# 5. Biodiversity Research in Malinau

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## Aims

### A biodiversity baseline

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

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

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

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

To develop a better baseline of what we already know about the animal species in Malinau and what it implies for management outcomes, CIFOR initiated a review of relevant wildlife literature (to be extended to include flora in the future). The review covered both published and unpublished sources and involved broad consultations with national and international experts and institutions. It helped us to clarify local needs and principles in defining 'wildlife friendly' forest management, and uncovered the main knowledge gaps where further research is likely to prove valuable.

## Achievements and outputs

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

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

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

Ultimately we have five classes of results:

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

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

## Reports and publications

See Annex in CD-ROM

## Selected research summaries

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

#### Overview

*General*

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

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

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

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

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

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

### *Overview of Methods*

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

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

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

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

Two hundred research plots were established in the Malinau watershed in four separate data collection periods (between November 1999 and November 2000). Sample sites represent a wide range of local environments. While forest variation was an emphasis, we also included a broad range of non-forest sites for comparison. We specifically sought out and included sites that may have restricted biota and are important to local people. To achieve this we developed maps together with the community, in conjunction with more conventional map materials. The distribution of the plots within each village area is shown in Figure 5.1.

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

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

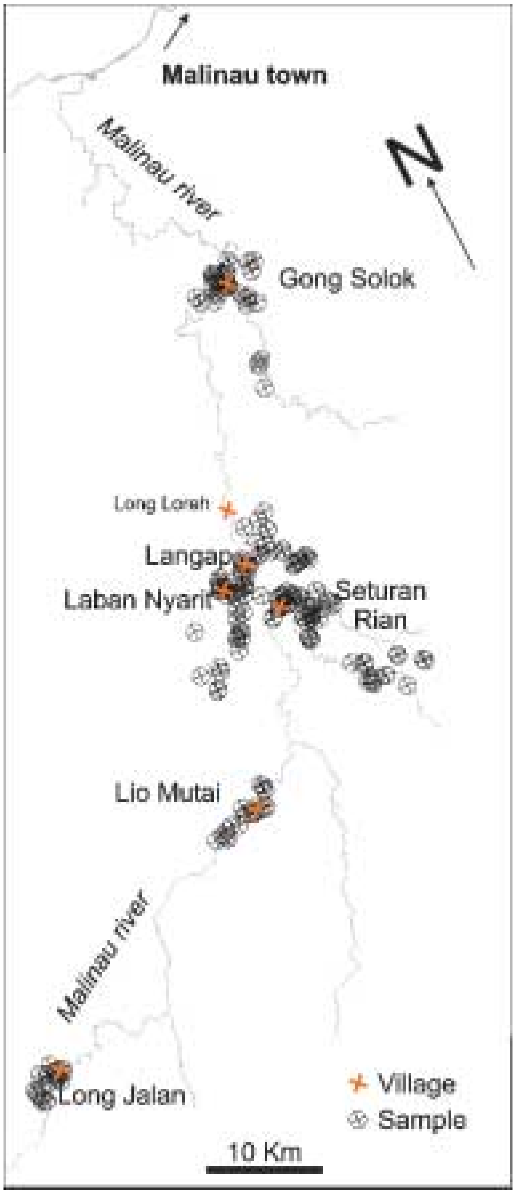
**Table 5.1** Survey phases, locations and dates

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

**Table 5.2** Classes for uses and measures of importance

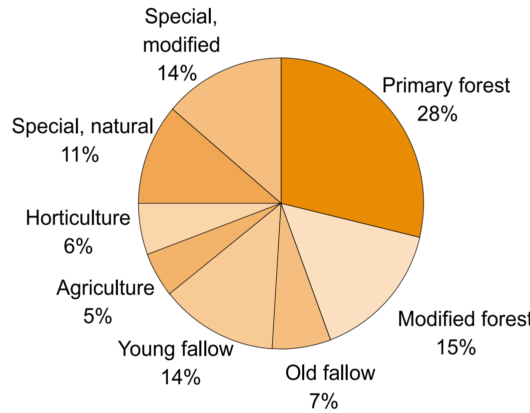
| No. | Category | Explanation |
|---|---|---|
| 1 | Food | Primary and secondary foods; famine foods |
| 2 | Medicine | Medicinal and health-related |
| 3 | Light construction | Poles and cut timbers for huts, forest camp structures, fences |
| 4 | Heavy construction | Poles and cut timber for houses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

**Figure 5.1** Distribution of survey villages and plots




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

**Figure 5.2** Distribution of plots by eight summary site type classes




The classes are defined as follows:

