laws, etc.) were used as a starting point.

Additional surveys produced a detailed summary of aquatic fauna including fish (some ITTO support) and invertebrates (without ITTO support), and an additional pilot summary looked at amphibians and reptiles. Apart from detailed information on species lists, these studies also included detailed attention to habitat, ecology, and how these species are used and viewed by local communities.

2.1.4.3.3. Assessment of rural development trends and future policy options including the effects of macro-level development activities on people dependent on the forest

It is generally accepted that forest people strictly depend on forest resources for their livelihood and that forests must be preserved to ensure their survival. The notion that indigenous communities may act as conservationists belongs to the same category of '*idÈes reÁues*'. In Malinau, as elsewhere, reality is very different. Dependency on forest products varies greatly among villages and among households and quite often, local people play an active role in forest conversion.

The research undertaken seeks to assess the actual dependency on forest products of local people in the BRF: (i) Who depends on forest products for their livelihoods and to what extent? (ii) Is it a deliberate choice or a forced one? and (iii) Would people seize other opportunities if offered? The answers to these questions are an absolute prerequisite to understand what is happening in Malinau, how such dynamic situations evolve, and thus to determine the best way to favour positive initiatives and avoid unwanted extremities.

2.1.4.3.4. Future scenarios for rural development

This activity addressed the problem of how to improve local people's livelihoods and forest management practices by anticipating economic development trends and policy needs. The research developed future scenarios that illustrate possibilities for reconciling forest management objectives with local people's needs.

The reorganization of CIFOR's work on community-based management has shifted the emphasis for this activity. The scenario research was linked to research on Adaptive Co-Management (ACM) of local forests and the creation of resource management agreements. The scenario research was one of several tools that were tested as part of an ACM approach to landscape management. In developing the tool and applying it, questions related to stakeholder participation and governance in resource management agreements were also examined. In Malinau, these efforts focused on the representation of communities in multiple stakeholder processes. The current activity was thus focusing on the testing of scenario-based methods for collaborative, adaptive management in Malinau. The research topics associated with this work were: (1) What information can be gained about trends in livelihoods, forest management and rural development? (2) The testing of the scenario method as a tool; and (3) What sort of attention to governance issues associated with use of this tool is necessary, especially the representation of different stakeholders? Due to the policy environment at the time the research was implemented, we shifted the field research strategy to better reflect local priorities related to land tenure and claims on local resources. Examinations were carried out on the negotiation of boundaries among villages, using action research based on participatory mapping and the governance conditions affecting how local stakeholders were able to reach agreement and negotiate effectively.

2.1.5. Workplan

The Project Agreement between CIFOR and ITTO was signed on 8 September 2001 on the implementation of Project PD 12/97 Rev.1 (F), Forest, Science and Sustainability: The Bulungan Model Forest. The Project Workplan was prepared and approved by the first Project Steering Committee (PSC) Meeting on 11 December 1997 in Jakarta. The first budget instalment was received on 30 December 1997; accordingly, the project execution was effective on 30 December 1997. The implementation of the project was delayed until 1 March 1998, when the Project Coordinator started his assignment, although initial activities were carried out by CIFOR scientists in January 1998. The Project Workplan was reviewed during the subsequent PSC Meetings and revised accordingly.

2.1.6. Required Inputs

The project required financial inputs provided by ITTO, the Government of Indonesia (GOI)/Ministry of Forestry (MOF) and CIFOR initially for the period of 30 December 1997–30 December 2000 as shown in Table 1.

However, various constraints, such as dependence on partners for heavy equipment and field operations, unstable political situations, availability of skilled human resources, unpredictable weather resulting in floods, late arrival of equipment, scattered distribution of and large distances between villages, different ethnic groups dealt with, high travel costs between villages, and other factors, not only led to a delay in the initiation and slowed down progress, but also resulted in unpredictable and high operational costs. The ITTC XXIX Session approved an extension until December 31, 2001, with an additional budget of US$130,741. The new budget allocation was:

ITTO funding	US$	965,650
ITTO additional funding	US$	130,741
Government of Indonesia funding	US$	362,500
CIFOR funding	US$	144,000
TOTAL	*US$1,602,891*	

Due to the economic crisis, the GOI was unable to fulfil its commitment, thus leaving a total operating budget of US$1,240,391. It provided in-kind contributions instead.

CIRAD-Forêt provided contributions to cover the salary of a RIL scientist and expenses for a French student intern. IRD paid the salary of a social

Table 1. Financial Inputs provided by ITTO, the Government of Indonesia/Ministry of Forestry and CIFOR initially for the period of 30 December 1997–30 December 2000

Budget component	TOTAL (USD)	ITTO	CIFOR	GOI/MOF
10 Project Personnel	783 600	**531 600**	0	252 000
20 Subcontracts	340 000	**244 000**	144 000	0
30 Duty Travel	84 800	**84 800**	0	0
40 Capital items	92 400	**32 400**	0	60 000
50 Consumable items	28 150	**7 650**	0	20 500
60 Miscellaneous	71 850	**41 850**	0	30 000
70 ITTO monitoring	21 000	**21 000**		
TOTAL	**1 421 800**	965 650	144 000	362 500
ITTO costs (5.5%)	50 350			
GRAND TOTAL	**1 472 150**			

scientist. CIFOR (on top of the aforementioned contribution), the MacArthur Foundation and USAID contributed complementary funds to cover expenses for constructing and managing field facilities, staff salaries, purchase of equipment and vehicles, PSC meetings, transportation, and travel. PT Inhutani II provided support to cover the cost of transporting two new tractors from Singapore to the Malinau concession as well as logging and other expenses, P.T. Trakindo Utama and Caterpillar Co. allowed the project to use two brand-new tractors for free for three months, and IFAD, ACIAR, and the Ford Foundation gave complementary funds to pay for various activities.

2.1.7. Project Rationale, Relevant Background Information and Location

In January 1996, the Indonesian Ministry of Forestry designated 302 900 ha of forest for CIFOR in Malinau District, East Kalimantan, to be developed as a long-term model of exemplary research-based management. The creation of this research forest—the first ever in Indonesia—grew out of a provision in the host-country agreement granting access to a long-term research site. The interest of CIFOR in this area is to carry out multidisciplinary research activities able to cover the complexity of forest management for multiple uses. For this reason, among CIFOR's six research programme areas, four (Sustainable Forest Management, Biodiversity Conservation, Adaptive Co-Management of Forests, and Forest Products and People) have been involved in the area for this initial three-year period. CIFOR and MOF expect to maintain research and development activities at BRF for a period of 10–20 years.

CIFOR's strategic research has focused on policy issues to enable more informed, productive, sustainable and equitable decisions about the management and use of forests. CIFOR and ITTO both have an international dimension and constitute fora for cooperation and consultation between Member Governments and Non-Governmental Organizations. As stipulated in the ITTO Action Plan, ITTO aims to encourage and promote sustainable and economically viable management systems. Cooperation between CIFOR, FORDA and ITTO through this research and development project will not only contribute to the achievement of the ITTO Year 2000 Objective but also enhance the relationship between these three institutions.

One of the greatest challenges for achieving sustainable forest management in the next century will be to address the increasing complexity of demands on tropical forest resources within a constrained land area. Demands for tropical forest extraction, conversion or protection are transforming

the way forests look and the way they are managed, with the result that tropical forested landscapes are perhaps the single most rapidly changing land type around the globe. These demands are complicated by coinciding claims over the use or control of the same area, the increasing number of social and private interests pursuing their diverse agendas and the multiple contexts of forest management, from the local to the regional, national and international scales.

