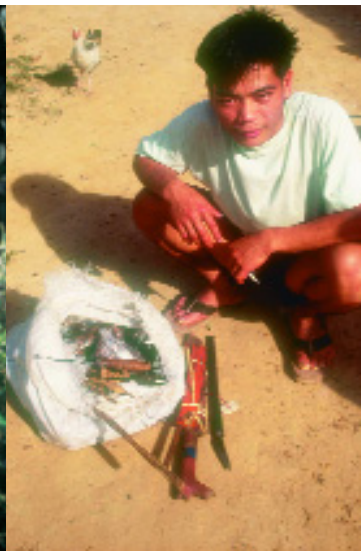
Income is Not Enough: The Effect of Economic Incentives on Forest Product Conservation

A comparison of forest communities dependent on the agroforests of Krui, Sumatra and natural dipterocarp forests of Kayan Mentarang, East Kalimantan

Eva Wollenberg, Ani Adiwinata Nawir, Asung Uluk and Herry Pramono



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All photographs were taken by Eva Wollenberg

Published by
CENTER FOR INTERNATIONAL FORESTRY RESEARCH
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Table of Contents

Acknowledgements iv
Preface v

1. Introduction: Purpose and Research Questions 1
1.1 The problem 1
1.2 Purpose 2
1.3 Explaining the influence of economic incentives on conservation: A framework for analysis 2
1.4 Structure of the report 6

2. Research Methods 7
2.1 Research design 7
2.2 Partners 7
2.3 Village selection 8
2.4 Data collection 8
2.5 Data analysis 10

3. Overview of Krui and Kayan Mentarang 13
3.1 Introduction 13
3.2 Overview 13
3.3 Kayan Mentarang 17
3.4 Summary 23

4. Local Forest Management at the Study Sites 25
4.1 Krui 25
4.2 Kayan Mentarang National Park 33
4.3 Summary 40

5. Income Levels and Dependence on the Forest 41
5.1 Introduction 41
5.2 Definitions 41
5.3 Other studies on forest income 41
5.4 Income levels 43
5.5 Household income sources 44
5.6 Changing livelihoods 49
5.7 Summary 50

6. The Influence of Economic Incentives on Damar and Gaharu Harvesting 53
6.1 Introduction 53
6.2 Indicators of damar conservation 53
6.3 Indicators of gaharu conservation 54
6.4 Causal pathways: linkage of economic benefits to conservation 54
6.5 Explanatory value of economic incentives for damar conservation in Krui 55
6.6 Explanatory value of income incentives for gaharu conservation in Kayan Mentarang 62
6.7 Income incentives and gaharu use 62

7. Conclusion 73

References 77

Tables

Table 2.1	Households sampled for income survey	9
Table 3.1	Conditions in Krui and Kayan Mentarang	24
Table 4.1	Agroforest conditions in villages surveyed, Krui	25
Table 4.2	Population characteristics, Krui	26
Table 4.3	Wealth distribution based on land-based and cash income-based criteria, Krui 1995-96	27
Table 4.4	Tenure and acquisition of *repong*, Krui	28
Table 4.5	Tenure of *repong*, Krui	28
Table 4.6	Livelihood sources based on *repong*, using locally defined wealth categories	29
Table 4.7	Division of ownership, management and use rights, Krui	30
Table 4.8	*Repong* management, Krui	31
Table 4.9	Population characteristics, Kayan Mentarang	34
Table 4.10	Gaharu collecting trips per household and days per trip	37
Table 5.1	Summary of findings from studies of incomes of forest communities	42
Table 5.2	Total and forest household income levels, Krui and Kayan Mentarang 1995-96	43
Table 5.3	Household income sources, Krui	44
Table 5.4	Average household income by source, Krui (Rp. 000)	45
Table 5.5	Damar resin collection income, Krui	46
Table 5.6	Households income sources, Kayan Mentarang	47
Table 5.7	Average household revenues by source, Kayan Mentarang (Rp. 000)	48
Table 5.8	Gaharu income and revenue, Kayan Mentarang	49
Table 6.1	Income incentives and conservation in Krui for households with only close *repong*	56
Table 6.2	Income incentives and conservation in Krui for households with only distant *repong*	57
Table 6.3	Conserver and nonconserver households by wealth (cash-based)	58
Table 6.4	Round-trip travel time between *repong* and house (hours)	59
Table 6.5	Value of rice production per household, Penengahan and Melaya (Rp. 000)	60
Table 6.6	Relationship between income incentives and conservation, Kayan Mentarang	63
Table 6.7	Costs and returns to labour from gaharu income per household	66
Table 6.8	Expenses among gaharu-collecting households	68
Table 6.9	Major sources of income for gaharu- and non-gaharu collecting households	69
Table 6.10	Household gaharu income per trip	70
Table A2.1	Mean harvest periods in Penengahan and Melaya	91
Table A2.2	Frequency of *repong* per household	91
Table A2.3	Repong traits for conserver and nonconserver households in close damar gardens	92
Table A2.4	Repong traits for conserver and nonconserver households in distant damar gardens	92

Figures

Figure 1.1	Value of income in the household economy	5
Figure 3.1	Map of villages surveyed – Krui	14
Figure 3.2	Map of villages surveyed – Kayan Mentarang	19

Annexes

Annex 1	Sketch maps of sample *repong* holdings from Krui	83
Annex 2	Notes for calculation of conservation indicators	91

Acknowledgements

This project benefited from the assistance and insights of many people. For the work conducted in Krui, the authors would like to thank Geneviève Michon, Hubert de Foresta, Iwan Tjitradjaja, Zulkifli Lubis, Amir Nadapdap, Ahmad Kusworo, Iwan Kurniawan, Abdi Wasik Ali, Rasidin, Rozi Maesa Putra, Almuhery, Mahmilawati, Afrida, Rachmat, Religius Helman, Edy Karizal, Hazairin, Chip Fay, Tim Krui, Meriem Bouramrane, Jadri and the people of Penengahan, Melaya and Negeri Ratu Ngaras who participated in the research.

For the work conducted in Kayan Mentarang the authors express their thanks to the staff of the World Wild Fund for Nature-Kayan Mentarang Project, especially Godwin Limberg, Cristina Eghenter, Njau Anau, Dolvina Damus, Samuel ST Padan, Trivina Adjang, Irang Lawing, An Lenjau, Daud Lalo, Octavius, Normanus, Tim Jessup and Frank Momberg. We also thank Bernard Sellato, Rajindra Puri, Anye Apui, Adjang Apui, Tonny Soehartono and the people of Apau Ping, Long Alango and Pujungan.

For general advice, critique, editing and support of the project we thank Hans Gregerson, Ricardo Godoy, Scott Guggenheim, Ambar Liano, Dina Hubudin, Yvonne Byron, the Biodiversity Conservation Network, Mary Ames, Susan Hussey, Neil Byron, Kuswata Kartawinata and Wil de Jong.

CIFOR and USAID provided the funds to support the research.

Preface

This paper describes the results of research conducted under CIFOR's Local People, Livelihoods and Devolution Project from 1995 to 1997. Although the research has been reported in a number of publications (Wollenberg and Nawir 1998; Wollenberg and Uluk 1998; Uluk and Wollenberg 1998; Tim Studi CIFOR, Watala, Universitas Indonesia 1999; Wollenberg 1999a, b, c), these have dealt with specific sites or aspects of the overall project. To address the central questions that initially drove the research and reflect the integrity of the original research design, the project members felt it important to also produce a single publication describing the overall research purpose and results for all the study sites.

We found this to be a challenging objective. From our survey data we were unable to rigorously test some of the more complex and interesting relationships among incomes, forest use and livelihoods that emerged from the fieldwork, and thus could only draw a number of tentative conclusions that require further testing. For a number of reasons, it was not possible to follow up with additional research. In producing this paper, we have therefore tried to strike a compromise by making the data and analysis available to a wider audience, while issuing the caveat that many of the points in the discussion should be considered informed hypotheses rather than conclusive findings. We hope that the paper will nevertheless serve to stimulate discussion and draw attention to the very important question of how forest-based incomes affect incentives for conservation.

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Income is Not Enough: The Effect of Economic Incentives on Forest Product Conservation

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Summary

Data from damar agroforest and hill dipterocarp forest sites in Indonesia suggest that income alone is inadequate for explaining why people conserve a non-timber forest product. The explanatory value of several cash income-based indicators was tested and the results showed that these indicators provide only a partial explanation of people's conservation behaviour. Instead, an understanding based on how the income potentially drives a conservation action, expectations about the role of the income in the household economy, and social values, capacities and institutions provides a more complete picture of how economic incentives affect people's harvesting behaviour. We found that an income source was more likely to be valued in the future to the extent that (1) the income from the product provided a source of food security rather than supplemental income; (2) the income from the product was used for specific purposes not easily substituted by other sources of cash; (3) there were not other cash sources available; (4) the income from the product was stable and low risk; and (5) there was an identity, value or status associated with maintaining the income from that product. We conclude that the single most important related policy intervention to achieve conservation is to provide the stability of conditions that enables people to expect the income source to be important into the future.

1. Introduction: Purpose and Research Questions

1.1 The problem

As natural forest areas decline and the commercial economy expands, livelihood options for forest-dwelling people are in a period of transition. Purchased goods are replacing items previously self-produced or traded through barter. Cash incomes are being sought to expand and diversify the household economy or to enable children to acquire education. In areas where forest resources are degraded or protected, villagers are seeking income sources compatible with forest regeneration and conservation. Although people living in forests have been engaged in market trade for centuries, the needs and opportunities for cash incomes are now greater than ever. Understanding local people's economic strategies and providing support for income generation are therefore attracting attention as a potentially important approach to meeting both rural development and conservation objectives.

Despite this increasing interest in the economies of forest dwellers, competing hypotheses have emerged about the incentives created by forest-based incomes and the impacts of related behaviour on the condition of the forest. On the one hand, it is assumed that people who value the forest will not destroy it. Cash incomes derived from forests are seen as one way of creating incentives for people to protect the resource and provide for its long-term management (McNeely 1988; de Beer and McDermott 1989; Peters *et al.* 1989; Nepstad and Schwartzman 1992; Panayotou and Ashton 1992; BCN 1997; Clay and Clement 1993; Evans 1993; Clay 1996; Peters 1996). These efforts focus on increasing the level of benefits available to forest dwellers from low-impact forms of forest use.

On the other hand, it has been difficult to demonstrate that income-generating uses of the forest do not ultimately increase incentives for further extraction, both locally and from outside entrepreneurs. Readily available profits encourage rapid exploitation and increases in market value can lead to higher levels of use

and competition (Dove 1993). Understanding the conditions under which incomes create incentives either for conservation or for overuse is important if income generation is to be promoted as a means of simultaneously addressing livelihood and conservation needs (Crook and Clapp 1998; Uphoff and Langholtz 1998; Wunder 1999)

1.2 Purpose

The purpose of this research is to advance understanding about the incomes of forest villagers and to better explain the conditions under which forest-based income creates incentives to conserve or exploit forest products.

1.3 Explaining the influence of economic incentives on conservation: A framework for analysis

> Economic inducements are likely to prove the most effective measures for converting overexploitation to sustainable use of biological resources. Conservation needs to be promoted through the means of economic incentives (McNeely 1988).
>
> Clearly, the best way to protect the viability of forest communities and to ensure the future of their resources is to expand the market for rainforest products (Baker 1989).

Statements such as these reflect an assumption that has become increasingly popular over the last decade: economic incentives can encourage people to engage in conservation. While economic incentives certainly influence villagers' forest management, the effect of those incentives is often unclear. In the course of our work and in reviewing the literature, we found three factors influenced the impacts of economic incentives. These reflected the relationship of the income to its conservation, to livelihood and to social contexts:

- The link between economic incentives and overcoming conservation threats or undertaking conservation actions.
- The role of economic benefits that are derived from the income, in the context of villagers' livelihoods.
- The social values, institutions and capacities mediating the effects of economic incentives.

To address these factors, we propose that three corresponding kinds of information are necessary to predict the effect of economic incentives: (1) identification of the plausible causal link between the income and the incentive it creates for a specific conservation activity; (2) an understanding of people's expectations of the future importance of the income, including trade-offs; and (3) an appreciation of the role of non-economic incentives or conditions as mediating influences on economic incentives. We use these information requirements to provide a framework for assessing the impacts of economic incentives.

We define conservation as *actions taken in the management of a forest that result in maintenance of the possibilities for future forest-related benefits*. For non-timber forest products (NTFPs), conservation means the sustainable management of the species for the product it yields in order to ensure availability in the future. As management aims may differ among stakeholders, it is necessary to define conservation relative to an interest group. Conservation is then actions that reduce use of the species, reduce threats to its sustainable management or improve the long-term abundance or quality of the species. They often require trade-offs between future and present benefits. We are therefore interested in incentives for *active* conservation, where we feel the need is most urgent, rather than passive conservation, which occurs where threats are so low or non-existent that the resource persists without management interventions. We assume that forest use reflects management decisions, and therefore employ the terms 'forest use' and 'management interchangeably'.

Plausible causal links

The impact of an incentive on conservation can be understood in terms of the logical path of cause-and-effect relationships by which the value attached to an income motivates people to engage in a conservation activity. Little attention has been given to recognising these paths or that multiple paths can occur for a single income source. A review of existing work suggests that three types of paths are useful for predicting conservation of NTFPs. Incentives can affect preferences about *which product* is to be harvested, *how much* is harvested and *who* is involved in managing the product. At least five examples have been reported in the literature:

1. High value associated with a low environmental-impact NTFP creates incentives to shift away from forest uses that have higher environmental impacts, like timber harvesting (Peters *et al.* 1989; Godoy *et al.* 1995; Melnyk and Bell 1996) *(which product)*.
2. High NTFP value encourages protection of the product's habitat and hence biodiversity conservation, provided that secure tenure and management capacities exist (Freese 1994; BCN 1997) *(how much)*.
3. A decline in NTFP value encourages extractors who still depend on the resource to over-harvest in order to maintain previous income levels (Browder 1992) *(how much)*.
4. High NTFP value leads to appropriation by elites and over-exploitation by all users in common-property systems if rules and enforcement are not sufficiently strong (McElwee 1994) *(how much* and *who)*.
5. High NTFP value attracts additional harvesters, especially outsiders and elite, more powerful interests (Dove 1993) *(who)*.

To be linked to conservation, the benefits associated with the income should create incentives appropriate to the desired management aim and threats. Two types of causal links lead to conservation: (1) incentives derived from conservation activities that produce income; and (2) incentives to trade off present for future benefits. Trade-offs require foregoing a benefit now, delaying that benefit or investing in inputs in the present to enhance benefits from the resource later.

Because of the relatively low density of most products in tropical forests, the value of NTFPs is unlikely to have a clear cause-and-effect link for conservation of forests as a whole, except where, for example, there are products from large mammals that depend on the protection of extensive areas of habitat (Salafsky and Wollenberg 2000). Rather, most NTFP harvesting is likely to degrade forests and simplify the ecosystem through efforts to increase the density of desired species (Crook and Clapp 1998). The focus of this report is therefore on the conservation of single resources and their products, which is where we suggest the impacts of economic incentives are more likely to be occur. Efforts to conserve forests on a wider scale have to consider non-incentive-based approaches or economic incentives associated with larger-scale activities such as ecotourism, protected research areas, carbon storage or biodiversity prospecting (see Salafsky and Wollenberg 2000 for a more extensive discussion).

Before cause-and-effect linkages can be analysed, however, resource-management aims and threats to those aims need to be identified. This is no small challenge. Objectives as diverse as protection of large mammals, maintaining forest cover or sustaining ecotourism profits, and threats as varied as over-harvesting due to open-access tenure, conversion to agriculture and the introduction of competitor species, require targeted, appropriate interventions. The geographic scale of conservation should be established. It is also not always clear *whose* objectives of forest management are at stake and how competing objectives should be reconciled. To identify threats and interventions requires knowledge of the capacity of the resource to tolerate disturbance and to regenerate, and an understanding of the impacts of interventions (Peters 1994; Crook and Clapp 1998). Without this understanding of aims and threats, it is difficult to draw conclusions about the role of income incentives.

Where income incentives lead to over-exploitation, the value of a product may itself be considered a threat to the conservation of the resource and will require countervailing incentives and actions. It is thus

possible for two or more causal paths to be in effect at the same time, which requires disentangling influences and feedback loops to identify the most significant conservation threats and incentives.

Depending on the management aim, multiple incentives may be needed, since threats often originate from multiple sources, both inside and outside a forest management system. Incentives may be necessary at both the level of the individual and the group (Pretty and Scoones 1989) and at different scales (Wells 1998).

The expected future importance of the income

High value will lead to purposeful maintenance of a forest product only where the **expected future importance** of the income is higher than its present worth. Again, a desired conservation outcome must be defined.

The concept of expected importance has two implications that depart from conventional approaches for assessing forest incomes: (1) consideration of the income in the context of the broader household economy; and (2) assessment of future rather than present value. Both have been overlooked in much of the current NTFP literature. Instead, there has been a tendency to explain or predict people's conservation actions as the net present monetary value of the returns to land or labour (Caldicott 1988; Peters *et al.* 1989; Hecht 1992; Gunatilake *et al.* 1993; Godoy *et al.* 1995; Melnyk and Bell 1996). Although a single dollar figure has the power of simplicity, it can be an oversimplification of the many factors influencing people's economic decisions. Current monetary value is important, but not sufficient to explain economic incentives.[1]

When household importance and future value are taken into account, *harvesting decisions rest upon an assessment of the importance of an income now against the importance of the income in the future*, assuming other conditions are equal. Importance is determined not only by the expected monetary value of the income, but also by the cultural value of the income source, anticipated household needs, the function of the income in the livelihood, economic capacities and strategies, present income sources and the availability of future alternatives to that income source (Figure 1.1).

Expected importance will be higher to the extent that the income functions to meet basic survival needs. Thus, products providing food security will be ranked higher than those providing supplemental cash. Villagers can be expected to protect the productivity of a forest species (or ecosystem) now to the extent that they expect to receive higher future benefits, expect few or no future alternatives of greater value to the household or where their future benefits depend on reducing benefits now. Villagers can be expected to use a forest product (or forest area) more in the case where they want to meet present needs at the risk of not meeting future needs or expect future alternatives to arise that yield higher value to the household

The concept of expected importance underscores the trade-offs people make between alternatives now and in the future. The trade-offs are interpreted according to a multidimensional measure of household importance, which is proposed here as a more realistic, albeit more complex, indicator of people's preferences than monetary value.

[1] We distinguish the concept of future expected importance from expected value used in economics. The latter translates value into current monetary values based on people's rate of time preferences (a discount rate). Our concept refers to whether people think they will use an income in the future and for what purpose.

Figure 1.1 Value of income in the household economy

I. Importance
   A. Cultural importance: meaning of the income and impact on people's identity, effect on social status
   B. Economic function of the income in the household: Which economic needs are met?
      1. Significance of the income to basic survival
      2. Contribution of the income to
         - cash needs/supply
         - food needs/supply
         - other consumption needs (shelter, clothing)
         - accumulation or savings
         - status
      3. Frequency and ease of availability or accessibility of the income, e.g., regular versus one-time income
      4. Relevance of the income to household needs – 'fit' with security and diversification, stage of household cycle, anticipated economic trends
      5. Complementary or synergistic role with other incomes, e.g., cash income to purchase fuel for small enterprise
   C. Monetary value of the income
      1. Absolute value
      2. Proportion of total household income

II. Substitutability in function or monetary value

Social values, institutions and capacities mediating the effects of economic incentives

Economic incentives, however, are only part of the picture. Social values, institutions and capacities are powerful influences that shape economic needs and strategies, provide competing incentives and mediate the influence of economic incentives. Together with economic incentives, these non-economic conditions create a context for behaviour that determines what people value as incentives (Pretty and Scoones 1989; Uphoff and Langholtz 1998). Social values can affect the cultural importance of the income in a household, as described above, by influencing the meaning of the resource, the identity of the people depending on it or their social status, as well as perceptions of obligations. As we discuss in later sections, damar cultivation in Krui provides an example of how strong the influence of social norms can be.

Two of the most important factors moderating the effect of economic incentives are the institutions and social capacity to manage a resource collectively. McElwee (1994) outlines how local common-property management institutions are likely to cope with the effects of forest-product commercialisation and high-value products. She notes that simple management rules are likely to be ineffective if the product has a high commercial value. Incentives for appropriating benefits from the product and not cooperating with others will be high, implying difficulty in enforcing rules. The elite, the state or outsiders are more likely to compete with local people where benefits are significant. Bribes or the use of force to escape the rules are more likely when large amounts of cash are at stake. McElwee notes that many local organisations do have the flexibility to adapt to conditions of changing markets and product value. To ensure sustainability, local institutions require not only this flexibility, but also the capacity to control access by different users, resolve conflicts, and distribute benefits. McElwee concludes that the intensity of commercialisation is a more important determinant of whether a resource will be managed sustainably than the fact of whether a product is commercially traded.

Summary

We propose that the level of income from a product is not enough to explain why people engage in conservation. Three types of information help understand the role of economic incentives in forest product conservation:

1. The incentive associated with a forest-based income is directly related to its importance in the household economy. Importance is reflected in the *(a) cultural importance attached to the income, (b) function of the income, (c) the monetary value of the income;* and *(d) the presence of alternatives.* Monetary value alone (expressed in various forms) is insufficient to explain how people value an income source.

2. Resource conservation will occur where the expected future importance of the income is as high or higher than its current importance, where all else is equal.

3. In addition to economic incentives, resource conservation depends on social values, institutions and capacities for managing the resource.

We explore the explanatory usefulness of this framework by investigating how income incentives influence forest management in two contrasting models of forest use, the cultivation of the damar agroforests of Krui and extraction from the natural dipterocarp forests of Kayan Mentarang.

For this study, we define conservation in terms of the goals of local villagers in Krui and Kayan Mentarang to sustain the production of damar and gaharu from their forests. In Krui, conservation of damar production requires maintenance of the damar tree, the protection of damar plantations from conversion for oil palm estates, and protection of claims to the land under the agroforests from the government forest department. In Kayan Mentarang, conservation of gaharu requires restricting collection, both internally and by outsiders, to protect current income opportunities. These aims and threats are discussed at greater length in the section describing the study sites. We measure conservation of a forest product by using a quantitative indicator, intensity of harvesting, in combination with qualitative information from local people's experiences about the impacts of this harvesting.

1.4 Structure of the report

Following this section, we first describe the methods used to conduct the study and the conditions at each of the study sites. We then report the findings from our survey about income levels during 1995-96 and villagers' dependence on forest income. In the final section we provide a more detailed review of incomes derived from damar and gaharu and apply the framework discussed here to understand the implications of these incentives for conservation. Some conclusions are drawn about the way income incentives are expected to function differently in agroforests and natural forests.

2. Research Methods

2.1 Research design

To test the hypothesis that income alone is not sufficient to explain conservation incentives, research was undertaken at two sites where: (1) forest-based incomes were significant and reliance on those incomes was high; (2) the forest was presumably managed sustainably; (3) notable outside threats to conservation of the forest existed – these would be the situations most challenging for sustainable management; and (4) local experiences were likely to be visible in policy arenas and thereby contribute to policy change. Within these constraints, the sites were selected to represent contrasting forest conditions for informing policy: an agroforest in a densely populated region relatively close to Jakarta and a natural forest with low population density remote from any major city and with relatively few economic alternatives.

The agroforest site selected was in the Pesisir district (*kecamatan),* an area also known as Krui, after the local market town in West Lampung, Sumatra. The agroforests in Krui yield significant cash income from a resin from the damar tree, *Shorea javanica*. The main threat to the agroforests has been their conversion to oil palm. There has also been a fear by some farmers of the loss of their rights to use land claimed by the Indonesian Forest Department. The natural dipterocarp forest site selected was in the Kayan Mentarang National Park, East Kalimantan, where forest products are used primarily for consumption by local people, and gaharu – a product of fungus-infected trees of *Aquilaria* sp. – is a major source of cash income. The main threats to gaharu in the natural forest are overuse by outside collectors and possibly also by local collectors. Both sites were selected within Indonesia for logistical reasons and in areas where research partners were already active.

2.2 Partners

At the agroforest site, the partner organisations most directly involved in the research were the University of Indonesia (UI) and Keluarga Pencinta Alam dan Lingkungan Hidup (WATALA), a Sumatra-based NGO. The UI team was led by Professor of Anthropology Iwan Tjitradjaja and graduate student Zulkifli Lubis, who conducted his master's thesis fieldwork in Krui in 1995 (Lubis 1996). WATALA staff provided field assistance in collecting data.

These efforts were with the input of and in coordination with 'Team Krui,' a consortium formed in 1994 to facilitate the sharing of research and information among the several organisations engaged in activities in the Krui area and interested in identifying models for sustainable community-based forest management. The consortium includes the International Centre for Research in Agroforestry (ICRAF), Office pour la Recherche Scientifique et Technique d'Outre-mer (ORSTOM), Center for International Forestry Research (CIFOR), University of Indonesia, Lembaga Alam Tropika Indonesia (LATIN), WATALA, the Forest Research Institute of Indonesia (LITBANG Kehutanan), and the Ford Foundation. The study was seen as one means to support policy reforms in favour of community-based management. The survey results may also be useful in monitoring the effects of a 1998 ministerial decree awarding long-term cultivation rights to the Pesisir farmers.

In contrast, at the national park site the primary research partner was the World Wide Fund for Nature Indonesia Program (WWF-IP), with most collaboration directly though its Kayan Mentarang Project. A related study on income from the *mata kucing* fruit (see Puri 1998) was conducted by an East-West Center postdoctoral fellow, Rajindra Puri, who also worked closely with WWF-KM. WWF has been active in the Kayan Mentarang area since 1990 with the objective of establishing national park status for the area (previously a nature reserve), which would enable local people to continue to live and conduct their livelihoods within the boundaries. Since national park status was declared in October 1996, WWF

has undertaken preparation of a management plan. This study was designed to provide input for the management plan – to indicate levels of forest dependence and the current status of villagers' incomes. It may also be used for monitoring changes that result from implementation of the management plan.

Researchers participating in the study (in addition to the authors of this report) included:

Krui
University of Indonesia: Iwan Tjitradjaja, Zulkifli Lubis
WATALA: Iwan Kurniawan, Abdi Wasik Ali, Rasidin
Survey Team: Rozi Maesa Putra, Almuhery, Mahmilawati, Afrida, Rachmat, Religius Helman, Edy Karizal, Hazairin

Kayan Mentarang
WWF: Godwin Limberg, Cristina Eghenter, Rajindra Puri
Survey Team: Asung Uluk, Njau Anau, Dolvina Damus, Samuel ST Padan, Trivina Adjang, Irang Lawing, An Lenjau, Octavius, Normanus

2.3 Village selection

Within each site two villages were selected for in-depth study, one where the forest was reputed to be in better condition supported by conservation behaviour, and the other where the forest was more degraded with less conservation behaviour. These villages were studied over the course of 12 months at each site. In Krui the villages were Penengahan and Melaya respectively, while in Kayan Mentarang they were Apau Ping and Long Alango.

In addition to these in-depth studies, additional villages were surveyed to broaden the representation of village types in the research. In Krui the village added for the survey was Negeri Ratu Ngaras, and in Kayan Mentarang the other villages added were Long Pujungan, Paking and a set of hamlets in the Krayan district. The survey was used to collect information about sources of income and forest management practices.

2.4 Data collection

Case studies, surveys and key respondent interviews were conducted between January 1995 and April 1997.

Case studies

Case studies in Melaya and Penengahan were initiated 1 October 1995. Twelve households (six in each village) were selected to reflect a cross-section of poor, medium and better-off households that cultivated damar. It was assumed that differences in wealth would be roughly associated with differences in livelihood strategies. The households were interviewed every two weeks about their income-generating activities and agroforest management. Life histories and sketch maps of landholdings were constructed for each household. In March 1996, the case studies were adjusted to provide a total of 20 households, 10 each in Penengahan and Melaya. These were continued until June 1996. Several households had to be replaced because they either moved or were no longer interested in participating. The criteria for determining wealth categories were based on locally defined wealth.

Case studies in Long Alango and Apau Ping were initiated in June 1995 and continued until April 1996. As transportation among these sites was expensive and required hazardous river travel, visits were scheduled

to occur once a month. Local logistical difficulties resulted in visits being made only about once every 2½ months. Interviews were conducted with 24 households, 12 in each village. As in Krui, the cases were selected to represent a cross-section of poor, medium and better-off households. Life histories and sketch maps were completed for each household. Interviews focused on household use of rattan, gaharu, cinnamon and wildlife.

Surveys

Income surveys were conducted in June 1996 for Krui and during July to September for Kayan Mentarang. The main purpose of the surveys was to collect comprehensive information about each household's income and use or management of the forests. The enumerators for the surveys were primarily people from the respective regions who could usually communicate in the local language (even though the questionnaires were a mix of local and Indonesian terms). Eight enumerators assisted with the data collection in Krui and six in Kayan Mentarang.