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

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

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

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

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

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

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

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

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

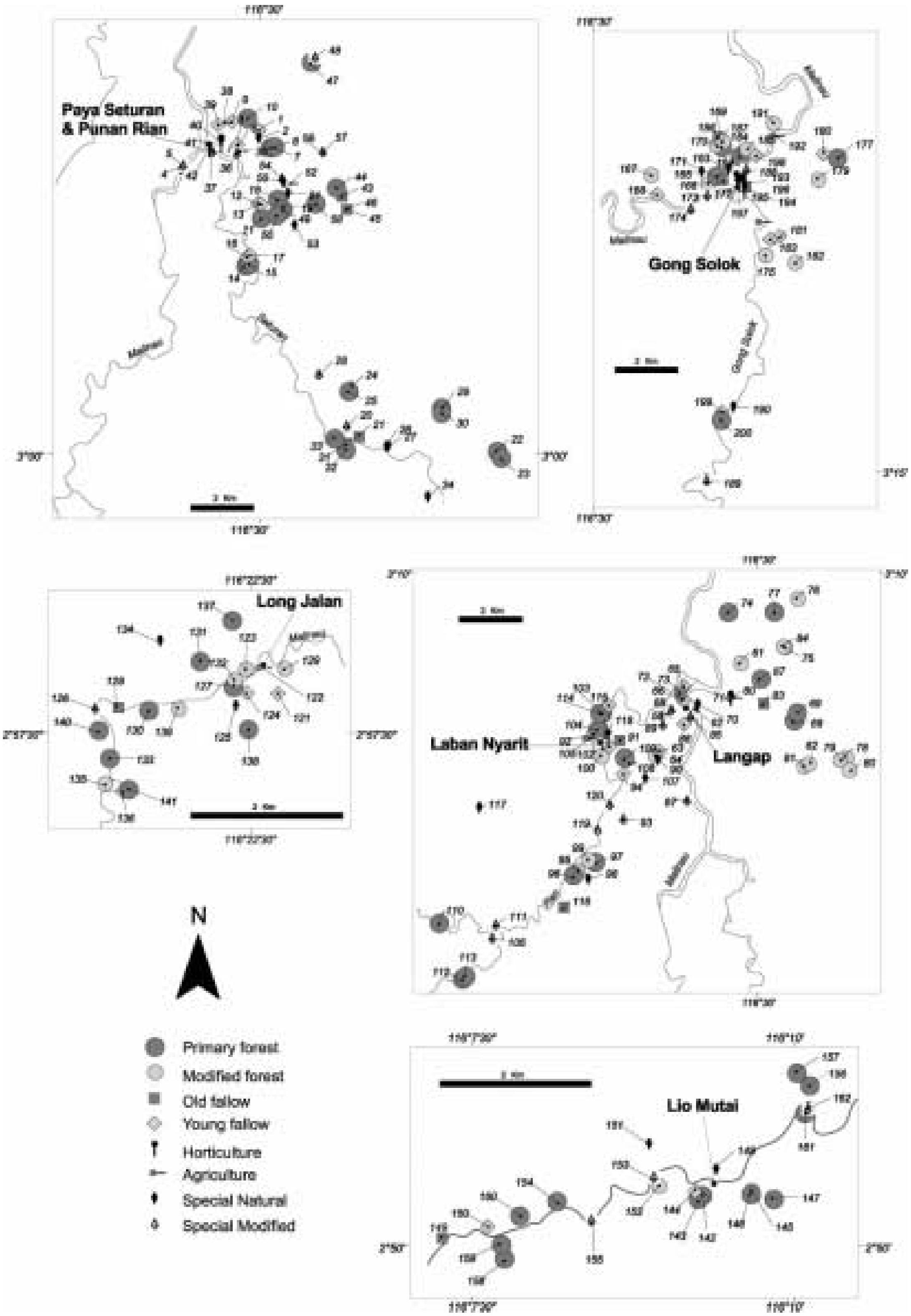
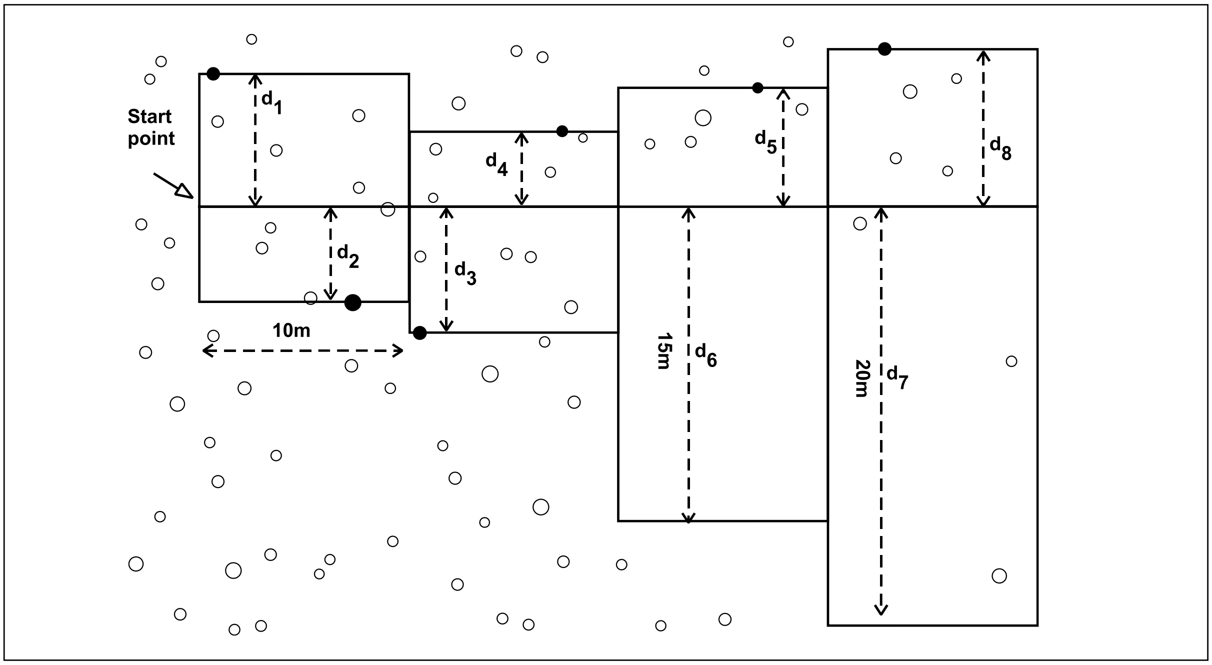


**Figure 5.4** Our novel tree sample unit




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

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

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

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

### *Overview of Results*

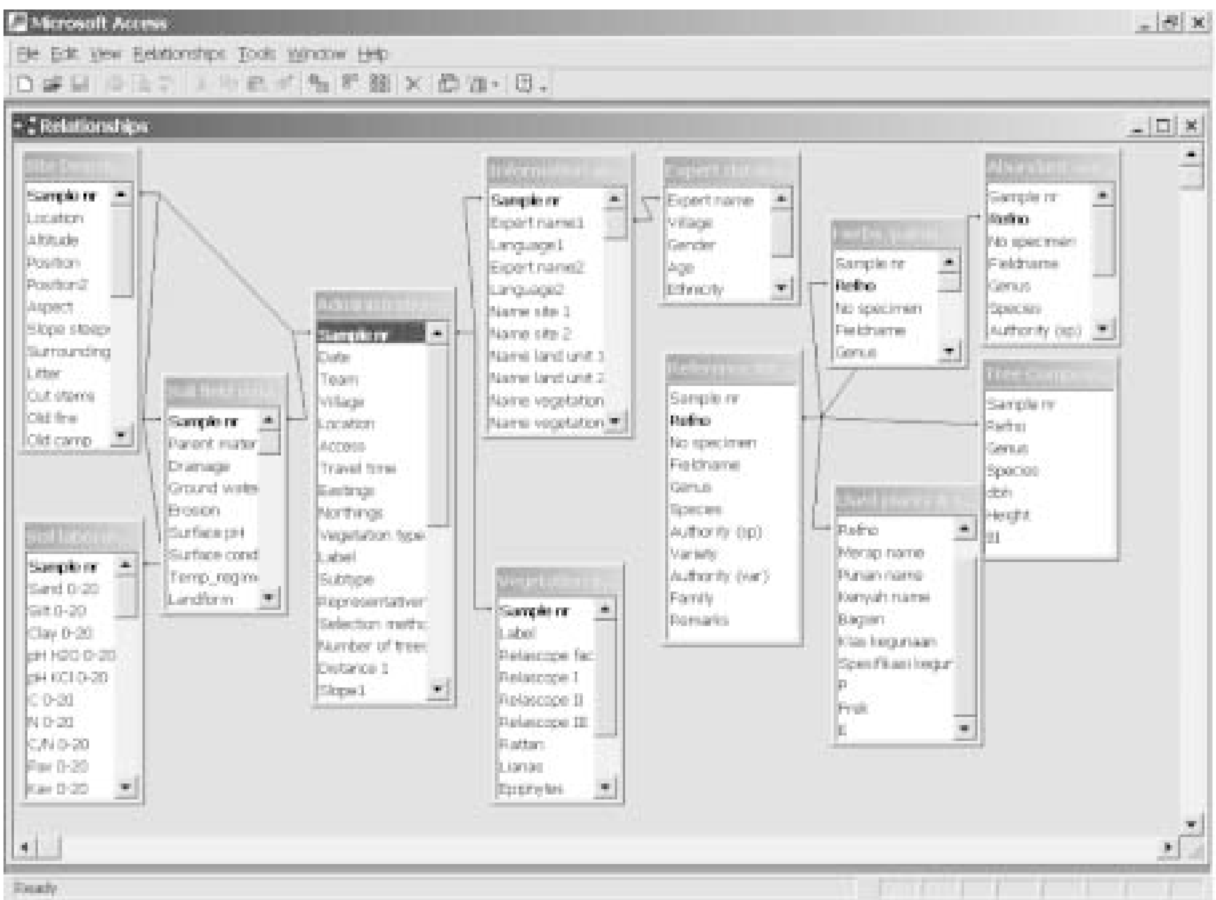
The following sections illustrate the breadth of the survey information, starting with the village data collections, followed by the field data, and some broader generalizations. For many results their significance lies in the specific details they provide. We have collected so much information that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