Although sustainability and how to maintain it at the forest management level is beginning to be understood, approaches for maintaining sustainability at the larger landscape scale remain poorly developed. The general objective of the present research is to carry out a systematic investigation of how to achieve forest sustainability for a 'large forest landscape' in the humid tropics, where diverse, rapidly changing and often conflicting land use demands exist.

This investigation requires an understanding of the technologies, policies and information needed for meeting multiple objectives, both within and across forest types, in a given area. The focus of such a landscape approach is on the links between different activities. The research will therefore aim to understand how to strengthen the synergies and compatibilities among demands, while minimizing the conflicts and negative impacts on sustainability.

2.1.8. Previous Preparatory Activities

There were no previous preparatory activities before the project was launched except the formulation of the Project Document and a related research project (coordinated by Eva Wollenberg) on local livelihoods and the relationship between income incentives and conservation behaviour. This work provided baseline information about the dependence of local people on the forest for five selected sites in BRF.

2.1.9. ITTO Context of the Project

2.1.9.1. Compliance with ITTO objectives

This project is consistent with the following ITTO objectives as stipulated in Article 1 of the ITTA (1994):

a) To contribute to the process of sustainable development.

b) To enhance the capacity of members to implement a strategy for achieving exports of tropical timber and timber products from sustainably managed sources by the year 2000.

c) To promote and support research and development with a view to improving forest management and efficiency of wood utilization as well as increasing the capacity to conserve and enhance other forest values in timber-producing tropical forests.

d) To encourage members to develop national policies aimed at sustainable utilization and conservation of timber-producing forests and their genetic resources and at maintaining the ecological balance in the regions concerned, in the context of the tropical timber trade.

2.1.9.2 Compliance with ITTO criteria

This project lies within the framework of the Committee on Reforestation and Forest Management, and is mainly related to the forest management area. It is also in line with all the objectives defined by this committee (ITTA, 1994, Article 27).

2.1.9.3. Relationship to ITTO Action Plan and Priorities

The project is consistent with the ITTO Action Plan and is related to the major objectives of the Committee on Reforestation and Forest Management, which are to promote the development of national policies and to support the development and implementation of sustainable forest management systems. The project is related to all the following priorities defined in the ITTO action plan:

- Forestry sector policy review.
- Studies on the economic and financial costs and benefits of forest management.

- Identification of field demonstration projects where sustainable production of timber and non-timber products may be combined.
- Comparative assessment of silvicultural treatments on permanent sample plots.
- Study of the effect of different levels of timber harvesting on forest sustainability.
- Promoting and financing demonstration projects for different models, and regional/subregional networks of such projects.
- Specification of training requirements for forest management and administration.
- Help to create networks on tropical forest management, and between tropical forestry research institutes.
- Help to finance exchange visits and workshop participation by technical personnel.

The project complies with the ITTO Libreville Action Plan 1998 to 2001: (1.4) ITTO Year 2000 Objective, which is the goal of having all tropical timber entering international trade come from sustainably managed sources by 2000.

The major actions cover forest policy, security of forest resources, prevention of unplanned deforestation, improvement of utilization, improvement of social and political environment on forest management, application of and training on reduced-impact logging, monitoring and research, and relationship with local people.

2.2. PROJECT CONTEXT

2.2.1. Relationship to Sectoral Policies Affecting Tropical Timber

The Indonesian Constitution stipulates that the State controls forests and utilization of resources therein. In this context the Government of Indonesia (GOI) controls, manages and administers the nation's forests under the provisions of the 1967 and 1999 Basic Forestry Laws. The Laws determine the status, function and utilization of forests. Since the 1970s, the government has granted concessions to logging companies, which have to comply with the regulation that the management of forest should be in accordance with the principle of multiple use and sustainable yield. In 1998 the government authorized communities to undertake timber harvesting through cooperatives and a programme on management of forest production by traditional societies, which involves non-government organizations (NGOs) working in partnership with local communities. Meanwhile the Government of Indonesia has given top priority to the attainment of ITTO's Year 2000 Objective. This project, by integrating silvicultural (Reduced-Impact Logging assessment), ecological (biodiversity assessment) and social aspects of natural forest management for multiple use, is a major contribution towards sustainable forest management. This project will provide some guidelines for long-term natural forest management and therefore makes an important contribution to the improvement of TPTI.

2.2.2. Relationship to Subsectoral Aims and Programmes

The project provided training activities, particularly on logging techniques and planning. Training sessions in the forest were organized by CIFOR in collaboration with PT Inhutani II and the Tropical Forest Foundation. The project provided facilities and allowed the use of experimental RIL sites for training by other organizations, such as various universities, the Berau Forest Management Project (a joint project of PT Inhutani II and the European Union) for training some of their staff, and the Center for Forestry Training of the Ministry of Forestry and the Indonesia Australia Specialized Training Project for training participants from various logging companies and Indonesian forestry agencies. The Ministry of Forestry will also use the sites for Asia-Pacific RIL training.

The ACM activity provided training on participatory mapping, conflict management and policy awareness for local people. Three multistakeholder dialogues were also sponsored, the last of which (supported primarily by funds from ACIAR) was a full two-day workshop.

2.3. PROJECT DESIGN AND ORGANIZATION

2.3.1. Adequacy of the Results of the 'Identification Phase'

The project correctly defined the choice of BRF as a location for research and for identifying the issues of sustainable forest management to tackle by integrating social, biological, environmental and silvicultural approaches, although as the project progressed, various rapid changes took place and required adjustment.

2.3.2. Sound Conceptual Foundation of the Project

The project concept and rationale were sufficiently defined in the Project Document, but the impacts of external influences were not predictable. The financial crisis, leading to the failure of the GOI to provide its financial contribution, and rapid changes in the political situation, for instance, were not anticipated and have had profound effects on the project, including the modification and delay of various activities. The dependency of project activities on third parties' commitment often slowed down the progress of the project.

2.3.3. Adequacy of Time and Other Resources for Project Formulation

The Project Document was produced in time for submission by the GOI to ITTC in May 1997 and the agreement was signed by ITTO, MOF and CIFOR on 8 September 1997. There was, however, a delay in the implementation of the project, due to the fact that the workplan was presented at the first Project Steering Committee meeting held on 11 December 1997 in Jakarta, as well as to the availability of the Project Coordinator, who commenced his service on 1 March 1998.

2.3.4. Understanding and Appropriateness of the Roles and Responsibilities of the Institutions Involved with Project Implementation.

As forestry research institutions, CIFOR and FORDA were appropriate as the executing agencies and had a good understanding of their responsibilities. Other institutions involved as partners included PT Inhutani II, the state-owned forest enterprise, and CIRAD-Forêt, LIPI, WCS-IP, Mulawarman University, Bandung Institute of Technology, BIOMA and SHK. While each institution involved understood its roles and responsibilities, these have been complicated by unforeseen circumstances. In addition, their capacities, functions and operational objectives were sometimes not in line with the needs of the project. This led to delays in project implementation.

2.3.5. Beneficiary Involvement with the Project's Efforts and Actions

The involvement of the main beneficiaries in the projects:

1. The people living in the area actively took part in the project through participatory mapping, the provision of local data and information and other active collaboration. Through participation and discussions, the project and the people gained a better understanding of enhancing conservation and sustainable utilization of the forest resources on which they depend, protection against inappropriate development, and better coordination with adjacent land users.

2. The Ministry of Forestry and policy makers provided full support for the project, anticipating the project outcome: the improvement of the Indonesian Selective Cutting and Planting System (TPTI) through providing rules and guidelines for RIL application on a concession scale, and better development of community-based forest management. FORDA, being the implementing agency, actively collaborated with CIFOR in the project execution. Other agencies within MOF gained benefits through training and use of the project facilities for training purposes.