Households were selected using a random number table and lists of current village residents. In Krui, 21% to 24% of each community was sampled. In Kayan Mentarang, 55% of the households in each village were sampled. The proportion of households was determined in consultation with a statistician on the basis of the variables to be tested and their variability. The total survey sample for both sites was 419 households (Table 2.1).

Table 2.1 Households sampled for income survey

Krui, Sumatra			Kayan Mentarang, Kalimantan		
Penengahan	81	(24%)	Long Alango	40	(55%)
Melaya	93	(21%)	Apau Ping	32	(55%)
Negeri Ratu Ngaras	49	(22%)	Pujungan	47	(55%)
			Krayan	46	(55%)
			Mentarang	33	(55%)
Total	223		Total	198	

Note: Percentage of total village population shown in parentheses.

All income data was based on recall for the previous one-year period. Recall data have limitations due to memory bias or intentional bias on the part of the respondent, but we selected recall data as the best method for capturing variation in production and tried to enhance its reliability through the use of prompts. Income data were collected in Krui for gross and net income. Costs measured included costs of hired labour, inputs such as fertiliser for rice fields, and transportation. Self-employment labour was not counted. Natural forest products (ironically!) were the only source of income not included in the survey because of the illegal nature of collection from the local forest, which is within the boundaries of the Bukit Barisan National Park. From the case studies it was apparent that people were reluctant to openly discuss this income source. From anecdotal evidence, however, forest-related (as opposed to agroforest) income comprises a small, if not insignificant, portion of most households' income. Prices of agroforest products were taken from farmers' reports of local market prices.

In Kayan Mentarang only gross income data were collected, as two to six hours were required for each interview to collect just this information. The diversity of forest products and income sources made data collection more tedious than in Krui. Prices of products were collected through a separate exercise (see the later section on valuing forest products). Recall information about the quantity of forest product collection was probably the most unreliable, as people were asked to recall quantities (in local units) for over 300 products and crops. Although the area had not yet been formally declared a national park, there was little sensitivity about overall forest use among residents. There may, however, have been reluctance to reveal the details of the harvesting of some products, such as gaharu, because of the high incomes received and the desire to keep such information private, even among family members. We assume that

the income figures reported to us are therefore a conservative estimate, and that actual gaharu incomes are probably higher than reported here.

Key respondent interviews

Key respondent interviews were conducted with individual households, village government and traditional leaders (*Kepala Desa* and *Kepala Adat* respectively), other government officials, elderly men and women, and traders in the Krui and Kayan Mentarang sites, as well as in surrounding villages. Interviews were sometimes conducted with individuals and sometimes in small focus groups. The interviews were used to collect life histories, forest or species management practices, price data and information about social institutions such as property rights systems, decision-making structures and community leadership. Historical information about price changes, forest use and access to the forest was also collected.

In Kayan Mentarang, special visits were made to downstream villages to where significant numbers of migrants had moved from the case-study villages. These interviews were held to determine the use of forest products in the case-study forest area by former residents and other people from outside the park.

Valuation of forest products

For the Kayan Mentarang site, additional information was needed about local prices of forest products. Since no formal market existed locally and many products were not exchanged for money, prices had to be elicited from respondents. This information was collected in April 1997 from 17 respondents, using four techniques. These techniques, their rationales and strengths and weaknesses are described in more detail in Wollenberg and Nawir (1998). The price of a product was recorded if the respondent could recall it being exchanged for money in local markets. If the product had never been exchanged, the price of the closest substitute for the product, the willingness-to-pay or the ranking of the product relative to other products was recorded. Willingness-to-pay was not surveyed in a manner consistent with rigorous contingency valuation studies. Instead, the question answered (not the question asked; see below) was 'how much would the product be sold for?'

These techniques were not used systematically by the respondents. The original intention was to ask all villagers about the price of local substitutes. What we found instead was that a larger number of products were traded locally for money than expected and that the prices were often standardised. Also, eliciting imputed prices was more difficult than expected because most villagers were unfamiliar with, and hence uncomfortable talking about, the price of a good. Despite efforts to standardise questions about the closest substitutes for forest products, villagers volunteered their own style of answering the valuation questions, which resulted in the willingness-to-pay and ranking estimates. Substitutes were difficult to identify as villagers wanted to have a dimension on which to compare the products such as flavour, shape, biological closeness, etc. Similarly, the dimension on which products were ranked sometimes did not seem consistent. The respondent in this case described only which products were 'best' or 'most valued' within a category such as mushrooms or rattans. The willingness-to-pay and ranking data were used only after comparison with the other sources of data, if they were found to be consistent and useful. The difficulty of eliciting valuation data underscores the problems with this sort of information for areas where prices are unfamiliar concepts.

To determine the price to be used in the analysis, preference was given to actual prices where three or more respondents provided the same answer. Other products were assigned an average of the substitute and willingness-to-pay prices. Rankings were used to crosscheck other values. The final prices are only valid for Long Alango, as the limited number of respondents interviewed for Long Pujungan (1) and Apau Ping (2) were deemed too small to be reliable. Also, transportation constraints restricted travel to these sites, hence visitors from these villages were interviewed in Long Alango.

2.5 Data analysis

Analysis of the data was conducted using SPSS version 6.1 and with frequent consultation with enumerators. For Krui, members of the Team Krui consortium, who were familiar with the site, were also consulted. Summaries of the findings were compiled in Bahasa Indonesia, and for Kayan Mentarang also in a local Kenyah dialect, and distributed to the respondents, other community members, local decision-makers and partners (Uluk and Wollenberg 1998; Wollenberg and Uluk 1998; Tim Studi CIFOR, WATALA, Universitas Indonesia 1999).

The results of the research are reported in four sections. Section 2 provides an overview of the two research sites, Krui and Kayan Mentarang. This is followed by a report of our findings about selected aspects of forest management at the sites. The fourth section then provides an analysis of forest-based incomes and people's dependence on the forest. Section 5 examines the relationship between income-related incentives and forest conservation. Analysis is focussed on the contrasting case-study sites of Melaya and Penengahan in Krui and Long Alango, Apau Ping and Pujungan in Kayan Mentarang as locations where a more in-depth understanding was possible. Incentives for people's conservation behaviour are analysed using incentive pathways and an understanding of the household's perception of the future importance of the income.

Where provided, foreign terms are in *Bahasa Indonesia*, unless otherwise noted.

3. Overview of Krui and Kayan Mentarang

3.1 Introduction

Indigenous forest management systems, such as the agroforests of Krui and the extractive use of the Kayan Mentarang natural forest, are often pointed to as examples of the capacity of local people to conserve forests. In this section we report on our findings about forest management at the sites, the broader context of management and the potential for conservation outcomes for each forest type. The comparison also highlights the variety of forest contexts in Indonesia and the need for policies that accommodate such diversity.

We begin with an overview of the study sites, and then compare the physical settings and management objectives associated with each system, their local social arrangements and external influences.

3.2 Krui

The Krui site has been studied intensively since 1983, led by researchers from the University of Montpellier in France, especially Geneviève Michon and Hubert de Foresta. This research has included work on biodiversity and the agroforest concept (Michon and de Foresta 1993, 1995, 1996a,b, 1997, 1999), regional land-use patterns (Dupain 1994), land tenure (Michon *et al*. 1996), marketing (Bouamrane 1996), socioeconomic conditions (Dupain *et al*. 1995), damar income (Levang and Wiyono 1993), community management (Aliadi *et al*. 1994; Tjitradjaja *et al*. 1994; Fay and de Foresta 1998, Fay *et al*. 1998), analysis of timber sales (Ames 1998), institutions (Nadapdap 1995) and decision-making (Lubis 1996). Long-term plots have been established by de Foresta for ecological and production studies. The background that follows is drawn from these materials. More complete accounts of the ecology, social system and management practices can be found in the studies cited above.

Most of the resin produced in Indonesia from the *Shorea javanica* tree is harvested from a single region – the three coastal districts (*kecamatan*) of Central, North and South Pesisir in Western Lampung, Sumatra (see Figure 3.1). These three districts also constitute the study area for the research. The general region is often referred to as Krui, after the local market town.

In Krui, farmers from 57 villages (Dupain 1994) cultivate *Shorea javanica* or damar in gardens that covered more than 55,000 hectares in 1998.[2] Krui enjoys a gentle, lower-elevation hilly terrain accessible by sea. The topography in Krui is far more accessible than Kayan Mentarang. With elevations ranging between 0 and 600 m asl, Krui's farmers are concentrated in a narrow coastal strip of land adjacent to the higher-elevation and more mountainous Bukit Barisan Selatan National Park. The forested park is rich in biodiversity, including Sumatran tigers and elephants that sometimes find their way to the coast. Rainfall averages 2,500 to 3,000 mm per year with about three months of significantly less rainfall. Travel to Krui is possible by bus from the island of Java, requiring only one to two days' travel from Jakarta. The provincial capital and nearest city, Bandar Lampung, is a five to seven hour journey by road.

[2] Estimates of land covered by mature (more than 15 years old) damar vary. We use here the most recent figure calculated from satellite-image interpretation by ICRAF/ORSTOM and the Indonesian Ministry of Forestry.

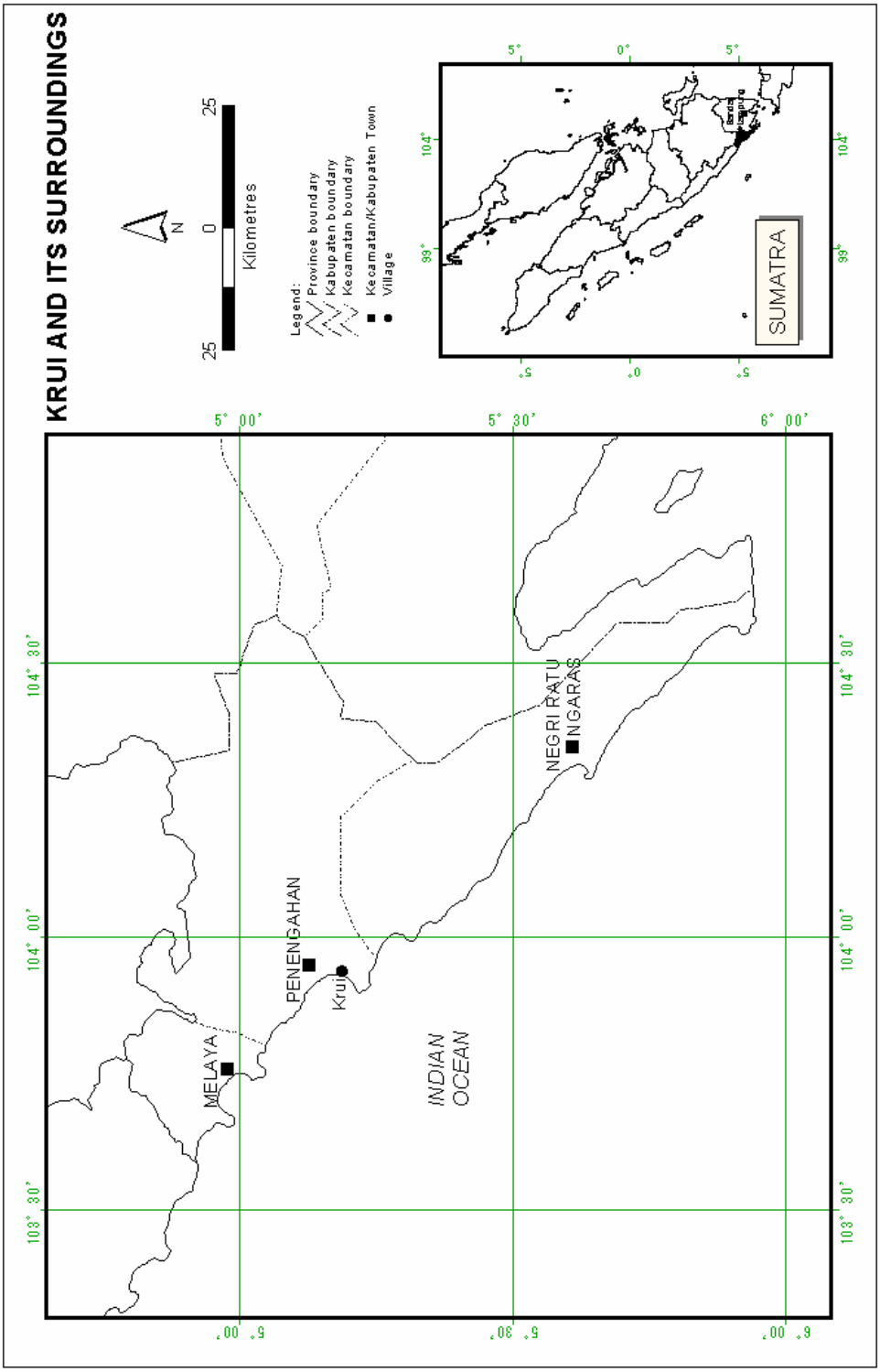

Figure 3.1 Map of villages surveyed - Krui

Krui has a moderate population density for a rural, forested area in Indonesia. The average population density of 35 people/km^2 is about 35 times greater in Krui than Kayan Mentarang (see Table 3.1 on page 23). The capacity of the agroforest to provide higher economic benefits on a smaller land area makes it possible to support such densities.

Lampung swidden farmers began domesticating damar from the nearby natural forest sometime in the nineteenth century and, in the 1930s, undertook widespread planting of the tree in specialised gardens (Michon 1985; Michon *et al*. 1995). Their actions were stimulated by an active trade with Dutch and British sea merchants that began at least three centuries ago. There has been a historically consistent demand for damar, which is now used primarily in the varnish and paint industry. This demand has been stable in part because the Krui area is one of the few world suppliers and no substitute materials of equal quality have been found. Villagers plant damar in gardens with an average of 8-9 other planted species and up to dozens of volunteer species. They tap the resin every 15-45 days and sell it for approximately $0.53/kilo (Rp. 1,200). Most of the other species are fruit trees harvested on an irregular basis. Durian (*Durio zibethinus* Murr.) and duku (*Lansium domesticum* Correa) are two of the most significant fruits cultivated, which are also important for the incomes they fetch (cf. Bouamrane 1996).

Repong in Penengahan

The damar gardens are usually the final stage in a managed successional sequence that begins with the clearing of a swidden field and the planting of rice (Lubis 1996). Rice is generally followed by short-term perennial cash crops (*tanaman muda*) such as coffee and black pepper. Damar is planted at the same time. The *tanaman muda*, which are seen as a major source of quick and substantial income, are cultivated intensively until the damar canopy closes and it is mature enough to be productive (20 to 35 years) (Michon 1985). The mature damar gardens are then treated as a long-term or permanent use and generally not converted. Local knowledge about damar management is highly developed in most villages and the ecological, productive potential for the damar tree seems high throughout the region (Michon *et al*. 1992). The gardens are cultivated in a way that mimics local forest in structure and complexity, partly because volunteer species are grown together with the planted species (de Foresta and Michon 1992; Michon and de Foresta 1992). They are the dominant feature of the landscape around Krui and are

referred to locally as *repong damar*. In the early 1990s, Levang and Wiyono (1993) found that income from *repong* ranged from US$400 to $2000 per household in Krui.

Although damar is the primary income for villagers in the region, fruits from the *repong* can also be an important source of cash from time to time. However, fruit trees produce irregular harvests, with only some years resulting in surpluses providing significant income. Bouamrane (1996: 89) reported, for example, that a long dry season in Krui in 1994, helped produce an exceptionally high *duku* (*Lansium domesticum*) harvest in March to mid-April 1995. Families were harvesting up to 250 kg per day during the 40-day season, with prices ranging from US$0.10 to $0.30 per kg. During the mid-1995 to 1996 period of our study, there were no such large fruit harvests

Penengahan and Melaya have good access by both road and sea

In terms of social organisation, village composition in Krui reflects the distribution of family clans sharing a common ancestor. Clans were the original basis for settlements and land claims. Several sub-ethnic groups of each clan can be found in any one village, with these groups reflecting traditional hierarchical differences in power. The strength of traditional social institutions, internal heterogeneity and degree of hierarchy varies significantly among villages. The level of settlement by outside migrants also varies between villages. Traditional leaders and village government heads are usually different individuals. Households usually consist of a nuclear family and several members of the extended family. The predominant religion is Islam.

The relative cohesiveness of traditional social structures at each site has supported the development of social norms about the importance of maintaining the forest resource and linking people's identity to the forest. In Krui, people often refer to themselves as *petani damar* (damar farmers) and, as discussed below, control over damar trees confers social status. The history of the agroforest is however more recent than that of the forest in Kayan Mentarang, which suggests these norms may be weaker (especially in some villages) in Krui.

In Krui, land tenure was historically based on clan claims. During the Dutch period, customary claims in Lampung were recognised, but subject to a process of forest delineation to claim the lands as state forest. The process was never formally completed (Fay *et al*. 2000), but some areas, especially the more hilly terrain, were designated as state forest land. The Indonesian government delineated state forest land in the agroforest areas in 1992-1996 (Pesisir Tengah and Pesisir Selatan 1992-1994 and Pesisir Utara 1994-1996) based on 1991 land-use planning decisions (de Foresta pers. comm.). *Repong* are now cultivated on a mix of private alienable agricultural land (*tanah milik*) and state forest land zoned primarily as limited

production forest (*hutan produksi terbatas*). A small percentage has *repong* in the national park as well. All three types of tenure lack security however (see discussion below). According to Michon (1997), *repong* evolved from common property forests used for swidden farming. As farmers began to domesticate damar and plant it on their swidden fields, these fields evolved into individual holdings. Nevertheless, there remains a 'common-property mentality' about the *repong* (Michon, personal communication) that reflects the social norms related to maintenance of the resource and a clan's or village's identity. Villages take pride in the extent of *repong* in their area and encourage their members to continue damar and *repong* cultivation.

Because of their structure and diversity, the damar agroforests have been nationally recognised as an innovative model for community-based forest management contributing to biodiversity conservation and providing an important buffer zone for the park.[3] Interest in maintaining the *repong* extends beyond the local farmers to NGOs, research institutes and state organisations concerned with the sustainability of the system and the potential lessons to be learned for other areas. The Team Krui consortium has been one of these groups. The wider interest in Krui may even be creating a revival and deepening of local interest and commitment to the *repong*. In January 1998, the Ministry of Forestry awarded special land-tenure status (*Kawasan Hutan dengan Tujuan Istimewa*, SK No 47/Kpts-II/1998) to the area to protect local people's rights to cultivate damar, which may be encouraging farmers to show their commitment to *repong* damar in order to acquire more secure land claims. At the same time, the special land status may 'lock up' the land in *repong* damar, thereby depriving local people of possibly more valuable, future alternative uses of the land.

There are also powerful interests interested in converting the *repong* to other uses. During the past two to four years, intense debates about local farmers' rights to land in Krui have occurred. On private land, much of which remains unregistered, farmers have faced pressures to yield their land to or join commercial operations in the conversion of their *repong* to oil palm plantations (Yanagisawa 1997). With improved infrastructure during, Krui's proximity to Jakarta and Java also makes it a prime target for migration and oil palm plantation development. On the government-claimed forest land, farmers have faced expulsion and destruction of their *repong*, especially with border demarcation efforts initiated by the Ministry of Forestry in 1995 (Fay *et al*. 2000).

Aside from the swidden-*repong* system, local people also rely on a variety of strategies to generate income. These include vegetable cultivation, permanent rice cultivation, husbandry of domesticated animals, wages for agricultural labour or damar harvesting, trade of damar, trade of petty goods, cottage industries such as mat weaving, government employment, other wage-earning opportunities, remittances from family members working elsewhere, some collection of natural forest products (e.g., rattan, natural damar, hunting) and some government aid.

3.3 Kayan Mentarang

In Kayan Mentarang, there has been significant research to document social and ecological conditions in the area, especially ethnobotanical and cultural studies (Sellato 1994; Sørensen and Morris 1997; Eghenter and Sellato 1999). Sellato (2000) provides a comprehensive history of the region. Useful work on people's forest management includes descriptive ethnographic overviews (Devung 1996, 1999) and detailed studies of succession (Syahirsyah 1999), medicinal plants (Gollin 1997), rattan (Sirait 1997; Stockdale and Ambrose 1996), gaharu (Soehartono 1998; Konradus 1999; Momberg *et al.* 2000), tree palms (Puri 1995), birds (van Balen 1995) and hunting (Puri 1997, 1998). Other relevant sources dealing

[3] The villagers responsible for maintaining the damar were awarded the nation's prestigious *Kalpataru* award in 1997 in recognition of the environmental significance of the agroforests. The Indonesian Minister of Forestry has also visited the site and stated that the agroforest system in Krui should be a model followed elsewhere in Indonesia.

Harvesting rattan in the forest near Apau Ping

with other regions of Kalimantan, include Chin (1984), Colfer and Dudley (1993), van Valkenburg (1997) and Wadley *et al*. (1997). We draw from these sources to provide an overview of Kayan Mentarang.

In contrast to the agroforests in Krui, the forests in Kayan Mentarang predate people's arrival. We can speculate from migration histories, old fruit gardens, traders' records and archaeological evidence that Kayan Mentarang's forests have been shaped by human use for at least 500 years. Kayan Mentarang National Park in East Kalimantan (see Figure 3.2), a 1.4 million ha area in the far, mountainous interior, is among the largest remaining contiguous forests in Asia. Elevations range from 600-2000 m asl, and rainfall is generally between 3,000 and 4,000 mm per year, with little to no dry season.

The terrain in Kayan Mentarang is demanding, with many steep slopes and access by river or foot (and in the last several decades occasional missionary planes). Access in Kayan Mentarang varies by site. At present, villages in Pujungan are accessible by the Kayan and Bahau Rivers, requiring three to five days' travel by boat from the coast, assuming favourable conditions. Mentarang is also reached by river, requiring less than a day's travel from the coast. Although Mentarang is substantially inland, the lack of rapids makes the travel time much shorter. Air travel is also available to nearby Malinau. Krayan, in contrast, is not accessible from the coast by river or road, only by air (one hour from the coast) or by foot, often together with some other form of travel. Krayan is however connected to interior Malaysia by road.

Kayan Mentarang has a small population (15,549 people in the three districts studied) and one of the lowest population densities in Indonesia (1 person/km^2). In this regard it is typical of other extensive forest areas in the Amazon and Congo Basins. The low population density, in combination with high out-migration over the last century, has probably been a key factor underlying the survival of the forest.

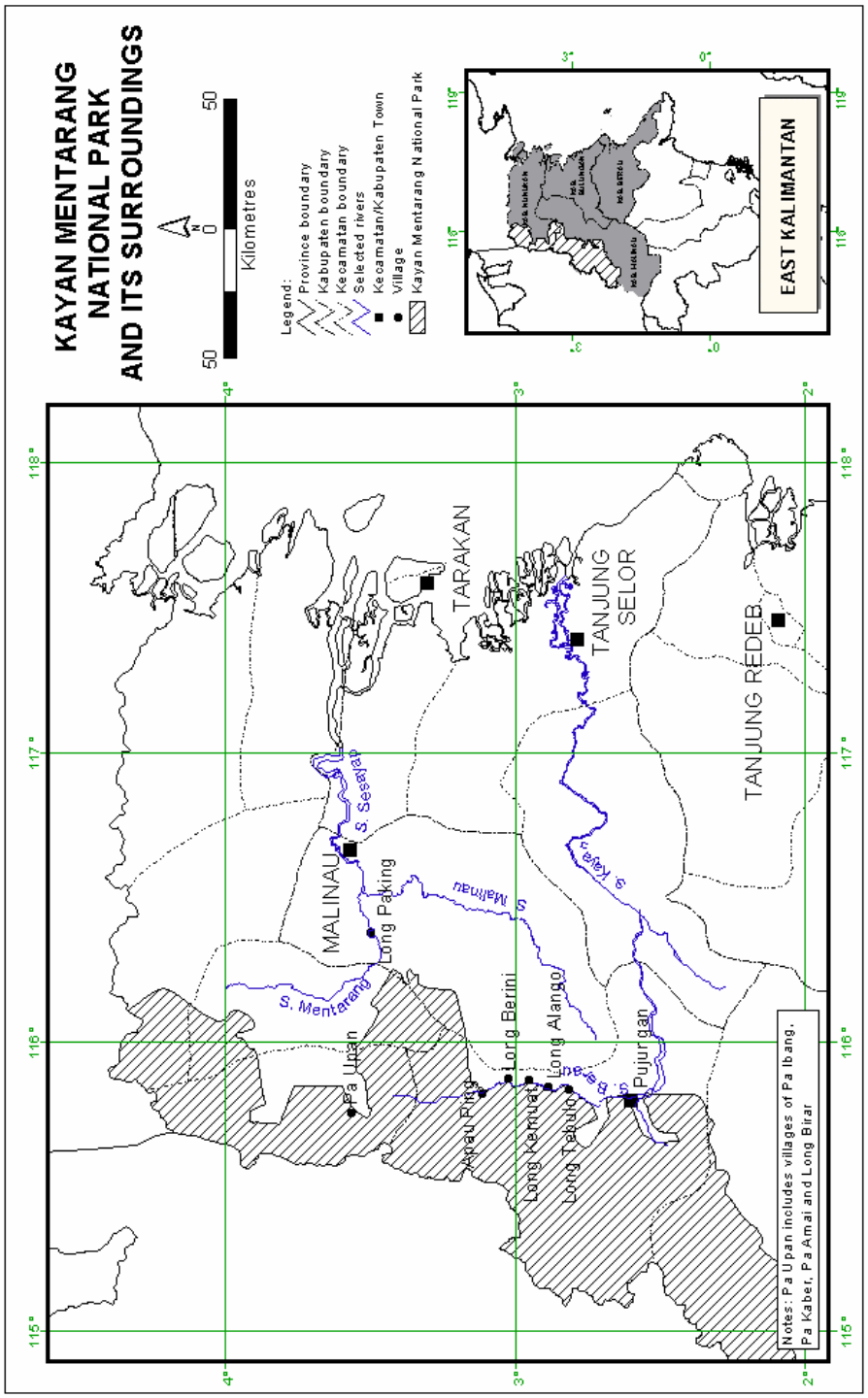

Figure 3.2 Map of villages surveyed – Kayan Mentarang

Local users of the forest are mostly Dayak swidden rice farmers and hunters and gatherers of forest products. In a fashion typical of Dayak groups, ethnic diversity is extremely high. In the study area of three administrative districts – Pujungan, Mentarang and Krayan – at least 13 distinct ethnic groups and languages exist. The majority of people are Christian.

In the past, these groups would move to new locations to seek more fertile lands, cope with internal village disagreements (factions would split and live in separate locations), avoid headhunting enemies or escape local pestilence. One group would rarely stay in the same settlement longer than a single generation. Thus diverse Dayak ethnic groups have occupied the study sites over time. Settlements tend to be more permanent now among the agricultural groups with the establishment of government infrastructure, but migration still occurs between villages. In the last 100 years there has been significant migration downriver to areas where health, education and economic opportunities are more abundant.

In Kayan Mentarang, the ethnic composition of the villages varies by region. In the Pujungan district, each village is dominated by one to two Kenyah ethnic groups, which are internally stratified by traditional aristocratic hierarchies. Small settlements of more egalitarian Punan hunter-gatherers occur on the Lurah River and in the villages of Peliran and Pujungan. In the Mentarang and Krayan areas, villages tend to be more ethnically diverse, although a single ethnic group is usually clustered together in a hamlet. Aristocratic differences are less distinctive, and do not occur at all for the Punan groups. In all the districts there is usually a traditional leader who oversees several villages or ethnic groups. Village government heads are often also traditional leaders or at least descended from traditional leaders, although this pattern seems likely to change in the near future with the weakening of the aristocratic order. While longhouses no longer exist in the Pujungan, Mentarang and Krayan areas, households often include more than one family head and extended family. The history and social structure of ethnic groups in Kayan Mentarang is described in more detail in Rousseau (1990), Eghenter and Sellato (1999), Kaskija (2000) and Sellato (2000).

Rivers are the predominant travel routes in Kayan Mentarang, and made difficult by numerous rapids


Harvesting rice, Long Alango

Despite their ethnic differences, Kayan Mentarang villagers have depended on the forest for centuries for nearly all their needs, with the result that the forest and its products are integral parts of their culture. Hundreds of forest products are utilised, with knowledge about their use and management varying among groups. The forest is a source of wild pig, several kinds of deer, fruits, spices, vegetables, medicinal items, timber, rattan and fuelwood. Even the swidden fields depend on the regrowth of forest to restore their fertility. Gaharu is the major source of cash income. Many aspects of daily life – from names of people, to decorative symbols and staple foods – come from the forest. Villagers said 'if the forest goes, we are gone'. People lament the loss of knowledge about the names of plants, animals and medicines from the forest that is occurring among the younger generation.