**Table 5.3** Village Survey exercises

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

* PDM = Pebble Distribution Method

**Figure 5.5** Links between the tables in the plot survey database



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

*Future work*

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

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

## Local people and local views

*Maps*

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

*Settlement history and important events*

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

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

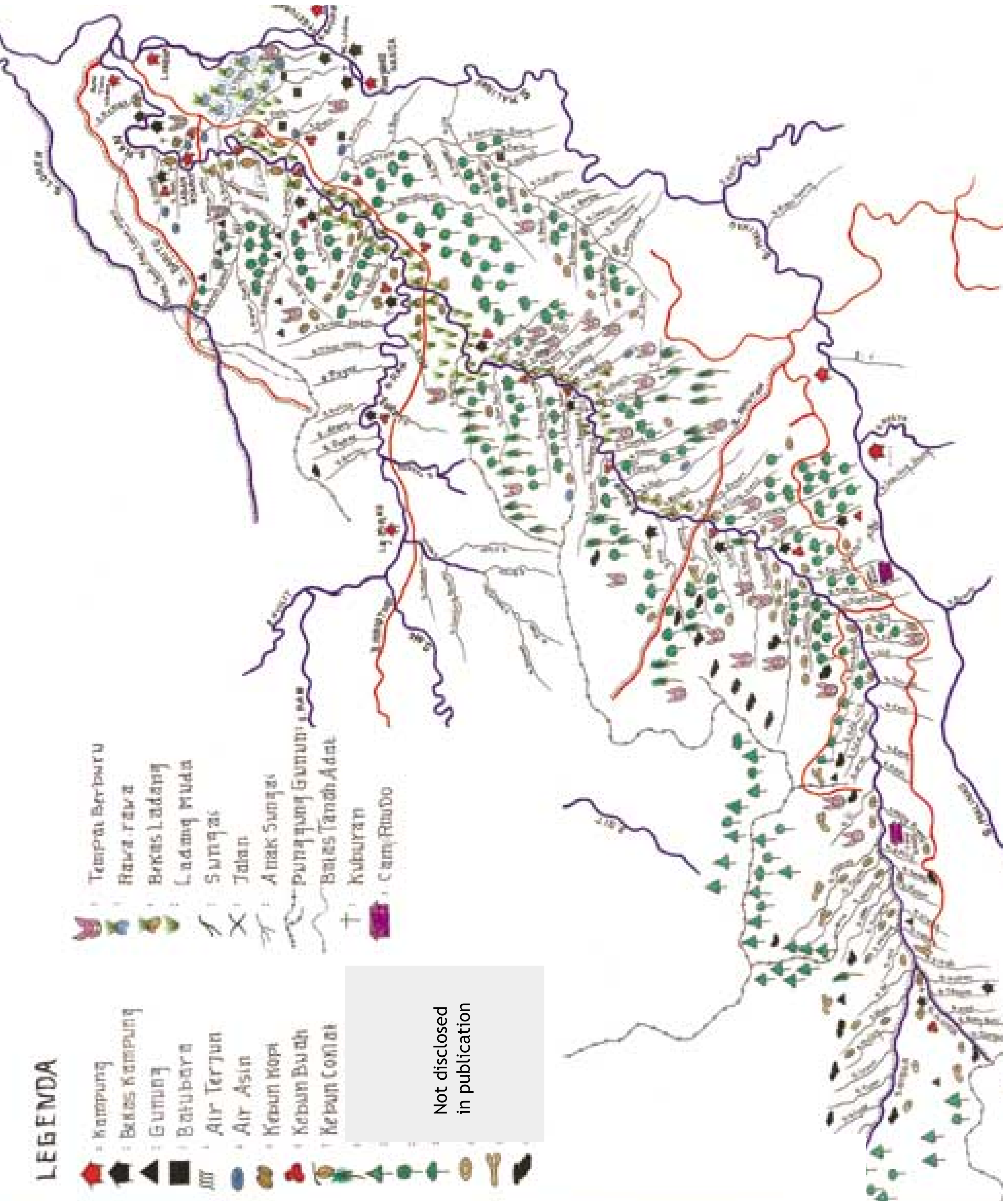
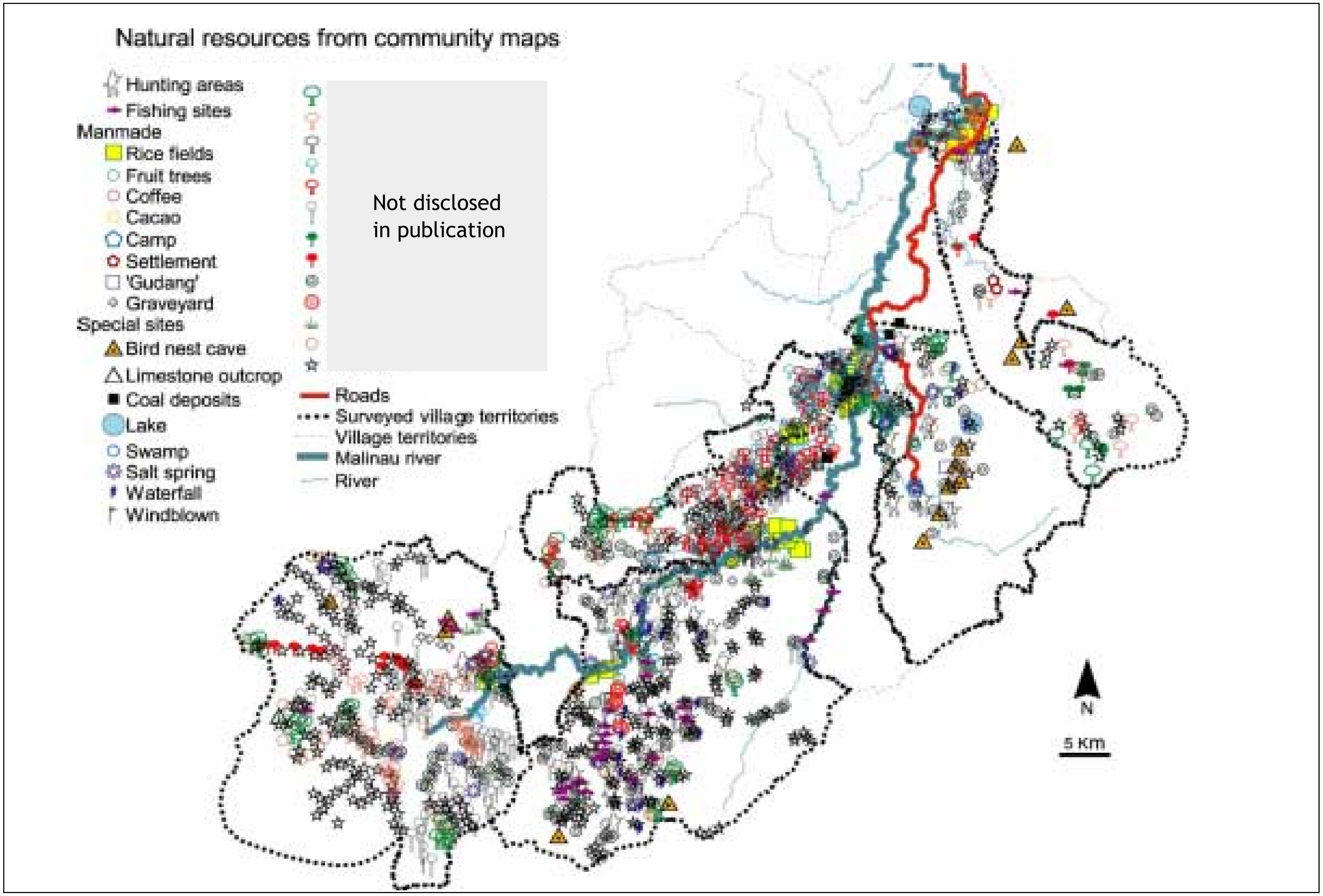



**Figure 5.6** Part of a Community map, made with Laban Nyarit

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




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

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

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

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

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

**Table 5.4** Summary of village movement history, Langap Village

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

*S = Sungai (River)