3. PT Inhutani II provided facilities and its concession at Malinau for the project, especially for the RIL experiment and subsequent implementation on commercial scales. At the same time, PT Inhutani II acquired technical knowledge for RIL implementation as part of forest management planning and control.

4. Other concessionaires in the vicinity of the project sites took part in the training activities organized by the project.

5. ITTO member countries and the global community participated in the project through the provision of consultancies and research activities on subjects complementing the projects. The project sites and Malinau district were also used as one of the sites for testing a model of Integrated Natural Resources Management that is being developed for tropical regions and will be applied by various international institutions.

6. Other partners of the project providing support included LIPI (*Lembaga Ilmu Pengetahuan Indonesia,* the Indonesian Institute of Sciences) in the inventory and identification of plant and fish species, the WCS-IP and Bandung Institute of Technology in wildlife surveys, and BIOMA and SHK in various field studies.

7. Young scientists, graduate and undergraduate students, technicians participated in various aspects of the projects.

2.4. PROJECT IMPLEMENTATION

2.4.1. The Most Critical Differences Between Planned and Actual Project Implementation

These include the following:

- Underestimated costs of the project during the project formulation and the failure of GOI/MOF to provide a budgetary (cash) contribution to the project due to the economic crisis led to the modification of the outputs and their activities, a reduction in the participation of the FORDA scientists, and inability to purchase and provide vehicles.

- RIL underwent implementation changes due to the dependence on PT Inhutani II and other partners' schedules and availability of heavy equipment and personnel as well as inadequacy of the budget.

- The reorganization of CIFOR's work on community-based management has shifted the scenario research that was linked to research on adaptive co-management (ACM) of forests. It led to the merging of Outputs 2.3–2.5 into a single output, 2.3.

- Initially, Outputs 1.5 and 1.6 comprised the gradient-based survey, which was designed to provide the basis for stratified sampling of the Bulungan area. However, following a change in project staff, a new approach—the Multidisciplinary Landscape Assessment (MLA)—was developed as it was recognised that this would be of greater value to achieving project goals. The ultimate goal of MLA is to develop a baseline of environmental information that explicitly includes factors that should determine good land use planning when seen from the perspective of local communities.

2.4.2. Measures and Actions that Could Have Avoided These Variations

The following measures and actions could have avoided the above variations: (1) better project formulation and planning during the proposal preparation stage, which should have been based on the details in outputs, activities, personnel, travel, and budgets; and (2) better planning during implementation, including regular revisions of existing plans adjusted to prevailing situations and budgetary conditions.

The actions taken to overcome the problems include (1) use of national scientists instead of expatriates; (2) use of funds from other sources, i.e., the MacArthur grant and the CIFOR additional budget for training, meeting, consultants, publication, research station facilities, personnel, equipment, running facilities, and vehicles, and (3) modification of outputs and reduction of activities.

2.4.3. Appropriateness of the Assumptions Made and Correct Identification of the Issues Involved

Assumptions made regarding the project background, justification, objectives and expected outputs were appropriate. Assumptions regarding implementation were mostly correct, although there have been some miscalculations as a result of unforeseen changes and, in particular, financial deficiency.

2.4.4. Project Sustainability after Project Completion as a Result of Project Implementation Conditions

Upon completion, the sustainability of the project would be contingent upon the following:

- The implementation of the Project Phase II, which is an expansion of Phase I, has a wider relevance to development of Malinau and will involve more stakeholders, including local government and local people.

- RIL programme:

  - PT Inhutani II's plan to implement RIL on a commercial scale, and its associated training and possibly a research agenda.

  - Development of a model on the scheduling of logging using data obtained during the project.

  - Monitoring in permanent sample plots of long-term impacts of logging on forest structure and species composition, growth, regeneration and forest dynamics in Phase II.

- Maintenance of (i) the Seturan Field Station at the Malinau concession for (1) monitoring of permanent plots on studies of growth, regeneration and forest dynamics, and (2) use of the research sites, facilities and information for training on RIL and research by local, national and international institutions and universities, and (ii) the Loreh guest house and its facilities, mainly for social science research.

- Extension of MLA activities to other parts of BRF in view of the fact that the expected research results will likely improve practices and lead to better sustainability in management (e.g. by means of improved RIL) and that there is some interest in using the MLA approach as part of a wider planning process. The value of this activity will depend on appropriate packaging and promotion of the methods and results.

- The impacts of the participatory mapping and conflict management will be sustainable with the support of the local district government to (1) follow up on engaging in participatory mapping training to complete the process initiated under this project, (2) resolve remaining disputes, (3) finalize maps according to changes in boundaries negotiated by villages, and (4) enforce principles about what is considered a legitimate process for settling boundary differences, the definition of a village and enforcement of boundary agreements. Stronger support from civil society (nongovernmental actors) groups interested in facilitating local communities, providing them with legal literacy and assisting them to negotiate with other actors would be necessary to build villagers' capacities to act on a more equal basis with other local institutions.

- A proposal by UNESCO to designate BRF and the neighbouring Kayan Mentarang National Park as a World Heritage Forest Site.

- The use of the Malinau area as one of the test sites in the tropics for developing an Integrated Natural Resource Management model.

- The possible participation of the BRF programme in the ITTO-supported development of the Kayan Mentarang National Park as an Indonesia-Malaysia transborder conservation area.

- The interest of PT Inhutani II and the local government in the development of the research sites in Malinau and beyond for scientific tourism and ecotourism.

2.4.5. Appropriateness of the Project Inputs

As indicated above, the financial input was inadequate due to inaccurate budgetary estimates for activities and the failure of the GOI/MOF to provide its contribution to the project. This affected the entire operation of the project, including the quantity and quality of personnel, material and management inputs to the project, and has led to the extension of the project with an additional budget.

2.5. PROJECT RESULTS

2.5.1. The Situation Existing at Project Completion as Compared to Pre-project Situation

As a result of the project implementation the following have been achieved:

(1) Methodology

RIL:

- Planning and implementation of RIL on a commercial scale by PT Inhutani II.

- More understanding of the necessity of the application of RIL in sustainable forest management by forestry officials and local governments.

MLA:

- The manual should allow wider use and adaptation of the methods.

- Several related activities, directly stimulated by the Malinau work, are planned or already in progress in other parts of the world.

- The main results of the surveys will be used to feed into and enrich other project outputs, such as the RIL guidelines.

ACM:

- Participatory mapping, negotiations , etc.

- Participation in the formulation of the Malinau District Government regulations on management of natural resources, especially forest resources.

- Participation in development of the Malinau District spatial plan.

(2) Capacity building

RIL:

- Use of the research sites, facilities and information for training on RIL and research by other institutions and universities.

- Improved capabilities of young scientists, universities, national research institutions, government agencies and NGOs participating in the project.

MLA:

- Most of the survey work and analysis has been done by or in close collaboration with local institutions.

- Much emphasis has been given to developing a number of young Indonesian scientists.

FPP:

- Involvement of numerous Indonesian young graduates in the research.
- Involvement of many student interns at Masters level (Indonesian and international).
- Involvement of two PhD students in the research.
- Training of *Yayasan Adat Punan* members in assessment methods, population census and computerized data analysis.

ACM:

- Training and facilitation in negotiation and participatory mapping among 21 villages, which have produced draft maps.
- Training in legal awareness about decentralization, conflict management.
- Community and multistakeholder dialogues.
- Participation in the formulation of the Malinau District Government regulations on management of natural resources, especially forest resources.
- Discussion of the development of the Malinau District spatial plan.
- Scenario methods seminar at the Ministry of Forestry, Jakarta.
- Scenario methods guide translated into Indonesian and distributed in the local district and among national stakeholders.