Records of trade with interior people in northeastern Borneo date back to at least the 16th century (Peluso 1983). Trade included highly coveted forest products such as rhinoceros horn, *jelutong*, birds nests, songbirds, gaharu and the gall stones of several animals used for medicinal purposes. The villagers of Kayan Mentarang are more actively engaged in trade now than ever before. Although rattan, song birds, cinnamon and timber have each been valuable trade items in recent decades, gaharu or aloewood[4] (a fungal-infected heartwood available from several *Aquilaria* species) has created a maelstrom of economic activity during the last five years. In 1995-96 the best quality gaharu (*super*) fetched extraordinary prices of approximately US$900/kg (Rp. 2 million), while even the lower qualities brought in far higher returns by weight than other local commodities, such as cinnamon, which sold for $0.44/kg (Rp. 1,000) in 1995. The gaharu boom has increased cash flow into the area and enabled a higher consumption of purchased goods. Local transport has experienced a revolution with the widespread ownership of outboard motors for the river boats previously powered only by people and their paddles. On the Bahau River, a trip to the nearest market town on the coast, which previously took at least a month one way, can now be done in as little as three or four days. Gaharu collecting has been especially active in the Bahau, Tubu and Malinau River basins. Local villagers perceive collection of gaharu by people from outside the community, especially groups of organised professional collectors, as a threat to local cash incomes.

A distinctive aspect of gaharu is that it has yet to be locally domesticated. Harvesting involves digging out the infected part of the tree or felling it. In searching for gaharu, villagers may fell trees that upon inspection do not contain the fragrant wood. Regeneration of the tree may take place in the wild, but the infection of the heartwood can take decades – if it occurs at all. Villagers sometimes slash the bark of standing trees to encourage infection, but even this has unpredictable effects.

In addition to the harvest of forest products, gaharu and the cultivation of swidden fields, local people rely on planted fruit gardens, some livestock, limited local employment (in some localities through WWF), government employment, trading of petty goods as well as some specialty items across the border with Malaysia, cottage industries, rentals of equipment such as boats or chainsaws, remittances from family

[4] For other sources on *Aquilaria* and gaharu see Hou (1960), Burkill (1966), Paoli *et al.* (1994), Oetomo (1995), Chang *et al.* (1997), Hartadi (1997) and Soehartono and Mardiastuti (1997).

Forest surrounding Apau Ping, from a northeastern aerial view. The settlement of Apau Ping is visible along the river edge

members working elsewhere (especially Malaysia), and aid from government or churches. Villagers in Kayan Mentarang are accustomed to boom-bust cycles in their primary sources of income over recent decades, including gaharu (Sellato 2000).

Historically, land tenure in the area was based on territories controlled by warring ethnic groups. Among the stratified Kenyah groups, leaders controlled territory and local population movement as a basis of wealth (Sellato 2000). During the Dutch era, especially around the turn of the 20th century through the 1920s, these territories were left alone, although people were encouraged to halt warfare, settle downriver and military posts were established in critical trade nodes like Pujungan. After Independence, with the rise of the timber industry in the 1960s, the government of Indonesia classified the area as state forest land. In the 1980s, a WWF-sponsored team surveyed the Kayan Mentarang area and recommended that it be gazetted as a nature reserve. In 1996, the status of the reserve was changed to national park to permit residence by local people.[5] Surrounding areas include state forest land of different classifications ranging from protected forest to conversion forest (*hutan konversi*, *hutan produksi terbatas* and *hutan produksi*, *hutan lindung*). The access to land in the park is presently based on village claims related to watershed boundaries, but access may change with the implementation of the park management plan.

Within villages, claims to land or plants are established through labour, i.e., clearing a swidden field and/or cultivating a plant. The allocation of a swidden site usually occurs in consultation with community elders. Forest products are generally available to anyone in the village, and to outsiders who request permission. Gaharu is the major exception to this rule and is discussed further in Section 6. Claims to trees may be staked by marking them and fallen fruits are free to anyone who finds them. The security of forest product claims varies among villages, however for most there is little capacity to restrict outside collectors, especially those who are surreptitious in their comings and goings. Outsiders have also been able to gain access to gaharu through the payment of fees to local authorities and by making use of certain family relationships (Wollenberg 1999a).

The World Wide Fund for Nature-Indonesia Programme, together with the Department of Environment, has played the lead role as a supporter of local conservation and local people's rights to use forest land. Beginning in 1990, WWF undertook efforts in the then nature reserve to establish a national park. Since the area's change in status in 1996, WWF has been concerned with preparing and implementing a

[5] According to Indonesian policy, local people can be given permission to live in and use a national park, but a nature reserve is strictly protected from any human use.

management plan that would enable zones for biodiversity protection and 'traditional' use by local villagers. As one of about 35 national parks in Indonesia, Kayan Mentarang is being looked to as a model for integrating conservation and development aims in remote areas.

Aside from the pressures for conserving biodiversity, local residents find themselves having to cope with logging, some legal and some illegal, especially in the Mentarang and Pujungan areas. Most people in the area see logging as a potential source of valuable income, but are against the idea of logging in forest near their own village. Logging is feared as one of the major threats to people's livelihoods.

3.4 Summary

The agroforests in Krui and natural forests in Kayan Mentarang face very different conditions relating to conservation and sustainability. Conservation in the agroforests requires the conscious planting of damar and other species over time. Conservation in the forest may require people to limit their hunting or harvesting practices in accordance with species abundance and resilience.

The persistence of these forest systems and of people's reliance on them is evidence that the ecological, productive potential of the respective resource in each area has, at least historically, been sufficient for meeting local needs. There is no evidence to suggest that population levels have exceeded the local carrying capacity. At both sites a mix of products is managed from the landscape, hence people have flexibility to manage the *repong* or the forest with varying species compositions and levels of productivity. The sloping terrain in both areas suggests that the existing forest-based systems are a more appropriate, dominant land use than intensive cultivation for maintenance of long-term productivity. Overall population pressure on the resources is substantially higher in Krui than Kayan Mentarang, but the high price of gaharu in Kayan Mentarang has created substantial pressure specifically on *Aquilaria* species.

Social capacities for conservation are medium to high at both sites. There is relatively high coherence of objectives and interests among local people, although these interests face insecurity at both sites because of the existence of possibly competing state forest management objectives. Formal land tenure in both areas is relatively insecure. In Krui, the private nature of *repong* management (i.e., by a household rather than a collective) reduces the need for coordination with others. In contrast, in Kayan Mentarang, coordination within and among villages is necessary for maintenance of the forest as a whole. The large land area of the forest in Kayan Mentarang makes adequate protection and monitoring unlikely. Local institutions promoting damar management are relatively strong in Krui, although not in all villages. In Kayan Mentarang the strong sense of heritage associated with the forest may be a more important influence on behaviour than the strength of local institutions, which is not the same among villages.

External influences on conservation are significant at both sites. Outside agents are responsible for supporting interventions that promote a 'conservation agenda', especially one that is consistent with local livelihood needs. Yet these may result ultimately in some restrictions on local people's economic choices. Government policies related to national park management and community-management of forests will play an increasingly important role in shaping local people's access to forest resources, the security of their access and their incentives for conserving the resource. Price changes of products and changing access to markets should theoretically have a greater influence on people's decisions to plant damar in Krui, where the entire composition of the *repong* or its existence might change. In Kayan Mentarang, price changes could alter forest product collection patterns, as they have with the recent gaharu boom, but they are unlikely to endanger the forest as a whole. Land speculation and conversion to other uses is a risk in Krui on the private, alienable land. The forest in Kayan Mentarang is protected by law.

A summary of conditions in Krui and Kayan Mentarang is provided in Table 3.1.

In the next section we give a closer look at the villages studied, and provide details about the local setting and management practices to support interpretation of the data in the following sections.

Table 3.1 Conditions in Krui and Kayan Mentarang[a]

Characteristic	Krui	Kayan Mentarang
Forest management objective	Production of damar *(Shorea javanica)* and other products from agroforest	Hunting and collection of products from primary and secondary natural, submontane forest (Dipterocarpaceae and Fagaceae dominant)
Major forest products	Damar resin , timber, fruits, e.g., duku *(Lansium domesticum)*, durian *(Durio zibethinus)*	Wildlife (especially wild pig), gaharu, fruits, rattan, timber
Primary source of cash income	Damar resin, although periodic fruit harvests can be important as well	Gaharu
Elevation	0-600 m asl	300-2000 m asl
Topography	Coastal with minor hilly areas	Inland, hilly and mountainous
Rainfall	2,500-3,000mm/year, 9 months wet season	3,000-4,000 mm/year, no dry season
Total population	101,307 people (1995) in three districts Pesisir Tengah 36,492 Pesisir Utara 19,787 Pesisir Selatan 45,028	Estim. 15,549 people in three districts Pujungan 2,827 (1993) Mentarang 3,665(1994) Krayan 8,987 (1996)
Total land area	291,020 hectares Pesisir Tengah 17,247 Pesisir Utara: 63,443 Pesisir Selatan 210,330[b]	1.8 million hectares Pujungan 840,000 ha Mentarang 677,800 ha Krayan 311,420 ha
Population density	35 people/km^2 (1995)	Approximately 1 person/km^2
Religion and ethnicity	Muslim. Predominantly Lampungese. Some Javanese, Sundanese and Batak migrants	Christian. Dayak Kenyah, Punan, Abai, Lundaye.
Social organisation	Clan, with internal hierarchy. Mix of traditional and government leadership.	Sub-ethnic groups, sometimes mixed in one settlement. Internally hierarchical. Mix of traditional and government leadership
Government land tenure status	Private, mostly unregistered agricultural land, government production forest and small areas in national park	National park, in which traditional land use is permitted, some state forest land and private land.
Land tenure according to customary law	Land in each village used to be owned by the clan, which became the property of individual households in the 1900s. Damar *repong* are inherited by the oldest son	Mixed. Agricultural property is allocated to individual households. Forest trees can be marked as household property. Fallen fruit is open access. Some villages maintain common forest area (*tana' ulen*). Property is inherited equally
Competing demands on forest	Oil palm plantation, damar resin theft, migrants, biodiversity protection, some elements of the Indonesian Forestry Ministry	Professional gaharu collectors from outside the community, logging, biodiversity protection
Primary sources of external assistance for local people's management of the forest	Team Krui Consortium; Some elements of the Indonesian Forestry Ministry, especially at the central level	World Wide Fund for Nature - Indonesia Programme; Indonesian government agency Perlindungan Hutan dan Pelestarian Alam (PHPA), which in 1999 was renamed Perlindungan dan Konservasi Alam (PKA)

Notes: a. Sources of statistical data: BPS (1993, 1994, 1995, 1996)
b. Conflicting data exist for the land area of Pesisir Selatan (based on comparison with ICRAF/ ORSTOM and LATIN mapping project)

4. Local Forest Management at the Study Sites

4.1 Krui

One village was selected for study in each of the districts of Pesisir Tengah (Central Pesisir), Pesisir Utara (North Pesisir) and Pesisir Selatan (South Pesisir). The patterns of *repong* damar cultivation in each district differ (see Dupain 1994) and the study was designed to capture this variation (Table 4.1). Central Pesisir had the largest extent of mature *repong*, with the villagers of Penengahan reputed for their commitment to and specialisation in the tradition of cultivating damar. Penengahan was the closest village to the market town and main road. It also had the highest population, a high population density and ethnic homogeneity (Table 4.2). The economic status of villagers (Table 4.3) was higher in Penengahan, based on locally defined definitions of wealth for the region,[6] as well as by income standards.

Table 4.1 Agroforest conditions in villages surveyed, Krui

Land use	Village		
	Penengahan Central Pesisir	Melaya North Pesisir	Ng. R. Ngaras South Pesisir
Land area[a]	1,530 ha	3,212 ha	13,535 ha[d]
% of damar agroforest[b]	88%	34%	51%
Damar agroforest condition	Mature damar agroforest	Less mature damar agroforest compared to Penengahan (clove conversion in early 1970s)	The oldest among all 'Ngaras clan' villages, but less mature than Penengahan and Melaya
Damar agroforest typology[c]	Specialised damar villages	Rice field and damar agroforest are both important	Rice field and damar agroforest are being established
Land availability	No expansion within village boundaries; land acquired outside village	Land available for agricultural expansion	Conversion to oil palm plantation occurs in neighbouring village within 'Ngaras clan' villages
Travel time to market by car/bus	10-15 minutes	45 minutes to 1½ hours	One to two hours

Notes: a. BPS district (*kecamatan*) reports
b. Based on information from mapping project (ICRAF/ORSTOM, LATIN, WATALA)
c. Dupain (1994)
d. This number seems too large in comparison to first-hand observation and local surveys

In North Pesisir, villagers' interest in and history of damar cultivation was least homogenous. The village of Melaya was selected to represent a village where farmers historically grew damar, but were less dependent on it. The *repong* here were less extensive and less complex in structure or species composition compared to those in Penengahan. Land was relatively abundant for cultivation because the population density in Melaya was lowest of the three sites. Migrants from Java have settled in the more hilly, inland reaches of the village. There were more poor households in Melaya based on both local and cash income standards.

[6] Wealthy households were defined as those producing more than two quintals of damar per month and owning at least one rice field. Poor households were those without land. Medium households were all others.

Table 4.2 Population characteristics, Krui

Characteristics	Village[a]		
	Penengahan - Central Pesisir	Melaya - North Pesisir	Ng. R. Ngaras - South Pesisir
Total Population	1,838	1,578	1,470
Number of households	343	454	237
Average members per family (according to survey)	8	6	7
Density (people/km^2)	120	49	104
Ethnicity	Lampungese	Lampungese, Javanese, Sundanese	Lampungese, Javanese, Sundanese
Sub-ethnicity	Sukajama, Berak, Kutabesi, Batin[b]	Batin, Penyandingan, Jejerlawok, Masagus[b]	Marga Ngaras

Notes: a. BPS subdistrict reports
b. Lubis (1996)

A major difference in damar management between Melaya and Penengahan was the large number of households in Melaya that responded to a boom in clove prices from 1970 to 1980 by felling damar trees and converting *repong* to clove plantations (Nadapdap 1995; Lubis 1996). Oral accounts by villagers recall significantly more *repong* conversions in Melaya compared to Penengahan. The landscape in 1995 and 1996 shows a greater abundance of *repong* in Penengahan than in Melaya. There were popular perceptions by people living in the villages that there were also differences in practical knowledge between these two communities, with Penengahan having more knowledge and attributing more importance to damar. Better knowledge of how to tap a tree over time was widely regarded by villagers as an important influence on the sustainability of resin production. Penengahan had more formal social institutions (such as *adat* rules) for dealing with damar conflicts.

Damar resin ready to be harvested, Malaya

In South Pesisir damar cultivation was much less developed as a proportion of total land area, probably because of distance from good sea harbours. In Negeri Ratu Ngaras village, South Pesisir, damar cultivation has been fairly recent, with areas cleared for cultivation in only the last one or two generations. Ngaras was farthest from the Krui market. Damar was highly valued, but there was a higher proportion

of land suitable to wet rice, which was widely cultivated. Population levels and densities were relatively high. Ngaras, more than the other two villages had been exposed to more in-migration and attempts at land conversion by outside commercial interests. The government leader at the time of this study was a Javanese.

Table 4.3 Wealth distribution based on land- and cash income-based criteria, Krui 1995-96[a]

Indicators	Wealth Distribution											
	All villages			Penengahan			Melaya			Ng. Ratu Ngaras		
	Poor	Medium	Wealthy	Poor	Medium	Wealthy	Poor	Medium	Wealthy	Poor	Medium	Wealthy
Local Indicators[b]												
Number of Households	5	133	85	2	36	43	2	72	19	1	25	23
Percentage	2.2	59.6	38.1	2.5	44.4	53.1	2.2	77.4	20.4	2.0	51.0	46.9
Cash Income (Rp 000)	2,292	2,259	4,171	1,588	3,166	5,333	4,026	1,918	3,135	233	1,936	2,855
Cash Income and Rice Production (Rp 000)	2,292	2,471	4,927	1,588	3,201	5,907	4,026	2,156	3,893	233	2,326	3,950
HH Cash Income- Based Indicators[c]												
Number of Households	74	75	74	19	21	41	38	35	20	17	19	13
Percentage	33.2	33.6	33.2	23.5	25.9	50.6	40.9	37.6	21.5	34.7	38.8	26.5
Cash Income (Rp 000)	798	2,090	6,090	900	2,273	6,869	699	2,248	5,024	904	1,597	5,276
Cash Income and Rice	965	2,532	6,725	1,069	2,516	7,299	869	2,604	5,654	1,060	2,416	6,562

Notes: a. Based on survey data
b. Damar production categories: wealthy = more than 2 quintals per harvest and the household owns rice fields; poor = if households does not own land of any kind; medium = remaining households
c. Total cash income categories: wealthy = highest 33%;; poor = lowest 33%; medium = remainder

The proportion of households depending on damar and cultivating *repong* was 91% in Penengahan, 38% in Melaya and 80% in Ngaras. The lower figure in Melaya was partly due to large areas cultivated as coffee plantations by Javanese migrants. On average, the households having agroforests managed one to two plots among all the villages. The average size of a *repong* plot was 0.81 ha, ranging from 0.7 ha in Penengahan and Melaya to 1.16 ha in Ngaras.[7] Nearly all the *repong* were on inherited land; between 74% and 87% of all households had *repong* that were inherited (Table 4.4). A smaller proportion of households had purchased or cleared land themselves. Although the surveyed households owned nearly all their agroforests outright, there were two cases of mortgaged land and, among the population not surveyed, we observed a few households with rented land. Of the owned *repong*, 64% to 77% were inherited, with the largest number of inherited *repong* owned by households in Penengahan (Table 4.4). Households in Ngaras and Melaya were more likely to acquire land by clearing it themselves than villagers in Penengahan. Maps of landholdings (Annex 1) show plot arrangements and the tenure status of *repongs* for eight of the case-study households in Penengahan.

[7] As all the survey data about *repong* were collected through interviews and recall, these should be considered estimates and not actual plot sizes.

Table 4.4 Tenure and acquisition of *repong*, Krui[a]

Tenure conditions	All villages		Village surveyed					
			Penengahan		Melaya		Ng. Ratu Ngaras	
	number of households with type of *repong*	%[b]	number of households with type of *repong*	%[b]	number of households with type of *repong*	%[b]	number of households with type of *repong*	%[b]
Owned:								
Inherited	120	81%	64	87%	27	77%	29	74%
Purchased	25	17%	13	18%	5	14%	7	18%
Cleared forest/ advance fallow	27	18%	10	14%	7	20%	10	26%
Received by mortgage	1	1%	1	1%				
Combination of purchased, inherited, or cleared land	3	2%	-	-	2	6%	1	3%
Average number of damar gardens per household	1.93		2.03		1.97		1.72	
Total sampled households with *repong*	148		74		35		39	

Notes: a. This table reports only for households with *repong.*

b. This column is the percentage of households that own *repong* under the stated tenure conditions. Percentages in this column do not add up to 100 because some households had more than one *repong*.

The land on which *repong* were cultivated was reported to be mostly 'clan lands', or private (Table 4.5). In some cases claims overlapped with state lands. There may have been some reluctance among villagers to report where their land was under state ownership, in light of the recent nature of forest delineation and debates about land claims. Also, the borders were not marked consistently and some villagers may not have been aware of the formal change in land status.

Table 4.5 Tenure of *repong*, Krui

Repong Tenure	Village			
	Penengahan	Melaya	Ngaras	Total
Owned by clan	131	65	64	260
National park	13	0	1	14
Production forest	1	0	2	3
Don't know	2	2	0	4
Total	147	67	67	281

One reason why *repong* cultivation is widespread was the prestige and social status associated with damar. Since inheritance of *repong* was traditionally through the oldest son, other children had to either acquire plots themselves or marry into families with *repong* to acquire status. Even first sons try to acquire more *repong* to increase their economic and social status. The status associated with damar was reflected in the way wealth was defined locally; the criteria used were the level of production of damar resin (more than 2 quintals per harvest) and ownership of wet rice land, not the size of landholdings or cash income. Thus, all better-off households by definition were *repong* holders. People of moderate wealth were equally likely to have damar gardens as not. Poor people owned no *repong* at all. A

household might have a higher income from another source, but higher social value was associated with abundant damar production. In Melaya, poor households actually earned more cash income than better-off households using local wealth categories (Table 4.3).

Table 4.6 Livelihood sources based on *repong*, using locally defined wealth categories, Krui

Wealth Category	People with income from *repong*		People with no income from *repong*		Sample Size
	Number	%	Number	%	
Poor	0	0	5	100	5
Middle	63	47	70	53	133
Better-off	85	100	0	0	85

Acquisition of *repong* was usually undertaken locally in Ngaras and Melaya. In Penengahan, land was scarce, because of the higher population, proximity to the national park and the steep terrain. Penengahan farmers therefore often sought land for planting perennial gardens in other villages, especially Rata Agung, Way Gedau, Way Lunik, and Atar Lintik, all in North Pesisir. These land areas could be substantial. One farmer, acquired 4 ha of land (a relatively large plot) in Rata Agung in 1984 as payment in kind for a debt, and purchased another 4 ha in 1986. It was usually the younger sons who were likely to seek land outside of Penengahan. These villagers also frequently sought land for rice, which they usually acquired in South Pesisir.

Sorting damar, Penengahan

Because of the large areas of land owned by some households, not all of the land was necessarily cultivated using household labour alone. Households sometimes managed the *repong* by sharing part of the harvest in exchange for labour. Some were also managed entirely by others in exchange for cash or damar payments. Most households owned *repong* and harvested damar themselves (Table 4.7). In Penengahan, the proportion of people that harvested their own *repong* was slightly lower than in Melaya and Ngaras, reflecting the greater distance to many of their plots (Mary and Michon 1987). Farmers in Penengahan were also more likely to allow their *repong* to be managed by others. Such arrangements could be expected to lead to low incentives to harvest damar in a sustainable way. Farmers frequently suggested that the people given rights to damar did not take good care of the *repong.* They tended to harvest the resin more frequently than the owner would have preferred and to not use care in the tapping and maintenance of the tapping holes from which damar was collected.

Table 4.7 Division of ownership, management and use rights, Krui

Damar garden management	All villages		Village					
			Penengahan		Melaya		Ng. Ratu Ngaras	
	number of households with type of *repong*	%[a]	number of households with type of *repong*	%[a]	number of households with type of *repong*	%[a]	number of households with type of *repong*	%[a]
1. Owned and harvested by household	128	87	61	82	32	91	35	90
2. Owned and shared (1:1)[b]	12	8	10	14	1	3	1	3
3. Owned and shared (1:2)[b]	4	3	2	3	2	6	0	0
4. Owned and management by others, shared (1:1)[c]	7	5	5	7	1	3	1	3
5. Owned and management by others, shared (1:2)[c]	6	4	3	4	0	0	3	8
6. Owned but mortgaged/given to others for their use	1	1	1	1	0	0	0	0
7. Other[d]	8	5	3	4	2	6	3	8
Total sampled households with *repong*	148		74		35		39	

Notes: a. This column is the percentage of households with *repong* under the stated management and ownership conditions. Percentages in this column do not add up to 100 because some households managed more than one *repong*.

b. The damar gardens are still under full control of the owner except for harvesting

c. The damar garden belongs to the owner, but the management decisions are in the hands of the person having tenure rights from the owner

d. Abandoned

The management practices associated with the *repong* were surveyed for each village (Table 4.8). The information was collected through recall and interview, so the accuracy and reliability are not clear; thus the data should be interpreted with caution. Farmers maintained an average of seven to nine species in their *repong*, both planted and volunteer. These were nearly all tree species. The number of cultivated species can be taken as an indicator of the biodiversity in the *repong*. A reduction in the number of species could be defined as a decline in the quality or integrity of the *repong*. Common species were damar, durian (*Durio zibethinus*), duku (*Lansium domesticum*), petai (*Parkia speciosa*), langsat (*Lansium* spp.), tangkil (*Gnetum gnemon*), rambutan (*Nephelium* spp.), betel nut palm (*Areca catechu*), various rattans and the palm *Arenga pinnata.* Some species, like most of the timber trees, were volunteer species rather than planted.

Table 4.8 *Repong* management, Krui

Characteristics of management	All villages	Village		
		Penengahan	Melaya	Ng. Ratu Ngaras
Number of species per *repong* [a]	9	9	9	7
Total tree population per *repong*	135	124	126	172
Total trees per ha	167	177	180	147
Total damar tree population per *repong* [b]	82	69	52	139
Total damar trees per ha [b]	117	130	85	122
Proportion of mature damar trees per ha	65%	74%	52%	53%
Proportion of young trees per ha	35%	26%	48%	47%
Number of holes per tree				
Vertical	9	10	8	9
Horizontal	4	4	4	3
total holes	35	39	31	31
Number of total holes planned per tree				
Vertical	10	10	10	10
Horizontal	4	4	4	4
total holes	43	43	42	42
Intervals between harvesting (days)				
a. Present practices	31	35	33	20
b. Practices one generation ago (30 years)	109	120	95	96
Proportion of households collecting damar more frequently than normal cycle	54%	56%	56%	46%
The shortest period between harvests (days)	16	18	13	13
Frequency of households with fallen trees on a *repong* in the last year	70	70	76	62
Level of damar theft since the local road was sealed. Households with:				
1. more cases of stolen damar	56%	c	56%	55%
2. less cases of stolen damar	4%	c	8%	5%
3. no difference	40%	c	36%	40%

Notes: a. Number species refers to cultivated species
b. Data includes both mature and young damar trees
c. Not measured in Penengahan as road access has not changed in recent years

The total tree population indicates the management burden of a household, while the trees per hectare are an indicator of the density of land use and forest cover. Melaya and Penengahan had similar *repong* structures. Ngaras had extremely high numbers of damar trees per *repong*, but the trees were generally younger and the *repong* larger, reflecting the earlier stage of *repong* establishment in Ngaras.

The number of holes per tree was a common indicator used by local people to show how well a tree was managed. In Krui, damar was tapped by creating a triangular-shaped incision through the bark into the cambium. The resin would slowly ooze out over the following days and coagulate at the base of the triangle, from where it was later collected. The holes were gradually enlarged over time to encourage more resin to seep out.

For a tree of a given diameter or age, villagers agreed that there was a maximum number of horizontal (*belah*) and vertical (*cacak*) holes that could be made. Any holes in excess of the accepted maximum indicated overuse and threatened either the long-term productivity of the tree or its structural stability. For example, trees 29 to 41 years old in Penengahan that were considered to be well-managed were found to have an average of three horizontal holes and 4.5 vertical holes (Taulana Sukandi, unpublished data 1997). In some cases the older trees in Taulana's study had fewer holes because the trees were in low-productivity sites and had smaller diameters than the younger trees in more fertile sites. Determining the maximum number of holes also depended on the site potential and hence required judgement. Holes that become too large were allowed to close, and new ones were made to beside then.

Damar after sorting

Because the number of holes varied by site condition and age of tree, this cannot be interpreted as an indicator of the level of management for conservation . The larger number of holes per tree in Penengahan most likely suggests that the trees were older and larger rather than overharvested. In fact, Penengahan had a reputation for being a model of well-managed *repong*. The smaller number of holes in Ngaras probably reflected the presence of younger trees.

In contrast, the number of days between harvests of the damar resin is a relatively good indicator of conservation. According to farmers, the optimum harvest time for damar was about 45 days or 1½ months. Recommendations by Indonesia's Forestry Center for Research and Development are similar (Apul Sianturi pers. comm.). Intervals of less than one month were considered 'not good.' Trees harvested at this rate are expected to have short productive lives and yield less overall. One to 1½ months was considered average; 1½ to two months good; and more than two months very good. Harvest periods that extended beyond 2½ months were considered uneconomical for the farmer. The optimum interval between harvests for meeting both economic objectives and maintaining tree productivity was 40 days. There was no indication that the optimum harvesting period varied with the age of the tree, although the volume of resin produced per tree tended to be higher from younger trees (after the age of production, which is between 20 and 35 years). Trees in a *repong* were often of mixed age classes, but harvested at the same time.

Most *repong* harvested in 1995-96 fell far below the optimum interval in all the study villages (Table 4.8). *Repong* in Penengahan had the longest periods, with an average of 35 days, while the shortest was in Ngaras with only 20 days. While the average intervals in Penengahan and Melaya can be considered acceptable for maintaining the productivity of damar trees, harvesting rates in Ngaras were beyond acceptable limits. Differences among villages were statistically significant. Harvesting intervals in all villages were shorter than those used by farmers approximately 30 years ago. While farmers' answers might be influenced by inaccurate recall, the belief that there has been a trend towards shorter harvesting intervals was widely held among nearly everyone to whom we talked.