**Table 5.5** Summary of village movement history, Long Jalan Village

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

**Table 5.6** Disasters and important events, Langap Village

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

**Table 5.7** Disasters and important events, Lio Mutai Village

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

### *Land and forest types*

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

### *Forest products*

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

### *PDM results*

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

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

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

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

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

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

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

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

Land and forest types

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

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

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

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

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

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

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

Importance over time

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

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

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

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

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

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

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

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

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

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

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

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

Importance and origin of plants and animals

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

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

Importance of species

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

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

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

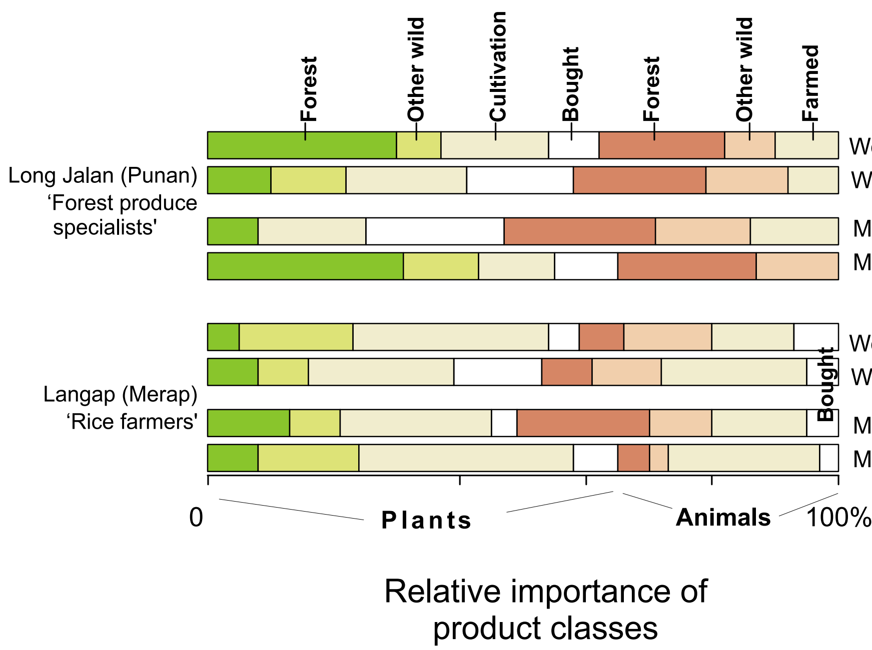
| | 30 years ago | Now | In 20 years |
|---|---|---|---|
| **All value** | 36 | 34 | 30 |
| **Food** | **13** | **10** | **5** |
| **Medicine** | 11 | 5 | - |
| **Light construction** | 15 | 4 | 5 |
| **Heavy construction** | - | 11 | 13 |
| **Boat construction** | - | 8 | 9 |
| **Tools** | - | 5 | 6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

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

### *General facts*

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

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




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

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

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

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

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

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

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

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

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

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

**Table 5.17** Example portion of PDM based on species by importance

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

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

**Table 5.18** Populations of survey villages

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

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

**Table 5.19** Ethnicity and religion of the sample villages

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

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

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

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

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

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

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

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

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

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

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

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

### *Livelihoods and some field stories*

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

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

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

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

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

**Table 5.21** Some examples from the questionnaires addressing perception

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

**Table 5.21** *Continued*

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

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

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

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

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

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

*Values of sites*

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

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

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

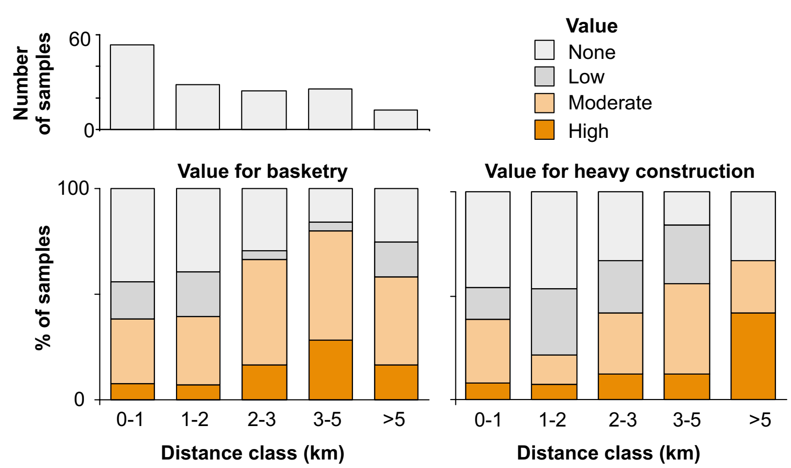
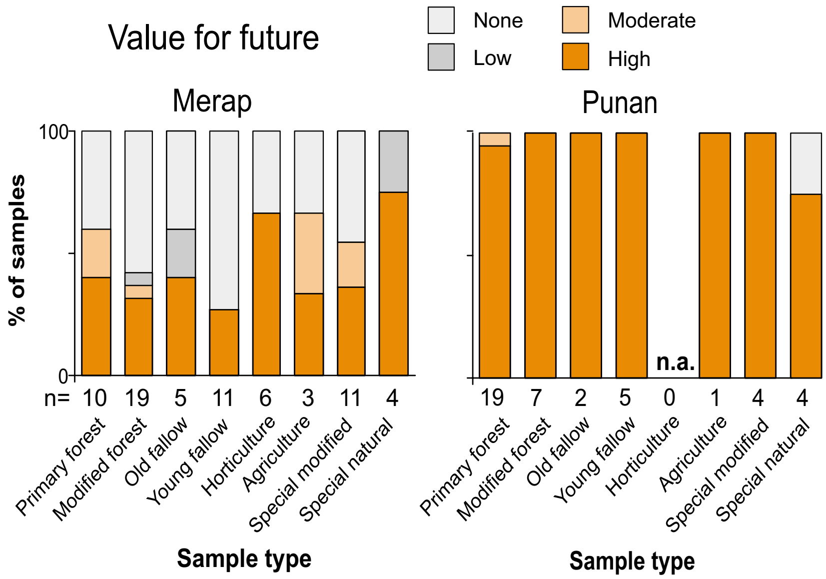


**Figure 5.10** A summary of 'importance for the future', reported by Merap and Punan informants in our samples, by site type. These summarise records from five of the seven communities, n.a. = not applicable (see Figure 5.2 for explanation of sample classes)