(3) Database at CIFOR

RIL:

- A model of RIL operations (topographical maps, tree maps, skidtrail locations, etc.) and data on tree species identification, species diameters, non-timber use, damage to canopy, ground and trees, growth, regeneration and reports.
- Tree data in permanent sample plots.

MLA:

- Wildlife in Malinau concession prior to logging.
- Review of impacts of logging on biodiversity.
- The MLA database linked social and biophysical data in 200 sample points and structured data on local preferences and views regarding the environment for seven communities.
- Surveys of reptiles, amphibians and fish.

FPP:

- Anthropological data on the Punan of the Malinau watershed.
- Traditional and modern medicine in Malinau.
- Cultural diversity in five villages of the Malinau watershed.
- Commercialisation of forest products in the Malinau district.
- Exploitation of aquatic resources.
- Impact of concessionaires on local people.
- Potential use of wastewood by local people.
- Household survey in five villages of the Malinau watershed and in all villages of the Tubu watershed.
- Illegal logging survey in Malinau, Berau and Pasir.

ACM - Future trends and scenarios:

- Baseline data on 27 villages.
- Georeferenced points for constructing maps.
- Guide to scenario methods as a tool for ACM of forests.

(4) Understanding of SFM for land use and resource planning by local government, PT Inhutani II, and local communities.

(5) Provision of:

- Database and products to local government, communities, PT Inhutani II and other stakeholders.
- Publications and reports (see Annexes in CD ROM).

- RIL guidelines and methods of topographic and tree mapping.

- MLA's new methods of biodiversity assessment integrating local community perception, social and biological aspects.

- ACM's guidelines and methodology on trends and future scenarios.

2.5.2. Extent to which the Project's Specific Objectives were Achieved

The project's specific objectives were mostly achieved, but certain aspects were only partially accomplished, including:

(1) Objective 1: The RIL implementation was partially achieved and due to various constraints its replication was not realized. The assessment of impacts on biodiversity was partially achieved (in some cases substantial alternative achievements—as agreed in steering committee meetings—were made) while those on soils and environment were not realized.

(2) Objective 2: The assessment of the role and importance of forest products for local communities was achieved. The actual level of dependency on forest products of households and communities was determined. The realization of predictive models has not been achieved. The assessment of rural development trends and future policy options was partly achieved through workshops, interviews and participant observation rather than scenario methods. Given the rapid changes associated with reforms in Indonesia at the time, the research was modified to conduct action research on using conflict management and boundary setting as mechanisms to adapt to changes, rather than to predict them.

2.5.3. Impact of the Project Results

2.5.3.1 Sectoral programmes

The following are the expected impact on sectoral programmes:

- One of the most important impacts of this first RIL experiment was certainly the progressive change in perception of these techniques on the part of PT Inhutani II Malinau Unit. The economic cost assessment study clearly showed that production and productivity were significantly increased with RIL and costs consequently reduced as well. RIL is therefore no longer regarded as an experimental tool for forest scientists but an efficient technique able to increase logging efficiency. The best demonstration of this is the decision of PT Inhutani II to harvest two blocks in the 2000 annual coupe with RIL techniques on their own initiative.

- The project will likely have positive impacts on forest research and management in Indonesia and beyond, and should make an important contribution to forest science worldwide.

- BRF and its existing research stations are providing a tropical rain forest venue for many aspects of forest research and training and a demonstration site for RIL at both the experimental stage and commercial-scale application.

- The project offers RIL methods and guidelines, integrated biodiversity methods, participatory mapping guidelines, and future scenario guidelines that can be applied by forestry agencies, concession holders, local government and universities in Indonesia and beyond.

- RIL studies will contribute guidelines, data and information to the improvement of the TPTI and RIL implementation on a commercial scale by various logging companies in Indonesia and elsewhere.

- The RIL research sites, data and information at Malinau have been used as demonstration sites and materials for reduced-impact logging operations by various organizations.

- Through ACM, forest management planning can be better coordinated among stakeholders from the district to village level. There is an indication that it also helps stimulate the use of accountability and transparency principles for decision making about how forests will be used and, together with the village administrative maps, provide a basis for local government to develop a more participatorily derived land use plan.

- Various forestry undergraduate students of Mulawarman University in Samarinda and Gadjah Mada University in Yogyakarta visited the sites as part of their field studies. Forestry student interns from Mulawarman University, Bogor Agricultural University, and the University of Aberdeen took part in the project. Several graduate students from Mulawarman University, Bogor Agricultural University, the University of London, the Swiss Federal Institute of Technology, Yale University, Oxford University, Wageningen University, the University of Montpellier, the University of Paris VII & XII, and Stirling University undertook their research in the project sites.

2.5.3.2. Physical environment

RIL implementation greatly reduced soil damage. Reduction was achieved through the increased accuracy of contour maps (a basic requirement for harvest planning), directional felling training, planning of skidtrail layout and landings, use of less destructive skidders and an understanding of environmental issues relating to buffer zones and other timber harvesting exclusion areas. Forest modification and conversion increased soil erosion and soil compaction, which led to the decrease of water quality of the rivers as reflected by the increase of turbidity and siltation. This will likely affect population of fish and other organisms living in the aquatic ecosystems in the area. Better understanding on the part of local government of sustainable forest management, which has led to the decision to stop issuing permits for small scale logging, is expected to reduce further forest destruction and degradation of the physical environment.

2.5.3.3. Social environment

The impact on social environment is beginning to be felt through more active involvement of communities in negotiations about land use in their territories and in seeking material benefits, although it will be significantly appreciated when Phase II of the project is completed.

2.5.3.4. Target beneficiaries

The impacts on target beneficiaries are as follows:

- The people living in the area, who benefit from improved livelihood options, enhanced conservation of the forest resources on which they depend, protection against inappropriate development, and better coordination with adjacent land users.

- ITTO member countries in the region, by contributing to the achievement of ITTO's Year 2000 Objective, providing a model of sustainable forest management, and developing new technologies, including the plan to use methods to be developed in the project in a survey in Mozambique.

- MOF and policy makers with regard to improvement of the Indonesian Selective Cutting and Planting System (TPTI) by endorsing and providing rules and guidelines for RIL (including *RIL Guidelines for Indonesia* produced by the project) application on a concession scale.

- PT Inhutani II, which acquired technical knowledge for RIL implementation as part of forest management planning and control.

- The global community, through bringing of one of the world's most important forest wilderness areas under exemplary management, and the conservation of both its biodiversity and of its global environmental functions.

2.5.4. Project Sustainability after Project Completion

See Section 2.4.4., which also presents sustainability after completion of the project.

A proposal for Phase II of the Project was submitted in June 2000. The Twentieth Review Panel, however, recommended a project evaluation to assess the achievements and shortcomings of the project prior to the formulation of the second phase. The project evaluation was undertaken from 25 April to 9 May 2001, barely enough time to consolidate the outcome into the proposal of Project Phase II before the deadline for the proposal submission on 15 June 2001. The 22nd Review Panel recommended that the Phase II proposal be further revised and resubmitted to ITTO before 19 November for review by the 23rd Review Panel.

2.6 SYNTHESIS OF THE ANALYSIS

(a) Specific Objective(s) Achievement

Objective 1: Partly realized
Objective 2: Partly realized

(b) Outputs

Outputs 1.1.–1.4.	:	About 90 % realized
Outputs 1.5.–1.6.	:	After modifications, 100% realized
Output 1.7	:	Fully realized
Outputs 2.1.–2.2.	:	90% realized
Outputs 2.3.–2.5	:	After modifications, 90 % realized

(c) Schedule

Certain activities were delayed, but not seriously, due to unfavourable field conditions. The extension of the project with an additional budget necessarily delayed the completion of the project.