Damar collectors returning home

Farmers said that cash needs had increased, especially since the mid-1980s. People needed money to send their children to school, build homes and buy furniture. Villagers harvested damar as the common means to acquire a steady income, more frequently to meet cash needs. It was not uncommon for farmers to visit their *repong* earlier than preferable, shortening the harvest interval in order to acquire cash quickly. They also sometimes borrowed money from nearby store owners and paid their debt later from damar income.

About half of the farmers surveyed had used a 'short' harvest cycle, i.e., collected damar more frequently than normal. Among these farmers, those in Melaya and Ngaras had the shortest collection period – barely two weeks. Penengahan farmers used slightly longer average cycles of 18 days. It is possible that respondents overstated the number of days or understated whether they engaged in this practice, since it is generally considered bad management of the *repong.* Even though it is a common practice, some farmers might have found it embarrassing to be admit to the practice. Nevertheless, local people felt that the short harvest cycle was one of the standard indicators of 'abusive use', i.e. nonconserving behaviour, of a *repong.*

Another indicator of poor management of the *repong* was the number of productive trees cut or that had fallen. It was common practice to cut older, unproductive damar trees in order to replace them with seedlings (cf. Petit and de Foresta 1996). Such practices contributed to the conservation of the *repong.* On rare occasions a farmer felled a productive tree because of a need for timber. Productive trees also fell over themselves because of poor management of tapping holes that weakened the structure. The question of whether productive or unproductive trees were cut was an even more sensitive issue than whether farmers had ever engaged in a shortened harvest cycle. Instead, we asked respondents about the total number of fallen trees to get at this information indirectly. Our findings show that 62%-76% of households had fallen trees, which may reflect the turnover of older trees as much as poor management. These data are too ambiguous for a useful conclusion to be drawn.

4.2 Kayan Mentarang National Park

The study was centred in the Pujungan, Mentarang and Krayan districts (*kecamatan*) of Bulungan, East Kalimantan. Case studies were conducted in the Pujungan district in villages along the Bahau River. Apau Ping and Long Alango were selected as contrasting case study sites. Apau Ping was selected as the village that is furthest upstream along the river, and hence the most remote from transportation and traders. It also had the largest forest area. Long Alango was the last major village before a set of difficult rapids, and therefore attracts more traders and other visitors. Long Alango's links with downstream villages was much stronger.

Settlements were relatively small in Kayan Mentarang compared to Krui, ranging from 269 people in Paking to 459 in Krayan (Table 4.9).[8] As at the regional level, population densities were much lower than for Krui, with the villages on the Bahau River (Long Alango, Apau Ping and Pujungan) showing extremely low population densities.

Table. 4.9 Population characteristics, Kayan Mentarang[a]

Characteristics	Village				
	Apau Ping	Long Alango	Pujungan	Paking	Krayan
Total Population	329	419	405	269	459
Number of households according to survey	58	72	86	60	84
Average members per family	7	6	6	na	na
Population density per square kilometre	.22	1.16	0.90	2.2	2.9
Age of head of household	42.5	46.9	42.1	41.3	41.1

Notes: a. Unless otherwise noted, population data were from BPS statistics for Pujungan (1993), Mentarang (1994) and Krayan (1996).

Our study of the villages of the Pujungan district focuses on Apau Ping and Long Alango, for which we have detailed information.

Apau Ping was the most remote, least developed and most homogeneous village. Dependence on forest products was highest here (Wollenberg and Uluk 1998). Villagers in Apau Ping also had access to the largest and more pristine forest area. Apau Ping's 58 households were nearly all Kenyah Leppo Ke'. Few outsiders ever reached Apau Ping, which was the village furthest upstream the Bahau River. Local residents and observers alike described Apau Ping to be more socially coherent and traditional. Public meetings occurred relatively frequently and large cross-sections of the community usually attended. This was despite the fact that Apau Ping was composed of four villages resettled in the original village: Apau Ping plus Pengayan, Long Lat and Long Tua. We observed conflict among households or disagreement with village leaders in Apau Ping to be less frequent compared to Long Alango in 1995-96.

Long Alango was intermediate to Pujungan and Apau Ping in access and development. It was a relatively homogeneous population of 72 households, most of whom were Kenyah Lepo' Ma'ut. Long Alango was more torn by internal conflict, and suffered from low levels of trust and weak leadership. There was more contact with outsiders due to its downstream location on the river, the presence of an airstrip and the

[8] Although the population in Krayan was a cluster of hamlets, they were very close together. Hamlets surveyed in Krayan were Pa Upan (15 households), Pa Ibang (22 households), Pa Kaber (20 households), Pa Amai (14 households), Long Birar (13 households). As each village was relatively small, for the purposes of this study they were clustered and treated as one.

nearby WWF research station. There were more households in Long Alango who depended on others to supply (or at least supplement) their food stocks, including the traditional *adat* leaders, teachers, traders and WWF employees. Although both Long Alango and Apau Ping shared the same *kepala adat besar* (chief customary leader), who resided in Long Alango, local villagers considered this leadership weak.

Long Alango residents had a reputation for making more intensive use for the forest. Villagers said they had to walk much farther in Alango to find gaharu compared to Apau Ping, even though the abundance of gaharu was reportedly greater in Long Alango.

Among the three Bahau villages, Pujungan was the most accessible and 'developed' in terms of infrastructure, trade and transport. It was the district capital, and previously a Dutch military outpost established at the confluence of two trading routes (Sellato 2000). Government jobs were abundant and the overall population depended less on forest products, including gaharu. Pujungan's 86 households were mostly Kenyah Uma' Lasan, but also included Punan, Javanese, Balinese and Bugis. Many Long Pujungan residents viewed collecting gaharu as a low-status activity and preferred trading the product or earning cash through other means, such as local trading, employment in one of the government offices or schools, or support services for these offices (e.g., the preparation of snacks). *Aquilaria* was abundant in the farther reaches of Pujungan, however because of the higher local population and higher accessibility to downstream villages, more of its gaharu had already been harvested.

The villages varied in other respects. In the same way that the strength of *repong* culture varied between Penengahan and Melaya in Jrui, the sense of local people's identification with and dependence on the forest varied between Apau Ping and Long Alango. Apau Ping livelihoods reflected a more isolated way of life, which villagers said was reminiscent of more traditional practices. Villagers in Long Alango and especially Pujungan increasingly used purchased goods as substitutes for forest products, e.g., nylon ropes for bark ropes and plastic bags instead of wrapping leaves. Villagers in Apau Ping more often relied on the traditional products from the forest.

Local Kenyah residents referred to *Aquilaria* spp. and gaharu generically as *sekau.* In the Bahau area, villagers – usually men – collected gaharu most intensively using harvesting expeditions of one to three weeks, and sometimes as long as three months. *Aquilaria* tends to be sparsely, but evenly distributed in the forest (LaFrankie 1994). The density of *Aquilaria* trees with diameter at breast height of more than 10 cm (dbh > 10 cm) was found to range between 1 and 5 trees per hectare in the village of Tebulo, adjacent to Long Alango, one of this study's sites (WWF and Long Tebulo Village 1996). No significant differences were found in the density of gaharu distribution in 2-3 km transect samples conducted by WWF in Apau Ping, Long Alango and Pujungan in 1997-98 (Carey Yeager, pers. comm.). The Tebulo evidence suggests, however, that variation in densities did exist even within small areas. According to villagers, there was more gaharu in Long Alango and Apau Ping than in Pujungan. The sparseness of *Aquilaria* meant that villagers had to invest significant travel time during harvesting just to find the *Aquilaria* tree, let alone a tree that contained gaharu. Local villagers also collected gaharu opportunistically while hunting or collecting other products. Gaharu expeditions were done either at villagers' own initiative or through the sponsorship of a local trader.

Where local traders sponsored trips, they provided food supplies to be exchanged for the cash equivalent in gaharu. Local collection groups consisted of two to six people according to our survey data. Our survey showed that single household may have one or more members participating in a gaharu-collection expedition. The average number of people per household that collected gaharu was 1.6 in Long Alango, 1.2 in Apau Ping and 1.1 in Pujungan. Individuals sometimes travelled alone when the gaharu was close to the village. Trips organised by outsiders were not included in this study, but we observed that their groups were larger and more frequently sponsored by traders. The average length of a trip ranged from eight days in Apau Ping to 14 days in Pujungan and 11 days in Long Alango (Table 4.10). Long Alango villagers engaged in more intensive gaharu collection, both by taking more trips and spending more days on each trip.

Wood chips containing gaharu, Long Alango

Large wood pieces containing gaharu, Long Alango

Table 4.10 Gaharu collecting trips per household and days per trip

Village	Number of gaharu collecting households	Average number of gaharu trips per household during 1995-96	Average number of days per trip
Apau Ping	26	2.69	8
Long Alango	28	2.96	14
Pujungan	18	2.17	11
Total	72	2.67	10.5

During a gaharu expedition, there was a general pattern of collection followed by most harvesters in the Bahau area. First, harvesters travelled to the general area where gaharu was expected to be found. They set up camp and during the next day fanned out from the camp site to search for *Aquilaria* trees. *Aquilaria beccariana* was reported to favour relatively wet locations. Harvesters can readily identify the *Aquilaria* tree by its characteristically crooked shape and white bark. The tree's wavy-edged leaves can be seen from as far as 10-15 metres. Fallen leaves on the ground are another way harvesters detect gaharu, as the leaves have a distinctive pattern of decomposition, retaining their green colour longer and maintaining the veined structure of the leaf. Harvesters can never be sure if an *Aquilaria* tree will yield gaharu. Infected wood is reportedly often found where trees grew on infertile soil and where ants entered the bark.

Collectors worked in pairs or as individuals, with the agreement that profits from the trip were shared equally. Accusations of secretly retaining gaharu for personal gain were not uncommon. The group also harvested trees while travelling. When collectors considered the gaharu near one campsite was exhausted, they moved on. One to two days was a typical length of stay at one campsite in the upper Bahau in 1995-96. During trips, collectors also usually hunted, collected fuelwood, cut poles and leaves for their shelter and sometimes collected fruit. They returned to the village when they had found sufficient gaharu or their supplies and spirits had run out. Average trip length during 1995-96 was 10.5 days (Table 4.10). Households engaged in an average of two to three trips per year (range of 1 to 6), with Long Alango households taking slightly more trips than those in the other villages ($F=2.712$, $df=71$, $p=.073$).

Villagers used three techniques for harvesting gaharu: *nepo,' nepeng* and *memai* (Kenyah terms). *Nepo'* refers to chopping and slicing the trunk of the *Aquilaria* tree using a machete or small axe. People used the *nepo'* technique to indicate whether infection existed and, if so, its quality and extent. If the collector found only a small amount, he would continue to *nepo'* to remove the gaharu available without cutting so deeply as to damage the tree. Collectors generally tried to not cut the tree if they did not have to, so they could return at a later date. They even slashed trees in strategic places to encourage the fungal infection. If the collector found a large amount in a single tree or was in a hurry, he would *nepeng (*fell) the tree to extract gaharu from as much of the tree as possible, including the roots. Outside collectors reputedly felled trees more often because they had no intention of returning to the site. *Memai* was the process of salvaging gaharu from fallen, dead trees. Collectors used their hands to squeeze and sift through the soft, decomposed wood of fallen trees.

Tenure rights to gaharu in the Bahau area have been evolving rapidly since the early 1990s, when the recent gaharu boom began (see Section 6 for more discussion, also Momberg *et al*. 2000). According to traders, the most recent gaharu boom in East Kalimantan began around 1989-90. At that time prices in the Bahau watershed area began increasing from about $50/kg to $150-300/kg. By 1995 prices reached $300-500/kg. Many collectors tripled or quadrupled their regular cash income. The increase in gaharu prices attracted professional collectors from as far away as Java, Sulawesi and Sumatra. In East Kalimantan traders brought in harvesters from other regions to work in groups of as many as 60 people and even hired helicopters to facilitate transport (Momberg *et al*. 2000).

During the early years of the boom, local villagers first became acquainted with the increasing price of gaharu when outside collectors started visiting the area in large numbers. In the Bahau area, the number of outsider collectors is estimated to have out-numbered local collectors beginning in 1991 (Momberg *et al*. 2000). There were no rules to govern gaharu collection in this period, although it was considered appropriate behaviour for visitors to report to the village head and request permission to use the village lands. The control of territory was historically derived from the way Kenyah aristocrats maintained their wealth (Sellato 2000). Leaders often took advantage of this control to exact fees or gifts in exchange for granting access. A glance at Dutch historical records suggests that little has changed since at least 1907:

> The inhabitants of the highlands…want to exploit the forests themselves. They are partially supported by their chiefs, but when it is in their own interest, these chiefs allow people from the lowlands to collect forest products in exchange for money or part of the product. The inhabitants of the highlands are obviously not very happy about that …
>
> Anonymous [Letter from the First Government Secretary to the Resident of Z.O. Borneo], 2 February 1907, translated from the Dutch by Carin Van Empel.

This practice was also consistent with that of local government officials requesting payments for favours. Government officials in Pujungan reportedly requested fees from gaharu collectors entering the district as well.

As local people began to feel jealous of outsiders collecting gaharu in their territories and questioned 'what will be left for our grandchildren', they attempted to increase their control over the resource in order to eliminate outside competition. In 1993 nine villages in the Upper Bahau Adat Area, including Long Alango and Apau Ping, mobilised to strengthen their collective claims to gaharu against outsiders (Momberg *et al*. 2000). All nine fall under the customary control of a traditional leader *(kepala adat)*, who organised a series of annual meetings with the other village heads to create and update rules of access to gaharu. For the first time that anyone could remember, village leaders created a written customary law. Pujungan was part of a different customary area and did not join the initiative.

The intent of the new Upper Bahau *adat* rules was to limit gaharu collection to the people or *masyarakat* of the Upper Bahau, according to nearly all accounts from village leaders and other community members. People explained that they wanted to reserve gaharu for their use and to collect the gaharu before outsiders did. The principle guiding the rules was hence that village membership provided entitlement to collect gaharu. Outsiders wanting to collect gaharu from forests within their village boundary, or what they began to call *tanah ulen* in Indonesian or *tana' ulen* in Kenyah (protected land), were to be restricted. Outsiders who entered without permission from the village head were supposed to be fined, sent home and their possessions seized. Interpretation of who was an outsider varied by village and by the influence an outsider might wield with the village head. In Long Alango, for example, relatives of families from the village, were allowed in, but charged fees of Rp. 50,000 (US$23 in 1995-96). Due to difficulties of enforcement and margin for interpretation of the rules by village leaders, as well as outright corruption in accepting payment in return for access to community lands, control of access has not been completely effective.

The rules included a fee structure intended to differentiate between outsiders and locals. Villagers wishing to collect gaharu in their own village territory paid Rp. 2,500 per collection trip, people from other villages in the Upper Bahau *adat* area paid Rp. 5,000 and people from outside the *adat* area paid Rp. 50,000. The rules also stipulated that a local person should accompany outsiders, ostensibly for transparency, but just as likely to acquire a cut of the profits. The official boundary keeper was the village head or traditional chief leader, both of whom customarily handle matters concerning outsiders and village territory.

Gaharu for sale in a Singapore apothecary

The fees were to be paid to the village leader for use in the *kas desa* or community chest for public needs. In fact, for local villagers, these payments differed little from the historical practice of tribute payment. Historically villagers of commoner rank were required to make payments in rice to their aristocratic 'lords', (*paren bio* in Kenyah) as the gaharu fees were pocketed directly by village leaders. In the 1980s the power of the aristocrats in the Upper Bahau area to request these payments declined rapidly. The aristocratic families were forced to start farming their own rice during these years, although we observed that some continued to receive occasional tributes even up to 1997. Village leaders probably saw gaharu as an opportunity to regain some of their declining wealth and power. They continued to ask villagers for payments, as well as request fees from outsiders. However, we know that in Long Alango fees were never collected from local villagers. Village leaders say they never tried. Evidence suggests that fees were collected in other villages, although unevenly.

The rules were made in public meetings by reaching consensus among the chief traditional leader for the Upper Bahau *adat* area, village heads and village members. The chief customary leader was responsible for the actual wording and recording of the rules. In practice, the members most actively participating in the meetings are those considered the *tokoh masyarakat* or prominent members of the community (roughly equivalent to village elders, but they do not have to be old). Village leaders and many of the *tokoh masyarakat* are members of the customary aristocratic class (*paren* in Kenyah) that have traditionally maintained control over village matters.

Despite these attempts to limit outside use, the regulations were unevenly implemented (see discussion in Section 6). Only in 1996 did the rules start to be more consistently applied throughout the Upper Bahau. Even with these rules, in areas far from settlements, collectors tended to consider the resource as open access. Near settlements, however, territorial claims were more likely to be observed and intruders were more likely to be caught. Many collectors intentionally entered a village's territory from afar and it was either impractical or not in their interest to report to the village head. Individuals could not make claims to ownership of an *Aquilaria* tree as they could for some timber trees or planted fruit trees.

Villagers in Pujungan reported that the 'closing' of the upper Bahau to collectors resulted in more collectors looking for gaharu in Pujungan. In mid-1998, the traditional leader of the Lower Bahau *adat*

area reported that Pujungan also decided to no longer allow people from other villages to collect gaharu within its village boundaries. According to local respondents, this decision was partially in retaliation for forest fires earlier in the year caused by outside gaharu collectors. As of August 1998, however, no users had been asked to leave.

4.3 Summary

The Krui damar agroforests and natural Dipterocarp forest of Kayan Mentarang provide an opportunity to understand the role of economic incentives in forest management for two distinctive forest systems. We can use these forests' management systems as models for policy learning, as the agroforest or forest has persisted despite use by local populations in both locations. As the dynamics underlying that management were quite different between the two forest types, we therefore also expect the cause and effect pathways of economic incentives to vary between the two sites.

In Krui, the damar agroforest was a planted forest based on individual ownership and a mix of private and state forest land. Population pressure was moderate. The agroforests were sustained as stable demand and supply of the forest resource over several generations had enabled local people to adapt sufficiently to their environment and be confident of receiving any long-term returns from their efforts. With domestication, the distribution of damar trees was geographically clustered and situated relatively close to people's settlements. Krui demonstrates the possibilities for economic incentives to function to create and maintain a forest. It should be relevant as a model for comparison with other planted forest areas.

In Kayan Mentarang, the natural Dipterocarp forest was state forest land, with much of this designated as national park. According to customary law, tenure was a mix of common and individual property. Population pressure was low. Forest use was sustainable, at least in part because of low use or demand relative to the regenerative capacity of the resource. Wild forest products such as gaharu occurred in dispersed spatial patterns, far from settlements and required significant time for collection. Kayan Mentarang demonstrated the role, however, of high economic incentives in encouraging overharvesting by local people and outsiders. It also showed how, with time, these incentives encouraged local communities to mobilise to protect the benefits from a high-value NTFP for their own use.

In both Krui and Kayan Mentarang, the threats to the forest were as much from external influences, such as oil palm and outside gaharu collectors as, they were from local people's lack of incentives for management. The importance that people assigned to forest benefits was likely to be lower (or at least at risk of being lower) where these external threats occurred, especially where land tenure rights were insecure or open access and people saw no hope for securing their rights. Incentives for management can be expected to be low where such conditions occur.

The villages within each study area showed a range of differences in biophysical and social conditions. This heterogeneity at the village level is also important to note in interpreting economic incentives, as livelihood strategies varied among villages and households. Awareness of the special features of the Krui and Kayan Mentarang study sites and the villages within them is necessary for interpreting the livelihood strategies and cause and effect pathways of incentives discussed in the following sections.

5. Income Levels and Dependence on the Forest

5.1 Introduction

During the latter half of the 20th century, forest dwellers in Indonesia, as elsewhere, have gained access to significantly larger amounts of cash income as transportation to markets has improved and opportunities for cash exchange and employment have increased. Market demands and the growing importance of cash in household livelihood strategies have created powerful economic incentives for harvesting of marketable forest products in areas like Krui and Kayan Mentarang.

In this section we report our findings about the levels of income that villagers in Krui and Kayan Mentarang derive from the forest. We show the different sources of this income, including that which is derived from the forest. More detailed discussion of the income from gaharu and damar and analysis of the corresponding incentives for management is presented in the next section.

5.2 Definitions

Income is defined here as *total revenues less total costs* (Leones and Rozelle 1991). Gross income refers to total revenues less cash costs, while net income is defined as total revenues less cash and imputed costs such as depreciation and labour costs. Unless noted otherwise, income reported here is gross income. We were able to calculate gross income more readily in Krui where cash costs were common, and used imputed values or reported revenues in Kayan Mentarang to indicate income levels there. Income often carries the connotation of cash income, yet for forest dwellers, the noncash or in-kind incomes, usually forest and agricultural products, are often a significant portion of incomes. Both types of income are therefore reported here.

Livelihood is defined as the means by which households (or other social units) manage their income, expenditures, assets and social relations to fulfil their economic needs (Bartlett 1980; Wilk 1989).

We use agroforest-dependent and forest-dependent interchangeably in the following discussion to reflect the nature of the different resource bases in Krui and Kayan Mentarang respectively.

5.3 Other studies on forest income

Studies of incomes of forest villagers are rare compared to agricultural income studies. The logistical difficulty of working in forest areas, far from markets and where often hundreds of products are used has proved to be a major hindrance to conducting forest income studies (Wollenberg and Nawir 1998). Even for those studies that have been conducted, few provide a comprehensive, quantitative account of income (Lim 1997). Most focus on the role of one source or a set of forest-derived income sources in the household economy (Reining *et al.* 1992; Lim and Ismail 1994; Godoy *et al.* 1995; Rajan 1995; Dury *et al.* 1996; Lim 1997. They also tend to use small household sample sizes (see Table 5.1 for a summary of studies about forest dwellers' income).

A comparison between studies that show forest dwellers' monetary incomes is of limited value without more information (see Table 5.1).[9] The percentage of forest dependence is also potentially misleading.

[9] The figures would have to be adjusted for inflation, so that incomes could be compared in constant prices (dollars in Table 5.1). In addition, the value of the currency locally should be expressed relative to the cost of basic staples such as sugar, corn, rice or coffee.

The concept of forest dependence is flawed to the extent it is expressed according to a single dimension or monetary unit. As has been demonstrated elsewhere (and discussed in the Introduction), the value of an income cannot be simply expressed monetarily. Values for food, security, cash, continuity of cultural heritage and social identity (through forest products such as meat of the wild pig for Christian Dayak groups, for example) may also be important.[10] The role of forest incomes cannot be discounted, even if they provide only a supplementary income for most forest-dwelling peoples (Arnold and Ruiz Pérez 1998). The value of such supplements could be crucial to household strategies of risk avoidance, as stable sources of food or products tradable for cash during times of shortage or emergency.

Table 5.1 Summary of findings from studies of incomes of forest communities

Reference	Reported Annual Income	Type of Income Described	Location	Sample
Lim 1997	$1364/household (1990) $667, $2410, $2544, $3172/ household (avg = $2199) (1992); 14% or $191 from forest for 1990 study	Monetary and non monetary household net income, forest income focus	Perak and Pahang, Malaysia Orang Asli	20, 13, 15, 102, 16 and 8 households respectively from 6 villages
Godoy *et al*. 1995	$95 to $820/person, NTFP per household = 13%-87%,	Monetary and non-monetary household income, NTFP focus	Bocay River and eastern territory of Sumu in Nicaragua	1-5 households from each of 11 Sumu communities
Gunatilake *et al*.. 1993	$31.80-$745.60/family 63% of total income & 59% of cash income from forest resources NTFP income = 16 %.	Monetary and nonmonetary household income, NTFP focus	Knuckles National Wilderness Area, Sri Lanka	60 households, stratified random sampling
Whiteman and Aglionby 1997	$237/adult $191 subsistence benefit for a total direct-use benefit of $428	Monetary and nonmonetary net income, forest and fisheries focus	Danau Sentaram Nature Reserve, West Kalimantan, Indonesia	1994 survey of 39 villages. 1995 survey of 10 villages. Both surveys used participatory appraisal techniques in group meetings including village head.
Padoch 1988	2%-85% of income from fallow or forest	Monetary household income, forest and fallow goods	Iquitos market area, Peru (Amazon)	13 villages surveyed, 5-10 households in each
Cavendish (in Clarke *et al*. 1996)	$200/household, 8.2% from woodlands	Monetary household income, woodlands focus	Chivi, Zimbabwe	213 households from 29 villages, random sample
Melnyk and Bell 1996	$4696 and $1902/household in each village respectively	Value of wild foods to households	Amazonas state, Venezuela	1 & 3 households from two Huottuja villages: 100% & 10% sample; observ-ed over 12 months
Campbell *et al*. 1995	$50-$85 per household	Value of woodland to households	Chimanimani District, Zimbabwe	23 and 36 households from 2 villages; random sample stratified by wealth; 12 products

To avoid oversimplifying the value of income and its role in influencing incentives, we consequently base our analysis of incentives not on income levels alone, but on the importance of the income in the local

[10] De Beer and McDermott (1989) and Falconer (1990) provide excellent reviews of the literature describing the value, rather than incomes, of forest products in Southeast Asia and western Africa respectively.

livelihood. As discussed in the Introduction, we determine an income's importance according to four factors: cultural meaning of the income, proportion of the income compared to total income, the function of the income in the household and the availability of alternatives.

Forest income is defined here as that derived directly from forest products. Forest income is thus distinguished from wage- or trade-derived income related to forests. To distinguish among different types of 'forest', products and incomes were identified by the land type from which they were collected, e.g., long fallow, short fallow, primary forest, river edge or agricultural land planted to perennials.

5.4 Income levels

Household income was collected in Krui and Kayan Mentarang in 1995-96 from our household surveys (Table 5.2). All villages in the two forest areas consistently had cash incomes that were *lower* than their respective regency *(kabupaten)* averages, with the exception of the villages in Krayan. Yet cash incomes statistics are misleading for forest communities that depend heavily on subsistence production from both agriculture and the forest. In-kind (non-cash) incomes also need to be taken into consideration. In Krui, although the addition of in-kind income (mostly wet rice or *padi* production) raised incomes closer to the provincial average, they were still lower on average. Only in Penengahan, where direct dependence on the agroforests was highest (91% of households with an average of 48% of their income from agroforests), did household income exceed the regency average for Lampung. Agroforest-dependent households had higher incomes on average than those who did not depend on damar.

Table 5.2 Total and forest household income levels, Krui and Kayan Mentarang 1995-96

Site	Annual cash income per capita (rupiah)	Annual total income per capita (rupiah)	Annual income per capita for forest-dependent households (rupiah)	Proportion of h-holds depending on cash income from forests (%)	Proportion of cash income from forest (%)	Regency average rural cash income per capita for 1996[a] (rupiah)
Krui	479,296	541,914	603,222	66	40	653,940
Penengahan	628,334	673,136	706,015	91	48	
Melaya	419,615	473,932	478,529	38	27	
Ngaras	346,197	454,021	520,085	80	52	
Kayan Mentarang	334,126	–	–	60	54	575,890
Apau Ping	228,939	–	–	84	67	
Long Alango[b]	370,036	2,564,917	2,564,917	75	69	
Long Pujungan	192,259	–	–	47	56	
Krayan	733,045	–	–	76	37	
Paking	228,761	–	–	33	22	

Notes: a. BPS 1996

b. Consumed forest products assigned value only for Long Alango. Proportion of all income from forest for Long Alango is 95%.

In Kayan Mentarang, the addition of in-kind income from *padi* and other agricultural and forest products in Long Alango raised the total income seven-fold, to a figure nearly 500% higher than the regency average.

All households in Krui had average cash incomes above the World Bank's poverty level for Indonesia of Rp. 360,000 per person per year.[11] Only two villages in Kayan Mentarang were over the poverty level in terms of cash income, but the figures from Long Alango suggest that the standard of living in terms of consumed subsistence goods from the forest and farm was well above this threshold.

The proportion of households depending on the forest for income ranged from 38% to 91% among villages in Krui and 33% to 84% in Kayan Mentarang. The high local variation suggests a need for caution in assuming that people within a region share common economic strategies. Variation in annual production can also be misleading. As discussed in the previous sections, fruit yields in some years can significantly increase incomes. The data presented here (Table 5.2) can be considered a base income; income in other years rose periodically with the availability of fruit harvests.

The proportion of income that the forest-dependent households derived from the forest also varied. For the Krui and Kayan Mentarang study areas, the proportion was about half of the income. On a village-by-village basis, the proportion of income ranged from 27% to 52% and in Kayan Mentarang from 22% to 69%. On average, the amount of income derived from the forest was higher in Kayan Mentarang than Krui.

5.5 Household income sources

There is wide variation in livelihood strategies among villages and among households within villages. The importance of the different sources of income varied (Tables 5.3 to 5.8).