## Soil

### *Introduction*

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

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

### *Description of soil types*

Scientific

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

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

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

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

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

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

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

*Local soil classification/characterisation*

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

*Soil fertility*

Scientific assessment

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

*Local perception of soil quality/fertility*

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

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

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

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

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

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

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

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

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

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

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

The relation between local and scientific perceptions of soil fertility

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

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

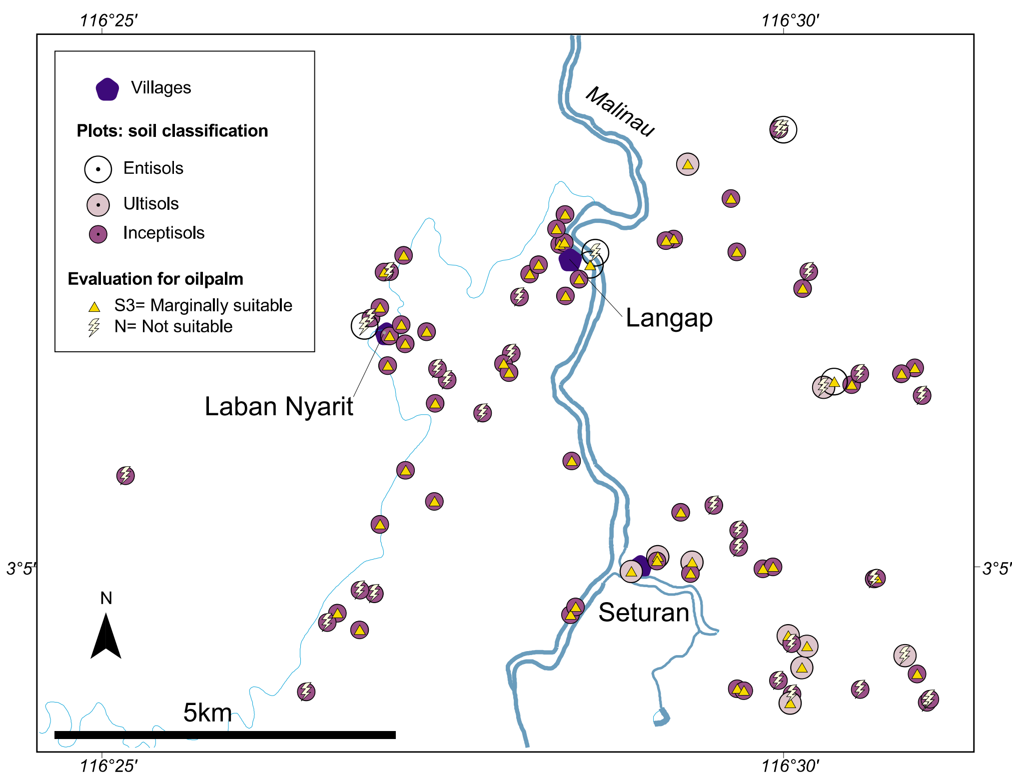
**Table 5.23** Significant rank correlations between local fertility perception (very fertile, fertile, quite fertile, and not fertile) and measured soil characteristics (inc. chemical characteristics at 0–20 cm depth)

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

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

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

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




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

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

### *Land evaluation*

Scientific assessment

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

Local assessment of suitability

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

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

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

### *Erosion and compaction*

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

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

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

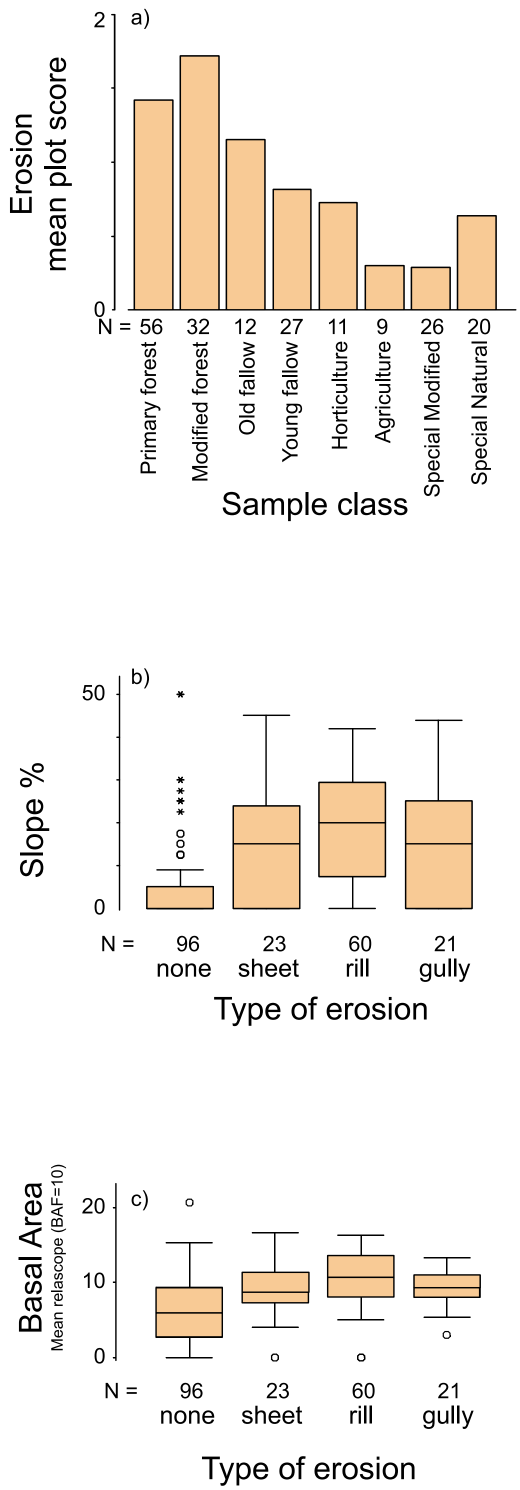
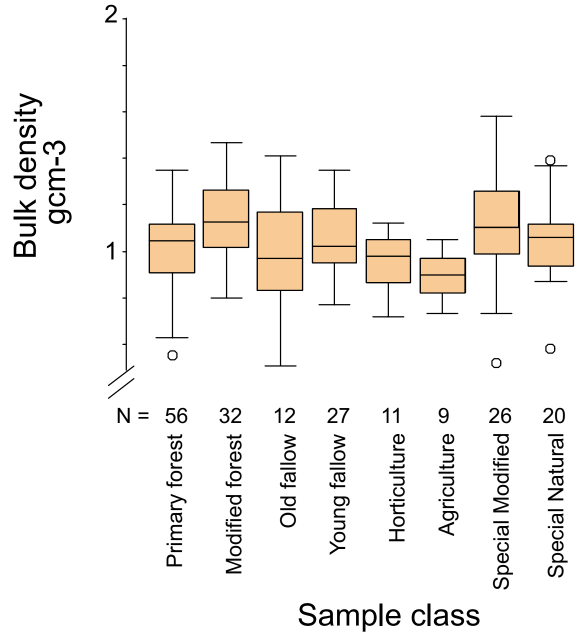



**Figure 5.13** Bulk density of the soil surface by sample class (see Figure 5.2 for explanation of sample classes)




### *Other aspects of sites and generalisations*

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

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

## Plants—general and ecology

### *Plant taxonomy and verification*

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

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

### *Vegetation ecology*

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

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

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

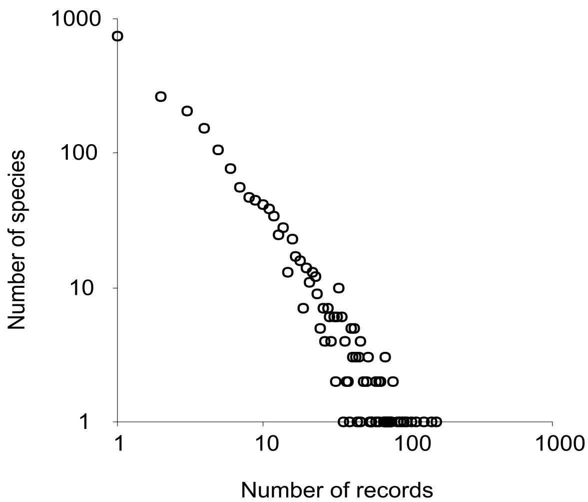
**Table 5.25** Overview of number of identified taxa per life form