(d) Actual expenditures

None of the activities had expenditure below the planned amount. The expenditure of some activities was > 10% above that planned and was covered by other funding sources. The overexpenditure was due to the inaccuracy of budgetary estimates during the proposal preparation stage and the failure of the Government of Indonesia to provide its contribution.

(e) Potential for replication

The RIL technique, Multiple Landscape Assessment, ACM-Future Scenario undertaking and Forest Product and People studies have significant potential for replication and application.

(f) Potential for scaling up

There is significant potential for scaling up and extension into Phase II.

Part 3: Conclusion and Recommendations

3.1. DEVELOPMENT LESSONS

A similar but shorter account appears in the Executive Summary in Section 1.4.1.

a. Project design

1. The well-structured and workable design, approaches and strategies of the Project, complemented with availability of qualified scientists and technical personnel and institutional, scientific and technical support provided by ITTO, CIFOR, MOF, PT Inhutani II, collaborators and partners were found important for the smooth execution of the project. They were likely to contribute a great deal to the attainment of the development objective.

2. The budget formulation and inaccurate design of the of the project, which were not based on accurate estimates or a detailed workplan and methodologies of the project's implementation, led to the budget shortfall and the necessity of making some reorientation and modification of component research outputs.

b. Changes in intersectoral links that affect the project's success

The Government of Indonesia has given top priority to the attainment of ITTO's Year 2000 Objective. This project, by integrating silvicultural (Reduced-Impact Logging assessment), ecological (biodiversity assessment) and social aspects of natural forest management for multiple use, is a major contribution to sustainable forest management. This project will provide some guidelines for long-term natural forest management and therefore makes an important contribution to the improvement of the current Indonesian forest management system (TPTI).

The financial and political crisis in Indonesia since 1997, however, led to a rapid change in the situation of the forests of Kalimantan. The depreciation of the Indonesian currency against other major currencies and the increase in the export market value of palm oil and coal led to a rapid expansion of land clearing for oil palm plantations and construction of roads to give access to coal deposits. Another factor that has had a major impact on forest resources has been the devolution of power from the central government to the district level, including the authority to allocate logging permits. For instance, permits for oil palm estates are being given for areas that are still the subject of logging concession agreements. The situation has been aggravated by fires in some areas. A series of catastrophic fires occurred in fairly rapid succession between 1982 and 1998. The extent and damage caused by these fires of the past two decades has been the worst in history. Forest fires may have a regional and global consequence because the areas involved are so extensive and effects are so devastating.

c. Additional arrangements that could improve cooperation between relevant parties interested in the project

Although there was no serious problem with cooperation between all the parties involved in the project, the cooperation could be improved by:

1. Holding the PSC meetings more frequently.

2. Organizing formal and informal meetings between scientists and stakeholders who are not PSC members.

3. Stakeholders, such as PT Inhutani II and local governments, being more involved in the execution of the project.

d. Factors that will most likely affect project sustainability after completion

These activities will likely affect project sustainability after completion:

1. The implementation of the Project Phase II, which is an expansion of Phase I, has a wider relevance to development of Malinau and will involve more stakeholders, including local government and local people.

2. PT Inhutani II's plan to implement RIL on a commercial scale, along with its associated training agenda and possibly a research programme.

3. Maintenance of the Seturan Field Station at the Malinau concession for:

   (1) monitoring of permanent plots on growth and regeneration studies,

   (2) use of the research sites, facilities and information for training on RIL and research by local, national and international institutions and universities, and

   (3) development of a model on the scheduling of logging using data obtained during the project.

4. Extension of MLA activities to other parts of BRF in view of the fact that the expected research results will likely improve practices and lead to better 'sustainability' in management (e.g. by means of improved RIL) and that there is some interest in using the MLA approach as part of a wider planning process.

5. The proposed designation by UNESCO of BRF and the neighbouring Kayan Mentarang National Park as a World Heritage Forest Site.

6. The use of the Malinau area as one of the test sites in the tropics for developing an Integrated Natural Resource Management model.

7. The possible participation of the BRF programme in the ITTO-supported development of the Kayan Mentarang National Park as an Indonesia-Malaysia transborder conservation area.

8. The interest of PT Inhutani II and the local government in the development of the research sites in Malinau and beyond for scientific tourism and ecotourism.

9. The devolution of power from the central government to the district level, including the authority to allocate logging permits.

3.2. OPERATIONAL LESSONS

A similar account appears in the Executive Summary in Section 1.4.2.

a. Project organization and management

1. The Project Steering Committee, representing ITTO, MOF, CIFOR, CIRAD -Forêt, PT Inhutani I, PT Inhutani II, NGOs, local governments, local communities, universities, and representatives of donors, supervised the implementation of the project. Fewer members would have made the committee more efficient and effective.

2. The project would run better if a project research assistant was seconded to the Project Coordinator.

3. The failure of MOF to provide a budgetary (cash) contribution to the project due to the economic crisis led to the modification of the outputs and their activities, reduction of participation of the FORDA scientists, and inability to purchase and provide vehicles.

4. RIL underwent implementation changes due to the dependence on PT Inhutani II and other partners' schedules and availability of heavy equipment and personnel.

5. Outputs 1.5 and 1.6 were revised and merged into a 'Multidisciplinary Landscape Assessment' (MLA), an integrating framework for much of the biodiversity, socio-economic, and land/ resource surveys needed as a baseline to assess what actually 'matters' in the local landscape. The ultimate goal of MLA is to develop a baseline of environmental information that explicitly includes factors that should determine good land use planning with special reference to the needs and preferences of local people.

6. Review of Outputs 2.1 and 2.2 led to combining them into a research agenda on assessment of the actual dependency on forest products of local people in the Bulungan Research Forest.

7. The reorganization of CIFOR's work on community-based management has shifted the scenario research that was linked to research on adaptive co- management (ACM) of forests. It led to the merging of Outputs 2.3–2.5 into a single output, 2.3.

b. Project documentation

1. A skilled staff member, preferably full time, was required to undertake the project documentation, to compile all data and information from the research and complementary data from other sources and make them meaningful and easily available, not only to the project but also to other users.

2. Baseline biophysical and social data and information compiled were not only those from the project but also other data relevant to the project and development of the Malinau area on different aspects and from different sources. These will provide good bases for developing and implementing the next phase of the project as well as for the development of Malinau in general.

3. The results of the project were disseminated through the provision of guidelines, methods, and scientific publications and reports.

c. Monitoring and evaluation; quality of project planning

1. Monitoring by the PSC should be systematic and continuous and the quality of project planning and results reviewed accordingly.

2. PSC meetings organized in the field, providing opportunities for members to visit field sites, would increase the quality of planning and the results of the project.

3. An annual mid-term evaluation would have been beneficial to the project.

4. Funding for the above activities should have been incorporated into the overall budget.

d. Definitions of roles and responsibilities of the institutions involved in project implementation

1. While each institution involved understood its roles and responsibilities, these were sometimes complicated by unforeseen circumstances. Additionally, their capacities, functions and operational objectives were not always in line with the needs of the project. This led to delays in project implementation.

2. CIFOR, in consultation with FORDA, assumed primary responsibility for the design and execution of research activities within the project.

3. The people living in the area actively took part in the project through participatory mapping, provision of local data and information and other active collaboration in the project's implementation.

4. MOF and policy makers took part through their support for the project, anticipating the project outcome of the improvement of the TPTI. Where required, MOF retained overall responsibility for the policies and activities carried out in BRF.