Krui

Table 5.3 Household income sources, Krui

Income source	Village						All villages	
	Penengahan		Melaya		Ng. Ratu Ngaras			
	number of hh[a]	%	number of hh[a]	%	number of hh[a]	%	number of hh[a]	%
Damar resin collection	71	87.7	35	37.6	37	75.5	143	64.1
Other *repong* income[b]	38	46.9	25	26.9	12	24.5	75	33.6
Damar trading	5	6.2	3	3.2	2	4.1	10	4.5
Damar-based wages	30	37.0	2	2.2	19	38.8	51	22.9
Short-term perennials	40	49.4	57	61.3	8	16.3	105	47.1
Vegetables	3	3.7	9	9.7	0	0	12	5.4
Rice production	45	55.6	56	60.2	37	75.5	138	61.9
Other trading	9	11.1	32	34.4	19	38.8	60	26.9
Government employee	6	7.4	12	12.9	9	18.4	27	12.1
Other land-based wages	17	21.0	13	14.0	4	8.2	34	15.2
Nonland-based wages	11	13.6	5	5.4	2	4.1	18	8.1
Total households	81		93		49		223	

Notes: a. Number of households deriving income from the source

b. Although they do not reflect the peak season for fruit harvests, this includes main fruit production such as duku *(Lansium domesticum)* and durian *(Durio zibethinus)*

[11] Based on minimum daily rice consumption

Although there was an overall pattern of income sources based on damar, short-term perennials and rice among all three villages, the actual proportion varied by village (Table 5.3). While in Penengahan and Ngaras more than half of the households had some income from both damar and rice production, in Melaya the most common (> 50% of households) income sources were short-term perennials and rice. Damar was less important. The enclave of Javanese coffee growers in Kakabu, Melaya, probably influenced this figure. It does indicate, however, the relative importance of rice compared to damar in Melaya (see discussion in Section 6). Melaya was also unusual in that only 2% of its households relied on damar wage incomes, while in Penengahan the level was 37% and in Ngaras 39%. This may reflect the relative availability of land in Melaya such that households tended to be self-reliant in producing damar and other agricultural products and there was not an excess of labour. In all villages, only a small proportion of households depended on damar trade (i.e., buying from harvesters and reselling) and vegetable production.

Table 5.4 Average household income by source, Krui (Rp. 000)

Income source	Villages		
	Penengahan	Melaya	Ngaras
Land-based cash income	2,784	1,284	1,506
Productive *repong*	1,821	742	1,478
Resin	1,490[k]	646[k]	1,420[k]
Tanaman tua[a]	331	96	58
Other land-based income[b]	963	542	28
Short-term perennials[c]	956	525	27
Vegetables	1	4	0
Fruit trees outside of *repong*	6	13	1
Rice production value[d]	321	339	713
Nonland-based income	1,536	926	830
Government employment	398	123	21
Damar trading	139	19	35
Other trading activities[e]	567	196	84
Damar-based wages[f]	266	22	134
Other land-based wages[g]	17	231	201
Non land-based wages[h]	100	75	100
Other[i]	49	260	255
Total[j]	4,641	2,549	3,049

Notes:
a. *Tanaman tua* are long-term perennials (mostly fruit trees): duku (*Lansium domesticum),* durian (*Durio zibethinus),* petai *(Parkia speciosa),* etc.
b. Other land includes coffee and pepper gardens, young damar, mixed garden, advanced fallow, new land.
c. *Tanaman muda*: coffee, pepper and minor income from cloves
d. Combination of sold rice and imputed rice production value from *sawah* (wet rice) and dry rice produced
e. Includes *warung* (a small shop next to the owner's house)
f. Collecting, transporting and sorting damar
g. Wages from agricultural work, e.g., weeding, planting, harvesting rice
h. Wages not related to agriculture or forest
i. Handicraft production, rentals, government aid
j. Net income was calculated for income types that incurred production costs: seeds, land, preparation, fertiliser, spaying.
k. Net damar resin income depends on whether harvesting is by owner or by share-cropping and, if the latter, the proportion taken by the harvester and owner

The more common the income source among households in a village, the higher the amounts generated from it. Penengahan households earned the highest amount from nearly all income categories (Table 5.4), except rice production (where Ngaras had the highest level), other land-based wages (Melaya) and 'other'

(Melaya). These differences may reflect Penengahan's proximity to the town of Krui and its produce and labour markets. Not only did Penengahan residents have access to higher prices, but over time they seemed to have specialised further than the other villages in their reliance on the cash economy.

Damar incomes were significant in all Krui villages (Table 5.5). We examined primarily incomes derived from collecting damar resin as the dominant source of damar-related income for most households. The average per capita income from damar alone was one-third or more of the regency rural income average of Rp. 653,940 (US$297.25). In two villages, three-quarters or more of the households relied on damar income. Melaya's lower percentage reflects the large number of migrant households from Java who tended to cultivate coffee rather than damar (these households resided mostly in the subvillage or *dusun* of Kakabu, which constituted 36 households or 38% of our sample from Melaya). Average revenues per household were highest in Ngaras, probably because of the higher proportion of productive trees.

Table 5.5 Damar resin collection income, Krui

	Penengahan	Melaya	Ngaras
Households with income from damar resin collection			
Number of households	71	35	37
Proportion of all households (%)	88	38	76
Average revenue from damar resin collection per household per year (Rp. 000)	1,986	1,793	2,184
Average income[a] from damar resin collection per year (Rp. 000)			
Per household	1,700	1,717	1,881
Per capita	241	252	361
Average income[a] from damar resin collection as Proportion of total income per household per year (%)	44	51	49
Average income[a] from all damar-related activities[b] per year (Rp. 000)			
Per household	2,056	1,812	2,044
Per capita	301	266	292
Average income[a] from all damar-related activities[b] as proportion of total cash income per year (%)	52	55	55
Average total income for households with income from damar resin collection	4,954	3,368	3,628

Notes: a. Recall that income figures reflect revenues less costs, e.g. gross income. Total income refers to cash income plus value of rice production. We report here averages only for households with income from damar resin collection.

b. Damar-related income sources include resin collection, trading and wage labor

Revenues were lowest in Melaya, as would be expected given the lack of good maintenance and history of conversion there. Penengahan and Ngaras have higher costs of transportation, however (to damar gardens and to Krui respectively), so Melaya's final damar income was slightly higher than that of Penengahan. Melaya households' higher proportion of income from damar reflected their lower overall income compared to Penengahan and Ngaras.

To understand the importance of all damar-related incomes, we also show in Table 5.5 incomes derived from damar-related activities, including earning of wages in damar collection, transport or sorting; trade and collecting damar resin. (Unless specified otherwise, damar income in this report refers only to income from resin collection). Penengahan and Ngaras households earned significant additional incomes of Rp.

356,000 to 163,000 on average from these other activities. When all damar related income is considered, households in all three villages depended on average on damar for about half of their total income.

For the total amount of damar income earned in Melaya, its importance in the household income is relatively high. This reflects Melaya's low average income. For households that depended on damar, the proportion was relatively similar for Penengahan and Melaya and somewhat lower for Ngaras.

Kayan Mentarang

There was an even more variable pattern of livelihood strategies in Kayan Mentarang than in Krui. There was also a higher level of diversification of sources for cash income among villagers in Kayan Mentarang. Among 50% or more of the households in each village had income from wages, gaharu, livestock (mostly chicken for consumption by other villagers), trade, cottage good production, other forest and agricultural products (often sawn timber, fruits and vegetables for local consumption), assistance and rentals. Except for employment with WWF and possibly trade, most sources were erratic and unpredictable, which may explain the higher levels of diversification.

The data reflect how villagers made the best of local conditions at each of the five sites. The only income source consistently found among more than 50% of households in all five villages was wages. Gaharu was a common income source for the majority of households in Apau Ping and Long Alango, even though the population densities were lowest. Trade was only common for Krayan and Paking, both of which had more ready access to larger markets than the Bahau villages. Cinnamon was a relatively minor income source used by only one-fifth of the households in Apau Ping, but did not appear in among any of the other villages for 1995-96. Apau Ping was known for having higher amounts of natural wild cinnamon, speculated to have been planted by early residents of the area. Employment by WWF occurred only in the Bahau villages because of the presence of a research station and its higher level of activity in the Bahau region during 1995-96.

Table 5.6 Household revenue sources, Kayan Mentarang

Source of cash income	Village										All villages	
	Apau Ping		Long Alango		Pujungan		Paking		Krayan			
	No. of h/h[a]	%	No. of h/h[a]	%	No. of h/h[a]	%	No. of h/h[a]	%	No. of h/h[a]	%	No. of h/h[a]	%
Gaharu	26	81	29	73	19	40	15	45	21	46	108	55
Cinnamon	6	19	1	3	0	0	0	0	0	0	7	4
Forest and agric. products[b]	6	19	22	55	17	36	33	100	20	43	98	50
Rice sales	10	32	14	35	10	21	5	15	13	28	52	26
Livestock	13	42	22	55	19	40	22	67	27	59	103	52
Wages	18	58	31	78	41	87	33	100	31	67	154	78
WWF	2	6	8	20	5	11	0	0	0	0	15	8
Trade[c]	1	3	5	13	2	4	20	61	25	54	53	27
Cottage goods[d]	16	52	18	45	18	38	14	42	6	13	72	37
Rentals[e]	5	16	7	18	11	23	17	52	3	7	43	22
Assistance[f]	14	45	20	50	5	11	25	76	43	94	107	54
Total	31	–	40	–	47	--	33	--	46	--	197	--

Notes: a. Number of households deriving income from the source
b. Other than gaharu and cinnamon
c. Routine trade through store or as a purchaser of goods such as gaharu and cinnamon
d. Irregular sales of weavings, hats, alcohol production etc.
e. Rentals of boats, outboard motors, chainsaws etc.
f. From govemment, church, village etc.

As in Krui, there were a variety of household strategies for meeting income needs in Kayan Mentarang in 1995-96 (Table 5.7). Revenue levels were associated with their frequency among households in each village. If gaharu, cinnamon and forest and agricultural products only are taken into account, Long Alango showed the highest dependence on forest revenues (Paking's high revenues from "forest and other agricultural products" was mostly from agriculture). Rice sales were highest in Pujungan, probably because of the higher proportion of government employees living there who generally did not cultivate sufficient supplies of rice for their own use.

The importance of gaharu income across villages in Kayan Mentarang varied (Table 5.8). The proportion of households depending on gaharu was highest in Long Alango and Apau Ping. The levels of average revenue, net income (revenues less actual and imputed costs) and percentage of highly dependent households correspond to the proportion of households depending on gaharu. We could not calculate income figures for Paking and Krayan as labour costs were not collected during the survey.

Like damar in Krui, gaharu generated large revenues, with significant income even after costs were subtracted. The income from gaharu alone in two villages was higher than the average cash income for the regency (*kabupaten*) of Bulungan in 1996 of Rp. 575,890 or US$262 (BPS 1996). Both absolute income and proportional income figures indicate that gaharu was a major component of villagers' livelihoods in Long Alango and Apau Ping, and to a lesser extent in Pujungan, Paking and Krayan.

Table 5.7 Average household revenues by source, Kayan Mentarang (Rp. 000)

Revenue Source	Village					All villages
	Apau Ping	Long Alango	Pujungan	Paking	Krayan	
Gaharu	963	1,335	594	519	913	929
Cinnamon	84	17	0	0	0	75
Forest and agric. products[a]	110	69	411	1,536	211	654
Rice sales	118	45	198	123	135	118
Livestock	28	80	49	250	367	181
Wages	251	200	288	449	554	354
WWF employment	18	66	247	0	0	120
Trade[b]	751	1,072	1,051	485	407	532
Sales of cottage goods[c]	327	161	282	60	na	254
Rentals[d]	95	3,149	85	221	245	671
Aid[e]	567	1,026	763	310	1,036	790
Total	3,312	7,220	3,968	3,953	1,281	4,678

Notes:
a. Other than gaharu and cinnamon. Most of these products tend to be vegetables or fruits, and most are cultivated agricultural products.
b. Routine trade through store or as a purchaser of goods such as gaharu and cinnamon
c. Irregular sales of weavings, hats, alcohol production, etc.
d. Rentals of boats, boat motors, chainsaw
e. From government, church or community

Table 5.8 Gaharu revenue and income, Kayan Mentarang

Village	Households with revenues from gaharu (%)	Average revenue from gaharu per household per year (Rp. 000)	Average gaharu income per household per year (Rp. 000)	Gaharu revenue as proportion of total revenues (%)	Proportion of households with 80% or more of cash revenues from gaharu (%)
Apau Ping	81	963	840	68	28
Long Alango	73	1,335	1,137	69	28
Pujungan	40	594	440	56	9
Paking	46	519	na	30	na
Krayan	46	913	na	26	na

Gaharu-earning households were also better off. The average cash income among these households was nearly two times higher than that among non-collecting households in Apau Ping, Long Alango and Pujungan (income data not available for Krayan and Paking). Gaharu-collecting households had average incomes of Rp.1,976,983 (US$899), while non-collecting households averaged only Rp. 1,053,091 (US$479) per year (t-test=-1.795, df=61, p=.078). Differences in gaharu incomes were statistically significant among the three villages, (F=2.893, df=72, p=.062).

Mature forests were lucrative sources of cash income because of gaharu (*Aquilaria* spp. is not generally found in cultivated or fallow landscapes). Gaharu constituted 100% of mature forest cash income in Apau Ping, 98% in Long Alango and 92% in Pujungan. The other major source of cash income from the forest during 1995-96 was wildlife sold for meat, especially wild pig. The price of meat was only Rp.1,500-2,000 ($US 0.68- 0.90 at the prevailing exchange rate) per kg, and generated relatively little income compared to gaharu. No rattan and only small amounts of wild cinnamon were sold, which fetched only about Rp.1,000 (US$0.08) per kg among collectors for an average income during the year of Rp. 84,167 (US$ 38.26) in Apau Ping and Rp. 16,500 (US$7.50) in Long Alango. Given the importance of the mature forest as a source of gaharu, access to this forest has important implications for people's cash incomes.

The majority of households in the Bahau area depended to some extent on gaharu income 1995-96 (Table 5.8). Apau Ping and Long Alango had the highest proportion of households that collected any gaharu, and Pujungan the lowest. In Apau Ping and Long Alango, gaharu was also the primary income for more than half of the households. While Apau Ping had the highest proportion of gaharu collecting households, Long Alango had the highest proportion of households that depend on gaharu for the majority of their income. Gaharu is probably most prominent in the upriver villages of Apau Ping and Long Alango because it is more attractiveness than other cash income alternatives in these areas. Long Alango residents also seemed to make heavier investments in gaharu collection than Apau Ping villagers (see Section 6).

As in Krui, the higher the proportion of households depending on a valuable forest product, the more we would expect to see collective action among that group. For gaharu, we were in fact able to see how communities with different levels of dependence reacted to the gaharu boom. From the data (Table 5.8), we would predict that the villagers in Long Alango and Apau Ping were among the first to act collectively, both within and across villages. A high proportion of households dependent on an income source may indeed be a precondition for achieving collective action.

5.6 Changing livelihoods

Based on interviews with elderly key respondents, young people and our own observations, we found that 12 major trends appeared to be taking place in Krui and Kayan Mentarang with respect to livelihood

constraints and opportunities. Improving income opportunities for forest dwellers has become an important component of rural development and conservation objectives for many organisations and projects. These trends at village level will be important in shaping the design of conservation and development-oriented interventions. Most of these trends have been occurring incrementally over the past two to three decades (the span of a generation). They require further testing to assess their validity.

(1) Cash-based and nonland-based incomes are becoming more important in forest areas with improving infrastructure.
(2) Households are depending less on forest-based income as access to employment and markets improves. If cash income is available, consumer goods from markets are preferred over those from the forest because of ease of acquisition.
(3) Household income strategies are becoming more profit-oriented.
(4) Individuals, especially young people, have become more significant economic actors than community or household units. This trend has implications for declining economic and social interdependence among family members. Also, individuals as well as households should be considered the relevant unit of consumption and production.
(5) Traditional systems of mutual aid ('social security systems') are eroding.
(6) Economic decisions are influenced by the increasing role of government in economic affairs with respect to:
    - costs associated with taxes, licences and
    - land security; fear of loss of land and eviction by the state.
(7) The locus of people holding authority and influence is shifting to people with economic influence or strong educational backgrounds and the importance of traditional leadership and social hierarchies are decreasing.
(8) Relations with traders are becoming more diverse. Economic differentiation and specialisation is increasing within villages, such that not all households are primarily farmers or forest collectors. Some households can afford to be primarily traders, service providers or other wage earners. The role of women in procuring cash income is becoming more important as local economies become commodified (e.g., selling of vegetables for cash in Kayan Mentarang) and as markets become more accessible through improved transport.
(9) Wealth is stored increasingly in the form of cash rather than in land, food supplies or inherited goods.
(10) The labour of children in the household economy has decreased as more attend school.
(11) There is more pressure from NGOs, universities and government to conform to environmentally sustainable practices.
(12) Competition for land and conflicts over resources has become more intense.
(13) Marketing of more diverse products such as fruits is becoming possible.

5.7 Summary

Income data for forest dwellers in Krui and Kayan Mentarang indicate that these forest communities were cash deficient, compared to the rural averages for the rest of their districts. However, households with incomes from forests were better off within these forest communities. Damar in Krui and gaharu in Kayan Mentarang were the most important forest products contributing to that income. Calculation of in-kind income indicated that villagers in Kayan Mentarang enjoyed much higher incomes than the rural average in their regency and than Krui in terms of the subsistence goods they collected from the forest or produce.

The average proportion of households depending on forest incomes was roughly similar in both Krui and Kayan Mentarang, 66% and 60% respectively. The wide variation in this proportion among villages was also similar for both study areas, between 33% and 91% for all villages surveyed. Similarly, the average

proportion of forest income among these households was similar for both study areas, 40% and 54% respectively, with a range among villages between 22% and 69%.

Livelihood patterns were more similar among villages in Krui than Kayan Mentarang, in that they reflect a more uniform dependence on damar, short-term perennials and rice production. Even in Krui though, significant differences occur among villages in both the frequency of the income source and level. In Kayan Mentarang, households in all villages tended to rely on a more diversified income base than in Krui. High levels of variation across villages in the pattern of common income sources show how people have adapted to different local economic opportunities. For forest products, the proportion of households dependent on an income source tended to be directly associated with the level of income from that income source. The differences in livelihood patterns among villages in Krui and Kayan Mentarang suggest that income sources such as damar and gaharu might play different functions in the household livelihood strategies of the respective villages.

Livelihood trends in Krui and Kayan Mentarang suggest a declining importance of forest incomes, and the knowledge, labour and institutions necessary to manage forest resources. There were more needs for cash as well as more opportunities for earning cash. At the same time, there was increasing pressure to manage forests sustainably with increasing involvement on the part of nongovernmental and government authorities to facilitate this aim. In the context of these trends, understanding economic incentives may become even more important than ever for policy makers interested in encouraging sustainable forest management.

6. The Influence of Economic Incentives on Damar and Gaharu Harvesting

6.1 Introduction

Unlike subsistence-oriented use that is limited by consumption needs, the economic incentives associated with products exchanged in markets create a more open-ended demand that can lead to rapid overuse of a resource, especially in larger international markets. In this chapter we examine the cases of Krui and Kayan Mentarang in an attempt to gain a better understanding of the influences that determined whether economic incentives encouraged conservation or promoted overuse of forest products.

In Krui and Kayan Mentarang, people's cash incomes were derived primarily from one product from one species. In Krui, that product was the resin of the damar tree. In Kayan Mentarang, it was gaharu, the fragrant fungal-infected heartwood of the *Aquilaria* tree. We focus on damar and gaharu as the predominant sources of cash income in each area, and because local people expressed concerns about the maintenance of these income sources. For both sites, we look at the conservation objective as the long-term maintenance of the supply of a product from the forest for local villagers' use. For both sites, a significant threat to reaching that objective was overharvesting.

We tested the association of economic incentives (prices and indicators of income) with levels of harvesting damar in Krui and gaharu in Kayan Mentarang. As discussed in Section 1, we sought to examine whether economic incentives led people to conserve forest products, and if so why. We also examined nonincome-based explanations. We conducted the analysis by looking at: (1) the cause-and-effect linkage of the income to conserving the resource; (2) expected importance of the income in the future; and (3) social values, institutions and norms mediating the influence of economic incentives.

6.2 Indicators of damar conservation

For farmers in Krui, trade-offs between the future and the present meant whether to harvest more damar now at the expense of a shorter productive life of the damar tree. We combined two indicators to measure the intensity of damar resin collection: the mean number of days between resin collections for a garden and the shortest period between resin collections ever experienced.[12] We defined conserved *repong* as those with a mean harvest period of more than 30 days and minimum harvest period of no less than 15 days. Overused *repong* were defined as those with mean harvest periods of 30 days or less and minimum harvest periods of less than 15 days. To classify households, we defined 'conserver' households as those that had a larger number of conserved *repong*, while 'nonconserver' households were those that had a larger number of overused *repong*. We defined ties as overuse, so that conservation would be estimated conservatively. See Annex 2 for more details about the calculation of the conservation indicator for Krui.

[12] Since our survey data were based on recalls of average harvest periods, we combined this indicator with the minimum harvest period as an indicator of occasional periods of overuse to show fluctuations from the average during the course of the year.

We chose these indicators based on common local knowledge of what was considered sustainable damar management in both Penengahan and Melaya.[13] We selected only those indicators that seemed the most reliable and unambiguous in their interpretation (see discussion of *repong* management in Section 3). In our statistical tests we controlled for travel time from the village to the *repong* to isolate the effects of income incentives. *Repongs* close to the village (one-hour round trip or less) are harvested more frequently because they are more accessible and theft of the accumulating resin from the tree is more frequent.

6.3 Indicators of gaharu conservation

In the natural forests of Kayan Mentarang, people trade off harvesting more forest products in greater quantities now at the expense of forest products being less available in the future.[14] As an indicator of gaharu conservation, we used the number of collecting trips multiplied by the number of people per trip from a single household in the last year. This indicator captured the household's intent to harvest gaharu. We defined households with three or more person-trips per year as having the 'intention of intensive use' and those with two or less as 'intention of less-intensive use'. The threshold was selected according to local perceptions of the number of trips associated with casual versus intensive gaharu collecting. We used this indicator to test the effects of economic incentives.

The lack of sufficient information about population ecology of *Aquilaria* and fungal infection rates prevented us from identifying a precise conservation threshold for gaharu. Given these difficulties, we define conservation and overuse in relative terms according to the level of gaharu extraction. We use the median as a cut-off point. More gaharu harvesting is expected to lead to more rapid depletion of the resource. The difficulties of selecting a threshold and adequate indicator are likely to be typical of other forest products for which little ecological information is available.

6.4 Causal pathways: linkage of economic benefits to conservation

The relevant conservation activity in both sites is therefore lower harvest intensity of a forest product.[15] In Krui, higher economic benefits were directly linked to less frequent harvests for a given level of labour per harvest. The longer the rest periods between harvests, the higher the resin yields per harvest (see Tables 6.1 and 6.2). If people harvested frequently they could earn higher yields in a given time period, but at the expense of a shorter productive life span of the tree. Farmers could delay their harvest now, knowing that they will harvest more later. There was therefore a potential economic incentive for damar conservation in Krui. The incentive should have been strongest in distant plots where households did not worry as much about theft of damar from their trees.

In Kayan Mentarang, however, economic incentives encouraged harvesting in the present period. Due to the relatively open-access nature of the forest, there was nothing to be gained by delaying harvesting as outside collectors would otherwise harvest the gaharu. Also, the natural production of gaharu was so

[13] Local people in Penengahan and Melaya also said that harvesting about once a month was optimum, although previous generations often harvested only once every two months. All productive trees were usually harvested at the same time from a single *repong*. As indicated in Section 3, harvest intensity normally ranged from 15 to 45 days between each *ngunduh*, or harvest, of the resin from trees in a *repong*. Our survey indicated that on average most people harvested damar at 15-day intervals during periods of extreme cash need. Government of Indonesia recommendations for optimal damar harvesting are also based on local informants' knowledge (Taulana pers. comm.). During the case-study work, villagers indicated that sudden needs for cash (e.g., for medical bills) were common and often met by shortening the harvesting cycle to gain quickly acquire income.

[14] Without knowing more about the reproduction of the gaharu fungus we cannot predict whether these future shortages are long lasting or only temporary.

[15] Lower harvest intensity also reduces the use of the forest overall through lessening direct impacts (e.g., damage to the tree) and secondary impacts (due to trails, campsites, noise).

slow and uncertain that there was no reliable relationship between a waiting period and increased yields. Prices were also volatile and could drop quickly. Given this uncertainty about tenure, yields and prices, as well as other factors discussed further below, economic benefits did not create incentives for gaharu conservation in Kayan Mentarang. Most people wanted to collect as much gaharu as they could before others did so.

6.5 Explanatory value of economic incentives for damar conservation in Krui

Prices

Price increases are often taken as indicators of the likelihood of increased exploitation or cultivation of a product, especially if the product's value is higher than other alternatives. Damar resin's 1995-96 price of Rp. 1,000 to Rp. 1,200 per kg had been remarkably stable over the last 50 years relative to rice. A number of farmers commented that they did not pay attention to price changes in deciding about how much damar to plant; they planted damar for their children, not for themselves. Nevertheless, the stability of the price has enabled villagers to have more secure expectations about the future value of the product.

Small price changes for damar itself (e.g., from Rp. 1,100 to Rp. 1,200) seemed to have little impact on harvest levels. We could discern no significant relationship between price and the frequency or amount of damar harvested from our case study data.

Although the prices for other products such as coffee (Rp. 4,000 to Rp. 5,000/kg) and pepper (Rp. 8,000/kg) rose on occasion, most farmers did not replace damar with these more valuable crops; perhaps because their prices fell as quickly as they rose.

Farmers in Krui were generally unresponsive to prices with respect to damar management. This inelastic response may be typical for planted perennial crops with yields over the long term, where farmers do not perceive the value of the tree according to price variations and are reluctant to give up the effort invested in growing the tree.

Income

We tested the influence of income incentives with the survey data by comparing conservation practices against six conventional indicators of income: (1) net damar income as a percent of total income; (2) net damar income; (3) net damar income relative to expenditures; (4) net damar income relative to alternative incomes; and (5) net damar income per tree. We did not have the data to calculate damar income per hour of labour. The indicators were tested separately for close and distant *repong* in Melaya and Penengahan (Tables 6.1 and 6.2).

There was no statistically significant relationship damar conservation and all but one of the income indicators. While the average income for conservers was higher than that for nonconservers for every indicator except one, these relationships were not statistically significant. With only one indicator showing statistical significance, it is also difficult to make a reliable interpretation of this indicator, other than to suggest that the pressure of higher expenditures relative to lower incomes may have driven people to harvest more. The lack of significant statistical relationships may be explained in part by the high level of variation among cases and, in Melaya, the limited number of distant *repong*. It is therefore not possible to conclude from this data that higher income benefits were associated with conservation behaviour while lower benefits were associated with overuse.

Table 6.1 Income incentives and conservation in Krui for households with only close *repong*

Damar income	Households			
	Mean Value	Mean for Conservers	Mean for Nonconservers	Significance of difference (t-test)
Net damar resin income as proportion of total income				
Penengahan	43%	46%	41%	0.781
Melaya	47%	47%	46%	0.884
Net damar resin income (Rp. 000)				
Penengahan	1,274	1,421	1,089	0.693
Melaya	1,406	1,514	1,268	0.511
Income relative to expenditures				
Penengahan	0.58	0.59	0.58	0.966
Melaya	0.87	0.83	0.92	0.774
Income relative to alternative routine incomes				
Penengahan				
Melaya	0.60	0.65	0.54	0.611
	0.75	0.76	0.73	0.844
Returns per productive tree (Rp. 000)				
Penengahan	46	33	68	0.474
Melaya	36	22	98	0.618

Instead, the data indicate that the influence of income incentives (if any) is more complex than simple indicators can show. To better understand this influence, we examine income incentives according to the conceptual framework developed in our first section and discuss how incentives need to be understood in the context of the broader damar *repong* culture and household economic strategies.

Household livelihood strategies in Krui

If price and income indicators alone are inadequate, how else might the differences in damar harvesting strategies of farmers be explained? Here we apply the conceptual framework presented in the first section to provide an alternative, plausible explanation of the impacts of economic incentives on harvesting. Using the framework, three kinds of information are necessary to interpret the effects of economic incentives: the cause-and-effect link of the incentive to overcoming conservation threats or undertaking conservation actions; the expected future importance of the income in the context of villagers' livelihoods; and the social values, institutions and capacities mediating the effects of economic incentives.