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

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

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

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




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

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

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

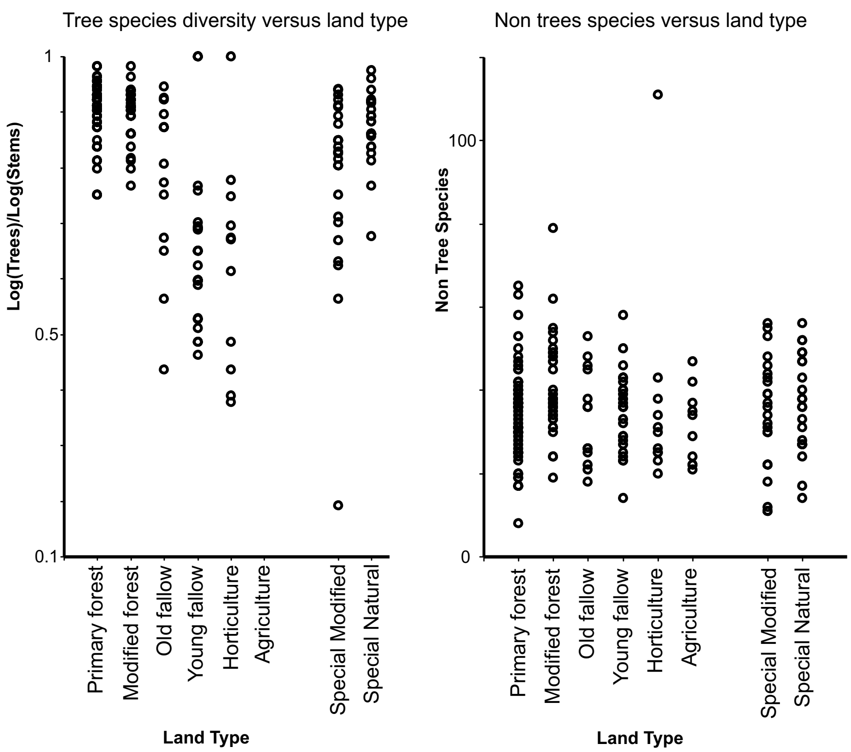
It is perhaps more ecologically meaningful to examine the species richness patterns per plot. In Figure 5.15 the tree diversity and non-tree transect species records are summarised by plot type. The tree richness of primary or lightly disturbed forest is generally higher than other tree communities,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

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

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

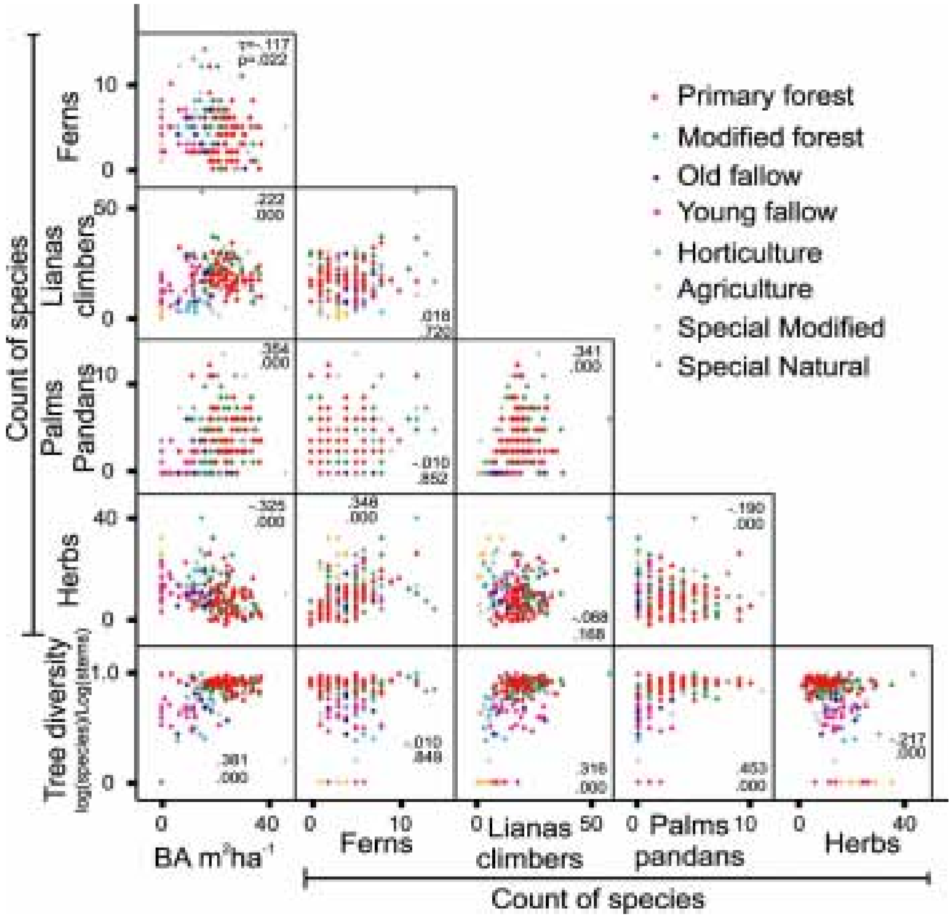
| | Primary forest 57 | Modified forest 32 | Old fallow 13 | Fallow 27 | Horticulture 11 | Agriculture 10 | Special-natural 22 | Special-modified 28 |
|---|---|---|---|---|---|---|---|---|
| **Primary forest** | 1200 | 634 | 329 | 325 | 142 | 59 | 529 | 479 |
| % | *100.0* | *52.8* | *27.4* | *27.1*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

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




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

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




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

## Plants—use

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

A very large number of plants and uses/values were recorded (17 603 records). This included 2052 separate species-uses/values in around 1457 species (not including some Kenyah records from the pilot survey). Of these species, 779 were trees, and 620 were herbs and climbers. The number of specific species-uses per use-class is illustrated in Figure 5.17.

Firewood and 'hunting place' (species noted for providing food for hunted animals) classes elicited especially long species lists. Yet eliminating these classes only reduces the total useful species lists by

**Table 5.28** Number of local informants that accompanied the field team

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

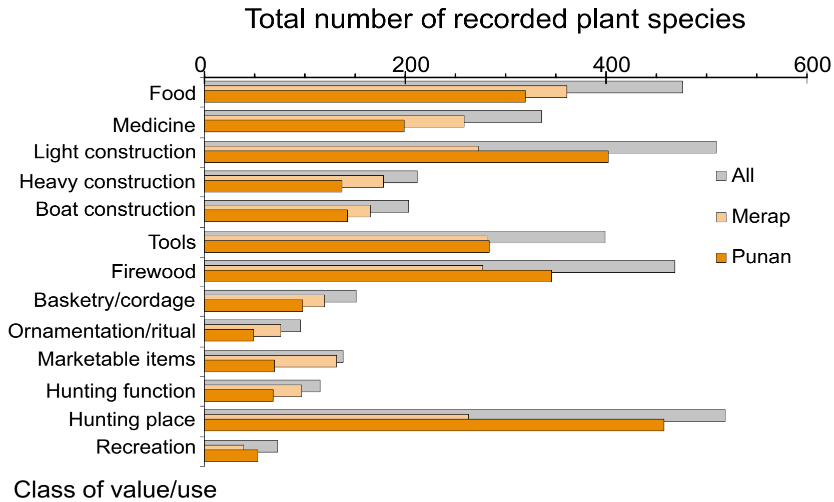
N.B. Three male Kenyah informants were also involved in the pilot study.