5. PT Inhutani II was responsible for the management of its concession area, and provided facilities and its concession for the project, especially in the RIL experiment and subsequent implementation on a commercial scale.

6. ITTO member countries and the global community participated in the project through the provision of consultancies and research activities on subjects complementing the project. The project sites at Malinau district were also used as a site for testing a model of Integrated Natural Resources

e. Actions to be taken to avoid variations between planned and actual implementation (schedule, costs, etc.)

1. The following measures and actions taken could have avoided the above variations: (1) better project formulation and planning during the proposal preparation stage, which should have been based on the details in outputs, activities, personnel, travel, and budgets; and (2) better planning during implementation, including regular revisions of existing plans adjusted to prevailing situations and budgetary conditions.

2. The actions taken to overcome the problems include (1) use of national scientists instead of expatriates; (2) use of funds from other sources, i.e., the MacArthur grant and the CIFOR core budget, for research station facilities, personnel, equipment, and vehicles, and (3) modification of outputs and reduction of activities.

f. External factors that influenced the project implementation and that could have been foreseen

1. Insufficient skilled human resources and experts in East Kalimantan forced the project to hire them from Java, resulting in higher travel expenditure and other costs.

2 External monitoring and evaluation should have been undertaken continuously in order to avoid variations between planned and actual implementation and to take necessary actions should such variations exist.

3. Several field activities were still active until early August 2001, large amounts of biodiversity data needed additional verification and processing, the critical process of reaching agreement with the government and PT Inhutani II on participatory mapping and other ACM aspects required completion, and opportunities for developing agreements among communities needed documentation. Employing young national scientists, while enhancing their capability, has also required the additional support of more senior and experienced scientists in finalizing the work accomplished and translating this into English for final reports.

g. External factors that influenced the project implementation and that could not have been foreseen

1. The inability of the GOI to provide the counterpart budget resulted in a budget shortfall (which was compensated by funds from other sources) that led to a reduction of the number of outputs and activities, modification of the methods employed, and limited the number of FORDA staff participating in the project.

2. The financial constraints and unpredictable political situation led to the delay of several activities and hampered the progress of the project. Furthermore, the number of specialized consultants required to implement the field activities was far greater than planned, leading to higher - than - anticipated expenses for this budget line.

3. Dependence on the tight logging schedules of PT Inhutani II, availability of consultants and workers, unpredictable weather resulting in floods, late arrival of tractors and other factors led to the delay in the initiation and slowed down the progress of the project.

4. Relationships with stakeholders (including local communities, PT Inhutani II, local governments, and the different ethnic groups dealt with) were

aspects that have to be taken into account in the socio-economic and landscape studies. These have not only slowed down the activities but also resulted in unpredictable and high costs of operation, which have been felt particularly in the later stage of the project implementation.

5. Complementary financial contributions from CIFOR, the MacArthur Foundation, USAID, PT Inhutani II, PT Trakindo Utama/Caterpillar, IRD and IFAD helped a great deal in overcoming the budgetary shortfall, without which the project would have achieved less.

3.3. RECOMMENDATIONS FOR FUTURE PROJECTS

Similar recommendations appear in the Executive Summary, Section 1.5.

3.3.1. Identification

1. The project should support national and international commitments.

2. The specific objectives to be tackled should be relevant and in accordance with the criteria of sustainable forest management as defined by ITTO.

3. The selection of problems to be addressed should reflect the critical needs of the country but their solutions should have national and international applications and implications.

3.3.2. Design

1. It is important to develop a common vision among stakeholders of what sustainable forest management on a landscape scale for BRF should be and provide them opportunities for more participation in the planning and implementation of a project. Project formulation and planning should be prepared by CIFOR and FORDA in collaboration with other stakeholders.

2. The momentum of research generated in Phase 1 should continue and expand to achieve a more intensive understanding of the biophysical and socio-economic environments in the forest area.

3. Phase 2 should be built upon Phase 1, which has satisfactorily laid the foundations for these long-term sustainable forest management objectives through baseline data gathering and synthesis and the piloting of RIL as a better option to conventional logging.

4. Many of the needed inputs for a sustainable forest management plan for the BRF as a model forest, including all required base maps on current land use and forest cover as well as more precise topographic maps, can be completed in Phase 2, hence this plan should be the principal output projected.

5. A project plan should (i) design activities in detail during the formulation and prior to the implementation of a project and use them as a basis for budget allocation and monitoring of the progress of the project, and (ii) include a scheme for the dissemination of results of the project through the provision of guidelines, methods, scientific publications and reports in both English and Indonesian, as well as translation of scientific results into policy, management and practical application.

3.3.3. Implementation

1. Involvement of stakeholders and confirmed institutional commitments in project implementation will likely ensure the success of sustainable forest management and development of a model forest.

2. It is important to demonstrate how to incorporate sustainable forest management principles into the district spatial land use plan.

3. Implementation should be based on a workplan and carried out jointly by CIFOR and FORDA in collaboration with partners, under the supervision of PSC.

4. Stakeholders, such as PT Inhutani II and local governments, should be more involved in the execution of the project.

3.3.4. Organization

1. The project should have a competent coordinator who has a solid background in forest ecology and silviculture but has a multidisciplinary vision so that he or she is able to integrate the social and biophysical aspects of the project.

2. Effective coordination and organization among partners, stakeholders and other relevant institutions should be ensured.

3. The PSC should monitor the project continuously. It should be small yet effective and efficient and consist of professionals who will be able to be actively involved in the supervision of the project execution.

4. The PSC, scientists and policy makers should meet regularly to ensure the smooth execution of the project.

5. Throughout the implementation of the project, constant cooperation among ITTO, CIFOR, FORDA, MOF, PSC, scientists, local government, local people, partners and collaborators should be ensured.

3.3.5. Management

1. The Project Coordinator should manage and coordinate all activities, including financial management and periodic reporting. He or she should be a competent manager and scientist who has an interdisciplinary vision of the project and has an ability to deal with people from the lower level in villages to high officials elsewhere, as well as good contact with national and international scientists and scientific institutions.

2. The Project Coordinator should ensure a strong link between the different parties involved in the project and overview the gathering of baseline information.

3. The project would benefit from a project research assistant and a field project supervisor being seconded to the Project Coordinator and included in the overall budget of the project.

4. CIFOR senior scientists, together with FORDA scientists, should direct the research activities in the site in consultation with the Project Coordinator.

Responsible for the Report

Name	:	Kuswata Kartawinata
Position held	:	Project Coordinator
Date	:	20 January 2002
Signature	:	