We suggest that higher benefits were linked to delaying harvesting only in the context of the 'traditional' *repong* culture. Changes in the social culture of *repong* management made it possible to earn benefits through more frequent harvesting. Krui farmers harvested less intensively where the income was essential for food security and harvested more where damar served as a cash supplement to existing staple food supplies. Cost-related incentives were as or more important than income incentives. Finally, the degree to which a household identified with the *repong* culture strongly influenced social incentives and capacities for damar maintenance.

Table 6.2 Income incentives and conservation in Krui for households with only distant *repong*

Damar income	Households			
	Mean Value	Mean for Conservers	Mean for Nonconservers	Significance of difference (t-test)
Net damar resin income as proportion of total income				
Penengahan	38%	40%	29%	0.316
Melaya	68%	94%	55%	---
Net damar resin income (Rp. 000)				
Penengahan	1,355	1,375	1,260	0.790
Melaya	1,128	1,692	846	---
Income relative to expenditures				
Penengahan	0.57	0.63	0.29	0.010
Melaya	1.41	0.82	1.71	---
Income relative to alternative routine incomes				
Penengahan	0.64	0.64	0.67	0.837
Melaya	0.75	1.00	0.63	---
Returns per productive tree (Rp. 000)				
Penengahan	30	34	16	.132
Melaya	23	na	7	---

Re-examining the causal pathway in Krui: the link between damar income and harvest periods

Do long harvest periods (which we have defined as conservation of damar) provide higher benefits than short harvest periods, i.e., does income from damar provide incentives for conservation? The answer is yes – and no. Resin yields did increase if farmers delayed their harvesting. On average in Penengahan and Melaya, harvests of 15 days yielded only about 46.6 kg per 100 trees while harvests of 60 days yielded 169 kg per 100 trees. Thus, for a given amount of harvest effort, net incomes were higher with conservation. Trees that were harvested less often also reportedly had a longer productive life span according to farmers. But farmers who harvested more frequently actually earned higher net incomes. They did this at the expense of higher labour inputs and the need to replant trees more often to compensate for the resulting shorter productive life of the tree.

Three strategies of damar management were therefore evident. One strategy was to intensively harvest damar trees, even though the frequency of harvest was beyond local norms of what was considered good management. These households did not adhere to the *repong* culture.

Poverty seems to have been one reason why some households harvested more often (Table 6.3). Poor households were more represented among nonconservers in Penengahan than in the general population (27% of nonconserver population compared to 18% of general population) and in Melaya (35% of

nonconservers compared to 23% of general population). Poorer households were probably under higher pressure for meeting immediate cash needs.
But medium and wealthy farmers also harvested frequently. We know from our case-study data and key respondent interviews that even these households sometimes experienced economic difficulties that forced them to harvest damar over shorter periods. Aside from such economic pressures, our field observations showed that some households preferred to use an intensive harvesting strategy year-round to maximise damar income. These households sought to maximise yields per unit time, rather than to maintain the productive lifetime of a tree. They tended to harvest a lot of damar as well as plant a lot of new damar trees. The survey data show that medium and wealthy households that adopted this strategy tended to have access to additional family or wage labour for frequent harvesting that made it possible to harvest frequently and plant trees.

The intensive management strategy was also more likely among households with a predominance of close rather than distant *repong*, probably because such intensive practices would not be economical with the longer travel time. The economic incentives associated with intensive damar harvesting encouraged these farmers to continue planting damar in large numbers, despite their larger holdings of existing trees. The average number of damar trees managed by nonconservers (in both Penengahan and Melaya) was 100 compared to the 59 trees managed by conservers (p=.030). The ratio of young trees to productive trees is 1.96 for nonconservers, and only 0.80 for conservers (p=.020).

Table 6.3 Conserver and nonconserver households by wealth (cash-based)

	Penengahan		Melaya	
	Number	%	Number	%
Poor				
Conservers	8	57	2	20
Nonconservers	6	43	6	80
Medium				
Conservers	14	70	10	63
Nonconservers	6	30	6	37
Wealthy				
Conservers	30	75	6	55
Nonconservers	10	25	5	45
Total	74	--	35	--

The other management strategy was to manage damar by aiming to maximise the productive life span of the tree rather than yields per unit time. These farmers either chose not to or did not have the capacity to intensively harvest damar. Our case-study data indicated that some farmers did not have the option of intensive harvesting for lack of labour or surplus cash to hire wage labour. They preferred to achieve higher yields per harvest than to expend the labour to harvest frequently. Others adhered to the traditional *repong* culture that valued damar trees as long-term assets to be passed on to one's descendants. Even where these households had labour surpluses they did not overuse their damar trees to avoid social stigma.

Thus, we propose that farmers in Krui responded to income incentives by using three management strategies that reflected different economic capacities and social preferences. For one set of farmers, poverty or needs for immediate income induced a short-term perspective that led to overharvesting. For a second set of farmers, who had extra labour, close *repong* and no value attached to the long-term productive life of the damar tree, their strategy was to maximise yields per unit time, which led to over-

harvesting.[16] This practice reflected a more market-oriented approach of capital accumulation that placed more value on income now than in the future. For the third group of farmers, who had limited labour, distant *repong* and the desire to maintain social norms of good management, people maximised yields per harvest effort. This strategy reflected a more 'traditional' subsistence orientation that valued security over income or a preference for lower labour inputs. The poverty-, market- and subsistence-oriented management strategies each had different implications for the intensity with which people harvested.

Understanding incentives in the context of household livelihood strategies and the expected importance of damar

We looked at the role of damar income in the household economy to explain why some households responded to economic incentives. We found that conserving households in both villages were probably responding to incentives to minimise labour costs associated with far *repong* when they harvested less frequently there. We also found that damar played a different role in the livelihoods of people in Penengahan than it did in Melaya. That role had implications for its substitutability and thus expected importance in the future.

For Penengahan, the survey data showed that *repong* travel time was the most important factor in explaining current levels of harvest intensity. Households that harvested *repong* less frequently travelled to approximately three hours from their house, compared to frequently harvesting households, which had *repong* only two hours on average from their house (see Table 6.4). As distant plots required more labour costs (travel time) per harvest and were less susceptible to theft, they were harvested less frequently than close ones ($F=5.35$, $df=73$, $p=.024$). In Penengahan, the difference in harvesting intensities between distant and close plots was highly significant ($p=.008$), and a comparison of the effects of harvesting intensity with other variables using a number of analyses showed that this was the single most important explanatory variable. Distance was not a significant factor in Melaya as all the plots were relatively close to the house. The longer distances in Penengahan were directly related to the higher population and consequent land scarcity villagers faced. Penengahan residents had to go farther – sometimes more than 30 km – north and south of the village to find available land. Lower population densities in Melaya made it possible for farmers to have fields closer to home, as well as be conducive to in-migration by other groups.

Table 6.4 Round-trip travel time between *repong* and house (hours)

Village	Total	Conservers	Nonconservers
Penengahan	2.6	2.9	2.0
Melaya	0.9	0.8	1.0

Damar yields may be less important determinants of harvesting frequency than the costs of harvesting. The *incentives associated with minimising costs of inputs like labour* were probably at least as important as incentives related to net income. This is consistent with the finding that there is an association of between income as a fraction of expenditures and harvest levels on distant *repong* (Table 6.1). It is also supported by other studies of smallholder economic strategies, especially for poorer households (Barlett 1980), for whom labour and other inputs are often the most important constraint to land-use decisions.

Even when taking distance into account, households varied in their harvesting intensities (Tables 6.1 and 6.2). To explain this variation, we explored how households differed in their expected future importance of damar income. Where households expected an income to be important into the future, we guessed that they would be more likely to conserve it. We contrasted households dependent on damar for food security with those who depended on rice. Damar-based food security was associated with conservation

[16] Overharvesting, in this context, refers to reducing the productive life of the damar tree. However if trees are replaced with sufficient regularity, the productivity of the site can be maintained.

in Penengahan and rice-based food security with overuse in Melaya.[17] As already noted, in the aggregate and for minimum harvest periods, harvest intensity was higher in Melaya than Penengahan.
We suggest that the interaction of two conditions during the process of damar domestication over the last century may explain how different responses to damar income have emerged. Penengahan and Melaya differ starkly in their respective (1) availability of local land for wet rice-based versus damar-based economic strategies, and (2) distance to the damar market in Krui.

These factors in combination affected the opportunities and constraints that have shaped the livelihood strategies and importance of different income sources in each village. Penengahan had a more hilly topography, yet was very close to the market in Krui (10 to 15 minutes by vehicle today). Melaya had more flat areas suitable to wet rice cultivation and until the early 1990s had poor access to Krui. Even in 1995-96, it took 45 minutes to one hour to travel from Melaya to Krui by car. Penengahan therefore had a comparative advantage historically in adopting a damar-based subsistence economy while Melaya had a comparative advantage in developing a wet rice-based one. Melaya relied more on its own rice production, in contrast to Penengahan where rice was purchased as well as produced. Our survey data showed that rice income was consistently higher in Melaya (Table 6.5), especially among the better-off. A total of 38% of landholdings in Melaya was planted to rice versus 28% in Penengahan. The proportion was even higher for wet rice (which produces higher yields): 35% in Melaya versus 19% in Penengahan.

Table 6.5 Value of rice production per household, Penengahan and Melaya (Rp. 000)

Wealth Category	Penengahan	Proportion of total cash income (%)	Melaya	Proportion of total cash income (%)
Poor	169	19	230	33
Medium	243	11	356	16
Better-off	430	6	634	13

Households in Melaya also met a higher proportion of their own rice consumption needs than the households in Penengahan, based on average rice expenditures of Rp. 8,714 per person per month (BPS 1996), or Rp. 627,408 per year for families in Melaya, which averaged six members. (In Penengahan, the average was Rp. 836,544 and families averaged eight members). Better-off Melaya households seemed likely to meet all their own rice consumption needs.

Melaya also had a higher proportion of short-term perennial crops (66% versus 39% in Penengahan,) and mixed gardens (53% and 23%). Like rice, these crops required more intensive labour inputs than damar. The availability of plots near farmers' houses in Melaya made these more labour-intensive strategies possible. Short-term perennial crops were also more valuable by weight and volume than damar, which is important where market transportation costs are higher. Javanese migrants had a preference for the cultivation of coffee as their primary source of livelihood, probably because of the relatively quick turn-around time for yields compared to damar and not being familiar with damar cultivation.[18] Insecure ownership cannot explain Melaya's shorter-term perspective in preferences for perennial crops and damar harvesting. Melaya had a higher level of ownership and harvesting by the owner of *repong*, 91% in Melaya versus 82% for Penengahan (Table 4.7).

We argue that the variation in conditions in Penengahan and Melaya resulted in different expected future importance attributed to damar income. In Penengahan, farmers found it more feasible and lucrative to sell damar to meet their rice consumption needs. Routine damar incomes constituted the foundation of their

[17] In practice, we found at least a dozen income strategies within these two villages, but the number of cases for each are too small to be meaningfully compared. We have therefore focused on food security patterns as a way of looking at patterns at the village level.
[18] Javanese migrants were beginning to plant more damar in the years just before the survey and were said by local farmers to be interested in cultivating *repong*.

food security. Villagers expected to depend on future damar incomes for meeting future basic needs. In contrast, villagers in Melaya met more of their rice needs from their own production. Distant markets and local agricultural conditions made it is less economically attractive for them to exchange damar for rice. Instead, damar incomes more often functioned to provide supplementary income. Damar incomes did not hold as high a future importance because they were more substitutable by other cash crops such as coffee or pepper. Because of additional transportation costs, it was more efficient for Melaya farmers to sell products that had higher value by weight. Because they had a higher degree of food security, Melaya farmers were better able to invest in higher-risk, high-value short-term perennials.[19] The differences in expected importance may also explain the conversion of damar *repong* to clove plantations in Melaya two decades ago. Farmers viewed damar and cloves as close functional substitutes in their livelihood strategy.

The implication of this explanation is that people are more likely to conserve a cash-generating resource to the extent that it is the source of food security. People are more likely to exploit a resource to the extent that they have an alternative source of food security.

Social norms for damar management

Social norms associated with the *repong* culture directly affected livelihood choices and capacities. The impacts of social and economic incentives were closely related.

In the Krui study sites, local farmers defined their identity, both now and in the future, by referring to damar. When asked what they did, people said *'kami petani damar'* or 'we are damar farmers'. When asked if they would continue to plant damar in the future, people said 'we are damar farmers, of course we will plant damar'. Those not cultivating damar admitted with embarrassment their lack of damar management knowledge. Social status was strongly influenced by ownership of *repong* and those who could afford to do so sought to enhance their status by acquiring more *repong* and planting more damar. Damar planting was seen as a practice to create wealth for future generations. Inheritance rules that specified the rights of the first son (the keeper of the lineage) to the *repong* indicated the importance of damar to the clan. Farmers distinguished between *hak milik penuh* (full ownership rights, typical of rice land) and *hak waris* (inheritance rights, typical of *repong); hak waris* conferred more limited usufruct rights and *repong* inheritors are bound by customary law to provide for their larger extended family from the damar trees on these lands (Michon *et al*. 1997a, b).

Although both villages shared this *repong* culture, there were differences in the intensity to which it was practised (Nadapdap 1995; Lubis 1996). Damar farmers in Penengahan saw damar as their primary source of food security in the future because they defined their way of life as expert damar farmers.[20] In Melaya, Javanese migrants did not associate with this identity and Lampungese residents identified with it less strongly. While most Lampungese residents in Melaya considered damar important and called themselves damar farmers, they did not develop the same degree of social institutions for maintaining damar as in Penengahan. Rules and decision-making bodies for managing land allocation, theft and conflict were more developed in Penengahan than in Melaya.[21] In Penengahan these issues were handled by an *adat* leader with written rules and procedures (Michon *et al*. 2000). In Melaya, no one could describe such rules and no such body or institution formally exists. When opportunities arose in 1995-

[19] Lubis (1996) noted that farmers in both villages recognised the higher gains to be made from short-term perennials compared to damar. Farmers referred to damar as their secure crop, and viewed any income from short-term perennials as based on fate or '*nasib*'.

[20] This identity may be changing among youth who have been increasingly seeking nondamar-related economic opportunities, especially wage jobs in Jakarta or Bandar Lampung and do not have the experience or knowledge to maintain the current damar practices.

[21] It is possible that the institutions in Penengahan have evolved to their current state because of the higher levels of population stress on the environment and their longer experience with damar cultivation rather than a social identity based on damar. Regardless of the cause of their development, the presence of these institutions reinforces the strength of the *repong* culture.

1996 to convert *repong* to oil palm, anecdotal accounts suggest that there was more interest in these schemes in Melaya than in Penengahan, although both villages have in the last two years worked to exclude oil palm plantations from their village boundaries. The longer average period of damar cultivation among households in Penengahan (three generations) compared to Melaya (two generations) may be one underlying influence on the differences in identity and distribution of damar.

6.6 Explanatory value of income incentives for gaharu conservation in Kayan Mentarang

Unlike the residents of Krui, the villagers of Kayan Mentarang did not historically trade any one forest product continuously (Sellato 2000). The reliance on existing products in the forest ready to be harvested at any time, has enabled Kayan Mentarang residents to be responsive to market fluctuations. While the levels of damar harvesting in Krui can not be easily explained by price or income indicators alone, gaharu harvesting can be directly linked to economic incentives. In Kayan Mentarang, economic benefits from gaharu provided clear incentives to use – and possibly overuse – the forest.

6.7 Income incentives and gaharu use

Prices

According to traders, the recent gaharu boom in East Kalimantan, began around 1989-90. At that time prices for the best grade gaharu in the Bahau watershed area began increasing from about $50/kg to $150-300/kg. By 1995 they reached Rp. 1-2,000,000 or $454-909/kg. The prices on the international gaharu market rose dramatically during this time, presumably because of shortages in gaharu supply in other regions. Many collectors tripled or quadrupled their regular cash income. The increase in gaharu prices attracted professional collectors from as far away as Java, Sulawesi and Sumatra. In East Kalimantan traders brought in harvesters from other regions to work in groups of as many as 60 people and even hired helicopters to facilitate transport (Momberg *et al*. 2000). In 1997, prices remained high for the highest quality gaharu, but for reasons that are unclear, dropped for low-quality material.[22] From traders' records it is also possible to see that the amount of gaharu harvested increased and declined dramatically with prices. Because the product is from a natural forest, there is very little lag time between villagers' receiving price information and their response in harvesting.

Income

Using other conventional indicators of income incentives, it is also possible to see that the income derived from gaharu has a highly significant relationship to the intensity of use (Table 6.6). Among the six indicators tested, revenues had the strongest association with intensity of use for all three villages. The tests show that *all villages indicated a trend to make a high number of collecting trips in association with higher gaharu revenues.* Net income was also closely associated with the number of trips made, except in Pujungan where the statistical significance between high and low number of trips was lower (p=.18). Households that made a high number of trips earned twice as much revenue and net income in Long Alango and Apau Ping compared with Pujungan.

[22] The devaluation of the Indonesian rupiah in 1997-98 by 300% to 700|% relative to the US dollar has led recently to demand for all grades of gaharu and a further increase in prices as exports are based on dollar rates. One kilogram of high-grade gaharu that sold for Rp. 1 million in 1995 (US$455), now fetches Rp. 7 million (about US$700).

Table 6.6 Relationships between income incentives and conservation, Kayan Mentarang

Gaharu income	Mean Value	Low number of trips	High number of trips	Significance of difference (F-test)
Gaharu revenues (Rp. 000)				
Apau Ping	963	387	1,539	.000
Long Alango	1,335	616	1,647	.034
Pujungan	594	421	914	.085
Net gaharu income (Rp. 000)				
Apau Ping	840	327	1,353	.001
Long Alango	1,137	529	1,380	.052
Pujungan	440	322	676	.181
Net gaharu income as percentage of total cash income				
Apau Ping				
Long Alango	.67	.61	.74	.233
Pujungan	.69	.49	.80	.000
	.56	.50	.63	.261
Net gaharu income relative to expenditures				
Apau Ping	.38	.14	.61	.014
Long Alango	.38	.21	.49	.161
Pujungan	.22	.20	.25	.645
Net gaharu income per household per trip (Rp. 000)				
Apau Ping	169	121	214	.044
Long Alango	316	214	355	.200
Pujungan	154	107	179	.265
Returns to labour (Rp. 000/person/day)				
Apau Ping	25	20	30	.137
Long Alango	36	24	41	.105
Pujungan	12	9	18	.080

The second indicator that showed an association across all three villages was returns to labour. *All the villages showed a trend to make a high number of collecting trips in association with higher returns to labour.* The more money collectors earned per day spent looking for gaharu, the more likely they would be to make three or more trips. Among the households making frequent trips, those in Long Alango received the highest returns to their labour at an average of Rp. 41,000 per day, while households in Pujungan earned only an average of Rp. 18,000 per day.

According to both indicators, higher levels of harvesting intensity appear to have occurred in Pujungan at lower levels of economic incentive. Pujungan households were less efficient in finding gaharu on a per day and per trip basis, yet they continued to collect. We can speculate that higher competition from outside collectors and associated reports of scarcity of gaharu in Pujungan is one reason why local people felt they had to collect more frequently[23] and also why their returns were lower.

Prices, revenues, net income and returns to labour were thus indicators of economic incentives that had significant associations with gaharu harvesting intensity. Although these indicators might seem sufficient

[23] This tendency to harvest more frequently where others are using the resource is analogous to the influence of theft on damar harvesting in Krui and a classic open-access problem.

to predict the effects of economic incentives on gaharu harvesting patterns, other factors in Kayan Mentarang mediate or accelerate the influence of these incentives. Using our framework, we discuss these factors further to provide a more complete understanding of the gaharu story.

Household livelihood strategies in Kayan Mentarang

As in Krui, we use our analytical framework to examine the incentives related to gaharu harvesting. For Kayan Mentarang, we propose that economic incentives need to be understood within a history of an evolving weak common-property system. The people controlling these common-property systems operated according to economic incentives that had their own logic of cause and effect that led to increased gaharu harvesting. The expected future importance of gaharu income was relatively low, but varied by village with access to alternative sources to cash. Some villages attempted to moderate gaharu extraction through fees and exclusion of outside collectors, but their capacities to do so were limited. We discuss the role of these factors further below. We expand the analysis to include the Pujungan site (where data are available) as the contrasts are sometimes clearer among the three villages.

Re-examining the causal pathway in Kayan Mentarang: the role of indirect economic benefits

Unlike in Krui, villagers in Kayan Mentarang controlled gaharu as part of a larger, collectively used and managed resource – the village territory and forest. For outsiders to gain access to this resource, they needed to request permission to enter the area. As discussed in Section 2, local customary and government leaders controlled access to gaharu and used this control to request fees from collectors. Nearly every village leader requested fees of some kind from visitors in the early 1990s. It was said that the district leader of Pujungan, who had a reputation for consistently requesting fees, even actively encouraged gaharu collecting by outsiders in order to collect this fee.

Ironically, certain local leaders in the Upper Bahau continued collecting significant amounts of fees with the establishment of tenure rules (see Section 4) intended to exclude outsiders. However, the rules that were created and subsequently implemented occurred in a period when profits were high, outside demand was enormous and local leaders had as much interest in maintaining allegiances with traders, officials and outsiders as they did with their own communities. These allegiances served to maintain lucrative flows of kickbacks and perquisites, and to consolidate power.

Rules limiting outsiders were consequently weakly enforced. Local people in both Long Alango and Apau Ping reported that more outside collectors arrived in 1995 than in any previous year of the boom. One leader in Apau Ping himself brought in and reportedly employed 55 workers from the downstream village of Long Peso in 1994 to collect gaharu, until community members protested vehemently later in the year. Outsiders regularly gained access to gaharu in exchange for payments they made to local leaders or as collectors serving as the *anak buah* (employee) of a local leader. Real or constructed relationships of outside collectors with leaders also created obligations of reciprocity that influenced leaders to bend the rules (see Wollenberg 1999a for a more in-depth discussion on this topic).

Some leaders were more aggressive than others in seeking personal gain. In May 1995 people in the subvillage Long Lat in Apau Ping reported that gaharu collectors from Pujungan did not come looking for gaharu in their subvillage territory anymore, in contrast to the subvillages of Long Tua and Apau Ping (all of the larger Apau Ping settlement). Long Alango leaders seemed to break the rules more often than any of the other village leaders judging from guestbook records of the village head, local reports and sightings of collectors in the village. They also persisted longer than other leaders in ignoring the community pleas to enforce rules. In October 1995, Long Alango residents said that outside gaharu collectors – 'guests' or *'tamu'* – still arrived almost every day. The comment is almost certainly an exaggeration, but it conveys a perception of scale of the problem.

The indirect benefits from leaders' fee arrangements stimulated further overharvesting. Leaders had incentives to continue to let in outsiders, rather than exclude them. In fact, the leaders were better off than before the rules were imposed as they could request higher payments. These indirect incentives were available only to a few local leaders, typically the village head or *adat* leader. Their actions not only resulted in outsiders continuing to collect gaharu, but also in local people feeling that their resources were threatened and wanting to harvest the gaharu as quickly as possible for themselves.

At the same time that rules were being weakly enforced by leaders, gaharu collectors, mostly young men, sometimes took matters into their own hands when they encountered outside collectors. In 1994 in Apau Ping, there were two incidents of youths seizing the machetes, axes and outboard motors of collectors who had not received permission to collect from the local leader of the Malinau River area. Similar incidents occurred in Long Alango and in other villages along the Bahau River. Over time, disgruntled community members, especially the youths earning gaharu income, also began to protest and pressure their leaders to enforce the rules more strictly. In 1995 and early 1996 these tensions were especially palpable in Long Alango, where the topic raised passionate discussion in nearly any gathering of men. The growing threat to the leaders' loss of legitimacy was manifested informally as well as through community meetings that eventually pressured them to apply rules more strictly. The four leaders in Apau Ping started enforcing access rules more consistently by the end of 1995 and early 1996. The leaders in Long Alango had a history of abusing village rules and poor accountability with their constituency, and they lagged in adopting rules. Long Alango began to enforce the rules sporadically during 1996 as threats from local youths became more violent. In March 1996, the village head of Long Alango said that no outsiders were given permission to collect gaharu anymore, even if they were willing to pay. Reports of access being granted to the odd visitor still occurred periodically.

As in Krui, differences in the economic opportunities and strategies among villagers created multiple paths of cause and effect of economic incentives. In contrast to Krui where the same income source created opposing incentives, in Kayan Mentarang the incentives were reinforcing. Villagers had a high incentive to use the resource as quickly as possible in part because leaders were allowing outsiders to enter in exchange for access fees. The gaharu experience suggests that the indirect incentives associated with providing access to the resource to others need to be considered in addition to the direct incentives associated with harvesting.

Understanding incentives in the context of household livelihood strategies and the expected importance of gaharu

Analysing the expected future importance of gaharu income demonstrates how a forest product can have multiple values in a household. We discuss below how high levels of income and returns to labour made the source highly valued, while the substitutability of the income and uncertainty associated with it made it less valued. These dimensions operate in opposition with each other. The substitutability and uncertainty, however, create incentives to use the income now than in the future.

Level of income

Gaharu was valued in Kayan Mentarang for helping to meet both daily and special expenses, and to a lesser extent for cash accumulation. Gaharu was the top source of income for 66% of the households in Apau Ping, 61% in Long Alango and 49% in Pujungan. It provided an average household net income of Rp. 849,704 across the three villages studied and annual revenues averaging Rp. 1,009,498 per household. These figures alone suggest that gaharu income was a valued as major source of cash.

Gaharu contributed to villagers' cash supplies for purchasing clothes, sugar, kerosene, tea, cooking oil, cigarettes and other items for daily use. Average annual expenditures for these basic daily supplies were Rp. 502,581 per person per household in 1995-96 (standard deviation of Rp. 420,234), with no significant

differences among villages. Additional cash supplies made possible the occasional, but important, special expenses of education, medical treatment, social events (marriages, naming ceremonies, Christmas and harvest celebrations) and transport. Average annual expenditures for special expenses in 1995-96 were Rp. 345,668 per person per household. These figures are for all households, including those that did not collect gaharu.

Returns to Labour

Based only on the high returns to labour, the importance of gaharu in local livelihoods should have been higher. Returns from gaharu varied significantly by village (Table 6.7) for both returns per trip ($F=5.676$, $df=71$, $p=.005$) and returns per person per day ($F=7.299$, $df=71$, $p=.001$). Long Alango had the highest returns, while Pujungan had the lowest. We calculated returns based on labour inputs, or the number of days spent travelling, as the greatest cost incurred by local harvesters (see also discussion in Section 3).[24]

Table 6.7 Costs and returns to labour from gaharu income per household

Village	Number of gaharu-collecting households)	Average labour cost per person per trip (Rp. 000) (Mean ±SE)	Gaharu returns per person per day (Rp. 000) (Mean ±SE)	Gaharu returns per trip (Rp. 000) (Mean ±SE)
Apau Ping	26	34 ± 4	25 ± 3	196 ± 25
Long Alango	28	44 ± 6	36 ± 5	360 ± 60
Pujungan	18	26 ± 6	12 ± 3	154 ± 32
Total	74	34 ± 3	26 ± 3	251 ± 29

Differences in returns probably reflect differences in collecting techniques, gaharu accessibility and possibly quality of gaharu collected. Investing higher amounts of time and people paid off in the case of Long Alango, probably because they were able to reach more distant areas of gaharu less visited by competing collectors. Only households in Long Alango earned Rp. 800,000 or more from any one trip at a time. Long Alango collectors may also have developed more knowledge about gaharu locations, making subsequent trips more efficient. In Pujungan the pay-off was less, probably because of the higher competition from downstream collectors and reportedly less accessible gaharu. Apau Ping had the least competition from outsiders, but collectors there tended to go out for shorter periods of time, which limited their coverage.

Compared to other forest products, gaharu returns were significant. The gaharu returns (Table 6.7) can be roughly compared with estimated returns for cinnamon of Rp. 12,500 (US$5.68) in Apau Ping and for

[24] The labour costs indicated here are only an estimate of the value of labour for purposes of comparison. Gaharu trip costs were measured as number of days spent collecting per harvester multiplied by the local wage rate of Rp. 5,000. This is a conservative estimate of costs since costs such as coffee, sugar, rice and cigarettes that were difficult to recall were not included. According to the actual receipts collected for a 20-day trip of six men sponsored by one of the authors (and therefore probably reflecting a higher cost than most trips) in 1998, the cost for food and supplies was Rp. 5,014 per person per day. This is probably an overestimate for comparison with the 1996-97 data due to the nature of the sponsor and the inflation of prices by about 60% in 1998. The labour for cleaning and selling the gaharu was also not counted. The value of labour also may vary over the year with the agricultural cycle. Households made more gaharu trips during April, May, June and July, which coincides with the period after the harvest and before the beginning of the clearing of land for the next swidden cycle. The demand for agricultural labour is lowest during these months.

rattan of Rp. 11,110 (US$5.05) in Pujungan.[25] Gaharu returns were far higher in Long Alango and Apau Ping and were also far higher than the average wage rate. Only in Pujungan did gaharu returns compete with nearly equal returns from cinnamon. However, wild cinnamon was not common in the Pujungan area and during 1995-96, no one in the survey reported selling it. The high returns associated with gaharu suggest that compared to other major forest income sources and probably most income sources, gaharu was an economically preferred income.