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

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

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

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




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

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

**Table 5.30** Total number of records and taxa of valued plants

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

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

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

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

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

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

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

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

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

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

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

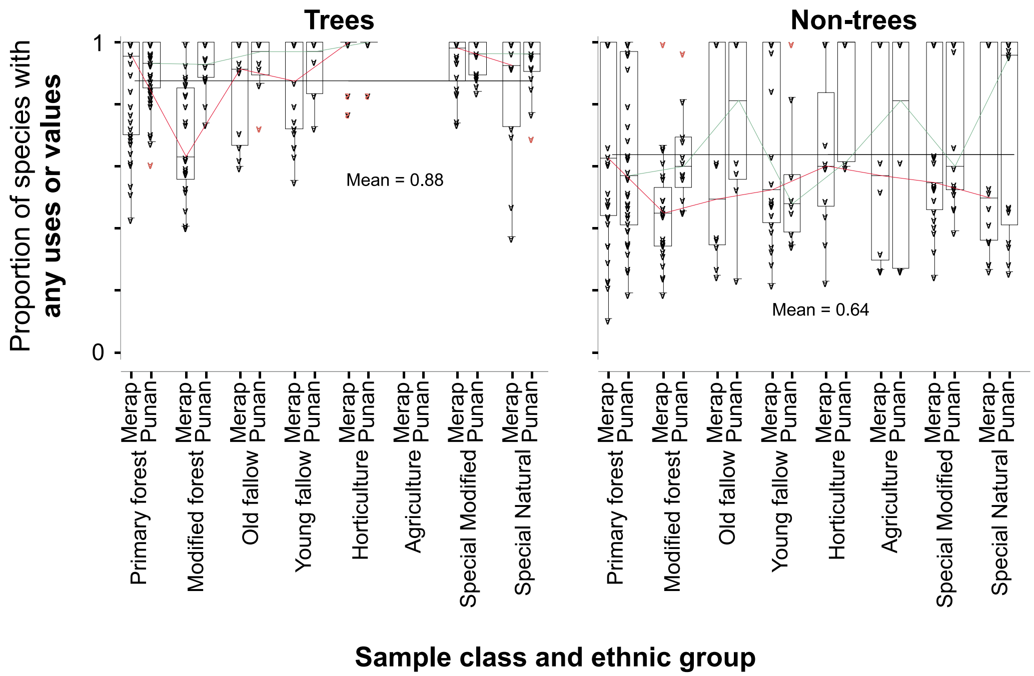



**Figure 5.19** Scatter summary of the per-plot proportion of all food-value species recorded by plot type, according to Merap and Punan informants (see Figure 5.2 for explanation of sample classes)

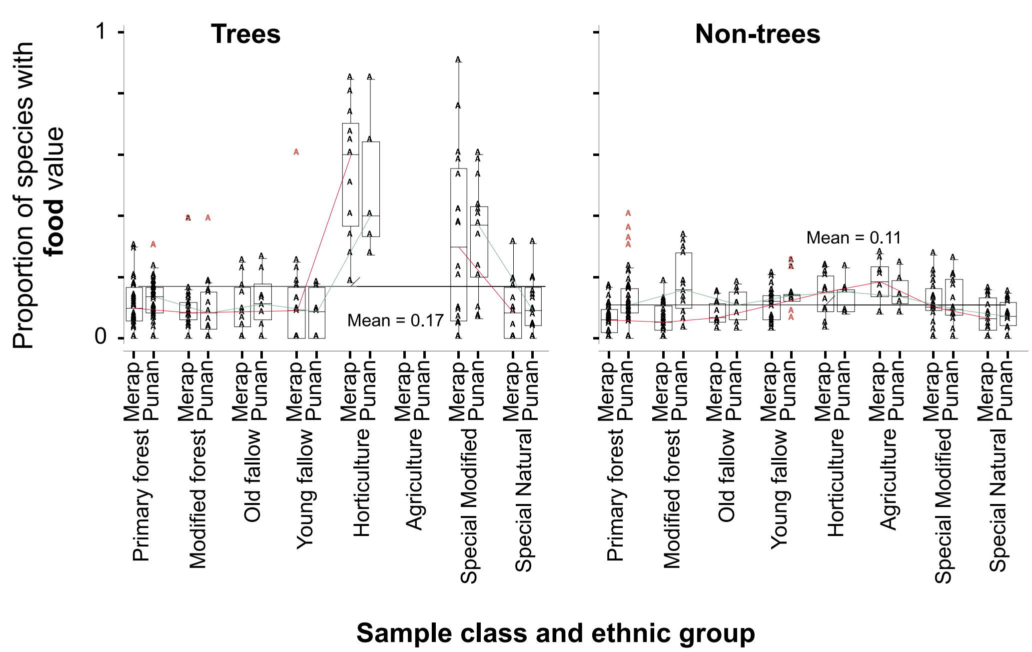


**Figure 5.20** Scatter summary of the per-plot proportion of all medicinal-value species recorded by plot type, according to Merap and Punan informants (see Figure 5.2 for explanation of sample classes)

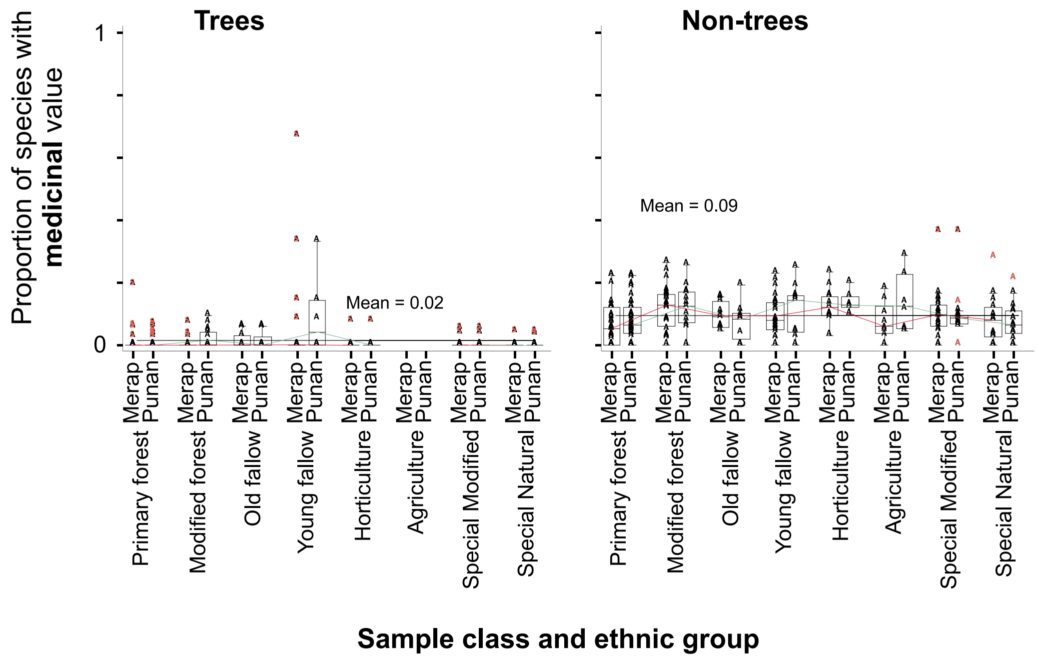



**Figure 5.21** Summary of the mean per-plot proportion of useful species recorded by plot type according to Merap and Punan informants for value classes 'ornamentation/ritual' (a, b) and 'hunting place' (c, d) (see Figure 5.2 for explanation of sample classes)