Acronyms

ACIAR	Australian Centre for International Agricultural Research
ACM	Adaptive Co-Management
APHI	Asosiasi Pengusaha Hutan Indonesia (Indonesian Association of Forest Enterprises)
BAPPEDA	Badan Perencanaan Pembangunan Daerah (the Regional Development Planning Board)
BRF	Bulungan Research Forest
CD-ROM	Compact Disc Read Only Memory
CIFOR	Center for International Forestry Research
CIRAD	Centre de Coopèration Internationale en Recherche Agronomique pour le Dèveloppement
CNV	Conventional Logging
FAO	Food and Agriculture Organization
FORDA	Forestry Research and Development Agency
FPP	Forest Products and People
GEF	Global Environment Facility
GIS	Geographic Information System
GOI	Government of Indonesia
IFAD	International Fund for Agricultural Development
INRM	Integrated Natural Resources Management
INTAG	Inventarisasi dan Tata Guna Hutan (Forest Inventory and Land Use)
IRD	Institut de Recherche pour le Dèveloppement
ITTC	International Tropical Timber Council
ITTO	International Tropical Timber Organization
KMNP	Kayan Mentarang National Park
LIPI	Lembaga Ilmu Pengetahuan Indonesia (Indonesian Institute of Sciences)
MLA	Multidisciplinary Landscape Assessment
MOF	Ministry of Forestry
NGO	Non-Governmental Organization
NTFP's	Non Timber Forest Product
PD	Project Document
PEMDA	Pemerintah Daerah (Local Government)
PSC	Project Steering Committee
PSP	Permanent Sample Plot
RIL	Reduced-Impact Logging
ROADENG	Road Engineering
SFM	Sustainable Forest Management
SHK	Sistem Hutan Kerakyatan (Community Forestry System)
STREK	Silvicultural Treatment for the Regeneration of logged-over Forest in East Kalimantan
TFF	Tropical Forest Foundation
TPTI	Tebang Pilih dan Tanam Indonesia (the Indonesian Selective Cutting and Planting System)
UNESCO	United Nations Educational, Scientific and Cultural Organization
USAID	United States Agency for International Development
WCS-IP	Wildlife Conservation Society - Indonesian Program
WWF	World Wide Fund for Nature

Annexes (In CD-ROM)

Annex 1. Mid-term Review Report.

Annex 2. Minutes of the Steering Committee Meetings.

Annex 3. List of Publications and Unpublished Reports of ITTO Project PD 12/97 Rev.1(F): Forest, Science and Sustainability: The Bulungan Forest Model.

Published articles are listed by their titles.
The full texts of unpublished reports can be accessed by clicking the titles

A. LIST OF PUBLICATIONS

I. Output 1.1 - 1.4: Effect of Reduced Impact Logging

a. Published articles

1. Chabbert, J. and H. Priyadi. 2001. Exploitation a Faible Impact (EFI) dans une foret a Borneo. Bois et Forets des Tropiques, 269: 83-86.

2. Dwiprabowo, H. 1999 Reduced Impact Logging Research in Malinau Concession, Bulungan, East Kalimantan. Proceedings of Regional Consultation on Implementation of Codes of Logging Practice and Directions for the Future, 12-16 July 1999, Port Vila, Vanuatu. Pacific Islands Forest and Trees Support Programme.

3. Dwiprabowo,H. 1999 Reduced Impact Logging: Felling and Skidding Productivity in Malinau Concession, Bulungan. Exposé of Research Results of International Cooperation Projects, 24-25 November 1999, Jakarta. Forestry and Estate Crops Research and Development Agency, Ministry of Forestry and Estate Crops. p:121-130.

4. Elias, G.B. Applegate, K. Kartawinata, Machfudh and A. Klassen. 2001. Reduced Impact Logging Guidelines for Indonesia. ITTO/CIFOR/MoF/ MacArthur/INHUTANI II. Bogor.114 p.

5. Elias, G.B. Applegate, K. Kartawinata, Machfudh and A. Klassen. 2001. Pedoman Reduced Impact Logging Indonesia. ITTO/CIFOR/MoF/ MacArthur/INHUTANI II. Bogor. 114 p.

6. Machfudh and H. Dwiprabowo. 2000. Teknik Penebangan Hutan yang Tepat, Benar dan Efisien. Bulletin Bappeda Kaltim Vol II(12):1-6.

7. Machfudh, P. Sist, K. Kartawinata and Efransjah. 2001. Changing Attitute in the Forest: A Pilot Project to Implement RIL in Indonesia Has Created Enthusiasm for the Practice Amongst Concessionaires. The Tropical Forest Update 11(2):10-11.

8. Sist, P., D. Dykstra, and R. Fimbel. 1998. Reduced Impact Logging Guidelines for Lowland and Hill Dipterocarp Forest in Indonesia. Bulungan Research Report Series No. 1a. CIFOR, Bogor, Indonesia.

9. Sist, P., D. Dykstra, and R. Fimbel. 1998. Pedoman Pembalakan Berdampak Rendah untuk Hutan Dipterocarpa Lahan Rendah dan Bukit di Indonesia. Research Report Series No. 1b. CIFOR, Bogor, Indonesia.

10. van Niewstadt, M.G.L., D. Sheil, and K. Kartawinata. 2001. The Ecological Consequences of Logging in the Burned Forest of East Kalimantan, Indonesia. Conservation Biology 15:1183-1186.

b. Submitted Articles

11. Sist, P., K. Kartawinata, H. Priyadi, and D. Sheil. Reduced-Impact Logging in Indonesian Borneo: Some Results Confirming the Need for New Silvicultural Prescription. Forest Ecology and Management.

12. Sist,P., R. Fimble, R. Nasi, D. Sheil and M-H. Chevallier. Sustainable Management of Mixed Dipterocarp Forests Needs More Ecological Rules than a Minimum Diameter for Harvesting. Ecological Application.

c. Articles in Preparation

13. Kartawinata,K., P. Sist, and S. Ridwan. Floristic Composition and Structure of a Dipterocarp Forest at Malinau, East Kalimantan, Indonesia. CIFOR, Bogor, Indonesia.

II. Outputs 1.5 – 1.6: Biodiversity and Multiple Landscape Assessments (MLA)

a. Published Articles

14. Sheil, D. and van Heist, M.2000. Ecology for Tropical Forest Management. International Forestry Review 2: 261-270.

15. Sheil, D. J. A. Sayer, and T. O'Brien. 1999. Tree Diversity and Conservation in Logged Rainforest. Science 284:1587.

16. Sheil, D. 1999. Tropical Forest Diversity, Environmental Change amd Species Augmentation after the Intermediate Disturbance Hypothersis. Journal of Vegetation Science, 10: 851-860.

17. Sheil, D. 2000. Conservation and Biodiversity Monitoring in the Tropics: Realities, Priorities and Distraction. Conservation Biology 15:1179-1182.

18. Sheil, D., R. K. Puri, I. Basuki, M. van Heist, Syafeuddin, Rukmiyati, M. A. Sardjono, I. Samsoedin, K. Sidiyasa, Chrisandini, E. Permana, E. M. Angi, F. Gatzweiler, A. Wijaya, with the help from the people of Paya Seturan, Long Lake, Rian, Langap, Laban Nyarit, Long Jalan, Lio Mutai and Gong Solok. 2002. Exploring Biological Diversity, Environment and Local People's Perswpective in Forest Landscapes - Methods for a Multidisciplinary Landscape Assessment. ITTO, CIFOR and MOF.

b. Articles in Press

19. Sheil, D., Ducey, M.J., Sidiyasa, K., Samsoedin, I. (in press). A New Type of Sample Unit for the Efficient Assessment of Diverse Tree Communities in Complex Forest Landscape. Journal of Tropical Forest Science.

c. Submitted Articles

20. Watt, A., D. Sheil, A. Watt, O. Phillips, A. Newton, D. Moss, C. Lyal, A. Lowe, V. Kapos, S. Jones, J. Hall, J. Healey, W. Hawthorne, A. Gillison, N. Garwood, and P. Eggleton. (submitted). Towards Better Methods of Rapid Biodiversity Assessment in Tropical Forests.

d. Articles in Preparation

21. Sheil, D. and S. Wunder. (in preparation). The Value of Tropical Forest to Local Communities: A Comment.

III. Outputs 2.1 – 2.2: Resilience, Susceptibility and Response of Forest Use

a. Published Articles

22. Katz. E. 1997. NWFPs in Bulungan, E. Kalimantan, Indonesia. *In*: Mittleman, A. J., Chun K. Lai, N. Byron, G. Mihon, and E. Katz. Non-wood Forest Products Outlook Study for Asia and the Pacific: Towards 2010. FAO-RAPA, Bangkok.