Role in Meeting Expenses

To better understand the function of gaharu income in the household, we compared households that did and did not collect gaharu in the villages of Apau Ping, Long Alango and Pujungan. We sought to determine first, whether households depended on gaharu for particular expenditures. Did gaharu-collecting households necessarily have higher expenditures? Second, were alternative sources of income used to meet household needs? Were gaharu incomes substitutable? To the extent expense patterns differed significantly between households collecting gaharu and those that did not, we expected gaharu income to have a higher expected importance. We sought to also determine whether gaharu was more closely associated with meeting a particular expense, namely daily needs or special occasional costs.

Households collecting gaharu did not have significantly different expenditures than others (Table 6.8), with the exception of total expenditures per person in Apau Ping ($F= 4.624$, $df=31$, $p=.187$). The high standard deviations of the other indicators mean there is no statistical association. A better predictor of expenses was total income per person per year (adjusted $R^2 = 0.76$, $p=.000$). This suggests that income sources other than gaharu were as important for meeting cash needs, i.e., gaharu for most households was only one of several income sources used to meet needs.[26] Households not collecting gaharu were able to use alternative income sources. There was no statistical relationship between wealth or assets and gaharu income, which was confirmed by the case studies and our own observations in the field.[27]

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[25] These data are based on reports in individual villages and not survey results across all villages. According to respondents in Apau Ping, one man could harvest about 17.5 kg of cinnamon bark in a day. At the price of Rp. 1,000 (US$0.45) in 1995, the revenues were 17,500 per person per day US$7.96). If costs are subtracted, returns of Rp. 12,500 (US$5.68) per person per day could be achieved. This is probably a high estimate for villages other than Apau Ping, since wild cinnamon was much rarer in these territories. Using information from a rattan (*sega* or *Calamus caesius*) collector in the Pujungan area, four people collected 1000 kg of rattan in 14 days. At the 1995 price of Rp. 900 (US$0.41), the revenues were Rp. 16,100 (US$ 7.32) per person, per day, or with costs subtracted, Rp. 11,110 (US$ 5.05). Like the cinnamon, this is probably a high estimate for villagers outside of the Pujungan area, since the collection site was well known for being a special protected zone for rattan and having high densities.

[26] Although some people, especially youths, over time gained reputations as regular gaharu collectors, it was unheard of in the study villages for a household to specialise in gaharu, to the point that it did not plant rice. Food security was always assured. Even in one village outside the study sites, there was one youth who worked full-time as a gaharu collector, yet he maintained an adopted family that kept him supplied with rice.

[27] We tested expenditures per household (rather than per person), and found that in Apau Ping expenditures at this level were more than twice as high for gaharu-collecting households than those who did not. Per household expenditures for special purposes ($F= 2.259$, $df=30$, $p=.144$) for expenditures on daily needs ($F= 5.927$, $df=30$, $p=.021$) and total expenditures ($F=9.252$, $df=31$, $p=.005$) all showed strong positive associations with gaharu collection. Most of these expenditures occurred however among households earning low rather than high levels of gaharu income. To understand whether these expenditures were associated with the level of gaharu income earned, we also looked at differences among three income groups, defined as no gaharu, low gaharu income and high. Low and high gaharu income groups were defined using the median value of Rp. 500,000 in gaharu income. We found that in Apau Ping households with low gaharu income spent more at the household level on daily needs ($F=3.080$, $df=31$, $p=.061$) and total expenditures ($F=4.611$, $df=31$, $p=.018$), than high income collectors or households not collecting at all. In Long Alango expenditures for daily needs were also about twice as high for gaharu collecting households. In contrast to Apau Ping, daily expenses directly increased with gaharu income ($F= 4.352$, $df=39$, $p=.020$). In Pujungan, there was no association of expenses with gaharu income.

A better indicator of gaharu-collection patterns was the level of male labour in the household. For all villages, gaharu collection was highly associated with the number of productive males in the household (ages 15-55). This was true in distinguishing between gaharu collectors and nongaharu collectors ($F=12.991$, $df=118$, $p=.000$) as well as between households collecting low and high amounts of gaharu (less or more than Rp. 500,000 per year respectively) ($F= 5.563$, $df=118$, $p=.005$). Nongaharu collecting households had an average of one productive male, while gaharu collecting households had an average of 1.6.

Table 6.8 Expenses among gaharu-collecting households

Village	Annual cash income	Expenditures for special purpose per person/household/year		Expenditures for daily needs per person/household/year		Total expenditure/per person/household/year	
		Not a gaharu collector	Gaharu collector	Not a gaharu collector	Gaharu collector	Not a gaharu collector	Gaharu collector
Apau Ping	Mean	95,266	156,550	351,741	472,434	431,129	628,983
N = 26	Std. Dev	87,083	144,642	212,704	293,859	277,021	331,885
Long Alango	Mean	1,099,766	412,010	451,192	448,160	1,550,957	860,170
N = 28	Std. Dev	3,468,200	679,623	287,270	374,155	3,497,100	931,638
Pujungan	Mean	310,005	148,877	548,484	636,477	858,489	785,353
N = 19	Std. Dev	967,157	231,608	282,098	779,701	1,095,356	1,003,460
TOTAL	Mean	496,748	252,537	497,441	505,819	983,390	758,357
N = 73	Std. Dev	1,929,110	458,188	279,230	490,576	1,963,204	791,029

This role of available male labour as an influence on gaharu harvesting was consistent with our own observations and villagers' own explanations. Not every household with extra male labour collected gaharu however. There was a perception that some people were skilled (*pintar cari gaharu*) and had good fate (*nasip yang baik*) in finding gaharu, while other people did not. Those that did not have good luck sought incomes from other sources. Also, gaharu collection was more common among younger, unmarried men, who banded together with their friends. If one man found a lot of gaharu, the next week his friends would join him on another expedition. A young man's social network influenced his interest in gaharu collecting, as well as the skills and knowledge brought to bear in harvesting from the other members of the group. Other villages often commented that the youths in Long Alango in particular were well organised and *pintar cari gaharu*.

We suspect that differences in expenditure among gaharu collectors and nongaharu collectors did not emerge because of variability in household savings and consumption patterns. In querying community members about how they spent money from gaharu, it was clear that some households had a reputation for saving their money and even having bank accounts in Tanjung Selor and Tarakan. Others spent gaharu money on cigarettes and alcohol. Some saved the money for building a house later. Some young collectors shared money with their families, while others did not. Among more entrepreneurial villagers there was a tendency to see gaharu as a way to accumulate capital for other economic activities. One collector in Long Alango saved enough from gaharu proceeds to open a store and sponsor other gaharu collectors to sell through him. He said it was important to raise capital as 'We have to think about the future: prices of goods are increasing, while wages are not'. It was common for most households to at least buy productive assets, such as chainsaws or outboard motors (*ketinting*), with their gaharu incomes. Owning these assets were also signs of social status and social competition caused some households to spend their money on one more outboard motors, just to have more than the neighbours.

Expense patterns thus varied tremendously among households. In terms of future value, the one pattern that emerged from expenditures was that many households valued the investment or status derived from capital generated by gaharu more than a gaharu income per se.

Households that did not have gaharu incomes proved surprisingly adept at meeting their cash needs from other sources. Although many people talked about looking for gaharu to meet special expenses, such as education, preparing for Christmas festivities or building a new house, nongaharu-collecting households were also able meet their needs for such expenses, at least with as much flexibility as those seeking gaharu. Common strategies on the Upper Bahau (Apau Ping and Long Alango) in 1995-96 were to sell surplus rice from the previous year to downstream villages or vegetables, chickens or alcohol (*ciu*, *burak*) within their own village. Households seeking larger sums constructed boats (*perahu*) for sale, earning Rp. 300,000 per boat (Long Alango price in 1995). In more extreme cases, a family member went to Malaysia to work, although in 1995-96, most families preferred to seek gaharu than to go to Malaysia. In Pujungan, households were able to meet their needs from wage labour because of the significant presence of government offices, as well as employees requiring household and farm help. They also supplemented their incomes with the sale of fish and vegetables. The choice of alternative income depended as much on the current market as on the mix of skills in the household. The influx of cash from gaharu almost certainly also helped to commodify the local economy over time, making it possible for more cash transactions rather than barter.

The range of options and extent of commodification varied however among communities. Not all communities had the option of significant alternative sources to gaharu for cash income. The lack of alternatives may explain why Apau Ping showed more dependence on gaharu for meeting expenses (Table 6.9). In Apau Ping only two alternatives provided major sources of incomes, compared to four each in Long Alango and Pujungan. In Pujungan in particular, there were more opportunities for stable wage incomes. The dependence on alternative sources of income in Apau Ping was also lower on average than those in Long Alango and Pujungan (Table 5.6).[28]

Table 6.9 Major sources of income for gaharu- and nongaharu-collecting households

Village	Income source	Nongaharu-collecting households	Gaharu-collecting households	Total
Apau Ping	Gaharu	0	19	19
	Livestock	3	0	3
	Wages	1	6	7
Long Alango	Gaharu	0	24	24
	Livestock	2	0	2
	Wages	4	3	7
	WWF employment	2	0	2
	Trade	2	2	4
Pujungan	Gaharu	0	12	12
	Livestock	2	1	3
	Wages	21	6	27
	WWF employment	3	0	3
	Trade	1	1	2

[28] However, average levels of income for some other sources was actually higher than for Long Alango or Pujungan, e.g., cinnamon sales and sale of cottage goods (Table 5.7). Rice sales, sales of agricultural and collected forest products and wages were on average higher than in Long Alango, while rentals were higher than in Pujungan. None of these however constituted a major income source, defined as the highest income-providing source for a given household.

The data suggest that households in Apau Ping individually and collectively probably placed a higher value on gaharu incomes than in the other two villages. The ability of Apau Ping residents to organise and more effectively pressure their leaders to exclude outside collectors may in part have been driven by this higher importance attributed to gaharu.

In addition to the substitutability of gaharu with other major sources of income, households also had the flexibility to quickly and sharply reduce their need for cash in response to shortages. Depending on need, they substituted home-produced products for purchased ones. We observed people using home-produced sugarcane juice as a sweetener, pork fat for cooking oil, resins from forest trees for lamps and local tobacco. People also shared celebration expenses with other households by combining events, delayed major purchases or pulled their children out of school. Credit or loans were usually possible for medical expenses.

Risk and variability

Villagers valued gaharu, but did not necessarily expect to depend on gaharu income in the future. People's perceptions of future income from gaharu were highly uncertain in 1995-96. Everyone interviewed noted that yields and prices were unpredictable and one's income depended on *nasip* (fate) more than anything else. Looking at the four most recent trips, households earned as little as Rp. 3,000, or as much as Rp. 1,000,000 for one trip (Table 6.10). Standard deviations were also high, even though the average among all households was remarkably constant. Traders' records over an 18-month period also showed highly variable payments per trip.

Table 6.10 Household gaharu income per trip

Trip #	Number of households	Range Minimum (Rp.)	Maximum (Rp.)	Mean gaharu income per household per trip (Rp.)	Standard deviation (Rp.)
1	71	15,000	900,000	217,817	189,843
2	60	10,000	1,000,000	243,667	184,361
3	36	3,000	1,000,000	286,250	242,947
4	22	5,000	950,000	286,000	248,164

Past use and levels of competition for gaharu were also high, with some people consequently feeling that gaharu supplies were already used up, or going to be used up quickly. The uncertainty associated with the poor implementation of access rules compounded this perception.

Local people frequently mentioned the history of cyclic booms and busts among forest products in Kayan Mentarang in relation to gaharu. Villagers emphasised that they had survived boom-bust cycles of other products in the past and would again. In only the ten years prior to the gaharu boom, villagers had witnessed precipitous prices rises and drops in domesticated ginger (*jahe merah*), coffee and rattan. Before that there were booms and busts in timber, cinnamon and resins. At the mercy of a single local trader for many years, villagers were forced to sell whatever the trader said the market demanded, including antique beads, gongs and jars. In the mid-1990s there was more competition among major traders (up to four reaching Long Alango), but product prices still varied dramatically. Some villagers said the gaharu price would surely drop, but it would also surely rise again. There was a feeling that, if necessary, they could find a new primary source of income, even if the level of income was not as high as from gaharu. In Apau Ping one villager specifically mentioned that he would switch to harvesting cinnamon should gaharu run out. These views indicate that gaharu income was perceived as something not permanent and at least partially substitutable with other income sources.

The expected future importance of gaharu income suggests that gaharu was highly valued as an income source, but was perceived as being more valuable at the current time than it would be in the future. The uncertainty associated with competition from outsiders, prices and yields encouraged people to make use of the gaharu while it was still available and valuable in the market. The experiences of Kayan Mentarang villagers with cycles in availability and demand for forest products and their flexibility in meeting expenses from other sources, both cash and in-kind, indicate that despite its high value, gaharu was replaceable. People may not acquire the same levels of cash income without gaharu in the local economy, but they would adapt relatively easily. The cash to be had from gaharu in the present was worth more to people than maintaining the gaharu for the future.

Social values, institutions and capacities

The impact of gaharu's high economic benefits on harvesting was not significantly mediated by social factors. In contrast to Krui, one social condition that reinforced the incentive to harvest at the present time was the lack of an identity or tradition associated with gaharu collecting. People in all three villages were accustomed to rapid changes in the market. While they identified culturally with the forest, they could not afford to develop an identity linked to a single forest product. From the cycles of products traded, we gained the impression that villagers valued the forest as a generalised resource more than they valued gaharu or any one product from it. A few individual collectors over time developed identities as gaharu collectors, but these people were seen as unusual. '*Dia tahan di hutan'*, 'he can withstand being in the forest' was a comment often heard to express surprise that someone would spend even three months at a time collecting gaharu, let alone specialise as a full-time collector. These identities were limited to individuals however and not extended to the household level.

Social conditions that mediated economic incentives included the establishment of rules, the pressure of the communities upon their leaders to apply rules more strictly and the eventual adoption of more exclusionary policies. Unfortunately, these conditions only ensured that gaharu was not collected by outsiders. The threat of immediate depletion was lessened, but local people still had to compete with members of their own villages and neighbours. The initial lack of application of the rules and continuing weak capacity to implement rules also reinforced rather than mediated economic incentives. Under stronger leadership and more organised local communities, tenure institutions could play a critical role in mediating economic incentives for overharvesting.

Social status influenced economic incentives for gaharu collection. In Pujungan, and not in Long Alango or Apau Ping, some households regarded gaharu as dirty work that was of low status. These households tended to be those with higher levels of education and often government positions. The high yields from gaharu were not sufficient incentive to harvest it themselves (although some sponsored others and traded gaharu). We found that in Pujungan, noncollectors had and average of 9.5 years of education, compared to collectors with 6.4 years ($F=7.232$, $df=43$, $p=.010$). Examining these statistics further for households earning low and high gaharu incomes, we also found that the 11 low-earning gaharu households had an average education of 5.1 years, while the five high-earning households had 8.8 years ($F= 6.050$, $df= 43$, $p=.005$). In Pujungan even some of the more educated households were therefore engaging in gaharu collection and were, perhaps because of better social connections and ability to finance trips, collecting larger amounts of gaharu.

Finally, social factors related to the logistics of the work itself discouraged some households from seeking gaharu. Gaharu harvesting was physically demanding work that required extended periods away from home. This made the income source unavailable to the physically less capable or those with responsibilities that kept them close to their families or fields. Some people also commented on the difficulty or danger of the work. The perception of being suited to forest work or not, and whether one had luck and skill also influenced whether a household sought gaharu income or not.

7. Conclusion

Data from Krui and Kayan Mentarang suggest that income alone is inadequate for explaining why people conserve a nontimber forest product. The explanatory value of a number of cash income-based indicators was tested and the results showed that these indicators provide only a partial rationale for people's conservation behaviour. Instead, an understanding based on the logic of cause and effect between an income and a conservation action, expectations about the role of the income in the household economy, and social values, capacities and institutions provide a more complete picture of how economic incentives affect people's harvesting behaviour. We stress that our analysis indicates only likely explanations. We interpreted the associations reported here based on the best information available to us, but we were not able to check our conclusions by testing all the counterfactual possibilities.

Using the framework in Krui, we found we could explain why damar conservation occurred in some villages despite low economic returns. We found that harvest practices varied depending on whether households used a more market-oriented strategy that aimed to harvest damar as quickly as possible, or on a *repong* culture strategy that aimed to maintain the long-term productivity of the tree. Poverty also directly influenced harvest frequency. Harvest practices varied further depending on proximity to *repong* and whether households used damar-based or rice-based strategies for achieving food security. Minimising labour costs seemed to be as important an economic incentive as the resulting income for explaining lower harvest intensities. Conserving households were those who were part of the *repong* culture and relied on damar for food security. The choice of which strategy households used reflected village-level social norms, local land availability, land productive potential and market accessibility. Damar incomes in Penengahan led to more sustained use of the damar tree because of its importance as an expected future supply of cash for meeting daily consumption needs. In Melaya rice production played a more important role in meeting daily consumption needs and damar's function in providing future needs was perceived to be less important.

The importance of the *repong* culture varied in Penengahan and Melaya, and was followed to different degrees among households. This culture resulted in perceived social benefits of status and group identity associated with damar cultivation that reinforce economic incentives to encourage farmers to plant and maintain damar trees. Associated social norms functioned as a brake to economic incentives, as they include rules for controlling overuse. The stability of damar prices in conjunction with the *repong* culture encouraged farmers to give damar a high future expected importance.

To summarise, in Krui, we observed that damar conservation was not linked to income incentives alone. Conservation occurred among some households even where income incentives were low, because

- a positive group identity was associated with the income source;
- higher social status was associated with use of the income source;
- there was an obligation to provide the resource as an inheritance to descendants;
- the resource fulfilled essential economic functions like food security;
- there was a lack of alternatives;
- local property institutions assured the future security of benefits; and
- the *repong* was far away and labour was limited.

Using the framework in Kayan Mentarang, we found that economic incentives were closely linked to harvesting intensities. Prices and the level of gaharu income created incentives for collectors to harvest more of the product. We also found that leaders' practices of demanding access fees from outsiders led to incentives for allowing in more outside collectors. These incentives reinforced each other resulting in higher harvesting intensities. As gaharu became economically scarce however, local gaharu collectors increased the pressure on leaders to exclude outsiders. Not all communities reacted with the same speed

to this pressure. Community responses were influenced by a local leader's sense of accountability to his community, the proportion of households that depended on gaharu for cash, and the lack of alternatives to cash income from gaharu. Apau Ping leaders responded more quickly than those in Long Alango or Pujungan.

Incentives for harvesting gaharu were further reinforced by livelihood strategies that placed a high value on gaharu. These strategies valued gaharu incomes in the present rather than future. High income and returns to labour encouraged gaharu harvesting, while the uncertainty and substitutability of gaharu as (a) a source of income and (b) in meeting household expenses meant that gaharu was more valued for its role at the current time than at some future date. Social values supported the trend to harvest gaharu intensively as villagers had no tradition of gaharu management, no identity associated with gaharu and, at least in Pujungan, gaharu collecting was a low-status activity. Institutions and capacities to enforce those institutions only marginally served to discourage harvesting, because of incentives available to leaders to break rules and because of the large area of forest involved.

In Kayan Mentarang, we observed that overuse was closely linked to income incentives. Overuse did eventually lead to conservation efforts where:

- there was a higher proportion of households that depended on gaharu in a village;
- there were fewer alternative sources of cash income;
- villages undertook effective collective action internally and between themselves to exclude outside collectors;
- leaders in charge of controlling access were more accountable to their communities; and
- escalating protest by village gaharu collectors led to change in leaders' attitudes and practices.

However, because of the low expected importance of gaharu in the future, these efforts were not sufficient to completely eliminate outsiders or to decrease local people's harvesting of gaharu in their own villages.

The two cases demonstrate well that the explanatory value of income incentives alone is limited. Our analytical framework indicates where we feel additional understanding is necessary to predict the impacts of income incentives. We feel this framework should be applicable to assessing the effects of an income activity on conservation more generally. The approach requires going beyond common financial and market analyses to emphasise instead how local people interpret economic signals in their own social, ecological and economic contexts. Applying the framework requires an iterative approach in which interactions among these contexts are explored.

In our application of the framework, we found that it helped to indicate the *multiplicity of incentives* that occur with any one income source.

- The same income source created incentives for conservation or over harvesting depending on the household livelihood strategy.
- Indirect benefits such as access fees influenced harvest levels indirectly and interact with other incentives.
- Incentives and behaviour needed to be analysed at the individual, household and village levels, e.g., incentives operating at the village level encouraged collective behaviour to exclude outsiders (see also Pretty and Scoones 1989).
- Livelihood strategies varied more than we expected within villages as well as among them.

We also found that the framework explained how conservation *depended on the uniqueness and future value more than the level of the income.* In Krui and Kayan Mentarang an income source was more likely to be valued in the future to the extent that:

- ? the income from the product provided a source of food security rather than supplemental income;
- ? the income from the product was used for specific purposes that were not easily substituted for by other sources of cash;
- ? there were no other cash sources available;
- ? the income from the product was stable and low risk; and
- ? there was an identity, value or status associated with maintaining the income from that product.

The framework also makes it possible to predict where households are likely to move out of a forest-dependent mode of resource use as their income increases (Godoy *et al*. 1995, Arnold and Ruiz Pérez 1998), and where they are likely to stay dependent.

The framework also showed that *noneconomic factors could be significant forces for mitigating or reinforcing economic incentives*. Among the most important of these were whether people identified with the income source and earned status from having or using it. Although social identity was a crucial factor explaining the damar conservation ethic in Krui, we might expect in the coming years that identity is one of the quickest aspects of local people's livelihoods to change. Similarly, villagers in Kayan Mentarang may think of themselves less and less as "forest people" over time. As people in forest areas become increasingly integrated into larger economic and social circles, their choices are rapidly increasing and their social identities subsequently less clear and in transition.

A second major social factor was the presence of institutions for controlling access. At each site the way in which access rights were defined and enforced had tremendous impact on harvest intensities. Closer, more discrete units seemed to be more easily controlled in this regard and contribute to expectations of more stable incomes, than forest products that were distant or dispersed. Use by others was an issue at both sites that encouraged overharvesting. Even in the private property systems of Krui, theft was a problem.

Use of the framework enabled comparison of how the *production system of an agroforest in Krui and the extractive forest system of Kayan Mentarang* differed in the logic of their economies and therefore in the possibilities for stability and expectations of future importance. In the agroforest system, people created a stable production system through investments of land, labour and other materials. This stability made it possible for many farmers to depend on damar for food security. Private land tenure reinforced this stability by giving control over land to households. These systems were slower changing in terms of responses to market signals, especially for tree crops and timber. Villagers had incentives to protect past investments or social obligations to preserve their inheritance, in addition to responding to income incentives. Stable systems would seem more likely to be associated with the development of an identity or values related to the product involved. The tendency towards stability contributes to a higher expected importance of the income in the future.

In contrast, in the extractive system of Kayan Mentarang, villagers relied on gaharu and other marketed forest products more opportunistically. As prices rose, people responded by harvesting. As prices dropped, they moved to other activities. To the extent these cycles are volatile, any opportunistic income is going to be less stable. With less stability, there are fewer possibilities for values, institutions and capacities to develop. The institutions are unlikely to be set up until a condition of economic or biological scarcity occurs – itself inducing other instabilities. With less income stability, it is also more likely that households will use the income in ways that permit substitution and people will actively seek ways of further diversifying their cash sources.

Our findings and the analytical framework also have implications for national *policy interventions*. Most attention to increasing incentives has focused on raising income levels from a forest product. This has meant seeking to improve prices and local people's capacities to capture higher benefits from a forest-based activity (through adding value, technological efficiency, increasing control over selling prices,

controlling access, etc). As we have shown, however, higher economic benefits do not necessarily lead to conservation. And sometimes low economic benefits are sufficient. A more contextual understanding of the influences of economic incentives on people's behaviour is necessary. To the extent that policy interventions become more sensitive to these contexts, we suggest that it will be possible to link income incentives to conservation.

Making policy sensitive to context is not simple. Our two case studies illustrate the levels of variation and complexity that occur in forest-based livelihoods even within fairly defined areas. They also demonstrate the range of possible impacts of different kinds of incentives on resource management behaviour and that incentives can change over time. To deal with this complexity, an in-depth understanding of local livelihood strategies is necessary. Policy interventions should focus on assessing these strategies and their impacts, for example, through periodic monitoring by local government in cooperation with communities. It may be possible to have more leverage over a system by influencing a village leader's behaviour, for example, than through changing benefit levels.

In addition, because of the instability of many extractive products, investments in policies related to these single products may be ineffective. Policy interventions in extractive systems will be more long-lasting if they cover a range of possible generic forest products. However, these kinds of generic interventions could work in opposition to efforts to shape policies based on the role of an income source within the livelihood strategies.

Our research suggests that *the single most important area in which policy interventions can achieve conservation is to provide the stability of conditions that enables people to expect the income source to be important into the future.* Stability could be improved, for instance, through better tenure security, access to multiple markets and flexibility in other sources of livelihood. Income sources that provide food security are more likely to be conserved. However, assuring stability is not a guarantee that households will not consider other income sources more important. As we saw in Krui, tenure security was not enough to explain conservation behaviour. Stability can also occur at the cost of depriving forest villagers of economic opportunities, which would not be consistent with development aims.

NTFPs have provided extremely important sources of cash income for some villagers living in forest areas. Damar in Krui and gaharu in the Bahau River area of Kayan Mentarang are examples of two such lucrative products. The harvesting of these products was the major source of cash income for the Krui and Bahau villagers. The incomes of these forest–dependent communities at most study sites exceeded the regency-level average income. The households depending on damar or gaharu had higher incomes than those not depending on these products.

Our cases illustrate that efforts to improve incentives for conservation need to look not only at the benefits generated by an income source, but also at the context in which those benefits affect behaviour. Standard income indicators alone did not explain damar conservation in Krui. The same indicators did explain harvest intensities in Kayan Mentarang, however, they did not explain whether people preferred to harvest for benefits in the present or future. Only if an income is expected to be important in the future, can we expect people to take action to conserve it. To understand those expectations requires a new way of thinking about policy interventions. We need to be more sensitive to the multiple meanings of a forest product in local people's livelihoods, and not only to a bottom line.