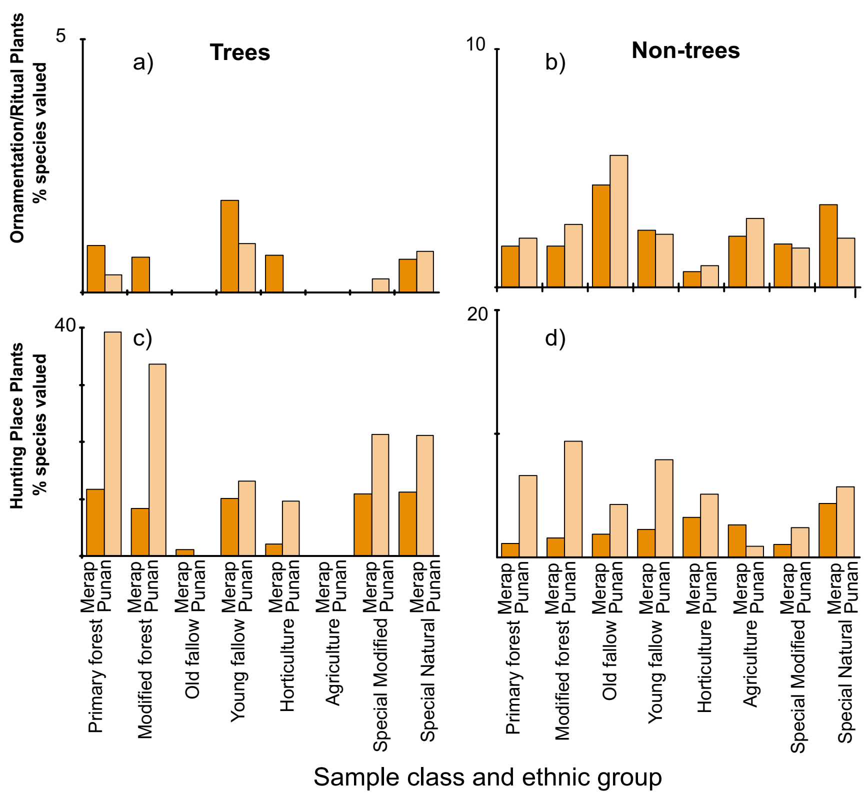
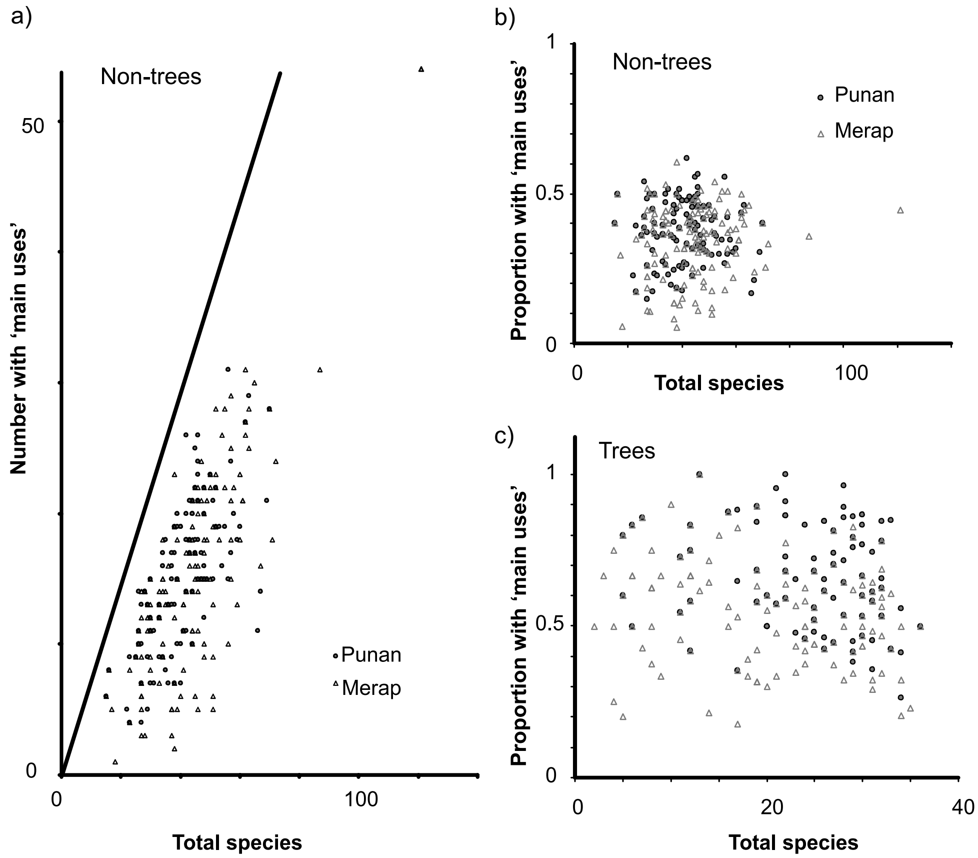


**Figure 5.22** a) Plot species richness versus species use. The line is 1:1. While the number of useful species is closely related to the total number of recorded species, there is no clear relationship between community richness and proportion of species used for either trees or non-trees (see b,c).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




## General conclusions

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

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

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

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

## Fish

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

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

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

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

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

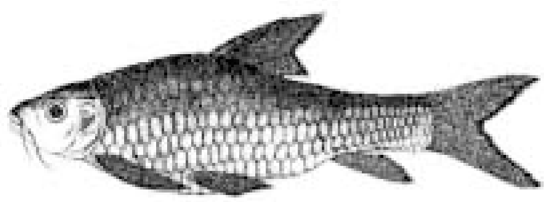
Local informants were able to identify 45 fish species shown to them in pictures. However, small species such as *Pangio anguillaris*, *Parhomaloptera microstoma*, *Protomyzon griswoldi* and *Betta unimaculata* were usually recognised by only the more experienced.

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

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

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

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



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

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

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

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

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

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

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

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

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

Several local species seem to have potential for cultivation: *Osphronemus septemfasciatus, Leptobarbus melanotaenia, Tor* spp, and *Osteochilus* *kahajanensis* (for food); and *Betta unimaculata*, *Puntius* sp, *Puntius sealei, Osteochilus waandersii,* and *Rasbora* spp. (as ornamentals). However, the practicality of such developments has not been assessed.

### Reptiles and amphibians

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

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

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

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

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

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

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

## *Wildlife survey*

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

### Mammals

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

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

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

### Birds

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

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

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

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

### Invertebrates

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

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

### Ecological processes

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

The data presented in this wildlife study provide baseline information against which subsequent data collected from the sites after logging may be compared. While the three study sites were relatively similar in their faunal composition, some significant differences in species composition and richness were observed between the CNV, RIL, and control areas. These differences may be the result of different site attributes. Post-logging comparisons are liable to be confounded by such differences.

## *Review of fauna sensitivity*

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

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

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

### Literature availability

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

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

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

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

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

A total of 29 of the 80 mammal species potentially found in the area were reviewed. Of these species the ecology of 41% can be considered 'well known' and 38% 'moderately known'. Many of these species have a role in seed dispersal and forest regeneration.

## Expert input

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

## Birds

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

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

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

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

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

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

## Mammals

### *Primates*

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

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

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

### *Squirrels*

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

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

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

### *Civets*

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

### *Forest ungulates*

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

### *Mammal research suggestions*

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

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

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

## Amphibians

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

Amongst the 83 species of frogs identified at Bulungan, two assemblages are readily differentiated, with little overlap in species composition: riparian and non-riparian. Forty-one species are associated with streamside environments, 39 do not breed in, or spend their adult life near streams, and three species are incompletely known. Not all 41 species of the riparian environment are wholly restricted to this zone (Inger personal communication). One, *Pseudobufo subasper*, is aquatic. Seventeen species breed and feed along streams and are thus fully restricted to this environment. An additional 22 species breed in streams or in rock pools at the sides of streams, but spread widely through the forest and apparently spend their post-metamorphic stage and much of the remainder of their lives away from flowing water. The last species, *Barbourula kalimantanensis,* is found along stream banks, but its exact breeding site is unknown. Among the non-riparian frogs, 31 species require pools or ponds to lay their eggs. Four species require treeholes and three require swamps or seepages. Only *Philautus mjobergi* lays its eggs directly on the forest floor, omitting an aquatic larval stage.

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

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

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

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

### *Research suggestions*

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

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

## Conclusion

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

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

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