23. Kuhn, C., E. Katz, and P. Levang. 2001. At Home in the Forest: The Punan People of the Malinau River. CIFOR, Bogor, Indonesia.

24. Obidzinksi, K., I. Suramenggala, and P. Levang. 2001. L'Exploitation Forestiere Illegale en Indonesie: Un Inquetant Processus de Legalisation Bois et Forets des Tropiques No. 270(4): 85-97

b. Articles in Press

25. Karskija, L. Punan Malinau and the Bulungan Research Forest – A Research Report. CIFOR, Bogor, Indonesia.

c. Articles in Prepararation

26. Issoufaly, Hatim, and Yusuf Tarigan. Agro-economic surveys in Long Jalan, Tanjung Nanga, Langap, Pulau Sapi and Respen Sembuak. CIFOR, Bogor, Indonesia.

IV. Outputs 2.3: Rural Development Trend and Future Scenario

a. Published Articles

27. CIFOR. Proses dan Hasil Lokakarya Pemetaan Masyarakat Hulu Sungai Malinau dengan CIFOR: Laporan Singkat. Informal Newsletter for Malinau Community No. 1, Nopember 1999. CIFOR, Bogor, Indonesia.

28. CIFOR. Kabar dari Tim Pendamping Pemetaan Desa Partisipatif Hulu Sungai Malinau. Informal Newsletter for Malinau Community No. 2, Juni 2000. CIFOR, Bogor, Indonesia.

29. CIFOR. Kabar dari Tim Pendamping Pemetaan Desa Partisipatif Hulu Sungai Malinau. Informal Newsletter for Malinau Community No. 3, Agustus 2000. CIFOR, Bogor.

30. CIFOR. Kabar dari Tim Pendamping Pemetaan Desa Partisipatif Hulu Sungai Malinau. Informal Newsletter for Malinau Community No. 4, Oktober 2000. CIFOR, Bogor.

31. CIFOR. Kabar dari Lokakarya Membangun Agenda Bersama II: Setulang, 4-6 Desember 200. Informal Newsletter for Malinau Community No. 5, Januari 2001. CIFOR, Bogor.

32. CIFOR. Kabar dari Tim Pendamping Pengelolaan Hutan Bersama Hulu Sungai Malinau. Informal Newsletter for Malinau Community No. 6, September 2001. CIFOR, Bogor, Indonesia.

33. Rhee, S. 2000. Adaptive Co-Management of Forests: How Powerful Stakeholders Represent Local Communities. TRI News: Annual Review of the Tropical Forestry Resources Institute, Yale School of Forestry and Environmental Studies, vol. 19: 10-14.

34. Sellato, B. 2001. Forest, Resources, and People in Bulungan. Elements for a History of Settlement, Trade, and Social Dynamics in Borneo, 1880-2000. CIFOR. Bogor. Indonesia.

35. Uluk, A., I. M. Sudana, and E.K. Wollenberg. 2001. Ketergantungan Masyarakat Dayak terhadap Hutan di Sekitar Taman Nasional Kayan Mentarang. CIFOR. Bogor. Indonesia.

36. Wollenberg, E. 2001. Incentives for Gaharu Collection in East Kalimantan. Economic Botany (June or September 2001 issue).

37. Wollenberg, E., A.S. Nawir, and A. Uluk. 2000. Income is not enough: The Effect of Economic Incentives on Forest Conservation. Working paper No. 22. CIFOR. Bogor. Indonesia.

38. Wollenberg, E., D. Edmunds, and L. Buck. 2000. Anticipating Change: Scenarios as a Tool for Increasing Adaptivity in Multi-Stakeholder Settings. CIFOR. Bogor. Indonesia. 38 p.

39. Wollenberg, E., D. Edmunds, and L. Buck. 2000. Using scenarios to make decisions about the future: anticipatory learning for the adaptive co-management of community forests. Landscape and Urban Planning 47(1), pp. 65-77.

40. Wollenberg, E., D. Edmunds, and L. Buck. 2001. Anticipating Change: Scenarios as a tool for adaptive forest management, a guide CIFOR, IFAD, ITTO and MOF. Bogor. 33 pp.

41. Wollenberg, E., D. Edmunds, and L. Buck. 2001. Mengantisipasi perubahan, skenario sebagai sarana pengelolaan hutan secara adaptif-suatu panduan CIFOR, IFAD, ITTO and MoF. Bogor. 33pp.

b. Articles in Press

42. Edmunds, D. and E. Wollenberg. A Strategic Approach to Multistakeholder Negotiations. Development and Change.

43. Edmunds, D. and E. Wollenberg. Historical Perspectives on Forest Policy Change in Asia: Finding Explanations for Why Devolution hasn't met Expectation. Environmental History.

44. Wollenberg, E. and H. Kartodihardjo. (in press). Devolution and Indonesia's New Basic Forestry Law. In Colfer, C., and D. Resosudarmo (edits). Indonesian Policy in the Marking. Resources for the Future.

c. Submitted Articles

45. Tim Pengelolaan Hutan Bersma Secara Adaptif and L. Buck. (Submitted). Pemetaan Desa Partisipatif sebagai alat menyelesaikan konflik studi kasus desa-desa derah aliran sungai Malinau. Landscape and Urban Planning. (accepted).

d. Articles in Preparation

46. Wollenberg,E. Accomodation of Multiple Stakeholders. International Journal for Agriculture, Governance and Ecology. Special issue.

B. UNPUBLISHED REPORTS

(Full Text can be accessed by clicking the title)

I. Output 1.1 – 1.4: Effects of Reduced Impact Logging.

1. Dwiprabowo, H., S. Grulois, P. Sist, and K. Kartawinata. Cost-benefit Analysis of Reduced-Impact Logging in Malinau concession, Bulungan, East Kalimantan. CIFOR, Bogor, Indonesia.

2. Klassen, A. W. Procedures for Topographic Forest survey. CIFOR, Bogor, Indonesia.

3. Klassen, A. W. Prosedur Survei Topografi Hutan. CIFOR, Bogor, Indonesia.

4. Klasson, Bernt. Felling Guidelines for Reduced Impact Logging in Tropical Moist Foresty. CIFOR, Bogor, Indonesia.

5. Klasson, Bernt. Pedoman Penebangan Untuk Pembalakan Berdampak rendah di Hutan Tropika Basah. CIFOR, Bogor, Indonesia.

6. Machfudh, P. Sist, H. Dwiprabowo, K. Kartawinata and H. Priyadi. Comparison between Conventional and Reduced Impact Logging in the Bulungan Research Forest Project, A poster presented in the International Conference on the Application of RIL to Advance Sustainabke Forest Management: Constraints, Challenges and Opportunity, 26 February –1 March 2001, Kuching Sarawak, Malaysia.

7. Machfudh, K. Kartawinata, H. Priyadi, D. Sheil, and P. Sist. Field Guide to Permanent Sample Plots in the Conventional Logging Block (Petak 28 and 29), Malinau Concession. CIFOR, Bogor, Indonesia.

8. Machfudh, K. Kartawinata, H. Priyadi, D. Sheil, and P. Sist. Field Guide to the Permanent Sample Plots in the Reduced Impact Logging Block (Petak 27), Malinau Concenssion. CIFOR, Bogor, Indonesia.

9. Priyadi, H. Growth, Mortality and Regeneration in RIL and Conventional Logging Areas. CIFOR, Bogor, Indonesia.

10. Provendier, D. Occurrence, Structure and Impact of Logging on Regeneration of *Agathis borneensis* in a Mixed Dipterocap Forest of East Borneo (Bulungan district). (Supported by other sources). CIFOR, Bogor, Indonesia.

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