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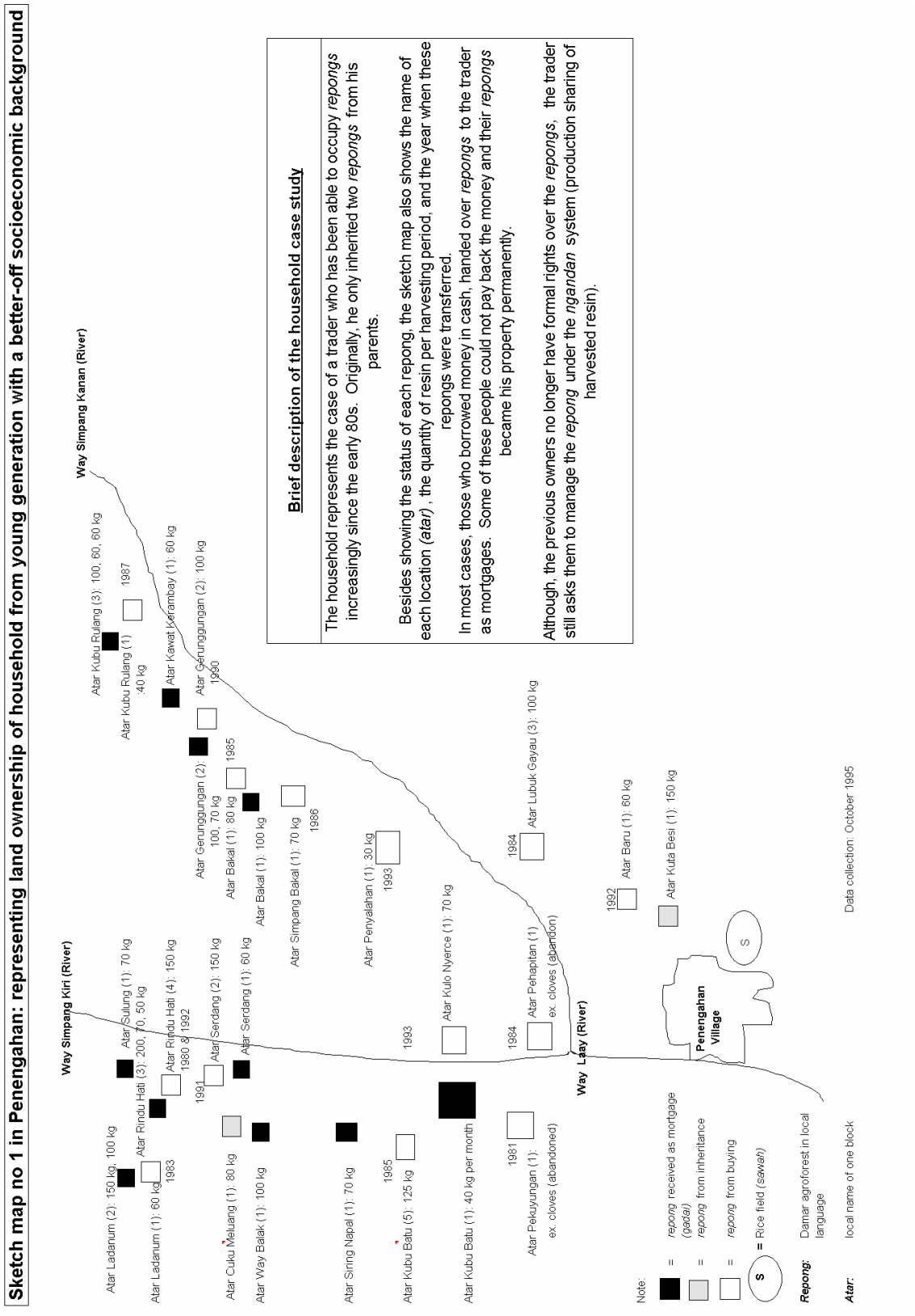
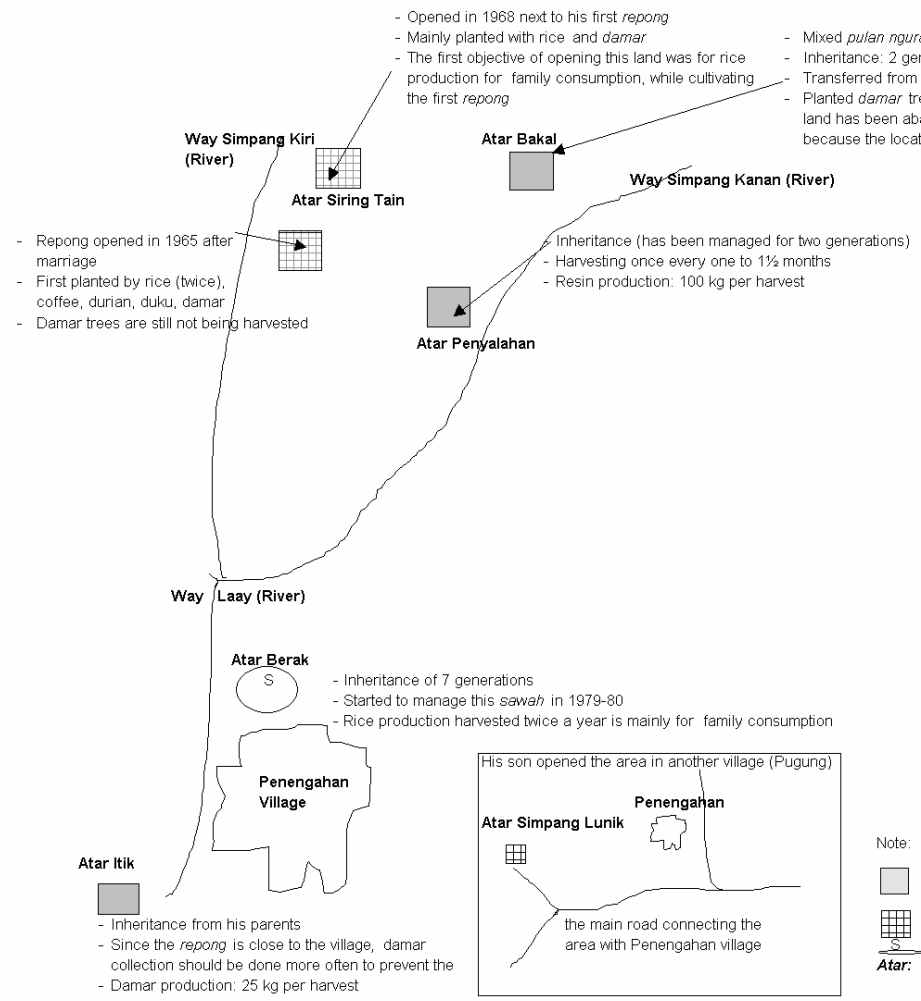
Annex 1

SKETCH MAPS OF SAMPLE *REPONG* HOLDINGS FROM KRUI


Sketch map no 1 in Penengahan: representing land ownership of household from young generation with a better-off socioeconomic background
Brief description of the household case study
The household represents the case of a trader who has been able to occupy repongs increasingly since the early 80s. Originally, he only inherited two repongs from his parents.
Besides showing the status of each repong, the sketch map also shows the name of each location (atar) , the quantity of resin per harvesting period, and the year when these repongs were transferred.
In most cases, those who borrowed money in cash, handed over repongs to the trader as mortgages. Some of these people could not pay back the money and their repongs became his property permanently.
Although, the previous owners no longer have formal rights over the repongs, the trader still asks them to manage the repong under the ngandan system (production sharing of harvested resin).
Way Simpang Kiri (River)
Way Simpang Kanan (River)
Way Lay (River)
Penengahan Village
Atar Ladanum (2): 150 kg, 100 kg
Atar Ladanum (1): 60 kg
1983
Atar Rindu Hati (3): 200, 70, 50 kg
Atar Sulung (1): 70 kg
Atar Rindu Hati (4): 150 kg
1980 & 1992
1991
Atar Serdang (2): 150 kg
Atar Cuku Meluang (1): 80 kg
Atar Way Balak (1): 100 kg
Atar Serdang (1): 60 kg
Atar Siring Napal (1): 70 kg
1985
Atar Kubu Batu (5): 125 kg
1993
Atar Kubu Batu (1): 40 kg per month
1981
Atar Pekuyungan (1): ex. cloves (abandoned)
1984
Atar Pehapitan (1) ex. cloves (abandon)
Atar Kulo Nyerce (1): 70 kg
Atar Penyalahan (1): 30 kg
1993
Atar Bakal (1): 100 kg
Atar Simpang Bakal (1): 70 kg
1986
Atar Bakal (1): 80 kg
1985
Atar Gerunggungan (2): 100, 70 kg
1990
Atar Kawat Kerambay (1): 60 kg
Atar Kubu Rulang (3): 100, 60, 60 kg
Atar Kubu Rulang (1) :40 kg
1987
Atar Gerunggungan (2): 100 kg
1984
Atar Lubuk Gayau (3): 100 kg
1992
Atar Baru (1): 60 kg
Atar Kuta Besi (1): 150 kg
S
Note:
= repong received as mortgage (gadai)
= repong from inheritance
= repong from buying
= Rice field (sawah)
Repong: Damar agroforest in local language
Atar: local name of one block
Data collection: October 1995

Sketch map no 2 in Penengahan: representing land ownership of household from older generation at the middle socioeconomic level



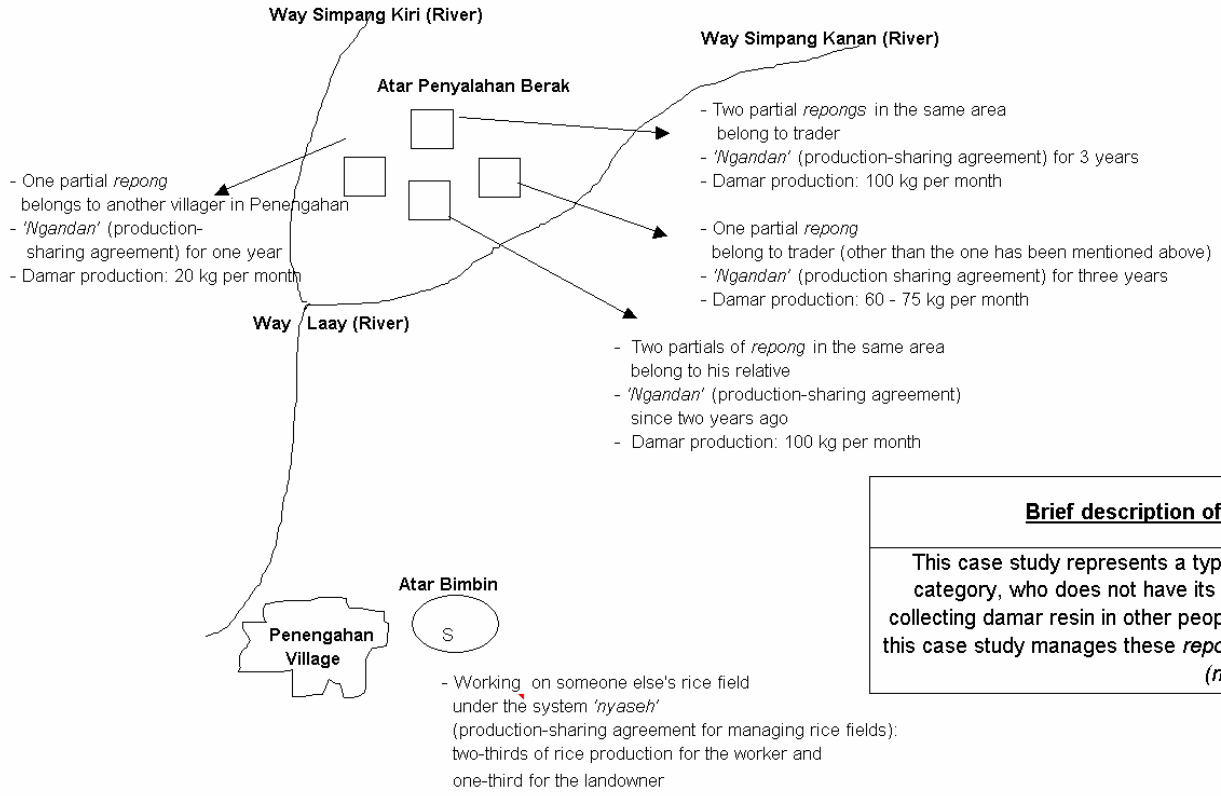
Brief description of the household case study

This case study represents a typical household in Penengahan village, in which the man of the family had to open new land(s) after he married, as part of his responsibility to fulfil the needs of the new family. However, since he is the oldest son in the family, he is also lucky enough to be entitled to inheritances of *repong* and *sawah* (rice field) from his parents.

His son, on the other hand, had to go to another village to open new *repong*, since there is limited land available in Penengahan.

Data collection: October 1995

Sketch map no 3 in Penengahan: representing land ownership of household from older generation with low socio-economic status

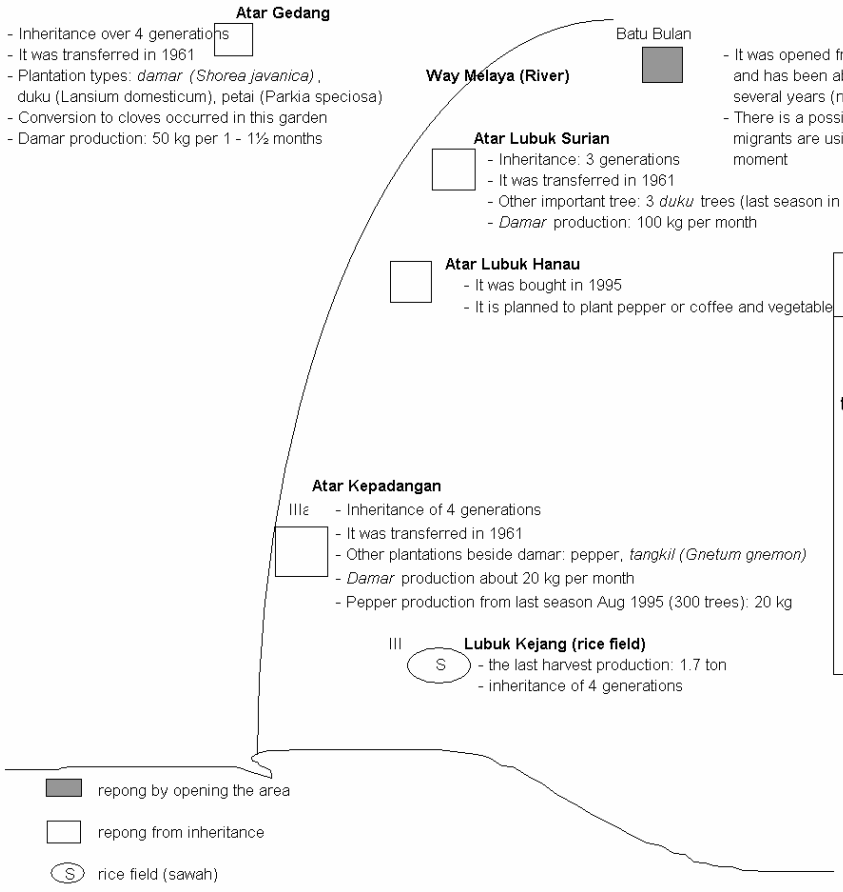


Brief description of the household case study

This case study represents a typical household in the low socio-economic category, who does not have its own *repong*, but has earns income from collecting damar resin in other people's *repongs* (usually traders). The man in this case study manages these *repongs* under a production-sharing agreement *(ngandan)*.

Data collection: October 1995

Sketch map no 4 in Melaya: representing land ownership of household from older generation with a better-off socioeconomic background



Brief description of the household case study

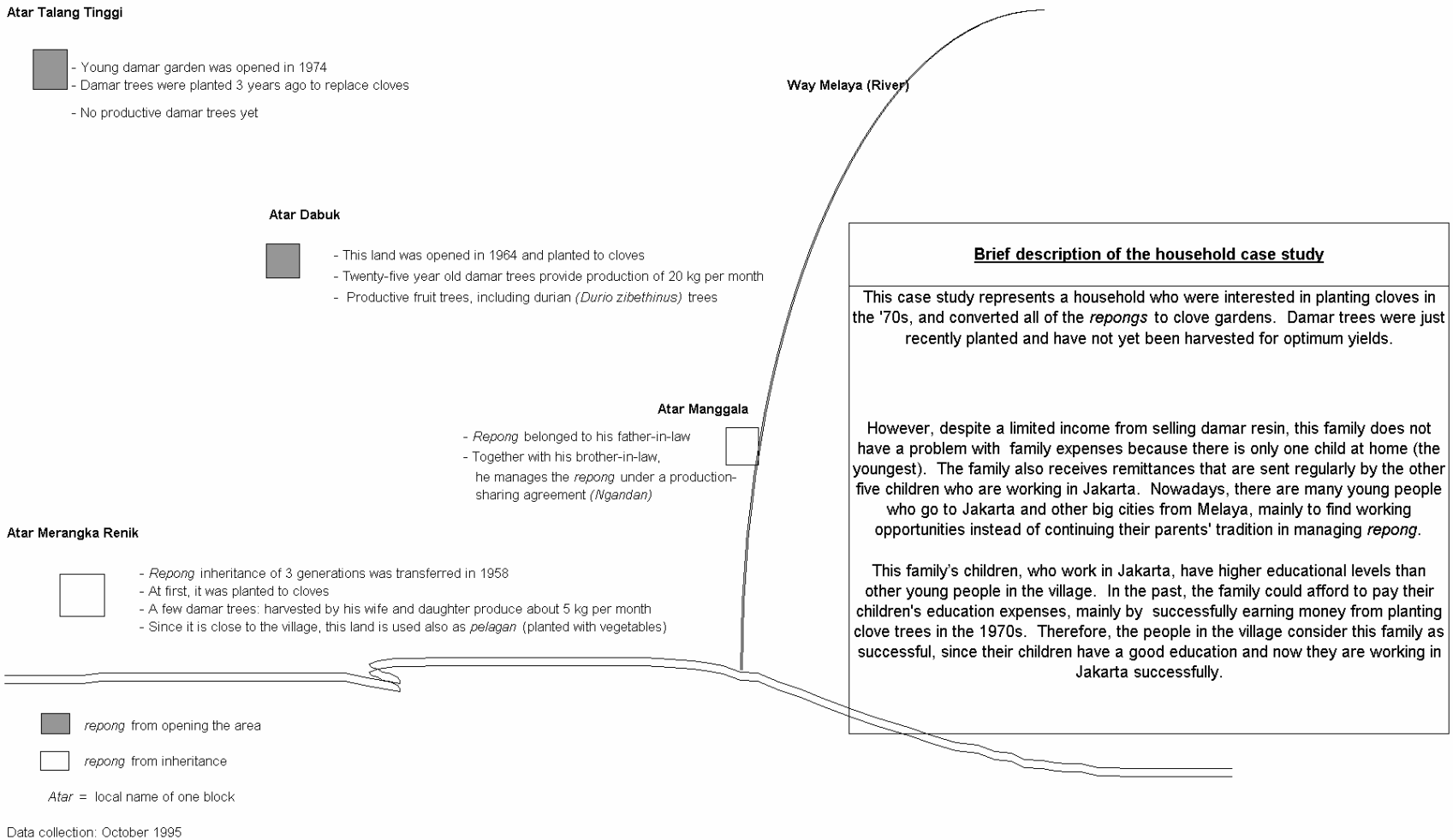
The *repongs* were mostly inherited, which have been transferred for three to four generations. The *repongs* supposedly considered to be old *repongs*. However, historically, some parts of these lands were converted to clove plantations (during the clove boom in the '70s). Therefore, most of the damar trees have not yet been harvested for optimum yields.

This family was lucky, because it has more than one *repong* and did not convert all of the *repongs* to cloves, unlike in most other households in Melaya.
As a typical better-off household in Melaya, this family owns a quite big area of rice field, which provides a significant rice production for the family. There is sufficient family labour available that it does not have a problem managing the rice fields intensively.

Atar = local name of one block

Data collection: October 1995

Sketch map no 5 in Melaya: representing land ownership of household from older generation at the middle socio-economic status



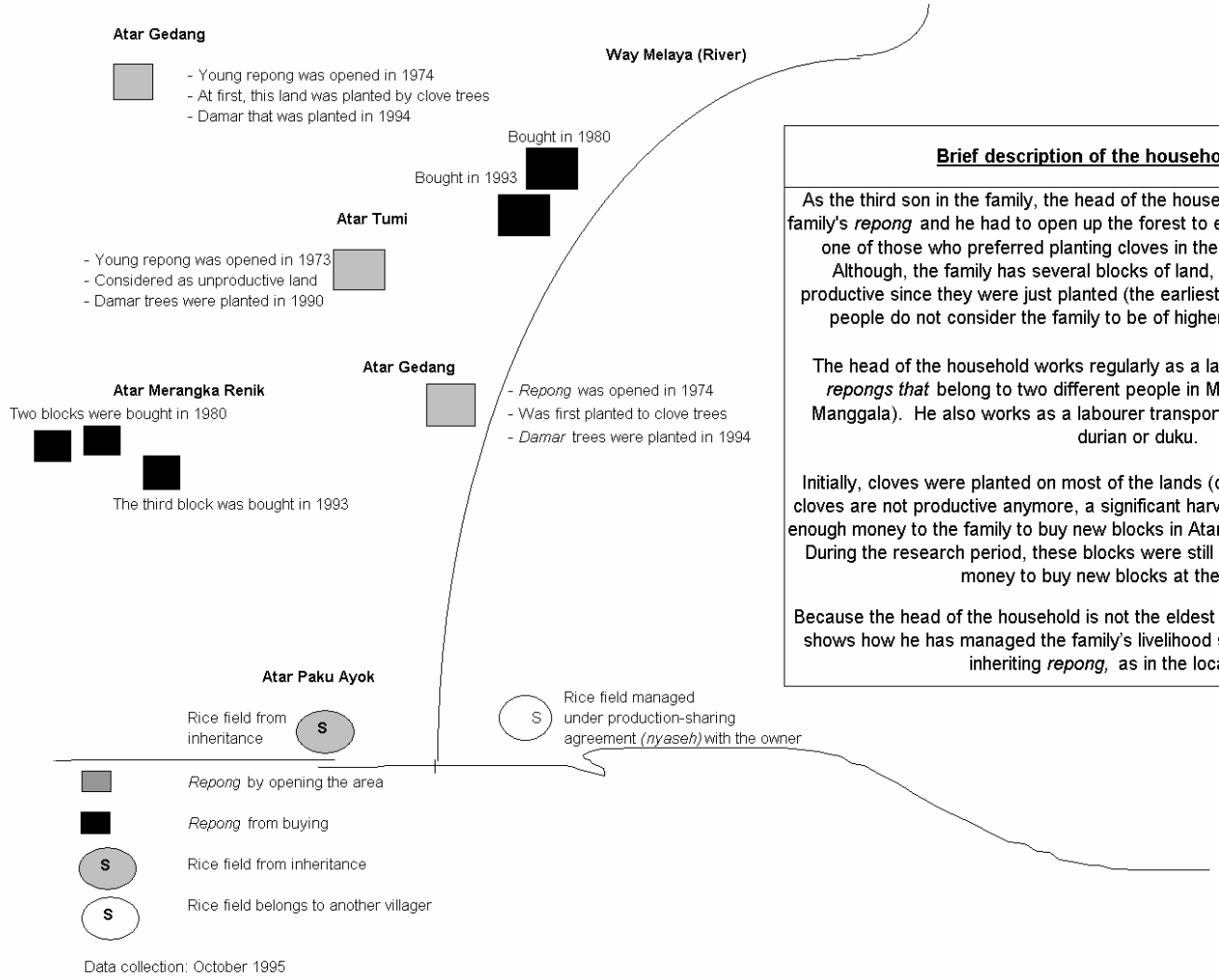
Brief description of the household case study

This case study represents a household who were interested in planting cloves in the '70s, and converted all of the *repongs* to clove gardens. Damar trees were just recently planted and have not yet been harvested for optimum yields.

However, despite a limited income from selling damar resin, this family does not have a problem with family expenses because there is only one child at home (the youngest). The family also receives remittances that are sent regularly by the other five children who are working in Jakarta. Nowadays, there are many young people who go to Jakarta and other big cities from Melaya, mainly to find working opportunities instead of continuing their parents' tradition in managing *repong*.

This family's children, who work in Jakarta, have higher educational levels than other young people in the village. In the past, the family could afford to pay their children's education expenses, mainly by successfully earning money from planting clove trees in the 1970s. Therefore, the people in the village consider this family as successful, since their children have a good education and now they are working in Jakarta successfully.

Sketch map no 6 in Melaya: representing land ownership of household from older generation at a low socioeconomic status



Brief description of the household case study

As the third son in the family, the head of the household is not entitled to inherit the family's *repong* and he had to open up the forest to establish *repong*. This family was one of those who preferred planting cloves in the past instead of damar trees. Although, the family has several blocks of land, the damar trees are not yet productive since they were just planted (the earliest was in 1990). Therefore, local people do not consider the family to be of higher socio-economic status yet.

The head of the household works regularly as a labourer collecting damar from *repongs that* belong to two different people in Melaya (in Atar Tumi and Atar Manggala). He also works as a labourer transporting other crops/fruits, such as durian or duku.

Initially, cloves were planted on most of the lands (during the 1970s). Although the cloves are not productive anymore, a significant harvest in 1980 was able to provide enough money to the family to buy new blocks in Atar Merangka Renik and Atar Tumi. During the research period, these blocks were still being mortgaged for borrowing money to buy new blocks at the same atar.

Because the head of the household is not the eldest son in his family, this case study shows how he has managed the family's livelihood strategy without the privilege of inheriting *repong,* as in the local tradition.

Annex 2

NOTES FOR CALCULATION OF CONSERVATION INDICATORS

Table A2.1 summarises the data used in constructing the damar conservation indicator for Penengahan and Melaya. While overall the harvesting periods for Penengahan are significantly longer than for Melaya, the break-down by close and distant *repongs* indicates that Penengahan's average is influenced by the higher number of households with distant *repong* where harvesting is conducted less frequently. The differences between Melaya and Penengahan are not statistically significant for the mean harvest periods but are for minimum harvest periods (p=.008, df 74) on the close plots. The lack of distant plots in Melaya prevents comparisons with these *repong*.

Table A2.1 Mean harvest periods in Penengahan and Melaya

	Penengahan	Melaya
Mean harvest periods		
All *repong*	35	33
Close *repong*	30	33
Distant *repong*	41	--
Minimum harvest periods		
All *repong*	18	13
Close *repong*	16	13
Distant *repong*	20	--
Number of households conserving damar tress	40	18
Close	17	18
Distant	23	--
Number of households overusing damar trees	16	17
Close	11	17
Distant	5	--

Analysis of conservation was conducted not only at the *repong* level but also for households. Scaling-up the conservation indicator to households resulted in the loss of information about variation in practices among *repong* managed by a single household. While 47% of the damar-collecting households managed only one *repong*, 53% managed two *repongs* or more (see Table A2.2). Among households with two or more *repong*, it was quite common to find a mix of conserved and overused *repong.* To classify households, 'conserver' households were defined as those that had a larger number of conserved *repong*, while 'nonconserver' households were those that had a larger number of overused *repong*. Where the number of conserver and overused *repong* was the same, these cases were classified as overuse, so that conservation would be estimated conservatively

Table A2.2 Frequency of *repong* per household

Number of *Repong*	Number of households	Percentage of households
1	70	47
2	44	30
3	20	14
4	5	3
5	7	5
6	2	1
Total	148	100

Other management indicators for the conservation of damar were explored, but found to be unsatisfactory. For example, local people most often point to an excessive number of tapping holes in a damar tree as a sign of unsustainability. They observe that the tree is being weakened structurally and its productive life will be shorter. However, since the number of holes varies with the age of the tree, and since trees were classified only as seedlings, immature trees and productive trees in the survey, we were not able to control for age. The number of damar trees planted might also seem to be a reasonable indicator, yet planting usually occurs in response to gaps in the *repong*. Damar tree planting would have to be compared for farmers with the same number and size of gaps. For similar reasons the proportion of young trees to productive trees or seedlings to total tree population were considered inadequate indicators. Finally, local people suggested that the felling of a productive damar tree was an important indicator of a farmer's attitude towards conserving damar trees, yet the stigma attached with such an activity made it unlikely that people would admit to cutting a damar tree in an interview. With any of these indicators, there remains the problem of how to determine thresholds for conservation and overuse. For example, it is not known what proportion of young trees to productive trees is necessary for maintaining the damar population, although such information may be available eventually from permanent plots studied nearby in the community of Pahmungan (H. de Foresta pers. comm.). The difficulty of finding a satisfactory indicator of conservation suggests that monitoring of sustainability in such systems is complex and may require considerable expense.

A summary of repong traits for conserver and nonconserver households appears in Table A2.3 and A2.4.

Table A2.3 Repong traits for conserver and nonconserver households in close damar gardens

	Indicator		Total
	Conserver	Non-conserver	
Damar per tree per year	23.53	22.82	23.12
Number of generations owned/manage garden	3	2	2
No. of young trees/productive trees	.80	1.96	1.47 *
Total number of damar trees	58.79	99.90	83.11 *
Total number of trees	185.85	280.57	241.07

* Significant at less than 5%

Table A2.4 Repong traits for conserver and nonconserver households in distant damar gardens

	Indicator		Total
	Conserver	Non-conserver	
Damar per tree per year	22.55	23.64	22.92
Number of generations owned/manage garden	2	2	2
No. of young trees/productive trees	.62	.91	.72
Total number of damar trees	79.19	73.44	77.19
Total number of trees	144.55	124.12	137.46

One of the difficulties in defining conservation for gaharu is the lack of definitive studies about the product distribution, its response to disturbance and its reproductive capabilities. Because the gaharu is the product of a parasitic relationship between a tree and fungus, it is necessary to know the incidence of infection. There is evidence to suggest, however, that gaharu is sensitive to overuse and is presently harvested unsustainably, at least in economic terms. Soehartono (1998) found that seedling damage was substantial around harvested trees in the upper Bahau and Malinau watersheds. Local people also confirm that their gaharu is currently *habis'* (gone) and that they have to walk much farther than before to find any at all. Vayda's (personal communication) assertion that gaharu in the Bahau cannot be overexploited is therefore

contrary to all empirical findings. He makes the presumption that the boom-bust nature of gaharu demand is widely enough spaced to permit adequate regeneration. While such spacing might explain the sustainability of gaharu to the present time, one difference between now and earlier booms in the Bahau region is that in the last five to 10 years, access to the upper Bahau watershed has improved dramatically with the introduction of motorised boats. The possibilities for earning cash incomes has increased dramatically, as has the numbers of people and scale of efforts from outside the region for collecting forest products – even by helicopter.

Any study of gaharu harvesting is also subject to bias introduced by harvesters unwilling to reveal their sources or profits. Gaharu values reported here should therefore be taken as minimum values.